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Beyond One-Size-Fits-All

Toward a Context-Sensitive Framework for Prevention, Diagnostics, and Treatment of Posttraumatic Stress Disorder

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Abstract

The exposure to trauma is highly prevalent. Importantly, traumatic events vary in terms of type and severity (e.g., man-made versus accidental trauma), duration and frequency of exposure. Following trauma exposure, it is evident that trauma survivors exhibit a wide range of posttraumatic responses, from minimal or transient symptoms to persistent and severe psychopathology, including posttraumatic stress disorder (PTSD). Contemporary models assume that these trajectories reflect a complex interplay of risk and protective factors shaping posttraumatic processing, particularly the encoding, consolidation and retrieval of trauma memories. Memory processes constitute a core mechanism in prominent aetiological accounts of PTSD and have directly informed the development of trauma-focused psychotherapies (TFP), as well as secondary preventive approaches targeting early post-trauma memory processing. Similarly, standardised PTSD assessment tools primarily operationalise core symptom dimensions that are hypothesised to result from maladaptive trauma memory processing. Both diagnostic assessment tools and TFP are supported by robust empirical evidence and are therefore widely recommended in various global contexts. However, much of the evidence base reflects average effects and may not capture clinically relevant variability in cross-context feasibility, diagnostic equivalence and treatment response adequately. This suggests that one-size-fits-all approaches focused on symptoms and disorders are unlikely to be adequate or valid for all individuals, contexts, and posttraumatic stages. These limitations become more urgent in the context of global crises (e.g., global pandemics, economic insecurity and geopolitical instability), which increase displacement and migration, and which may further elevate trauma exposure and PTSD risk, while also increasing contextual heterogeneity within service settings. Accordingly, two priorities emerge: (i) strengthening the cross-context equivalence of PTSD assessment (e.g., across language and culture), and (ii) improving prevention and treatment for individuals who differ in terms of their linguistic, cultural, and structural contexts. The present dissertation addresses these gaps by integrating findings from four studies on the prevention of PTSD, its diagnostic assessment, and its treatment within a novel framework of context-sensitive trauma care mapped onto a posttraumatic continuum.

In *Study 1*, we conducted a systematic review of experimental studies investigating whether sleep or wakefulness following analogue trauma reduces intrusive re-experiencing. Both conventional and individual participant data (IPD) meta-analyses were used, taking into account methodological and contextual moderators. The findings provided evidence for a small effect favouring sleep over wakefulness (log-ROM = 0.25, $p < .001$), suggesting that sleep is

associated with fewer intrusions, but not with the occurrence of intrusions versus no intrusions. No evidence was found for an effect of sleep on intrusion distress (log-ROM = 0.09, p = .522). The findings from *Study 1* suggest that sleep following analogue trauma could be protective, as it reduces the frequency of intrusions. Further research is required to determine its impact following real-world trauma and establish its clinical significance. In order to apply these findings to real post-traumatic contexts, it is crucial that individuals are able to sleep after experiencing trauma. Therefore, contextual factors such as safety, stability, and opportunities for rest must also be considered prerequisites for sleep-focused prevention strategies in future clinical research.

Study 2 examined the cross-linguistic and cross-cultural comparability of the German and Arabic versions of the PTSD checklist for DSM-5 (PCL-5) using measurement invariance testing. In a heterogeneous sample (n = 283 German; n = 295 Arabic), Arabic-speaking participants reported nearly twice as many (predominantly man-made) traumatic events and showed higher PCL-5 scores than the German subsample, which reported fewer, mainly accidental, events. Internal consistency was excellent (Cronbach's α = .96), and confirmatory factor analyses (CFA) showed good model fit, favouring the Anhedonia and Hybrid models. Multi-group confirmatory factor analyses (MGCFA) supported configural, metric and threshold invariance, underscoring the conceptual robustness across both language versions. However, scalar invariance could not be established, indicating differential item functioning between the Arabic and German versions of the PCL-5. Differences in item intercepts could lead to divergent PCL-5 sum scores even when latent PTSD severity is equivalent. This limits the comparability of PCL-5 sum scores between the Arabic and German versions and highlights the need for context-sensitive diagnostics.

Studies 3 and *4* investigated moderate-intensity aerobic exercise training (MAET) as an adjunct to narrative exposure therapy (NET) for traumatised refugees and asylum seekers in Germany. *Study 3* describes the randomised controlled trial (RCT) protocol, including the rational, design, randomisation, intervention arms, and outcomes. *Study 4* reports preliminary pre-post data (t_0–t_1) on general psychological distress, PTSD symptom severity, depressive symptoms, and sleep quality. This data was analysed using multilevel and Bayesian models as well as exploratory moderator analyses, to account for variability in treatment response. A significant improvement in symptom severity was observed following NET across all outcomes, whereas MAET did not enhance primary symptom reduction beyond NET. Preliminary findings indicated reduced dropout rates in the NET+ group, thereby suggesting the potential benefits of MAET for therapy

implementation. The moderator analyses indicate context-dependence of the adjunct effects, which is particularly evident in less improvement in PTSD severity among subjects with a temporary residence permit (≤3 years) in the NET^{+} group ($\beta = -17.10$, $t = -2.77$, $p = .011$). Thus, *Study 4* suggests that TFP, particularly NET, which targets memory-related mechanisms in PTSD, remains the preferred treatment for refugees with PTSD. The incremental benefit of MAET is uncertain and appears to be context-dependent. Accordingly, *Studies 3* and *4* support an integrative approach that retains TFP as the baseline treatment for PTSD, with adjuncts considered only if context-sensitive.

In response to concerns that one-size-fits-all approaches inadequately capture the heterogeneity of posttraumatic trajectories / PTSD and the individual needs of patients, this dissertation emphasises that optimising post-trauma care requires an integrative, context-sensitive approach. The findings from present studies on early secondary prevention, diagnostic assessment and treatment converge on the view that improving clinical precision and effectiveness requires a joint consideration of mechanism-relevant processes, especially trauma-memory processing, and the linguistic, cultural and structural context conditions. Notably, the included studies do not experimentally isolate mechanisms of action; rather, they provide a coherent empirical basis that will inform future research investigating how posttraumatic mechanisms and contextual determinants interact to shape outcomes. Although the studies examined prevention, assessment and treatment separately, their findings can be integrated along the post-traumatic timeline and consolidated into a stage-based perspective on the course of post-traumatic symptoms and adaptation processes. Accordingly, the dissertation lays the groundwork for longitudinal research approaches by systematically mapping risk profiles, symptom trajectories, and treatment responses over time. These will ultimately enable more precise answers to be found to the question of which intervention works best for whom and when. To facilitate translation into routine care, future research should combine heterogeneity-sensitive designs (e.g., adaptive multi-arm trials) with clinically feasible, repeated monitoring of dynamic risk and protective profiles. In clinical practice, staging frameworks can provide a pragmatic analogue to such experimental monitoring, thereby supporting adaptive and individualised treatment decisions. Overall, the dissertation highlights practical and empirical considerations for context-sensitive post-trauma care and points to ways of better connecting clinical research with clinical practice.

Zusammenfassung

Traumatische Ereignisse sind hochprävalent. Gleichwohl variieren traumatische Ereignisse substanziell in Bezug auf deren Art und Schweregrad (z. B. „man-made" versus akzidentelle Traumata), deren zeitliche Ausdehnung sowie der Häufigkeit und Wiederholung der Exposition. Entsprechend variieren auch posttraumatische Verläufe. Die Symptome reichen von einer minimalen, vorübergehenden traumabezogenen Belastung bis hin zu anhaltenden, schweren psychischen Erkrankungen wie der Posttraumatischen Belastungsstörung (PTBS). Gegenwärtige Modelle gehen davon aus, dass posttraumatische Verläufe durch ein komplexes Zusammenspiel von Risiko- und Schutzfaktoren bedingt sind, die die posttraumatische Verarbeitung, insbesondere die Kodierung, Konsolidierung und den Abruf traumatischer Erinnerungen, beeinflussen. Diese Gedächtnisprozesse stellen einen zentralen Mechanismus in prominenten Ätiologiemodellen von PTBS dar. Sie bilden die Grundlage für die Entwicklung der traumafokussierten Psychotherapie (TFP) sowie für sekundäre Präventionsansätze, die auf die Verarbeitung von Erinnerungen unmittelbar nach einem Trauma abzielen. Ebenso operationalisieren standardisierte Testverfahren zur diagnostischen Beurteilung von PTBS in erster Linie zentrale Symptomdimensionen, von denen angenommen wird, dass sie unteranderem aus der maladaptiven Gedächtnisverarbeitung der traumatischen Erfahrung resultieren. Sowohl diagnostische Testverfahren als auch TFP werden durch solide empirische Belege gestützt und werden daher weltweit für die Anwendung in verschiedenen Kontexten empfohlen. Jedoch basieren viele der vorliegenden Erkenntnisse auf durchschnittlichen Effekten und spiegeln möglicherweise klinisch relevante Unterschiede in Bezug auf die kontextübergreifende Durchführbarkeit, diagnostische Äquivalenz und das Ansprechen auf die Behandlung nicht angemessen wider. Demnach sind symptom- oder störungsfokussierte „One-Size-Fits-All"-Ansätze möglicherweise nicht für alle Betroffenen, Kontexte und posttraumatischen Phasen gleichermaßen adäquat oder valide. Diese Einschränkungen werden im Kontext globaler Krisen (z. B. globale Pandemien, wirtschaftliche Unsicherheit und geopolitische Instabilität) umso dringlicher zu adressieren, da diese Krisen mit vermehrten Flüchtlingsbewegungen und Migration einhergehen. Hierdurch werden das Risiko für Traumata und PTBS zusätzlich erhöht, während gleichzeitig die Diversität innerhalb selektiver Versorgungsstrukturen steigt. Daraus ergeben sich zwei Handlungsschwerpunkte: (i) die Stärkung der kontextübergreifenden Gleichwertigkeit bei der diagnostischen Beurteilung von PTBS (z. B. über Sprach- und Kulturgrenzen hinweg) und (ii) die Verbesserung der Prävention und Behandlung von Betroffenen, wobei sprachliche, kulturelle und strukturelle Kontexte berücksichtigt werden. Die vorliegende Dissertation begegnet diesen Optimierungsbedarfen,

indem sie Ergebnisse aus vier Studien zur Prävention von PTBS, ihrer diagnostischen Beurteilung und ihrer Behandlung in einen innovativen Rahmen kontextsensitiver Traumaversorgung entlang eines posttraumatischen Kontinuums integriert.

Die *Studie 1* ist eine systematische Übersichtsarbeit, die experimentelle Studien integriert, in denen geprüft wurde, ob Schlaf oder Wachheit nach einem analogen Trauma das intrusive Wiedererleben reduziert. Es wurden sowohl eine klassische als auch eine Metaanalyse auf Basis der individuellen Patientendaten (IPD) relevanter Primärstudien durchgeführt, wobei methodische und kontextuelle Moderatoren der Studien berücksichtigt wurden. Die Ergebnisse lieferten Hinweise auf einen geringen Effekt zugunsten des Schlafes gegenüber posttraumatischer Wachheit (log-ROM = 0.25, $p < .001$). Demnach ist Schlaf mit weniger Intrusionen verbunden. Es gibt jedoch keinen Hinweis darauf, dass Schlaf mit dem Auftreten von Intrusionen im Vergleich zu keinem Auftreten von Intrusionen assoziiert ist. Außerdem zeigte sich kein Zusammenhang zwischen dem posttraumatischen Schlaf und der intrusionsbedingten Belastung (log-ROM = 0.09, $p = .522$). Insgesamt deuten die Ergebnisse von *Studie 1* darauf hin, dass posttraumatischer Schlaf eine schützende Wirkung haben könnte, da er die Häufigkeit von Intrusionen nach analogem Trauma verringert. Weiterführende Forschungsarbeiten sind erforderlich, um die Bedeutung dieser Erkenntnisse für die klinische Praxis zu ermitteln und ihre Auswirkungen nach einem realen Trauma zu bestimmen. Um diese Erkenntnisse auf reale posttraumatische Kontexte anzuwenden, ist es entscheidend, dass die Betroffenen nach einem Trauma in der Lage sind zu schlafen. Daher müssen kontextuelle Faktoren wie Sicherheit, Stabilität und Ruhemöglichkeiten ebenfalls als Grundvoraussetzungen für schlafbezogene Präventionsstrategien in zukünftiger klinischer Forschung berücksichtigt werden.

Studie 2 untersuchte die sprach- und kulturübergreifende Kompatibilität der deutschen und arabischen Version der „PTSD-Checklist for DSM-5“ (PCL-5) unter Verwendung von Messinvarianz-Analysen. Aus der untersuchten Stichprobe ($n = 283$ Deutsch; $n = 295$ Arabisch) berichteten die arabischsprachigen Teilnehmenden fast doppelt so viele, vorwiegend „man-made“ traumatische Ereignisse erlebt zu haben im Vergleich zu den deutschsprachigen, die von weniger und eher akzidentellen Traumata berichteten. Die arabischsprachigen Teilnehmenden wiesen außerdem höhere Summenwerte im PCL-5 auf. Die interne Konsistenz war ausgezeichnet (Cronbachs $\alpha = 0.96$), und die Konfirmatorische Faktorenanalysen (CFA) belegten eine gute Modellanpassung aller getesteter Modelle, wobei das Anhedonie- und das Hybridmodell die Daten am besten abbildeten. Die Multi-Gruppen-Konfirmatorische

Faktorenanalysen (MGCFA) bestätigten die konfigurale, metrische und Schwellenwertmessinvarianz und unterstreichen damit die konzeptionelle Robustheit beider Versionen der PCL-5. Die Skalare Messinvarianz konnte jedoch nicht bestätigt werden, was auf unterschiedliche Item-Funktionen zwischen der arabischen und der deutschen Version des PCL-5 hindeutet. Unterschiede in den „Item-Intercepts“ könnten zu divergierenden PCL-5-Summenwerten führen, selbst wenn der latente Schweregrad der PTBS vergleichbar ist. Dadurch wird die Vergleichbarkeit der PCL-5-Summenwerte zwischen der arabischen und der deutschen Version eingeschränkt und die Bedeutsamkeit sprach-, kultur- und damit insgesamt kontextsensitiver Diagnostik hervorgehoben.

Die *Studien 3* und *4* untersuchten die Durchführbarkeit und Wirksamkeit eines moderaten Ausdauertrainings (MAET) als adjuvante Intervention zur Narrativen Expositionstherapie (NET) bei traumatisierten Geflüchteten und Asylsuchenden in Deutschland. *Studie 3* umfasst das Studienprotokoll der randomisierten kontrollierten Studie (RCT) und berichtet das zugrundeliegende Rational, das Studiendesign, das Randomisierungsverfahren, die Interventionsarme sowie die vorgesehenen primären und sekundären Endpunkte. In *Studie 4* werden vorläufige Daten in einem Prä-Post Vergleich (t_0–t_1) der allgemeinen psychischen Belastung, der Schwere der PTBS-Symptome, der depressiven Symptome und der Schlafqualität mithilfe von Mehrebenen- und Bayes-Analysen sowie explorativen Moderatoranalysen unter Berücksichtigung der Variabilität in der Behandlungsreaktion ausgewertet. Nach Abschluss der NET zeigte sich über alle Endpunkte hinweg eine signifikante Reduktion der Symptomschwere. Ein zusätzlicher Effekt von MAET auf die primäre Symptomreduktion durch NET hinaus ließ sich hingegen nicht nachweisen. Die explorativen Analysen ergaben eine geringere Abbruchquote in der NET^+ Gruppe, woraus sich potenzielle Vorteile von MAET für die Implementierung der Therapie ableiten lassen. Die Moderatoranalysen weisen darüber hinaus auf eine Kontextabhängigkeit des adjuvanten Effekts hin, was sich insbesondere in einer geringeren Verbesserung der PTBS-Symptomschwere bei Teilnehmenden mit einer befristeten Aufenthaltsgenehmigung von ≤ 3 Jahren in der NET^+ Gruppe zeigt ($\beta = -17.10$, $t = -2.77$, $p = .011$). Damit deutet *Studie 4* darauf hin, dass traumafokussierte, Mechanismen orientierte Psychotherapie, insbesondere die NET, für Geflüchtete mit PTBS weiterhin als bevorzugter Behandlungsansatz anzusehen ist. Ein inkrementeller Zusatznutzen von MAET bleibt hingegen unklar und scheint von kontextuellen Bedingungen abzuhängen. Folglich stützen die *Studien 3* und *4* einen integrativen Ansatz, der

traumafokussierte Psychotherapie als Basisbehandlung der PTBS beibehält und adjuvante Interventionen nur dann vorsieht, wenn diese kontextsensitiv konzipiert sind.

In Anbetracht der vorgebrachten Kritik, dass „One-Size-Fits-All“-Ansätze die Heterogenität posttraumatischer Verläufe bzw. der PTBS und die individuellen Bedürfnisse der Betroffenen nur unzureichend abbilden, gelangt diese Dissertation zu dem Schluss, dass eine Optimierung der posttraumatischen Versorgung einen integrativen, kontextsensitiven Ansatz erfordert. Die Befunde der vorliegenden Studien zur frühen Sekundärprävention, Diagnostik und Behandlung konvergieren in der Auffassung, dass eine Optimierung der klinischen Präzision und Effektivität einer simultanen Berücksichtigung von Mechanismus relevanten Prozessen, insbesondere der Verarbeitung traumabezogener Erinnerungen, sowie sprachlicher, kultureller und struktureller Kontextbedingungen bedarf. Es ist zu betonen, dass die eingeschlossenen Studien keine Wirkmechanismen untersuchen. Vielmehr liefern sie eine kohärente empirische Grundlage, die künftige Forschung dazu anregen kann, zu untersuchen, wie posttraumatische Prozesse und kontextuelle Determinanten interagieren und posttraumatische Verläufe beeinflussen. Trotz der selektiven Ausrichtung der Studien auf Prävention, Diagnostik und Behandlung lassen sich ihre Befunde entlang der posttraumatischen Zeitachse integrieren und zu einer stadienbezogenen Perspektive auf den Verlauf posttraumatischer Symptome und Anpassungsprozesse verdichten. Damit legt die Dissertation eine Grundlage für longitudinale Forschungsansätze, indem sie Risikoprofile, Symptomverläufe und Behandlungsreaktionen über die Zeit hinweg systematisch abbildet. Dies ermöglicht eine präzisere Beantwortung der Frage, welche Intervention für wen und zu welchem Zeitpunkt am effektivsten ist. Zukünftige Forschung sollte sich daher darauf konzentrieren, die Translation in die Routineversorgung zu erleichtern, indem sie heterogenitätssensitive Studiendesigns (z.B. adaptive Multi-Arm-Studien) mit klinisch implementierbarem, kontinuierlichem Monitoring dynamischer Risiko- und Schutzprofile kombiniert. In der klinischen Praxis bieten sich „Staging-Frameworks“ als pragmatisches Analogon zu einem solchen experimentellen Symptommonitoring an, mit dem adaptive sowie individualisierte Therapieentscheidungen unterstützt werden können. Insgesamt hebt die Dissertation praxisrelevante und empirisch fundierte Aspekte einer kontextsensitiven posttraumatischen Versorgung hervor und diskutiert Möglichkeiten, die klinische Forschung stärker mit der klinischen Praxis zu verzahnen.

List of Manuscripts

The present dissertation is based on four manuscripts. *Study 1*, *Study 2*, and *Study 3* have been published in international peer-reviewed journals. *Study 4* is currently being prepared for submission to an international peer-reviewed journal. I am the first author of *Studies 2*, *3*, and *4*, and the second author of *Study 1*. All co-authors have contributed to the respective manuscripts and are listed in the corresponding publications. All manuscripts are reproduced in full in this dissertation with the consent of the co-authors. Including the published articles complies with the copyright regulations of the respective publishers. Any minor deviations from the published versions are limited to formatting and harmonising the citation style. In particular, the references are not reproduced separately for each manuscript but are compiled in a single consolidated reference list at the end of the dissertation.

Study 1

Schäfer, S. K., Lüder, C. C., Porcheret, K., Hu, X., Margraf, J., Michael, T., Holmes, E. A., Werner, G. G., Wilhelm, I., Woud, M. L., Zeng, S., Friesen, E., Haim-Nachum, S., Lass-Hennemann, J., Lieb, K., Kunzler, A. M., Wirth, B. E. & Sopp, M. R. (2023). To sleep or not to sleep, that is the question: A systematic review and meta-analysis on the effect of post-trauma sleep on intrusive memories of analog trauma. Behaviour Research and Therapy, 167, 104359. DOI 10.1016/j.brat.2023.104359

Study 2

Lüder, C. C., Equit, M., Becker, N., Schönfelder, A., Glaesmer, H., Nesterko, Y., & Michael, T. (2025). Crossing cultural barriers: an initial cross-cultural validation of the Arabic compared to the German version of the Posttraumatic Stress Disorder Checklist for DSM-5 using multi-group confirmatory factor analysis. European Journal of Psychotraumatology, 16(1), 2565898. DOI 10.1080/20008066.2025.2565898

Study 3

Lüder, C. C., Michael, T., Lass-Hennemann, J., Schanz, C. G., Venhorst, A., Meyer, T., & Equit, M. (2023). Moderate-intensity aerobic exercise training as an adjunct to trauma-focused psychotherapy in traumatized refugees and asylum seekers: study protocol of a randomized controlled trial. European Journal of Psychotraumatology, 14(2), 2251777. DOI 10.1080/20008066.2023.2251777

Study 4

Lüder, C. C., Michael, T., Venhorst, A., Meyer, T., & Equit, M. (2025). Moderate-intensity aerobic exercise training as an adjunct to trauma-focused psychotherapy in traumatized refugees and asylum seekers: study protocol of a randomized controlled trial. In Preparation.

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List of Abbreviations

AIC	Akaike information criterion
AG	actigraphy
APA	American Psychiatric Association
APT	adaptive platform trial
BDNF	brain-derived neurotrophic factor
BF	bayes factor
BIC	Bayesian information criterion
BSCL	Brief Symptom Checklist
CAPS-5	Clinician-Administered PTSD Scale for DSM-5
CBC	complete blood count
CD	Cook's distance
CFA	confirmatory factor analysis
CFI	comparative fit index
CI	confidence interval
COVRATIO	covariance ratio
CPET	cardiopulmonary exercise testing
CPTSD	complex posttraumatic stress disorder
C-reps	contextualized representations
DSM-5	Diagnostic and Statistical Manual of Mental Disorders (5th ed.)
ECG	electrocardiogram
FCS	fully conditional specification
FIML	full information maximum likelihood
GRADE	Grading of Recommendations, Assessment, Development and Evaluations
HAMD	Hamilton Depression Scale
HPA	hypothalamic–pituitary–adrenal (axis)
HSCL-25	Hopkins Symptom Checklist-25
ICC	intraclass correlation coefficient
ID	intrusion distress
IES-R	Impact of Events Scale-Revised
IF	intrusion frequency

IPD	individual participant data
ITT	intention-to-treat principle
LEC-5	Life Events Checklist for DSM-5
LMM	linear mixed-effects models
MAET	moderate-intensity aerobic exercise training
MAR	missing at random
MGCFA	multi-group confirmatory factor analysis
NET	narrative exposure therapy
NICE	National Institute for Health and Care Excellence
npRCT	nested-precision randomized controlled trial
OR	odds ratio
PCL-5	Posttraumatic Stress Disorder Checklist for DSM-5
PSQI	Pittsburgh Sleep Quality Index
PTSD	posttraumatic stress disorder
RCT	randomized controlled trial
REM	rapid-eye-movement (sleep)
REML	restricted maximum likelihood
RMSEA	root mean square error of approximation
ROC	receiver operating characteristic
SCID-5-CV	Structured Clinical Interview for DSM-5 – Clinician Version
SES	socioeconomic status
SMART	sequential multiple assignment randomized trial
S-reps	sensory-bound representations
SRMR	standardized root mean square residual
TFP	trauma-focused psychotherapy
TLI	Tucker-Lewis index
VA/DoD	(U.S.) Department of Veterans Affairs and Department of Defense
WAEC	War and Adversity Exposure Checklist
WHO	World Health Organization
WLSMV	weighted least square mean and variance

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"The good physician [therapist] treats the disease;

the great physician [therapist] treats the patient who has the disease."

— Sir William Osler 1849–1919
(as cited in Luz, 2019)

1. Introduction

In contrast to most psychiatric diagnoses, posttraumatic stress disorder (PTSD) is explicitly anchored to exposure to a qualifying traumatic event (Criterion A; American Psychiatric Association [APA], 2022), thereby linking the symptom syndrome to an identifiable external precipitant. Leading cognitive and information-processing models propose that PTSD symptoms persist when the traumatic experience is insufficiently integrated into autobiographical memory and instead remains represented in vivid, sensory, easily cue-triggered form (e.g., Brewin et al., 2010; Ehlers & Clark, 2000; Foa & Kozak, 1986). Prospective and experimental findings support the relevance of trauma-memory processing and characteristics for subsequent PTSD symptoms (e.g., Halligan et al., 2003), which has contributed to the conceptualisation of PTSD as a memory-related disorder (van Marle, 2015). At the same time, trauma-memory processing is strongly shaped by contextual factors, including characteristics of the traumatic exposure itself. Traumatic events vary substantially in type, duration, and repetition, reflecting trauma complexity (Cloitre et al., 2009). Correspondingly, trauma type is closely linked to subsequent symptom profiles and PTSD risk (Kessler et al., 2017). Beyond event characteristics, additional contextual risk and protective factors are thought to interact with peri- and posttraumatic memory processes, thereby influencing posttraumatic trajectories and, in particular, PTSD risk and symptom complexity (e.g., Cloitre et al., 2009; Vallières, Hyland, & Murphy, 2021). However, this complex interplay is not yet fully understood (Tortella-Feliu et al. 2019; Vallières, Hyland & Murphy, 2021). Over the past decades, substantial evidence has emerged regarding the assessment and psychotherapeutic treatment of PTSD, leading to substantial advances in trauma-related mental health care (see Burback et al., 2024 for a "state-of-the-art review"). Standardised diagnostic instruments, that reliably capture the core symptom dimensions of PTSD showed good psychometric properties (e.g., Blevins et al., 2015; Weathers et al., 2018). Moreover, trauma-focused psychotherapy (TFP) that directly targets memory-related mechanisms of trauma processing has been shown to achieve clinically meaningful reductions in symptoms on average in controlled trials (Lewis et al., 2020). Thus, it is recommended as a first-line treatment for PTSD (APA, 2024). However, considerable inter-individual variability has been observed in both measurement accuracy (e.g., McDonald & Calhoun, 2010) and treatment response (Herzog & Kaiser, 2022). This heterogeneity calls into question the appropriateness of one-size-fits-all approaches to PTSD assessment, prevention, and treatment (e.g., Cloitre et al., 2015). Consequently, the key question is no longer whether assessments and interventions work on

average, but rather for whom and under which contextual conditions. Current debates on context-sensitive, precision-focused, and personalised mental health care (Moggia et al., 2024) reflect this conceptual shift. This has led to the creation of integrative frameworks that recognise and explicitly incorporate heterogeneity into the design and evaluation of posttraumatic care (Bryan et al., 2021; Herzog & Kaiser, 2022). In particular, a systematic investigation of risk and protective factors, as well as a needs assessment, is required to inform the context- sensitive adaptation of diagnostic assessment and prevention and treatment approaches, and their subsequent implementation and integration into routine clinical practice. This dissertation builds on these implications, contributing to a research agenda aimed at improving the accuracy of PTSD assessment, as well as the efficacy and real-world effectiveness of prevention and treatment. The subsequent chapter offers a comprehensive overview of the theoretical and empirical background to this research. The first section introduces the concepts of trauma and PTSD, illustrating their relevance using key prevalence findings. The subsequent section outlines aetiological frameworks, paying particular attention to contextual risk and protective factors and trauma-related memory processes in the development and trajectory of PTSD. Current approaches to diagnostics, treatment and (secondary) prevention are then reviewed and evaluated in terms of diagnostic accuracy, efficacy in prevention and treatment, and clinical effectiveness across different populations and settings. The chapter concludes by identifying key research gaps and setting out the aims of the present dissertation.

1.1. General Theoretical Background on Trauma and Posttraumatic Stress Disorder

1.1.1. Traumatic Events

The term ‘trauma’ is derived from the Greek word “τραῦμα”, meaning wound (Liddell & Scott, 1968). Thus, in a medical context, trauma refers specifically to intensive physical harm to the organism caused by an injurious event. Within everyday discourse, the term trauma is broadly used to describe a wide range of exposure to distressing events, including experiences such as separations and bullying (Ehring & Kunze, 2021), which often elicit a general stress response. However, in the field of psychology and psychotherapy, the definition of trauma is more narrowly specified. According to the Diagnostic and Statistical Manual of Mental Disorders, 5th Edition (DSM-5; APA, 2022), trauma is defined as exposure to actual or threatened death, serious injury, or sexual violence, which may occur through direct experience,

witnessing such events, or being informed that they have occurred to close others. In accordance with this, traumatic events can range widely in terms of their type. The classification of traumatic events developed by Terr (1991; 2003) and Herman (1992) is a comprehensive framework that considers this variance in traumatic events by using quantitative (frequency and duration: type I vs. type II) and qualitative criteria (cause: interpersonal/ "man-made" vs. accidental). On the quantitative scale, type I trauma is defined as a single, brief traumatic event, while type II trauma is characterised by multiple or prolonged traumatic event(s) (Herman, 1992). On the qualitative scale, trauma can be categorised as accidental or interpersonal. According to the literature, accidental trauma is attributed to unintentional or natural causes, including severe traffic accidents, occupational hazards in high-risk professions (e.g., firefighting, police, emergency medical services) and natural disasters such as fires, earthquakes, and floods. In contrast, interpersonal trauma is characterised by deliberate human actions intended to cause harm to others, including physical or sexual violence, abuse, war crimes, torture, and other forms of intentional victimisation (Terr, 2003; see also Maerker & Michael, 2013).

1.1.2. Posttraumatic Stress Disorder

PTSD is classified in the DSM-5 as a trauma- and stressor-related disorder characterised by persistent disturbances in cognitive, emotional, and behavioural functioning that last for more than one month following exposure to a traumatic event (APA, 2022). Thus, experiencing a traumatic event is the essential prerequisite for developing PTSD and is the primary criterion that distinguishes it from other stress-related and anxiety disorders (APA, 2022). At the symptom level, PTSD is most prominently characterised by re-experiencing the traumatic event, which can manifest in various forms. Intrusive re-experience of the traumatic event usually manifests as brief, involuntary memories of the traumatic event (Brewin, 2014; Michael et al., 2005) and is typically accompanied by intense physiological and emotional stress reactions (Iyadurai et al., 2019). Posttraumatic intrusions may occur multimodally, with visual forms being the most prevalent (Hackmann et al., 2004). Furthermore, nightmares represent a form of re-experiencing that occurs at a more subliminal level (Germain, 2013; Nappi et al., 2016). The re-experiencing of trauma with a pronounced "here-and-now" quality, in which individuals perceive or behave as if the event were happening again, is referred to as dissociative re-experiencing or "flashbacks". Such episodes can range from a partial disruption of thoughts and perceptions to, in severe cases, a near-complete loss of awareness (APA, 2022).

In essence, trauma-related stimuli (whether internal or external) function as triggers for the manifestation of re-experiencing. Moreover, due to a compromised ability to temporally and spatially contextualize traumatic memories, re-experiencing cannot be attributed to these trauma-related triggers (Brewin et al., 2010; Michael et al., 2005). Consequently, re-experiencing symptoms are perceived as a real and immediate threat. (Brewin, 2001; Ehlers & Clark, 2000; Ehlers et al., 2002). Thus, the confrontation with internal and external trauma-related stimuli lead to intense and persistent psychological and physical stress reactions. Against this background, avoidance is a central, albeit maladaptive, way of managing the perceived threat and is thus a characteristic symptom of PTSD in itself. Individuals diagnosed with PTSD typically avoid stimuli that are associated with the trauma or trigger a strong stress response (APA, 2022). These stimuli may include situations, activities, places, objects, memories, cognitions, and emotions that are either directly associated with the trauma or resemble trauma-related cues through processes of stimulus generalisation. According to Ehlers and Clark (2000), avoidance (behaviour) is a particularly central symptom of PTSD, as it prevents the disconfirmation of threat-related appraisals, reinforces the cycle of distress, and thereby contributes substantially to the persistence of the disorder (see Chapter 1.1.5). Negative alterations in cognition and affect play a pivotal role in the maintenance of PTSD. These symptoms encompass difficulties in consciously recalling aspects of the traumatic event, as well as pervasive negative cognitions that extend beyond the trauma itself and promote a persistently negative view of the self, others, and the world. Such distorted cognitions frequently concern the causes and consequences of the trauma, particularly issues of responsibility, and are commonly accompanied by pronounced feelings of guilt and shame (e.g., Ehlers & Clark, 2000). Together, these cognitive and emotional disturbances contribute to negative affect (Liu et al., 2014; Tsai et al., 2014). At the same time, a persistent inability to experience positive emotions, often referred to as anhedonia, constitutes another symptom of PTSD (Liu et al., 2014; Tsai et al., 2014). It is typically characterised by a marked loss of interest in previously rewarding activities, social withdrawal, and a pronounced sense of detachment or estrangement from others. A heightened attention to potential threat further reinforces a persistent sense of danger and exacerbates symptoms of chronic hyperarousal, which can manifest as hypervigilance and exaggerated startle responses (anxious arousal; Liu et al., 2014; Tsai et al., 2014). This is often accompanied by symptoms of dysphoric arousal, including concentration problems and sleep disturbances (Liu et al., 2014; Tsai et al., 2014). Finally, externalising symptoms, such as irritability, risk-taking behaviour, and aggressive behaviour, are frequently observed in PTSD (Tsai et al., 2014).

1.1.3. Prevalences of Trauma and Posttraumatic Stress Disorder

Trauma exposure is highly prevalent worldwide, with approximately 70 % of the population experiencing at least one potentially traumatic event during their lifetime (Benjet et al., 2016; Kessler et al., 2017), with particularly high prevalence over 80% observed among first responders (e.g., Patterson, 2001) and even more elevated in populations in conflict-affected regions[1] (e.g., Blackmore et al., 2020; Kessler et al., 2017, Koenen et al., 2017; Nesterko et al., 2019). In this context the prevalence of trauma exposure is shown to be consistent across men and women (e.g., Tolin & Foa, 2006). On average, individuals report having experienced 4.6 traumatic events and 2.9 different trauma types across their lifetime (Benjet et al., 2016). In general population samples, the most prevalent trauma types are affecting or witnessed in loved ones (35.7%), accidents (34.3%), and unexpected death of a loved one (31.4%). Interpersonally related traumas, such as physical violence (22.9%), intimate partner sexual violence (14.0%), and war-related traumas (13.1%), are reported less commonly (Kessler et al., 2017). The number and type of traumatic events vary across men and women (Langeland & Olff, 2024), with men, generally, reporting a higher prevalence and broader variety of trauma exposure than women (Olff, 2017; Tolin & Foa, 2006). A recent meta-analysis showed that women are significantly more likely than men to be exposed to sexual assault (odds ratio [OR] = 5.99, 95% CI [4.42, 8.93]). In contrast, men are more likely to report accidents (OR = 0.67, 95% CI [0.57, 0.79]), nonsexual assault (OR = 0.62, 95% CI [0.56, 0.69]), combat or war exposure (OR = 0.28, 95% CI [0.18, 0.43]), life-threatening illness or injury (OR = 0.68, 95% CI [0.54, 0.86]), and witnessing death or injury (OR = 0.80, 95% CI [0.72, 0.90]). While 30.5% of the general population report exposure to four or more different traumatic events (Benjet et al., 2016), cumulative exposure to multiple trauma types is particularly common in high-risk occupational groups, such as first responders (Geronazzo et al., 2017) and military personnel (Trautmann et al., 2017). However, the patterns of trauma exposure also differ by profession. Medical personnel are primarily exposed to medically induced trauma, whereas police officers and soldiers are more frequently exposed to interpersonal violence or combat-related trauma. The prevalence of cumulative trauma exposure is particularly pronounced among populations residing in conflict-affected regions. For instance, 86.3% of individuals in these settings report exposure to three or more trauma types (Mahmood et al., 2019). Among displaced populations, particularly those from North Africa and the Middle East, up to 75.7% report histories of interpersonal trauma (Fazel et al., 2005; Nesterko et al., 2019; Quosh et al.,

[1] In this dissertation, the term conflict-affected regions refers to countries and regions affected by armed conflict or protracted political instability, primarily including, Syria, Iraq, Afghanistan, Eritrea, and Ukraine.

2013). Following a traumatic event, approximately 50–80% of survivors develop stress-related symptoms, such as intrusive re-experiencing, negative mood, dissociation, avoidance, hyperarousal, and sleep disturbances, that typically remit over time (Bonanno, 2004; Diamond et al., 2022). Only about 3.9% of the general population, corresponding to 5.6% of trauma-exposed individuals, meet criteria for PTSD (Kessler et al., 2017; Morina et al., 2014). However, prevalence estimates vary substantially as a function of trauma type and population characteristics. The highest PTSD rates are found among individuals exposed to interpersonal trauma, with meta-analytic evidence indicating that around 25% develop PTSD after interpersonal events (e.g., assault or abuse), whereas approximately 10% of those exposed to non-interpersonal or accidental trauma develop PTSD. Women show a higher lifetime prevalence of PTSD (around 10–12%) than men (around 5–6%; Olff, 2017). Moreover, prevalences range from 4.4% to 28% among medical professionals (Sendler et al., 2016), 6.4% to 57% in firefighters (Salleh et al., 2020), and 8.0% to 14.2% in police officers (Brewin et al., 2022; Syed et al., 2020), reaching 1.1% to 34.8% for combat-related PTSD in military personnel (Xue et al., 2015). Individuals residing in conflict-affected regions show almost tenfold higher prevalence rates than the general population, with around 26% of civilian war survivors meeting criteria for PTSD (Morina et al., 2018). Recent studies further indicate that refugees and asylum seekers display similarly elevated PTSD rates, ranging from approximately 31% to 40% (Blackmore et al., 2020; Gäbel et al., 2006; Nesterko et al., 2020). More recently, Bilewicz et al. (2024) reported that 47.5% of forcibly displaced Ukrainian migrants exhibited symptoms consistent with PTSD. These populations with elevated PTSD rate such as individuals in conflict-affected regions, refugees, and high-risk occupational groups not only exhibit a higher prevalence of PTSD itself but are also particularly more vulnerable to complex comorbidity profiles and chronic PTSD courses. In general, PTSD is highly associated with co-occurring psychiatric disorders, including mood, anxiety, and personality disorders, as well as sleep disturbances (Milanak et al., 2019), with comorbid depression being present in more than half of affected individuals (Hoppen et al., 2021). Moreover, PTSD is linked to an increased risk of cardiovascular, metabolic, and musculoskeletal conditions (Ryder et al., 2018) and to markedly elevated suicide risk, particularly when left untreated (Davidson et al., 1991). Women not only show higher PTSD prevalence but also higher rates of comorbid disorders than men (Christiansen & Hansen, 2015). Overall, these patterns underline that trauma exposure, trauma type, and PTSD do not occur in isolation but are embedded in broader constellations of mental and physical health problems. However, the reported estimates are not exhaustive and may not fully capture current trends, as they are influenced by factors such as study design, sampling

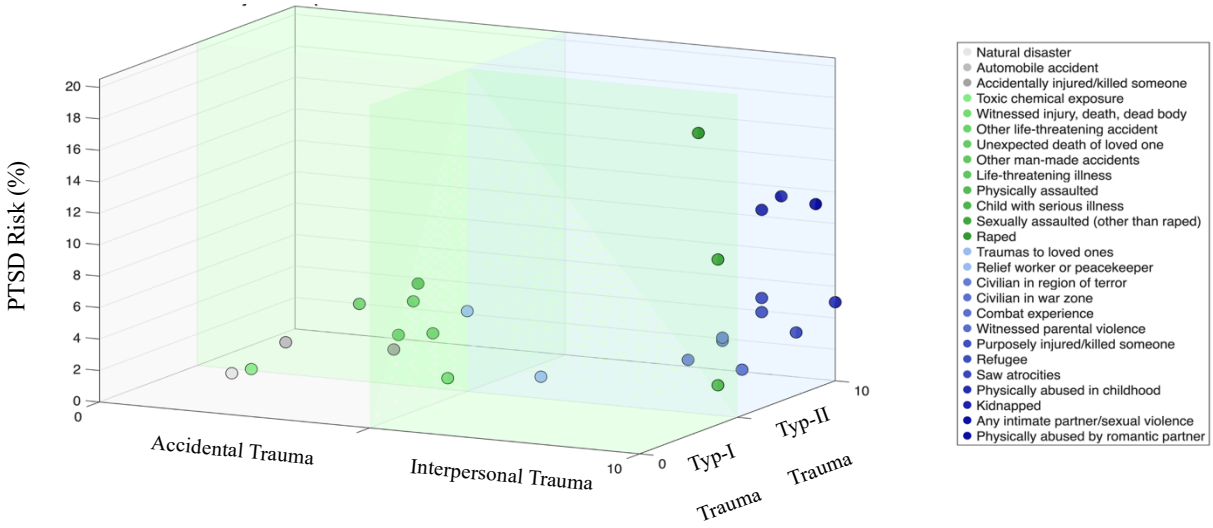
strategies, and temporal context. Consequently, prevalence rates should be interpreted as approximate ranges rather than definitive values.

1.1.4. Risk and Protective Factors on Trauma and Posttraumatic Stress Disorder

The wide variation in prevalence rates and posttraumatic trajectories indicates that individuals differ significantly in their vulnerability to, and recovery from, trauma exposure This has directed increasing attention to risk and protective factors that are hypothesised to essentially shape posttraumatic trajectories (Olff, 2017; Schnyder et al., 2015). As illustrated schematically in Figure 1.1, the conditional risk of developing PTSD is primarily determined by trauma type. Particularly, Figure 1.1 illustrates that PTSD is less likely to develop following single-incident or accidental trauma, such as natural disasters or traffic accidents (Kessler et al., 2017; traumatic events depicted in the light green quadrants in Figure 1.1). In contrast, cumulative or prolonged interpersonal trauma is associated with the highest risk of developing PTSD (Kessler et al., 2017; see traumatic events depicted in the blue quadrant in Figure 1.1). Furthermore, there is a robust correlation between prolonged exposure to trauma, such as repeated abuse or sustained victimisation, and the development of more chronic and severe courses of PTSD (see Figure 1.1).

Figure 1.1

Conditional Risk of PTSD by Trauma Type



Note. Each data point represents a specific traumatic event, coloured grey, green, or blue according to its allocation to one of four trauma-type quadrants. Data points and label terms are adapted from Kessler et al. (2017, Table 3; https://doi.org/10.1080/20008198.2017.1353383). Traumatic events were classified within a four-field framework adapted from Maercker and Augsburger (2019, Table 2.1, p. 16). Two independent raters located each event on two 11-point scales (0–10): one ranging from accidental to interpersonal trauma, and the other from single-incident (Type I) to prolonged or repeated (Type II) trauma. The vertical position of each data point reflects the conditional risk of PTSD associated with that event (in %), with higher positions indicating greater risk. Overall, events located in the blue quadrant are associated with the highest conditional risk of PTSD, followed by events in the two green quadrants (except for "rape"; Kessler et al., 2017), whereas events in the grey quadrant show the lowest risk. The legend on the right indicates that point colour darkens with increasing PTSD risk within each quadrant.

Empirical evidence indicates a dynamic and multifaceted interplay of pre-, peri-, and posttraumatic factors in processing and integrating the traumatic experiences (e.g., Ozer et al., 2003). Pre-traumatic factors encompass predisposing vulnerabilities, including prior adversity, genetic liability, and personality traits. These factors have been shown to influence the likelihood of exposure to trauma and impact subsequent processing of the event. Consequently, these factors have also been demonstrated to impact the risk of developing PTSD (e.g., Breslau et al., 2006). Peri-traumatic factors, defined as occurring during or immediately after a traumatic event, influence how the experience is encoded and interpreted. This has been demonstrated to influence initial stress responses and early adaptation, which are crucial in the development of PTSD. Posttraumatic factors are defined to manifest in the aftermath of a traumatic event, influencing the development of PTSD. Indeed, these factors have been shown to shape vulnerability to PTSD by influencing processes such as information processing and memory consolidation, cognitive reappraisal, coping mechanisms, social support, exposure to ongoing stressors, and access to mental health care. Together, pre-, peri-, and posttraumatic

factors have a significant substantial impact on long-term outcomes, contributing to trajectories that range from recovery to the persistence of psychopathology. To provide a structured overview of these influences, Table 1.1 summarises major risk and protective factors examined in current research, conceptually organised into three domains: biological and neurophysiological factors, environmental and social factors, and psychological and cognitive–emotional factors. Symbols indicate each factor's stage-specific salience (● = primary/most proximal relevance; ○ = secondary/variable relevance). Stage assignment is intended as a heuristic, as many factors can operate across stages.

The following sections prioritise biological and neurophysiological, as well as environmental and social risk and protective factors, because these domains capture context-dependent constraints and resources that systematically contribute to heterogeneity across populations and settings. They therefore offer particularly informative leverage points for context-sensitive adaptation in the prevention, diagnostics, and treatment of PTSD. Psychological and cognitive-emotional risk and protective factors (such as self-efficacy [e.g., Benight & Bandura, 2004], resilience-related constructs [e.g., Bonanno et al., 2004; Fletcher & Sarkar, 2013; Ozer et al., 2003], cognitive flexibility and emotion regulation [e.g., Martin & Rubin, 1995; Bonanno et al., 2013; Sopp et al., 2025]) remain clinically central. In the present framework, however, this domain is conceptualised primarily as a proximal pathway through which biological, neurophysiological and environmental, social risk and protective factors affect posttraumatic outcomes (e.g., Beierl et al., 2019). This domain is included in Table 1.1 to provide a comprehensive overview. Furthermore, psychological and cognitive-emotional risk and protective factors are selectively addressed in the following sections and in the section on aetiological mechanisms and memory processing (Chapter 1.1.5).

Table 1.1 *Risk and Protective Factors for Posttraumatic Stress Disorder*

	References	Pre	Peri	Post
Biological and neurophysiological factors				
Genetic and epigenetic vulnerability	Koenen et al., 2017	●		○
Sex (assigned at birth)	Langeland & Olff, 2024	●	●	●
Age at trauma exposure	Koenen et al., 2017			
Physical health status and somatic comorbidity	Garfin et al., 2018; Silverman et al., 2014; Avdibegovic et al., 2010	●	○	○
Neurobiological sensitivity and physiological stress response	Yehuda, 2002; Heim & Nemeroff, 2009	○	●	●
Neuroendocrine alterations (e.g., HPA-axis alterations)	Yehuda, 2002; Fischer et al., 2021	○	○	●
Neurobiological sensitisation (e.g., amygdala, hippocampal alterations)	Shin et al., 2006; Kremen et al., 2012	○		●
Sleep (e.g., early post-trauma sleep and consolidation)	Diekelmann & Born, 2010; Sopp et al., 2019	○	○	●
Trauma memory processing and integration	Berntsen & Rubin, 2007		●	●
Psychological and cognitive-emotional factors				
Mental health status and psychiatric comorbidity	Brewin et al., 2000; Koenen et al., 2017	●	○	●
Cognitive appraisal & maladaptive beliefs	Ehlers & Clark, 2000; Foa et al., 2006	○	○	●
Coping style (e.g., avoidance, rumination)	Brewin et al., 2000; Ozer et al., 2003	○		●
Resilience (e.g., locus of control, coherence)	Bonanno, 2004; Fletcher & Sarkar, 2013; Schäfer et al., 2019	●		●
Self-concept and identity-related beliefs	Ehlers & Clark, 2000; Ozer et al., 2003	○		●
Self-efficacy	Bandura, 1997; Samuelson, 2017	○		●
Cognitive flexibility	Martin & Rubin, 1995; Troy et al., 2011	○		●
Emotion regulation capacity	Bonanno et al., 2012; Troy et al., 2011	●	○	●
Perceived threat and loss of control	Ozer et al., 2003; Brewin et al., 2000		●	○
Dissociation	Lanius et al., 2010		●	○

Table 1.1 (continued.)

	References	Pre	Peri	Post
Environmental and social factors				
Socioeconomic disadvantage and material hardship	Olff, 2017	●		○
Trauma exposure characteristics	Kessler et al., 2017; Brewin et al., 2000		●	○
Ongoing threat and adversity (secondary stressors)	Silove et al., 1997; Georgiadou et al., 2018	●	○	●
Access to trauma-informed health care	Fazel et al., 2012	○	○	●
Gender-related aspects	Langeland & Olff, 2024	●		●
Cultural context and stigma	Schnyder et al., 2016	●		●
Discrimination and structural barriers	Sibrava et al., 2019	●	○	●
Social support / family support	Wang et al., 2021	○	○	●
Social acknowledgment and social recognition	Maercker & Müller, 2004		○	●

Note. This table provides a non-exhaustive selection of major risk and protective factors for PTSD and organised into three domains: biological and neurophysiological factors, psychological and cognitive–emotional factors, and environmental and social factors. References are provided as illustrative examples of empirical support and are not intended to be exhaustive. Symbols indicate the stage in which each factor is typically most salient (● = primary/most proximal relevance; ○ = secondary/variable relevance). Stage assignment (pre, peri and post trauma) is intended as a heuristic and does not imply strict temporal boundaries.

1.1.4.1. Biological and Neurophysiological Risk and Protective Factors on Trauma and Posttraumatic Stress Disorder

As posited by Garfin et al. (2018), physical and mental health can buffer against prolonged stress reactions and mitigate acute trauma symptoms. Research indicates that physical fitness is crucial for maintaining body awareness and a well-regulated stress response system, both of which act as protective factors against acute stress (Silverman & Deuster, 2014). At a neurobiological level, physical activity has been demonstrated to be associated with increased neurotrophic signalling, including elevated levels of brain-derived neurotrophic factor (BDNF). This may, in turn, support plasticity in fronto-limbic networks that are implicated in stress regulation and extinction learning (see e.g., Crombie et al., 2021). Consistent with this, physical fitness has been linked to emotional stability and resilience-related states and traits, thereby serving as a protective factor against maladaptive stress responses and PTSD (e.g., Childs & de Wit, 2014; Rosenbaum et al., 2015). In contrast, low physical fitness is associated with increased vulnerability to traumatic stress exposure and PTSD, an association partly mediated by anxiety sensitivity, that is defined as the tendency to

interpret bodily anxiety symptoms as threatening (e.g., Marshall et al., 2010). Moreover, physical pain is another factor that mediates the relationship between poor physical fitness and PTSD risk. Recent research has indicated that particularly intense pain during or shortly after trauma exposure is associated with a higher likelihood of subsequent PTSD (e.g., Connor et al., 2020). In a similar vein, chronic pain has been demonstrated to be closely associated with PTSD, with evidence indicating bidirectional influences (e.g., Asmundson et al., 2002). Furthermore, symptoms of posttraumatic stress and, in some cases, PTSD have also been reported in reciprocal relationship to serious and chronic medical conditions, including cardiovascular and cerebrovascular disease (Edmondson et al., 2013; Edmondson & von Känel, 2017), respiratory disorders (e.g., asthma, ; Allgire et al., 2021; chronic obstructive pulmonary disease; Abrams et al., 2015), endocrine disease (e.g., diabetes; Lunkenheimer et al., 2023; Vancampfort et al., 2016), and cancer (Brown et al., 2020; Cordova et al., 2017), particularly when illness onset or acute exacerbations are experienced as life-threatening events. An increased risk of PTSD due to severe and chronic illnesses likely reflects the effects of both disease-related (Edmondson, 2014) and additional treatment-related stressors, such as invasive procedures, repeated hospitalisations, and intensive care (Cyr et al., 2021). Taken together, these findings emphasise that somatic health status and disease burden play a crucial role in shaping both the context of trauma exposure and the physiological substrate on which the psychological trauma response unfold.

Beyond physical health, mental health encompasses risk and protective factors that influence how people perceive, process and recover from traumatic experiences. Accordingly, pre-existing psychiatric conditions, such as anxiety disorders and somatoform disorders, can serve as predictors of an elevated risk of developing PTSD (e.g., Hapke et al., 2005). Moreover, depressive symptoms have been demonstrated to induce sensitisation of the stress response system (cf. Gold, 2014) and may occur prior to and following the onset of PTSD (e.g., Brady et al., 2000; King et al., 2009; Shalev et al., 1998). The co-occurrence of PTSD and depression has been demonstrated to impede the diagnostic process and is associated with a more chronic course of PTSD (Brady et al., 2000). Moreover, pretreatment depression has been shown to reduce treatment efficacy of TFP (e.g., Kline et al., 2021). Beyond depressive disorders, several psychiatric disorders are characterised by heightened stress reactivity, which predisposes individuals to maladaptive responses during and after trauma. This amplifies psychopathology (cf. see the vulnerability-stress models in Ingram & Luxton; 2005) and may impede effective recovery. In line with this, current research shows that acute stress disorder (ASD), a

psychopathological stress response that emerges shortly after trauma, increases the risk of developing PTSD by approximately twenty-fold (Holeva et al., 2001).

Taken together, these findings point to elevated physiological stress reactivity as a key mechanism linking pre-existing physical and mental health conditions to PTSD risk. Empirical findings suggest that chronic stress progressively sensitises the stress-response system, thereby lowering the threshold for exaggerated responses even to minor stressors and increasing baseline vulnerability to PTSD (cf. Lupien et al., 2009). Specifically, the duration and intensity of the physiological stress response during and after trauma have been demonstrated to predominantly influence trauma processing, thereby playing a pivotal role in the development of PTSD (cf. Lupien et al., 2009). Although the acute physiological stress response is generally considered adaptive for immediate survival, evidence indicates that, when excessive or prolonged, it can result in long-term neuroendocrine dysregulation. This, in turn, leads to heightened reactivity to stress and an increased vulnerability to developing PTSD (see Heim & Nemeroff, 2009; Yehuda, 2004). At a neuroendocrine level, heightened cortisol secretion in response to acute or chronic stress has been demonstrated to trigger dysregulation of the hypothalamic–pituitary–adrenal (HPA) axis (Fischer et al., 2021). Acute increases in cortisol have been observed to enhance the HPA axis negative feedback loop, initially enhancing glucocorticoid receptor sensitivity and subsequently leading to lower basal cortisol levels over time. Lower basal cortisol levels have been repeatedly associated with greater PTSD symptom severity across key symptom domains (see Fischer et al., 2021). Furthermore, current findings indicate dysregulation in other neuroendocrine systems as additional contributors to vulnerability to and maintenance of PTSD (e.g., Ravi et al., 2019). These stress-associated neuroendocrine dysregulations frequently manifest at the neurostructural level. Dysregulation of the HPA axis, the most extensively studied neuroendocrine system in the context of PTSD, has been associated with heightened sensitivity and increased activity of the amygdala (see Cacciaglia et al., 2017). These neurobiological alterations have been linked to range of PTSD symptoms (cf. Admon, Milad, & Hendler, 2013), such as hyperarousal, irritability, sleep disturbances, heightened vigilance, and exaggerated fear responses. Moreover, reduced hippocampal volume and a decreased connectivity to the ventromedial prefrontal cortex have been shown in patients with PTSD, and have been linked to impairments in executive and memory functions (cf. Admon et al., 2013; Kremen et al., 2012). Genetically informed twin- and prospective studies suggest that individual neurobiological characteristics (e.g., structural differences such as a smaller hippocampal volume) are present prior to trauma and may

influence PTSD vulnerability after trauma exposure (see Gilbertson et al., 2002; Kremen et al., 2012). At the same time, stress and trauma can trigger synaptic reorganisation in the hippocampus, the amygdala and the prefrontal networks, promoting heightened stress reactivity and trauma memory (cf. McEwen et al., 2016; Pitman et al., 2012). However, the interaction between premorbid characteristics and trauma-associated neuroendocrine and neurostructural modifications over time has not yet been fully clarified (Gilbertson et al., 2002; Pitman et al., 2012; Yehuda, 2002). Thus, conceptual models often assume reciprocal, potentially self-reinforcing feedback processes that may contribute to and maintain maladaptive trauma processing (McEwen, 1998; Pitman et al., 2012). Building on this, it is important to note that trauma- and PTSD-related neurophysiological and neurofunctional changes consistently affect brain regions that are central to memory processing (Elzinga & Bremner, 2002; Pitman et al., 2012; Rauch et al., 2006). Deficits in autobiographical, verbal, and working memory, together with reduced executive control, may bias information processing towards bottom-up responding and facilitate more automatic, cue-driven retrieval of trauma-related memories. This amplifies intrusive re-experiencing (see Brewin, 2011; Harvey et al., 1998; Streb et al., 2016; Sündermann et al., 2013). Dissociation has been demonstrated to disrupt memory integration and has been shown to be strongly associated with intrusive re-experiencing (see Ehlers et al., 2008; Lanius et al., 2010). Beyond the frequency of intrusions, their qualitative characteristics, particularly emotional distress (e.g., Hackmann et al., 2004) and the "here-and-now" quality (Michael et al., 2005), are stronger predictors of PTSD. Intrusive re-experiencing may perpetuate distress, thereby reinforcing neurofunctional dysregulation in a self-sustaining cycle that underlies and maintains maladaptive trauma processing (cf. McNally et al., 2011). Building on this, emerging evidence suggests that sleep may play a crucial role in posttraumatic memory consolidation and emotional regulation. During systems consolidation, memory traces are gradually redistributed from the hippocampus to neocortical networks, with these processes occurring predominantly during slow-wave and rapid-eye-movement (REM) sleep (Diekelmann & Born, 2010; Kleim et al., 2016). While sleep generally facilitates adaptive memory integration, its immediate effects after trauma remain a subject of debate (Diekelmann & Born, 2010, Kleim et al., 2016; Sopp et al., 2019). Some findings suggest that sleep deprivation may reduce implicit fear memory formation (Kuriyama et al., 2010), whereas others indicate that sleep strengthens contextual representations that inhibit intrusive re-experiencing (Bisby & Burgess, 2017; Sopp et al., 2019; Zeng et al., 2021). Experimental studies have corroborated this finding, demonstrating that sleep exerts a modestly positive effect on intrusive re-experiencing (e.g., Kleim et al., 2016). However, there are also contrary findings (e.g.,

Porcheret et al., 2015). Despite the varying evidence base, overall, posttraumatic sleep appears to play a crucial moderating role in the development of PTSD by influencing neurophysiological processes of memory consolidation and emotional regulation. This underscores the importance of examining the risk and protective factors in relation to the various dimensions of PTSD symptoms in a differentiated manner.

Beyond the impact of memory processing and sleep-dependent consolidation on trauma-related symptomatology, individual differences in genetic and epigenetic factors may further modulate susceptibility to PTSD, shaping the neural and cognitive mechanisms underlying risk and resilience. Genetic predispositions modulate neurobiological stress sensitivity, indirectly affecting PTSD vulnerability. Furthermore, epigenetic modifications have been demonstrated to render environmental influences susceptible to altered gene expression, modulating the risk of developing PTSD (Mehta and Binder, 2012, Khan et al., 2025). Transgenerational trauma has been identified as a relevant risk factor on trauma and PTSD with a considerable epigenetic component (e.g., Youssef et al., 2018). Evidence suggests that epigenetic modifications, resulting from psychological and social processes such as family dynamics, parenting styles, and coping strategies play a pivotal role in transmitting the traumatic experiences and their consequences from one generation to the next. Consequently, subsequent generations of individuals with a history of traumatic experiences exhibit increased vulnerability to trauma and PTSD (see Lehrner & Yehuda, 2018). Thus, epigenetic mechanisms operate as a central interface between neurobiological and environmental factors that contribute to the development of PTSD.

1.1.4.2. Environmental and Social Risk and Protective Factors on Trauma and Posttraumatic Stress Disorder

Public health research highlights that environmental and contextual conditions may engender structural vulnerabilities that influence the risk for psychopathology by affecting trauma exposure, access to health care, and broader social and demographic circumstances (e.g., Tol et al., 2013). In this context, sociodemographic determinants such as age, gender, education, occupation, and associated socioeconomic status (SES) are of particular relevance. Individuals at both the younger and the very old ages frequently demonstrate heightened vulnerability to PTSD, as developmental factors exert a significant influence on cognitive and emotional regulatory capacities: Adolescents demonstrate heightened sensitivity to stress (Spear, 2009)

and a relative paucity of effective coping strategies (Compas et al., 2001), whereas older adults may experience age-related declines in memory and emotion regulation (Salthouse, 2010), both of which are recognised as risk factors for PTSD (e.g., Barlis et al., 2025). Gender can be considered a proxy risk factor for PTSD, as women are more likely to experience certain types of traumata (e.g., pre-, peri-, or postnatal complications, sexualised violence) and tend to employ more internalising coping strategies (Vogt et al., 2007). These factors increase vulnerability to trauma exposure and PTSD. Furthermore, the impact of gender on the risk for PTSD is mediated by social factors related to gender roles. Consequently, women demonstrate a two- to threefold higher risk of developing PTSD in comparison to men (Christiansen & Elklit, 2012; Olff, 2017; Tolin & Foa, 2006). Furthermore, education has been shown to be a significant predictor of socioeconomic resources and coping capacity. Higher levels of educational attainment and professional success have been consistently linked to better mental health outcomes (see Benjet et al., 2016). Conversely, lower levels of education have been demonstrated to increase vulnerability to trauma exposure and PTSD (Folayan et al., 2024) and are moreover associated with reduced access to social and healthcare support. In addition, low socioeconomic status has been found to be associated with secondary risk factors, including social isolation and limited social support (Alhaffar & Janos, 2021; Ben Salah et al., 2023). This suggests a predisposition for individuals to experience trauma exposure and PTSD.

From a more external perspective, environmental factors encompass an interplay of political, cultural and social factors associated with the risk or resilience to trauma and PTSD. Within this context, safe environments with low trauma potential confer protection by promoting physical and mental well-being, acting as pre-traumatic protective factors. Such environments have been shown to promote stability and are associated with a heightened sense of control prior to trauma, thereby providing a buffer against the development of PTSD (cf. Benight & Bandura, 2004). Conversely, environments frequently impacted by natural disasters have been linked to elevated rates of trauma exposure (Bromet et al., 2017). However, this observation does not inherently imply an increase in the risk of PTSD, as natural disasters can be classified as accidental trauma. Conversely, elevated poverty and crime rates, which are almost manifestations of man-made trauma, have been associated with an increased risk of developing PTSD (e.g., Ravi et al., 2023). The most severe exposure to man-made trauma occurs in conflict zones characterised by political instability, human rights violations, and ongoing threats such as persecution, torture, and interpersonal violence (Steel et al., 2009). Consequently, populations originating from regions including parts of North Africa and the

Middle East have been found to be at an increased risk of developing PTSD (Fazel et al., 2005; Nesterko et al., 2020). The confrontation with such aversive, persistent, and life-threatening environments prompts many of the affected individuals seeking refuge. This form of displacement and forced migration has been shown to compound the risk of cumulative interpersonal trauma. Forcibly displaced individuals, including refugees and asylum seekers, have been found to report a significantly higher prevalence of traumatic interpersonal experiences in comparison to individuals residing within the conflict zone (see Fazel et al., 2012). In addition to prolonged exposure to several traumatic events in conflict zones, persistent threats, and uncertainty during flight, as well as poor living conditions in refugee camps have been shown to be directly associated with increased PTSD severity (de Jong et al., 2001). Research in this field has identified delays in the asylum process, experiences of discrimination, social stigma, and social isolation as key factors that exacerbate psychological distress, foster social disintegration, and limit access to mental health care (cf. Fazel et al., 2012; Silove et al., 1997). Among these populations, structural deficits, including restricted access to trauma-informed and culturally sensitive mental health services, contribute to diagnostic inaccuracies and insufficient treatment, thereby reinforcing vulnerability to chronic and persistent PTSD symptomatology (see Fazel et al., 2012; Kleber et al., 2016). In this context, cultural sensitivity extends beyond clinical practice, emphasising that cultural norms and practices themselves shape both vulnerability and resilience (Oakley et al., 2021). Cultural frameworks have been demonstrated to influence the perception, expression, and integration of trauma, thereby affecting coping mechanisms, help-seeking behaviours, and recovery trajectories. Cultural norms and practices have been demonstrated to influence coping mechanisms at both the individual and social levels, thereby impacting the perception and management of trauma (see Bovey et al., 2025). Religion and spirituality, as integral components of culture, have the capacity to engender resilience by offering coherence, meaning, and a framework for adaptive coping mechanisms (Park, 2013; Weber & Pargament, 2014.). The affiliation of individuals with religious communities has been demonstrated to have a positive effect on their sense of belonging and social integration (VanderWeele, 2017). This, in turn, facilitates access to supportive networks and social recognition. Concurrently, cultural and religious norms have the capacity to amplify feelings of shame and guilt (Shi et al., 2021), or to disseminate moral conflict in the aftermath of traumatic events, thereby increasing the risk of developing PTSD (see Kip et al., 2022). The positive impact of social connections on resilience and protection against trauma-related stress has been demonstrated in a number of studies (see Bonanno, 2004 and see Wang et al., 2021 for meta-analysis). Supportive family relationship has been shown to

enhance coping mechanisms and mitigate the risk of developing PTSD (see Allen et al., 2021), but effects are usually small and depend on context. Acknowledgement and validation from others are of particular importance, as they stabilise recovery and promote adaptive coping after trauma (Maerker & Müller, 2004). Insufficient social support and acknowledgement have been demonstrated to result in withdrawal and social isolation, thereby worsening PTSD symptoms (Brewin et al., 2000; Kaniasty & Norris, 1993; Maerker & Müller, 2004). Parental blame, emotional unavailability, and dysfunctional family dynamics have been demonstrated to increase vulnerability to the development of PTSD (Afzal et al., 2023). Social marginalisation, discrimination, or a lack of recognition has been demonstrated to increase trauma vulnerability and limit access to protective resources (e.g., Matheson et al., 2019; Williams & Mohammed, 2009). In the context of transgenerational trauma, such relational patterns may influence stress regulation and trauma susceptibility through epigenetic pathways (Youssef et al., 2018).

As outlined above, a broad range of risk and protective factors for trauma exposure and PTSD has been identified in the last decade of research. The dynamic interplay among the risk and protective factors is particularly evident in shaping an individual's vulnerability to PTSD (see Brewin et al., 2000; Koenen et al., 2017; Ozer et al., 2003). These vulnerability patterns can be conceptualised as multidimensional profiles characterised by specific constellations of biological, psychological, and environmental risk and protective factors. Examining such profiles across populations allows recurring constellations to be empirically delineated and high-risk groups for PTSD to be identified (Kessler et al., 2014). These high-risk groups, in turn, form the basis for individualised diagnostics, targeted prevention, and personalised treatment planning. A substantial body of research has identified several high-risk groups. Thus, individuals exposed to traumatic events during sensitive developmental periods, including childhood abuse, neglect, or parental loss, demonstrate significantly increased vulnerability, particularly when such exposures occur during childhood or older age (Brewin et al., 2000; Koenen et al., 2017). Furthermore, individuals suffering from severe physical disease, particularly those who develop the disease at a young age and undergo invasive treatments or repeated hospitalisations, often exhibit increased physiological arousal and higher levels of distress, which is associated with an increased risk of trauma-related mental health issues (see Chapter 1.1.4.1. for more details). Specific occupational groups, including first responders and military personnel are repeatedly exposed to potentially life-threatening events and therefore constitute another population with an elevated risk of developing PTSD (e.g., Arena et al., 2025; Gates et al., 2012). Meta-analytic findings indicate that adult civilian populations residing in

war-affected regions are among those at highest risk for PTSD, consistent with the combination of cumulative trauma exposure and persistently threatening living conditions associated with armed conflict settings (Morina et al., 2018). Furthermore, refugees and migrants are considered to be at particularly high risk, especially when confronted with additional adversities such as social isolation, unemployment, and insecure legal status in the host country (e.g., Blackmore et al., 2020; Johnson & Thompson, 2008). In a similar vein, ethnic minority groups have been demonstrated to exhibit an elevated degree of vulnerability, a phenomenon that is presumably attributable to the interplay of social disadvantage, marginalisation, and cumulative stress exposure (e.g., Polanco-Roman et al., 2024). Empirical findings further suggest that, within these high-risk populations, individuals with PTSD differ systematically from trauma-exposed individuals without PTSD in how they encode, appraise, and remember traumatic experiences (Petzold & Bunzeck, 2022). This offers insight into mechanisms that contribute to both the onset and the maintenance of the disorder. Taken together, these observations emphasise the importance of identifying high-risk groups and vulnerability profiles as a foundation for developing context-sensitive prevention strategies, early intervention approaches, and personalised treatment programmes in posttraumatic mental health care. At the same time, these findings emphasise the necessity to examine the underlying etiological mechanisms, particularly those related to memory processing, and contextual influences on it, in order to comprehend why some individuals develop PTSD following trauma, while others demonstrate resilience.

1.1.5. Aetiological Mechanisms and the Role of Memory in the Pathogenesis of Posttraumatic Stress Disorder

Together the risk and protective factors determine both the vulnerability to and severity of PTSD by influencing in part memory processing. Memory processing unfolds across encoding, where experiences are initially perceived and stored; consolidation, which stabilizes initial fragile memories; and retrieval, the process of accessing stored information. The following sections provide a brief introduction to key memory processes and emphasise their importance during and after trauma, drawing on selected aetiological models that have been described as viewing PTSD as, at least in part, a memory-related disorder.

1.1.5.1. Fundamental Mechanisms of Memory Processing

Memory consolidation is a dynamic process that is essential for transforming fragile, newly encoded memories into stable representations stored in long-term memory system (Squire et al., 2015). Reconsolidation further stabilizes these memories, making them more resistant to forgetting. Research suggests that while system consolidation occurs during both wakefulness and sleep, sleep provides an optimal state, supporting effective neural reorganization in emotional memory consolidation (Dudai et al., 2015; Rasch & Born, 2013). From a neurophysiological perspective, emotional memory consolidation relies on the coordinated activity of the amygdala, hippocampus and neocortical structures to reorganize and strengthen emotional memories into long-term storage (Dudai et al., 2015). A widely accepted nomenclature of long-term memory separates declarative from non-declarative memory systems (Squire, 1992). The declarative memory system, also referred to as explicit memory, includes knowledge that can be consciously accessed and recalled (Eichenbaum et al., 2000). Declarative memory is further subdivided into two distinct categories: semantic memory and episodic memory. Semantic memory encompasses general knowledge and concepts (Quillan, 1966), whereas episodic memory is concerned with specific autobiographical experiences (Conway, 2001). Accordingly, the spatial and temporal contextualization of autobiographical content is regarded as an inherent component of episodic memory (Tulving, 1983). Conversely, the non-declarative memory, referred to as implicit memory, operates unconsciously. It encompasses procedural memories, which include skills and habits, as well as implicit processes such as associative learning (e.g., fear conditioning) and perceptual priming (Squire, 1992). Associative learning and perceptual priming are of paramount importance, as they make the world more deterministic and facilitate appropriate adaptive responses, while minimizing cognitive load (Henson et al., 2014). Associative learning encompasses the formation of stimulus-stimulus and stimulus-response bindings, which reliably enable rapid, context-dependent physiological, emotional, cognitive, or behavioural responses to associated stimuli (Henson et al., 2014). Fear conditioning, as a specific form of associative learning, is of the utmost importance as it enables individuals to recognize threats based on specific threat-associated stimuli and automatically initiate responses to mitigate the threat. Perceptual priming is characterized by increased and reinforced processing and recognition of the perceptual properties of stimuli based on their prior exposure. By lowering the perceptual threshold for previously exposed stimuli, stimulus response is unconsciously facilitated, making perceptual priming an adaptive way to interact efficiently with the environment (Wiggs et al., 1998). Overall, perceptual priming can be conceptualized within the framework of transfer-appropriate

processing (Morris et al., 1977; Roediger et al., 1989), as it facilitates processing, recognition, and stimulus response through the congruence of perceptual encoding and recognition processes. Transfer-appropriate processing posits that memory performance is enhanced when the conditions presented during encoding, such as context and cognitive processes, correspond to those presented during retrieval. Transfer-appropriate processing distinguishes data-driven processing and conceptually driven processing. Data-driven processing primarily involves implicit memory processes, such as encoding perceptual features of stimuli, independent of higher-order cognitive systems. As a result, data-driven encoding primarily supports automatic, stimulus-driven memory retrieval, often lacking deeper contextual integration. In contrast, conceptually driven processing engages elaborative, attention-driven encoding that integrates information within a broader context, fostering meaningfulness and autobiographical coherence. This type of processing enhances the capacity for intentional memory retrieval within the framework of the explicit memory system (Roediger et al., 1989).

1.1.5.2. The Role of Memory Processing in Posttraumatic Stress Disorder

PTSD is commonly conceptualized as a memory disorder, in which stress-related modifications in encoding, consolidation, and retrieval processes lead to a pathological imbalance between declarative (explicit) and non-declarative (implicit) memory systems (Brewin et al., 2010; Ehlers & Clark, 2000; Elzinga & Bremner, 2002; Foa & Kozak, 1986; McNally, 2006). In particular, explicit memory is markedly impaired in individuals with PTSD (see Samuelson, 2011), as evidenced by the disorganized and fragmented nature of trauma memory when compared to trauma-exposed individuals without PTSD (Jelinek et al., 2009). Conversely, it is suggested that the implicit memory for trauma-related stimuli is improved in PTSD (Halligan et al., 2002). This is demonstrated through the improved subliminal processing of trauma-related stimuli, which often manifests as heightened perceptual priming (see Sündermann et al., 2013). In addition, people with PTSD often show stronger stress reactions to trauma-related cues than to neutral cues (Pitman et al., 2012). These reactions are commonly explained as a maladaptive conditioned fear response, such that trauma-related cues can trigger intense arousal even when no current threat is present (McNally, 1998; Michael et al., 2005; Milad et al., 2009). One proposed mechanism is that high arousal during the traumatic event promotes a sensory-driven and fragmented encoding of the experience, making later intrusions more likely and more easily triggered by perceptual cues (Brewin et al., 2010).

The assumption of an imbalance in the processing of memory concerning traumatic events (Brewin, 2001) has substantially informed several influential aetiological models of PTSD. Foa and Kozak's (1986) Emotional Processing Theory emphasizes the role of maladaptive fear networks in the development of PTSD. While fear networks initially serve adaptive survival functions, maladaptive processing of traumatic events can lead to pathological fear network. Within the theoretical framework of the Emotional Processing Theory, intrusive trauma memories are conceptualised as the expression of a maladaptive fear network. This network is composed of complex, highly interconnected representations of trauma-related stimuli, responses and interpretations, whose associative strength is further amplified by sensory–perceptual elements. The cognitive model of Ehlers and Clark (2000) is based on the transfer appropriate processing theory by Roediger (1989). It highlights the predominance of data-driven, perceptually focused processing during trauma, which impairs contextual integration and autobiographical memory and thereby perpetuates intrusive re-experiencing and a persistent sense of present threat. In a similar vein, Brewin's Dual Representation Theory (Brewin et al., 2010) extends earlier cognitive models by explicitly incorporating neurophysiological correlates of trauma memory. The model distinguishes between two complementary memory systems: sensory-bound (situationally accessible) representations (S-reps), which are linked to early sensory cortices, the amygdala, and the insula; and contextualized (verbally accessible) representations (C-reps), which engage the hippocampus, medial temporal cortex, and ventromedial prefrontal cortex. When S-reps dominate and C-reps fail to be integrated following trauma, trauma memories become intrusive, vivid, and contextually fragmented. Neuroimaging evidence supports this assumption, showing amygdala hyperactivity, reduced hippocampal volume, and decreased connectivity with the ventromedial prefrontal cortex in PTSD patients with intrusions (see Brewin et al., 2010).

Taken together, the aetiological models reviewed above converge on the view that maladaptive trauma-memory processing during and following trauma exposure is a key mechanism in the development and maintenance of PTSD. Accordingly, traumatic memory representations are positioned at the core of symptom development and persistence, as reflected in the disorder's memory-based hallmark symptoms, including intrusive re-experiencing, avoidance, and hyperarousal (Brewin et al., 1996; Ehlers & Clark, 2000; Michael et al., 2018; Pitman et al., 2012). However, these models cannot be understood in isolation. As outlined in Chapter 1.1.4, a substantial body of evidence suggests that memory-related processes play a mediating role concerning the impact of contextual risk and protective factors on PTSD. This

indicates that memory processes may serve as a plausible pathway through which contextual conditions, before, during and after trauma, are translated into divergent posttraumatic trajectories. In particular, risk and protective factors are hypothesised to predominantly exert their effect through the modulation of encoding, consolidation, and retrieval processes across the peri- and posttraumatic stages. In summary recent theoretical frameworks posit that risk and protective factors determine whether traumatic experiences are adaptively integrated into memory or persist as intrusive, distressing re-experiences in the context of a PTSD.

1.1.6. Implications for Diagnostic, Prevention and Treatment Approaches in Posttraumatic Stress Disorder

This theoretical framework provides a recent aetiological perspective on PTSD, situating trauma memory processes at the core of the disorder's pathogenesis and simultaneously acknowledging the modulatory effects of contextual risk and protective factors on the onset and persistence of PTSD. This perspective is of significant clinical importance. Thus, the following sections synthesise contemporary approaches to prevention, diagnostics, and treatment, providing a comprehensive overview of current clinical practice and appraising the effectiveness of these contemporary approaches across various contexts.

There is an extensive empirical evidence base for PTSD assessment. A wide range of diagnostic instruments is available and widely used, showing good to excellent internal consistency (e.g., Cronbach's α (CAPS-5 and PCL-5) = .83–.97; Wojujutari et al., 2024; Forkus et al., 2023) and strong convergent validity with other established PTSD screening measures and clinician-administered interviews, underscoring their suitability for assessing core PTSD symptoms (e.g., Blevins et al., 2015; Weathers et al., 2018). Diagnostic instruments based on the DSM-5 are particularly prevalent in clinical practice and research, including the Clinician-Administered PTSD Scale for DSM-5 (CAPS-5; Weathers et al., 2018) and the PTSD Checklist for DSM-5 (PCL-5; Blevins et al., 2015). These two assessment tools primarily operationalise PTSD by evaluating DSM-5 symptom clusters. International clinical guidelines recommend the use of these standardised, validated tools for diagnostic evaluation and symptom monitoring (e.g., National Institute for Health and Care Excellence [NICE], 2018). Nevertheless, recent psychometric research continues to raise questions regarding generalisability of the latent factor structure of the PCL-5 across various populations. The findings of factor-analytic research suggest that aspects of construct validity may vary across populations, with particularly notable

cultural and linguistic differences being observed (e.g., Ibrahim et al., 2019; Pettrich et al., 2024). In line with this, sensitivity and specificity analyses indicate that established PCL-5 cut-off scores may need to be adapted to the population examined to optimise diagnostic accuracy (e.g., Ibrahim et al., 2018a). Furthermore, there is evidence that the discriminant validity of PTSD assessment tools can be constrained by substantial symptom overlap between PTSD and common comorbid conditions, such as depressive and anxiety disorders (cf. Al Barathie & Karam, 2025; Flory & Yehuda, 2015). This overlap complicates differential diagnosis and may increase the risk of false-positive classification (cf. Forkus et al., 2023). Taken together, these findings indicate that PTSD assessment tools reliably capture core symptom dimensions of the disorder, however their diagnostic performance is not uniform across various populations. Consequently, recent research has increasingly emphasised measurement invariance testing and the evaluation of diagnostic performance. For clinical decision-making in heterogeneous samples, one pragmatic option is to derive population-appropriate cut-off scores that balance sensitivity and specificity based on receiver operating characteristic (ROC) analyses (e.g., Pettrich et al., 2025).

While valid assessment tools facilitate the identification and monitoring of posttraumatic symptoms, the clinical benefit ultimately depends on linking assessment results to evidence-based interventions. In this regard, an extensive evidence base exists for the treatment of PTSD. In accordance with this, clinical guidelines consistently recommend trauma-focused psychotherapy (TFP) as the first-line intervention, with pharmacotherapy considered in selected cases (e.g., limited feasibility of TFP or as an adjunct in severe trajectories) (APA, 2024; NICE, 2018; U.S. Department of Veterans Affairs & U.S. Department of Defense [VA/DoD], 2023). These recommendations reflect the current evidence base indicating TFP as among the most effective interventions for PTSD, including Prolonged exposure (Foa et al., 2007), Cognitive processing therapy (Resick et al., 2024), Eye movement desensitisation and reprocessing (Shapiro, 1989), and Narrative exposure therapy (NET; Schauer et al., 2011). The therapeutic principle underlying TFP is the systematic activation of trauma-related memories and the integration of sensory–affective (“hot”) memory elements with contextual, temporally ordered (“cold”) information into a coherent autobiographical narrative (e.g., Schauer et al., 2011). This integration is intended to reduce the involuntary re-experience of trauma memories and thereby alleviate core PTSD symptoms. Although there is a generally robust evidence base for TFP, considerable inter-individual differences in response to treatment and treatment retention are observed. Thus, it has been shown that approximately one third of patients receiving TFP

continue to experience clinically relevant PTSD symptoms after treatment, even if they no longer meet the full diagnostic criteria (see Bradley et al., 2005). Furthermore, a meta-analysis by Lewis et al. (2020) found evidence that the pooled dropout rate from RCTs of TFP is associated with an 18% (95%CI [15, 21) dropout rate, which is significantly greater ($\beta = 0.069$; $p = .021$) than dropout rates (14%; 95%CI [10, 18]) from RCTs of non-trauma-focused psychotherapies. This meta-analysis considered primary studies on different samples. In a sample-specific meta-analysis, TFP in severely traumatised populations such as military personnel and veterans was associated with higher dropout rates of 27.1% (Edwards-Stewart et al., 2021). Moreover, Lely et al. (2019) show in their meta-analysis that NET (Schauer et al., 2011) is associated with a dropout rate ranging from 0.00% to 25.49% ($M = 5.85\%$, $SD = 8.51\%$). It should be noted that primary studies of TFP in refugees and asylum-seekers have reported the highest dropout rates above 20% (Hensel-Dittmann et al., 2011; Morath et al., 2014; Stenmark et al., 2013). Thus, although NET was developed for individuals exposed to complex and cumulative trauma (Robjant & Fazel, 2010; Schauer et al., 2011) and is frequently described as appropriate for heterogeneous and constrained services (e.g., Neuner et al., 2008; Siehl et al., 2020), its integration into routine care seems to be impeded by contextual barriers. Unstable living conditions, such as ongoing stressors for example following migration, and cultural or linguistic limitations can hinder the access and the adherence to treatment, thereby increasing the dropout risk (Schick et al., 2018). Conversely, preliminary evidence indicates that NET delivered under more supportive contextual conditions is associated with higher retention and adherence, which may be linked to better clinical outcomes (Lely et al., 2019; de la Rie et al., 2020). To sum it up, recent studies suggest that treatment response and retention in TFP vary across different populations and contexts. However, the evidence on the factors that influence treatment retention and dropout remains limited. Consequently, in future research context-related moderators and their impact on treatment response and retention should be more considered (Carlsson et al., 2025; Wright et al., 2025).

In contrast to the robust empirical evidence supporting diagnostic assessments and established treatments, empirical evidence for secondary preventive interventions following trauma exposure is less consolidated. Research on early preventive approaches varies widely in terms of study design (including analogue paradigms and clinical trials), intervention protocol, timing relative to the index trauma (prevention vs. early treatment), outcomes and target populations. Consequently, the findings are at times inconsistent. A range of secondary preventive approaches that have been examined include pharmacological strategies (e.g.,

Shalev et al., 2012; Stein et al., 2018), sleep-based interventions (e.g., Kleim et al., 2016), and cognitive interference tasks targeting memory consolidation (e.g., Holmes et al., 2019). The results of these studies have been found to be overall variable and inconsistently replicated. Moreover, the prevention literature further indicates that trauma-focused protocols are not uniformly beneficial. Routine single-session psychological debriefing delivered shortly after trauma exposure has not demonstrated preventive benefit and has raised concerns about potential adverse effects (Bisson & Andrew, 2007; Rose et al., 2002). By contrast, early multi-session trauma-focused interventions, most notably trauma-focused (cognitive) behavioural therapy delivered to individuals with acute stress symptoms or early PTSD, have shown modest benefits when applied in indicated, high-risk samples (e.g., Roberts et al., 2019; Schneider et al., 2025). Taken together, the prevention literature is characterised by substantial heterogeneity across intervention protocols and methodological features, which complicates cross-study comparability and likely contributes to variability in observed effects.

Although there is robust evidence on the diagnostic validity of PTSD assessments and the efficacy of PTSD treatment, the engagement and outcomes often vary markedly between individuals (Herzog & Kaiser, 2022). This lack of convergence between average evidence and person-specific responses is not unique to PTSD, as it is a widely discussed phenomenon across medicine and psychology when complex health conditions are treated via one-size-fits-all approaches (broadly discussed in Angus & Chang, 2021, Fisher et al., 2018). This has prompted attention to be paid to the impact of individual differences on assessment and treatment. Moreover, it has facilitated the development and evaluation of personalised and precision-care frameworks (Hamburg & Collins, 2010), with early exemplars being drawn from the field of cancer prevention and treatment. Moreover, in the last decades, there has been an increasing emphasis on individualised approaches in the domain of psychotherapy research and practice (Lutz, 2002; Zipfel et al., 2024). Indeed, there is growing evidence that suggests that personalised treatment is an effective strategy for enhancing outcomes in psychotherapy. It has been shown that incorporating patients' treatment preferences into shared decision-making, particularly by matching patients to their preferred intervention when feasible, is associated with lower dropout rates and slight improvements in therapeutic outcomes (Markowitz et al., 2016; Swift et al., 2011). A recent meta-analysis across diverse personalised psychological interventions reported a small but significant advantage of personalised psychotherapy over standardised treatment approaches (d = 0.14, 95% CI [.08, .20]; p < .001; Nye et al., 2023). Overall, these developments reflect a gradual move away from strictly disorder-focused,

categorical one-size-fits-all approaches toward more dimensional and integrative frameworks for prevention, diagnosis, and treatment of psychological disorders. Across research traditions, these frameworks are variously conceptualised and labelled as “individualised”, “personalised”, “precision” psychotherapy. While these labels slightly differ in emphasis and terminology, they converge on the shared goal of integrating evidence across mechanisms, patient characteristics, preferences, and context, to optimise diagnostics, clinical decision-making and intervention. In the context of PTSD, such an integrative approach preserves insights from mechanism-based research, most prominently on memory-related core mechanism PTSD while systematically incorporating patient-specific internal factors (e.g., biological and neurophysiological factors, and psychological and cognitive–emotional factors) and external contextual factors (e.g., environmental and social factors, and psychological and cognitive–emotional factors) into a holistic framework (cf. Cohen, Delgadillo & DeRubeis, 2021). A growing body of research supports that integrating memory-based aetiological models with empirical evidence on contextual risk and protective factors represents a promising avenue for improving diagnostics and treatment in PTSD (Herzog & Kaiser, 2022). In the present thesis, this integrative framework is referred to as “context-sensitive psychotherapy” (adapted to “culture-sensitive psychotraumatology”; Schnyder et al., 2016).

Contemporary revisions of diagnostic classification systems, most notably the introduction of the International Classification of Diseases, 11th edition (ICD-11; World Health Organization [WHO], 2018) continue to emphasise the core symptoms of PTSD (i.e., re-experiencing, avoidance, and a persistent sense of current threat), while similarly placing greater conceptual weight on the nature and context of trauma exposure (WHO, 2018). A key innovation of the ICD-11 is the formal distinction between PTSD and Complex PTSD (CPTSD), thereby explicitly acknowledging differences in trauma type (e.g., single-incident versus prolonged or repeated interpersonal trauma), symptom profiles, and clinical presentation (Brewin et al., 2017; WHO, 2018). The transition from ICD-10 to ICD-11 can thus be understood as reflecting a more context-informed diagnostic framework that accounts for heterogeneity in traumatic experiences and their psychological sequelae. At the psychometric level, this development is accompanied by an increasing focus on contextual and ecological validity in diagnostic research. Recent studies have examined the measurement invariance of widely used PTSD instruments (e.g., PCL-5, CAPS-5) across populations, trauma types, and cultural–linguistic contexts (see Armour et al., 2016; Forkus et al., 2023 for overview). Thus the primary aim of this line of work is to ensure that diagnostic tools capture the latent construct

of PTSD comparably across contexts, thereby improving diagnostic accuracy in heterogeneous populations.

Moreover, this integrative framework is increasingly reflected in contemporary approaches to treatment development and implementation. Early efforts to operationalise contextual sensitivity in PTSD care were often pursued through stratified (subgroup-based) psychotherapy, aiming to match established evidence-based interventions to patients with shared characteristics such as age, gender, comorbidity profiles, or occupation, hypothesised to influence treatment response. However, the evidence for prescriptive effects remains mixed (cf. Chapter 1.1.4). Particularly prominent in research are stratified approaches on occupational subgroups (e.g., Mackoff, Lennox, & Torchalla, 2025), such as among first responders, healthcare workers and military personnel (e.g., Kanstrup et al., 2024; Litz et al., 2018; Skeffington et al., 2016). In these cases, explicit consideration is given to trauma type, exposure patterns, organisational culture, and service-related delivery constraints delivering interventions (cf. Torchalla & Lennox, 2025). Tailoring PTSD treatment to individual strengths, resources, and contextual constraints appears particularly relevant for severely affected and hard-to-reach populations, such as refugees with PTSD (see Hook et al., 2021). More recent approaches extend this line of work by explicitly recognising that patients' needs and contextual constraints that may change during treatment. Accordingly, adaptive and data-informed strategies have been currently developed that draw on patient-specific trajectories to optimise treatment sequencing, intensity, or modality in a flexible manner (e.g., Sripada et al., 2023).

Furthermore, adjunct interventions are conceptualised to enhance the context-sensitivity in trauma-focused care. Based on positive clinical experience in inpatient settings German S3 guideline for PTSD recommends for example occupational therapy, art therapy, music therapy, body- and movement-based therapies, and physiotherapy as adjuncts to trauma care (Schäfer, Becker et al., 2019) In parallel, a broad range of adjuncts is being evaluated alongside TFP or pharmacotherapies, including aerobic exercise, mindfulness-based interventions, neurofeedback, non-invasive brain stimulation, and pharmacological agents intended to facilitate learning or memory processes during exposure-based treatment ("cognitive enhancers") (e.g., Bryant et al. 2023; Craske et al., 2014). However, the available evidence on these adjuncts remains heterogeneous (Michael et al., 2019; Michael et al., 2020) and, overall, does not yet allow clear conclusions about which adjuncts provide clinically meaningful incremental benefit for which patients, under which contextual conditions.

Finally, there is limited research on individualised PTSD prevention. While there is some evidence that individualised prevention measures in certain high-risk situations (e.g., among first responders) can facilitate recovery, there is insufficient robust data to recommend these prevention strategies for the general population (Qi et al., 2016). Similarly, although adjunct preventive interventions such as mindfulness or yoga have favourable safety profiles, the evidence for their effectiveness as preventive strategies remains sparse and inconclusive (Niles et al., 2018). Unlike the comparatively robust evidence base for PTSD diagnosis and treatment, the current data are insufficient to support context-sensitive, individualised post-trauma prevention. This highlights the fact that prevention is a relatively underdeveloped component of context-sensitive mental health care.

2. Classification of the Dissertation in the Current Research Context

Taken together, the preceding chapters suggest that research on PTSD prevention, diagnostic assessment, and treatment has, for much of the past two decades, primarily emphasised disorder-focused assessments and interventions. A substantial body of research has yielded robust average effects, thereby implicitly encouraging the assumption of broad applicability and supporting one-size-fits-all models of posttraumatic care (Cloitre et al., 2015).

2.1. Gap of Research

As previously outlined, the efficacy of secondary prevention varies considerably, and systematic syntheses remain limited. In the specific domain of post-trauma sleep, that is often proposed as a preventive approach, findings are inconsistent. current evidence is largely drawn from a small set of analogue-trauma studies und existing meta-analyses neglect individual participant data (IPD). This prevents both a more in-depth analysis of the effects on post trauma symptoms and moderator analyses. A more comprehensive synthesis comparing post-trauma sleep with wakefulness across the full analogue evidence base, ideally using IPD, is needed to clarify early PTSD-relevant mechanisms and inform early secondary prevention.

PTSD assessment instruments, on average, demonstrate robust psychometric properties and are widely used in various settings. However, the routine use assumes equivalence of the assessment across cultures and contexts, even though many widely used assessment instruments were developed primarily in Western contexts. In light of converging global crises (e.g.,

pandemics, geopolitical instability and economic strain), which increase forced displacement and trauma exposure, concerns about the comparability of PTSD severity across languages and cultures have become more salient. Consequently, the cross-cultural validity of conventional measures should be critically evaluated, and recent work on measurement invariance highlights the importance of accounting for context-specific differences in PTSD diagnosis. Recent advances in research on measurement invariance support the argument that context-specific differences should be taken into account in PTSD diagnostics. Accordingly, observed cross-context differences in PTSD symptom levels and prevalence estimates may partly reflect measurement non-equivalence (i.e., lack of measurement invariance across language versions), which can bias mean comparisons and other between-group inferences, rather than indicating true differences in latent severity (e.g., Ziegler & Bensch, 2013). However, measurement invariance testing has not yet been established sufficiently, limiting confidence in the equivalence of PTSD severity scores across different contexts. Consequently, the validity of cross-group comparisons remains limited.

Despite the strong evidence for the efficacy of TFP, which are recommended as a first-line treatment for PTSD, significant limitations persist in highly distressed populations. In patients characterised by a high comorbidity rate, ongoing psychosocial stress, and unstable living conditions, the implementation and engagement of TFP is often difficult (Hook et al., 2021; Schick et al., 2018), because it may contribute to higher dropout and persistent clinically relevant symptoms in a substantial subgroup (Bradley et al., 2005; Edwards-Stewart et al., 2021; Lewis et al., 2020). Adjunct interventions have therefore been proposed to enhance trauma-focused care, but the evidence remains heterogeneous and overall limited (Michael et al., 2019; Michael et al., 2020). Moreover, adjunct effects are often evaluated using mean symptom change, which may fail to detect small yet clinically significant benefits and process outcomes such as acceptability, adherence, and retention are frequently underemphasised (Lewis et al., 2020). Consequently, final conclusions about the additive value of adjuncts remain difficult, underscoring the need for studies that jointly evaluate clinical effects and feasibility of adjuncts to TFP in high-risk populations (Michael et al., 2019; Schick et al., 2018).

Overall, a substantial body of research has been conducted, providing a robust evidence base for standardised diagnostic assessments and treatments for PTSD, that has initially led to their widespread implementation. Nevertheless, the evidence is frequently presented as average effects. Moreover, the variability in the feasibility and accuracy of PTSD assessment and treatment, as well as in the heterogeneity in treatment response across posttraumatic stages and

populations indicates that a one-size-fits-all approach remains inadequate (see. Fisher, Medaglia & Jeronimus, 2018). In a similar vein, this theory is supported by evidence demonstrating that contextual factors can impact measurement accuracy and treatment effects. However, research that explicitly integrates mechanism-focused approaches (e.g., trauma-memory processes) and contextual determinants, while examining how contextual risk and protective factors shape measurement accuracy and treatment effects, remains comparatively rare. Consequently, it is currently difficult to establish which diagnostic assessments and interventions are most valid, feasible and beneficial for whom and under which contextual conditions. This issue is particularly salient given the rising incidence of trauma exposure stemming from converging global crises, which has been shown to increase the risk of PTSD in diverse populations (Smith et al., 2023). Providing more context-sensitive approaches could address this issue and mitigate the potential increase in prevalence.

2.2. Aims and Research Question

Taking this into consideration, the present dissertation aims to address these research gaps by applying a context-sensitive framework to derive implications for optimising the prevention, diagnosis and treatment of PTSD across different settings and populations.

Study 1 is situated within a literature characterised by heterogeneous and partly contradictory findings on whether sleep in the immediate aftermath of (analogue) trauma reduces subsequent intrusive re-experiencing. To synthesise this evidence while explicitly accounting for between-study variability, we combined a conventional meta-analysis with an IPD meta-analysis and examined moderators capturing differences in experimental paradigms, sample characteristics, and outcome operationalisations. This approach provides a basis for identifying contextual and methodological conditions that may shape observed effects and for refining implications for early post-trauma prevention research in PTSD.

Study 2 examines the validity of a widely used PTSD screening instrument in the context of linguistic and cultural heterogeneity. Using measurement invariance analyses , the study tests whether the Arabic and German versions of the PCL-5 capture the same latent construct and to what extent score interpretations are comparable across groups, thereby informing whether, and at which level of measurement invariance (configural, metric, threshold, scalar), context-sensitive adaptations or psychometric safeguards are warranted for valid clinical decision-making.

Building on concerns that one-size-fits-all treatments for PTSD do not adequately address its heterogeneity and complexity, nor the individual needs of patients (Cloitre, 2015), *Study 3* is conceptualized as the study protocol of a RCT examining the effect of moderate-intensity aerobic exercise training (MAET) as an adjunct to NET in traumatised refugees and asylum seekers, a population that is characterised by substantial contextual and clinical complexity. Thus *Study 3* outlines the rationale, design, randomisation procedure, intervention arms, and primary and secondary outcomes, thereby providing the methodological foundation for examining whether MAET can be meaningfully integrated as an adjunct into routine trauma-focused care for high-risk population.

Study 4 builds on the RCT protocol outlined in *Study 3* and analyses preliminary pre–post (t_0–t_1) outcome data on general psychological distress, PTSD symptom severity, depressive symptoms, and sleep quality. Retaining the core aim of *Study 3*, it evaluates whether MAET confers incremental benefit as an adjunct to NET in traumatised refugees and asylum seekers, compared with NET delivered as monotherapy. By applying multilevel and Bayesian modelling alongside exploratory moderator analyses, *Study 4* refines the evaluation of the incremental effect of MAET as an adjunct to NET. This methodological approach aims to account for inter-individual variability in treatment response. Furthermore, it offers preliminary insights into patient- and context-related characteristics that may moderate the adjunct effect. Consequently, the results of *Study 4* may be instrumental in the formulation of context-sensitive augmentation strategies for TFP in severely distressed populations, such as refugees and asylum seekers.

3. Study 1: To sleep or not to sleep, that is the question: A systematic review and meta-analysis on the effect of post-trauma sleep on intrusive memories of analog trauma[2]

Schäfer, S. K., Lüder, C. C., Porcheret, K., Hu, X., Margraf, J., Michael, T., Holmes, E. A., Werner, G. G., Wilhelm, I., Woud, M. L., Zeng, S., Friesen, E., Haim-Nachum, S., Lass-Hennemann, J., Lieb, K., Kunzler, A. M., Wirth, B. E. & Sopp, M. R. (2023). *To sleep or not to sleep, that is the question: A systematic review and meta-analysis on the effect of post-trauma sleep on intrusive memories of analog trauma.* Behaviour Research and Therapy, 167, 104359. DOI 10.1016/j.brat.2023.104359

3.1. Abstract

Distressing intrusive memories of a traumatic event are one of the hallmark symptoms of posttraumatic stress disorder. Thus, it is crucial to identify early interventions that prevent the occurrence of intrusive memories. Both, sleep and sleep deprivation have been discussed as such interventions, yet previous studies yielded contradicting effects. Our systematic review aims at evaluating existing evidence by means of traditional and individual participant data (IPD) meta-analyses to overcome power issues of sleep research. Until May 16th, 2022, six databases were searched for experimental analog studies examining the effect of post-trauma sleep versus wakefulness on intrusive memories. Nine studies were included in our traditional meta-analysis (8 in the IPD meta-analysis). Our analysis provided evidence for a small effect favoring sleep over wakefulness, log-ROM = 0.25, $p < .001$, suggesting that sleep is associated with a lower number of intrusions but unrelated to the occurrence of any versus no intrusions. We found no evidence for an effect of sleep on intrusion distress. Heterogeneity was low and certainty of evidence for our primary analysis was moderate. Our findings suggest that post-trauma sleep has the potential to be protective by reducing intrusion frequency. More research is needed to determine the impact following real-world trauma and the potential clinical significance.

[2] ***Note***. Additional information (e.g., analytic code, materials) on this systematic review can be found at the Open Science Framework: https://osf.io/j2av3/); In this dissertation, the Supplementary Materials for *Study 1* are provided in Appendix A.

3.2. Background

The majority of the world's population will experience at least one potentially traumatic event during their lifetime (e.g., physical or sexual assault, natural disasters, war; Kessler et al., 2017). Following trauma, up to 59% of survivors experience stress-related symptoms (Kliem & Kröger, 2013). In most survivors, these symptoms remit naturally over time. However, a significant subgroup (15-30%) experiences ongoing and chronic stress-related symptoms, manifesting in the form of posttraumatic stress disorder (PTSD; Kessler, Sonnega, Bromet, Hughes, & Nelson, 1995). PTSD is characterized by spontaneous, involuntary (intrusive) memories of the traumatic event, which are highly distressing, vivid, and feature "here and now" quality (i.e., events seem to be happening in the present). By continuously intruding into the everyday life of trauma survivors, intrusive memories lead to a sense of continuous threat and are hypothesized to trigger hyperarousal (e.g., irritability, sleep disturbances) and avoidance of trauma reminders (i.e., self-isolation; Ehlers & Clark, 2000). This hypothesis is supported by longitudinal research showing that early intrusion characteristics (e.g., frequency, distress; Kleim, Graham, Bryant, & Ehlers, 2013; Michael, Ehlers, Halligan, & Clark, 2005) predict persistent PTSD symptoms making them one of the hallmark symptoms of PTSD (Iyadurai et al., 2019).

PTSD patients experience on average 17 intrusive memories over one week (Pfaltz, Michael, Meyer, & Wilhelm, 2013). This high symptom frequency results in severe decrements of functioning (Alonso et al., 2010), comorbid physical (e.g., cardio-respiratory diseases) and mental disorders (e.g., depression), and impairments of quality of life (Alonso et al., 2004; Olatunji, Cisler, & Tolin, 2007). Critically, many patients (48-82%) experience a chronic course of PTSD, retaining their diagnosis for decades (Perkonigg et al., 2005; Zlotnick et al., 2004). Research efforts are thus focused on developing effective prevention strategies, which can be deployed in proximity to the traumatic event.

To divert the path from early intrusive memories to persistent PTSD, intervention strategies target at their underlying memory processes (Iyadurai et al., 2018, 2019; Pace-Schott, Seo, & Bottary, 2023). According to the cognitive model of PTSD (Ehlers & Clark, 2000), intrusive memories arise from the impact of traumatic stress on memory formation. That is, traumatic stress is proposed to enhance data-driven processing (i.e., bottom-up processing that relies heavily on perceptual and sensory information) which, in turn, strengthens associative learning and reduces the elaboration of explicit trauma memories as well as the integration of the trauma into the autobiographical memory system. As a result, trauma reminders trigger

implicit - but not explicit - memory recall, facilitating the emergence of spontaneous, involuntary trauma memories. Moreover - due to the deficient explicit recall - trauma survivors lack awareness that their current sensory impressions derive from a past event (i.e., autonoetic awareness). In a similar vein, Brewin, Gregory, Lipton, and Burgess (2010) propose that traumatic stress reduces the formation of contextual representations of the traumatic event, which impairs voluntary, explicit memory retrieval. Conversely, they suggest that stress enhances the formation of sensory representations, which drive intrusive trauma memories. Intrusion development is assumed to be further facilitated by weak contextual representations, which fail to exert top-down control over strong sensory representations (Bisby & Burgess, 2017).

Based on these models, prevention strategies have been focused on reducing implicit (sensory) trauma memories and strengthening explicit (contextual) trauma memories in the post-encoding stage by targeting either consolidation or reconsolidation processes (Deeprose, Zhang, DeJong, Dalgleish, & Homes, 2012; Hørlyck, Bisby, King, & Burgess, 2019; Krans, Näring, Holmes, & Becker, 2009). One line of research has specifically focused on a prolonged stage of consolidation, referred to as 'systems consolidation' (Kleim, Wysokowsky, Schmid, Seifritz, & Rasch, 2016). During systems consolidation, new memory representations are redistributed from short-term storage in the hippocampus to neocortical long-term stores (Diekelmann & Born, 2010). This process is assumed to occur during sleep. Accordingly, research shows that sleep - as opposed to wakefulness - enhances the retention of previously acquired emotional memories (Sopp, Michael, & Mecklinger, 2018). These effects are evident across different memory domains but are most pronounced for episodic memories, facilitating explicit, contextually rich memory recall (Atienza & Cantero, 2008; Drosopoulos, Wagner, & Born, 2005). However, specific studies also found the opposite pattern, indicating that a lack of sleep reduces implicit fear memories without affecting explicit memory recall (Kuriyama, Soshi, & Kim, 2010).

On a neurophysiological level, memory redistribution is assumed to occur during slow wave sleep (SWS), mediated by the propagation of slow oscillations and sleep spindles (Diekelmann & Born, 2010). However - in the context of emotional memory consolidation - empirical findings also suggest an involvement of rapid eye movement (REM) sleep (Hutchison & Rathore, 2015; Schäfer et al., 2020). Consonantly, REM theta activity (4–7 Hz) - the oscillatory signature of REM sleep - has been shown to correlate with post-sleep emotional memory performance (Nishida, Pearsall, & Walker, 2008; Sopp, Michael, Weess, &

Mecklinger, 2017). Beyond sleep's impact on memory retention, studies have also indicated that consolidation processes occurring during sleep may affect the emotional tone of memories. On the one hand, these processes have been suggested to reduce the affective tone of emotional memories (van der Helm & Walker, 2009). On the other hand, empirical findings have found sleep to preserve or even intensify the affective charge associated with emotional stimuli (Jones & Spencer, 2019; Pace-Schott et al., 2011).

Based on these findings, researchers have considered sleep after trauma as a potential target for reducing intrusive trauma memories (Pace-Schott et al., 2023). However, in light of the heterogeneity of empirical findings, the underlying assumptions and suggested interventions differ dramatically. One line of research (Kuriyama et al., 2010; Porcheret, Holmes, Goodwin, Foster, & Wulff, 2015) hypothesizes that sleep-related consolidation mechanisms strengthen implicit memory processes, thereby facilitating intrusion development after trauma. Consequently, sleep deprivation during the night after trauma is proposed as a prevention strategy (Cohen et al., 2023). Another line of research (e.g., Kleim et al., 2016; Sopp, Brueckner, Schäfer, Lass-Hennemann, & Michael, 2019; Zeng, Lau, Li, & Hu, 2021) suggests that - by selectively strengthening explicit rather than implicit trauma memories - sleep may reduce intrusion development. These effects are assumed to emerge because facilitating explicit, contextually rich recall should - in turn - inhibit stimulus-driven reactivation of sensory representations (Bisby & Burgess, 2017). Moreover, explicit contextually rich recall supports autonoetic awareness, which may prevent the "here and now" quality of any arising intrusions (Ehlers, 2010). Based on these assumptions, interventions promoting restful post-trauma sleep are proposed to reduce intrusions, and thereby the development of persistent PTSD symptoms.

So far, experimental research on the effects of post-trauma sleep on PTSD symptoms is limited to studies from the field of experimental psychopathology that employ different variants of the analog trauma paradigm. This paradigm involves exposing non-clinical participants to aversive stimuli (e.g., film clips or aversive pictures; Holmes & Bourne, 2008; James et al., 2016). These materials contain scenes depicting highly stressful or traumatic events (i.e., actual or perceived threat and serious injuries; American Psychiatric Association, 2022), which cause significant distress in most people. Many studies showed that exposure to such materials reliably elicits PTSD-like symptoms (e.g., intrusive memories, physiological arousal, negative cognitions; James et al., 2016), which normally reside after a few days. The analog trauma paradigm provides a tool for studying cognitive, emotional and memory processes involved in the onset and persistence of PTSD symptoms under controlled laboratory conditions. Moreover,

it allows examining potential targets of PTSD prevention and treatment (e.g., sleep manipulations). Beyond the advantage of high experimental control, previous research points to weaknesses of analog paradigms including ethical issues (Jaffe, DiLillo, Hoffman, Haikalis, & Dykstra, 2015; but see: Stirling, Nixon, & Takarangi, 2023) and a lack of ecological validity, preventing a transfer to real-world trauma (James et al., 2016). However, to date, analog trauma is the most widely used experimental paradigm to study processes involved in PTSD development and persistence, with a considerable number of successful translations to the clinical setting (Iyadurai et al., 2019; Woud et al., 2021). Also, in studies on the potential impact of post-trauma sleep, these studies allow for highest experimental control and are thus able to provide insights on underlying memory processes when real-world studies using experimental designs are not yet available. Moreover, real world studies on this topic bring about several (ethical and practical) issues, most prominently acceptance of acutely traumatized individuals to wear polysomnography devices and to be randomized to a sleep deprivation intervention (Repantis et al., 2020). Hence, it is important to finetune such interventions in a non-clinical setting, prior to attempting replication in the context of real-world trauma.

Two recently published reviews (Davidson & Marcusson-Clavertz, 2023; Larson, Schapiro, & Gehrmann, 2023) quantitatively summarize available evidence on the effects of post-trauma sleep on intrusive memories of analog trauma, both finding a small favorable effect of sleep over wakefulness on the number of intrusive memories (SMD = 0.26 in Davidson & Marcusson-Clavertz, 2023, based on 367 participant from 6 studies; SMD = 0.29 in Larson et al., 2023, based on 437 participants from 8 studies), and no effect of sleep for intrusion-related distress (SMD = –0.14 in Davidson & Marcusson-Clavertz, 2023). However, both reviews suffered from the small number of primary studies (with small sample sizes per study) and the unavailability of individual participant data (IPD), which prevented both a more in-depth analysis of the effects on intrusion frequency and intrusion distress as well as moderator analyses examining divergent findings from primary studies. The present systematic review aimed at addressing these gaps to shed further light on the effects of post-trauma sleep compared to wakefulness on intrusive memory based on the whole body of available evidence from experimental analog studies.

For this summary, researchers of the field have provided primary datasets of their studies, which were analyzed on study level (traditional meta-analysis based on aggregated data) and on participant level (IPD meta-analysis). While most systematic reviews and meta-analysis rely on aggregated (or summary) data extracted from published primary studies, IPD analyses use

original data from primary studies, which are re-analyzed in a combined model (Tierney, Stewart & Clark, 2022). These analyses have the potential to improve the quality of data and produce more reliable results (Stewart & Tierney, 2002). Among the greatest advantages of IPD analyses is their potential to examine participant-level moderators. While meta-analyses on aggregated data only examine the moderating effects of sample averages (e.g., mean sample age, gender balance per sample), IPD analyses have the potential to examine the association of participant-level moderators with individual-level effect estimates (Cuijpers et al., 2022). This is particularly promising in fields requiring high resources like sleep research, where statistical power in primary studies is often insufficient for complex statistical models and to examine participant-level moderators.

In our review, we replicate findings from Davidson and Marcusson-Clavertz (2023) as well as Larson et al. (2023) by means of traditional meta-analysis. However, beyond these traditional analyses, we conducted IPD analyses differentiating the involvement of sleep in the onset of intrusions (any vs. no intrusive memories) and the severity of intrusive memories among those who experience intrusions. In line with state-of-the-art approaches (Franke et al., 2021), we modelled two parameters; one estimating the probability of not experiencing (i.e. zero) vs. experiencing (i.e. non-zero) intrusions/intrusion distress; and the other estimating intrusion (distress) severity for individuals with intrusions >0 (see Figure 3.1). Thereby, we provide insights into the question of whether sleep may protect trauma-exposed individuals from the experience of any intrusive memory and/or might reduce the severity of intrusions among those who are sensitive to potentially traumatic events. Moreover, we combine our quantitative analyses with an in-depth qualitative summary focusing on associations of sleep physiology and intrusive memory as well as on potentially underlying processes in implicit and explicit memory of (analog) trauma. Thereby, our review aims at summarizing what is known and what is still unknown on the effects of post-trauma sleep on intrusive memories in order to path the way for future research in the field.

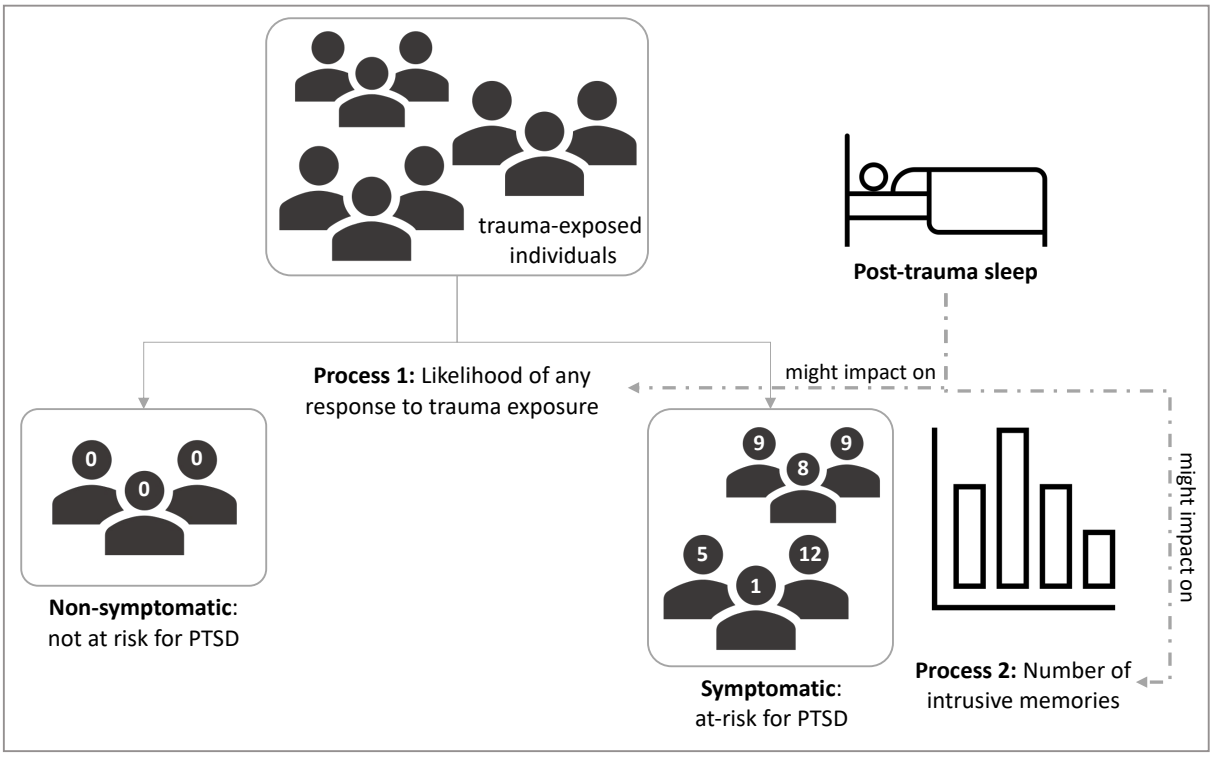
3.3. Methods

This systematic review was prepared in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Page et al., 2021) and recommendations for reporting IPD meta-analysis (Stewart et al., 2015). The review was registered retrospectively on the Open Science Framework (OSF; registration

https://doi.org/ 10.17605/OSF.IO/4DH2V, link to OSF project: https://osf.io/j2av3/), where we also provide the protocol, materials and aggregated data relevant to this review. Changes from registration to final review were only minor and are presented in Supplementary Material (A1).

Figure 3.1

Schematic illustration on the processes involved in the onset of intrusions. Post-trauma sleep could potentially impact on both, the likelihood of experiencing any versus no intrusion (process 1) and the severity of intrusions among those experiencing intrusive memories (process 2)



Literature search. Relevant search terms were identified by the research team to cover the most frequently used terms in the literature. Using these terms, a literature search based on title, abstract, and keywords was performed in six databases: EBSCOhost (PsycINFO and PsycARTICLES), PTSDpubs, PubMed, Scopus, and Web of Science (see Supplementary Material [A2] for search strings). Moreover, reference lists of included studies and related reviews were checked for eligible studies (Azza, Wilhelm, & Kleim, 2020; Davidson & Marcusson-Clavertz, 2023; Larson et al., 2023). Additionally, authors of studies included in the IPD analyses were asked if they were aware of other (un)published studies meeting our

inclusion criteria. A date-of-publication criterion was not defined. The most recent literature search was run on May 16th, 2022.

Selection criteria. Studies meeting the following criteria were included: 1) The experimental study reported on a sample that encoded aversive visual stimuli (e.g., trauma film, aversive pictures). 2) One group of participants subsequently underwent a post-trauma (or post-aversive stimuli) sleep opportunity, while another group stayed awake during the daytime or was exposed to (partial) sleep deprivation during the nighttime (e.g., REM sleep deprivation). 3) Following sleep or wakefulness, the frequency of intrusive memories was assessed using an intrusion diary or a laboratory intrusion assessment (e.g., intrusion triggering task[3]). 4) Participants were mentally healthy adults. Samples were excluded if 1) they exclusively investigated the effect of sleep in the context of specific memory tasks (e.g., think-no-think paradigm), or 2) the necessary data for effect size calculation were not available by May 16th, 2022 (for the meta-analysis on aggregated data) or December 31st, 2021 (for IPD meta-analysis).

Study selection. Authors CL, EF, and SKS screened titles/abstracts and full texts in duplicate for inclusion eligibility. The interrater agreement achieved for inclusion/exclusion decisions was excellent, kappa = 1.0 at both levels. Corresponding authors of all eligible studies were contacted and asked to provide raw data from their study to perform the IPD meta-analysis.

Data Extraction.

Meta-analysis on aggregated data. Using a standardized Excel form, data for each study was extracted by two independent coders (CL, EF). The interrater agreement for extracted data was excellent, *kappa* = 1.0 for *n*s, *M*s, and *SDs*. Data on intrusion distress were coded as a secondary outcome. For intrusion distress, we adopted the definition used in the original studies (e.g., Porcheret et al., 2015; participants were asked to rate the level of distress experienced with the intrusion from 0 = "not at all" to 10 = "extremely"). The only exception was the study by Werner, Schabus, Blechert, and Wilhelm (2021), for which aversiveness ratings served as an

[3] The intrusion triggering task (ITT) is a paradigm that simulates intrusive memories triggered by trauma reminders in everyday life of PTSD patients. During the ITT, auditory fragments of the aversive picture stories are presented while participants are engaged in an ongoing task (e.g., face rating test unrelated to the aversive material). While participants performed the rating, task sentence fragments from the picture stories or from an unrelated source are presented via headphones. Participants are instructed not to pay attention to these sounds. After the task ends, participants are asked to indicate the number of intrusions that they had experienced during the task. For more details see: Sopp et al. (2019); Sopp et al. (2021); Streb et al. (2017); Wegerer et al. (2013)

index of intrusion distress. Other coded variables were related to study characteristics (e.g., type of wake group) or sample characteristics (e.g., participants' mean age, percentage of female participants).

Individual participant data meta-analysis. Two independent team members (CL, student research assistant) extracted IPD based on generic standardized Excel forms and integrated single study datasets into one individual participant dataset. All disagreements between coders were resolved through discussion or consultation of a third reviewer (RS, SKS), and in unclear cases, study authors were contacted to provide additional information. All data were checked for integrity by one team member (e.g., data for primary and secondary outcomes within reasonable range, consistent reporting of covariates), with no evidence for issues with data quality.

Data Synthesis.

Qualitative synthesis. We performed a narrative synthesis of study findings on intrusion frequency and intrusion distress. For this purpose, we clustered studies based on different study designs: 1) sleep versus total sleep deprivation during nighttime; 2) sleep versus wakefulness during daytime (and nighttime); 3) sleep versus partial sleep deprivation during nighttime; and 4) nap vs. wakefulness. Subsequently, we summarize associations between sleep physiology and intrusions narratively and report on effects on explicit and implicit trauma memory based on the differentiation proposed by Kuriyama et al. (2010). The narrative synthesis was performed by the last author (RS) and was checked by the first author (SKS).

Quantitative synthesis. Combining meta-analysis on aggregated data and IPD, our analyses compared results from data reported in individual studies (i.e., meta-analysis on aggregated data) and those obtained from multilevel analyses (i.e., IPD meta-analysis). The former allowed for the inclusion of all eligible studies, while the latter allowed for modeling two processes (i.e., occurrence of intrusions and severity of intrusions) and participant-level moderators (e.g., participants' age, gender; Mathew & Nordström, 2010). All analyses were performed in *R* version 4.1.3 (R Core Team, 2020). Analytic code and aggregated data are available at the OSF (https://osf.io/j2av3/). Due to data privacy reasons, data for the IPD analyses will be made available upon reasonable request by the study authors.

Manipulation check for negative mood. First, we used IPD to check whether the exposure to analog trauma resulted in a significant increase in negative mood. This analysis was performed using the *R* package *lme4* (Bates, 2010) and employed a multilevel model with

time and group as fixed effects and a random intercept and slope for study. We expected negative mood to increase from pre-to-post exposure to the traumatic material, without any difference between experimental groups (i.e., sleep vs. wake group).

Meta-analysis on aggregated data. Meta-analyses on aggregated data were performed using the *R* package *metafor* (Viechtbauer, 2010). To mirror findings from a meta-analysis solely based on published findings, these analyses used data reported in published articles (e.g., *M*s reported in a table of the publication). *M*s and *SDs* were only calculated from IPD in case no other information was available.

Effect size calculation. For effect size calculation, experimental groups per study were chosen to be as similar as possible across studies. In case there was more than one condition relevant to our research question, they were either combined or we selected the one that is most comparable to other studies. As most of the studies did not comprise more than two conditions, we decided not to use multilevel meta-analyses (van den Noortgate, López-Lopéz, Marín-Martínez, & Sánchez-Meca, 2015). The meta-analyses used log-transformed *ratio of means* (log-ROMs) and corresponding sampling variances as effect size measures (Friedrich, Adhikari, & Beyene, 2011), with positive log-ROMs indicating that intrusion frequency or distress were lower in the sleep as compared to the wake group. For illustrative purpose, we transformed log-ROMs to ROMs that express the percentage increase in the mean value of intrusion frequency and distress of the wake group relative to the sleep group. We decided to use log-ROMs instead of *standardized mean differences* (SMDs) as our IPD analyses revealed that raw data for intrusion frequency and intrusion distress followed non-normal distributions and recent simulation studies found non-normality from primary studies to bias SMD estimates (Sun & Cheung, 2020). We used 95% confidence intervals (CIs) as indicator of significance. For all analyses, we used forest plots for visualization.

Main analyses and heterogeneity. All analyses used maximum likelihood estimations, weighted studies based on an inverse-variance approach, and relied on random-effects models that allow for true between-study variance (Field & Gillett, 2010). Residual heterogeneity of study effects was indicated by Cochran's Q statistic (i.e., weighted sum of squared differences between the observed effects and the weighted mean effect size, which can be tested for statistical significance, whereby a significant Q statistics indicates substantial heterogeneity), and I^2, which expresses heterogeneity as percentage (0–100%; Higgins, Thompson, Deeks, Altman, 2003). I^2 reflects the proportion of variance that reflects true

variance in effect sizes rather than sampling error (Borenstein, Higgins, Hedges, & Rothstein, 2017), with values of 50% and above indicating substantial between-study heterogeneity (Deeks, Higgins, & Altman, 2022).

Outliers and influential cases. Outliers and influential cases were identified based on studentized deleted residuals (SDRs), Cook's distances (CD), and covariance ratios (COVRATIO). SDRs below and above ± 1.96, CD values > 0.45, and COVRATIOs <1 were considered as outlier or influential case (Cook & Weisberg, 1982; Viechtbauer & Cheung, 2010).

Moderator analyses. The impact of study-level moderators (i.e., mean age, gender distribution, number of follow-up assessments in days) was investigated by meta-regressions for continuous variables, with significance being assessed using *QM* statistics. Subgroup analyses for categorical moderators were not performed due to the small number of studies per subgroup.

Meta-analysis on individual participants data.

Effect size calculation. Analyses followed a one-step approach, that is, analyses were performed on a merged dataset containing all IPD with participants being clustered in studies (Mathew & Nordström, 2010). IPD meta-analysis was performed using the *R* packages *GLMMapdative* (Rizopoulos, 2019), *glmmTMB* (Brooks et al., 2017), and *DHARMa* (Hartig, 2020). We conducted separate multilevel analyses to examine the effect of sleep versus wakefulness on intrusion frequency (Model 1, primary outcome) and intrusion distress (Model 2, secondary outcome). Intrusion frequency and intrusion distress were used as dependent variables and group as independent variable. For intrusion frequency, we used the absolute number of reported intrusions. For intrusion distress, we divided the severity of reported distress levels by the number of intrusions, whose result was further divided by the range of distress assessment (i.e., intrusion distress = [total score of reported distress/frequency of intrusions]/range of distress assessment). This resulted in scores ranging from 0 to 1, with 1 indicating maximum distress for each intrusion on the respective scale. Participants who did not experience any intrusion were removed from this analysis.

Model selection and diagnostics. All models were examined to fit our data based on residual distributions (i.e., under- and overdispersion, zero-inflation, normal distribution [Kolmogorov-Smirnov]; Borhan et al., 2020; Perumean-Chaney, Morgan, McDowall, & Aban, 2013). For intrusion frequency as count variable, our analyses used zero-inflated negative

binominal models (see Supplementary Materials [A3] for details on model selection). For intrusion distress as a continuous variable, we employed a hurdle model for semi-continuous data. Those models allowed to differentiate two processes: First, the occurrence of any vs. no intrusion/intrusion distress; and second, the number of intrusion or the severity of intrusion distress (in cases where at least one intrusion/at least some distress was present; see Figure 3.1 for an illustration). All models allowed for random intercepts per study. The inclusion of random slopes per study was evaluated based on the change in model fit using a likelihood ratio test (LRT).

Outliers. Outliers were examined as part of the residual diagnostics.

Moderator analyses. We examined the effects of participant-level variables on the intrusion frequency, intrusion distress and their interaction with the group (moderator effect). The moderators include age, gender, depressive symptoms at baseline, and increases in negative mood due to aversive stimuli. Cluster mean centering was applied for all participant-level moderators.

Quantitative synthesis. Combining meta-analysis on aggregated data and IPD, our analyses compared results from data reported in individual studies (i.e., meta-analysis on aggregated data) and those obtained from multilevel analyses (i.e., IPD meta-analysis). The former allowed for the inclusion of all eligible studies, while the latter allowed for modeling two processes (i.e., occurrence of intrusions and severity of intrusions) and participant-level moderators (e.g., participants' age, gender; Mathew & Nordström, 2010). All analyses were performed in *R* version 4.1.3 (R Core Team, 2020). Analytic code and aggregated data are available at the OSF (https://osf.io/j2av3/). Due to data privacy reasons, data for the IPD analyses will be made available upon reasonable request by the study authors.

Risk of bias assessment.

Publication bias. Results of meta-analyses may overestimate the true population effect due to publication bias (DeVito & Goldacre, 2019). To reduce its potential impact, our search also included grey literature (i.e., dissertations, preprints) and study authors were asked for available unpublished data. Although the number of studies was small ($k = 9$), publication bias was assessed on an exploratory basis for the meta-analysis on aggregated data using visual inspection of funnel plots and rank correlation tests (Kendall's τ) to examine their symmetry (Egger, Smith, Schneider, & Minder, 1997). A significant rank correlation test provides evidence for the presence of a publication bias. In addition, we used contour-enhanced funnel

plots to examine if "missing" studies would fall into the area of non-significant findings (Peters, Sutton, Jones, Abrams, & Rushton, 2008).

Internal risk of bias. Meta-analytical findings can be biased by insufficient study quality such as flaws in study design, analysis, or reporting (Higgins et al., 2011). Since standard internal-bias assessment checklists were not applicable, we used an adapted version of a quality checklist developed for a meta-analysis on the impact of sleep on emotional memory (Schäfer et al., 2020). The 11-item checklist is based on state-of-the-art criteria in sleep research (e.g., study design, control of wake/sleep deprivation conditions). Study quality as indicator of internal risk of bias was rated independently by two raters (CL, student research assistant). Ratings could range between 0 and 1, with higher scores indicating better quality (i.e., lower risk of bias). Meta-regression was used to statistically examine the impact of internal risk of bias on the effect estimates.

Certainty of evidence. The certainty of evidence for intrusion frequency and intrusion distress was assessed in duplicate using an adapted version of GRADE (Grading of Recommendations, Assessment, Development and Evaluations; Schünemann et al., 2022). We used the internal risk of bias assessment described above for the GRADE domain "risk of bias". To assess imprecision, we calculated optimal information sizes based on standard recommendations (Garcia-Alamino, Bankhead, Heneghan, Pidduck, & Perera, 2017). Certainty of evidence can either be very low, low, moderate, or high.

Sensitivity analyses. To examine the robustness of our findings, we performed sensitivity analyses investigating the impact of analytic decisions. We decided to use log-ROMs as effect size measure of our meta-analysis. However, we re-ran our meta-analyses on aggregated data using SMDs as check for robustness. Moreover, as statistical approaches varied between primary studies (i.e., Poisson regressions; Porcheret et al., 2015; *t*-tests; Sopp et al., 2021), we examined if our results from the IPD meta-analysis depended on modeling decisions. For this purpose, we recalculated our analyses based on comparable distributions (i.e., intrusion frequency: negative binominal hurdle model; intrusion distress: zero-inflated gamma model).

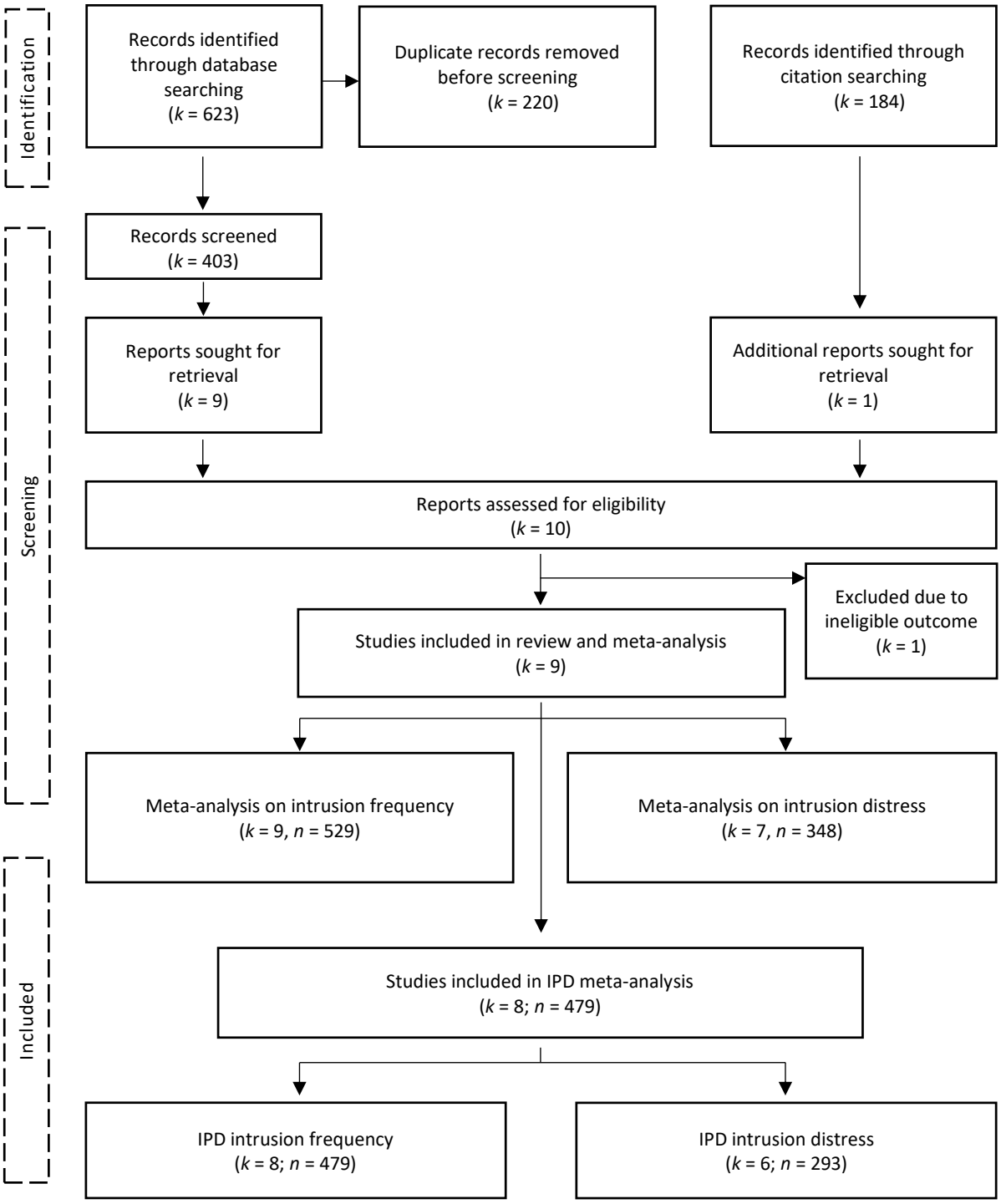
3.4. Results

Search results and study characteristics. The study selection procedure is illustrated in the PRISMA flowchart (see Figure 3.2). Our search in six databases yielded 623 records, of which 220 were removed as duplicates. Four-hundred-three records were screened at

title/abstract level and another 184 records were identified via citation searching, with 10 being assessed at full-text level. Nine studies were included in our review and our meta-analysis on aggregated data (see Table 3.1); eight in our meta-analysis on IPD. Data of one study (Kleim et al., 2016) could not be obtained for IPD meta-analysis. All studies were published between 2015 and 2021. Three studies (Porcheret et al., 2015; Porcheret al., 2019; Zeng et al., 2021) examined the effects of sleep versus total sleep deprivation during nighttime. Two studies investigated the effect of sleep versus wakefulness during the daytime (or daytime and nighttime; Kleim et al., 2016; Sopp et al., 2021). Another two trials studied the effects of sleep versus partial sleep deprivation during nighttime (Sopp et al., 2019; Werner et al., 2021) and two studies examined the effects of nap sleep versus wakefulness (Wilhelm et al., 2021; Woud et al., 2018).

Figure 3.2

PRISMA Flowchart of the Study Selection Process



Note. Lastly updated on May 16th, 2022. IPD = individual participant data, k = number of studies, *n* = number of participants.

Qualitative summary.

Effects on intrusion frequency and intrusion distress. Effects on intrusion frequency and intrusion distress as reported in primary studies are summarized based on different study designs.

Sleep versus total sleep deprivation during nighttime. Three studies investigated the effect of total sleep deprivation versus sleep during the first night after analog trauma on subsequent intrusive memories (Porcheret et al., 2015, 2019; Zeng et al., 2021). In the first study on this subject, Porcheret et al. (2015) exposed participants to a traumatic film after which they either returned home to sleep or underwent a full night of sleep deprivation in the laboratory (see Table 3.1 for study characteristics). Results demonstrated significantly higher intrusion frequencies in the sleep group than in the sleep deprivation group. These effects were evident on the first two days after exposure to the trauma film including the period of acute sleep deprivation. In addition, distress ratings as assessed by the Impact of Event Scale-Revised (Weiss, 2007) were significantly higher in the sleep than in the sleep deprivation group. In a follow-up study to their first experiment, Porcheret et al. (2019) reinvestigated the effects of sleep as opposed to sleep deprivation on analog intrusions. Their design was largely identical to their 2015 study with the exception that sleep deprivation was conducted at home rather than at the lab. Analyses revealed different effects, depending on the inclusion of the high rate of participants who slept to some extent in the sleep deprivation group. Without excluding these participants, results did not reveal any consistent differences between groups. After their exclusion, analyses showed significantly lower intrusion frequencies in the sleep group than in the sleep deprivation group. No differences emerged for intrusion distress. Finally, using a similar design, Zeng et al. (2021) reinvestigated the impact of sleep versus full night sleep deprivation at the lab on intrusive memories of a traumatic film. Results showed fewer intrusions in the sleep than in the sleep deprivation group but revealed no difference in intrusion distress.

Table 3.1 *Study and Sample Characteristics of Studies Included in Meta-analysis on Aggregated Data*

Study	Participants	$n_{sleep,}$ ($n_{intrusion}$)	$n_{wake,}$ ($n_{intrusion}$)	Age *M*(*SD*)	% female	Aversive stimuli	Outcome assessment	Follow-up (days)	Sleep duration (min)	Sleep design	Sleep recording	Sleep context	Results as reported	Risk of bias[5]
1. Sleep vs. total sleep deprivation during nighttime														
Porcheret et al., 2015	mentally healthy students with normal sleep quality and no extreme diurnal preference, no participation in a similar study	21 (17; 81%)	18 (12; 67%)	21.53 (1.95)	70.73	Trauma film (15-min compilation of traumatic and distressing clips depicting scenes like suicide, bullying, injury, cutting to the face)	IF/ID: paper-and-pencil diary	6	NA	Nocturnal sleep	AG	home	IF: ↓; ID: ↓	low
Porcheret et al., 2019	mentally healthy young adults with normal sleep quality and no extreme diurnal preference, no participation in a similar study	24 (17; 71%)	26 (22; 85%)	24.18 (3.73)	54.00	Trauma film (15-min compilation of 11 traumatic and distressing clips depicting scenes of a car crash, self-harm and genocide)	IF/ID: paper-and-pencil diary	6	433.20	Nocturnal sleep	AG, PSG	home	IF: – (↓)[6]; ID: –	low
Zeng ent al., 2021[1]	mentally and physically healthy young adults (mostly university students) with normal sleep quality	30 (15; 50%)	30 (18; 60%)	20.50 (2.02)	68.33	Trauma film (a 14-min film of 9 aversive clips depicting fatal accidents (e.g., car and plane crashes, train wreck)	IF/ID: online diary (and lab-based intrusion monitoring task)	7	403.62	Nocturnal sleep	AG	home	IF: ↑; ID: –	high

Table 3.1 (continued.)

Study	Participants	$n_{sleep,}$ ($n_{intrusion}$)	$n_{wake,}$ ($n_{intrusion}$)	Age *M*(*SD*)	% female	Aversive stimuli	Outcome assessment	Follow-up (days)	Sleep duration (min)	Sleep design	Sleep recording	Sleep context	Results as reported	Risk of bias[5]
2. Sleep vs. wakefulness during daytime or day- and nighttime														
Kleim et al., 2016 (not included in IPD)	mentally healthy young females, recruited via newspapers, no lifetime trauma exposure	32 (32; 100%)	33 (33; 100%)	23.80 (3.09)	100	Trauma film (12 min from 'Irreversible' showing physical and sexual violence)	IF/ID: paper-and-pencil diary	7	420.00	Nocturnal sleep	PSG	home	IF: ↑; ID: ↑	high
Sopp et al., 2021	mentally and physically healthy students with normal sleep quality and no extreme diurnal preference, no lifetime trauma exposure	38 (34; 89%)	37 (35; 95%)	22.51 (2.98)	82.66	Traumatic picture stories (including 12 negative pictures from the International Affective Picture System and the Nencki Affective Picture System database showing a mutilated or heavily injured person)	IF: ITT	1	447.70	Nocturnal sleep	PSG	lab	IF: ↑; ID: not assessed	high
3. Sleep vs. partial sleep deprivation														
Sopp et al., 2019[2]	mentally healthy students with normal sleep quality and no extreme diurnal preference, no participation in a similar study	21 (12; 57%)	20 (16; 80%)	22.44 (2.50)	65.85	Traumatic picture stories (including five negative pictures from the International Affective Picture System showing a mutilated or heavily injured person)	IF: ITT	1	217.86	Nocturnal sleep	PSG	lab	IF: ↑; ID: not assessed	low
Werner et al., 2021[3]	mentally healthy young females (mostly university students) with normal sleep quality	28 (23; 82%)	21 (19; 90%)	22.32 (3.16)	100	Aversive pictures (20 negative pictures from the International Affective Picture System, mean valence 1.64 [range 1–9])	IF/ID: Intrusion Memory Questionnaire (paper-and-pencil)	3	26.58	Nap	PSG	lab	IF: ↑; ID: ↑	low

Table 3.1 (continued.)

Study	Participants	$n_{sleep,}$ $(n_{intrusion})$	$n_{wake,}$ $(n_{intrusion})$	Age *M*(*SD*)	% female	Aversive stimuli	Outcome assessment	Follow-up (days)	Sleep duration (min)	Sleep design	Sleep recording	Sleep context	Results as reported	Risk of bias[5]
4. Nap sleep vs. wakefulness														
Wilhelm et al., 2021	mentally healthy young females, recruited at the university, no lifetime trauma exposure and normal sleep quality	33 (33; 100%)	23 (23; 100%)	23.50 (0.70)	100	Trauma film (12 min from 'Irreversible' showing physical and sexual violence)	IF/ID: paper-and-pencil diary	7	64.42	Nap	PSG	lab	IF: –; ID: – (↑)[7]	low
Woud et al., 2018[4]	mentally healthy young adults, no lifetime trauma exposure and normal sleep quality	51 (42; 82%)	43 (39; 91%)	23.09 (3.65)	76.60	Trauma film (a compilation of distressing clips depicting serious and life-threatening injuries and violence)	IF/ID: paper-and-pencil diary	7	41.42	Nap	PSG	lab	IF: ↑; ID: –	high

Note. ↑: effect in favor of sleep over wakefulness/ sleep deprivation, i.e., fewer intrusive memories or less severe intrusion distress; ↓: effect in favor of wakefulness/ sleep deprivation over sleep, i.e., fewer intrusive memories or less severe intrusion distress; –: no evidence for a difference between sleep and wakefulness/ sleep deprivation. AG = Actigraphy; IF = intrusion frequency; ID = intrusion distress; ITT = Intrusion Triggering Task (based on Streb et al., 2017; Wegerer et al., 2013); *n* = number of participants; NA = not available; PSG = polysomnography.

[1] The study by Zeng et al. (2021) reported data on more than one intrusion measure. In this case, we chose the diary assessment as most similar to the majority of included studies.

[2] Due to the partial nighttime sleep deprivation design employed by Sopp et al. (2019), second night half sleep duration is reported as sleep duration.

[3] The study of Werner et al. (2021) comprised more than one group that underwent post-trauma sleep or sleep deprivation. For the purpose of our meta-analysis, we chose the groups most similar to other studies (i.e., REM sleep deprivation and REM sleep) to reduce between-study heterogeneity. For our moderator analysis on sleep duration, we subtracted the sleep duration of the REM sleep deprivation group from the sleep duration of the REM sleep group (i.e, 80.38 min – 53.80 min = 26.58 min).

[4] The study by Woud et al. (2018) reported data on participants that received either positive or negative cognitive bias modification training. As this intervention was not of interest for our meta-analysis, both sleep and wake groups were combined.

[5] Risk of bias ratings reflect inverse measures of study quality, that is, 1 – study quality. Studies with quality ratings > 0.77 were assumed to have low risk of bias, studies with quality ratings < 0.77 were rated as high risk of bias.

[6] Porcheret et al. (2019) found evidence for a difference in favor of sleep deprivation over sleep when they excluded participants from analyses that slept at least for short periods during sleep deprivation at home.

[7] Wilhelm et al. (2019) found in a secondary analysis that participants in the sleep group that reached REM sleep reported lower intrusion distress.

Sleep versus wakefulness during daytime. Two studies investigated the effects of sleep as opposed to wakefulness during daytime or both day- and nighttime. In the study of Kleim et al. (2016), participants were exposed to a traumatic film and either had a full night of sleep at home afterwards or were deprived of sleep. Half of the wake group was exposed to the trauma film in the evening and was subsequently sleep deprived during the night, whereas the other half was exposed to the trauma film in the morning and subsequently remained awake during the day. Wakefulness during the daytime versus nighttime did not affect outcome measures, allowing to collapse these subgroups for further analyses. Analyses of 7-day diary data revealed lower intrusion frequencies in the sleep than in the wake group, with the effect being most pronounced on days 3–7 indicating a delayed benefit of sleep. Groups also differed in intrusion distress with the sleep group reporting significantly lower ratings than the wake group. Sopp et al. (2021) investigated the impact of sleep as opposed to wakefulness on analog intrusions during the daytime. After being exposed to traumatic picture stories, participants either had a full night of sleep (50% at the lab, 50% at home) or a 12-h period of wakefulness during daytime. Groups did not differ in intrusion frequency in an intrusion triggering task.

Sleep versus partial sleep deprivation. Two studies investigated the effect of sleep as opposed to partial sleep deprivation on analog intrusions. In the study by Sopp et al. (2019), participants viewed traumatic picture stories prior to a full night sleep or a limited sleep opportunity with sleep deprivation during the second night half systematically reducing the amount of REM sleep (Ekstrand, Barrett, West, & Meier, 1977). Intrusions were assessed in the morning using an intrusion triggering task showing lower intrusion frequency in the sleep than in the partial sleep deprivation group. Werner et al. (2021) similarly manipulated sleep duration to compare participants that underwent a nap with REM sleep, a nap with REM awakening, and a nap without REM sleep at the lab after having been exposed to traumatic pictures. Analyses revealed significantly reduced intrusions (number and duration) in the REM sleep group and REM awakening group as compared to the no REM sleep group on day 3. Groups also differed in intrusion distress (i.e., aversiveness), with the REM sleep and the REM awakening group showing lower distress.

Nap sleep versus wakefulness. Finally, two studies compared the effects of nap sleep with wakefulness during the daytime. Wilhelm et al. (2021) investigated the effect of a 90-min nap in the lab as opposed to a 90-min wake period during the daytime on intrusive memories of a trauma film. Intrusion frequency and distress did not differ between groups. In a secondary analysis, the authors found that participants who reached REM sleep reported lower intrusion

distress than those with no REM sleep or no sleep at all. There was no evidence for an effect of sleep on intrusion frequency. In another study by Woud et al. (2018), participants viewed a traumatic film and were then subjected to a cognitive bias modification training. Subsequently, they were either given a nap opportunity of 90 min at the lab or remained awake. Collapsing effects across training groups provided evidence for an effect of nap sleep on intrusive memories, with participants of the nap group reporting fewer intrusions than their wake counterparts. No differences emerged for intrusion distress.

The relationship between sleep physiology and intrusions. Four studies assessed polysomnography and reported on associations of sleep physiology and intrusions (see Supplementary Material [A4] for detailed results). Of these, one study provided support for a role of slow wave sleep (SWS) in intrusive memories. Sopp et al. (2021) found that a longer SWS duration (% and min) was associated with fewer intrusions (n = 38). Werner et al. (2021) provided support for the involvement of REM sleep, finding longer REM sleep duration (% and min) to be associated with fewer and less aversive intrusions (on day 3) as well as shorter intrusion duration (n = 68). Two studies provided evidence for the involvement of both Non-REM and REM sleep. Kleim et al. (2016) found evidence for negative correlations between stage 2 sleep and parietal fast sleep spindles (13–15 Hz) and intrusion frequency (n = 18). By contrast, they found that stage 1 sleep, more time spent awake after sleep onset, and REMs were linked to more intrusions. Wilhelm et al. (2021) reported that more REM sleep and higher slow wave activity were correlated with less intrusion distress (n = 32).

Effects on explicit and implicit analog trauma memory. Our summary follows the differentiation of explicit and implicit trauma memory by Kuriyama et al. (2010). A more detailed version of this summary can be found in Supplementary Material (A5).

Effects of sleep on explicit analog trauma memory. Two studies investigated the impact of sleep during the nighttime on explicit trauma memory using a visual recognition memory test (Porcheret et al. 2019; Zeng et al., 2021). Porcheret et al. (2019) examined visual recognition memory for the trauma film at day 2 using images from the trauma film and new images. Analyses indicated that participants of the sleep group recognized more images from the trauma film than participants from the sleep deprivation group. Zeng et al. (2021) conducted an immediate (day 1) and delayed (day 8) recognition memory test using screenshots from the trauma film as old stimuli (50% aversive scenes, 50% neutral scenes) together with screenshots from similar, but unwatched films as new stimuli. Analyses revealed that participants of the sleep group had better recognition memory (i.e., higher rate of correct rejection to new pictures)

than participants of the sleep deprivation group on day 1, while no differences emerged on day 8. Two studies investigated the impact of sleep on explicit trauma memory using a visual recognition memory test that differentiated between divergent retrieval processes, that is, recollection- and familiarity-based retrieval (Yonelinas, 2002). Sopp et al. (2019) assessed explicit memory of traumatic picture stories by presenting objects that had been embedded into the picture stories and new objects. After awakening or sleep deprivation in the second night half, participants were asked to indicate for each object whether it had been presented in the picture stories ('old') or not ('new'). For each object that they identified as 'old', they were asked to indicate whether their recognition judgement was based on *remembering* details of its previous presentation or on a feeling of *knowing*. Analyses revealed that participants of the sleep group showed higher recollection-based recognition memory than participants of the partial sleep deprivation group, while no difference emerged for familiarity-based recognition. In a follow-up study, Sopp et al. (2021) investigated explicit memory for relevant and irrelevant objects presented in the traumatic picture stories. Participants were exposed to picture stories with relevant and irrelevant objects, which were supplemented with new items during a recognition test. Results revealed higher recognition memory for relevant, but not irrelevant, objects in the sleep as compared to the wake group.

Two studies investigated the impact of (nap) sleep as opposed to wakefulness during the day- or nighttime on explicit trauma memory using a verbal recognition memory test based on questions or statements on the trauma film (Porcheret et al., 2019; Woud et al., 2018). Both studies found no differences between sleep and wake groups.

Effects of sleep on implicit analog trauma memory. One study investigated the impact of sleep as on implicit trauma memory, assessed in terms of processing fluency. Sopp et al. (2019) presented half of the objects from the traumatic picture stories and distractor objects in a blurred picture identification task, where participants should label the blurred objects as soon as they recognized them. No evidence for a between-group difference emerged. Four studies investigated the impact of (nap) sleep on implicit trauma memory, assessed in terms of fear ratings (Porcheret et al., 2019; Werner et al., 2021; Wilhelm et al., 2021; Zeng et al., 2021), with no strong evidence for between-group differences. Wilhelm et al. (2021) used pictures from the trauma film to assess emotional responses 8 days after exposure. Before and after viewing aversive pictures, subjective mood and arousal were measured by visual analog scales as well as current affective state using a questionnaire. Analyses revealed that mood generally

decreased across presentation and that this effect was less pronounced in the nap group as compared to the wake group.

Quantitative summary.

Sample characteristics. The final meta-analysis on aggregated data comprised nine studies (N = 529, n_{sleep} = 278, n_{wake} = 251) for intrusion frequency and seven for intrusion distress (N = 348, n_{sleep} = 179, n_{wake} = 169). The meta-analysis on IPD comprised eight studies (N = 479, n_{sleep} = 247, n_{wake} = 232) for intrusion frequency and six studies for intrusion distress (N = 293, n_{sleep} = 150, n_{wake} = 143). The weighted mean age was 22.71 years (SD = 2.73) for the meta-analysis on aggregated data (22.53 years, SD = 3.34, for the IPD meta-analysis), and 80.60% were female (78.03% for the IPD meta-analysis).

Manipulation check for negative mood. Our meta-analysis on IPD allowed us to examine whether the exposure to aversive stimuli resulted in an increase in negative mood. Across all studies, negative mood increased by 23.6% from pre-to-post exposure. A linear mixed model with random intercept and slope per study revealed a significant increase in negative mood, b = 0.11, 95% CI [0.06, 0.15], p = .002, that was independent from experimental group, b = 0.00, 95% CI [-0.02, 0.03], p = .724.

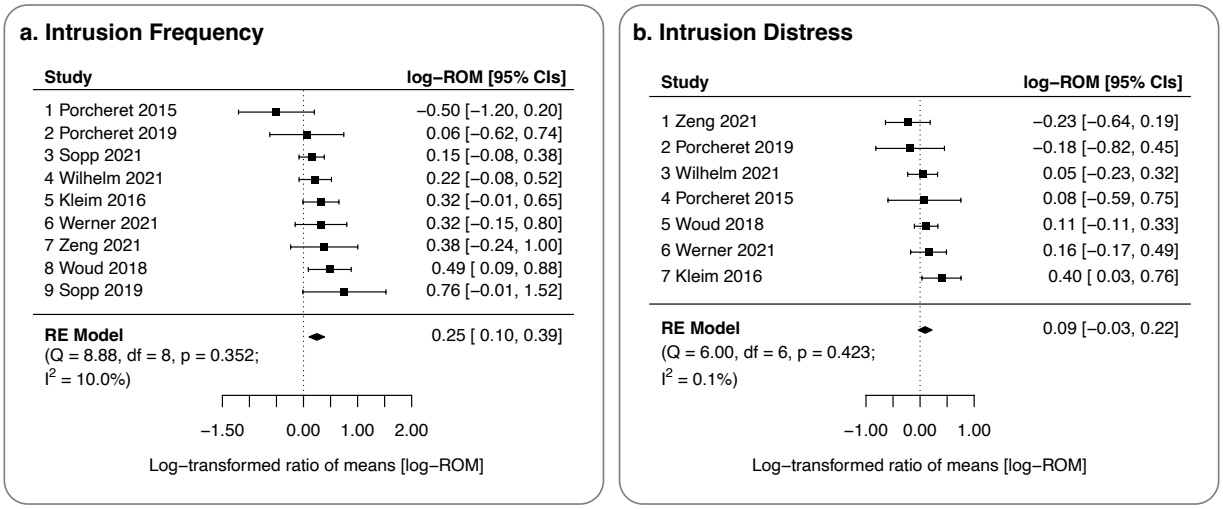
Meta-analysis on aggregated data.

Main analyses: ***Intrusion frequency.*** The forest plot presented in Figure 3.3a displays the effect sizes and CIs of all samples. Effect estimates ranged from –0.50, 95% CI [–1.20, 0.20] to 0.76, 95% CI [–0.01, 1.52]. Most effect estimates (8 out of 9; 89%) were numerically positive, that is, participants who underwent post-trauma sleep as compared to wakefulness experienced fewer intrusions. Table 3.2 presents the results of the main meta-analysis using a random-effects model. The analysis provided evidence for an effect of sleep on intrusion frequency, log-ROM = 0.25, 95% CI [0.10, 0.39], p < .001. Participants in the sleep groups experienced 28% fewer intrusions than those in the wake groups. There was no evidence of heterogeneity of effect sizes as indicated by a non-significant Q statistic, $Q(8)$ = 8.88, p = .352, and a I^2 of 10.0%. This absence of heterogeneity supports the generalizability of the findings beyond the included studies to the wider population. Certainty of evidence for the primary outcome was moderate due to the increased risk of bias resulting from the inclusion of nonrandomized studies (see Supplemental Material [A6]).

Main analyses: **Intrusion distress**. The forest plot presented in Figure 3.3b shows the effect estimates and CIs of all samples included in the analysis on intrusion distress. Effect estimates ranged from –0.23, 95% CI [–0.64, 0.19], to 0.40, 95% CI [0.03, 0.76]. Five out of seven effect sizes (71%) were numerically positive, that is, participants who were in the post-trauma sleep group reported lower levels of distress than those in the wake group. The meta-analysis provided no evidence for an effect of sleep compared to wakefulness on intrusion distress, log-ROM = 0.09, 95% CI [–0.03, 0.22], $p = .145$. There was no significant heterogeneity as shown by a non-significant Q statistic, $Q(6) = 6.00$, $p = .423$, and a I^2 of 0.1%. Certainty of evidence for intrusion distress was very low due to the inclusion of nonrandomized studies and imprecision (see Supplementary Material [A6]).

Figure 3.3

Forest Plots of Meta-Analyses on Intrusion Frequency and Intrusion Distress



Note. Forest plots of the meta-analysis on aggregated data on (a.) intrusion frequency and (b.) intrusion distress. CI = confidence interval; M(log-ROM) = log-transformed ratio of means; RE Model = random effects model.

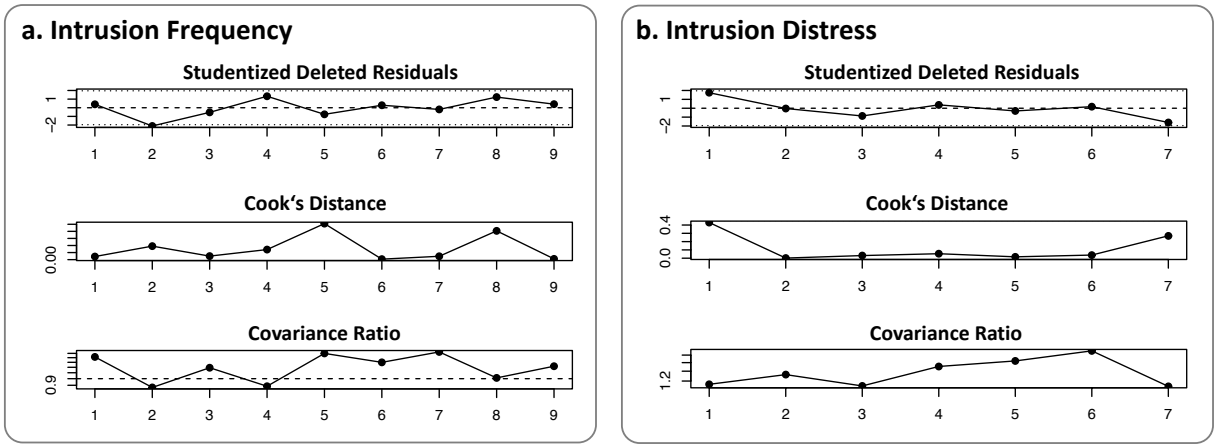
Table 3.2 *Results of the Meta-Analysis on Aggregated Data*

Analysis				95% CI						
	N/n	***k***	**EE**	**lower**	**upper**	***p***	***Q***	**df**	***p(Q)***	I^2	**Certainty**
1. Main analysis (log-ROM)											
Intrusion frequency	529	9	0.25	0.10	0.39	< .001	8.88	8	.352	9.95	⊕⊕⊕◯ **Moderate**
			ROM = 1.28	1.11	1.48						
Intrusion distress	348	7	0.09	−0.03	0.22	.145	6.00	6	.423	0.05	⊕◯◯◯ **Very low**
			ROM = 1.10	0.97	1.25						
2. Sensitivity analysis (SMD)											
Intrusion frequency	529	9	0.31	0.13	0.48	< .001	8.08	8	.426	0.94	⊕⊕⊕◯ **Moderate**
Intrusion distress	348	7	0.15	-0.06	0.36	.168	5.86	6	.439	0.00	⊕◯◯◯ **Very low**

Note. EE = effect estimate; *N*/*n*= number of participants; *k* = number of studies; log-ROM/SMD = log-transformed ratio of means/standardized mean difference; ROM = ratio of means; *p* = significance value of log-ROM/SMD; 95% CI = 95% confidence interval; *Q* = *Q* statistic; df = degrees of freedom of Q statistic; *p(Q)* = significance value of *Q* statistic; I^2 = percentage of heterogeneity reflecting true effect size variance. The certainty column shows the overall GRADE rating (see Supplementary Material [A3] for details).

Figure 3.4

Outlier and Influence Diagnostics for the Meta-Analyses on Intrusion Frequency and Intrusion Distress



Note. Influence diagnostics of the meta-analysis on aggregated data on (a.) intrusion frequency and (b.) intrusion distress. Study numbers per outcome correspond to those presented in Figure 3.2.

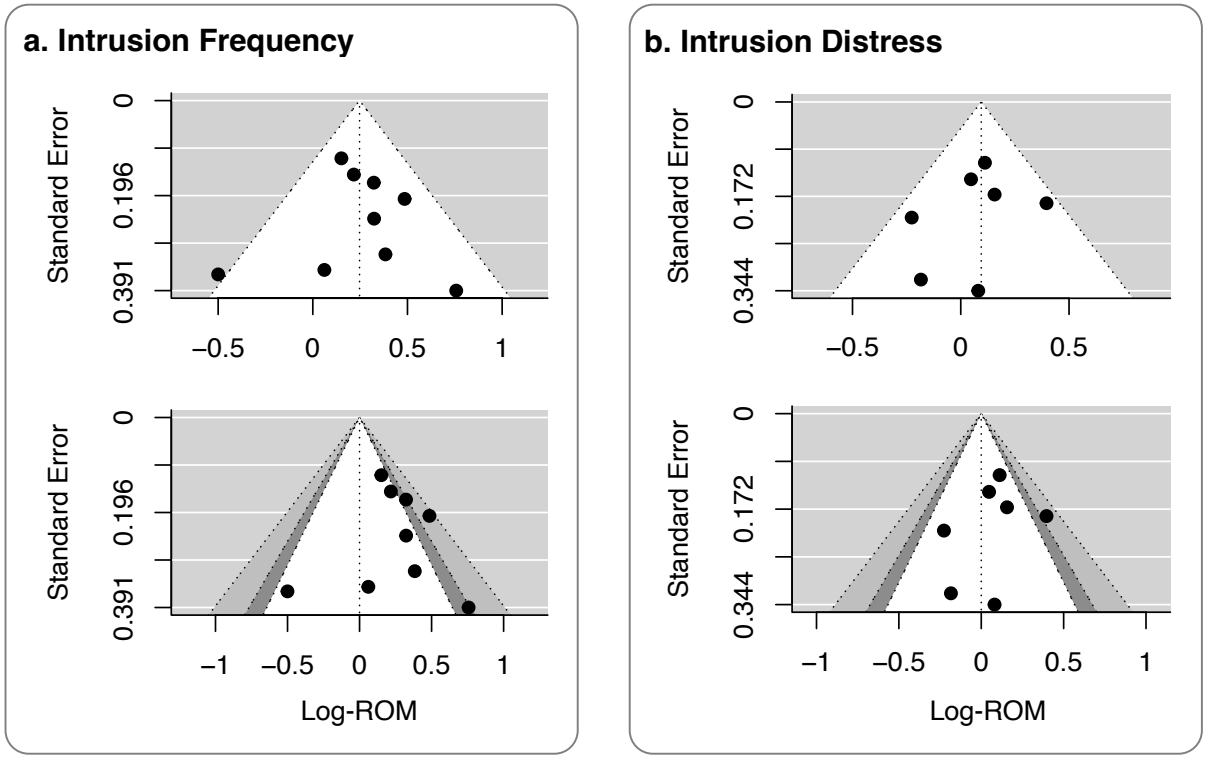
Main analyses: **Outlier and influence analyses.** Figure 3.4a and b display outlier and influence analyses based on SDRs, Cook's distances (CD), and covariance ratios (COVRATIO). For both outcomes, none of the studies was identified as outlier or influential case.

Main analyses: **Moderator analyses.** Given the homogeneous results for both outcomes, it is debatable if moderator analyses should be performed. However, most recommendations suggest performing a-priori planned analyses even in absence of heterogeneity (Geyskens, Krishnan, Steenkamp, & Cunha, 2009). For intrusion frequency, there was no moderator effect of the samples' mean age, $QM(1) = 0.23$, $p = .633$, or gender, $QM(1) = 0.07$, $p = .785$. Also, neither the number of follow-up assessments in days, $QM(1) = 0.24$, $p = .622$, nor the average duration of post-trauma sleep, $QM(1) = 0.81$, $p = .369$, significantly predicted effect estimates. For intrusion distress, there was neither a moderator effect of mean age, $QM(1) = 1.43$, $p = .232$, gender, $QM(1) = 1.69$, $p = .194$, number of follow up-assessments in days, $QM(1) = 0.07$, $p = .788$, nor average post-trauma sleep duration, $QM(1) = 0.04$, $p = .838$.

Main analyses: **Publication bias.** Visual inspections and non-significant rank correlation tests indicated symmetry of the funnel plots for intrusion frequency, Kendell's $\tau = 0.11$, $p = .761$ (see Figure 3.5a), and intrusion distress, Kendell's $\tau = -0.14$, $p = .773$ (see Figure 3.5b). Also, the contour-enhanced funnel plot did not indicate that non-significant findings were more likely to be missing.

Figure 3.5

Funnel Plots for the Meta-Analyses on Intrusion Frequency and Intrusion Distress



Note. Funnel plots and contour-enhanced funnel plots of all studies included in the analysis on intrusion frequency (a.) and intrusion distress (b.). For the contour-enhanced funnel plots, the white area indicates findings being insignificant at $p \geq .10$, the darker grey areas indicate p-values between $.05 < p \leq .10$ (marginally significant findings), while the lighter grey areas mirror p-values between $.01 < p \leq .05$. All studies following beyond these boundaries would be significant at $p \leq .001$. log-ROM = log-transformed ratio of means.

Main analyses: **Internal risk of bias**. For our analyses on intrusion frequency, study quality ratings ranged between 0.50 and 1.00, with median study quality rating at 0.77. For intrusion distress, the range of quality ratings of the included studies was between 0.50 and 0.92, and median study quality was at 0.77. For both outcomes, effect estimates were not significantly related to study quality [intrusion frequency: $QM(1) = 0.03$, $p = .870$; intrusion distress: $QM(1) = 1.70$, $p = .193$].

Main analyses: **Sensitivity analyses**. To examine if our findings were dependent on our decision to choose log-ROMs instead of SMDs as effect measure, we re-ran our analyses by using SMDs as the effect measure. For intrusion frequency, this analysis provided evidence for an effect of sleep on intrusion frequency, SMD = 0.31, 95% CI [0.13, 0.48], $p < .001$, suggestion fewer intrusions after post-trauma sleep compared to wakefulness, which was numerically - but not significantly - larger than the effect found using log-ROMs (see Table

3.2). For intrusion distress, consistent with the analysis using log-ROMs, there was no evidence for an effect of post-trauma sleep, SMD = 0.15, 95% CI [-0.06, 0.36], $p = .168$.

***Meta-analysis on* individual participant data.**

Main analyses: ***Intrusion frequency***. As models based on zero-inflated Poisson distributions showed significant overdispersion, $p < .001$, and models based on negative binominal distributions indicated significant zero-inflation, $p = .016$, we employed a zero-inflated binominal model. Including group as fixed effect in both parts of the model improved model fit when compared to a model that only included a random intercept for study in both model parts, $LRT(2) = 8.69$, $p = .013$, while including a random slope did not result in a better model fit, $LRT(7) = 1.65$, $p = .977$. Residual diagnostics of the final model indicated a good fit (Kolmogorov-Smirnov test: $p = .747$) and identified no outliers ($p = .062$). The zero part of the model showed no between-group difference, $b = 0.53$, 95% CI [-0.40, 1.46], $p = .266$, that is, the occurrence of any intrusions was equally likely in both groups (see Table 3.3). In the count part of the model, there was evidence for a between-group difference, $b = -0.19$, 95% CI [−0.35, −0.03], $p = .020$, indicating that the number of intrusions was higher in the wake groups as compared to the sleep groups. A sensitivity analyses based on a hurdle model did not change our results.

Main analyses: **Intrusion distress**. As a model based on a Gaussian distribution indicated significant zero inflation, $p < .001$, we employed a lognormal hurdle model for semi-continuous data. When we compared a model including group as fixed effect in both parts of the model with a random intercept only model, there was no increase in fit, $LRT(2) = 0.51$, $p = .775$. The same applied to the inclusion of a random slope, which also did not improve model fit compared to the random intercept-only model, $LRT(9) = 6.78$, $p = .660$. Although the inclusion of group did not improve model fit, we present a model including a fixed effect for group in both model parts for comparison with the meta-analysis on aggregated data (see Table 3.3, Model 1). Residual diagnostics of this model demonstrated good fit (Kolmogorov-Smirnov test: $p = .122$) and identified no outliers ($p = .509$). The zero part of the model showed that the occurrence of any intrusion distress was equally likely in both groups, $b = -0.15$, 95% CI [−1.15, 0.86], $p = .773$, and the continuous part of the model demonstrated that the severity of intrusion distress did not differ between groups, $b = -0.06$, 95% CI [−0.22, 0.11], $p = .522$ (see Table 3.3, Model 1). When we employed a zero-inflated gamma distribution for sensitivity analyses, our results remained unchanged, pointing to the robustness of our findings.

Moderator analyses: **Intrusion frequency**. We examined moderator effects of age, gender, depressive symptoms, and increases of negative mood from pre-to-post exposure. Age and gender showed no moderator effects in the zero part of the model, $p \geq .346$ (see Table 3.3, Model 2), while age significantly moderated the effect of group (sleep vs. wake) in the count part, $b = -0.05$, 95% CI [−0.10, 0.00], $p = .038$, indicating that the protective effect of sleep was more pronounced with increasing participant age. Depressive symptom levels had no moderator effect, neither in the zero part, $b = -1.32$, 95% CI [−4.52, 1.88], $p = .417$, nor in the count part of the model, $b = -0.02$, 95% CI [−0.08, 0.05], $p = .600$ (see Table 3.4). Larger increases of negative mood from pre-to-post exposure were associated with more severe intrusions in the count part of the model, $b = 0.61$, 95% CI [0.22, 1.01], $p = .002$, but did not moderate the impact of sleep on intrusion frequency, $b = -0.02$, 95% CI [−0.81, 0.77], $p = .963$. No moderator effect emerged in the zero part of the model.

Moderator analyses: **Intrusion distress**. For intrusion distress, there was no moderator effect of age and gender, neither in the count nor the zero part of the model, $p \geq .193$, except for a three-way interaction between group, age, and gender in the zero part, $b = -1.05$, 95% CI [−1.98, −0.12], $p = .026$ (see Table 3.3, Model 2). However, neither for females nor males of all ages, there was evidence for an effect of group on the occurrence of any (vs. no) intrusion distress. Depressive symptoms had no significant moderator effect in the zero part of the model but showed a significant interaction with group in the continuous part of the model, $b = 0.06$, 95% CI [0.00, 0.11], $p = .048$, with numerically larger effect estimates for group when depressive symptoms were less severe (see Table 3.4). However, even when limiting our sample to those with below median depressive symptoms for illustrative purpose, the effect of group remained non-significant. Moreover, increases in negative mood from pre-to-post exposure had no moderator effect in both model parts, $p \geq .676$, but a significant main effect on intrusion distress in the count-part, $b = 0.82$, 95% CI [0.45, 1.18], $p < .001$, with stronger increases being associated with more intrusion distress.

Table 3.3 *Results of Multilevel Models for Intrusion Frequency and Intrusion Distress*

	Model 1			Model 2		
	b	95% CI	*p*	*b*	95% CI	*p*
a. Intrusion frequency						
Count part						
(Intercept)	1.49	1.09, 1.88	< .001	1.48	1.10, 1.87	< .001
Group	−0.19	−0.35, −0.03	.020	−0.19	−0.35, −0.03	.017
Age				0.01	−0.01, 0.03	.354
Gender				0.21	−0.02, 0.44	.070
Group x Age				−0.05	−0.10, 0.00	.038
Group x Gender				0.28	−0.18, 0.74	.237
Age x Gender				0.05	−0.02, 0.12	.139
Group x Age x Gender				0.01	−0.13, 0.15	.878
Zero part						
(Intercept)	−2.40	−3.29, −1.50	< .001	−2.46	−3.37, −1.55	< .001
Group	0.53	−0.40, 1.46	.266	0.41	−0.56, 1.40	.413
Age				−0.05	−0.21, 0.11	.547
Gender				−0.24	−1.47, 0.99	.703
Group x Age				−0.07	−0.39, 0.25	.671
Group x Gender				−0.40	−3.00, 2.21	.766
Age x Gender				−0.17	−0.52, 0.18	.345
Group x Age x Gender				−0.33	−1.02, 0.36	.346
k_{Study}	8			8		
$n_{Participants}$	478			476		
b. Intrusion distress						
Continuous part						
(Intercept)	−1.55	−1.85, −1.26	< .001	−1.56	−1.84, −1.27	< .001
Group	−0.06	−0.22, 0.11	.522	−0.05	−0.22, 0.11	.525
Age				−0.01	−0.04, 0.01	.353
Gender				0.04	−0.21, 0.28	.764
Group x Age				0.02	−0.03, 0.07	.396
Group x Gender				0.33	−0.17, 0.83	.193
Age x Gender				−0.04	−0.12, 0.04	.311
Group x Age x Gender				0.09	−0.07, 0.25	.280
Zero part (hurdle)						
Intercept	−2.83	−3.61, −2.06	< .001	−3.14	−4.16, −2.12	< .001
Group	−0.15	−1.15, 0.86	.773	−0.53	−1.88, 0.83	.447
Age				−0.09	−0.32, 0.15	.467
Gender				−1.22	−2.54, 0.10	.070
Group x Age				−0.30	−0.79, 0.19	.228
Group x Gender				−1.62	−4.31, 1.08	.239
Age x Gender				−0.40	−0.85, 0.05	.085
Group x Age x Gender				−1.05	−1.98, −0.12	.026
k_{Study}		6			6	
$n_{Participants}$		293			292	

Note. *k* = number of effect sizes; *n* = number of participants.

Table 3.4 *Details of Moderator Analyses*

	Depressive symptoms				Increase of negative mood		
	b	95% CI	*p*		*b*	*z*	*p*
a. Intrusion frequency							
Count part				**Count part**			
(Intercept)	1.55	0.83, 2.28	< .001	(Intercept)	1.49	1.11, 1.87	< .001
Group	−0.25	−0.47, −0.02	.030	Group	−0.19	−0.35, −0.04	.015
Depressive symptoms	−0.01	−0.04, 0.02	.421	Increase in negative mood	0.61	0.22, 1.01	.002
Group x Depressive symptoms	−0.02	−0.08, 0.05	.600	Group x Increase in negative mood	−0.02	−0.81, 0.77	.963
Zero part				**Zero part**			
(Intercept)	−5.14	−12.19, 1.91	.153	(Intercept)	−2.38	−3.29, −1.47	< .001
Group	−0.02	−5.58, 5.53	.994	Group	0.51	−0.41, 1.43	.273
Depressive symptoms	−0.32	−1.47, 0.84	.589	Increase in negative mood	0.31	−2.34, 2.97	.817
Group x Depressive symptoms	−1.32	−4.52, 1.88	.417	Group x Increase in negative mood	0.22	−4.86, 5.31	.932
k_{Study}		4				8	
$n_{Participants}$		271				478	
b. Intrusion distress							
Continuous part				**Continuous part**			
(Intercept)	−1.53	−1.95, −1.12	< .001	(Intercept)	−1.55	−1.85, −1.26	< .001
Group	0.00	−0.19, 0.19	.989	Group	−0.06	−0.22, 0.10	.473
Depressive symptoms	0.00	−0.03, 0.03	.916	Increase in negative mood	0.82	0.45, 1.18	< .001
Group x Depressive symptoms	0.06	0.00, 0.11	.048	Group x Increase in negative mood	−0.15	−0.90, 0.59	.676
Zero part (hurdle)				**Zero part (hurdle)**			
(Intercept)	−3.32	−4.46, −2.19	< .001	(Intercept)	−2.84	−3.62, −2.06	< .001
Group	1.25	−0.25, 2.75	.102	Group	−0.16	−1.18, 0.85	.766
Depressive symptoms	0.04	−0.17, 0.25	.733	Increase in negative mood	−0.69	−3.52, 2.15	.656
Group x Depressive symptoms	−0.09	−0.52, 0.35	.693	Group x Increase in negative mood	−0.96	−6.72, 4.80	.890
k_{Study}		4				6	
$n_{Participants}$		220				293	

Note. *k* = number of effect sizes; *n* = number of participants.

3.5. Discussion

This review aimed to provide a qualitative and quantitative summary of the current state of research on the effect of sleep versus wakefulness after exposure to experimental analog trauma on subsequent intrusive memories. Specifically, we aimed to answer the question of whether research supports a beneficial or detrimental effect of post-trauma sleep on subsequent intrusive memories. In line with two recent reviews (Davidson & Marcusson-Clavertz, 2023; Larson et al., 2023), our meta-analyses on aggregated data showed that sleep as opposed to wakefulness is associated with fewer intrusive memories, while there was no evidence for an impact of sleep on intrusion distress. Study-level moderators such as the number of assessment days had no impact on effect size estimates. Beyond previous reviews, the availability of individual participant data (IPD) allowed us to perform more in-depth analyses. While we found evidence that sleep as opposed to wakefulness was related to a lower number of intrusions in participants experiencing at least one intrusion, sleep was unrelated to the occurrence of intrusions, i.e., sleep did not affect the likelihood of experiencing any versus no intrusions. Moreover, IPD also allowed us to perform participant-level moderator analyses showing that a higher age may be associated with a more pronounced protective effective effect of sleep. However, these findings need further replication in larger, more diverse samples.

Our qualitative summary showed that of nine studies investigating the impact of post-trauma sleep versus wakefulness on intrusive memories, five found evidence for a positive impact of sleep on analog intrusions (Kleim et al., 2016; Sopp et al., 2019; Werner et al., 2021; Woud et al., 2018; Zeng et al., 2021). One study found evidence for a positive impact of sleep deprivation on analog intrusions (Porcheret et al., 2015), and three studies provided inconclusive results (Porcheret et al., 2019; Sopp et al., 2021; Wilhelm et al., 2021). We also examined the effect of post-trauma sleep on explicit and implicit trauma memory: Of five studies investigating the impact of sleep versus sleep deprivation on explicit trauma memory, three found evidence for sleep significantly enhancing explicit trauma memory as compared to sleep deprivation (Sopp et al., 2019, 2021; Zeng et al., 2021). One study provided mixed evidence, indicating that sleep enhanced visual memory but not verbal memory (Porcheret et al., 2019). Correspondingly, one study found no evidence for an impact of sleep on explicit trauma memory using a verbal memory test (Woud et al., 2018). Of five studies investigating the impact of sleep versus sleep deprivation on implicit trauma memory, four did not find any evidence for group differences (Porcheret et al., 2019; Sopp et al., 2019; Werner et al., 2021; Zeng et al., 2021;). One study found that sleep compared to wakefulness reduced implicit

memory as evident in mood responses (Wilhelm et al., 2021). Finally, four studies investigated associations between Non-REM and REM sleep physiology and analog intrusions. Two studies found evidence for an involvement of both Non-REM and REM sleep (Kleim et al., 2016; Wilhelm et al., 2021). Only single studies found evidence for an involvement of REM sleep (Werner et al., 2021) and SWS (e.g., Sopp et al., 2021).

Across both analytical approaches chosen for our quantitative summary, we found evidence in favor of a beneficial rather than a detrimental effect of post-trauma sleep on subsequent intrusion frequency. That is, participants experienced fewer intrusions if they had slept after exposure to analog trauma than if they remained awake or were partially sleep deprived. Due to the lack of heterogeneity, these effects can be generalized beyond the current samples to the wider population of healthy young adults experiencing analog trauma. IPD analyses further suggest that sleep does not affect the occurrence of any versus no intrusive memories per se. However, in the subgroup of individuals who experienced any intrusions after exposure to analog trauma, post-trauma sleep compared to wakefulness was associated with fewer intrusions.

Overall beneficial effects of post-trauma sleep on intrusion frequency may emerge because post-trauma sleeping reduces the frequency of intrusions in participants that are prone to develop intrusions in response to analog trauma. If confirmed by further research, these findings suggest that prevention strategies that aim to improve sleep should be developed and tested on individuals at-risk for intrusion development and later onset of PTSD. Such individuals could be identified based on pre-trauma (e.g., trait rumination, prior psychopathology; Schultebraucks et al., 2021) and/or peri-trauma (e.g., peritraumatic distress, dissociation; Massazza, Joffe, & Brewin, 2021; Massazza, Joffe, Hyland, & Brewin, 2021) risk factors. However, such an approach would require a strong (empirical) consensus on primary risk factors that should be targeted, which does not exist at present (Bonanno, 2021; Kalisch et al., 2017).

Moreover, it must be noted that our analyses revealed small-to-medium effect sizes reflecting a small difference of average intrusion frequency between sleep and wake groups. Given the high individual and societal burden associated with PTSD (Davis et al., 2022; Olatunji et al., 2007; Pacella, Hruska, & Delahanty, 2013), even small-to-medium effect sizes of prevention measures could make a great difference as they may prevent a substantial number of PTSD cases when delivered to a larger population of traumatized individuals. However, studies translating other interventions found to be effective in experimental psychopathology

to clinical populations provided evidence for potential decreases of effect sizes and point to the importance of distinguishing lab-based research from randomized controlled trials with clinical samples (Wiers, Boffo, & Field, 2018). Moreover, a recent meta-analysis on the effectiveness of consolidation/reconsolidation interventions for the prevention and treatment of PTSD provided evidence for smaller effect sizes for PTSD prevention (Astill Wright, Horstmann, Holmes, & Bisson, 2021). Hence, further research in clinical populations needs to establish whether the magnitude of effects is sufficient to justify a clinical implementation of sleep-enhancing interventions. These studies may also examine whether sleep, mainly targeting the process of memory consolidation, might be used as a mechanism-focused adjunct of other interventions (Kleim et al., 2014; see Blackwell, 2020; for a similar idea on cognitive bias modification).

While our analyses support a beneficial effect of sleep on intrusion frequency, we did not find evidence for sleep-related effects on intrusion distress. On the one hand, this lack of evidence may have emerged since these analyses relied on a smaller subsample of studies and participants. On the other hand, our results could indicate that the sleep-related processes that modulate intrusion frequency do not affect distress levels. In fact, there have been different accounts as to how sleep may reduce intrusions (Azza et al., 2020; Germain, Buysse, & Nofzinger, 2008), with one assuming that sleep supports memory consolidation, thereby strengthening explicit trauma memory and inhibiting the occurrence of intrusions (based on e.g., Diekelmann & Born, 2010). The other account proposed a role of sleep in reprocessing and weakening of the affective component of traumatic memories, resulting in reduced intrusion distress (based on van der Helm & Walker, 2009). The current results seem to support the first hypothesis while providing no support for the second. However, since our analyses did not focus on underlying processes, caution is warranted in drawing strong conclusions. Some additional insights can be gathered from our qualitative synthesis. That is, four of five studies (i.e., Porcheret et al., 2019; Sopp et al., 2019; Sopp et al., 2021; Zeng et al., 2021) investigating the effect of sleep on explicit trauma memory found an enhancing effect of sleep. Implicit trauma memory - mostly assessed by pre-to-post-sleep changes in mood/affective ratings during presentation of traumatic stimuli - was only found to be reduced after sleep in one of five studies (i.e., Wilhelm et al., 2021). These findings support the notion that sleep influences intrusions by modulating explicit trauma memory, rather than supporting the reprocessing of the affective component of traumatic memories. The neurophysiological underpinning of this process requires further investigation. Our qualitative synthesis showed mixed evidence for an

involvement of Non-REM and REM sleep. However, this evidence is based on correlational findings in very small samples, which - so far - have not been replicated across studies. For the current review, we were not able to perform meta-analyses on sleep characteristics and their association with intrusion frequency or intrusion distress due to substantial between-study heterogeneity of sleep assessments (home vs. lab-based) and reported associations. However, building on findings of the current review, future studies may explicitly focus on memory processes and their neurophysiological correlates, and thus make them a potential target for future meta-analyses.

Although our analyses provided evidence for sleep having a beneficial impact on intrusion frequency, one of the included studies has revealed opposing findings (Porcheret et al., 2015). We aimed to find the source of these discrepancies by exploring differences between studies that could account for opposing effects (see e.g., Schenker et al., 2021). Traditional meta-analytical moderator analyses on study characteristics did not reveal any significant findings, which was not surprising as the main analyses pointed to homogeneous effect estimates. Participant-level moderator analyses only revealed one robust finding, which was that the beneficial effects of sleep tended to be larger with increasing participant age. However, it must be noted that the age range across studies was restricted (*Range* = 18–35 years), which limits the interpretation and generalization of this finding. Reasons for the divergent finding by Porcheret et al. (2015) may lie in the fact that the assessment of intrusions included the acute period of sleep deprivation, whereas this phase was excluded in other studies. Alternatively, the use of the total sleep deprivation may have elicited these effects, since they were reproduced in their follow-up study, albeit only in a secondary analysis (Porcheret et al., 2019; but see: Zeng et al., 2021, who employed a similar design finding a medium-sized favourable effect of sleep). Other factors that may have introduced variance between studies are type of recruitment (university vs. community sample), stimulus material (trauma film vs. aversive pictures), and intrusion assessment (paper-pencil or electronic). To date, the small number of studies does not allow for subgroup analyses, however, future meta-analysis based on a larger number of primary studies should examine those variables by means of moderator analyses. Statistically, our results might also point to the fact that differences in observed effect estimates may be explained by sampling error and divergent findings can be viewed as upper and lower end of a single distribution of effect estimates. At the same time, the number of included studies was low, which limits the power of heterogeneity tests (von Hippel, 2015), and may have resulted in overlooked true between-study differences. Moreover, it is important to note that our

moderator analyses in both meta-analyses only included variables that were available for a relevant number of included studies, limiting the scope of these analyses and thus our ability to clarify the emergence of opposing effects of sleep. Further research investigating multiple potentially relevant moderators, ideally in sufficiently powered studies and more heterogeneous samples (e.g., with respect to gender and age), is thus needed to characterize potential boundary conditions of the detrimental or beneficial impact of sleep on intrusive memories.

Beyond the limitations noted above, several others need to be considered. First, our project involved into a systematic review over time, therefore, it was not prospectively preregistered. There were no major changes with respect to research questions and modelling decisions in the course of our project, however, we cannot exclude that the retrospective registration biased our findings. Second, our analyses aggregated data across studies with very different designs (e.g., [partial] sleep deprivation, nap sleep) and assessment methods (e.g., intrusion triggering task, intrusion diary). However, the lack of significant heterogeneity supports the notion that - despite procedural differences - effect estimates were eligible for meta-analyses. Another limitation concerns the fact that the number of studies included in our analyses ($k = 9$) is low compared to other meta-analyses in the trauma field (e.g., Clark, Mackay, & Holmes, 2015; Schäfer, Becker, King, Horsch, & Michael, 2019). However, the limited number of studies gave us the unique opportunity to gather almost all primary datasets ($k = 8$) and conduct an IPD meta-analysis. These analyses strongly improved interpretation beyond previous work in the field (Davidson & Marcusson-Clavertz, 2023; Larson et al., 2023) by showing that sleep is not a significant predictor of any (vs. no) intrusions but of the number of intrusions. As such, the current study constitutes an example of how collaboration can advance the field beyond the contributions of individual studies. This is especially important in the field of sleep research that is often limited by small sample sizes. Collaborative efforts and meta-analytical data analyses may help to answer questions that cannot be addressed by individual studies, while increasing the replicability of findings, which is essential to translate findings from experimental to clinical research. However, the sample size of our meta-analysis is still small, which may limit the validity of our findings. Sample sizes of primary studies ranged between 39 and 94 participants, while our meta-analysis included 529 participants (or 479 participants, respectively). There is still a strong need for large multi-lab replication studies running a single experimental design at different sites. Previous research showed that meta-analysis and multi-lab replication projects may yield different results, with effects tending to be larger in meta-analysis compared to multi-lab replication studies due to (small) differences in

statistical analyses, publication bias, potential method- and context sensitivity and experimenter effects (Lewis, Mathur, VanderWeele, & Frank, 2022). Finally, it is important to emphasize that all included studies investigated analog symptoms in healthy participants. Although this approach is commonly used in PTSD research (Iyadurai et al., 2019), it prevents us from drawing strong inferences on how effects may unfold after real-world trauma exposure – effects may be different for different types of trauma and may also differ in size. It is one of the major strengths of analog trauma that such paradigms allow for (partly) causal modelling of processes involved in the onset, persistence and treatment of PTSD (James et al., 2016). However, doubts have been raised about their ecological validity (Lau-Zhu, Holmes, & Porcheret, 2018). In case of our research, one may question whether processes involved in the occurrence of intrusions during an intrusion triggering task (Streb, Conway, & Michael, 2017; Wegerer, Blechert, Kerschbaum, & Wilhelm, 2013) are the same as those eliciting intrusions in everyday life of PTSD patients. Moreover, research indicates that disturbed sleep may have a different impact on emotional processing in those with mental disorders than in healthy individuals, thus putting into question whether findings from healthy samples can be generalized to clinical populations (van Someren, 2021). Bridging the gap between experimental research in the lab and clinical research in the field thus constitutes an important next step (Blackwell & Woud, 2022), for which the present review may provide a base. Nevertheless, one must consider that hypotheses derived from analog studies may not prove to be valid in real-world settings.

Future research should focus on investigating the effects of sleep on intrusions in the immediate aftermath of real-world trauma. So far, only one longitudinal observational study examined the link between post-trauma sleep and intrusive memories after real-world trauma (Porcheret et al., 2020), finding a U-shaped association between sleep duration in the first night post-trauma and intrusive memories in the first week post-trauma, with both “too little” and “too much” sleep being associated with more intrusive memories in the first week posttrauma. Moreover, also both an increase and decrease from pre-to-post-trauma sleep duration were associated with more intrusive memories. However, no associations emerged between post-trauma sleep and PTSD symptoms after two months. Other studies (e.g., Neylan et al., 2021; Schenker et al., 2023) examined the association of subjective and objective sleep data with subsequent PTSD symptoms. Schenker et al. (2023) found a link between subjective sleep disruptions and next-day PTSD symptoms, while objective sleep data was unrelated to PTSD symptoms. Similary, Zhou et al. (2023) found an association between subjectively perceived sleep distrubances within two weeks after trauma and PTSD symptoms 3-months post-trauma.

Neylan et al. (2021) showed a link between retrospectively reported pre-trauma insomnia, sleep-stress reactivity and nightmares, and post-trauma symptoms of PTSD and depression. Similarly, Reffi et al. (2023) found that pre-pandemic sleep reactivity predicted stress reactions and depression during the Covid-19 pandemic. Future studies should employ experimental designs in clinical contexts (within existing ethical boundaries) and may also examine how different sleep-related interventions may be used to reduce intrusions. Generally speaking, interventions could comprise elements of evidence-based treatment of insomnia like cognitive behavioural techniques and relaxation as well as evidence-based interventions to promote sleep health (e.g., Buysse, 2014; Edinger et al., 2021). Future studies will provide insights on whether these interventions are also suitable for reducing post-trauma sleep disturbances, which may be qualitatively different from sleep problems related to insomnia, requiring a focus on issues such as PTSD-related nighttime hyperarousal psychoeducation, identification of alternatives to PTSD-related safety behaviours, nightmare psychoeducation, psychoeducation about PTSD avoidance in the context of substance/medication use, cognitive techniques, and behavioural tracking to challenge beliefs and avoidance behaviours (Carlson et al., 2022). These treatment targets may require including non-standard components such as sleep-directed hypnosis (Cordi, Rossier, & Rasch, 2020; Friesen, Sopp, Cordi, Rasch, & Michael, 2023), which has been shown to be effective in alleviating sleep problems and depression in PTSD patients (Galovsky et al., 2016). Due to the high level of standardization, such interventions could be disseminated in a self-guided web-based format, which would allow targeting traumatized individuals in the immediate aftermath of trauma.

One may also think that the use of sleep-inducing medication might help to promote post-trauma sleep. However, a robust evidence base challenges the use of sleep-inducing medication for improving sleep quality (Solomon et al., 2021) and shows that sleep medication negatively impacts on sleep-related memory processes (Leong et al., 2022; Seibt et al., 2008). Thus, future research should focus on non-pharmacological sleep-inducing interventions, while pharmacological interventions may increase the risk of long-term alterations of sleep.

Future studies may also examine the complex interplay of intrusive reexperiencing with other PTSD symptom clusters (i.e., avoidance, numbing, hyperarousal, negative cognitions, and mood; American Psychiatric Association, 2022). Due to the critical role of sleep in memory consolidation, intrusive memory is the most proximal outcome of sleep interventions. However, future studies should investigate whether and how sleep-related processes may affect other symptom domains that are found to be highly influential in PTSD development (e.g., trauma-

related alterations in cognition; Kube, Berg, Kleim, & Herzog, 2020) as well as a potential mediating role of intrusive memories.

3.6. Conclusion

The present systematic review summarized evidence on the effect of sleep versus wakefulness on intrusive memories after experimental analog trauma. By means of traditional meta-analysis, we found evidence for a small effect of sleep as compared to wakefulness on intrusive memory, with sleep being associated with a lower number of intrusions but unrelated to intrusion distress. Our meta-analyses on IPD supported these findings and provided additional insights such that sleep was related to lower intrusion frequency but did not affect the occurrence of any versus no intrusive memory. Despite divergent findings of individual studies employing different study designs, our meta-analyses yielded homogeneous results pointing to a small beneficial effect of sleep after analog trauma. Future studies should critically examine the clinical significance of this effect as well as its association with memory processes and their neurophysiological underpinning based on larger and more diverse samples.

3.7. Declarations

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4. Study 2: Crossing cultural barriers: an initial cross-cultural validation of the Arabic compared to the German version of the Posttraumatic Stress Disorder Checklist for DSM-5[4]

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4.1. Abstract

Posttraumatic stress disorder (PTSD) is prevalent worldwide, yet its phenomenology and prevalence vary according to individual and contextual factors. Due to heightened exposure to (post-) conflict environments, many Arabic-speaking individuals are at high risk of PTSD. The PTSD Checklist for DSM-5 (PCL-5) is a widely used screening tool for PTSD symptoms, validated in several languages, including German and Arabic. However, despite its frequent cross-linguistic and cross-cultural use, a comprehensive cross-linguistic and cross-cultural validation of the PCL-5 Arabic version still remains outstanding. To ensure the cross-linguistic and cross-cultural comparability of the PCL-5 German and Arabic versions, this study examined the measurement invariance in a heterogeneous sample of German-speaking (n = 283) and Arabic-speaking individuals (n = 295). Sociodemographic data and characteristics of stressful life events were assessed. Subsequently, we examined the internal consistency of the PCL-5 Arabic and German versions and broaden current investigations on structural validity as conducted via confirmatory factor analyses (CFA) by multi-group confirmatory factor analyses (MGCFA) across both language versions. The present findings show that the Arabic-speaking subsample reported more man-made trauma, which was associated with higher PCL-5 sum scores compared to the German-speaking subsample. The PCL-5 showed excellent internal consistency (Cronbach's α = .96). CFA indicated good model fit for all models tested, favouring the Anhedonia and Hybrid models. While MGCFA confirmed configural, threshold, and metric invariance, the scalar invariance could not be established. The present study supports previous research indicating that the factorial structure of the PCL-5 is consistent across both language versions in the CFA. Nevertheless, our findings show a lack of scalar invariance in the MGCFA, which suggests potential bias in the cross-linguistic and cross-cultural comparability of the

[4] ***Note***. In this dissertation, the Supplementary Materials for *Study 2* are provided in Appendix B.

PCL-5 sum scores between the Arabic and the German versions. This highlights the need for context-, language-, and culture-sensitive diagnostics to ensure accurate PTSD assessments.

4.2. Background

Post-traumatic stress disorder (PTSD) is a prevalent psychological response to traumatic experiences (Koenen et al., 2017) and is commonly assessed using PTSD assessments such as the PTSD Checklist for DSM-5 (PCL-5) (Forkus et al., 2023). The development of PTSD assessment tools is predicated on the theoretical conceptualisation of the PTSD symptom structure. Several theoretical models of PTSD symptom structure have been proposed in previous research, with these models being assessed for their applicability across diverse samples.

Conceptualisation of PTSD. While the DSM-5 (American Psychiatric Association, 2013) proposes a four-factor model of PTSD, including *intrusion, avoidance, negative alterations in cognition and mood*, and *alterations in arousal and reactivity*, current research has indicated limited stability of this model (Armour et al., 2015; Blevins et al., 2015) and suggested that alternative structural models, such as the Dysphoria model, the Dysphoric arousal model, the Anhedonia model, the Externalising behaviour model and the Hybrid model may provide a better model fit. For an overview see Supplementary Materials (Table B1). The Dysphoria model (Simms et al., 2002) and the Dysphoric arousal model (Elhai et al., 2011) were derived from the DSM-5 model. The Dysphoria model comprises four factors: *intrusion, avoidance, dysphoria*, and *alterations in arousal and reactivity*. In this model, the factor of *negative alterations in cognitions and mood* was replaced by *dysphoria*, which includes the symptoms of irritability or aggression, difficulties concentrating, and difficulties sleeping. *Dysphoria* refers to a state of general dissatisfaction or discomfort, often associated with strong feelings of sadness, irritability, or anxiety. As a result, the factor of *alterations in arousal and reactivity* includes three symptoms in the Dysphoria model instead of six symptoms, as in the DSM-5 model: risky and destructive behaviour, hypervigilance, and an exaggerated startle response. The Dysphoric arousal model consists of five factors, with the *alterations in arousal and reactivity* from the DSM-5 model separated into two distinct clusters of hyperarousal: *dysphoric arousal* and *anxious arousal.* The Anhedonia (Liu et al., 2014) and Externalising behaviour models (Tsai et al., 2014) were derived from the Dysphoric arousal model and were extended to six-factor models. The Anhedonia model separates *negative alterations in cognition*

and mood into two distinct factors: changes in *negative affect* and *anhedonia*. The Externalising behaviour model also comprises six factors. Unlike the Anhedonia model, though, the Externalising behaviour model combines the factors of loss of positive affect (*anhedonia*) and *negative affect* into a single overarching factor entitled *numbing*. Further, *dysphoric arousal* was divided into two separate factors: *externalising behaviour* and *dysphoric arousal*. Finally, the Hybrid model (Armour et al., 2015) integrates the previously proposed Anhedonia and Externalising behaviour models into a comprehensive seven-factor model, including *intrusion, avoidance, negative affect, anhedonia, externalising behaviour, anxious arousal,* and *dysphoric arousal.*

Assessment of PTSD: post-traumatic stress disorder checklist for DSM-5. The PCL-5 is a self-report screening tool that assesses the severity of PTSD symptoms based on the DSM-5 criteria for PTSD, referring to a most distressing traumatic event as defined by Criterion A of the DSM-5 (American Psychiatric Association, 2013). Traumatic events are identified using the Life Events Checklist (LEC-5; Weathers et al., 2013a). Both the PCL-5 and LEC-5 are available in multiple languages (Hoffmann et al., 2022), including German and Arabic, and are widely used in clinical and research settings across diverse populations (e.g., Lüder et al. 2023), requiring cross-group psychometric robustness of the PCL-5.

Internal consistency of the PCL-5 in a cross-cultural comparison. Internal consistency is a key aspect of psychometric robustness and a fundamental prerequisite for structural validity, as it initially assesses how reliably the items of the PCL-5 capture PTSD symptoms. In this context, Forkus et al. (2023) reviewed n = 47 studies on the psychometric properties of the PCL-5 and concluded, that overall, the PCL-5 is a psychometrically strong assessment tool with good internal consistency (Cronbach's $\alpha > .80$). A psychometric evaluation of the German version of the PCL-5 with a clinical sample also showed high internal consistency ($\alpha = .95$; Krüger-Gottschalk et al., 2017). Ibrahim et al. (2018) found good internal consistency ($\alpha = .85$) for the Arabic version of the PCL-5 in a war-affected sample, while Brahim et al. (2022) reported excellent internal consistency ($\alpha = .98$) for the Tunisian Arabic version in a military sample.

Structural validity of the post-traumatic stress disorder checklist for DSM-5 in a global and cross-cultural comparison. Relying on the substantial internal consistency of the PCL-5, current research has focused on evaluating its structural validity, an essential step in assessing the extent of which theoretical models of PTSD correspond to its clinical manifestation. The findings obtained to date offer a slightly heterogeneous perspective on which

theoretical model most accurately aligns with the data, with studies conducted across diverse samples yielding inconsistent results: Forkus et al. (2023) reviewed findings from 39 studies, most of which conducted factor analyses on the English version of the PCL-5 in White, military, or university samples. In 15 of these studies, the seven-factor Hybrid model was identified as the best-fitting model, while three studies reported comparable fit between the Anhedonia and Hybrid models (e.g., Blevins et al., 2015). Krüger-Gottschalk et al. (2017) and Pettrich et al. (2024) examined the structural validity of the German version of the PCL-5, with inconclusive results in Krüger-Gottschalk et al. (2017), while Pettrich et al. (2024) identified the Hybrid model as the best fitting model encompassing all PCL-5 items. Ibrahim et al. (2019) showed findings from the CFA of the Arabic version of the PCL-5 in favour of the Anhedonia and Hybrid models. The authors further extended single-group CFA to multi-group CFA (MGCFA) between the Arabic and Kurdish versions of the PCL-5 in a sample of war-affected displaced persons from Iraq and Syria. The MGCFAs revealed configural, metric, and scalar invariance between the Arabic and Kurdish versions of the PCL-5.

The global and cross-Cultural prevalence of PTSD. Within its widespread application in clinical and research settings, the PCL-5 serves not only as a tool for assessing PTSD symptom severity, but also for estimating prevalence rates of PTSD, taking into account varying cut-off scores. Notably, the estimated lifetime prevalence of PTSD in the general world population is 3.9% (Koenen et al., 2017). However, prevalence of trauma exposure (approximately 70%) far exceeds that of PTSD (Kessler et al., 2017). The global prevalence of PTSD varies considerably, as it is influenced by environmental context, which affects both the frequency (multiple vs. single events) and type (man-made vs. accidental) of trauma. Particularly Arabic-speaking refugees and asylum seekers from North Africa and the Middle East are frequently exposed to severe human rights violations, further exacerbated by ongoing conflict and political instability following the Arab Spring (Ibrahim et al., 2019; Quosh et al., 2013). Consequently, they face a heightened risk of cumulative man-made trauma (Fazel et al., 2005; Nesterko et al., 2020), significantly increasing their vulnerability to PTSD (AlShawi, 2018; Ibrahim et al., 2018a; Nesterko et al., 2020).

Gap in current research. Considering this comprehensive body of research, it can be summarised that despite the higher prevalence of PTSD in conflict-affected populations from low- and middle-income countries, the factor structure underlying the PCL-5 has predominantly been examined in populations from non-war-affected, high-income countries (Forkus et al., 2023). To date, research has not directly compared the structural validity of the PCL-5 between

the Arabic and German versions. The paucity of cross-linguistic and cross-cultural investigations of the PCL-5's factor structure poses significant limitations to its generalizability and applicability across diverse populations.

Aims of the current study. To address this gap, the present study examines the measurement invariance of the German (Krüger-Gottschalk et al., 2017) and Arabic (Ibrahim et al., 2018a) versions of the PCL-5 among German- and Arabic-speaking individuals in Germany. To achieve this, we first assess trauma exposure (measured with the LEC-5) and PTSD symptoms (measured with the PCL-5). Based on previous research (e.g., Georgiadou et al., 2017), we expect the number of traumatic experiences and PTSD symptoms to be higher in the Arabic-speaking subsample compared to the German subsample. To advance cross-cultural research on the structural validity of the PCL-5, subsample and total sample CFAs of the six most common factor models (see Supplementary Material [B1]) assess structural validity of both versions, guiding subsequent analyses of (configural, threshold, metric, scalar, and full) measurement invariance using MGCFA. In accordance with current research, it is hypothesised that the Anhedonia and Hybrid models will demonstrate the best model fit across both the Arabic and German subsamples, thereby providing evidence for the assessment of a similarly conceptualised construct of PTSD.

4.3. Methods

Participants. Following established recommendations (e.g., Chen, 2008 Davidov et al., 2014; Milfont & Fischer, 2010; Putnick & Bornstein, 2016), a target sample size of approximately 300 participants per group was aimed for, as this is considered sufficiently large for testing measurement invariance. A total of n = 630 non-clinical and clinical participants were recruited for the data analysis. Participants with incomplete PCL-5 data (n = 52, 8.3%) were excluded using listwise deletion, resulting in a final sample of n = 578 participants. Participants completed either the German or Arabic version of the PCL-5, resulting in two groups: German-speaking (n = 295) and Arabic-speaking (n = 283). In the following, German- or Arabic-speaking participants are referred to as German or Arabic participants. In the present study, data on participants' age, gender (Langeland & Olff, 2024), nationality, and country of origin was collected. Moreover, the participants' mental health status was ascertained by the question: "Are you currently experiencing psychological distress?". Participants who responded affirmatively to this question were classified as 'clinical' in the absence of a formal

diagnosis. These participants were subsequently asked whether they were currently receiving psychiatric or psychotherapeutic treatment. A comprehensive overview of the sample's characteristics is provided in Table 4.1.

Measures. The questionnaires on sociodemographic data were professionally translated and back-translated in a similar way as is used for the translations of standardised instruments for the assessment of PTSD (see Krüger-Gottschalk et al., 2017; Nesterko et al., 2020)

Exposure to stressful life events. The German (Krüger-Gottschalk et al., 2017) and Arabic (Nesterko et al., 2020) versions of the LEC-5 (Weathers et al., 2013a), a structured 16-item assessment tool, were used to assess criterion A of PTSD symptomatology, namely exposure to traumatic events (American Psychiatric Association, 2013). The LEC-5 has been internationally validated and is available in several languages, making it a frequently referenced instrument for the detailed examination of trauma exposure in various contexts. Specifically, the LEC-5 queries the traumatic event to which the PCL-5 refers. If no traumatic event could be identified on the LEC-5, participants were asked to report their most stressful life event as a reference for answering the PCL-5.

PTSD. PTSD symptoms over the past month were assessed using the PCL-5 (Blevins et al., 2015), a 20-item self-report assessment tool rated on a five-point Likert scale from 0 (*not at all*) to 4 (*extremely*). The scores for each item are aggregated to yield an overall severity sum score ranging from 0 to 80, with higher scores indicating more severe symptoms. As with the LEC-5, we used the German (Krüger-Gottschalk et al., 2017) and Arabic (Nesterko et al., 2020) versions of the PCL-5.

Procedure. Data was collected through an online survey, with recruitment coordinated by three psychological research centres and outpatient clinics, enrolling participants between 2022 and 2024. Informed consent was obtained from all participants. Those who refused to provide their informed consent were not permitted to participate. Overall, participants provided sociodemographic data and completed the LEC-5 and PCL-5, and they were compensated for their participation. The study was approved by the local ethics committee (ethics committee number: 2123) in October 2021.

Data Analysis. All statistical analyses were conducted using R 4.1.0 (R Core Team, 2021). For the CFAs and MGCFAs, the lavaan package (Rosseel, 2012) was used. Due to the current limitations in handling ordinal variables with Full Information Maximum Likelihood (FIML; Enders & Bandalos, 2001) in lavaan, listwise deletion was applied to cases with missing

PCL-5 data. This conservative approach was chosen to ensure valid estimations under the given model assumptions.

First, we computed descriptive statistics for the sociodemographic, psychological distress, and current treatment data, focusing especially on the descriptive analysis of stressful or traumatic life events assessed using the LEC-5, and PTSD symptom severity measured with the PCL-5. Then, the internal consistency of the PCL-5 was assessed using Cronbach's alpha to ensure an adequate level of reliability for subsequent structural modelling.

To evaluate the structural validity of the PCL-5 in a cross-cultural comparison, we conducted separate CFAs for both, the German and Arabic subsamples, examining the DSM-5 model, Dysphoria model, Dysphoric arousal model, Anhedonia model, Externalising behaviour model, and Hybrid model. The primary aim of these separate CFAs was to examine whether the same models provided the best fit within each subsample, thus offering preliminary insights into the cross-linguistic and cross-cultural comparability of the PCL-5's structural validity. Subsequently, the same set of models was evaluated in a CFA conducted on the total sample. The best-fitting model from this analysis was used as the baseline model for the subsequent MGCFA. Based on the recommendations by Somaraju et al. (2022) measurement invariance of the PCL-5 across the German and Arabic subsamples was examined using a hierarchical procedure. Specifically, we sequentially tested for configural invariance(equal factor structures across the subsamples), threshold invariance (given the ordinal nature of the data, thresholds were also tested for equality across subsamples), metric invariance (equal factor loadings across the subsamples), scalar invariance (equal loadings, thresholds, and intercepts across the subsamples), and full invariance (equal loadings, thresholds, intercepts, and residuals across the subsamples) (Somaraju et al., 2022). A comprehensive overview on the interpretation of measurement invariance levels in cross-cultural research can be found in Milfont and Fischer (2010). Due to the ordinal nature of the PCL-5 variables, CFA and MGCFA were conducted using a Weighted least square mean and variance (WLSMV) adjusted estimator with theta parameterisation, as recommended by Muthén and Christoffersson (1981), to effectively handle categorial data and address data skewness. Since well-fitting models may sometimes yield significant χ^2 values when the factor structure is complex (Bentler & Bonett, 1980), we further considered the recommendations of Hu and Bentler (1999) for assessing model fit. Models in CFA and MGCFA are considered well-fitting if the comparative fit index (*CFI*) and Tucker–Lewis index (*TLI*) are $\geq .95$, the root mean square error of approximation (*RMSEA*) is $< .06$, and the standardised root mean square residual (*SRMR*) is $\leq .08$ (Hu & Bentler, 1999). In the

model fit comparison, differences were considered negligible when the fit indices were as follows: $\Delta CFI < .002$, $\Delta TLI < .01$, $\Delta RMSEA < .015$, and $\Delta SRMR < .030$ (Chen, 2008; Hu & Bentler, 1999; Meade at al., 2008). To compare nested models in MGCFA, we used the Satorra–Bentler test (Satorra & Bentler, 2001), which is robust against violations of normal distribution.

Table 4.1 *Demographic Characteristics*

Characteristic	German subsample *n* = 283		Arabic subsample *n* = 295		Total sample *n* = 578	
	n (%)	*M (SD)*	*n* (%)	*M (SD)*	*n* (%)	*M (SD)*
Age[a]		35.33 (12.36)		34.41 (10.90)		34.86 (11.64)
Gender						
Male	92 (32.51)		183 (62.03)		275 (47.58)	
Female	188 (66.43)		111 (37.63)		299 (51.73)	
Prefer not to say	3 (1.06)		1 (0.34)		4 (0.69)	
Country of origin						
Germany	283 (100.00)		1 (0.34)		284 (49.13)	
Middle Eastern countries	-		250 (84.75)		250 (43.25)	
African countries	-		37 (12.54)		37 (6.40)	
Other countries	-		1 (0.34)		1 (0.17)	
Psychological disorder/ distress[b]						
No	230 (81.27)		219 (74.24)		449 (77.68)	
Yes	53 (18.73)		76 (25.76)		129 (22.32)	
Psychological or psychiatric treatment						
No	244 (86.22)		242 (82.03)		486 (84.08)	
Yes	39 (13.78)		53 (17.97)		92 (15.92)	
PTSD[c]						
Sum score	283 (100.00)	14.13 (15.72)	282 (95.59)	26.63 (19.76)	565 (97.75)	20.37 (18.90)
Traumatic events[d]						
At least one	233 (82.33)		261 (88.47)		494 (85.47)	
Total per person		2.89 (2.66)		5.73 (4.16)		4.34 (3.78)

Note. Percentages are based on the total (sub)sample. Totals may vary slightly from 100% due to rounding and missing data. [a]in years; [b]participants answering *yes* to psychological disorder/ distress were classified as clinical; *no* as non-clinical; [c]according to the PCL-5; [d]according to the LEC-5.

4.4. Results

Descriptive Statistics. The participants in the present study were either German- (n = 295) or Arabic-speaking (n = 283), and all resided in Germany to control for institutional conditions. Of the Arabic-speaking subsample, n = 121 participants indicated that they were residing in Germany as refugees or asylum seekers, while n = 68 reported having immigrated for professional or personal reasons. A considerable proportion of the Arabic participants were from Syria, while the remaining participants came from various African and Middle Eastern countries (see Table 4.1 for details). The German participants were exclusively from Germany. While the total sample demonstrated a balanced gender distribution, the Arabic and German subsamples exhibited significant differences ($\chi^2(1) = 48.46$, $p < .001$, for details *see Table 4.1).* In total, 22.32% of participants reported suffering from a mental disorder or psychological distress, with no significant difference observed between the two subsamples ($\chi^2(1) = 3.73$, $p = .054$). Similarly, a slightly lower proportion of the total sample (15.92%) reported receiving psychotherapeutic and/or psychiatric treatment, also with no meaningful difference between the two subsamples ($\chi^2(1) = 1.59$, $p = .207$). All participants reported experiencing at least one stressful life event. Among them, 85.47% of the total sample (88.47% of Arabic participants and 82.33% of German participants) reported exposure to at least one potentially traumatic event, as assessed with the LEC-5. The remaining reported events were reviewed for plausibility and included experiences such as bullying, parental separation, or the loss of a pet. Furthermore, based on the LEC-5, the total sample reported an average of $M = 4.34$ ($SD = 3.78$) traumatic events experienced or witnessed per person. Specifically, the Arabic subsample reported an average of $M = 5.73$ ($SD = 4.16$) traumatic events per person, approximately twice as many as the German subsample ($M = 2.89$, $SD = 2.66$; $t(502.66) = 9.80$, $p < .001$; see Table 4.1). In terms of trauma type, the most commonly reported events included transport accidents and severe human suffering. However, the distribution of trauma types varied notably between the German and Arabic subsamples. In the Arabic subsample, the most commonly reported events were man-made, such as a fire or explosion, combat or exposure to a war zone. By contrast, in the German subsample, the most common events were accidental, such as transport accidents or life-threatening illness or injury (see Supplementary Material [B2]). Regarding the PTSD symptom severity, the total sample (n = 565) showed a mean PCL-5 score of $M = 20.37$ (SD = 18.90; range = [0, 80]). Mean PCL-5 scores were significantly higher in the Arabic subsample ($M = 26.63$, $SD = 19.76$, range = [0; 80]) compared to the German subsample (M = 14.13, $SD = 15.72$, range = [0; 71]; $W = 55{,}054$, $p < .001$), indicating a greater PTSD symptom burden in the Arabic subsample.

Internal Consistency. The internal consistency of the PCL-5 demonstrated excellent reliability in the total sample (Cronbach's α = .96, 95% CI [.95–.96]), as well as in the German (Cronbach's α = .95, 95% CI [.94–.96]) and Arabic (Cronbach's α = .96, 95% CI [.95–.96]) subsamples. The average inter-item correlation was $M(r)$ = 0.54, with negligible differences between the German and Arabic versions of the PCL-5. Notably, inter-factor correlations allowed us to measure PTSD as a cohesive construct.

Structural Validity. To assess structural validity, the most common six models (see Supplementary Materials [B1]) were tested using separate and overall CFAs. The fit indices for the separate CFAs of the German and Arabic versions of the PCL-5 are presented in Table 4.2, and the fit indices for the overall CFA are shown in Table 4.3. Examining the German version of the PCL-5, the CFAs indicated an excellent model fit for both the Hybrid and Anhedonia models, while all models were considered to have an adequate fit. Differences in fit indices comparing the Anhedonia and Hybrid models indicated a negligible change in model fit that marginally favoured the Anhedonia model over the Hybrid model.

For the Arabic version of the PCL-5, the CFA results indicated an acceptable model fit for all models tested, but the Hybrid model was favoured. Given the generally good model fit, we investigated the changes in fit indices, but we found that the ΔCFI, ΔTLI, $\Delta SRMR$, and $\Delta RMSEA$ showed negligible changes in model fit. The CFA of the total sample confirmed the findings of a good to excellent model fit for both the Anhedonia and Hybrid models, with a marginal preference for the Hybrid over the Anhedonia model.

Table 4.2 *Overview of Model Fit Indices from the CFAs per Subsample*

German subsample													
Model	*n*	*npar*	χ^2	df	*p*	*CFI*	*ΔCFI*	*SRMR*	*ΔSRMR*	*TLI*	*ΔTLI*	*RMSEA* [90% CI]	*ΔRMSEA*
DSM-5	283	106	266.375	164	<.001	.975	-	.055	-	.972	-	.071 [.062–.080]	-
Dysphoria	283	106	263.386	164	<.001	.975	-	.057	-	.971	-	.071 [.062–.080]	-
Externalising behaviour	283	115	202.608	155	.006	.981	-	.050	-	.976	-	.065 [.056–.074]	-
Dysphoric arousal	283	110	205.452	160	.009	.981	-	.050	-	.978	-	.063 [.053–.072]	-
Hybrid	283	121	127.076	149	.903	.989	-	.040	-	.987	-	.049 [.038–.059]	-
Anhedonia	283	115	131.364	155	.916	.990	.000	.041	-.001	.988	-.001	.047 [.036–.057]	.002

Arabic subsample													
Model	*n*	*npar*	χ^2	df	*p*	*CFI*	*ΔCFI*	*SRMR*	*ΔSRMR*	*TLI*	*ΔTLI*	*RMSEA* [90% CI]	*ΔRMSEA*
Dysphoria	282	106	286.397	164	<.001	.970	-	.047	-	.965	-	.085 [.077–.094]	-
Dysphoric arousal	282	110	204.159	160	.010	.979	-	.042	-	.975	-	.072 [.063–.081]	-
DSM-5	282	106	208.335	164	.011	.979	-	.042	-	.976	-	.071 [.062–.080]	-
Externalizing behaviour	282	115	185.597	155	.047	.980	-	.040	-	.976	-	.071 [.062–.080]	-
Anhedonia	282	115	156.335	155	.455	.985	-	.037	-	.981	-	.063 [.053–.072]	-
Hybrid	282	121	135.745	149	.774	.986	-.002	.034	.003	.983	-.001	.060 [.050–.070]	.022

Note. Models are presented in hierarchical order, with the best-fitting model at the bottom. ΔCFI and ΔRMSEA represent differences in fit indices relative to the immediately preceding model with a slightly poorer fit. *n:* number of participants; *npar:* number of parameters; χ^2*:* chi-square; df*:* degree of freedom; *CFI*: comparative fit index; *SRMR*: standardised root mean square residual; *TLI*: Tucker–Lewis index; *RMSEA*: root mean square error of approximation.

Table 4.3 *Overview of Model Fit Indices from the CFAs in the Total Sample*

Model	Total sample												
	n	*npar*	χ^2	df	*p*	*CFI*	*ΔCFI*	*SRMR*	*ΔSRMR*	*TLI*	*ΔTLI*	*RMSEA* [90% CI]	*ΔRMSEA*
Dysphoria	565	106	434.458	164	<.001	.974	-	.042	-	.970	-	.081 [.075–.087]	-
DSM-5	565	106	349.954	164	<.001	.980	-	.038	-	.976	-	.072 [.066–.078]	-
Dysphoric arousal	565	110	322.838	160	<.001	.981	-	.037	-	.977	-	.071 [.065–.077]	-
Externalising behaviour	565	115	314.054	155	<.001	.980	-	.037	-	.976	-	.073 [.067–.079]	-
Anhedonia	565	115	193.955	155	.018	.989	-	.030	-	.986	-	.055 [.048–.061]	-
Hybrid	565	121	178.296	149	.051	.989	.000	.029	.001	.986	.000	.055 [.048–.061]	.000

Note. Models are presented in hierarchical order, with the best-fitting model at the bottom. ΔCFI and ΔRMSEA represent differences in fit indices relative to the immediately preceding model with a slightly poorer fit. *n:* number of participants; *npar:* number of parameters; χ^2*:* chi-square; df*:* degree of freedom; *CFI*: comparative fit index; *SRMR*: standardised root mean square residual; *TLI*: Tucker–Lewis index; *RMSEA*: root mean square error of approximation

In summary, the separate and the total sample CFAs suggest that both the Anhedonia and Hybrid models have a good to excellent model fit. Consequently, we tested measurement invariance by comparing the German and Arabic versions of the PCL-5 based on both the Hybrid and Anhedonia models via MGCFA, which involved a series of hierarchical model tests.

Measurement Invariance. We first assessed configural and threshold invariance based on the Anhedonia model, then we tested metric, scalar, and full invariance. The Anhedonia model confirmed configural and threshold invariance, with fit indices meeting the cut-off criteria. Notably, in the MGCFA of the Anhedonia model, metric invariance was evaluated as given. Testing scalar invariance, *CFI* = .986, *TLI* = .986, *SRMR* = .044 and *RMSEA* = .053, 90% *CI* [.046–.059] (see Table 4.4), suggested a reasonably good model fit, χ^2(df = 378) = 519.095, $p < .001$. Additionally, the comparison of the metric and scalar models, indicated by $\Delta\chi^2$(df = 14) = 91.888, $p < .001$, led to the rejection of the assumption of scalar and full invariance. Following the same procedure mentioned above, the results of the MGCFA based on the Hybrid model confirmed both configural and threshold invariance (see Table 4.4 for fit statistics). For metric invariance, the model test indicated a good model fit for the metric model, while the remaining fit indices suggested a good model fit for the scalar model: *CFI* = .986, *TLI* = .985, *SRMR* = .043, *RMSEA* = .054, 90% *CI* [.047–.060]. However, scalar invariance was rejected in the MGCFA based on the Hybrid model, as indicated by χ^2(df = 364) = 490.434, $p < .001$ and $\Delta\chi^2$(df = 13) = 91.135, $p < .001$, when comparing the metric to the scalar invariance model. Full invariance was similarly rejected due to the rejection of scalar invariance in the MGCFA based on the Anhedonia and Hybrid models. In the MGCFA, the German and Arabic versions of the PCL-5 did not show scalar invariance. The fit indices (*CFI* and *TLI*) also increased up to metric invariance and then decreased, while *RMSEA* reached its lowest value during metric invariance testing and increased thereafter (see Table 4.4). This suggested a good model fit for the configural and threshold invariance model, assuming that metric invariance did not degrade the model fit. Testing the scalar invariance model revealed significant chi-square values ($p < .001$) and a significant decrease in model fit ($\Delta\chi^2$) from the metric to the scalar invariance model. This confirmed the rejection of scalar invariance, indicating differences in the intercepts between the two versions of the PCL-5 across subsamples.

Table 4.4 *Fit Statistics for the MGCFA of the German and Arabic versions of the PCL-5 across German and Arabic Subsamples*

Anhedonia model	*n*	*npar*	χ^2	df	*p*	*CFI*	*SRMR*	*TLI*	*RMSEA* [90% *CI*]
Configural model	565	230	287.700	310	.814	.987	.039	.985	.055 [.047–.062]
Threshold model	565	190	346.418	350	.544	.987	.039	.986	.051 [.045–.058]
Metric model	565	176	427.206	364	.012	.989	.044	.989	.047 [.040–.054]
Scalar model	565	162	519.095	378	<.001	.986	.044	.986	.053 [.046–.059]
Full model	565	142	519.095	398	<.001	.985	.044	.986	.052 [.046–.058]
Hybrid model	*n*	*npar*	χ^2	df	*p*	*CFI*	*SRMR*	*TLI*	*RMSEA* [90% *CI*]
Configural model	565	242	262.820	298	.930	.988	.037	.985	.054 [.047–.061]
Threshold model	565	202	321.539	338	.732	.988	.037	.987	.051 [.044–.058]
Metric model	565	189	401.350	351	.033	.989	.043	.988	.048 [.041–.055]
Scalar model	565	176	490.434	364	<.001	.986	.043	.985	.054 [.047–.060]
Full model	565	156	490.434	384	<.001	.985	.043	.985	.053 [.047–.059]

Note. n: number of participants; *npar:* number of parameters; χ^2*:* chi-square; df*:* degree of freedom; *CFI*: comparative fit index; *SRMR*: standardised root mean square residual; *TLI*: Tucker–Lewis index; *RMSEA*: root mean square error of approximation.

4.5. Discussion

The present study investigated the cross-cultural validation of the German and Arabic versions of the PCL-5 to ensure its cross-cultural comparability. Initially, the present findings indicate that, while no significant difference was observed between the Arabic and German subsamples in terms of exposure to at least one traumatic event, the two subsamples differ in terms of trauma frequency and trauma type. The Arabic participants reported nearly twice as many traumatic events per person, with a significantly higher rate of man-made trauma. This finding aligns with previous research (Blackmore et al., 2020; Nesterko et al., 2020) that identifies cumulative exposure to interpersonal trauma as a significant risk factor for the development of severe PTSD. Correspondingly, the Arabic subsample displayed higher PCL-5 scores than the German subsample, that reported fewer, predominantly accidental traumatic events. These findings underscore the importance of a robust, culturally sensitive validation of the PCL-5 to enable a valid interpretation of (the observed) differences in symptom severity and prevalence.

The internal consistency of the PCL-5 was found to be excellent, supporting its status as a psychometrically robust instrument (Blevins et al., 2015; Brahim et al., 2022; Krüger-Gottschalk et al., 2017) and justifying further investigation of its structural validity.

The subsample CFAs and the total sample CFA demonstrated an adequate fit for all tested models. The Hybrid and Anhedonia models exhibited the best model fit, consistent with the conceptual overlap between these six to seven factor models. Both models include the core symptom clusters of PTSD such as *intrusion, avoidance, negative affect, anhedonia*, as well as *dysphoric* and *anxious arousal*. The Hybrid model further differentiates *dysphoric arousal* by isolating *externalising symptoms* (e.g., irritability, risk-taking behaviour), thereby recognising that heightened negative affect or cognitive distress does not necessarily lead directly to behavioural dysregulation.

While the Anhedonia and Hybrid models are frequently identified as the most suitable structures in both the Arabic and German PCL-5 (e.g., Ibrahim et al., 2019), this alone does not justify conclusions about cross-cultural comparability (Brown et al., 2015). Moreover, an examination of the PCL-5's measurement invariance is essential to ensure the comparability of outcomes in its global application. In light of the ongoing political unrest and global refugee movements, the evaluation of the cross-cultural applicability of the PCL-5, particularly between European and Middle Eastern populations, is highly relevant. Addressing this, the present study applied MGCFA to test measurement invariance across the German and Arabic versions of the

PCL-5. The results of the MGCFA, based on the Anhedonia and Hybrid models, supported configural, metric, and threshold invariance, underscoring the instrument's conceptual robustness in this cross-linguistic and potentially cross-cultural contexts. The confirmed metric invariance suggests that the PCL-5 items exhibit a comparable correlation with underlying PTSD factors in both the German and Arabic versions. However, the lack of scalar invariance suggests that some items may function differently across both, the Arabic and the German versions. In particular, differences in item intercepts have the potential to lead to different PCL-5 sum scores, even when the underlying level of PTSD severity is equivalent across groups. The underlying causes of the differences in item intercepts cannot be definitively ascertained based on the present findings. One possible explanation for this phenomenon is that lacking scalar invariance reflects variations in the meaning-making and expression of PTSD symptoms across the Arabic and the German languages and cultures (Hosny et al., 2023). For instance, certain symptoms of PTSD may carry different connotations, are more or less socially acknowledged, or are interpreted differently in terms of severity or salience, potentially influencing the item responses (Hinton & Lewis-Fernández, 2011; Hosny et al., 2023). Therefore, a comparison of the PCL-5 sum scores of the German and Arab versions may result in an inaccurate interpretation, as the observed differences may reflect a measurement bias rather than actual differences in symptom severity. A frequently applied approach in current research involves the utilisation of sample-specific cut-off adjustments (Pettrich et al., 2025), derived from sensitivity and specificity analyses. Although such adjustments have been implemented empirically in previous studies, measurement invariance of the PCL-5 German and Arabic version had not yet been formally examined. The present findings are consistent with these prior adaptations and offer preliminary empirical evidence that validates their efficacy.

Limitations. Due to the specificity of the examined sample, particularly the Arabic subsample, the scalar non-invariance observed in this study suggests that PCL-5 outcomes may not be fully comparable between German individuals and Arabic individuals with refugee or migration backgrounds. Although the total sample was recruited in Germany to align living conditions and ensure system standardisation, the Arabic subsample differs from the German subsample in terms of sociocultural homogeneity. Specifically, the Arabic subsample primarily includes migrants and refugees from various countries of origin, resulting in increased heterogeneity within the subsample and potentially contributing to selection bias. Accordingly, differences between the subsamples extend beyond mere linguistic or cultural variation. Due to this sociocultural heterogeneity and other confounding factors, the results must be interpreted

with caution, as Arabic culture should not be treated as a homogenous construct. Thus, no conclusions should be drawn regarding the comparability of PCL-5 outcomes across all Arabic-speaking populations. Additionally, processes of cultural adaptation in the host country may have influenced symptom reporting, potentially leading to an underestimation of measurement variance in the cross-cultural comparison and overly optimistic conclusions.

A selection bias is likely introduced by conducting the (MG)CFA as a complete-case analysis by including only participants with complete PCL-5 data. This may limit representativeness of the sample, as missing data, which is not entirely random, may systematically exclude certain subgroups. Although alternative methods for handling missing data, such as FIML, are well-established in structural equation modelling, FIML is currently not fully supported for ordinal (categorical) indicators in lavaan (Rosseel, 2012). Therefore, we opted for a conservative approach using WLSMV estimation in lavaan to ensure appropriate modelling of ordinal data. This approach also minimises potential bias from imputation and enhances internal validity, but at the cost of a reduced sample size and a potential increase in selection bias if data is not missing completely at random. Consequently, this limits ecological validity and the generalizability of our findings.

The lack of scalar invariance often prompts testing for partial scalar invariance, which involves freeing intercepts for items exhibiting non-invariance (Putnick & Bornstein, 2016). However, as discussed above, the limited comparability of the subsamples can complicate such analyses. Additionally, when assessing partial scalar invariance, it is assumed that only a limited number of items vary across groups. Conversely, the absence of scalar invariance alongside robust metric invariance demonstrated in the present study suggests that a considerable number of items likely exhibit non-invariance. Therefore, the examination of partial invariance appears to be unwarranted in this context.

Another limitation of the present study is that it considered only those factor models that had already been assessed in both the German and Arabic versions of the PCL-5. While this approach ensures a methodologically well-founded model selection, it does not claim to be exhaustive. For instance, the parsimonious and psychometrically robust two-factor bifactor model proposed and tested by Pettrich et al. (2024) in the German PCL-5 version was not included in the analyses.

Clinical implications. Parsimonious models, such as the DSM-5 model, have demonstrated clinical advantages (e.g., Pettrich et al., 2024). The reduced number of factors in general results in an increased number of items per factor, thereby enhancing model stability

for parsimonious models. Thus two- to four-factor models have been proposed to enhance clinical utility (e.g., Schmitt et al., 2018). Conversely, more complex models comprising numerous narrowly defined factors are challenging to implement in clinical practice, particularly when individual factors are represented by fewer than three items (e.g., avoidance or anxious arousal). This has been demonstrated to be associated with diminished psychometric stability and limited interpretability (Rasmussen et al., 2019). Nonetheless, while complex factor models may complicate clinical implementation, they allow for a more nuanced representation of PTSD symptomatology. For instance, the Hybrid and Anhedonia models differentiate symptom clusters (e.g., intrusions, avoidance, negative mood/cognition, hyperarousal), supporting more precise diagnosis. Consistently, these two multidimensional models demonstrated superior model fit compared to parsimonious factor models, such as the DSM-5 model, in the present study.

As previously indicated, the lack of scalar invariance in the superior models examined in MGCFA indicates that PCL-5 cut-off scores may necessitate sample-specific adaptation. Current research recommended cut-off scores ranging from 22 to 49. For instance, Krüger-Gottschalk et al. (2017) proposed a cut-off of 31–33 for German samples, while Ibrahim et al. (2018) advocated a cut-off of 23 for Arabic samples from (post-)conflict regions. The adaptation of cut-off scores to the cultural, linguistic, and contextual characteristics of the target population, as described previously, has the potential to enhance the accuracy and comparability of PTSD assessments across groups (see also Ibrahim et al., 2018a). In heterogeneous populations, sample-specific cut-off adaptations remain the most pragmatic approach to minimise diagnostic bias, ensuring cultural sensitivity and maintaining the comparability to ensure the global validity of the PCL-5.

Future research. Future research should aim to identify models that achieve an optimal balance between good model fit, model parsimony, clinical utility, and diagnostic precision. In order to consider clinical implications, it is essential that future research include parsimonious models in their measurement invariance analysis, considering all recent factor models for PCL-5.

The present findings are currently limited to German- and Arabic-speaking populations in Europe. Future research should include more diverse populations (e.g., Hansen et al., 2023) to enhance generalizability and validate diagnostic instruments that account for population-specific differences in symptom perception and expression, enabling accurate cross-group comparisons (Kleim & Ehlers, 2008; Wortmann et al., 2016). To ensure diagnostic accuracy

across diverse populations and contexts, measurement invariance analyses of the PCL-5 should be extended. This will improve prevalence estimates, facilitate the identification of treatment needs, and enhance access to psychotherapeutic care.

While the present study primarily focused on measurement invariance between the German and Arabic versions, other studies have examined either the factor structure or the convergent and divergent validities of the PCL-5 separately within the German and Arabic samples (e.g., Ibrahim et al. 2018; Krüger-Gottschalk et al., 2017). Thus the present conclusions are based on a combination of the current research, and the present study findings. Due to the methodological scope of the analyses, a full integration of these additional evaluations was not feasible within the present study. Therefore, to strengthen the basis from speculative to concrete recommendations on cut-off adaptations, we intend to expand the present study of measurement invariance by conducting a comprehensive psychometric evaluation of the PCL-5, encompassing assessments of construct validity, convergent and discriminant validity, as well as criterion validity. In this regard, sensitivity, specificity, and ROC analyses will be employed to ascertain subgroup-specific cutoff scores for the PCL-5 German and Arabic version.

To comprehensively assess measurement invariance in cross-cultural PTSD assessment, future research should extend such designs beyond a single instrument, such as the German and Arabic versions of the PCL-5. While preliminary evidence supports the hypothesis of configural, metric, and scalar invariance of the Impact of Event Scale–Revised (IES-R) across gender, age, and marital status (e.g., Ali et al., 2022), cross-linguistic or cross-cultural invariance for IES-R and also for clinical interviews like the Clinician-Administered PTSD Scale for DSM-5 (CAPS-5; Weathers et al., 2013b), between English or other Western language and Arabic versions, remains largely unexplored. Expanding measurement invariance testing to a broader range of tools would therefore enhance understanding of the cross-cultural applicability of the Western conceptualisation of PTSD.

4.6. Conclusion

Overall, both the German and Arabic versions of the PCL-5 are reliable diagnostic tools for assessing PTSD symptoms, with a six-to-seven-factor structure (Anhedonia and Hybrid models) being confirmed for both versions by single-group CFAs. Moreover, the present study provides important evidence for metric measurement invariance of the PCL-5 across the German and Arabic populations, allowing meaningful comparisons of PTSD symptom structure between these populations. However, the scalar non-invariance suggests that the sum scores are not directly comparable, as it is debatable whether the strength in symptom experience and

expression of PTSD in PCL-5 differ between German and Arabic. Addressing this, future research is needed to validate context-sensitive, population-adapted cut-off scores to improve diagnostic accuracy. In addition, comprehensive psychometric research is needed, including the investigation of measurement invariance in other PTSD instruments in several populations for a more global view on PTSD assessment adequacy.

In a broader context, our findings underscore the critical need for cultural, linguistic, and contextual sensitivity in the assessment of PTSD to avoid bias in epidemiologic research (e.g., prevalence estimates) and clinical practice (e.g., assessment of mental health care needs and identification of appropriate treatment), particularly when applying Western-developed instruments to populations with divergent cultural backgrounds. Ultimately, adopting flexible, context-adapted approaches will enhance both psychometric robustness and clinical utility, ensuring fair, valid cross-cultural PTSD diagnoses and better-informed treatment decisions.

4.7. Declarations

No potential conflict of interest was reported by the authors. This article has earned the Center for Open Science badge for Open Materials. The materials are openly accessible at https://github.com/CharinaCLueder/ccv_pcl5. Data supporting the results of this study are available upon request. Requests for access to the data can be directed to the corresponding author at charina.lueder@uni-saarland.de. The R scripts used for the analyses reported in the present study are publicly available at https://github.com/CharinaCLueder/ccv_pcl5. The study reported in this article was not formally preregistered. Informed consent was obtained from all participants prior to their inclusion in the study. The participants' informed consent form, English version, is provided in Supplementary Materials (B3). The German and Arabic versions of the PCL-5 were either publicly accessible or procured directly from the original authors (who also served as co-authors of this study) and have been cited in accordance with APA standards. The Ethics Committee of the Faculty of Empirical Human Sciences and Economics at Saarland University approved the ethics application for this study in October 2021 (Ethics Committee reference number: 2123). All procedures were conducted in accordance with the ethical standards outlined in the Declaration of Helsinki. Prior to participation, all individuals were required to provide written informed consent (see Supplementary Materials [B3] for English version).

5. Study 3: Moderate-intensity aerobic exercise training as an adjunct to trauma-focused psychotherapy in traumatized refugees and asylum seekers: study protocol of a randomized controlled trial.[5]

Lüder, C. C., Michael, T., Lass-Hennemann, J., Schanz, C. G., Venhorst, A., Meyer, T., & Equit, M. (2023). *Moderate-intensity aerobic exercise training as an adjunct to trauma-focused psychotherapy in traumatized refugees and asylum seekers: study protocol of a randomized controlled trial.* European Journal of Psychotraumatology, 14(2), 2251777. DOI 10.1080/20008066.2023.2251777

5.1. Abstract

Refugees with exposure to multiple traumatic events are at high risk for developing posttraumatic stress disorder (PTSD) and depression. Narrative exposure therapy (NET) is an effective treatment for the core symptoms of PTSD, but it does not reliably reduce depressive symptoms. Endurance exercise on the other hand was consistently found to be effective in treating depression making it a promising adjunct to NET. Up to date, no studies exist investigating the combination of NET and endurance exercise in a sample of refugees with PTSD and comorbid depression. In the proposed randomized controlled trial, we aim to investigate whether a combination of NET and moderate-intensity aerobic exercise training (MAET) enhances treatment outcome for refugees with PTSD and comorbid depressive symptoms. We expect a greater improvement in psychopathology in participants who receive the combined treatment. 68 refugees and asylum seekers with PTSD and clinically relevant depressive symptoms will be recruited in the proposed study. Participants will be randomly assigned to receive either NET only (NET-group) or NET plus MAET (NET^{+}-group). All participants will receive 10 NET sessions. Participants in the NET^{+}-group will additionally take part in MAET. Primary (PTSD, depression) and secondary (general mental distress, agoraphobia and somatoform complaints, sleep quality) outcome measures will be assessed before treatment, after treatment, and at six-month follow-up. The hypotheses will be tested with multiple 2 x 3 mixed ANOVA's.

[5] ***Note***. In this dissertation, the Supplementary Materials for *Study 3* are provided in Appendix C.

5.2. Background

An increasing number of people is forced to leave their homes because of war, human rights violations and natural disasters. Since 2020, the number of forcibly displaced people worldwide exceeded 1% of the world' s population (UNHCR, 2021). The United Nations High Commissioner for Refugees (UNHCR) reported that in May 2022 over 26.3 million refugees were under UNHCR's mandate and that 4.5 Mio asylum seekers out of 101.1 Mio displaced people worldwide had to flee their hometowns due to war, violent conflicts, and persecution (UNHCR, 2022). Most of them have been exposed to traumatic events before, during and after their flight. A recent German study showed that 85.5 % of newly arrived refugees reported having experienced at least one traumatic event (Nesterko et al., 2020): 75.7% of the participants reported interpersonal traumatic events. Physical assault was the most frequently experienced event, followed by interpersonal threat/assault with a weapon. Incidents of severe human suffering, and sexual assaults were also reported. Sexual assaults were more frequently reported by women than by men.

In fact, refugees tend to be exposed to multiple man-made traumatic events posing them at a particularly high risk for the development of posttraumatic stress disorder (PTSD) and comorbid depressive symptoms (Blackmore et al., 2020; Fazel et al., 2005; Nesterko et al., 2020). Two recent studies showed that 35–40% of refugees[6] in Germany suffer from PTSD and 21.7 % from depression (Gäbel et al., 2006; Nesterko et al., 2020). These high rates stand in contrast to the one-year prevalence rates of PTSD (2.3 %) and depression (7.7 %) in the general population in Germany (Jacobi et al., 2014). PTSD and depression often co-occur (e.g., Blackmore et al., 2020) and tend to maintain or even reinforce each other. PTSD patients suffering from comorbid depression show a higher impairment in global functioning (Momartin et al., 2004) and a reduced treatment progression and treatment response (Haagen et al., 2017).

Trauma-focused psychotherapy (TFP) is the gold standard for treating PTSD (e.g., Lewis et al., 2020). For patients with PTSD and depression, the National Institute for Health and Care Excellence (NICE) recommends that PTSD is treated first unless the depression is severe enough to make psychotherapeutic treatment of PTSD difficult or puts the person at risk of harming themselves (NICE, 2018). Narrative exposure therapy (NET) is a TFP developed for survivors of traumatic events (Schauer et al., 2011). In NET, patients construct a chronological

[6] In this studyprotocol the term "refugees" is used interchangeably with "refugees and asylum seekers". Therefore, the term "refugees" refers to both individuals who have been granted refugee status and those who are seeking asylum.

narrative of their lives with emphasis on the traumatic experiences. Research on the efficacy of NET in treating PTSD in refugees consistently show significant improvements in PTSD symptoms although not all patients achieve loss of diagnosis (Cusack et al., 2016).

Studies on the effects of NET on depression show mixed results (e.g., Kip et al, 2020; Nosè et al 2017; Stenmark et al., 2013). While some studies found significant reduction of depression symptoms (e.g., Adenauer et al., 2011), others did not (Hensel-Dittmann et al., 2011) or found no long-term effects (Alghamdi et al., 2015). Several adjuvant interventions have been proposed as boosters of TFP with respect to PTSD and comorbid symptoms (Michael et al., 2019). Of these possible adjuvant interventions aerobic exercise seems to be a particularly promising option (for example see Bryant et al., 2022). Exercise in general has been found to have beneficial effects on several psychological disorders, which may be explained by neurobiological mechanisms including modifications in the Hypothalamic–Pituitary–Adrenal (HPA) axis activity, monoamine metabolism (Alghadir & Gabr, 2020; Autry & Monteggia, 2012; Ploski & Vaidya, 2021)., and Brain-Derived Neurotrophic Factors (BDNF) (Castrén & Monteggia, 2021; Knaepen et al., 2010, Powers et al., 2015). Additionally, psychological factors such as increased self-efficacy and self-esteem may also contribute to the effectiveness of exercise in treating psychological disorders (Asmundson et al., 2013; Holz & Michael, 2013).

Effects of exercise on depressive symptoms. Extensive empirical evidence shows that exercise significantly reduces depression (Schuch et al., 2016). Wegner et al. (2014) that synthesize meta-analyses on the effects of exercise on anxiety and depression found a moderate anti-depressant effect. A current systematic review and meta-analysis by Björkman and Ekblom (2022) on the effect of physical exercise on PTSD including different types of aerobic and resistance exercise also found a beneficial effect of exercise on depressive symptoms in PTSD patients. While the above-described studies and meta-analyses focus on exercise as a stand-alone treatment, there are a few studies focusing on exercise as an adjuvant treatment. Rosenbaum et al. (2015) investigated the effect of a 12-week exercise intervention (walking programme) in addition to treatment as usual (TAU) in a sample of PTSD patients and found a large effect favour combined intervention to decrease depressive symptoms. Nordbrandt et al. (2020) conducted a similar study in a refugee sample with PTSD but did not find an effect on mixed exercise as an adjunct to TAU on depression symptoms.

Effects of exercise on PTSD symptoms. There is preliminary evidence that exercise may also reduce PTSD symptomatology (Fetzner & Asmundson, 2015; Hegberg et al., 2019, Knappe et al., 2019). A systematic review by Vancampfort et al. (2017) found that exercise is especially

effective in reducing PTSD-symptomatology for patients with a lower baseline physical fitness. In the above-mentioned meta-analysis Björkman and Ekblom (2022) also reported a positive effect of physical exercise on PTSD as a primary outcome. The effects of exercise as an adjunct to standard treatment for PTSD patients have rarely been investigated. Qualitative research focusing on exercise as a component of treatment for traumatized refugees provides support for the health-promoting effects of such interventions, as indicated by self-report measures. (e.g., Nilsson et al., 2019). Powers et al. (2015) found that TFP plus exercise led to a significant greater reduction in PTSD symptomatology as compared to TFP only. However, the validity of these results is limited due to the small sample size (n = 9). Furthermore, Rosenbaum et al. (2015) found a moderate effect favouring a combined intervention in the decrease of PTSD symptoms. However, Nordbrandt et al. (2020) did not find a significant effect of adjuvant exercise on PTSD symptoms compared to TAU. Given the heterogeneous nature of exercise interventions in different studies, it is difficult to determine the appropriate programme variables (frequency, intensity, duration, and type of exercise) for an effective exercise intervention. However, BDNF and HPA axis regulation as potential mechanisms of action point to a more beneficial effect of moderate to intense endurance exercise as compared to other types of exercise. In line with this, Stanton and Reaburn (2014) reviewed the evidence of five RCTs examining the characteristics of effective exercise in reducing depression. The review supports the notion that the most effective exercise programmes include aerobe endurance exercise of moderate intensity, three times weekly ranged from four to twelve weeks, with both individual and group training being effective. Furthermore, Wegner et al. (2020) reviewed several meta-analyses in a sample of depressed children and adolescents and summarized aerobic exercise as the most frequently implemented type of exercise (41 min, three times a week, over 11.5 weeks).

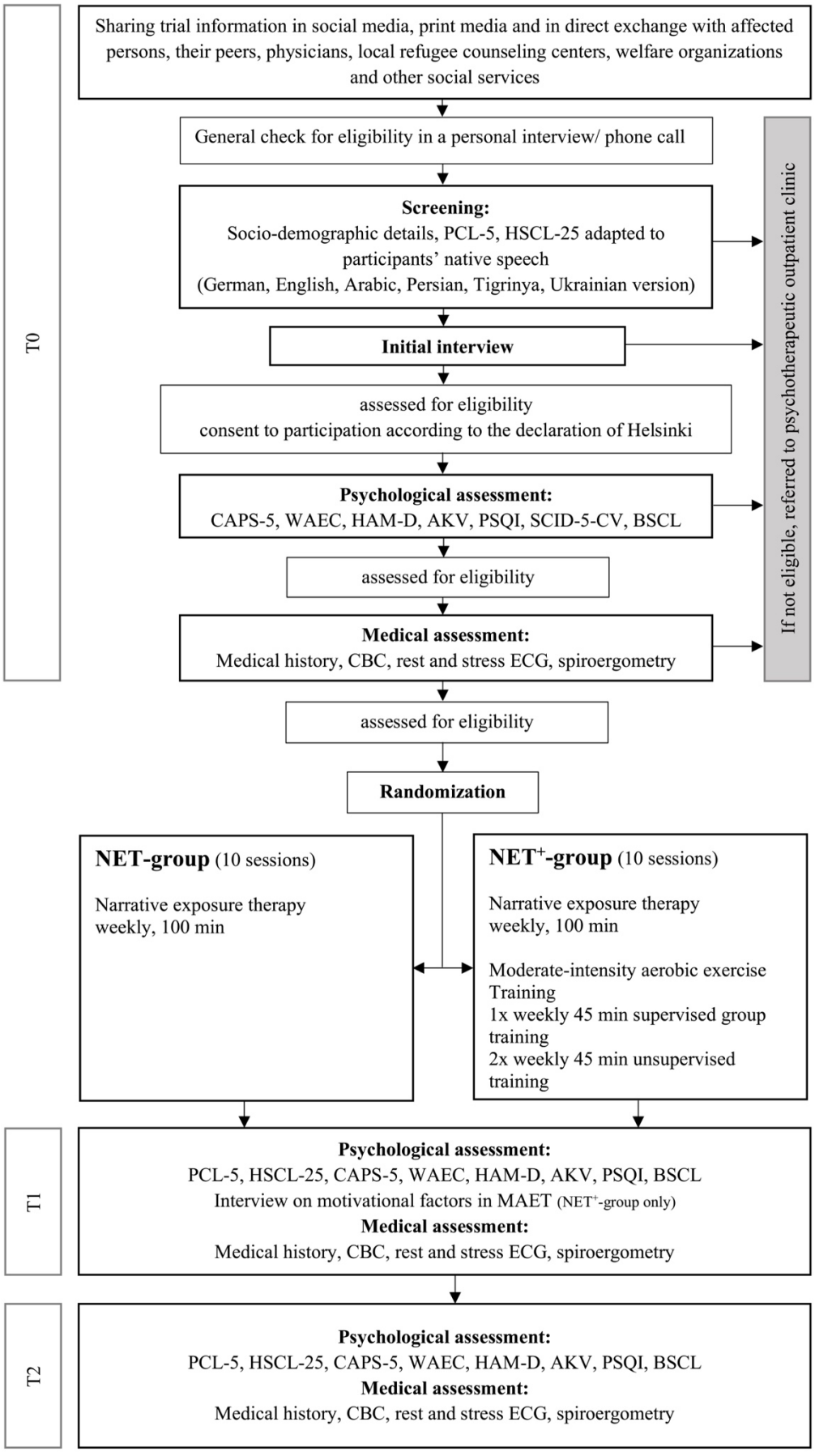
Summary and Objectives. To summarize NET reduces consistently PTSD symptoms in refugees, but many keep PTSD diagnostic status. Further, there is insufficient evidence that NET improves depressive symptoms. Physical exercise, as an adjunct to NET seems a promising option to improve both PTSD and depression symptoms. Thus, the proposed randomized controlled trial (RCT) aims to investigate whether a combination of NET and moderate-intensity aerobic exercise training (MAET) (NET^{+}-group) enhances treatment outcome for refugees with PTSD and comorbid depressive symptoms in comparison to NET as a stand-alone treatment (NET-group).

Hypotheses. Compared to the NET-group, participants in the NET$^+$-group show greater improvement in primary (PTSD, depression) and secondary outcomes (general mental distress, agoraphobia and somatoform complaints, sleep quality) from pre to post treatment and at follow-up.

Trial Design. The proposed study is a single-blind RCT comparing a combined treatment including NET and MAET (NET$^+$-group) with NET only (NET-group). All participants receive ten NET sessions. Participants in the NET$^+$-group additionally participate in a MAET consisting of three weekly running exercises over a therapy period ranging from 10 to 15 weeks. Please note, the timing of each MAET session is unrelated to the weekly NET sessions. Outcome measures are assessed pre treatment (T0), after treatment completion (T1) and at six-month follow-up (T2). An overview of the RCT is given in the flowchart shown in Figure 5.1.

Figure 5.1

Flowchart of the Procedure of the Current Clinical RCT



5.3. Methods

Study Setting. NET is offered at the Psychotherapeutic Outpatient Clinic, which is part of the Department of Clinical Psychology and Psychotherapy at Saarland University. Medical diagnostic is performed at the Institute of Sports and Preventive Medicine at Saarland University.

Funding details and preregistration. The present trial is supported by the German Research Foundation (DFG) under Grant 426361032. The trial is preregistered in German Clinical Trials Register (DRKS) (DRKS ID: DRKS00022145).

Sample size and power calculation. Sample size was calculated using G*Power 3.1.9.2. (Faul et al., 2009) to detect the interaction in a 2 x 2 ANOVA (group: NET^+ vs. NET; time: pre vs. post) with a power of .80 ($\alpha = .025$ because of two primary outcomes). The a priori power calculation resulted in a total sample size of $n = 68$ assuming a moderate adjuvant effect and at least a small correlation between the test times ($r = .15$).

Recruitment and eligibility criteria. Multiple local social services and employment agencies are involved in the recruitment of participants, and study eligibility is determined by the criteria specified in Table 5.1.

Table 5.1 Eligibility and Exclusion Criteria

Eligibility Criteria
1) German health insurance (registration as a recognized refugee in Germany required)
2) minimum age of 16 years
3) the diagnosis of PTSD
4) clinically relevant depression symptoms
5) no endurance training in the one-year period prior to study participation
6) no experience of endurance training in the past (i.e., not more than one weekly unit of endurance sports during the last two years and no lifetime competitive practice in endurance sports)
Exclusion Criteria
1) physical constraints: • cardiovascular diseases • serious deviations in Complete Blood Count (CBC) • further physical restrictions that preclude participation in moderate endurance training (e.g., serious systemic diseases, coronary stenosis with angina pectoris, cardiac insufficiency under resting conditions, severe cardiac arrhythmia, and acute illnesses, such as acute infections, severe electrolyte imbalance, recent heart attacks, heart wall aneurism)
2) eating disorders (due to the risk of abusing physical activity for weight loss)
3) acute psychosis
4) acute suicidal behaviour
5) substance abuse disorders/ drug and alcohol abuse
6) pregnancy
7) medication with of benzodiazepines

Notes. Participants currently undergoing pharmacological treatment will not be excluded from the study. However, it is requested that participants maintain a stable dosage and type of medication, with the exception of benzodiazepines, in order to include medication as a covariate in the final analyses. Participants receiving treatment with benzodiazepines cannot be included in the randomized controlled trial (RCT).

Procedure.

Screening. A first check of inclusion and exclusion criteria is assessed during a phone call before the screening questionnaires (PCL-5; Blevins et al., 2015; HSCL-25; Derogatis et al., 1974) are sent to potential participants. Screening questionnaires and diagnostic questionnaires are provided in participants' native languages. For illiterate people the screening and diagnostic questionnaires are conducted as an interview supported by interpreters.

Initial interview. Participants, who report psychological distress in the screening questionnaires, are invited to an initial interview to assess study eligibility. During the initial interview, participants are informed about the study protocol neglecting the hypotheses of the trial. If the initial interview suggests participants' study eligibility (suspected diagnosis of PTSD and depressive symptoms), participants are asked to provide informed consent and are invited to participate in detailed psychological and medical diagnostic sessions. Participants, who show signs of clinical distress, but are not eligible for study participation also receive a treatment offer at the Psychotherapeutic Outpatient Clinic of Saarland University.

Psychological assessment. The psychological assessment includes the Clinician-Administered PTSD Scale (CAPS-5; Weathers et al., 2013), the Hamilton Depression Scale (HAM-D; Hamilton, 1960; 1967) and the Structured Clinical Interview for DSM-5 Clinician Version (SCID-5-CV; First et al., 2016), the War and Adversity Exposure Checklist (WAEC; Ibrahim et al., 2018b) and self-report questionnaires assessing general mental distress (Brief Symptom Checklist (BSCL); Franke, 2017), sleep quality (Pittsburgh Sleep Quality Index (PSQI); Buysse et al., 1989) and agoraphobic symptoms and somatoform symptoms (*Fragebogen zu körperbezogenen Ängsten, Kognitionen und Vermeidung* AKV; Ehlers et al., 2001). All measures (except of the SCID-5-CV) will also be assessed after the completion of treatment (T1) and at six-month follow-up (T2).

Medical assessment. To assess participants' physical eligibility a detailed medical diagnostic is performed (including evaluation of medical history, resting and stress Electrocardiogram (ECG), spiroergometry, Complete Blood Count (CBC)).

Randomization. Participants are assigned to the NET^{+} and NET-group via computer-assisted randomization using Mersenne Twister in IBM SPSS Statistics version 22.0 (IBM Corp, 2013). After completion of the diagnostic sessions, participants receive a closed envelope containing group assignment.

NET and NET^{+}. Participants are randomly assigned to the NET vs. NET^{+}- group. All participants receive 10 NET sessions. The NET^{+}-group additionally receive MAET. The total duration of the treatment is estimated to range from 10–15 weeks.

Language mediation and translation. All sessions are accompanied by interpreters who are fluent in the participants' native speech and in German. Each interpreter is informed about the rationale and procedure of NET prior to the start of the first diagnostic session. During therapeutic sessions, interpreters are instructed to take a neutral role and solely translate everything the participant and psychotherapist are saying. NET sessions are transcribed by students who passively participate in the psychotherapeutic sessions.

Mental hygiene. Every fourth therapy session, language mediators and co-writing students receive group supervision led by the head of the Psychotherapeutic Outpatient Clinic of Saarland University to prevent psychological distress (through the refugees' narratives). In addition, there is the possibility of individual supervision if required.

Treatment fidelity. NET is conducted by licensed psychotherapists and psychotherapists in initial training. Participating psychotherapists were trained in NET in a two-day online workshop and receive supervision after every session. Additionally, all psychotherapeutic sessions are audio recorded.

Table 5.2 *Treatment Overview*

Session No.	Therapeutic Content	
1	Exploratory sessions	Relationship-oriented
		Assess of medication, suicidal behavior, risk of dissociation
		Development of the emergency plan
		Review of psychosocial problems
2		Psychoeducation on Trauma, PTSD, and memory
		Rationale and basic principles of NET and trauma-focused therapy
		Preparing for the following NET sessions
3	Narrative Exposure Therapy	Lifeline
4		Starting the narration at birth
		In-sensu exposure of the first traumatic life-event
5–11		Rereading of the previous narration to add further details if necessary
		Continuing the in-sensu exposure of further traumatic events following the narration
12		Rereading of the whole written narration/ relaying of the lifeline
		Appreciating and signing the written narration
		Optimistic perspective on future considered in a positive light

Notes. MAET starts in the third session together with the beginning of NET.

Intervention

Exploratory sessions and psychoeducation. Participants first undergo two exploratory sessions aiming at developing a therapeutic alliance (participant, psychotherapist, interpreter, co-writing students) and providing psychoeducation about PTSD and NET. Details on the content of the exploratory sessions can be found in Table 5.2.

Narrative exposure therapy. In the present trial NET consists of 10 weekly sessions (each with a duration of 100 min). The therapy takes place at the Psychotherapeutic Outpatient Clinic of Saarland University and is conducted by licensed psychotherapists or psychotherapists in initial training. In order to minimize the exclusion of individuals due to financial constraints that prevent them from traveling to therapy, the study will provide coverage for travel costs when necessary. The psychotherapists receive a professional NET coaching before starting the therapy and receive supervision by an experienced psychotherapist after every second double session. During the first NET session the participant's lifeline — with traumatic events symbolized by stones, situations of grief symbolized by candles and positive events symbolized by flowers — is laid (Elbert et al., 2015). The following sessions consist of the in-sensu

exposure for each traumatic event. To ensure an effective exposure the psychotherapist encourages participants to recall the traumatic events in emotion, sensation, cognition and physiological details. The exposure of a maximum of two traumatic events must be completed in one session. In the final session the events are reviewed as a holistic narration. The participant, the psychotherapist, the co-writing student, and the interpreter sign the narrative which is subsequently handed to the participant.

Narrative. Written transcripts of each session are provided by the co-writing students. The traumatic events are documented in the past tense and submitted weekly to the psychotherapist for revision. The participants are encouraged to revise and add to the narrative in each follow-up session and in the final NET session.

Moderate-intensity aerobic exercise training. Moderate-intensity aerobic exercise training (MAET) in the present study is adapted to the national recommendation for the treatment of depression recommended by WHO for health of adults aged between 18 and 64 (DGPPN, 2017; WHO, 2022). The NET^{+}-group receives three weekly outdoor sessions of MAET consisting of 45 min of jogging at 60% heart rate reserve (±5 bpm) (e.g., Stanton and Reaburn (2014)) with one MAET group session of no more than three participants supervised by a medical and psychological supervisor and two unsupervised exercise sessions per week. The route will be chosen to be close to participants' place of residence and with only a slight incline. Depending on individuals' baseline fitness levels, the intensity of MAET varies along a continuum from walking to jogging. Walking is typically assumed to occur at low baseline fitness levels, while jogging is associated with elevated baseline fitness levels. To be included in the final analysis participants must complete 70 % of MAET (Hecksteden et al., 2013). Each participant of the NET^{+}-group receives a mobile heart rate monitor with integrated memory function (Sigma ID.Free) and a compatible heart rate belt (Sigma R1 ANT+/BLE + COMFORTEX) to control and record parameters such as duration (in min), route (in m), speed (in min/km), altitude (in m) and average heart rate (in bpm) during MAET. To ensure an aerobic exercise training with moderate intensity, the heart rate monitor is programmed to display a green light when participant's heart rate was in the individually predefined heart rate zone. In addition to the digital recording of the MAET, participants document the completed MAET session and their mood before and after MAET training in a diary.

Primary outcomes.

Posttraumatic stress disorder. PTSD symptoms are assessed with the PTSD Checklist for DSM-5 (PCL-5), the Clinician-Administered PTSD-Scale for DSM-5 (CAPS-5), and the

War and Adversity Exposure Checklist (WAEC). All three measures are assessed before the start of the treatment (T0), post-treatment (T1) and at six-month follow-up (T2).

Depression. Depressive symptoms are assessed with the Hopkins Symptom Checklist-25 (HSCL-25) and the HAM-D. Depressive symptoms are assessed before treatment (T0), post-treatment (T1) and at six-month follow-up (T2).

Secondary outcomes. Secondary outcomes are also assessed at T0, T1 and T2.

General mental distress. General mental distress is measured using the BSCL, the German version of the Brief Symptom Inventory (BSI; Derogatis, 1993).

Agoraphobia and somatoform complaints. Agoraphobic symptoms and somatoform complaints are assessed with the Questionnaire on Body-Related Anxieties, Cognitions and Avoidance, AKV (Ehlers et al., 2001), a self-report measure, which is a compilation of the Body Sensations Questionnaire (BSQ; Chambless et al., 1984), the Agoraphobic Cognitions Questionnaire (ACQ; Chambless et al., 1984) and the Mobility Inventory (MI; Chambless et al., 1985). Somatoform complaints are physical complaints for which no physical cause has been found that would sufficiently explain the extent of the complaints.

Sleep quality. The PSQI (Buysse et al., 1989) is a self-report measure assessing sleep quality and sleep disturbances over the past month.

Physical assessments. The physical assessments include a resting ECG, stress ECG, CBC and spiroergometry.

Additional measures.

Socio-demographic information. Participants' age, sex, region of origin, native speech, further languages, medication, family status and duration of living in Germany are assessed once prior to study inclusion.

Comorbidities. The SCID-5-CV (First et al., 2016) is conducted to assess further comorbid psychological disorders in a semi-structured interview at T0.

Motivation in moderate-intensity aerobic exercise training. Participants are interviewed concerning their motivation during MAET at T1. Questions on motivational factors are answered for supervised group training and unsupervised training separately (see supplementary material C4).

Measurements. Table 5.3 gives a comprehensive summary of employed physical and psychological assessments and outcomes. Details can be found in the Supplementary Materials (C1, C2).

Data management.

***Statistical methods*.** All statistical analyses will be conducted by a member of the research team, who was not involved in the data collection process and the study interventions, using R version 4.1.2 (R Core Team, 2021). Alpha level for the main analyses is set to .025 due to multiple primary outcomes. Multiple 2 x 3 mixed ANOVA's (group: NET^+ vs. NET; time: pre vs. post vs. six-month follow-up) will be conducted to examine symptom severity in primary outcomes (PTSD and depression) and secondary outcomes. Contrasts will be conducted to separately examine the group-specific development of symptom severity over time (T0 vs T1; T0 vs T2; T1 vs T2).

Dealing with missing data. The statistical analyses will include the whole sample data of the RCT. Dropping out of trial will not exclude participants from final analyses. In this case the missing data will be imputed using Fully Conditional Specification (FCS; Sterne et al., 2009).

Table 5.3 *Assessments' Characteristics and Schedule*

Assessments and Measures	Evaluation	Schedule of Assessment T0	T1	T2	Outcome
Sociodemographic details	Self-report	x			Additional
PCL-5	Self-report	x	x	x	2nd
HSCL-25	Self-report	x	x	x	2nd
CAPS	Interview	x	x	x	1st
WAEC	Interview	x	x	x	1st
HAM-D	Interview	x	x	x	1st
BSCL	Self-report	x	x	x	2nd
AKV	Self-report	x	x	x	2nd
PSQI	Self-report	x	x	x	2nd
SCID-5-CV	Interview	x			Additional
Medical history	Self-report, Interview	x			Explorative
CBC		x	x	x	Explorative
Spiroergometry		x	x	x	Explorative
Submaximal parameters		x	x	x	Explorative
Resting ECG		x	x	x	Explorative
Stress ECG		x	x	x	Explorative
Motivation in MAET	Interview		x		Explorative

Notes. T0 = Baseline assessment before randomization and treatment; T1 = assessment after treatment completion; T2 = assessment at six month follow-up; PCL-5 = PTSD Checklist for DSM-5; HSCL-25 = Hopkins Symptom Checklist-25; CAPS = Clinician-Administered PTSD Scale; WAEC = War and Adversity Exposure Checklist; HAMD-D = Hamilton Depression Scale; BSCL = Brief Symptom Checklist; AKV = Questionnaire on Body-Related Anxieties, Cognitions and Avoidance (*Fragebogen zu körperbezogenen Ängsten, Kognitionen und Vermeidung*); PSQI = Pittsburgh Sleep Quality Index; SCID-5-CV = Structured Clinical Interview for DSM-5 Clinician Version; CBC = Complete Blood Count; ECG = Electrocardiogram; MAET = Moderate-intensity Aerobic Exercise Training.

5.4. Discussion

NET reduces PTSD symptoms in refugees, but many keep PTSD diagnostic status. Further, there is insufficient evidence that NET improves depressive symptoms. Endurance exercise has been shown to improve depressive symptoms and there is some evidence that it may also impact on PTSD symptomatology. Thus, physical exercise as an adjunct to NET seems a promising option to improve both PTSD and depression symptoms. However, up to date, no studies exist investigating the combination of NET and exercise in a sample of refugees with PTSD and depressive symptoms in a RCT. The present RCT aims to close this gap in research and aims to clarify whether the effectiveness of NET can be enhanced by MAET. The results of the current RCT will be crucial to improve mental health care for refugees. If NET^{+} proves to be superior to NET alone, future trials should investigate the combination of other trauma-focused therapies with MAET. Importantly, MAET may not only impact on PTSD and depression symptoms, but may also enhance patients' physical health, which has been shown to be poor in refugees.

Challenges of the trial. First, the recruitment of the sample might prove to be difficult due to the strict psychological and physical exclusion criteria. Recent studies have highlighted the underrepresentation and neglect of women's participation, especially of traumatized female refugees, in health-promoting exercise programmes and clinical trials (e.g., Pebole et al., 2021). Potential imbalance in gender distribution within a sample of traumatized refugees might be a potential challenge for the current RCT due to several reasons. Exclusion of female participants is justified based on physiological factors, such as a higher probability of experiencing extreme variations in ferritin levels. Additionally, social considerations, such as childcare responsibilities, may hinder female participation. Furthermore, cultural- and trauma-related factors, such as difficulties associated with mixed-gender group training in public settings, further contribute to the exclusion of females from the study. In response, the RCT addresses these issues for example by incorporating trauma-informed considerations in exercise and psychotherapy, such as providing childcare services to promote equal opportunities for participation.

Furthermore, dropout rates might be high. Trauma-focus in psychotherapy is associated with high dropout rates, and in our trial treatment is combined with a very thorough psychological and physiological diagnostic, which may lead to high dropout rates in both groups, which might be even higher in the NET^{+} group due to the higher rate of weekly appointments.

Gender specific dropout rates due to cultural and trauma-associated barriers for refugee women to participate in public, group-based MAET may require special attention, as they have a significant impact on feasibility. Nonetheless, the implementation of individualized treatment approaches, such as matching gender in MAET, undermines the quality criteria of a RCT. However, considering the importance of evaluating these factors, further research should contemplate to specifically examine the acceptability and feasibility aspects in general.

It is also important to acknowledge that the participants did not have free choice in the type of sport intervention. Allowing free choice of sport could potentially enhance participant engagement, reduce dropout rates, and potentially amplify the intervention's effectiveness. However, offering a wide range of sports activities would compromise the feasibility of conducting a randomized controlled trial (RCT).

Furthermore, language and cultural barriers might affect therapy by interfering with a solid therapeutic alliance. We will work with language and cultural interpreters to minimize this challenge.

Limitations. The limitations of our trial are those typical for empirical assessment of psychological therapy such that it is impossible to conduct double-blind trials. Participants are randomly assigned to NET^+ vs. NET group. However, participants in the NET^+ group know that they receive a more comprehensive treatment, which might be part of the reason that patients in the NET^+ group perform systematically better than participants in NET group. Also, a systematic underperformance of participants in the NET^+ group is conceivable, as the combined treatment requires a higher level of motivation and compliance. However, all outcome measures will be assessed blinded to the intervention group and independent of the leading researchers and therapists.

Finally, we do not examine the mechanisms of action that underlie our hypothesis. It has been posited that the interaction of neurobiological processes and psychological factors achieve the beneficial effect of endurance exercise on psychological symptoms. Anticipating the findings that confirm our hypotheses, future studies should explore the underlying mechanisms of action.

Overall, the present RCT shows high external validity while adhering to scientific standards. The RCT is the first trial assessing whether the efficacy of NET can be augmented by endurance exercise. The results of the current RCT may boost clinical treatment approaches to improve the mental health care of traumatized refugees.

Trial status. The study was pre-registered in DRKS on July 29, 2020 (DRKS ID: DRKS00022145). At the time of submission of this manuscript, the data collection is in progress. The date of inclusion of the first subject was in October 2020. Due to the health policy situation of the global Covid-19 pandemic, the implementation of the trial is delayed. The completion of the data collection was initially scheduled for 2023. Due to the impact of the Covid-19 pandemic, a one-year delay is expected, moving the prospective completion of data collection to 2024.

Ethics approval and consent to participate. The Ethics Committee of the Faculty of Empirical Human Sciences and Economics of Saarland University approved the ethics committee application from 13 September 2017 to 10 October 2017 (Ethics committee number: 1713). Respectively, all methods are conducted in accordance with the ethical standards of the Declaration of Helsinki. All participants will have to provide written informed consent before being included in the study (see Supplementary Materials [C3]).

5.5. Declarations

No potential conflict of interest was reported by the author(s). This work was supported by Deutsche Forschungsgemeinschaft [grant number 426361032]. Availability of data is not applicable yet.

6. Study 4: Exercise Every Other Day Keeps the Trauma at Bay: A Two-Level Linear Mixed-Effects Model Analysis of Moderate-Intensity Aerobic Exercise as an Adjunct to Narrative Exposure Therapy in Refugees and Asylum Seekers[7]

Lüder, C. C., Michael, T., Venhorst, A., Meyer, T., & Equit, M. (2025). *Exercise Every Other Day Keeps the Trauma at Bay: A Two-Level Linear Mixed-Effects Model Analysis of Moderate-Intensity Aerobic Exercise as an Adjunct to Narrative Exposure Therapy in Refugees and Asylum Seekers.* In Preparation.

6.1. Abstract

Narrative Exposure Therapy (NET) is a first-line treatment for posttraumatic stress disorder (PTSD), particularly for severely affected individuals, such as refugees and asylum seekers. These patients frequently exhibit co-occurring depressive symptoms. Despite consistent evidence of NET's effectiveness, many patients maintain PTSD status. Since moderate-intensity aerobic exercise training (MAET) has proven to be an effective treatment for depression, and has also been shown to benefit PTSD patients, it is a promising adjunct approach to NET, particularly among highly affected populations such as refugees and asylum seekers. Therefore, Lüder et al. (2023) conducted a randomized controlled trial (RCT) to investigate the effects of MAET as an adjunct to NET in traumatized refugees, compared to NET alone. In this context, the present study builds on preliminary data from Lüder et al. (2023) and examines the pre–post effects of the combined treatment approach, including NET and MAET compared to NET alone. This study is conducted independently as a part of a cumulative dissertation project. In addition to the methods proposed by Lüder et al. (2023), the analysis scheme of the present study includes two-level linear mixed-effects models, Bayesian multilevel models, and exploratory analyses to better account for individual variability and the nested data structure within a sample of $n = 30$ participants (instead of $n = 68$ initially planned). The analyses focus on pre- (t_0) and post-assessment (t_1) data assessing psychological distress, symptom severity of PTSD and depression and sleep quality. Follow-up data were not included, as data collection for this time point is still in progress and not yet complete. The findings of the present study show that NET significantly reduced psychological distress, improved sleep quality, and reduced the severity of depressive symptoms and PTSD in the analyzed sample. However, the combined treatment was not superior to NET alone. Model comparisons favored

[7] ***Note***. In this dissertation, the Supplementary Materials for *Study 4* are provided in Appendix D.

models incorporating a treatment-by-time interaction, suggesting that changes over time may differ between treatment conditions. Crucially, this does not necessarily imply an advantage of the combined treatment, but rather highlights the need for further research on the role of physical activity as an adjunct to trauma-focused psychotherapy (TFP). Moreover, exploratory analyses suggested a moderating effect of residence permit status. Combining the rigor of the RCT with real-world conditions resulted in a small, heterogeneous sample, which compromises the generalizability of the results, but at the same time ensures ecological validity. While no direct superiority of the combined treatment was observed for the primary outcomes, the findings are preliminary and should be interpreted with caution. Nevertheless, physical activity has revealed itself to be a low-threshold adjunct with the potential to improve access to, acceptance of and adherence to TFP among severely affected populations, such as traumatized refugees. Concurrently, the present study emphasizes the relevance of considering contextual and individual factors under real-world clinical conditions.

6.2. Background

Trauma-focused psychotherapy (TFP), particularly Narrative exposure therapy (NET, Neuner et al., 2011), has been consistently demonstrated to reduce symptoms of posttraumatic stress disorder (PTSD) across various populations. NET is especially well-suited for individuals who have experienced multiple or prolonged traumatic events. Thus, NET has largely been applied in samples of refugees and asylum seekers (Macallin & Wynn, 2021). Although NET has been shown to substantially reduce PTSD symptoms, a significant proportion of individuals nonetheless continue to meet diagnostic criteria for PTSD following treatment (Larsen et al., 2019). Furthermore, trauma-focused interventions are associated with elevated dropout rates (Lewis et al., 2020). Moreover, a considerable proportion of individuals affected by PTSD manifest multimorbidity, with current research suggesting that approximately half of the refugees affected also exhibit depressive symptoms (Nickerson et al., 2017). In a meta-analysis of randomized controlled trials (RCTs), Kline et al. (2021) suggest, that higher baseline depression can impair the response of TFP for PTSD. Furthermore, co-occurring depressive symptoms have an additional negative impact on general psychological well-being and sleep quality, which in the long term contributes to chronic PTSD and further impairs the response to trauma-focused treatment (e.g., Slavish et al., 2022). This underscores the importance of a comprehensive, adaptive, and effective treatment approach for PTSD that is adjusted to the varied demands of heterogeneous patient populations. To address these needs, enhancing

treatment responsiveness and the efficacy of TFP, adjunct interventions are frequently considered. Research has indicated that physical exercise exerts a beneficial effect on general mental health (Stathopoulou et al., 2006) and sleep quality (Banno et al., 2018). It has been demonstrated that physical exercise can serve as an effective treatment for psychological disorders, with particular emphasis on the mitigation of symptoms related to depression and PTSD (Björkman & Ekblom, 2022). From the wide range of physical exercise related interventions, particularly moderate-intensity aerobic exercise training (MAET) has demonstrated notable efficacy as a mono-therapeutic treatment for psychological disorders (Stanton & Reaburn, 2014), including depression and PTSD. However, current research predominantly focuses on MAET as a mono-therapeutic treatment, with a paucity of research on MAET as an adjunct to TFP (Powers et al., 2015). In the context of TFP, such as NET, the incorporation of MAET as adjunct holds promise to complement in a comprehensive treatment approach, with the objective of enhancing general mental health, particularly among refugees and asylum seekers.

6.3. Methods

Study design and Participants. To address this gap, Lüder et al. (2023) proposed a single-blind RCT to evaluate the efficacy of a combined treatment consisting of NET and MAET, compared to NET alone, in reducing PTSD and depressive symptoms as primary outcomes and psychological distress, agoraphobic symptoms, somatoform complaints, and sleep quality as secondary outcomes on a sample of $n = 68$ traumatized refugees and asylum seekers.

This study follows the general objectives and procedural framework of the study protocol by Lüder et al. (2023). However, it offers an adapted statistical approach to address the reduced sample size on $n = 30$ participants collected between April 2020 and April 2025, the individual variability, and the nested data structure. A two-level linear mixed-effects model was employed to assess psychological distress, PTSD, and depression symptom severity, and sleep quality before (t_0) and after treatment (t_1) to examine the short-term efficacy of the combined treatment compared to NET mono-therapy. Overall, the present study was conducted as an independent investigation within the framework of a cumulative dissertation project.

Eligibility. Participants in the RCT were recruited using a multimodal approach supported by local community stakeholders (see Lüder et al., 2023). Participants were included

if they were at least 16 years old, were forcibly displaced from their country of origin and were currently residing in Germany. To participate in the RCT, participants had to be identified with PTSD as the primary diagnosis and comorbid depressive symptoms. Additionally, participants had to report no prior experience of endurance training. For a more detailed description of eligibility criteria, see Lüder et al. (2023). An overview of the present sample and treatment characteristics is provided in Table 6.1.

Ethics approval and consent to participate. The RCT was approved by the local ethics committee (1713) and conducted in accordance with the Declaration of Helsinki. Written informed consent was obtained from all participants. For further procedural details, see Lüder et al. (2023).

Funding and Registration. The underlying RCT is funded by the German Research Foundation (DFG) (Grant 426361032) and initially preregistered in German Clinical Trials Register (DRKS) (DRKS ID: DRKS00022145). In line with principles of good scientific practice and to ensure transparency, the present study, implementing a modified analysis scheme from the initial RCT to account for individual variability and the nested data structure, was registered on the Open Science Framework (https://doi.org/10.17605/OSF.IO/NS6WE).

Table 6.1 *Samples and Treatment Characteristics*

	NET group *n* = 15	NET⁺ group *n* = 15	Total sample *n* = 30	Test statistic	*p*
Age, M (SD)	27.13 (7.66)	27.81 (8.65)	27.47 (8.04)	$t(27.95) = -0.23$	.822
Sex, % (*n*)					
male	73.33 (11)	53.33 (8)	63.33 (19)	-	.450
female	26.67 (4)	46.67 (7)	36.67 (11)		
Country of origin, % (*n*)					
Syria	46.67 (7)	20.00 (3)	33.33 (10)		
Afghanistan	33.33 (5)	20.00 (3)	26.67 (8)		
Ukraine	6.67 (1)	20.00 (3)	13.33 (4)		
Iraq	6.67 (1)	6.67 (1)	6.67 (2)		
Iran	-	6.67 (1)	3.33 (1)	-	.415
Turkey	-	6.67 (1)	3.33 (1)		
Croatia	-	6.67 (1)	3.33 (1)		
Uzbekistan	6.67 (1)	-	3.33 (1)		
Morocco	-	6.67 (1)	3.33 (1)		
Lebanon	-	6.67 (1)	3.33 (1)		
Native language, % (*n*)					
Arabic	40.00 (6)	40.00 (6)	40.00 (12)		
Dari	26.67 (4)	13.33 (2)	20.00 (6)		
Ukrainian	6.67 (1)	20.00 (3)	13.33 (4)		
Pashto	6.67 (1)	6.67 (1)	6.67 (2)		
Farsi	-	6.67 (1)	3.33 (1)	-	.774
Bandari	6.67 (1)	-	3.33 (1)		
Kurdish	6.67 (1)	-	3.33 (1)		
Turkish	-	6.67 (1)	3.33 (1)		
Uzbek	6.67 (1)	-	3.33 (1)		
Bosnian	-	6.67 (1)	3.33 (1)		

Table 6.1 (continued.)

Years of residence in Germany, M (SD)	5.92 (3.89)	3.53 (3.02)	4.64 (3.60)	t (22.55) = 1.80	.085
Residence permit[1], % (*n*)					
temporary					
< 1 year	13.33 (2)	26.67 (4)	20.00 (6)		
1–3 years	t6.67 (1)	13.33 (2)	10.00 (3)	-	.860
> 3 years	60.00 (9)	53.33 (8)	56.67 (17)		
permanent	6.67 (1)	6.67 (1)	6.67 (2)		
Traumatic events[2], M (SD)	13.87 (4.89)	12.40 (4.05)	13.13 (4.95)	t (27.97) = 0.81	.426
Comorbid psychiatric disorder, % (*n*)	40.00 (6)	46.67 (7)	43.33 (13)	-	1.000
Crisis sessions, % (*n*)	20.00 (3)	33.33 (5)	26.67 (8)	-	.682
Language mediation, % (*n*)	60.00 (9)	93.33 (14)	76.67 (23)	-	.080
Treatment duration[3], M (SD)					
NET	139.55 (95.41)	112.42 (46.60)	125.39 (73.59)	t (14.23) = 0.85	.407
MAET	-	88.89 (33.60)		-	-
Number of treatment sessions, M (SD)					
NET	10.00 (0.82)	9.83 (0.39)	9.91 (0.61)	W = 103.50	.696
MAET	-	26.66 (5.34)		-	-
MAET characteristics					
Time M (SD)	-	46.52 (0.96)		t_{45} (8) = 6.91	<.001***
Pace M (SD)	-	10.08 (2.71)		-	-
Incline, M (SD)	-	17.47 (16.53)		t_0 (7) = 4.37	<.001***
Target heart rate, M (SD)	-	112.99 (9.99)		t (7)= −8.69	<.001***
Actual heart rate, M (SD)	-	136.18 (10.81)			

Note. NET = Narrative exposure therapy; MAET = moderate-intensity aerobic exercise training; Participants in the NET group received NET as a standalone treatment; Participants in the NET$^+$ group received a combined treatment including NET and MAET as an adjunct; [1]in years; [2]assessed by War and Adversity Exposure Checklist (WAEC, Ibrahim et al., 2018b); [3]in days; W = Wilcoxon rank-sum statistic (equivalent to Mann–Whitney U); t_{45} = t-test against the reference (time = 45 minutes); t_0 = t-test against the reference (incline = 0 m); $^{***}p < .001$; Percentages are based on the total (sub)sample size, due to rounding or missing data, totals may not sum to 100%.

Procedure. The study design of the RCT is described in detail in Lüder et al. (2023). As illustrated in Figure 6.1, following the baseline assessment at t_0, participants who met the inclusion criteria were randomly assigned to receive either NET only (NET group), or a combined treatment including NET and MAET (NET^+ group), using a computer-assisted procedure based on the Mersenne twister algorithm implemented in IBM SPSS Statistics, version 22.0 (IBM Corp., 2013). Notably, the randomization was single-blinded.

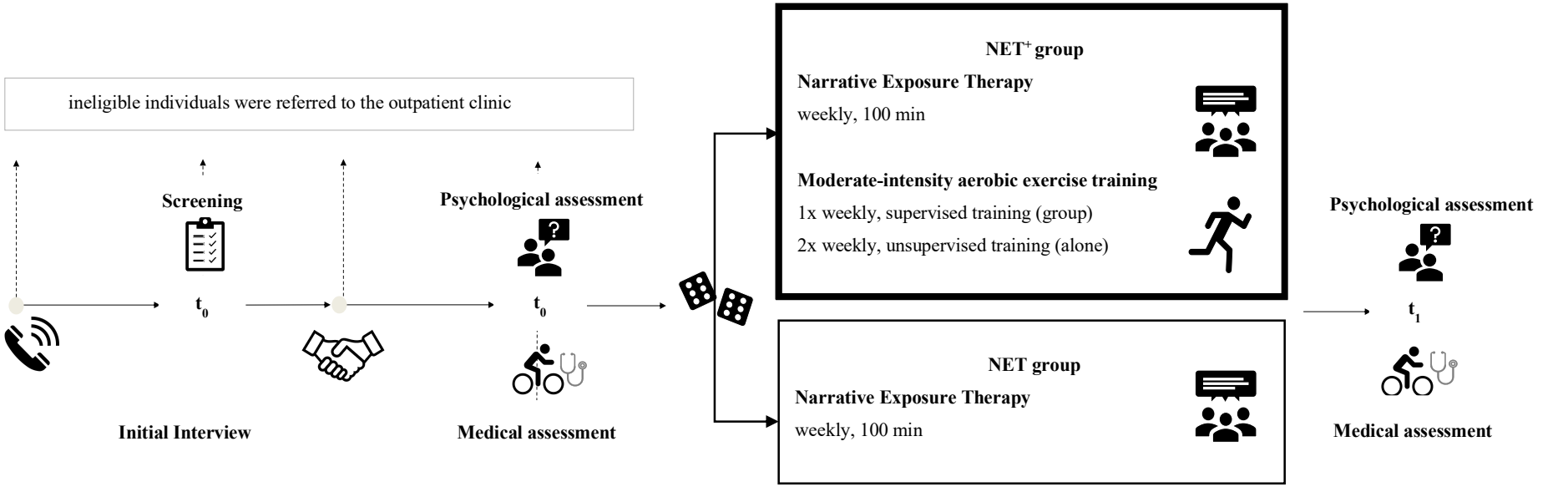
Treatments. Over a period of 10–15 weeks, participants received at least two exploratory sessions which aimed to establish a therapeutic rapport and foster motivation. These sessions also entailed psychoeducation on PTSD and comorbid depressive symptoms, as well as on NET and MAET. Subsequently, a series of ten weekly NET sessions was administered (Neuner et al., 2011), each session comprising 100 minutes. The NET was conducted by trained psychotherapists, accompanied by research assistants to write down the participants' narrative elaborated during the therapy. When necessary, interpreters fluent in German and participants' native languages assisted in sessions after receiving instruction on NET procedures and neutral translation conduct. Participants assigned to the combined treatment approach received MAET as an adjunct to NET, with the moderate intensity of exercise recommended by the WHO (2022). MAET consisted of 45 minutes of walking or jogging outdoors at 60±5 % heart rate reserve, three times a week (cf. Stanton & Reaburn, 2014). Every third MAET session was conducted in a group setting of up to three participants and supervised by a research assistant who specialized in sports medicine. The remaining sessions were self-directed. The adherence and intensity of MAET were monitored using a mobile heart rate monitor (Sigma ID.Free), supported by a compatible chest strap (Sigma R1 ANT+/BLE + COMFORTEX). To control for the moderate intensity of the MAET, the mobile heart rate monitor displayed a green light when the predefined heart rate zone was maintained during MAET. A detailed description of both treatment approaches and further details on the implementation of the RCT (e.g., mental hygiene, treatment adherence, etc.) can be found in Lüder et al. (2023).

Outcomes and Assessment. The outcomes examined in the present study represent a subset of those from Lüder et al. (2023) at t_0 and t_1, with consistent definitions and operationalizations. Sociodemographic data (e.g., gender, age, family status, native language), details on migration and flight (e.g., country of origin, duration of residence and residence permit in Germany) and characteristics of traumatic events were assessed at baseline (t_0) using the War and Adversity Exposure Checklist (WAEC, Ibrahim et al., 2018b). The primary outcomes included PTSD (PTSD Checklist for DSM-5 [PCL-5], Blevins et al., 2015; Clinician-

Administered PTSD Scale-5 [CAPS-5], Weathers et al., 2013) and depressive symptoms (Hopkins Symptom Checklist-25 [HSCL-25], Derogatis et al., 1974; Hamilton Depression Scale [HAMD], Hamilton, 1960, 1967). The secondary outcomes included psychological distress (Brief Symptom Checklist [BSCL], Franke et al., 2017) and sleep quality (Pittsburgh Sleep Quality Index [PSQI], Buysse et al., 1989). For all outcome measures, higher scores indicate greater symptom severity. Physiological parameters were also measured at t_0 and t_1 using standard clinical methods by trained medical professionals.

Figure 6.1

Schematic Overview of the Study Procedure and Assessment



Note. The figure illustrates the study procedure, as outlined in the RCT by Lüder et al. (2023), reduced to encompass the assessments and time points relevant to the present study; NET = Narrative exposure therapy; t_0 = pre treatment; t_1 = post treatment; SCID-5-CV = Structured Clinical Interview for DSM-5 – Clinician Version (First et al., 2016); WAEC = War and Adversity Exposure Checklist (Ibrahim et al., 2018b); PCL-5 = PTSD Checklist for DSM-5 (Blevins et al., 2015); CAPS-5 = Clinician-Administered PTSD Scale-5 (Weathers et al., 2013); HSCL-25 = Hopkins Symptom Checklist-25 (Derogatis et al., 1974); HAMD = Hamilton Depression Scale (Hamilton, 1960; 1967); BSCL = Brief Symptom Checklist (Franke et al., 2017); PSQI = Pittsburgh Sleep Quality Index (Buysse et al., 1989); CBC = Complete Blood Count; ECG = electrocardiogram performed at rest and during stress; CPET = cardiopulmonary exercise testing; CPET was initially performed as a stress test, including assessment of the target heart rate.

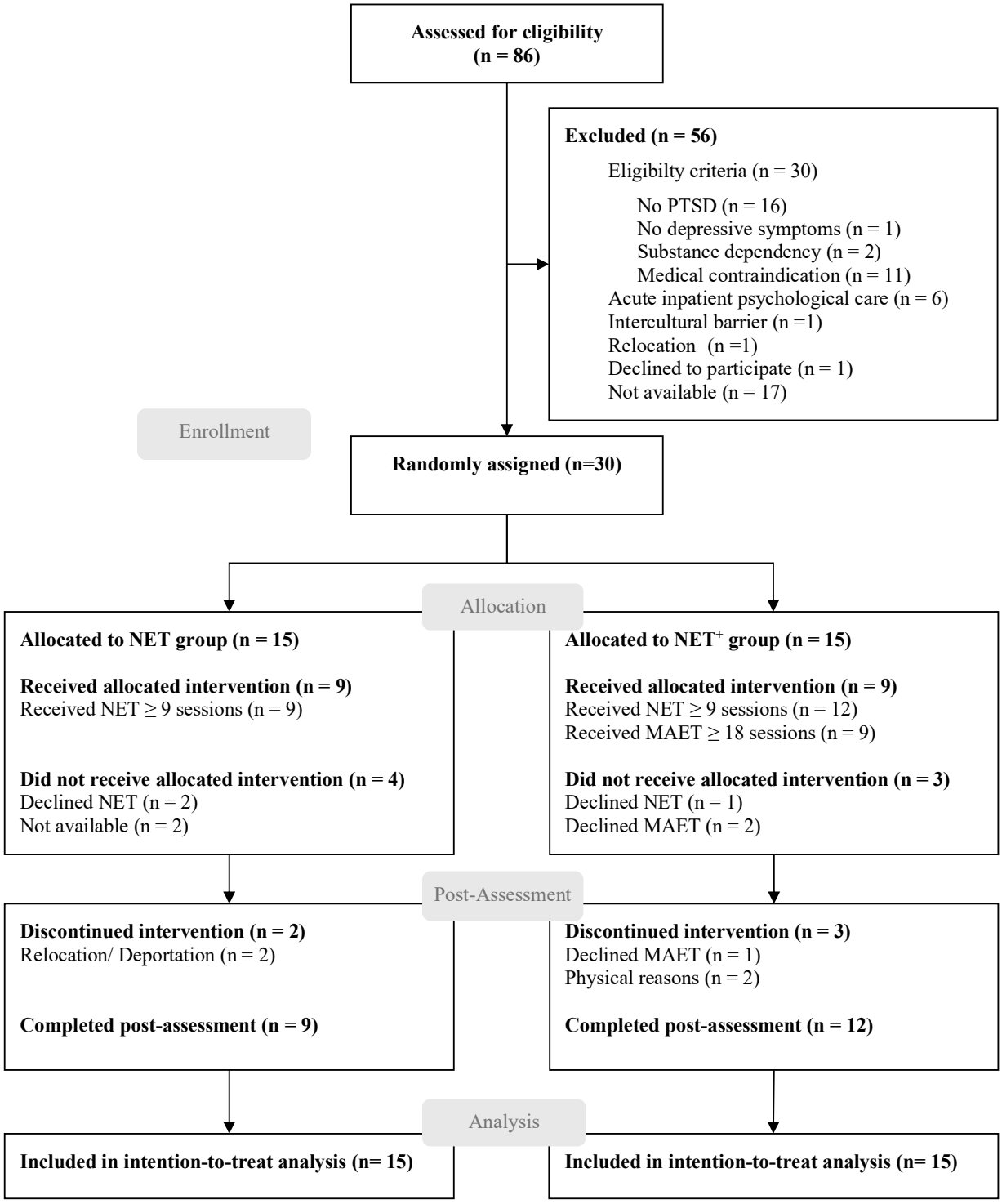
Statistical Analyses. All statistical analyses were conducted in R version 4.4.3 (R Core Team, 2025), using the packages mice (van Buuren & Groothuis-Oudshoorn, 2011), lme4 (Bates et al., 2003), lmerTest (Kuznetsova et al., 2017), brms and rstan (Bürkner, 2017; Carpenter et al., 2017), as well as bayestestR (Makowski et al., 2019). Figures 6.4–6.6 were generated using MATLAB R2025a (The MathWorks Inc., 2025). Prior to data analysis, the extent and pattern of missing data in primary and secondary outcomes were examined. Missing data in the clinical outcomes ranged from 14.37% (HAMD) to 24.52% (PSQI). Specifically, 23.71% of data were missing for psychological distress (BSCL), 15.04% for PTSD symptom severity outcome measures (CAPS, PCL-5), and 14.85% for depression-related outcome measures (HSCL-25, HAMD). Most missing data resulted from participant dropout. Of the 30 individuals enrolled at t_0, 30.00% discontinued treatment (see Figure 6.2). In particular, nine participants discontinued treatment before completing three NET sessions, with six from the NET group and three from the NET$^+$ group (see Figure 6.2). Three participants in the NET$^+$ group largely refused to participate in MAET but remained in the RCT and provided data at t_1. In accordance with the intention-to-treat (ITT) principle (Gupta et al., 2011), all participants remained in their originally assigned treatment group for the final data analyses, regardless of (partial) treatment adherence or dropout. To mitigate potential bias from incomplete data, missing values were addressed via multiple imputation, using the Fully Conditional Specification (FCS, Sterne et al., 2009) method implemented through the MICE algorithm. FCS was based on the original dataset from Lüder et al. (2023), incorporating preliminary observations across three time points (t_0, t_1, t_2). Although t_2 reflects outcomes at six-month follow-up and is part of the broader RCT by Lüder et al. (2023), it is not considered in the present analyses, as data collection at t_2 will be completed at the end of 2025. Imputations were conducted within conceptually related variable clusters: psychological distress (BSCL), posttraumatic stress symptoms (PCL-5 and CAPS items), depressive symptoms (HSCL-25 and HAMD items), and sleep quality (PSQI). Thus, a set of item-wise regression models was defined, incorporating a second-order polynomial for time, fixed effects for treatment group, and their interaction, to account for non-linear symptom changes over time and group differences in these changes. The item responses were treated as ordinal variables and imputed using proportional odds logistic regression (polr) to preserve their ordinal scale properties. Ten imputed datasets were generated, with ten iterations each, using a consistent predictor matrix, and setting a random seed (seed = 123) to ensure reproducibility. Given that pooled estimates were not appropriate for the planned main analyses of the present study, they were consistently conducted using the first of the ten imputed datasets, as recommended for specific contexts (cf. von Hippel et al., 2007).

It is noteworthy, that the data analyses of the present study employed statistical approaches that are independent of those suggested by Lüder et al. (2023) and focus on a subset of the imputed dataset. Descriptive and inferential statistical analyses were conducted to characterize the sample, control for baseline group differences, and examine outcomes over the course of the study. In the main analyses, two-level linear mixed-effects models (LMM) were estimated using restricted maximum likelihood (REML) to account for the nested structure of the data, with time (t_0 vs. t_1) modeled at level 1 within participants (level 2), and treatment (NET vs. NET$^+$) included as a between-participants factor at level 2. Fixed effects include treatment (NET vs. NET$^+$), time (t_0 vs. t_1), and the Treatment×Time interaction. A random intercept was specified for each participant to capture inter-individual variability at t_0. The same model structure was applied across all primary and secondary outcomes, with the model specified in Figure 6.3.

Significance testing for fixed effects was based on Satterthwaite's approximation of degrees of freedom (e.g., Luke, 2017), with statistically significant results considered at $p < .05$. Additionally, standardized β-coefficients were computed, and explanatory power of the models was assessed using marginal and conditional R^2 (Nakagawa & Schielzeth, 2013), as well as intraclass correlation coefficients (*ICC*). Following conventional guidelines (e.g., Lorah, 2018), $R^2 \geq .30$ indicates substantial explanatory power of the model examined (Cohen et al., 1988). $ICC \geq 0.50$ indicates that a substantial proportion of the variance is attributable to differences between participants (at level 2), warranting multilevel modeling (Hox et al., 2017).

Figure 6.2

CONSORT Participant Flow Diagram (adapted from Lüder et al., 2023)



Note. This CONSORT flowchart (Hopewell et al., 2025) is adapted from Lüder et al. (2023). Individuals who did not reach the randomization stage were referred to the outpatient clinic of the Division of Clinical Psychology and Psychotherapy at Saarland University. All randomized participants were included in the intention-to-treat (ITT) analyses. Missing outcome data were addressed using multiple imputation via fully conditional specification (FCS). NET = Narrative exposure therapy; MAET = moderate-intensity aerobic exercise training; Participants in the NET group received NET as a standalone treatment; Participants in the NET^{+} group received a combined treatment including NET and MAET as an adjunct.

Figure 6.3

Two-level Structured Model Specification with Random Intercepts

outcome ~ treatment * timepoint + (1 | participant)

Level 2 (between participants factor – treatment):

$$\pi_{0i} = \beta_0 + \beta_2 \cdot treatment_i + \beta_3 \cdot (treatment \times timepoint) + r_{0i}$$

Level 1 (within participants factor - timepoint):

$$Y_{ij} = \pi_{0i} + \beta_1 \cdot timepoint_{ij} + \varepsilon_{ij}$$

Note. $_i$ = participant; $_j$ = time; Y = observed value of the dependent variable; β_0 = intercept at t_0; β_1 = main effect of time; β_2 = main effect of treatment; β_3 = interaction effect; r_{0i} = participant-level deviation from π_0; ε = residual error.

To complement the frequentist analyses and enhance the robustness of inference in the context of a small sample size, Bayesian (multilevel) models were estimated (van de Schoot et al., 2021). The models were fit with four chains of 2000 iterations each (1000 warm-up iterations), using a fixed random seed (seed = 123) for reproducibility (Gelman & Shalizi, 2013). Bayes factors (BF_{10}) were computed based on marginal likelihoods estimated via bridge sampling (Gronau et al., 2017), to quantify the relative evidence for the model including the (Treatment×Time) interaction term, compared to the simpler model neglecting the interaction. BF_{10} were interpreted according to established guidelines (Kass & Raftery, 1995), with $BF_{10} \geq 1$ indicating increasing support for the model including the interaction, and $BF_{10} \leq 1$ indicating greater support for the simpler model excluding the interaction.

To gain further insights, we conducted visual inspections of symptom changes at the treatment and participants' level. Differences in within-group variability between treatment groups lead us to exploratory analyses of the Treatment×Time×Covariate interactions. Also, in this context, a random intercept for each participant was included to account for inter-individual variability at baseline (t_0). The significance testing of fixed effects was conducted using Satterthwaite's approximation of degrees of freedom (e.g., Luke, 2017), with $p < .05$ considered

statistically significant. In the exploratory analyses, degrees of freedom are not reported, as they were approximated using Satterthwaite's method. Covariates examined included age (Hall et al., 2020, Rosenbaum et al., 2015), sex (cf. Marshall et al., 2010), country of origin and native language, considered together as a proxy for cultural background (cf. Rio & Saligan, 2023). To allow for clear contrasts in exploratory model tests, participants were clustered into three culturally distinct groups: Arabic, Central Asian, and Eastern European. The Arabic group includes participants from Syria, Iraq, Lebanon, and Morocco, who share Arabic as a common language and exhibit a high degree of cultural similarity. The Central Asian group includes people from countries such as Afghanistan (who speak Dari or Pashto), Uzbekistan (who speak Uzbek), Iran (who speak Farsi) and Turkey (who speak Turkish). Although these countries are linguistically very different, their languages fall into two larger language families, Turkic and Persian, and are thought to be closely historically and culturally entwined (e.g., Canfield, 1991). The Eastern European group consists of participants from Ukraine and Croatia, speaking Ukrainian and Croatian, both Slavic languages (e.g., Ivanov et al., 2025). This group was defined based on geographic proximity and the assumption of shared cultural elements (e.g., Ivanov et al., 2025). Furthermore, residence permit was incorporated as an additional covariate. For further exploratory examination of within-group effects, separate mixed-effects models were conducted within the NET^{+} group that included time, a specified MAET-related covariate, and their interaction. These covariates included the total number of MAET sessions and two indicators of MAET implementation accuracy (Stanton & Reaburn, 2014; Ekkekakis et al., 2011): (1) the deviation between actual and target heart rate in MAET and (2) the incline during MAET, both reflecting increased physical exertion, thus potential deviations from the prescribed intensity of MAET.

6.4. Results

Descriptive and Comparative Analyses of the Sample and Treatment Characteristics. Of the $n = 86$ individuals initially screened for eligibility, $n = 30$ were enrolled in the RCT. The mean age was 27.47 ($SD = 8.04$) years, ranging from 16–42 years. Of these participants, $n = 19$ were biologically male and $n = 11$ were biologically female, in all cases consistent with self-identified gender (Langeland & Olff, 2024). There were no significant differences in age ($t(27.95) = -0.23$, $p = .822$) or sex ($p = .450$, see Table 6.1) across treatment groups. As outlined above, all participants were recruited in Germany, with the majority originating from Syria (33.33%), Afghanistan (26.67%), and Ukraine (13.33%). No significant

group differences were observed regarding country of origin (p = .415) or native language (p = .774; for details, see Table 6.1). The most frequently reported native languages were Arabic (40%), Dari (20%), and Ukrainian (13.33%). Participants differed, but not significantly, across the treatment groups in their length of residence in Germany (t (22.55) = 1.80, p = .085). In particular, the mean duration of residence in Germany for participants in the NET$^+$ group (M = 3.53 years, SD = 3.02) was nearly half that of the NET group (M = 5.92 years, SD = 3.89). A larger proportion of participants in the NET$^+$ group (n = 6) than in the NET group (n = 3) reported holding a temporary residence permit valid for three years or less. However, the overall distribution of asylum status, including residence permit, did not differ significantly between treatment groups (p = .860).

Using the SCID-5-CV, nearly half of the sample (n = 13) met criteria for at least one additional psychiatric disorder besides PTSD and depression, with no group differences. Participants reported an average of 13.13 (SD = 4.95) traumatic events. According to the WAEC, the exposure to traumatic events was similar among the groups (t (27.97) = 0.81, p = .426). The most frequently reported trauma was witnessing (n = 26) or experiencing (n = 25) physical assault. Other common traumas were separation from family due to war (n = 24), loss of loved ones (n = 23), witnessing weapon attacks (n = 23) and exposure to corpses (n = 22). Notably, no substantial group differences were observed in the number of traumatic events (t (27.97) = 0.81, p = .426). See Table D1 for details on trauma exposure. With respect to the treatment's implementation, the participants received an average of 9.91 NET sessions (SD = 0.61) over a period of approximately 125.39 days (SD = 73.59), with no significant differences between the groups in both, duration (t (14.23) = 0.85, p = .407) and count of NET sessions (W = 103.50, p = .696). A total of eight participants (n = 3 in the NET group; n = 5 in the NET$^+$ group) additionally attended one to two crisis sessions in response to acute psychological distress, including suicidal tendency, fear of deportation, or experiences of domestic violence, similar across both groups (p = .682). Therapist allocation did not differ significantly between treatment groups (p = .069). Overall, language mediation was required in 76.67% of NET. No significant group differences were observed (p = .080). The allocation of the individual interpreters between the treatment groups did not demonstrate a significant difference (p = .174). In the remaining cases, NET was conducted in either German or English. In the NET$^+$ group, a total of nine participants completed an average of 26.66 MAET sessions (SD = 5.34) over 88.89 days (SD = 33.60) as an adjunct to NET. Participants performed MAET at an average pace of 10.08 minutes per kilometer (SD = 2.71). The MAET sessions

lasted on average 46.52 minutes ($SD = 0.96$), which was significantly longer than the predefined duration of 45 minutes (t (8) = 6.91, $p < .001$). Moreover, participants' actual heart rates deviated significantly from the target heart rate, with an average per-person deviation of 25.92 beats per minute (bpm; $SD = 11.94$; t (7) = −8.69, $p < .001$). Additionally, a significant deviation from prescribed incline was observed, with a mean difference of 17.47 meters (SD = 16.53; t (7) = 4.37, $p < .001$).

Frequentist Analyses of Treatment×Time Effects on Primary and Secondary Outcomes. Consistent with the descriptive statistics on the primary and secondary outcomes presented in Table 6.2, the LMM showed no significant group differences at baseline in any of these outcomes, as evidenced by the non-significant treatment effects at t_0 (see Table 6.3). Significant main effects of time were found across all primary and secondary outcomes (see Table 6.3), with the most pronounced effect observed for the reduction of PTSD symptom severity over time (t (28) = −7.93, $p < .001$) as assessed by the CAPS-5, corresponding to a large, standardized effect size (standardized $\beta = -0.73$, 95% CI [−0.87, −0.59]). No significant Treatment×Time interaction effects were observed for any outcome variables in the LMM (see Table 6.3).

Model fit indices are summarized in Table 6.4 with the CAPS-5 model showing the highest marginal $R^2 = 0.52$, indicating substantial explanatory power of the fixed effects. Conditional R^2, accounting for both fixed and random effects, ranged from 0.57 (PCL-5) to 0.73 (CAPS-5), confirming good overall model fit. Complementarily, ICCs ranged from 0.39 (PCL-5) to 0.65 (BSCL), indicating that a considerable proportion of variance is attributable to differences between participants, with the highest proportion of between-subjects variance observed for psychological distress (BSCL) (see Table 6.4).

Table 6.2 *Descriptive Data of the Primary and Secondary Outcomes*

Outcome		t_0	t_1
		M (SD)	M (SD)
Mental Distress			
BSCL	NET group	108.33 (48.51)	81.20 (33.65)
	NET$^+$ group	115.40 (52.74)	104.67 (40.32)
	Total sample	111.87 (49.92)	92.93 (38.39)
Posttraumatic Stress Disorder			
PCL-5	NET group	53.40 (12.11)	33.40 (14.63)
	NET$^+$ group	54.53 (15.33)	38.07 (15.49)
	Total sample	53.97 (13.59)	35.73 (14.99)
CAPS-5	NET group	36.87 (8.18)	17.60 (11.11)
	NET$^+$ group	36.27 (8.32)	18.67 (7.78)
	Total sample	36.57 (8.11)	18.13 (9.44)
Depressive Symptoms			
HSCL-25	NET group	2.98 (0.51)	2.23 (0.63)
	NET$^+$ group	3.04 (0.53)	2.49 (0.62)
	Total sample	3.01 (0.51)	2.36 (0.63)
HAMD	NET group	23.47 (6.71)	18.07 (9.24)
	NET$^+$ group	25.40 (7.40)	18.93 (9.39)
	Total sample	24.43 (7.01)	18.50 (9.16)
Sleep Quality			
PSQI	NET group	11.73 (4.01)	8.60 (3.40)
	NET$^+$ group	12.60 (4.91)	10.13 (3.83)
	Total sample	12.17 (4.43)	9.37 (3.64)

Note. t_0 = pre treatment; t_1 = post treatment; NET = Narrative exposure therapy; Participants in the NET group received NET as a standalone treatment; Participants in the NET+ group received a combined treatment including NET and MAET as an adjunct; BSCL = Brief Symptom Checklist (Franke et al., 2017); PCL-5 = PTSD Checklist for DSM-5 (Blevins et al., 2015); CAPS-5 = Clinician-Administered PTSD Scale-5 (Weathers et al., 2013); HSCL-25 = Hopkins Symptom Checklist-25 (Derogatis et al., 1974); HAMD = Hamilton Depression Scale (Hamilton, 1960; 1967); PSQI = Pittsburgh Sleep Quality Index (Buysse et al., 1989)

Table 6.3 *Fixed Effects Estimates from Linear Mixed-Effects Models for Primary and Secondary Outcomes*

Model		*β* (Estimate)	*SE*	df	*t*	*p*	Standardized *β* [95% CI]
BSCL	Intercept	108.33	11.47	39.29	9.45	<.001***	
	Treatment	7.07	16.22	39.29	0.44	.665	0.17 [−0.16, 0.50]
	Time	−27.13	9.57	28.00	−2.84	.008**	−0.21 [−0.36, −0.06]
	Treatment × Time	16.40	13.53	28.00	1.21	.236	0.09 [−0.06, 0.24]
PCL-5	Intercept	53.40	3.73	48.63	14.31	<.001***	
	Treatment	1.13	5.28	48.63	0.21	.831	0.09 [−0.18, 0.35]
	Time	−20.00	4.12	28.00	−4.85	<.001***	−0.54 [−0.72, −0.37]
	Treatment × Time	3.53	5.83	28.00	0.61	.55	0.05 [−0.12, 0.23]
CAPS-5	Intercept	36.87	2.31	46.67	15.96	<.001***	
	Treatment	−0.60	3.27	46.67	−0.18	.855	0.01 [−0.21, 0.23]
	Time	−19.27	2.43	28.00	−7.93	<.001***	−0.73 [−0.87, −0.59]
	Treatment × Time	1.67	3.44	28.00	0.49	.631	0.03 [−0.10, 0.17]

Table 6.3 (continued.)

Model		*β* (Estimate)	*SE*	df	*t*	*p*	Standardized *β* [95% CI]
HSCL-25	Intercept	2.98	0.15	44.56	20.15	<.001***	
	Treatment	0.06	0.21	44.56	0.29	.771	0.12 [−0.16, 0.40]
	Time	−0.75	0.15	28.00	−5.10	<.001***	−0.50 [−0.66, −0.34]
	Treatment × Time	0.19	0.21	28.00	0.92	.363	0.07 [−0.09, 0.24]
HAMD	Intercept	23.47	2.13	41.77	10.99	<.001***	
	Treatment	1.93	3.02	41.77	0.64	.525	0.08 [−0.31, 0.31]
	Time	−5.40	1.95	28.00	−2.77	.010*	−0.35 [−0.51, −0.19]
	Treatment × Time	−1.07	2.75	28.00	0.39	.701	−0.03 [−0.19, 0.13]
PSQI	Intercept	11.73	1.05	42.17	11.15	<.001***	
	Treatment	0.87	1.49	42.17	0.58	.563	0.14 [−0.17, 0.46]
	Time	−3.13	0.97	28.00	−3.22	.003**	−0.33 [−0.49, −0.17]
	Treatment × Time	0.67	1.38	28.00	0.485	.632	0.04 [−0.12, 0.20]

Note. BSCL = Brief Symptom Checklist (Franke et al., 2017); PCL-5 = PTSD Checklist for DSM-5 (Blevins et al., 2015); CAPS-5 = Clinician-Administered PTSD Scale-5 (Weathers et al., 2013); HSCL-25 = Hopkins Symptom Checklist-25 (Derogatis et al., 1974); HAMD = Hamilton Depression Scale (Hamilton, 1960; 1967); PSQI = Pittsburgh Sleep Quality Index (Buysse et al., 1989); *β* (Estimate) = non-standardized estimate; SE = standard error; df = degrees of freedom; t = t statistic; standardized *β* = standardized estimate; CI = confidence interval; * $p < .05$, ** $p < .01$, *** $p < .001$.

Table 6.4 *Model Fit Statistics for Linear Mixed-Effects Models on Main Outcomes*

Outcome	Model	Marginal R^2	Conditional R^2	ICC	BF_{10}
Mental distress					
	BSCL	0.08	0.68	0.65	72.61
PTSD					
	PCL-5	0.30	0.57	0.39	18.81
	CAPS-5	0.52	0.73	0.45	9.48
Depressive Symptoms					
	HSCL-25	0.26	0.64	0.51	0.87
	HAMD	0.12	0.64	0.58	7.38
Sleep quality					
	PSQI	0.13	0.63	0.57	3.71

Note. Marginal R^2 = variance explained by the fixed effects; Conditional R^2 = variance explained by fixed and random effects; ICC = intraclass correlation coefficients; BF_{10} = Bayes factor comparing the model including the interaction term to the reduced model excluding the interaction term; BSCL = Brief Symptom Checklist (Franke et al., 2017); PCL-5 = PTSD Checklist for DSM-5 (Blevins et al., 2015); CAPS-5 = Clinician-Administered PTSD Scale-5 (Weathers et al., 2013); HSCL-25 = Hopkins Symptom Checklist-25 (Derogatis et al., 1974); HAMD = Hamilton Depression Scale (Hamilton, 1960; 1967); PSQI = Pittsburgh Sleep Quality Index (Buysse et al., 1989).

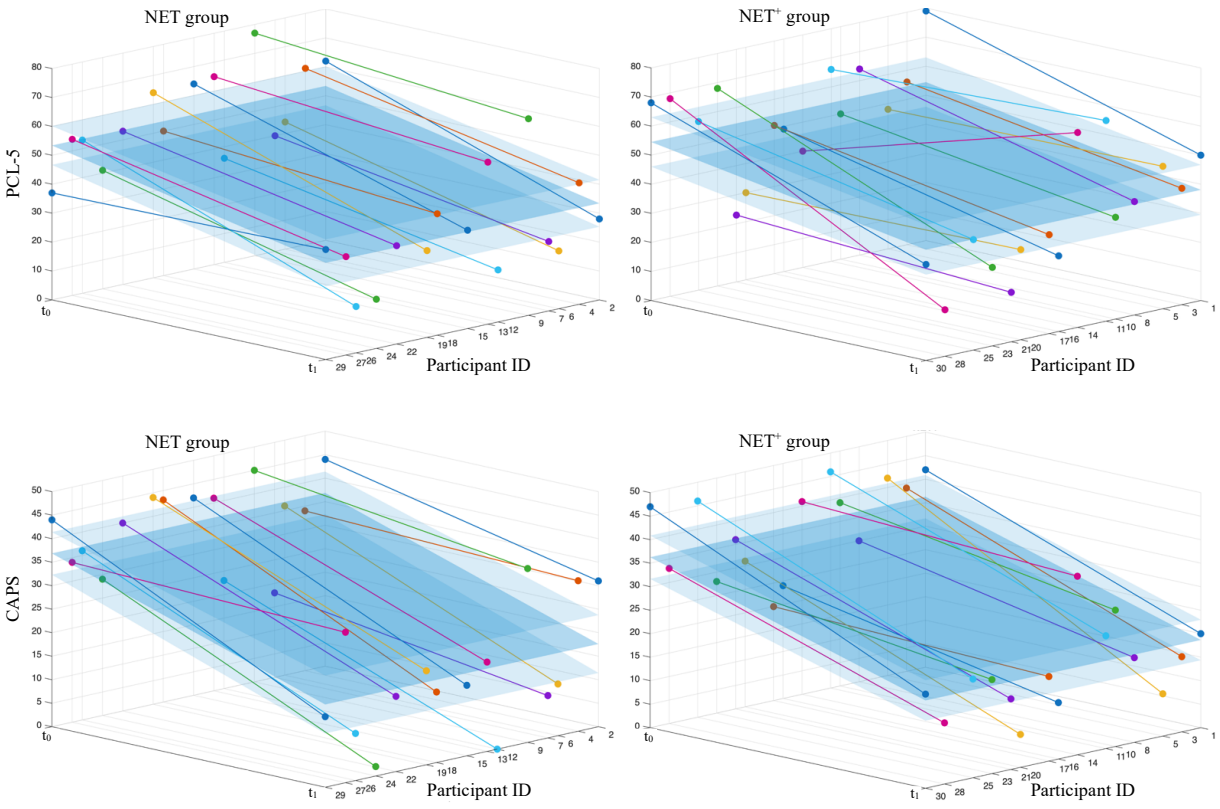
Bayesian Analyses of Treatment×Time Effects on Primary and Secondary Outcomes. While the frequentist analyses did not provide sufficient evidence for the Treatment×Time interaction, subsequent Bayesian analyses revealed moderate to strong evidence in favor of models incorporating the interaction term (see Table 6.4). Models that included a Treatment×Time interaction showed greater predictive efficacy for psychological distress (BF_{10} = 72.61 for BSCL), PTSD symptoms (BF_{10} = 18.81 for PCL-5; BF_{10} = 9.48 for CAPS-5), and depressive symptoms (BF_{10} = 7.38 for HAMD), compared to models that neglected the interaction term.

Visual Inspection of Symptom Changes across Treatment Groups. Symptom changes of each participant are presented in Figures 6.4–6.6: PTSD symptoms (Figure 6.4), depressive symptoms (Figure 6.5), general psychological distress and sleep quality (Figure 6.6). A visual inspection of these symptom changes overall revealed heterogeneous patterns of within-group variability across outcomes. The changes for the HSCL-25 (Figure 6.5) and the PSQI (Figure 6.6) did not demonstrate any notable variations between treatment groups. Psychological distress, as measured by the BSCL (Figure 6.6), demonstrated the most remarkable

heterogeneity in symptom changes within both treatment groups. In contrast, PTSD symptom severity assessed by the CAPS-5 (Figure 6.4) showed a uniform decrease across the NET and NET$^+$ groups. Regarding self-reported PTSD symptom severity measured by the PCL-5 (Figure 6.4), and depressive symptoms measured by the HAMD (Figure 6.5), the intragroup variability of symptom changes differed between the NET and NET$^+$ groups, indicating systematic variation within the treatment groups. Changes in HAMD scores demonstrated greater variability in the NET group, while those in PCL-5 scores exhibited increased variability in the NET$^+$ group. Given the contrasting patterns of symptom change observed in the NET and NET$^+$ groups, the next step was to examine the influence of various covariates on HAMD and PCL-5 scores.

Figure 6.4

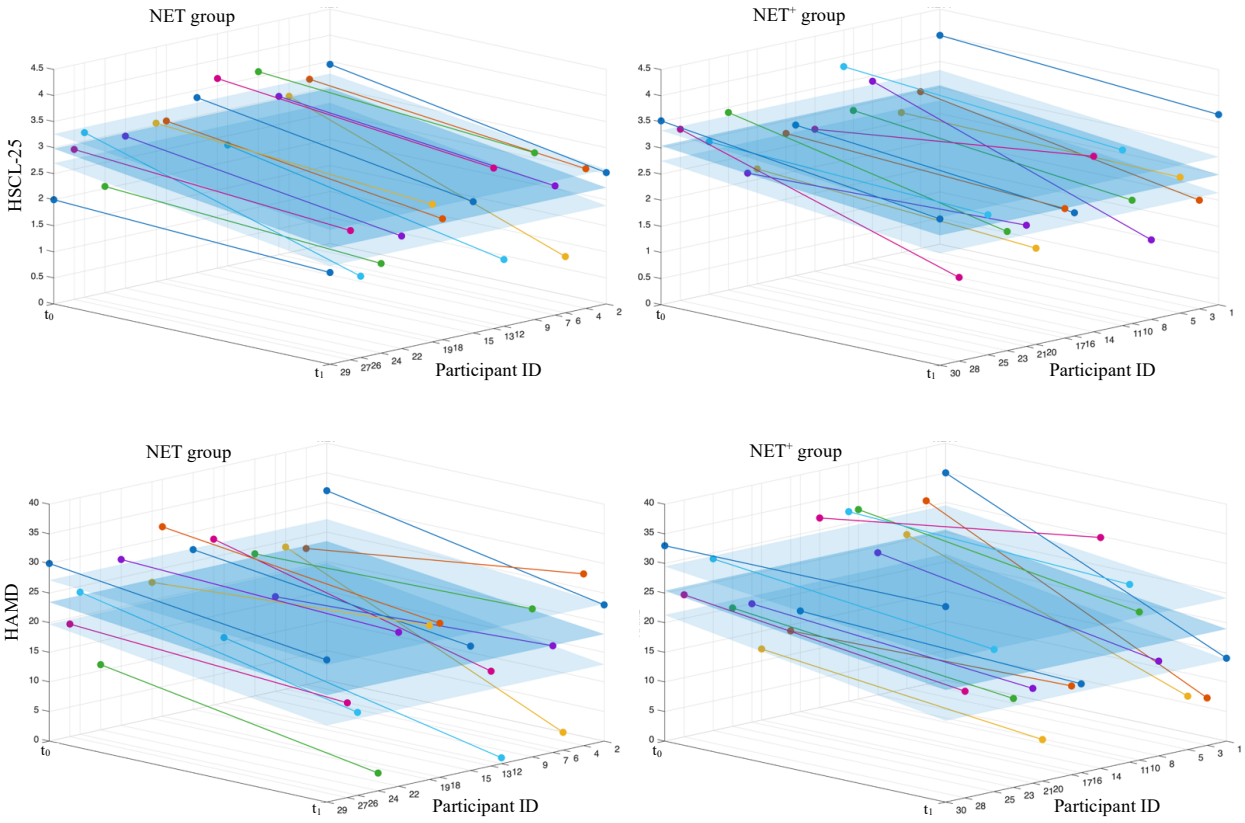
Changes of PTSD Symptoms across Treatment Groups



Note. t_0 = pre treatment; t_1 = post treatment; NET = Narrative exposure therapy; Participants in the NET group received NET as a standalone treatment; Participants in the NET$^+$ group received a combined treatment including NET and MAET as an adjunct; PCL-5 = total sum score of PTSD Checklist for DSM-5 (Blevins et al., 2015); CAPS-5 = total sum score of Clinician-Administered PTSD Scale-5 (Weathers et al., 2013); Blue surface shows mean symptom change; lighter surfaces, 95% CI.

Figure 6.5

Changes of Depressive Symptoms across Treatment Groups

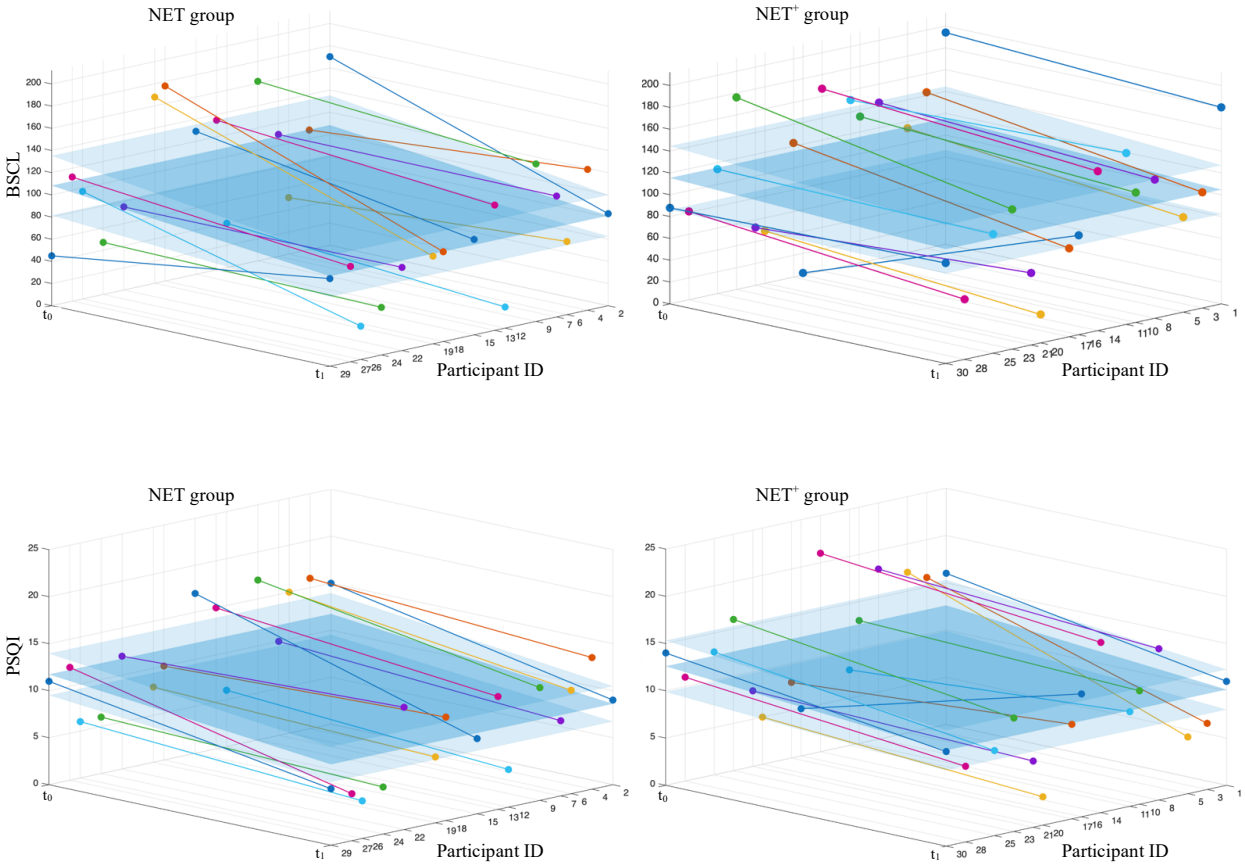


Note. t_0 = pre treatment; t_1 = post treatment; NET = Narrative exposure therapy; Participants in the NET group received NET as a standalone treatment; Participants in the NET$^+$ group received a combined treatment including NET and MAET as an adjunct; HSCL-25 = total mean score of Hopkins Symptom Checklist-25 (Derogatis et al., 1974); HAMD = total sum score of Hamilton Depression Scale (Hamilton, 1960; 1967); Blue surface shows mean symptom change; lighter surfaces, 95% CI.

Exploratory Analyses and Impact of Covariates. Tables D2–D5 in the Supplementary Materials present the results of exploratory analyses examining the potential moderating effects of predefined covariates on HAMD and PCL-5 scores. Of all models tested in the exploratory analyses, only the three-way interaction between treatment, time, and residence permit reached statistical significance in predicting PCL-5 scores ($\beta = -17.10$, $t = -2.77$, $p = .011$), building on a significant two-way interaction between treatment and time ($\beta = 46.30$, $t = 2.75$, $p = .011$). No other covariate significantly moderated treatment effects on PCL-5 or HAMD outcomes across models tested in the exploratory analyses.

Figure 6.6

Changes of Psychological Distress and Sleep Quality across Treatment Groups

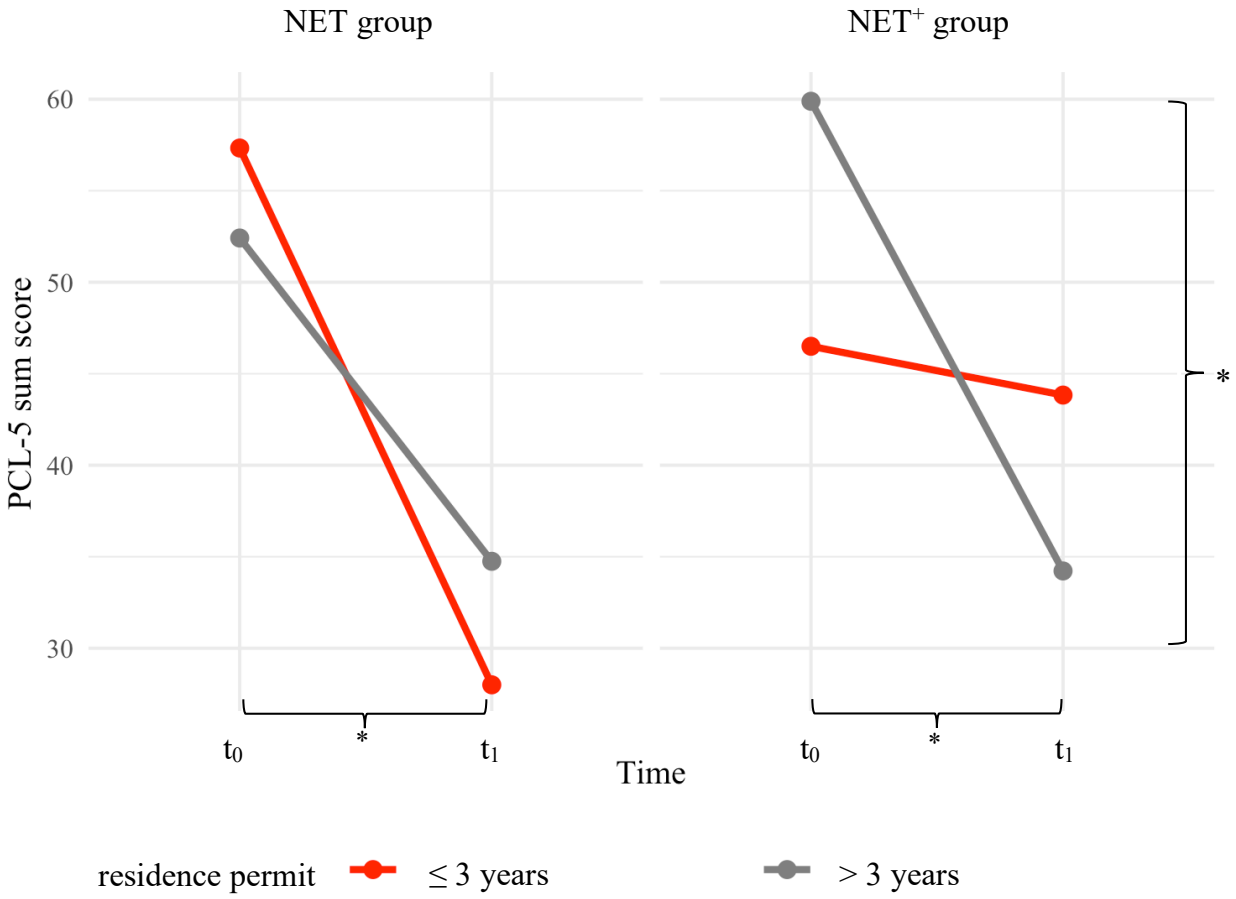


Note. t_0 = pre treatment; t_1 = post treatment; NET = Narrative exposure therapy; Participants in the NET group received NET as a standalone treatment; Participants in the NET$^+$ group received a combined treatment including NET and MAET as an adjunct; BSCL = total sum score of Brief Symptom Checklist (Franke et al., 2017); PSQI = total score of Pittsburgh Sleep Quality Index (Buysse et al., 1989); Blue surface shows mean symptom change; lighter surfaces, 95% CI.

The Treatment×Time×Residence permit interaction is illustrated in Figure 6.7. As shown, participants in the NET$^+$ group with a temporary residence permit limited to three years exhibited substantially less improvement in self-reported PTSD symptoms (PCL-5 scores) compared to those with the same temporary residence permit receiving NET only, as well as those with temporary to permanent residence permit exceeding three years across both treatment groups.

Figure 6.7

Three-way Interaction of Treatment, Time and Residence Permit on PCL-5



Note. PCL-5 = PTSD Checklist for DSM-5 (Blevins et al., 2015); t_0 = pre treatment; t_1 = post treatment; NET = Narrative exposure therapy; Participants in the NET group received NET as a standalone treatment; Participants in the NET$^+$ group received a combined treatment including NET and MAET as an adjunct; $^*p < .05$.

6.5. Discussion

The present study confirms the effectiveness of NET in reducing general psychological distress, improving sleep quality, and reducing the severity of depressive and PTSD symptoms in a sample of traumatized refugees with PTSD and co-occurring depressive symptoms in line with current research (cf. Wright et al., 2020). Contrary to our initial hypothesis, no evidence was found that the combined treatment was more effective than NET monotherapy. Concurrently, the findings provide no evidence that exercise as an adjunct to TFP is inherently detrimental. Recent studies have demonstrated that physical activity has a positive impact on psychological well-being (Stathopoulou et al., 2006). In particular, large effects have been observed when exercise is examined as a standalone treatment for depressive symptoms (Stanton & Reaburn, 2014). When exercise is implemented as an adjunct to psychotherapy, its

effects tend to be more modest, particularly when the primary treatment exhibits a substantial effect. This makes it very difficult to identify any additional benefits of the adjunct, even if they are present (Blackwell et al., 2019). Despite the absence of statistically significant interaction effects in the frequentist analyses, Bayesian modeling revealed that the model incorporating the interaction term demonstrated a superior fit in comparison to the model lacking this term. This discrepancy indicates that the methodical framework of the present RCT may have lacked the sensitivity to detect interaction effects, a limitation that is frequently observed in psychotherapy research (cf. Angus et al., 2024) and is worthy of discussion in the context of clinical and research perspectives. Moreover, Stanton and Reaburn (2014) underscore the substantial heterogeneity in how exercise is conceptualized within psychotherapeutic contexts, differentiating between type, intensity, frequency, and timing. In accordance with recent recommendations (e.g., Stanton & Reaburn, 2014; Ding et al., 2020), the MAET employed in the present RCT was designed to incorporate parameters with the potential to optimize efficacy. Nonetheless, during the practical implementation of the present study, deviations from the MAET protocol occurred, including variations in training frequency and inconsistencies with the predefined MAET characteristics. While deviations from MAET protocol did not influence relevant effects, one characteristic of participants receiving the combined treatment appeared relevant: exploratory analyses indicated that the Treatment×Time interaction was moderated by residence permit of the participants. Specifically, participants in the NET^{+} group with temporary residence permit ≤ 3 years showed less symptom improvement, or even increased PTSD symptoms over time, compared to those with permanent residence permit > 3 years (see Figure 6.7). This effect was not observed in the NET group. These exploratory findings are consistent with prior research indicating that a temporary residence permit in refugees can impede psychological recovery by perpetuating a chronic sense of threat (Georgiadou et al., 2018; Nickerson et al., 2011). Holding a temporary residence permit necessitates recurrent bureaucratic procedures (in Germany) and leads to perceived insecurity and psychological distress (Bakker et al., 2014). Conversely, a permanent residence permit has been demonstrated to foster a sense of safety and future orientation. Previous studies have shown that transitioning from a temporary to a permanent residence permit is associated with significant reductions in PTSD and depressive symptoms (Nickerson et al., 2011). Given the observed phenomenon, it can be hypothesized that participants with temporary residence permits may experience increased cognitive load due to heightened perceived insecurity. At the same time a successful implementation of a combined treatment, such as NET^{+}, requires an increased allocation of organizational, cognitive, and motivational resources, for time management, additional physical

activity, and the overcoming of cultural or physical barriers. Individuals with high cognitive load have fewer cognitive resources available throughout the day, which makes it challenging for them to adhere to the demands of the combined treatment. This could potentially impede their engagement with therapeutic components. This, in turn, can hinder symptom improvement or even contribute to the exacerbation of symptoms. Notably, these interpretations do not claim to provide a comprehensive explanatory model and remain speculative. Nevertheless, the results underscore the importance of tailoring treatment complexity to individuals' cognitive capacity and emotional load, for example, as influenced by perceived security in forcibly displaced populations with limited residence permit < 3 years.

Limitations. Overall, this study's findings must be interpreted with caution, particularly considering several methodological limitations.

Impact of dropout and missing data handling on study findings and interpretation. Dropout rates in studies examining PTSD treatments vary considerably depending on sample characteristics, study design, and the use of trauma-focused interventions (Ehring et al., 2014) with Semmlinger et al. (2025) reporting a dropout rate of 15.38% among refugees in Germany. The present study also revealed a higher dropout rate in the NET than in the NET^{+} group. Participants ceased participation for various reasons, including severe emotional distress during NET sessions, a lack of motivation to engage in either NET or MAET, the onset of physical health problems during treatment, and external factors such as deportation (see Figure 6.2). Irrespective of dropout or reduced treatment adherence, the intention-to-treat (ITT) principle was applied, ensuring that all participants were analyzed according to their original treatment group assignment (Gupta et al., 2011). The percentage of missing data due to dropout ranged from 14.37% (HAMD) to 24.52% (PSQI). Given the heterogeneity of reasons for dropout, it can be assumed that the missing data is missing at random (MAR), thus satisfying the assumptions for the Fully Conditional Specification (FCS) method. This approach provides the most accurate approximation of missing values for the present trial. However, it should be noted that this is merely an estimation technique, thus resulting in an approximation of the true data. This, in addition to the limited sample size, further restricts the interpretability and robustness of the present findings.

Divergent statistical approaches and their impact on study findings and interpretation. It is noteworthy that the present study contains adaptations in data analyses, primarily using LMMs instead of 2×2 ANOVAs for multiple outcomes, to accommodate hierarchical data structures and intra-group variability by modeling nested data structure. The analyses are based

on data from t_0 and t_1, with t_2 being neglected. The analysis scheme has been demonstrated to reduce the risk of inflated Type I errors (Luke, 2017) and to provide greater flexibility and statistical efficiency, particularly in clinical trials with small sample sizes. This approach facilitates more appropriate data handling in the context of an underpowered RCT. Nevertheless, this post hoc modification of the analysis scheme constitutes a methodological limitation, as it engenders the possibility of data-driven bias.

Impact of limited statistical power on the interpretation of study findings. Despite adjustments of the statistical analysis scheme, the sample size (n = 30) remained substantially below the target sample size (n = 68) considered necessary to detect moderate interaction effects (Lüder et al., 2023). Consequently, the frequentist analyses in the present study may have lacked sufficient statistical power to detect the small effect of adjunct treatment, particularly shown in a perceived Treatment×Time interaction effect. Bayesian analyses, in contrast to frequentist analyses, suggest a high probability of interactions for most outcomes, with the exception of depressive symptoms (HSCL-25). However, the direction of these interactions remains unclear due to limited statistical power in the frequentist analyses.

Challenges in recruiting refugees for clinical research. The reduced sample size can be attributed to several challenges during the recruitment process, along with the extended study period from three to five years. A particularly salient challenge was the concurrence of the initial recruitment phase with the onset of the Covid-19 pandemic in 2020. The implementation of public health restrictions in Germany has led to a substantial increase in the logistical and procedural demands of conducting the present clinical research. Consequently, clinical studies such as this one, which were conducted during the pandemic, often report a negative impact on the recruitment of participants (c.f. Vindegaard & Benros, 2020; Wittmann et al., 2022). Moreover, the specific characteristics of the target refugee sample led to a series of structural, logistical, psychosocial, and sociocultural challenges during the recruitment process and subsequently. Despite the high prevalence of PTSD and depression among forcibly displaced populations, these individuals have severely limited access to psychotherapeutic care due to restricted access to healthcare services in general, bureaucratic hurdles and language barriers, which are further compounded by the limited availability of interpreters. Moreover, refugees face considerable challenges, including the potential loss of, and separation from family members, which can lead to diminished social support and acknowledgment. Cross-sectional studies have reported moderate correlations (r = .25–.45) between self-perceived social acknowledgment and PTSD severity (Mueller et al., 2008). Longitudinal analyses have

indicated that lower acknowledgment predicts increases in symptoms over time (e.g., Mueller et al., 2008). These findings underscore the crucial role of social acknowledgment in shaping trauma outcomes. Moreover, factors such as cultural stigma, limited familiarity with the western concept of psychotherapy, the role of physical activity within the framework of mental health, and mistrust towards formal institutions serve as additional barriers (e.g., Koç & Kafa, 2019.). Emotional responses such as shame and guilt are particularly relevant in the context of PTSD. Their expression and impact can vary depending on the cultural context (e.g., Maercker & Hecker, 2016). These effects are not directly to be addressed within the framework of the current treatment protocol. Consequently, the specific characteristics of the sample made both recruitment and adherence difficult. However, these challenges are not exclusive to the present study. In particular, the limited adherence to treatment constitutes a more general challenge to standardization, especially to RCTs conducted in forcibly displaced populations. RCTs are characterized by methodological rigor, which does not allow for flexible, individualized treatment adaptations in progress (Herzog & Kaiser, 2022). Conversely, a sample of traumatized, forcibly displaced individuals exhibits a wide range of symptoms, which likely requires individualized and adaptable psychotherapeutic approaches. The inclusion and exclusion criteria of this RCT represent merely a single facet of the methodological rigor of the RCT. The present study excluded individuals with physical impairments that could impede exercise participation, which limits the generalizability of the findings, as such impairments are common among refugees due to experiences of violence and torture. Furthermore, the present RCT excluded individuals with prior experience of endurance training. This meant that participants who may have used exercise as a personal resource or coping strategy were excluded. Thus, the MAET approach may not be considered resource oriented. This is in contrast to recommendations to adapt treatments to the strengths and resources of individuals, particularly in contexts involving severely affected and hard-to-reach patient groups, such as refugees with PTSD and depression (Hook et al., 2021). Consequently, these factors may increase the risk of reduced adherence to the study's treatments, especially MAET. Due to the various challenges faced by the target group, it was unavoidable for deviations to occur in clinical practice from the planned treatment protocol. However, these deviations were carefully monitored. While these deviations compromise the internal validity of the present study, they enhance the ecological validity by more accurately reflecting the realities of treating traumatized refugees. The lack of a significant interaction between treatment and time, as well as the heterogeneity of symptom trajectories, may reflect the challenges associated with applying a strictly controlled study design, such as a randomized controlled trial, to a sample

that is both heterogeneous and clinically complex (Schouler-Ocak & Kastrup, 2019; Bäumel et al., 2024). Nevertheless, to the best of our knowledge, this is the first study to examine the use of MAET as an adjunct to TFP in this specific and highly relevant clinical setting. Unlike previous studies on MAET, which have focused on depression and, less frequently, PTSD and have typically employed simple linear models for less complex samples, our RCT examined the effect of MAET beyond that of NET by using LMM to account for the hierarchical data structure. The statistical approach further incorporated frequentist analyses and Bayesian model comparisons, serving to enhance the precision of the results obtained.

Clinical implications. The implementation of MAET as an adjunct to NET in the present study was based on two primary considerations. Firstly, there is substantial evidence to support the mono-therapeutic efficacy of MAET in alleviating depressive symptoms. According to biopsychosocial models, this may enhance NET's effects on both primary PTSD and co-occurring depressive symptoms and moreover potentially reduce dropout rates. Secondly, MAET is widely regarded as clinically applicable due to its cost-effectiveness, accessibility, and low-threshold nature. However, it must be acknowledged that MAET is only one specific type of exercise, which may not address the diverse needs of all participants examined.

At the same time, this limitation highlights the exercises' conceptual and modal variability as a key strength, which could make exercise a valuable adjunct to psychotherapy. Indeed, this variability enables the adaptation of treatments to the individual patient's needs, while considering personal strengths and resources, psychosocial and cultural factors, physiological capacities and limitations, and broader contextual factors. Recent research findings indicate that personalized exercise prescriptions promote self-responsibility, improve self-regulation, and enhance adherence to adjunct treatments (Almarcha et al., 2024). In addition, it has been demonstrated that personalized exercise interventions increase self-efficacy and motivation in a highly distressed veteran population (Browne et al., 2025), suggesting that they may also be effective with similarly complex clinical samples, such as traumatized refugees with PTSD and depression. In clinical practice, the incorporation of patient choices in the conceptualization of exercise as an adjunct could be a promising solution (Johnson et al., 2025). This approach addresses two objectives simultaneously: offering practical implications for implementing comprehensive, individualized treatment and enhancing treatment adherence and effectiveness by increasing motivational components.

Future research. Translating adaptive, individualized clinical approaches into a methodological framework is challenging, as clinical practice and clinical research might

“operate as a house divided” (Angus et al., 2024, p. 160). Herzog and Kaiser (2022) emphasize that traditional RCTs do not adequately address the complexity and individual variability inherent in psychotherapeutic treatments. Idealized study conditions often differ greatly from real-world psychiatric and psychotherapeutic care (Schmacke, 2006). Accordingly, investigating the effectiveness of complex, long-term psychotherapies requires adaptive methodological approaches (Leichsenring & Rabung, 2008, 2011). In recent years, a number of trial designs have been developed to optimize the translation of clinical inquiries into appropriate research frameworks (Pallmann et al., 2018). The following experimental designs are particularly well-suited to address the present research question. One of the most well-known adaptive trial designs is the Sequential Multiple Assignment Randomized Trial (SMART; Murphy, 2005). This multi-arm design involves the random allocation of participants to psychotherapeutic treatments across multiple randomization stages, with assignments adapted to participants’ symptom changes and treatment responses to prior interventions and their characteristics. This enables to identify the most fitting treatment approach for each participant (Lorenzoni et al., 2023). The Leapfrog Design, adapted from oncology research (Blackwell et al., 2019), is an innovative, adaptive trial approach, allowing the simultaneous, efficient evaluation of multiple treatments using sequential Bayesian analyses. It allows investigators to “leap over” treatment options by discontinuing ineffective arms and introducing promising new interventions into the ongoing trial. This framework enhances the efficiency of clinical translation, reduces the required sample size, saves resources, and decreases the risk of false-negative results while supporting continuous treatment optimization (Blackwell et al., 2023). The nested-precision RCT (npRCT) (Kappelmann et al., 2021) is a design that integrates features of traditional RCTs, such as initial randomization to treatment arms, while also considering individual characteristics and treatment responses at predefined interim stages. At these stages, subsequent randomization occurs, whereby participants within their original treatment groups receive continuation, adaptation, or alternative treatments (nested randomization). This iterative process allows for the flexible, data-driven optimization of treatment sequences, improving the identification of the most effective therapy for distinct subgroups.

Future research on adjunct treatments, such as exercise, in psychotherapeutic care should use multi-arm adaptive designs incorporating modular treatment arms, predefined decision rules, online symptom monitoring, and transparent reporting. These designs ensure validity when dealing with real-world clinical complexity. With careful documentation of exercise-,

participant-, and context characteristics, a further step would be to cluster these into exercise and patient profiles for adjunct treatment based on a large dataset. Machine learning can assess intervention–patient profile matching to derive tailored therapy recommendations. The effectiveness of these recommendations can then be systematically tested to ensure they are both effective and appropriate. The implementation of a personalized allocation and validation process is likely to entail a substantial investment of time and financial resources during the development and execution phases. Early applications of machine learning were conducted by Rollmann et al. (2023) to individualize psychodynamic therapy according to patient needs. These findings suggest that the field is still in its infancy but holds considerable promise for advancing individualized psychotherapy.

6.6. Conclusion

The present study lies at the intersection of methodological rigor and clinical applicability. The findings demonstrated no statistically significant superiority of a combined treatment including NET and MAET in traumatized refugees with PTSD and co-occurring depressive symptoms in Germany, compared to NET only. However, the lack of significant results under these conditions should not preclude the usage of exercise as an adjunct to TFP, even for this population. The validity of the present findings is limited by the modest and heterogeneous sample, which resulted from challenges in recruiting participants and implementing the clinical treatment. Notwithstanding the constraints on interpretability, the circumstances in which the results were obtained reflect real-world conditions and thereby enhance ecological validity.

The present study demonstrates the feasibility and benefit of delivering a (combined) psychotherapeutic treatment in outpatient care for forcibly displaced individuals, despite numerous challenges. Notwithstanding the fact that the combined treatment did not result in greater improvement in symptom severity than NET as mono-therapy, a greater proportion of participants in the NET^{+} group successfully completed NET. In this context, the study emphasizes the importance of incorporating patients' unique capabilities and requirements and contextual characteristics by adding adjuncts to psychotherapy. Considering the heterogeneity of exercise, its variability should not be regarded as a limitation, but rather as an opportunity to tailor treatments precisely to each patient's unique needs, making it a flexible adjunct. Future research should focus on ensuring that interventions are appropriately translated from clinical

practice to the research context. This could be achieved through more flexible, adaptive, multi-arm trial designs that vary exercise characteristics across arms, balancing methodological rigor with the complexity and diversity of real-world mental health care.

7. Discussion

7.1. General Discussion of the Studies' Findings within an Overarching Framework

In this dissertation, between-person differences in PTSD symptom expression and treatment effects are interpreted as clinically meaningful variation, providing the empirical basis for an integrative, context-sensitive synthesis of PTSD care. The following section critically appraises *Studies 1, 2,* and *4*, situates their findings within the current evidence base, and examines the relative relevance of memory-related mechanisms and contextual factors to diagnosis, prevention, and treatment. Finally, limitations, clinical implications, and directions for future research are outlined.

7.1.1. Core Memory Mechanisms and Context in a Longitudinal Post-trauma Perspective

In *Study 1*, the aggregated-data meta-analysis and the analysis of individual participant data (IPD) showed that post-trauma sleep was slightly more effective than wakefulness at reducing the frequency of intrusions in an analogue trauma paradigm. In the meta-analysis of aggregated data, sleep was associated with fewer intrusions (log-ROM = 0.25, 95% CI [0.10, 0.39], $p < .001$) compared to wakefulness. Consistently, the IPD meta-analysis provided evidence for a between-group difference in the count component of the model, $b = -0.19$, 95% CI [−0.35, −0.03], $p = .020$, showing that participants in the wake conditions experienced a higher number of intrusions than those who slept. However, these findings cannot be generalized on posttraumatic distress. Neither the aggregated-data meta-analysis (log-ROM = 0.09, 95% CI [−0.03, 0.22], $p = .145$) nor the IPD meta-analysis provided evidence that sleep compared to wakefulness reduced distress ($b = -0.06$, 95% CI [−0.22, 0.11], $p = .522$). Furthermore, the likelihood of experiencing any intrusions did not differ between sleep and wake groups (see Table 3.3). Overall, the small-to-moderate effect on intrusion frequency was consistent across heterogeneous study designs, supporting the effects' robustness.

This suggests that sleep may influence early memory processes following trauma, interpreting the effect of sleep as a manipulation of early consolidation-related processes. This finding aligns with prior research indicating that consolidation-supportive approaches can yield preventive effects after trauma (e.g., Wright et al. (2021); $N = 2821$; RR = 0.67, 95% CI [0.50, 0.90]), albeit typically of limited magnitude. Importantly, such approaches aim

to facilitate natural memory processing rather than directly modifying trauma memories, that stands in contrast to interventions such as psychological debriefing, which have not demonstrated benefit and may be harmful (Bisson & Andrew, 2007; Rose et al., 2002). *Study 1* therefore provides evidence that conditions thought to support memory processing, such as sleep, may reduce early intrusive re-experiencing in an analogue trauma paradigm. However, because these findings derive from experimental analogue models on non-clinical samples, the transfer of the evidence to clinical populations and practice is limited. Moreover, posttraumatic sleep alone is unlikely to be sufficient to meaningfully shift broader early posttraumatic responses. Early memory processing is shaped by several contextual factors through their impact on acute stress responses and recovery conditions (see Chapter 1.1.4). From this integrative perspective, sleep can be on the one hand conceptualised as a consolidation-relevant biological state and on the other hand as a context-sensitive resource that moreover depends on contextual factors such as safety, stability, and other environmental factors (Bobba, Bacaro & Crocetti, 2023; Charuvastra & Cloitre, 2009). As the results show, sleep may influence the frequency of early intrusions following trauma. However, the occurrence of intrusions and their associated distress are likely shaped by additional contextual risk and protective factors. Against this background, early post-trauma interventions appear most effective when they target the individual's contextual environment, thereby supporting natural memory processing. Optimizing contextual factors directly (e.g., through sleep, a key mediator of memory consolidation) or indirectly (e.g., by ensuring safety to facilitate sleep) may promote the adaptive integration of traumatic memories, that prevents from PTSD.

Study 2 addressed the dissertation's broader question of whether widely used PTSD screenings can be interpreted equivalently across linguistically and culturally heterogeneous settings. In accordance with this objective, *Study 2* demonstrated the PCL-5 to possess excellent internal consistency across both, the German- and Arabic-speaking subsamples (Cronbach's α = .96; 95% CI [.95–.96]). The CFA in *Study 2* indicated good model fit across all tested models, with the Anhedonia and Hybrid models showing the best fit in each subsample. These findings are in line with prior evidence (e.g., Ibrahim et al., 2019). Moreover, the MGCFA supported configural, metric and threshold invariance. Thus, findings of MGCFA indicate that the factor structure and item–factor relations were comparable across the PCL-5 German and Arabic versions. However, scalar invariance was not supported, indicating that some items may be endorsed differently as a function of group affiliation. Consequently, raw sum scores may not be fully comparable and could over- or underestimate between-group

differences in PTSD severity. It is therefore recommended to interpret variations in total scores with caution, as they may be partly influenced by contextual variations in symptom reporting and not necessarily indicative of genuine differences in latent PTSD severity between individuals. This interpretation aligns with cross-cultural research showing that PTSD symptom expression and reporting vary with sociocultural and linguistic context (e.g., Hinton & Lewis-Fernández, 2011; 2018). It also fits newer accounts highlighting meaning-making and social acknowledgement as key influences on how symptoms are experienced and communicated (e.g., Honsy et al., 2023). Moreover, it is important to note that the two subsamples from *Study 2* differed not only in language and culture but also in trauma-related characteristics. It was found that the Arabic-speaking subgroup most commonly reported man-made traumatic events, whereas the German-speaking subsample most commonly reported accidental events. More broadly, unmeasured contextual factors may have contributed to group-specific item-response patterns, emphasising the need to characterise the subsamples in future research more comprehensively. Where intergroup comparisons are required, strategies such as psychometric adjustments (group-specific cut-off scores) may help reduce bias (e.g., Ibrahim et al., 2018a). Overall, *Study 2* supports the dissertation's perspective that core PTSD symptom dimensions are largely stable across German and Arabic languages and cultures, while context can shape how latent severity is reflected in observed PCL-5 scores.

Study 3 examines an adjunct treatment approach in traumatised refugees in Germany, combining NET as a mechanism-based trauma-focused treatment with MAET as a low-threshold adjunct. *Study 4* evaluates initial outcome data from this RCT and demonstrates that NET was associated with substantial pre–post improvements in psychological distress, PTSD and depression symptom severity and sleep quality. This pattern is consistent with research supporting the effectiveness of trauma-focused interventions, including NET, in highly burdened populations from (post-)conflict regions (e.g., Hijazi et al., 2014; Neuner, Elbert & Schauer, 2018; Robjant & Fazel, 2010). It also reinforces the premise of the dissertation that targeting memory-related mechanisms is central to PTSD treatment. The initial hypothesis posited that MAET would offer additional benefits over NET on the examined outcomes. This hypothesis is based on previous research, which suggests that physiological adjuncts such as exercise can demonstrate broad beneficial psychological effects (cf. Powers et al., 2015), as physical activity is an integral component of a global health approach (see Bouchard, Blair & Haskell, 2012) across (cultural) contexts. However, the findings in *Study 4* did not support this hypothesis. In *Study 4* we found that MAET did not lead to any additional improvements in

primary symptom outcomes beyond those achieved by NET. These results augment existing metanalytical evidence demonstrating considerable variability in the efficacy of adjunct treatments in TFP, with only a minority exhibiting modest yet statistically significant outcomes (Michael et al., 2019; Powers et al., 2015; Yehuda et al., 2015). Despite the absence of any discernible effects of the adjunct on primary outcomes, the findings suggest that it exerts its influence on process level. As demonstrated by the findings of exploratory analyses, the NET^{+} group exhibits a lower dropout rate in comparison to the NET-group. Despite the fact that the dropout rate does not constitute an a priori registered endpoint and consequently necessitates a cautious interpretation, this observation is clinically relevant. In principle, the effect of MAET may be less incremental and more relevant for the implementation of NET. MAET could act as a facilitating element that enhances, for example, accessibility, adherence, and continuation of NET. In routine care, this could translate into higher completion rates by reducing context-related barriers to sustained engagement with trauma-focused treatment. Furthermore, the moderator analyses in *Study 4* provide additional support for the dissertation's conceptual framework by demonstrating that treatment effects do not occur in isolation. A substantial three-way interaction of treatment, time, and residence permit was observed to have a significant impact on the severity of PTSD symptoms, as measured by the PCL-5 scale. The findings indicated that participants who held a temporary residence permit with a duration limited to three years exhibited considerably diminished improvement in the NET^{+} group ($\beta = -17.10$, $t = -2.77$, $p = .011$). Despite the exploratory nature of the moderator analyses, the findings are consistent with research suggesting that ongoing limited residence permits can perpetuate threat and impede psychological recovery among refugees (Georgiadou et al., 2018; Nickerson et al., 2011).

Overall, *Study 4* corroborates prior findings that NET, as a primarily mechanism-focused PTSD treatment, is well suited to traumatised refugee samples and appears to be the main driver of robust symptom improvement in this population. Moreover, MAET was conceptualised as a low-threshold adjunct to enhance the treatment's context-sensitivity. However, preliminary results indicate that such MAET should not be generalised and understood as a one-size-fits-all supplement (cf. Browne et al., 2025). The findings of *Study 4* demonstrate that both treatment effects and potential additional benefits of adjuncts arise under structural contextual conditions and are co-determined by the interaction of contextual risk and protective factors. In order to achieve the best possible outcome, it is essential that both, treatment and adjuncts are

conceptualised context-sensitively. Future research should clarify how this can best be implemented in clinical practice.

7.1.2. Interim Summary

Taken together, the findings from the present studies provide converging evidence for the relevance of integrative approaches addressing both, core mechanisms and context-sensitivity in prevention, assessment, and treatment of PTSD. It is therefore evident that approaches which address only one dimension are unlikely to capture the complexity of PTSD sufficiently for accurate assessment or effective care.

On the one hand, particularly early posttraumatic trajectories are shaped by contextual factors that modulate trauma-memory processing and, in turn, determine whether the event is consolidated as an integrated autobiographical memory or persists in a fragmented, intrusive form. In line with this, *Study 1* suggests that mechanisms-focused preventive interventions are most effective when embedded in an early contextual scaffold that supports adaptive consolidation. Consequently, early prevention may need to target both memory-related core mechanisms and the contextual framework to facilitate naturalistic, adaptive memory integration after trauma.

On the other hand, *Study 4* demonstrated significant symptom improvement in established PTSD following TFP, particularly NET. This lends support to the conceptualisation of PTSD as a memory-related disorder (see Chapter 1.1.5), as trauma-focused treatments primarily target maladaptive trauma-memory processing. Furthermore, it accords with evidence for NET's effectiveness across diverse cultural contexts (e.g., Crombach & Siehl, 2018). Concurrently, *Study 4* suggests that the overall efficacy of treatment and the potential incremental benefits of adjunct components vary according to contextual constraints that influence engagement and retention, which are fundamental prerequisites for NET's exposure-based memory-integration processes (Elbert, Schauer, & Neuner, 2015). Consequently, an integrative treatment approach appears to be most promising. This approach maintains mechanisms-focused psychotherapy as the primary intervention, while adapting both implementation and adjuncts to the patient's context to ensure maximum effectiveness.

Study 2 provides support for a latent factor structure of the PCL-5 that is largely comparable across the German and Arabic versions. At the same time, it is suggested that symptom meaning and communication vary with sociocultural and linguistic context, which

can limit the comparability of observed scores across groups (as also suggested by the findings of *Study 2*). Therefore, even in cases where the latent structure is shared, a dual focus is required in PTSD assessment. Firstly, robust measurement of core symptom dimensions must be maintained. Secondly, it is imperative to ensure that the assessment and its results are applied and interpreted in context. In future research and clinical practice, greater consideration must be accorded to this dual focus on PTSD assessment in order to ensure valid diagnostic assessment of PTSD.

Despite the fact that the studies examined prevention, assessment, and treatment separately, they each address one of three stages of posttraumatic processing. Consequently, they can be integrated along the post-traumatic timeline. Despite the absence of a comprehensive longitudinal analysis in the included studies, they, in sum, provide a foundation for stage-sensitive longitudinal research aimed at mapping risk profiles, symptom trajectories, and treatment responses in greater detail over time. Conducting such research would facilitate greater investment in mechanisms and causal pathways, thereby enabling more accurate answers to the question of which interventions are most effective for whom at which stage of posttraumatic processing.

7.2. Limitations

Although the present dissertation makes a significant contribution to the refinement of context-sensitive prevention, diagnostic assessment and treatment in posttraumatic processing, the following limitations should be considered. Firstly, the included studies are embedded in a theoretical model that conceptualises the relevance of context-sensitivity and the dynamic interplay of influencing factors across posttraumatic stages. But none of these studies directly operationalises or experimentally manipulates contextual factors or core memory processes. Consequently, specific mechanisms of action remain to be empirically validated. Furthermore, the included study designs are predominantly cross-sectional. Only the RCT in the *Studies 3* and *4* employs a two-wave structure. However, it is important to note that this study design do not constitute longitudinal assessments commencing from the point of trauma exposure. Correspondingly, inferences about the relative importance of mechanism-based and contextual factors for assessment and intervention across posttraumatic trajectories are informed by the stepwise convergence of findings across the included studies. They are not based on dynamic, within-person modelling of posttraumatic trajectories since trauma exposure, nor on direct tests

of mechanisms of action. Even though each study included in this dissertation adheres to elevated methodological standards and employs state-of-the-art analytical approaches appropriate for its specific research question, the overall evidence base is characterised by considerable heterogeneity in study designs, objectives, samples, and assessment strategies. This variation can be attributed to the fact that the individual studies were originally designed to address distinct research aims rather than to pursue a unified, overarching empirical agenda. Consequently, while all studies can be conceptually situated within a shared framework of context-sensitivity, their methodological and conceptual diversity limits the integrability of the findings and restricts the extent to which a holistic interpretation across studies is feasible. This heterogeneity, therefore, serves to reinforce the broader limitation that context-sensitivity, as a theoretical integrative construct, is not empirically operationalised in a consistent manner across the dissertation.

Furthermore, there are limitations on the studies' findings generalisability. *Study 1* synthesised a small number of heterogeneous analogue designs, which constrained the feasibility of comprehensive moderator analyses that could have informed causal inference. Consequently, the generalisability of the findings remains debatable. Evidence derived from analogue paradigms does not yet warrant direct clinical implications; however, the observation of clear, statistically significant effects across diverse designs suggests that the sleep-related effect, albeit small, is relatively robust. Notably, the restricted number of suitable studies facilitated conducting highly rigorous IPD meta-analyses, thereby enhancing both internal consistency and data quality. However, it should be noted that the findings are specific to healthy samples and analogue experimental settings, which substantially restricts ecological validity and external generalisability (Lau-Zhu, Holmes, & Porcheret, 2018). Consequently, hypotheses derived from analogue research may not be directly translatable to real-world clinical contexts. In *Study 2*, the measurement invariance of the PCL-5 was evaluated across German- and Arabic-speaking participants. The entire sample was drawn exclusively from individuals residing in Germany. Furthermore, approximately 42.75% of the Arabic-speaking subgroup reported a migration or refugee background. Migration and forced displacement represent salient contextual determinants that are likely to shape trauma exposure (e.g., type, severity, and chronicity), as well as subsequent posttraumatic trajectories (Blackmore et al., 2020). These factors may also influence the prevalence and comorbidity profiles of PTSD and depression, patterns of symptom expression, and response styles in diagnostic assessments. Consequently, the Arabic-speaking subgroup comprises a highly selective population and

cannot be assumed to represent Arabic-speaking populations more broadly. Furthermore, the CFA models examined in *Study 2* were not exhaustive. Recently proposed, more parsimonious factor models were not tested (cf. Pettrich et al., 2025), which further limits the interpretability of the findings and constrains their generalisability beyond the specific sample and model specifications used in *Study 2*. *Studies 3* and *4* are based on the same RCT that included a highly specific and relatively small sample of trauma-exposed refugees living in Germany who met criteria for PTSD and reported clinically relevant depressive symptoms. The limited sample size imposes constraints on the generalisability of the observed effects and reduces statistical power, particularly for detecting the a priori expected small adjunct effects of MAET over and above NET. Participant recruitment, trial implementation, and complete data collection were substantially disrupted by major global and personal crises, including the Covid-19 pandemic and geopolitical conflicts, as well as by participants' mobility, language barriers, and unstable living conditions. To reduce the loss of data whilst remaining in accordance with the intention-to-treat principle, suitable imputation strategies were employed. Moreover, it is important to note that *Study 4* presents preliminary outcomes that are currently restricted to pre–post comparisons, as follow-up data have not yet been incorporated. This preliminary status imposes further limitations on the interpretability of the results and the robustness of the inferences that can be drawn at this stage. The extension of analyses in *Study 4* to include Bayesian approaches partially addresses these constraints by enabling estimation of effect tendencies under limited sample sizes. The RCT design was initially selected to meet the methodological gold standard for evaluating the added value of MAET as an adjunct to NET, with the objective of maximising internal validity. However, as discussed in detail in *Study 4* and noted above, the trial faced substantial contextual constraints in its real-world execution (see Corrigan & Salzer, 2003). Consequently, despite the strengths of RCT methodology, conducting trials in highly vulnerable populations under naturalistic conditions can expose important limits to feasibility and ecological validity. This underscores an inherent tension between methodological rigour and contextual realism in trauma research with forcibly displaced populations. Consequently, future research may benefit from incorporating integrative or alternative designs that more accurately reflect the complex contextual realities of severely burdened groups, including refugees (see Chapter 3.4).

As previously mentioned, the data collection process for *Studies 2* to *4* was conducted under particularly challenging conditions. The data were collected between 2020 and 2025, a period characterised by a series of global crises, including the Covid-19 pandemic, ongoing

geopolitical conflicts (for example, those in the Middle East and the Russia–Ukraine war), climate-related stressors, and increased forced migration. It is hypothesised that these contextual conditions exerted a significant influence on various factors, including trauma exposure and living circumstances, the progression of symptoms and resilience processes, and the recruitment process as well as the overall feasibility of (clinical) research. It is worth noting that a significant number of studies, particularly clinical trials, conducted during this period reported constraints related to reduced sample sizes and difficulties in maintaining protocol adherence (McDermott & Newman, 2020; 2022; Saad et al., 2022). Similarly, *Studies 2* to *4* in this dissertation were affected by pandemic-related barriers that constrained the recruitment and resulted in smaller-than-planned samples. Consequently, the findings of these studies should be interpreted in light of this specific historical and socio-cultural context, as this may reduce their transferability to other time periods, regions, or care settings. While acknowledging these limitations, the methodological rigor and ecological validity of the included studies (except for *Study 1*; see Lau-Zhu, Holmes, & Porcheret, 2018) provide a solid foundation for deriving integrative clinical implications. Preliminary implications derived from the individual empirical findings have been discussed in detail in the respective manuscripts.

7.3. Clinical implications

While acknowledging these limitations, the methodological rigour and ecological validity of the included studies (with the exception of *Study 1*; Lau-Zhu, Holmes, & Porcheret, 2018) provide a solid foundation for deriving integrative clinical implications. The preliminary implications derived from the individual empirical findings have been discussed in detail in the respective manuscripts. The subsequent sections intentionally extend beyond the scope of individual studies providing clinical implications. These implications must therefore be regarded as conceptual recommendations, offering an orientation for context- and time-sensitive clinical practice, but requiring systematic empirical validation (see Chapter 3.4).

7.3.1. From Subtyping to Multidimensional Risk Profiles Across Posttraumatic Trajectories

As PTSD prevalence and symptom presentation vary systematically with trauma type (see Figure 1.1), it is clinically useful to incorporate trauma characteristics into diagnostic assessment and risk stratification (Liu et al., 2017). In accordance with this, the ICD-11 introduces a taxonomy that differentiates between PTSD and Complex PTSD (CPTSD).

Although the ICD-11 does not specify a particular trauma type to be indicative of CPTSD, research and clinical consensus indicate that the likelihood of developing CPTSD is increased in cases of prolonged and repeated interpersonal trauma (Cloitre et al., 2013). This distinction serves to illustrate the clinical value of trauma-informed subtyping in improving diagnostic precision and informing more tailored treatment planning. However, it must be noted that trauma characteristics represent merely one dimension of context. As outlined in Chapter 1.1.4, linguistic and cultural factors also influence the perception, labelling and communication of trauma-related stress symptoms. Consequently, it is recommended that diagnostic assessment instruments be adapted to the linguistic and cultural background if measurement invariance across subsamples cannot be ensured (see *Study 2*). In this regard, one potential approach would be to implement subgroup-sensitive cut-off scores to maintain diagnostic validity (e.g., Pettrich et al., 2025). However, given its inherent categorical nature, subtyping has tended to potentially oversimplify symptom variability and the complexity of posttraumatic processing. The individualised conception of multidimensional risk and resilience profiles has been demonstrated to be a more comprehensive approach to tailored diagnostics. This approach integrates pre-traumatic vulnerabilities (e.g., genetic liability, prior psychopathology; Schultebraucks et al., 2021), peri-traumatic responses (e.g., dissociation; Dokkedahl & Lahav, 2024), and early posttraumatic influences (e.g., social support; Wang et al., 2021; coping style; Bryant & Harvey, 1995). Collectively, these factors shape the onset and clinical expression of trauma-related symptoms and PTSD. Risk and resilience profiles can be derived along the posttraumatic processing continuum, enabling early identification of individuals at elevated risk of intrusive memories, acute stress disorder, and subsequent PTSD (cf. Delgadillo, Moreea & Lutz, 2016). In sum, the use of risk and resilience profiles in the diagnostic assessment of PTSD has been shown to yield substantial diagnostic precision (Cloitre et al., 2015). At the individual level, context-sensitive diagnostics require consideration of cultural concepts and idioms of distress in posttraumatic symptoms and PTSD. Otherwise, there is a risk of misinterpreting culturally and linguistically shaped metaphors and explanatory models during diagnostic assessment (Cork, Kaiser, & White, 2019). To illustrate this point, during the baseline assessment (t_0) in *Study 4*, a Pashto-speaking participant with an Afghan background stated: “When I wake up at night, a jinn is sitting on my chest” (CAPS-5 diagnostic protocol excerpt, from *Study 4*; translated from Pashto). To determine the underlying phenomenology and meaning of this remark, contextual explanations were necessary. In this case, the phrase was consistent with nocturnal distress characterised by acute somatic anxiety sensations (e.g., chest tightness and dyspnoea), rather than perceptual experiences. This underscores the need to

integrate linguistic–cultural context and patient meaning-making into diagnostic assessment (cf. Galsgaard, 2021) and for clinicians' intercultural competence to translate culturally bound symptom descriptions into clinically relevant information (Cork, Kaiser, & White, 2019).

7.3.2. Diagnostic Staging Across Posttraumatic Trajectories

Moreover, clinical staging constitutes a progressive integrative approach between diagnostics and treatment that was originally developed in the field of oncology to evaluate the stages of diseases (cf. Sobin et al., 2015). This approach has been adopted into psychiatric research and clinical practice to guide stage-appropriate stepped care in mental health disorders (Bisson et al., 2019; McGorry et al., 2006). More recently, staging has been applied to trauma-related disorders (Bryant, 2019). In particular, McFarlane et al. (2017) and Nijdam, Vermetten, & McFarlane (2023) have proposed staging models for PTSD (see Table 1 and Table 2 in Nijdam et al., 2023 for further details). The staging approach formalises the temporal dynamics of posttraumatic processing, emphasising the need to consider symptoms and functioning over time. This enables the recognition of clinically relevant subclinical trajectories and the transition to full-threshold PTSD at an earlier stage. This temporal differentiation aligns with the demand for high-quality trauma care that proactively anticipates adverse trajectories rather than merely reacting once chronic PTSD has manifested (see Burback et al., 2024). Despite accumulating evidence of heterogeneous posttraumatic trajectories depending on contextual factors and being associated with distinct clinical phenotypes and outcomes, staging approaches remain largely absent from current international PTSD guidelines. This suggests that staging approaches' potential to refine diagnostics and treatment planning has not yet been realised.

7.3.3. Context-sensitive Interventions Across Posttraumatic Trajectories

In light of staging, the categorical classification of PTSD interventions (e.g., prevention versus acute treatment) should be critically reviewed, as the boundaries between prevention and treatment are becoming increasingly blurred in terms of the timeline of post-traumatic processing. Rather than categorising interventions, it would be more appropriate to reconceptualise post-traumatic care as a continuum of mental health services that can be adapted to the post-traumatic stages. The initial stage following trauma exposure can be effectively managed with context-focused interventions (e.g., establishing safety, reducing ongoing threat and stabilisation). However, persistent or worsening PTSD trajectories more

strongly indicate the necessity for TFP, including across contexts (see Robjant & Fazel, 2010, for evidence of the cross-cultural effectiveness of NET). It is important to note that contextual and mechanism-based dimensions remain clinically relevant throughout the treatment process. However, their relative importance should vary based on the individual's context and stage of post-traumatic adaptation. This emphasis aligns with the broader heterogeneous evidence base, which does not allow for the formulation of universally valid treatment recommendations. Consequently, latent risk- and resilience profiles analyses at each stage are imperative, as they facilitate the differentiation of individuals who are likely to benefit from the intervention from those for whom it may be ineffective or potentially harmful. This aligns with the fundamental principles of context-sensitive adaptation, empowering clinicians to predict which patients should receive which intervention, and the appropriate stage at which treatment should be initiated, escalated, de-escalated, or switched (cf. Cohen & DeRubeis, 2018; Delgadillo et al., 2020; Schwartz et al., 2021). In clinical practice, these prognostic principles can be translated into data-informed decision rules, including algorithmic tools for treatment selection (e.g., Lutz et al., 2024). To ensure context-sensitivity throughout the care process, it is recommended that systematic monitoring be implemented (Mallinckrod et al., 2008). The repeated evaluation of symptoms, functioning, and contextual determinants can be utilised to derive empirical decision rules and clinical decision-support tools indicating when to continue, intensify, augment, or change interventions. Emerging research indicates the potential for data-driven algorithms to be integrated into routine care and psychotherapeutic practice, with the aim of enhancing treatment allocation to patients (Lutz et al., 2022; Moggia et al., 2024). For instance, in cases of major depression, a multi-site cluster-randomised trial demonstrated that a computer-assisted, algorithm-guided stratified care model, whereby patients are matched to low- versus high-intensity treatment at baseline, can yield clinically meaningful and cost-effective advantages over traditional stepped care (Delgadillo et al., 2022). However, only a small proportion of participants in this trial presented with PTSD (2.9%), which limits direct inferences for PTSD-specific care. In conclusion, there is a paucity of comparable evidence for comprehensive, staging-informed diagnostic and treatment algorithms in PTSD. Nevertheless, the present findings suggest that adapting posttraumatic assessment and intervention within such a context-sensitive framework is a particularly promising direction for future research.

7.3.4. Context-sensitive Adjuncts Across Posttraumatic Trajectories

As the international guidelines recommend TFP as first-line treatment for PTSD (WHO, 2013; Bisson et al., 2019) in practice, these interventions presuppose a minimally safe and stable treatment context in which basic needs are met, and ongoing or recurrent threat is sufficiently contained. Otherwise, exposure to threat may undermine the therapeutic effects (Tol et al., 2014). Consistent with this rationale, the NET manual emphasises establishing a safe therapeutic setting and, particularly in disaster and conflict contexts, addressing acute practical needs before commencing exposure-based trauma processing (Schauer, Neuner, & Elbert, 2011). From this perspective, adjunct interventions should not be conceptualised merely as add-ons, but as instruments for shaping the therapeutic context in which trauma-focused work can be delivered more safely and effectively. Accordingly, integrative interventions alongside primary PTSD treatment constitute a key route for implementing context-sensitivity in routine care (cf. Billing & Nicholls, 2025). At present, however, the evidence base for adjuvant approaches remains heterogeneous and is often derived from small trials, limiting the basis for firm guideline recommendations (Michael et al., 2019; Metcalf et al., 2020). This variability aligns with *Study 3*, which suggests that adjuncts may exert their primary benefit less through incremental symptom reduction and more through process outcomes such as improved adherence and reduced dropout, thereby strengthening the conditions under which TFP can unfold sustainably, even when additional symptom gains are modest. Recent developments in personalised, preference-sensitive adjunct programmes, particularly in exercise-based interventions, illustrate this potential. Tailored prescriptions may foster self-regulation, self-responsibility, and sustained engagement with health-related interventions (Almarcha, Sturmberg, & Balagué, 2024), and flexible formats have been shown to improve feasibility and uptake in highly vulnerable populations (e.g., older veterans with serious mental illness; Browne et al., 2025). Applied to trauma care in clinical practice, these findings support the view that adjuncts (e.g., aerobic exercise) are most likely to be clinically valuable when collaboratively designed, timed, and dosed in line with an individual's risk profile and stage of posttraumatic processing. In summary, the integrated evidence in this dissertation supports the idea that one size does not fit all, not only for diagnostic and primary treatment decisions, but also for adjunct interventions. The benefit of these interventions likely depends on contextual factors such as timing and intensity, thereby highlighting a broader shift from uniform treatment models towards a more context-sensitive approach to PTSD care.

7.4. Future Research

Even though the relevance of context-sensitive approaches in the assessment and treatment of trauma survivors is increasingly recognised, their comprehensive investigation remains in its infancy. Implementing adaptive, individualised clinical approaches within a coherent methodological framework is particularly challenging. As clinical practice and clinical research continue to "operate as a house divided" (Angus et al., 2024, p. 160), the integration of these two domains becomes essential for accelerating progress in providing context-sensitive care for trauma survivors in future research. Previous studies have predominantly used conventional RCT designs, characterised by narrowly defined samples, a limited number of assessment points (typically pre-, post-, and follow-up) and minimal variation in treatment arms (typically two to three; Wallace, Frank, & Kraemer, 2013). As outlined in *Study 4*, the limitations of the RCT impede its capacity to capture the temporal dynamics of posttraumatic processing and to examine the impact of multiple contextual moderators in posttraumatic processing. Although RCTs remain the gold standard in clinical research (e.g., Hariton & Locascio, 2018) and provide valid evidence for treatment efficacy, their findings are inherently selective (cf. Grossman & Mackenzie, 2005). Consequently, they cannot determine when, for whom, and under which contextual conditions specific interventions are most effective. The findings of this dissertation support the latest research trends, reflecting ongoing advances in research on context-sensitive psychotherapy for mental disorders, including PTSD.

In order to move forward in the field of research on context-sensitive treatment for trauma survivors, it is essential to strengthen the diagnostic foundations on which treatment decisions are based. Therefore, future research should require renewed attention to multidimensional, etiologically informed models that capture the complex interplay between risk and protective factors and trauma-related core mechanisms across posttraumatic processing. Greater conceptual and empirical clarity about these interactions is a prerequisite for deriving valid, person-specific risk and resilience profiles for PTSD. Building on such profiles, future studies could move beyond correlational evidence by testing causal assumptions more directly. One promising strategy is counterfactual validation (cf. Nguyen et al., 2020 for counterfactual treatment validation), for example by experimentally manipulating hypothesised contextual risk factors and examining whether these changes produce the predicted effects on clinical outcomes. However, the feasibility of this approach depends on a robust empirical consensus regarding which core mechanisms and contextual factors should be prioritised for manipulation.

At present, such consensus is largely lacking, underscoring the need for further research to identify and validate key mechanism and context targets in posttraumatic adaptation.

Despite the absence of a robust theoretical consensus, risk- and resilience profiles may guide treatment allocation or context-sensitive care. However, translating flexible care models, such as the clinical staging framework proposed by Nijdam et al. (2023), into empirically testable research designs is challenging. Recent research increasingly indicates marked heterogeneity in posttraumatic processing and treatment response, challenging conventional analytic approaches. Accordingly, methodological advances are needed to model mechanism-context interactions in a way that accommodates heterogeneity while remaining interpretable and clinically informative. In this context, aggregated data are crucial for establishing the empirical basis needed to draw valid and generalisable inferences. Meta-analytic approaches, particularly IPD meta-analyses, offer a powerful pathway for improving the precision and generalisability of scientific inferences (see *Study 1*). IPD meta-analyses facilitate harmonisation of variables across studies, enable assessment of variance, facilitate examination of moderators at the participant level, and derive more valid estimates of effects than conventional aggregate-level meta-analyses, especially when primary studies are small, heterogeneous, or inconsistent in design (Wallace, Frank, & Kraemer, 2013). *Study 1* provides concrete evidence of the added value of IPD approaches in the analogue trauma field. Compared with aggregate-level meta-analyses, the IPD re-analysis revealed a more nuanced pattern, showing that post-trauma sleep does not predict the occurrence (vs. non-occurrence) of intrusive memories per se, but rather the frequency of intrusions among those who experience them. It is evident that this level of detail cannot be obtained from aggregated data meta-analysis (Cooper & Patall, 2009). Conventional meta-analyses collapse across individual-level variability, thereby obscuring distributional properties that are crucial for mechanistic interpretation. This example demonstrates how high-quality evidence synthesis can advance the field beyond the contributions of individual studies, enhance reproducibility, and shed light on the role of contextual variables in posttraumatic processing. On a broader level, these findings underscore the potential of IPD meta-analytic methods to address key limitations of selective RCTs and aggregate data meta-analyses (Cooper & Patall, 2009) by providing more precise and generalisable estimates of risk and resilience factors and their associations with treatment response. Such evidence can inform the development of context-sensitive interventions by clarifying for whom and under which contextual conditions specific treatments are most effective. In future, coordinated multi-site data pooling and sustainable open-science

infrastructures should be supported and expanded to enable ongoing quantitative evidence synthesis. However, although IPD meta-analyses improve risk profile construction and treatment adaptation, thereby increasing precision and power, they remain inherently retrospective. Therefore, they are unable to model the real-time adaptive decision-making required for context-sensitive care as risks and contexts evolve.

Consequently, a range of methodological approaches is required to facilitate context-sensitive care in real time. Precision-focused frameworks that continuously monitor symptoms, functioning, risk and resilience factors, and contextual conditions, and which feed this information back into treatment planning, are central to contemporary models of personalised mental health care (Leichsenring & Rabung, 2008, 2011; Lutz, Deisenhofer et al., 2022; Schwartz et al., 2021). Empirical evidence indicates that routine monitoring can facilitate the timely identification of non-response and treatment-disrupting processes, thereby guiding the adaptation of treatment components (McAleavey et al., 2024). This underscores the efficacy of routine outcome monitoring as a pragmatic foundation for context-sensitive decision-making in routine clinical practice (see Lutz et al., 2022). Looking ahead, research in precision-psychotherapy may benefit from extending the classical RCT toward nested-precision RCTs (Kappelmann et al., 2021), which combine standard randomisation with algorithm-informed treatment allocation. In nested-precision RCTs, participants are initially randomised to broad treatment arms, while subsequent treatment decisions are guided by predictive algorithms based on patient characteristics and interim outcomes. This approach enables a direct empirical test of whether personalised allocation yields superior outcomes compared with continued random assignment, thereby providing a rigorous pathway to validate precision-based decision rules under controlled conditions. Furthermore, the leapfrog trial (Blackwell et al., 2019) is a simplified Bayesian adaptive platform design developed for clinical psychological intervention research. Using prespecified interim analyses, it can drop poorly performing arms and add promising new arms while the trial is ongoing, improving efficiency relative to running multiple stand-alone RCTs (Blackwell et al., 2023). In the field of trauma research, the leapfrog trial could be used to examine a broader range of interventions (including adjuncts) and moderators, given that heterogeneity is explicitly incorporated via stratification variables and decision rules (Blackwell, 2024). More broadly, the adaptive platform trials (APTs) are prospective trials conducted under a master (platform) protocol that can evaluate multiple interventions for a condition within one ongoing framework. Unlike traditional fixed designs, they use prespecified adaptive rules that update trial operations based on accumulating data (Adaptive

Platform Trials Coalition, 2019; Noor et al., 2020). Recent psychotherapy and mental health research argues that platform trials can accelerate evidence generation and calls for closer integration with advanced analytic methods (Gold et al., 2022) When combined with machine learning, repeatedly collected patient data may help model links between risk patterns, context, and symptom trajectories (e.g., Delgadillo & Gonzalez Salas Duhne, 2020). This in turn can inform allocation algorithms or adaptive decision rules (Bzdok & Meyer-Lindenberg, 2018)

Ultimately, the future of context-sensitive posttraumatic research in diagnostics and treatment does not lie in the further generalisation of specific interventions. Rather, it lies in the empirical validation and continuous optimisation of clinical decision architectures. This involves developing adaptive, mechanism-informed systems (cf. Gómez Penedo et al., 2023) that match individuals to the right intervention at the right time under the right contextual conditions. Such developments are essential for realising a learning trauma-care system in which clinical practice and clinical research are no longer "a house divided" (Angus et al., 2024, p. 160) but mutually reinforcing components of a dynamic, personalised mental health ecosystem (Lutz & Deisenhofer, 2022). To move PTSD research beyond one-size-fits-all treatment models, APTs offer a pragmatic vehicle to operationalise this dissertation's context-sensitive framework and to examine profile- and stage-informed interventions. Accordingly, they should be prioritised in future research on trauma survivors' mental health.

7.5. Conclusion

This dissertation examined approaches to the assessment, prevention and treatment of PTSD from the integrative perspective of context-sensitive psychological care for trauma survivors.

Although established assessment and treatment procedures are supported by a solid evidence base, posttraumatic trajectories, symptom experience and its expression and communication, as well as treatment response, remain highly heterogeneous. As a result, there is a need for optimization, which is also underscored by the studies' findings in the dissertation. Specifically, the studies show that integrative approaches that combine mechanism-based and contextual factors are needed at every stage after the trauma. *Study 1* showed that sleep after analogue trauma exposure reduced the frequency of intrusive memories to a small to moderate extent compared to wakefulness but did not reduce the likelihood of intrusions or their distress. This suggests a limited, consolidation-related preventive effect that is also context-dependent

and can only be cautiously transferred to clinical populations. *Study 2* showed that the PCL-5 exhibits very high reliability and largely comparable latent factor structure across German- and Arabic-speaking subsamples but does not achieve scalar invariance. It can therefore be assumed that individual items are answered differently depending on the context, so that sum scores between the subsamples are not fully comparable without taking the context into account. *Studies 3* and *4* show that NET was associated with significant symptom improvement in traumatised refugees with PTSD and depressive symptoms, while additional MAET showed no adjunct effects across primary outcomes. However, evidence suggests that the adjunct could support the implementation of NET (e.g., lower dropout rate) and that context-dependent effects influence the effect (e.g., moderation by residence status). Overall, this underscores that both treatment effects and potential additional benefits of adjuncts arise under structural contextual conditions, which reinforces a context-sensitive treatment approach. Overall, the results highlight the importance of contextual sensitivity (e.g., linguistic, cultural, etc.) in PTSD assessment in order to reduce bias in epidemiological research and in the clinical decision-making that follows. Thereby context sensitivity does not mean replacing the gold-standard but rather applying and interpreting it in such a way that variance in, for example, living conditions, culture, resources, and expressions of psychological distress are appropriately taken into account. The present dissertation lays the groundwork for a more precise, context-sensitive trauma care approach that bridges research and clinical practice by translating monitoring of risk-profiles from adaptive (multi-arm) research designs into routine clinical decision-making. In clinical settings, a staging framework can serve as the practical analogue of such monitoring, supporting adaptive and individualised treatment decisions that, in Osler's words, "treat the patient who has the disease"**.**

References

Abrams, T. E., Blevins, A., & Weg, M. W. V. (2015). Chronic obstructive lung disease and posttraumatic stress disorder: Current perspectives. *International Journal of Chronic Obstructive Pulmonary Disease*, *10*, 2219–2233. https://doi.org/10.2147/COPD.S71449

Adaptive Platform Trials Coalition. (2019). Adaptive platform trials: Definition, design, conduct and reporting considerations. *Nature Reviews Drug Discovery*, *18*(10), 797–807. https://www.nature.com/articles/s41573-019-0034-3

Adenauer, H., Catani, C., Gola, H., Keil, J., Ruf, M., Schauer, M., & Neuner, F. (2011). Narrative exposure therapy for PTSD increases top-down processing of aversive stimuli - Evidence from a randomized controlled treatment trial. *BMC Neuroscience, 12*(1), 127.

Admon, R., Leykin, D., Lubin, G., Engert, V., Andrews, J., Pruessner, J., & Hendler, T. (2013). Stress-induced reduction in hippocampal volume and connectivity with the ventromedial prefrontal cortex are related to maladaptive responses to stressful military service. *Human Brain Mapping*, *34*(11), 2808–2816. https://doi.org/10.1002/hbm.22100

Admon, R., Milad, M. R., & Hendler, T. (2013). A causal model of post-traumatic stress disorder: Disentangling predisposed from acquired neural abnormalities. *Trends in Cognitive Sciences*, *17*(7), 337–347. https://doi.org/10.1016/j.tics.2013.05.005

Afzal, N., Ye, S., Page, A. C., Trickey, D., Lyttle, M. D., Hiller, R. M., & Halligan, S. L. (2023). A systematic literature review of the relationship between parenting responses and child post-traumatic stress symptoms. *European Journal of Psychotraumatology*, *14*(1), 2156053. https://doi.org/10.1080/20008066.2022.2156053

Alghadir, A. H., & Gabr, S. A. (2020). Hormonal Function Responses to Moderate Aerobic Exercise in Older Adults with Depression. *Clinical Interventions in Aging, 15*, 1271–1283. https://doi.org/10.2147/CIA.S259422

Alghamdi, M., Hunt, N., & Thomas, S. (2015). The effectiveness of Narrative Exposure Therapy with traumatised firefighters in Saudi Arabia: A randomized controlled study. *Behaviour Research and Therapy, 66*, 64–71. https://doi.org/10.1016/j.brat.2015.01.008

Alhaffar, M. H. D. B. A., & Janos, S. (2021). Public health consequences after ten years of the Syrian crisis: A literature review. *Globalization and Health*, *17*(1), 111. https://doi.org/10.1186/s12992-021-00762-9

Ali, A. M., Al-Amer, R., Kunugi, H., Stanculescu, E., Taha, S. M., Saleh, M. Y., Alkhamees, A. A., & Hendawy, A. O. (2022). The Arabic version of the Impact of Event Scale-Revised: Psychometric evaluation among psychiatric patients and the general public within the context of COVID-19 outbreak and quarantine as collective traumatic events. *Journal of Personalized Medicine, 12*(5), 681. https://doi.org/10.3390/jpm12050681

Allen, L., Jones, C., Fox, A., Copello, A., Jones, N., & Meiser-Stedman, R. (2021). The correlation between social support and post-traumatic stress disorder in children and adolescents: A meta-analysis. *Journal of Affective Disorders*, *294*, 543–557. https://doi.org/10.1016/j.jad.2021.07.028

Allgire, E., McAlees, J. W., Lewkowich, I. P., & Sah, R. (2021). Asthma and posttraumatic stress disorder (PTSD): Emerging links, potential models and mechanisms. *Brain, Behavior, and Immunity*, *97*, 275–285. https://doi.org/10.1016/j.bbi.2021.06.001

Almarcha, M., Sturmberg, J., & Balagué, N. (2024). Personalizing the guidelines of exercise prescription for health: Guiding users from dependency to self-efficacy. *Apunts Sports Medicine*, *59*(223), 100449. https://doi.org/10.1016/j.apunsm.2024.100449

Alonso, J., Angermeyer, M., Bernert, S., Bruffaerts, R., Brugha, T., Bryson, H., de Girolamo, G., de Graaf, R., Demyttenaere, K., & Gasquet, I. (2004). Disability and quality of life impact of mental disorders in Europe: results from the European Study of the Epidemiology of Mental Disorders (ESEMeD) project. *Acta Psychiatrica Scandinavica*, 109(420), 38–46.

Alonso, J., Petukhova, M., Vilagut, G., Chatterji, S., Heeringa, S., Üstün, T. B., Alhamzawi, A. O., Viana, M. C., Angermeyer, M., Bromet, E., Bruffaerts, R., de Girolamo, G., Florescu, S., Gureje, O., Haro, J. M., Hinkov, H., Hu, C. Y., Karam, E. G., Kovess, V., … Kessler, R. C. (2010). Days out of role due to common physical and mental conditions: results from the WHO World Mental Health surveys. *Molecular psychiatry*, 16(12), 1234–1246.

AlShawi, A. F. (2018). Prevalence of posttraumatic stress disorders among a sample of internally displaced persons in Iraq: A preliminary study. *Journal of Community Medicine & Health Education, 8*(2). https://doi.org/10.4172/2161-0711.1000599

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). American Psychiatric Publishing.

American Psychiatric Association. (2022). *Diagnostic and statistical manual of mental disorders.* (5th ed., text rev.). American Psychiatric Publishing.

American Psychological Association. (2024). *Guidelines on key considerations for working with adults with PTSD and traumatic stress disorders.* American psychiatric association. https://www.apa.org/practice/guidelines/adults-ptsd-traumatic-stress-disorders.pdf

Angus, D. C., & Chang, C.-C. H. (2021). Heterogeneity of Treatment Effect: Estimating How the Effects of Interventions Vary Across Individuals. *JAMA*, *326*(22), 2312–2313. https://doi.org/10.1001/jama.2021.20552

Angus, D. C., Huang, A. J., Lewis, R. J., Abernethy, A. P., Califf, R. M., Landray, M., Kass, N., Bibbins-Domingo, K., & JAMA Summit on Clinical Trials Participants. (2024). The Integration of Clinical Trials With the Practice of Medicine: Repairing a House Divided. *JAMA*, *332*(2), 153–162. https://doi.org/10.1001/jama.2024.4088

Arena, A. F., Gregory, M., Collins, D. A. J., Vilus, B., Bryant, R., Harvey, S. B., & Deady, M. (2025). Global PTSD prevalence among active first responders and trends over recent years: A systematic review and meta-analysis. *Clinical Psychology Review*, *120*, 102622. https://doi.org/10.1016/j.cpr.2025.102622

Armour, C., Műllerová, J., & Elhai, J. D. (2016). A systematic literature review of PTSD's latent structure in the Diagnostic and Statistical Manual of Mental Disorders: DSM-IV to DSM-5. *Clinical Psychology Review*, *44*, 60–74. https://doi.org/10.1016/j.cpr.2015.12.003

Armour, C., Tsai, J., Durham, T. A., Charak, R., Biehn, T. L., Elhai, J. D., & Pietrzak, R. H. (2015). Dimensional structure of DSM-5 posttraumatic stress symptoms: Support for a hybrid anhedonia and externalizing behaviors model. *Journal of Psychiatric Research, 61*, 106–113. https://doi.org/10.1016/j.jpsychires.2014.10.012

Asmundson, G. J., Coons, M. J., Taylor, S., & Katz, J. (2002). PTSD and the Experience of Pain: Research and Clinical Implications of Shared Vulnerability and Mutual Maintenance Models. *The Canadian Journal of Psychiatry*, *47*(10), 930–937. https://doi.org/10.1177/070674370204701004

Asmundson, G. J. G., Fetzner, M. G., DeBoer, L. B., Powers, M. B., Otto, M. W., & Smits, J. A. J. (2013). Let's Get Physical: A Contemporary Review of the Anxiolytic Effects of Exercise for Anxiety and Its Disorders. *Depression and Anxiety, 30*(4), 362–373. https://doi.org/10.1002/da.22043

Astill Wright, L., Horstmann, L., Holmes, E. A., & Bisson, J. I. (2021). Consolidation/reconsolidation therapies for the prevention and treatment of PTSD and re-experiencing: a systematic review and meta-analysis. *Translational psychiatry, 11*(1), 453.

Atienza, M., & Cantero, J. L. (2008). Modulatory effects of emotion and sleep on recollection and familiarity. *Journal of Sleep Research*, 17(3), 285–294.

Autry, A. E., & Monteggia, L. M. (2012). Brain-Derived Neurotrophic Factor and Neuropsychiatric Disorders. *Pharmacological Reviews, 64*(2), 238–258. https://doi.org/10.1124/pr.111.005108

Avdibegovic, E., Delic, A., Hadžibeganovic, K., & Selimbašic, Z. (n.d.). Somatic Diseases in Patients with Posttraumatic Stress Disorder. *MED ARH*.

Azza, Y., Wilhelm, I., & Kleim, B. (2020). Sleep early after trauma: A target for prevention and early intervention for posttraumatic stress disorder? *European Psychologist*, 25(4), 239–251.

Bates, D. M. (2010). *lme4: Mixed-effects modeling with R*. Retrieved from http://lme4.r-forge.r-project.org/book/

Baddeley, A., Conway, M., Aggleton, J., & Conway, M. A. (2001). Sensory–perceptual episodic memory and its context: Autobiographical memory. *Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences*, *356*(1413), 1375–1384. https://doi.org/10.1098/rstb.2001.0940

Bakker, L., Dagevos, J., & Engbersen, G. (2014). The Importance of Resources and Security in the Socio-Economic Integration of Refugees. A Study on the Impact of Length of Stay in Asylum Accommodation and Residence Status on Socio-Economic Integration for the Four Largest Refugee Groups in the Netherlands. *Journal of International Migration and Integration*, *15*(3), 431–448. https://doi.org/10.1007/s12134-013-0296-2

Banno, M., Harada, Y., Taniguchi, M., Tobita, R., Tsujimoto, H., Tsujimoto, Y., Kataoka, Y., & Noda, A. (2018). Exercise can improve sleep quality: A systematic review and meta-analysis. *PeerJ*, *6*, e5172. https://doi.org/10.7717/peerj.5172

Barathie, J. A., & Karam, E. G. (2025). Exploratory factor analysis of post traumatic stress disorder checklist for DSM-5: Investigating post traumatic stress disorder interconnected dynamics with depression and anxiety in the aftermath of multiple collective stressors. *PLOS ONE*, *20*(5), e0323422. https://doi.org/10.1371/journal.pone.0323422

Barlis, K. L., Terner, J., Huynh, N. X., & Huggins, A. A. (2025). Fear Learning and Memory in the Aging Brain: Neural Mechanisms of PTSD Risk and Resilience in Older Adults. *Biological Psychiatry: Cognitive Neuroscience and Neuroimaging*. https://doi.org/10.1016/j.bpsc.2025.12.003

Bates, D., Maechler, M., Bolker, B., & Walker, S. (2003). *lme4: Linear Mixed-Effects Models using "Eigen" and S4.* (p. 1.1-37). https://doi.org/10.32614/CRAN.package.lme4

Bäumel, A. C., Sauter, A., Weber, A., Leitzmann, M., & Jochem, C. (2024). Subjective health status and health literacy of African refugees and asylum seekers in Germany: A cross-sectional survey. *International Journal of Migration, Health and Social Care*, *20*(2), 261–275. https://doi.org/10.1108/IJMHSC-05-2023-0045

Beierl, E. T., Böllinghaus, I., Clark, D. M., Glucksman, E., & Ehlers, A. (2020). Cognitive paths from trauma to posttraumatic stress disorder: A prospective study of Ehlers and Clark's model in survivors of assaults or road traffic collisions. *Psychological Medicine*, *50*(13), 2172–2181. https://doi.org/10.1017/S0033291719002253

Ben Salah, A., DeAngelis, B. N., & al'Absi, M. (2023). Uncertainty and psychological distress during COVID-19: What about protective factors? *Current Psychology*, *42*(25), 21470–21477. https://doi.org/10.1007/s12144-022-03244-2

Ben-Eltriki, M., Rafiq, A., Paul, A., Prabhu, D., Afolabi, M. O. S., Baslhaw, R., Neilson, C. J., Driedger, M., Mahmud, S. M., Lacaze-Masmonteil, T., Marlin, S., Offringa, M., Butcher, N., Heath, A., & Kelly, L. E. (2024). Adaptive designs in clinical trials: A systematic review-part I. *BMC Medical Research Methodology*, *24*(1), 229. https://doi.org/10.1186/s12874-024-02272-9

Benight, C. C., & Bandura, A. (2004). Social cognitive theory of posttraumatic recovery: The role of perceived self-efficacy. *Behaviour Research and Therapy*, *42*(10), 1129–1148. https://doi.org/10.1016/j.brat.2003.08.008

Benjet, C., Bromet, E., Karam, E. G., Kessler, R. C., McLaughlin, K. A., Ruscio, A. M., Shahly, V., Stein, D. J., Petukhova, M., Hill, E., Alonso, J., Atwoli, L., Bunting, B., Bruffaerts, R., Caldas-de-Almeida, J. M., Girolamo, G. de, Florescu, S., Gureje, O., Huang, Y., … Koenen, K. C. (2016). The epidemiology of traumatic event exposure worldwide: Results from the World Mental Health Survey Consortium. *Psychological Medicine*, *46*(2), 327–343. https://doi.org/10.1017/S0033291715001981

Bentler, P. M., & Bonett, D. G. (1980). Significance tests and goodness of fit in the analysis of covariance structures. *Psychological Bulletin, 88*(3), 588–606. https://doi.org/10.1037/0033-2909.88.3.588

Berntsen, D., & Rubin, D. C. (2007). When a trauma becomes a key to identity: Enhanced integration of trauma memories predicts posttraumatic stress disorder symptoms. *Applied Cognitive Psychology*, *21*(4), 417–431. https://doi.org/10.1002/acp.1290

Bilewicz, M., Babińska, M., & Gromova, A. (2024). High rates of probable PTSD among Ukrainian war refugees: The role of intolerance of uncertainty, loss of control and subsequent discrimination. *European Journal of Psychotraumatology*, *15*(1), 2394296. https://doi.org/10.1080/20008066.2024.2394296

Billings, J., & Nicholls, H. (2025). PTSD and complex PTSD, current treatments and debates: A review of reviews. *British Medical Bulletin*, *156*(1), ldaf015. https://academic.oup.com/bmb/article-pdf/doi/10.1093/bmb/ldaf015/64415290/ldaf015.pdf

Bisby, J. A., & Burgess, N. (2017). Differential effects of negative emotion on memory for items and associations, and their relationship to intrusive imagery. *Current Opinion in Behavioral Sciences*, 17, 124–132.

Bisson, J., & Andrew, M. (2007). Psychological treatment of post-traumatic stress disorder (PTSD). *Cochrane Database of Systematic Reviews*, *3*. https://doi.org/10.1002/14651858.CD003388.pub3

Bisson, J. I., Berliner, L., Cloitre, M., Forbes, D., Jensen, T. K., Lewis, C., Monson, C. M., Olff, M., Pilling, S., Riggs, D. S., Roberts, N. P., & Shapiro, F. (2019). The International Society

for Traumatic Stress Studies New Guidelines for the Prevention and Treatment of Posttraumatic Stress Disorder: Methodology and Development Process. *Journal of Traumatic Stress*, *32*(4), 475–483. https://doi.org/10.1002/jts.22421

Björkman, F., & Ekblom, Ö. (2022). Physical Exercise as Treatment for PTSD: A Systematic Review and Meta-Analysis. *Military Medicine*, *187*(9–10), e1103–e1113. https://doi.org/10.1093/milmed/usab497

Blackmore, R., Boyle, J. A., Fazel, M., Ranasinha, S., Gray, K. M., Fitzgerald, G., Misso, M., & Gibson-Helm, M. (2020). The prevalence of mental illness in refugees and asylum seekers: A systematic review and meta-analysis. *PLOS Medicine*, *17*(9), e1003337. https://doi.org/10.1371/journal.pmed.1003337

Blackwell, S. E. (2020). Clinical efficacy of cognitive bias modification interventions. *The Lancet Psychiatry*, *7*(6), 465–467.

Blackwell, S. E. (2024). Using the 'Leapfrog' Design as a Simple Form of Adaptive Platform Trial to Develop, Test, and Implement Treatment Personalization Methods in Routine Practice. *Administration and Policy in Mental Health and Mental Health Services Research*, *51*(5), 686–701. https://doi.org/10.1007/s10488-023-01340-4

Blackwell, S. E., Schönbrodt, F. D., Woud, M. L., Wannemüller, A., Bektas, B., Rodrigues, M. B., Hirdes, J., Stumpp, M., & Margraf, J. (2023). Demonstration of a 'leapfrog' randomized controlled trial as a method to accelerate the development and optimization of psychological interventions. *Psychological Medicine*, *53*(13), 6113–6123. https://doi.org/10.1017/S0033291722003294

Blackwell, S. E., & Woud, M. L. (2022). Making the leap: From experimental psychopathology to clinical trials. *Journal of Experimental Psychopathology, 13*(1). https://doi.org/10.1177/20438087221080075

Blackwell, S. E., Woud, M. L., Margraf, J., & Schönbrodt, F. D. (2019). Introducing the Leapfrog Design: A Simple Bayesian Adaptive Rolling Trial Design for Accelerated Treatment Development and Optimization. *Clinical Psychological Science*, *7*(6), 1222–1243. https://doi.org/10.1177/2167702619858071

Blevins, C. A., Weathers, F. W., Davis, M. T., Witte, T. K., & Domino, J. L. (2015). The Posttraumatic Stress Disorder Checklist for DSM-5 (PCL-5): Development and Initial

Psychometric Evaluation. *Journal of Traumatic Stress*, *28*(6), 489–498. https://doi.org/10.1002/jts.22059

Bobba, B., Bacaro, V., & Crocetti, E. (2023). Embedded in Contexts: A Systematic Review of the Longitudinal Associations Between Contextual Factors and Sleep. *Adolescent Research Review*, *8*(4), 403–422. https://doi.org/10.1007/s40894-023-00204-0

Bonanno, G. A. (2004). Loss, Trauma, and Human Resilience: Have We Underestimated the Human Capacity to Thrive After Extremely Aversive Events? *American Psychologist*, *59*(1), 20–28. https://doi.org/10.1037/0003-066X.59.1.20

Bonanno, G. A. (2021). The resilience paradox. *European journal of Psychotraumatology*, 12(1), 1942642.

Bonanno, G. A., & Burton, C. L. (2013). Regulatory Flexibility: An Individual Differences Perspective on Coping and Emotion Regulation. *Perspectives on Psychological Science*, *8*(6), 591–612. https://doi.org/10.1177/1745691613504116

Borenstein, M., Higgins, J. P. T., Hedges, L. V., & Rothstein, H. R. (2017). Basics of meta-analysis: I2 is not an absolute measure of heterogeneity. *Research Synthesis Methods*, 8(1), 5–18.

Borhan, S., Kennedy, C., Ioannidis, G., Papaioannou, A., Adachi, J., & Thabane, L. (2020). An empirical comparison of methods for analyzing over-dispersed zero-inflated count data from stratified cluster randomized trials. *Contemporary Clinical Trials Communications*, 17, 100539.

Bouchard, C., Blair, S. N., & Haskell, W. L. (2012). *Physical Activity and Health*. Human Kinetics.

Bovey, M., Hosny, N., Dutray, F., & Heim, E. (2025). Trauma-related cultural concepts of distress: A systematic review of qualitative literature from the middle east and North Africa, and Sub-Saharan Africa. *SSM - Mental Health*, *7*, 100402. https://doi.org/10.1016/j.ssmmh.2025.100402

Bradley, R., Greene, J., Russ, E., Dutra, L., & Westen, D. (2005). A Multidimensional Meta-Analysis of Psychotherapy for PTSD. *American Journal of Psychiatry*. https://doi.org/10.1176/appi.ajp.162.2.214

Brady, K. T., & Brewerton, T. (n.d.). *Comorbidity of Psychiatric Disorders and Posttraumatic Stress Disorder*.

Brahim, C. B., El Kefi, H., Awissawi, A., Kabtni, W., Baatout, A., Bouizouita, I., Bouguerra, C., Eddif, S., & Oumaya, A. (2022). Validation en arabe littéraire chez les militaires tunisiens de la Post-Traumatic Stress Disorder Checklist for DSM-5. *Pan African Medical Journal*, *43*(28). https://doi.org/10.11604/pamj.2022.43.28.35869

Bredemeier, K., Larsen, S., Shivakumar, G., Grubbs, K., McLean, C., Tress, C., Rosenfield, D., DeRubeis, R., Xu, C., Foa, E., Morland, L., Pai, A., Tsao, C., Crawford, J., Weitz, E., Mayinja, L., Feler, B., Wachsman, T., Lupo, M., … Thase, M. (2022). A comparison of prolonged exposure therapy, pharmacotherapy, and their combination for PTSD: What works best and for whom; study protocol for a randomized trial. *Contemporary Clinical Trials*, *119*, 106850. https://doi.org/10.1016/j.cct.2022.106850

Breslau, N., Lucia, V. C., & Alvarado, G. F. (2006). Intelligence and Other Predisposing Factors in Exposure to Trauma and Posttraumatic Stress Disorder: A Follow-up Study at Age 17 Years. *Archives of General Psychiatry*, *63*(11), 1238–1245. https://doi.org/10.1001/archpsyc.63.11.1238

Brewin, C. R. (2001). Memory processes in post-traumatic stress disorder. *International Review of Psychiatry*, *13*(3), 159–163. https://doi.org/10.1080/09540260120074019

Brewin, C. R. (2011). The Nature and Significance of Memory Disturbance in Posttraumatic Stress Disorder. *Annual Review of Clinical Psychology*, *7*(Volume 7, 2011), 203–227. https://doi.org/10.1146/annurev-clinpsy-032210-104544

Brewin, C. R. (2014). Episodic memory, perceptual memory, and their interaction: Foundations for a theory of posttraumatic stress disorder. *Psychological Bulletin*, *140*(1), 69–97. https://doi.org/10.1037/a0033722

Brewin, C. R., Andrews, B., & Valentine, J. D. (2000). Meta-analysis of risk factors for posttraumatic stress disorder in trauma-exposed adults. *Journal of Consulting and Clinical Psychology*, *68*(5), 748–766. https://doi.org/10.1037/0022-006X.68.5.748

Brewin, C. R., Cloitre, M., Hyland, P., Shevlin, M., Maercker, A., Bryant, R. A., Humayun, A., Jones, L. M., Kagee, A., Rousseau, C., Somasundaram, D., Suzuki, Y., Wessely, S., van Ommeren, M., & Reed, G. M. (2017). A review of current evidence regarding the ICD-11

proposals for diagnosing PTSD and complex PTSD. *Clinical Psychology Review*, *58*, 1–15. https://doi.org/10.1016/j.cpr.2017.09.001

Brewin, C. R., Gregory, J. D., Lipton, M., & Burgess, N. (2010). Intrusive images in psychological disorders: Characteristics, neural mechanisms, and treatment implications. *Psychological Review*, *117*(1), 210–232. https://doi.org/10.1037/a0018113

Brewin, C. R., Miller, J. K., Soffia, M., Peart, A., & Burchell, B. (2022). Posttraumatic stress disorder and complex posttraumatic stress disorder in UK police officers. *Psychological Medicine*, *52*(7), 1287–1295. https://doi.org/10.1017/S0033291720003025

Brierley, J. D., Giuliani, M., O'Sullivan, B., Rous, B., & Eycken, E. V. (2025). *TNM Classification of Malignant Tumours*. John Wiley & Sons.

Bromet, E. J., Atwoli, L., Kawakami, N., Navarro-Mateu, F., Piotrowski, P., King, A. J., Aguilar-Gaxiola, S., Alonso, J., Bunting, B., Demyttenaere, K., Florescu, S., de Girolamo, G., Gluzman, S., Haro, J. M., de Jonge, P., Karam, E. G., Lee, S., Kovess-Masfety, V., Medina-Mora, M. E., … Kessler, R. C. (2017). Post-traumatic stress disorder associated with natural and human-made disasters in the World Mental Health Surveys. *Psychological Medicine*, *47*(2), 227–241. https://doi.org/10.1017/S0033291716002026

Brooks, M. E., Kristensen, K., van Benthem, K. J., Magnusson, A., Berg, C. W., Nielsen, A., Skaug, H. J., Machler, M., & Bolker, B. M. (2017). GlmmTMB balances speed and flexibility among packages for zero-inflated generalized linear mixed modeling. *The R Journal*, *9*(2), 378–400.

Brown, G. T. L., Harris, L. R., O'Quin, C. R., & Lane, K. (2015). Using Multigroup Confirmatory Factor Analysis to Evaluate Cross-Cultural Research: Identifying and Understanding Non-Invariance. *International Journal of Research and Method in Education.* https://doi.org/10.1080/1743727X.2015.1070823

Brown, L. C., Murphy, A. R., Lalonde, C. S., Subhedar, P. D., Miller, A. H., & Stevens, J. S. (2020). Posttraumatic stress disorder and breast cancer: Risk factors and the role of inflammation and endocrine function. *Cancer*, *126*(14), 3181–3191. https://doi.org/10.1002/cncr.32934

Browne, J., Mills, W. L., Lopez, C. T., Philip, N. S., Hall, K. S., Young, A. S., Guthrie, K. M., & Wu, W.-C. (2025). "One Size Doesn't Fit All": Design Considerations for an Exercise Program to Improve Physical Function in Older Veterans with Serious Mental Illness.

International Journal of Environmental Research and Public Health, *22*(2), 191. https://doi.org/10.3390/ijerph22020191

Bryan, C. J., Tipton, E., & Yeager, D. S. (2021). Behavioural science is unlikely to change the world without a heterogeneity revolution. *Nature Human Behaviour*, *5*(8), 980–989. https://doi.org/10.1038/s41562-021-01143-3

Bryant, R. A. (2019). Post-traumatic stress disorder: A state-of-the-art review of evidence and challenges. *World Psychiatry*, *18*(3), 259–269. https://doi.org/10.1002/wps.20656

Bryant, R. A., Dawson, K. S., Azevedo, S., Yadav, S., Cahill, C., Kenny, L., Maccallum, F., Tran, J., Rawson, N., Tockar, J., Garber, B., & Keyan, D. (2023). Augmenting trauma-focused psychotherapy for post-traumatic stress disorder with brief aerobic exercise in Australia: A randomised clinical trial. *The Lancet Psychiatry*, *10*(1), 21–29. https://doi.org/10.1016/S2215-0366(22)00368-6

Bryant, R. A., & Harvey, A. G. (1995). Avoidant coping style and post-traumatic stress following motor vehicle accidents. *Behaviour Research and Therapy*, *33*(6), 631–635. https://doi.org/10.1016/0005-7967(94)00093-Y

Burback, L., Brult-Phillips, S., Nijdam, M. J., McFarlane, A., & Vermetten, E. (2024). Treatment of Posttraumatic Stress Disorder: A State-of-the-art Review. *Current Neuropharmacology*, *22*(4), 557–635. https://doi.org/10.2174/1570159X21666230428091433

Bürkner, P.-C. (2015). *brms: Bayesian Regression Models using 'Stan'* (p. 2.22.0) [Data set]. https://doi.org/10.32614/CRAN.package.brms

Button, K. S., Ioannidis, J. P. A., Mokrysz, C., Nosek, B. A., Flint, J., Robinson, E. S. J., & Munafò, M. R. (2013). Power failure: Why small sample size undermines the reliability of neuroscience. *Nature Reviews Neuroscience*, *14*(5), 365–376. https://doi.org/10.1038/nrn3475

Buysse D. J. (2014). Sleep health: can we define it? Does it matter? *Sleep*, *37*(1), 9–17.

Buysse, D. J., Reynolds, C. F., Monk, T. H., Berman, S. R., & Kupfer, D. J. (1989). The Pittsburgh sleep quality index: A new instrument for psychiatric practice and research. *Psychiatry Research, 28*(2), 193–213. https://doi.org/10.1016/0165-1781(89)90047-4

Bzdok, D., & Meyer-Lindenberg, A. (2018). Machine Learning for Precision Psychiatry: Opportunities and Challenges. *Biological Psychiatry: Cognitive Neuroscience and Neuroimaging*, *3*(3), 223–230. https://doi.org/10.1016/j.bpsc.2017.11.007

Cacciaglia, R., Nees, F., Grimm, O., Ridder, S., Pohlack, S. T., Diener, S. J., Liebscher, C., & Flor, H. (2017). Trauma exposure relates to heightened stress, altered amygdala morphology and deficient extinction learning: Implications for psychopathology. *Psychoneuroendocrinology*, *76*, 19–28. https://doi.org/10.1016/j.psyneuen.2016.11.012

Canfield, R. L. (1991). Turko-Persia in historical perspective (p. 1, "Origins"). Cambridge, United Kingdom: Cambridge University Press.

Carlsson, J., Bruhn, M., Poschmann, I. S., Silove, D., Westergaard, M. L., Mortensen, E. L., & Sandahl, H. (2025). Identifying robust predictors of treatment response in trauma-affected refugees: Results from a randomised controlled trial. *PLOS ONE*, *20*(9), e0324935. https://doi.org/10.1371/journal.pone.0324935

Carlson, G., Saldana, K., Kelly, M., McGowan, S. K., DeViva, J., McCarthy, E., ... & Martin, J. (2022). Identifying Trauma-Informed Adaptations to Cognitive Behavioral Therapy for Insomnia among Women Veterans: Results of an Expert Panel. *Sleep*, *45*(A208-A209).

Carpenter, B., Gelman, A., Hoffman, M. D., Lee, D., Goodrich, B., Betancourt, M., Brubaker, M., Guo, J., Li, P., & Riddell, A. (2017). Stan: A Probabilistic Programming Language. Journal of Statistical Software, 76, 1–32. https://doi.org/10.18637/jss.v076.i01

Castrén, E., & Monteggia, L. M. (2021). Brain-Derived Neurotrophic Factor Signaling in Depression and Antidepressant Action. *Biological Psychiatry, 90*(2), 128–136. https://doi.org/10.1016/j.biopsych.2021.05.008

Chambless, D. L., Caputo, G. C., Bright, P., & Gallagher, R. (1984). Assessment of fear of fear in agoraphobics: The Body Sensations Questionnaire and the Agoraphobic Cognitions Questionnaire. *Journal of Consulting and Clinical Psychology, 52*(6), 1090–1097. https://doi.org/10.1037/0022-006X.52.6.1090

Chambless, D. L., Caputo, G. C., Jasin, S. E., Gracely, E. J., & Williams, C. (1985). The Mobility Inventory for Agoraphobia. *Behaviour Research and Therapy, 23*(1), 35–44. https://doi.org/10.1016/0005-7967(85)90140-8

Charuvastra, A., & Cloitre, M. (2009). Safe Enough to Sleep: Sleep Disruptions Associated with Trauma, Posttraumatic Stress, and Anxiety in Children and Adolescents. *Child and Adolescent Psychiatric Clinics of North America*, *18*(4), 877–891. https://doi.org/10.1016/j.chc.2009.04.002

Chemtob, C., Roitblat, H. L., Hamada, R. S., Carlson, J. G., & Twentyman, C. T. (1988). A cognitive action theory of post-traumatic stress disorder. *Journal of Anxiety Disorders*, *2*(3), 253–275. https://doi.org/10.1016/0887-6185(88)90006-0

Chen, F. F. (2008). What happens if we compare chopsticks with forks? The impact of making inappropriate comparisons in cross-cultural research. *Journal of Personality and Social Psychology, 95*(5), 1005–1018. https://doi.org/10.1037/a0013193

Childs, E., & de Wit, H. (2014). Regular exercise is associated with emotional resilience to acute stress in healthy adults. *Frontiers in Physiology*, *5*. https://doi.org/10.3389/fphys.2014.00161

Christiansen, D. M., & Elklit, A. (2012). Sex differences in PTSD. *Posttraumatic Stress Disorder in a Global Context*, 113–142.

Christiansen, D. M., & Hansen, M. (2015). Accounting for sex differences in PTSD: A multi-variable mediation model. *European Journal of Psychotraumatology*, *6*(1), 26068. https://doi.org/10.3402/ejpt.v6.26068

Clark, I. A., Mackay, C. E., & Holmes, E. A. (2015). Low emotional response to traumatic footage is associated with an absence of analogue flashbacks: an individual participant data meta-analysis of 16 trauma film paradigm experiments. *Cognition and Emotion, 29*(4), 702–713.

Cloitre, M. (2015). The "one size fits all" approach to trauma treatment: Should we be satisfied? *European Journal of Psychotraumatology*, *6*(1), 27344. https://doi.org/10.3402/ejpt.v6.27344

Cloitre, M., Garvert, D. W., Brewin, C. R., Bryant, R. A., & Maercker, A. (2013). Evidence for proposed ICD-11 PTSD and complex PTSD: A latent profile analysis. *European Journal of Psychotraumatology*, *4*(1), 20706. https://doi.org/10.3402/ejpt.v4i0.20706

Cloitre, M., Stolbach, B. C., Herman, J. L., Kolk, B. van der, Pynoos, R., Wang, J., & Petkova, E. (2009). A developmental approach to complex PTSD: Childhood and adult cumulative

trauma as predictors of symptom complexity. *Journal of Traumatic Stress*, *22*(5), 399–408. https://doi.org/10.1002/jts.20444

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Lawrence Erlbaum.

Cohen, H., Ephraim-Oluwanuga, O. T., Akintunde, O. T., Gureje, O., Matar, M. A., Todder, D., & Zohar, J. (2023). The potential beneficial effect of sleep deprivation following traumatic events to preventing PTSD: Review of current insight regarding sleep, memory, and trauma resonating with ancient rituals-Àìsùn Oku (African) and Tsuya (Japanese). *Neuropsychopharmacology reports*, *43*(1), 2–11.

Cohen, Z. D., Delgadillo, J., & DeRubeis, R. J. (2021). Personalized treatment approaches. In *Bergin and Garfield's handbook of psychotherapy and behavior change: 50th anniversary edition, 7th ed* (pp. 673–703). John Wiley & Sons, Inc.

Cohen, Z. D., & DeRubeis, R. J. (2018). Treatment Selection in Depression. *Annual Review of Clinical Psychology*, *14*(Volume 14, 2018), 209–236. https://doi.org/10.1146/annurev-clinpsy-050817-084746

Compas, B. E., Connor-Smith, J. K., Saltzman, H., Thomsen, A. H., & Wadsworth, M. E. (2001). Coping with stress during childhood and adolescence: Problems, progress, and potential in theory and research. *Psychological Bulletin*, *127*(1), 87–127. https://doi.org/10.1037/0033-2909.127.1.87

Connor, J. P., Brier, Z. M. F., & Price, M. (2020). The Association Between Pain Trajectories With Posttraumatic Stress Disorder, Depression, and Disability During the Acute Posttrauma Period. *Psychosomatic Medicine*, *82*(9), 862–868. https://doi.org/10.1097/PSY.0000000000000866

Contractor, A. A., Elhai, J. D., Fine, T. H., Tamburrino, M. B., Cohen, G., Shirley, E., Chan, P. K., Liberzon, I., Galea, S., & Calabrese, J. R. (2015). Latent profile analyses of posttraumatic stress disorder, depression and generalized anxiety disorder symptoms in trauma-exposed soldiers. *Journal of Psychiatric Research*, *68*, 19–26. https://doi.org/10.1016/j.jpsychires.2015.05.014

Conway, M. A. (2001). Sensory–perceptual episodic memory and its context: Autobiographical memory. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *356*(1413), 1375–1384. https://doi.org/10.1098/rstb.2001.0940

Cook, R. D., & Weisberg, S. (1982). *Residuals and influence in regression.* Chapman and Hall.

Cooper, H., & Patall, E. A. (2009). The relative benefits of meta-analysis conducted with individual participant data versus aggregated data. *Psychological Methods*, *14*(2), 165–176. https://doi.org/10.1037/a0015565

Cordi, M. J., Rossier, L., & Rasch, B. (2020). Hypnotic suggestions given before nighttime sleep extend slow-wave sleep as compared to a control text in highly hypnotizable subjects. *International Journal of Clinical and Experimental Hypnosis*, 68(1), 105–129.

Cordova, M. J., Riba, M. B., & Spiegel, D. (2017). Post-traumatic stress disorder and cancer. *The Lancet Psychiatry*, *4*(4), 330–338. https://doi.org/10.1016/S2215-0366(17)30014-7

Cork, C., Kaiser, B. N., & White, R. G. (2019). The integration of idioms of distress into mental health assessments and interventions: A systematic review. *Global Mental Health*, *6*, e7. https://doi.org/10.1017/gmh.2019.5

Corrigan, P. W., & Salzer, M. S. (2003). The conflict between random assignment and treatment preference: Implications for internal validity. *Evaluation and Program Planning*, *26*(2), 109–121. https://doi.org/10.1016/S0149-7189(03)00014-4

Craske, M. G., Treanor, M., Conway, C. C., Zbozinek, T., & Vervliet, B. (2014). Maximizing exposure therapy: An inhibitory learning approach. *Behaviour Research and Therapy*, *58*, 10–23. https://doi.org/10.1016/j.brat.2014.04.006

Crombie, K. M., Sartin-Tarm, A., Sellnow, K., Ahrenholtz, R., Lee, S., Matalamaki, M., Almassi, N. E., Hillard, C. J., Koltyn, K. F., Adams, T. G., & Cisler, J. M. (2021). Exercise-induced increases in Anandamide and BDNF during extinction consolidation contribute to reduced threat following reinstatement: Preliminary evidence from a randomized controlled trial. *Psychoneuroendocrinology*, *132*, 105355. https://doi.org/10.1016/j.psyneuen.2021.105355

Cuijpers, P., Ciharova, M., Quero, S., Miguel, C., Driessen, E., Harrer, M., Purgato, M., Ebert, D., & Karyotaki, E. (2022). The contribution of "individual participant data" meta-analyses of psychotherapies for depression to the development of personalized treatments: a systematic review. *Journal of personalized medicine*, *12*(1), 93.

Cusack, K., Jonas, D. E., Forneris, C. A., Wines, C., Sonis, J., Middleton, J. C., Feltner, C., Brownley, K. A., Olmsted, K. R., Greenblatt, A., Weil, A., & Gaynes, B. N. (2016).

Psychological treatments for adults with posttraumatic stress disorder: A systematic review and meta-analysis. *Clinical Psychology Review*, *43*, 128–141. https://doi.org/10.1016/j.cpr.2015.10.003

Cyr, S., Guo, D. X., Marcil, M.-J., Dupont, P., Jobidon, L., Benrimoh, D., Guertin, M.-C., & Brouillette, J. (2021). Posttraumatic stress disorder prevalence in medical populations: A systematic review and meta-analysis. *General Hospital Psychiatry*, *69*, 81–93. https://doi.org/10.1016/j.genhosppsych.2021.01.010

Davidov, E., Meuleman, B., Cieciuch, J., Schmidt, P., & Billiet, J. (2014). Measurement Equivalence in Cross-National Research. *Annual Review of Sociology*, *40*(1), 55–75. https://doi.org/10.1146/annurev-soc-071913-043137

Davidson, J. R. T., Hughes, D., Blazer, D. G., & George, L. K. (1991). Post-traumatic stress disorder in the community: An epidemiological study. *Psychological Medicine*, *21*(3), 713–721. https://doi.org/10.1017/S0033291700022352

Davidson, P., & Marcusson-Clavertz, D. (2023). The effect of sleep on intrusive memories in daily life: a systematic review and meta-analysis of trauma film experiments. *Sleep*, *46*(2), zsac280.

Davis, L. L., Schein, J., Cloutier, M., Gagnon-Sanschagrin, P., Maitland, J., Urganus, A., Guerin, A., Lefebvre, P., & Houle, C. R. (2022). The Economic Burden of Posttraumatic Stress Disorder in the United States From a Societal Perspective. *The Journal of Clinical Psychiatry*, 83(3), 40672.

Deeks, J.J., Higgins, J.P.T., Altman, D.G. (2022). Analysing data and undertaking meta-analyses. In J. P. T. Higgins, J. Thomas, J. Chandler, M. Cumpston, T. Li, M. J. Page & V. A. Welch (Eds.), *Cochrane Handbook for Systematic Reviews of Interventions* (pp. 241–284). Cochrane Collaboration. doi:10.1002/9781119536604.ch10

Deeprose, C., Zhang, S., DeJong, H., Dalgleish, T., & Holmes, E. A. (2012). Imagery in the aftermath of viewing a traumatic film: Using cognitive tasks to modulate the development of involuntary memory. *Journal of Behavior Therapy and Experimental Psychiatry*, 43(2), 758–764.

de Jong, J. T. V. M., Komproe, I. H., Van Ommeren, M., El Masri, M., Araya, M., Khaled, N., van de Put, W., & Somasundaram, D. (2001). Lifetime Events and Posttraumatic Stress

Disorder in 4 Postconflict Settings. *JAMA*, *286*(5), 555–562. https://doi.org/10.1001/jama.286.5.555

de la Rie, S. M., Smid, G. E., van der Aa, N., van Est, L. A. C., Bisseling, E., & Boelen, P. A. (2020). Feasibility of narrative exposure therapy in an outpatient day treatment programme for refugees: Improvement in symptoms and global functioning. *European Journal of Psychotraumatology*, *11*(1), 1759983. https://doi.org/10.1080/20008198.2020.1759983

Delgadillo, J., Ali, S., Fleck, K., Agnew, C., Southgate, A., Parkhouse, L., Cohen, Z. D., DeRubeis, R. J., & Barkham, M. (2022). Stratified care vs stepped care for depression: A cluster randomized clinical trial. *JAMA Psychiatry*, *79*(2), 101–108. https://jamanetwork.com/journals/jamapsychiatry/article-abstract/2786974

Delgadillo, J., & Gonzalez Salas Duhne, P. (2020). Targeted prescription of cognitive–behavioral therapy versus person-centered counseling for depression using a machine learning approach. *Journal of Consulting and Clinical Psychology*, *88*(1), 14–24. https://doi.org/10.1037/ccp0000476

Delgadillo, J., Moreea, O., & Lutz, W. (2016). Different people respond differently to therapy: A demonstration using patient profiling and risk stratification. *Behaviour Research and Therapy*, *79*, 15–22. https://doi.org/10.1016/j.brat.2016.02.003

Department of Veterans Affairs and Department of Defense (2023). *VA/DoD clinical practice guideline for management of posttraumatic stress disorder and acute stress disorder*. https://www.healthquality.va.gov/guidelines/MH/ptsd/. Accessed April, 2025

Derogatis, L. R., Lipman, R. S., Rickels, K., Uhlenhuth, E. H., & Covi, L. (1974). The Hopkins Symptom Checklist (HSCL): A self-report symptom inventory. *Behavioral science*, *19*(1), 1-15.

DeVito, N. J., & Goldacre, B. (2019). Catalogue of bias: Publication bias. *BMJ Evidence-Based Medicine*, 24(2), 53.

DGPPN, BÄK, KBV, & AWMF. (2017). *S3-Leitlinie/Nationale Versorgungsleitlinie Unipolare Depression – Kurzfassung, 2. Auflage.* https://doi.org/10.6101/AZQ/000366

Diamond, P. R., Airdrie, J. N., Hiller, R., Fraser, A., Hiscox, L. V., Hamilton-Giachritsis, C., & Halligan, S. L. (2022). Change in prevalence of post-traumatic stress disorder in the two

years following trauma: A meta-analytic study. *European Journal of Psychotraumatology*, *13*(1), 2066456. https://doi.org/10.1080/20008198.2022.2066456

Diekelmann, S., & Born, J. (2010). The memory function of sleep. *Nature Reviews Neuroscience*, *11*(2), 114–126. https://doi.org/10.1038/nrn2762

Ding, D., Mutrie, N., Bauman, A., Pratt, M., Hallal, P. R. C., & Powell, K. E. (2020). Physical activity guidelines 2020: Comprehensive and inclusive recommendations to activate populations. *The Lancet*, *396*(10265), 1780–1782. https://doi.org/10.1016/S0140-6736(20)32229-7

Dokkedahl, S. B., & Lahav, Y. (2024). Peritraumatic dissociation and posttraumatic stress symptoms: The moderating role of perceived threat. *European Journal of Psychotraumatology*, *15*(1), 2338670. https://doi.org/10.1080/20008066.2024.2338670

Drosopoulos, S., Wagner, U., & Born, J. (2005). Sleep enhances explicit recollection in recognition memory. *Learning & memory*, 12(1), 44–51.

Dudai, Y., Karni, A., & Born, J. (2015). The Consolidation and Transformation of Memory. *Neuron*, *88*(1), 20–32. https://doi.org/10.1016/j.neuron.2015.09.004

Edmondson, D. (2014). An Enduring Somatic Threat Model of Posttraumatic Stress Disorder Due to Acute Life-Threatening Medical Events. *Social and Personality Psychology Compass*, *8*(3), 118–134. https://doi.org/10.1111/spc3.12089

Edmondson, D., Richardson, S., Fausett, J. K., Falzon, L., Howard, V. J., & Kronish, I. M. (2013). Prevalence of PTSD in Survivors of Stroke and Transient Ischemic Attack: A Meta-Analytic Review. *PLOS ONE*, *8*(6), e66435. https://doi.org/10.1371/journal.pone.0066435

Edmondson, D., & von Känel, R. von. (2017). Post-traumatic stress disorder and cardiovascular disease. *The Lancet Psychiatry*, *4*(4), 320–329. https://doi.org/10.1016/S2215-0366(16)30377-7

Edinger, J. D., Arnedt, J. T., Bertisch, S. M., Carney, C. E., Harrington, J. J., Lichstein, K. L., Sateia, M. J., Troxel, W. M., Zhou, E. S., Kazmi, U., Heald, J. L., & Martin, J. L. (2021). Behavioral and psychological treatments for chronic insomnia disorder in adults: an American Academy of Sleep Medicine clinical practice guideline. *Journal of clinical sleep medicine*, *17*(2), 255–262.

Edwards-Stewart, A., Smolenski, D. J., Bush, N. E., Cyr, B.-A., Beech, E. H., Skopp, N. A., & Belsher, B. E. (2021). Posttraumatic Stress Disorder Treatment Dropout Among Military and Veteran Populations: A Systematic Review and Meta-Analysis. *Journal of Traumatic Stress*, *34*(4), 808–818. https://doi.org/10.1002/jts.22653

Egger, M., Smith, G. D., Schneider, M., & Minder, C. (1997). Bias in meta-analysis detected by a simple, graphical test. *BMJ*, 315(7109), 629–634.

Ehlers, A. (2010). Understanding and Treating Unwanted Trauma Memories in Posttraumatic Stress Disorder. *Journal of Psychology*, 218(2), 141–145.

Ehlers, A., & Clark, D. M. (2000). A cognitive model of posttraumatic stress disorder. *Behaviour Research and Therapy*, *38*(4), 319–345. https://doi.org/10.1016/S0005-7967(99)00123-0

Ehlers, A., Hackmann, A., Steil, R., Clohessy, S., Wenninger, K., & Winter, H. (2002). The nature of intrusive memories after trauma: The warning signal hypothesis. *Behaviour Research and Therapy*, *40*(9), 995–1002. https://doi.org/10.1016/S0005-7967(01)00077-8

Ehlers, A., Margraf, J., & Chambless, D. (2001). *Fragebogen zu körperbezogenen Ängsten, Kognitionen und Vermeidung: AKV.* Beltz-Test.

Ehring, T., & Kunze, A. (2020). Posttraumatische Belastungsstörung. In J. Hoyer & S. Knappe (Eds), *Klinische Psychologie & Psychotherapie* (pp. 1159–1182). Springer. https://doi.org/10.1007/978-3-662-61814-1_51

Ehring, T., Welboren, R., Morina, N., Wicherts, J. M., Freitag, J., & Emmelkamp, P. M. G. (2014). Meta-analysis of psychological treatments for posttraumatic stress disorder in adult survivors of childhood abuse. *Clinical Psychology Review*, *34*(8), 645–657. https://doi.org/10.1016/j.cpr.2014.10.004

Eichenbaum, H. (2000). A cortical–hippocampal system for declarative memory. *Nature Reviews Neuroscience*, *1*(1), 41–50. https://doi.org/10.1038/35036213

Ekkekakis, P., Parfitt, G., & Petruzzello, S. J. (2011). The Pleasure and Displeasure People Feel When they Exercise at Different Intensities. *Sports Medicine*, *41*(8), 641–671. https://doi.org/10.2165/11590680-000000000-00000

Ekstrand, B. R., Barrett, T. R.,West, J. N., Meier, W.G. (1977). The effect of sleep on human long-term memory. In R. R. Drucker-Colin & J. L. McGaugh (Eds.), *Neurobiology of Sleep and Memory* (pp. 419–438). Academic Press.

Elbert, T., Schauer, M., & Neuner, F. (2015). *Narrative Exposure Therapy (NET): Reorganizing Memories of Traumatic Stress, Fear, and Violence* (pp. 229–253). https://doi.org/10.1007/978-3-319-07109-1_12

Elhai, J. D., Biehn, T. L., Armour, C., Klopper, J. J., Frueh, B. C., & Palmieri, P. A. (2011). Evidence for a unique PTSD construct represented by PTSD's D1–D3 symptoms. *Journal of Anxiety Disorders, 25*(3), 340–345. https://doi.org/10.1016/j.janxdis.2010.10.007

Elzinga, B. M., & Bremner, J. D. (2002). Are the neural substrates of memory the final common pathway in posttraumatic stress disorder (PTSD)? *Journal of Affective Disorders*, *70*(1), 1–17. https://doi.org/10.1016/S0165-0327(01)00351-2

Enders, C. K., & Bandalos, D. L. (2001). The relative performance of full information maximum likelihood estimation for missing data in structural equation models. *Structural equation modeling*, *8*(3), 430-457.

Faul, F., Erdfelder, E., Buchner, A., & Lang, A.-G. (2009). Statistical power analyses using G*Power 3.1: Tests for correlation and regression analyses. Behavior Research Methods, 41(4), 1149–1160. https://doi.org/10.3758/BRM.41.4.1149

Fazel, M., Reed, R. V., Panter-Brick, C., & Stein, A. (2012). Mental health of displaced and refugee children resettled in high-income countries: Risk and protective factors. *The Lancet*, *379*(9812), 266–282. https://doi.org/10.1016/S0140-6736(11)60051-2

Fazel, M., Wheeler, J., & Danesh, J. (2005). Prevalence of serious mental disorder in 7000 refugees resettled in western countries: A systematic review. *The Lancet*, *365*(9467), 1309–1314. https://doi.org/10.1016/S0140-6736(05)61027-6

Feng, C. X. (2021). A comparison of zero-inflated and hurdle models for modeling zero-inflated count data. *Journal of Statistical Distributions and Applications*, 8(1), 8.

Fetzner, M. G., & Asmundson, G. J. G. (2015). Aerobic Exercise Reduces Symptoms of Posttraumatic Stress Disorder: A Randomized Controlled Trial. *Cognitive Behaviour Therapy, 44*(4), 301–313. https://doi.org/10.1080/16506073.2014.916745

Field, A. P., & Gillett, R. (2010). How to do a meta-analysis. *British Journal of Mathematical and Statistical Psychology*, 63(3), 665–694.

First, M. B., Williams, J. B. W., Karg, R. S., & Spitzer, R. L. (2016). *User's guide for the SCID-5-CV structured clinical interview for DSM-5® disorders: Clinical version.* American Psychiatric Publishing.

Fischer, S., Schumacher, T., Knaevelsrud, C., Ehlert, U., & Schumacher, S. (2021). Genes and hormones of the hypothalamic–pituitary–adrenal axis in post-traumatic stress disorder. What is their role in symptom expression and treatment response? *Journal of Neural Transmission*, *128*(9), 1279–1286. https://doi.org/10.1007/s00702-021-02330-2

Fisher, A. J., Medaglia, J. D., & Jeronimus, B. F. (2018). Lack of group-to-individual generalizability is a threat to human subjects research. *Proceedings of the National Academy of Sciences*, *115*(27), E6106–E6115. https://doi.org/10.1073/pnas.1711978115

Fletcher, D., & Sarkar, M. (2013). Psychological Resilience. *European Psychologist*, *18*(1), 12–23. https://doi.org/10.1027/1016-9040/a000124

Flory, J. D., & Yehuda, R. (2015). Comorbidity between post-traumatic stress disorder and major depressive disorder: Alternative explanations and treatment considerations. *Dialogues in Clinical Neuroscience*, *17*(2), 141–150. https://doi.org/10.31887/DCNS.2015.17.2/jflory

Foa, E. B., & Kozak, M. J. (1986). Emotional processing of fear: Exposure to corrective information. *Psychological Bulletin*, *99*(1), 20–35. https://doi.org/10.1037/0033-2909.99.1.20

Foa, E., Hembree, E., & Rothbaum, B. (2007). *Prolonged exposure therapy*. https://books.google.de/books?hl=de&lr=&id=dJqHDwAAQBAJ&oi=fnd&pg=PA46&dq=foa+2007+prolonged+exposure&ots=ECZhpmTlhy&sig=YTXfbm-EX31gM_wSGHtmkf_Msdk

Folayan, M. O., Zuñiga, R. A. A., Ellakany, P., Yousaf, M. A., Osamika, B. E., Virtanen, J. I., Gaffar, B., Lawal, F. B., Khalid, Z., Aly, N. M., Lusher, J., & Nguyen, A. L. (2024). Socio-economic factors associated with post-traumatic stress symptoms among adolescents and young people during the first wave of the COVID-19 pandemic. *Scientific Reports*, *14*(1), 2276. https://doi.org/10.1038/s41598-023-50333-8

Forkus, S. R., Raudales, A. M., Rafiuddin, H. S., Weiss, N. H., Messman, B. A., & Contractor, A. A. (2023). The Posttraumatic Stress Disorder (PTSD) Checklist for DSM–5: A systematic review of existing psychometric evidence. *Clinical Psychology: Science and Practice*, *30*(1), 110–121. https://doi.org/10.1037/cps0000111

Franke, G. H. (2017). *BSCL: Brief-symptom-checklist: Manual.* Hogrefe.

Franke, L. K., Rattel, J. A., Miedl, S. F., Danböck, S. K., Bürkner, P. C., & Wilhelm, F. H. (2021). Intrusive memories as conditioned responses to trauma cues: An empirically supported concept? *Behaviour Research and Therapy*, *143*, 103848.

Friedrich, J. O., Adhikari, N. K., & Beyene, J. (2011). Ratio of means for analyzing continuous outcomes in meta-analysis performed as well as mean difference methods. Journal of Clinical Epidemiology, 64(5), 556–564.

Friedman, M. J., Keane, T. M., & Resick, P. A. (2007). *Handbook of PTSD, First Edition: Science and Practice*. Guilford Press.

Friesen, E., Sopp, M. R., Cordi, M. J., Rasch, B., & Michael, T. (2023). Sleep-directed hypnosis improves subjective sleep quality but not extinction memory after exposure to analog trauma. *Cognitive Therapy and Research*, *47*(2), 255–268.

Galovski, T. E., Harik, J. M., Blain, L. M., Elwood, L., Gloth, C., & Fletcher, T. D. (2016). Augmenting cognitive processing therapy to improve sleep impairment in PTSD: A randomized controlled trial. Journal of consulting and clinical psychology, 84(2), 167–177.

Gäbel, U., Ruf, M., Schauer, M., Odenwald, M., & Neuner, F. (2006). Prävalenz der Posttraumatischen Belastungsstörung (PTSD) und Möglichkeiten der Ermittlung in der Asylverfahrenspraxis. *Zeitschrift Für Klinische Psychologie Und Psychotherapie*, *35*(1), 12–20. https://doi.org/10.1026/1616-3443.35.1.12

Galsgaard, M. (2021). Jinn Beliefs in Western Psychiatry: A Study of Three Cases from a Psychiatric and Cultural Perspective. In A. Böttcher & B. Krawietz (Eds), *Islam, Migration and Jinn: Spiritual Medicine in Muslim Health Management* (pp. 185–213). Springer International Publishing. https://doi.org/10.1007/978-3-030-61247-4_10

Garcia-Alamino, J. M., Bankhead, C., Heneghan, C., Pidduck, N., & Perera, R. (2017). Impact of heterogeneity and effect size on the estimation of the optimal information size: analysis of recently published meta-analyses. *BMJ*, *7*(11), e015888.

Garfin, D. R., Thompson, R. R., & Holman, E. A. (2018). Acute stress and subsequent health outcomes: A systematic review. *Journal of Psychosomatic Research*, *112*, 107–113. https://doi.org/10.1016/j.jpsychores.2018.05.017

Gates, M. A., Holowka, D. W., Vasterling, J. J., Keane, T. M., Marx, B. P., & Rosen, R. C. (2012). Posttraumatic stress disorder in veterans and military personnel: Epidemiology, screening, and case recognition. *Psychological Services*, *9*(4), 361–382. https://doi.org/10.1037/a0027649

Gelman, A., & Shalizi, C. R. (2013). Philosophy and the practice of Bayesian statistics. *British Journal of Mathematical and Statistical Psychology*, *66*(1), 8–38. https://doi.org/10.1111/j.2044-8317.2011.02037.x

Georgiadou, E., Morawa, E., & Erim, Y. (2017). High Manifestations of Mental Distress in Arabic Asylum Seekers Accommodated in Collective Centers for Refugees in Germany. *International Journal of Environmental Research and Public Health*, 14. https://doi.org/10.3390/ijerph14060612.

Georgiadou, E., Zbidat, A., Schmitt, G. M., & Erim, Y. (2018). Prevalence of Mental Distress Among Syrian Refugees With Residence Permission in Germany: A Registry-Based Study. *Frontiers in Psychiatry*, *9*, 393. https://doi.org/10.3389/fpsyt.2018.00393

Germain, A. (2013). Sleep Disturbances as the Hallmark of PTSD: Where Are We Now? *American Journal of Psychiatry*. https://doi.org/10.1176/appi.ajp.2012.12040432

Germain, A., Buysse, D. J., & Nofzinger, E. (2008). Sleep-specific mechanisms underlying posttraumatic stress disorder: Integrative review and neurobiological hypotheses. *Sleep Medicine Reviews, 12(3)*, 185–195.

Geronazzo-Alman, L., Eisenberg, R., Shen, S., Duarte, C. S., Musa, G. J., Wicks, J., Fan, B., Doan, T., Guffanti, G., Bresnahan, M., & Hoven, C. W. (2017). Cumulative exposure to work-related traumatic events and current post-traumatic stress disorder in New York City's first responders. *Comprehensive Psychiatry*, *74*, 134–143. https://doi.org/10.1016/j.comppsych.2016.12.003

Geyskens, I., Krishnan, R., Steenkamp, J.B. E. M., & Cunha, P. V. (2009). A Review and Evaluation of Meta-Analysis Practices in Management Research. *Journal of Management*, 35(2), 393–419.

Gilbertson, M. W., Shenton, M. E., Ciszewski, A., Kasai, K., Lasko, N. B., Orr, S. P., & Pitman, R. K. (2002). Smaller hippocampal volume predicts pathologic vulnerability to psychological trauma. *Nature Neuroscience*, *5*(11), 1242–1247. https://doi.org/10.1038/nn958

Gold, P. W. (2015). The organization of the stress system and its dysregulation in depressive illness. *Molecular Psychiatry*, *20*(1), 32–47. https://doi.org/10.1038/mp.2014.163

Gómez Penedo, J. M., Rubel, J., Meglio, M., Bornhauser, L., Krieger, T., Babl, A., Muiños, R., Roussos, A., Delgadillo, J., Flückiger, C., Berger, T., Lutz, W., & grosse Holtforth, M. (2023). Using machine learning algorithms to predict the effects of change processes in psychotherapy: Toward process-level treatment personalization. *Psychotherapy*, *60*(4), 536–547. https://doi.org/10.1037/pst0000507

Gronau, Q. F., Sarafoglou, A., Matzke, D., Ly, A., Boehm, U., Marsman, M., Leslie, D. S., Forster, J. J., Wagenmakers, E.-J., & Steingroever, H. (2017). A tutorial on bridge sampling. *Journal of Mathematical Psychology*, *81*, 80–97. https://doi.org/10.1016/j.jmp.2017.09.005

Grossman, J., & Mackenzie, F. J. (2005). The Randomized Controlled Trial: Gold standard, or merely standard? *Perspectives in Biology and Medicine*, *48*(4), 516–534. https://muse.jhu.edu/pub/1/article/188201

Gupta, S. K. (2011). Intention-to-treat concept: A review. *Perspectives in Clinical Research*, *2*(3), 109. https://doi.org/10.4103/2229-3485.83221

Haagen, J. F. G., ter Heide, F. J. J., Mooren, T. M., Knipscheer, J. W., & Kleber, R. J. (2017). Predicting post-traumatic stress disorder treatment response in refugees: Multilevel analysis. *British Journal of Clinical Psychology,* *56*(1), 69–83. https://doi.org/10.1111/bjc.12121

Hackmann, A., Ehlers, A., Speckens, A., & Clark, D. M. (2004). Characteristics and content of intrusive memories in PTSD and their changes with treatment. *Journal of Traumatic Stress*, *17*(3), 231–240. https://doi.org/10.1023/B:JOTS.0000029266.88369.fd

Hall, K. S., Morey, M. C., Beckham, J. C., Bosworth, H. B., Sloane, R., Pieper, C. F., & Pebole, M. M. (2020). Warrior Wellness: A Randomized Controlled Pilot Trial of the Effects of Exercise on Physical Function and Clinical Health Risk Factors in Older Military Veterans

With PTSD. *The Journals of Gerontology: Series A*, *75*(11), 2130–2138. https://doi.org/10.1093/gerona/glz255

Halligan, S. L., Clark, D. M., & Ehlers, A. (2002). Cognitive processing, memory, and the development of PTSD symptoms: Two experimental analogue studies. *Journal of Behavior Therapy and Experimental Psychiatry*, *33*(2), 73–89. https://doi.org/10.1016/S0005-7916(02)00014-9

Halligan, S. L., Michael, T., Clark, D. M., & Ehlers, A. (2003). Posttraumatic stress disorder following assault: The role of cognitive processing, trauma memory, and appraisals. *Journal of Consulting and Clinical Psychology*, *71*(3), 419–431. https://doi.org/10.1037/0022-006X.71.3.419

Hamburg, M. A., & Collins, F. S. (2010). The Path to Personalized Medicine. *New England Journal of Medicine*, *363*(4), 301–304. https://doi.org/10.1056/NEJMp1006304

Hamilton, M. (1960). A rating scale for depression. Journal of Neurology, Neurosurgery, and Psychiatry, 23(1), 56–62. https://doi.org/10.1136/jnnp.23.1.56

Hamilton, M. (1967). Development of a rating scale for primary depressive illness. *British Journal of Social and Clinical Psychology,* 6(4), 278–296. https://doi.org/10.1111/j.2044-8260.1967.tb00530.x

Hankin, B. L., & Abela, J. R. Z. (2005). *Development of Psychopathology: A Vulnerability-Stress Perspective*. SAGE Publications.

Hansen, M., Vaegter, H. B., Ravn, S. L., & Andersen, T. E. (2023). Validation of the Danish PTSD Checklist for DSM-5 in trauma-exposed chronic pain patients using the Clinician-Administered PTSD Scale for DSM-5. *European Journal of Psychotraumatology*, 14(1). https://doi.org/10.1080/20008066.2023.2179801

Hapke, U., Schumann, A., Rumpf, H.-J., John, U., & Meyer, C. (2006). Post-traumatic stress disorder: The role of trauma, pre-existing psychiatric disorders, and gender. *European Archives of Psychiatry and Clinical Neuroscience*, *256*(5), 299–306. https://doi.org/10.1007/s00406-006-0654-6

Hariton, E., & Locascio, J. J. (2018). Randomised controlled trials—The gold standard for effectiveness research. *BJOG : An International Journal of Obstetrics and Gynaecology*, *125*(13), 1716. https://doi.org/10.1111/1471-0528.15199

Hartig, F. (2020). *DHARMa: Residual Diagnostics for Hierarchical (multi-level/mixed) Regression Models*. R package version 0.3.2.0. https://CRAN.R-project.org/package=DHARMa

Harvey, A. G., Bryant, R. A., & Dang, S. T. (1998). Autobiographical memory in acute stress disorder. *Journal of Consulting and Clinical Psychology*, *66*(3), 500–506. https://doi.org/10.1037/0022-006X.66.3.500

Hecksteden, A., Wegmann, M., Steffen, A., Kraushaar, J., Morsch, A., Ruppenthal, S., Kaestner, L., & Meyer, T. (2013). Irisin and exrcise training in humans – Results from a randomized controlled training trial. *BMC Medicine, 11*(1), 235. https://doi.org/10.1186/1741-7015-11-235

Hegberg, N. J., Hayes, J. P., & Hayes, S. M. (2019). Exercise Intervention in PTSD: A Narrative Review and Rationale for Implementation. Frontiers in Psychiatry, 10, 133. https://www.frontiersin.org/articles/10.3389/fpsyt.2019.00133

Heim, C., & Nemeroff, C. B. (2009). Neurobiology of posttraumatic stress disorder. *CNS Spectrums*, *14*(1 Suppl 1), 13–24.

Hensel-Dittmann, D., Schauer, M., Ruf, M., Catani, C., Odenwald, M., Elbert, T., & Neuner, F. (2011). Treatment of Traumatized Victims of War and Torture: A Randomized Controlled Comparison of Narrative Exposure Therapy and Stress Inoculation Training. *Psychotherapy and Psychosomatics*, *80*(6), 345–352. https://doi.org/10.1159/000327253

Henson, R. N., Eckstein, D., Waszak, F., Frings, C., & Horner, A. J. (2014). Stimulus–response bindings in priming. *Trends in Cognitive Sciences*, *18*(7), 376–384. https://doi.org/10.1016/j.tics.2014.03.004

Herman, J. L. (1992). *Trauma And Recovery: The Aftermath Of Violence- From Domestic Abuse To Political Terror*. Basic Books.

Herzog, P., & Kaiser, T. (2022). Is it worth it to personalize the treatment of PTSD? – A variance-ratio meta-analysis and estimation of treatment effect heterogeneity in RCTs of PTSD. *Journal of Anxiety Disorders*, *91*, 102611. https://doi.org/10.1016/j.janxdis.2022.102611

Higgins, J. P. T., Altman, D. G., Gøtzsche, P. C., Jüni, P., Moher, D., Oxman, A. D., Savović, J., Schulz, K. F., Weeks, L., & Sterne, J. A. C. (2011). The Cochrane Collaboration's tool for assessing risk of bias in randomised trials. *BMJ*, *343*, d5928.

Higgins, J. P., Thompson, S. G., Deeks, J. J., & Altman, D. G. (2003). Measuring inconsistency in meta-analyses. *BMJ*, *327*(7414), 557–560.

Hijazi, A. M., Lumley, M. A., Ziadni, M. S., Haddad, L., Rapport, L. J., & Arnetz, B. B. (2014). Brief Narrative Exposure Therapy for Posttraumatic Stress in Iraqi Refugees: A Preliminary Randomized Clinical Trial. *Journal of Traumatic Stress*, *27*(3), 314–322. https://doi.org/10.1002/jts.21922

Hinton, D. E., & Lewis-Fernández, R. (2011). The cross-cultural validity of posttraumatic stress disorder: Implications for DSM-5. *Depression and Anxiety*, *28*(9), 783–801. https://doi.org/10.1002/da.20753

Hoffman, J., Ben-Zion, Z., Arevalo, A., Duek, O., Greene, T., Hall, B. J., Harpaz-Rotem, I., Liddell, B., Locher, C., Morina, N., Nickerson, A., Pfaltz, M. C., Schick, M., Schnyder, U., Seedat, S., Shatri, F., Fong Sit, H. von Känel, R. & Spiller, T. R. (2022). Mapping the availability of translated versions of posttraumatic stress disorder screening questionnaires for adults: A scoping review. *European journal of psychotraumatology*, 13(2), 2143019.

Holeva, V., Tarrier, N., & Wells, A. (2001). Prevalence and predictors of acute stress disorder and PTSD following road traffic accidents: Thought control strategies and social support. *Behavior Therapy*, *32*(1), 65–83. https://doi.org/10.1016/S0005-7894(01)80044-7

Holmes, E. A., & Bourne, C. (2008). Inducing and modulating intrusive emotional memories: a review of the trauma film paradigm. *Acta psychologica*, *127*(3), 553–566.

Holmes, E. A., James, E. L., Coode-Bate, T., & Deeprose, C. (2009). Can Playing the Computer Game "Tetris" Reduce the Build-Up of Flashbacks for Trauma? A Proposal from Cognitive Science. *PLOS ONE*, *4*(1), e4153. https://doi.org/10.1371/journal.pone.0004153

Holz, E., & Michael, T. (2013). Sport und Bewegung bei Depression. *PiD - Psychotherapie im Dialog, 14*(3), 61–63. https://doi.org/10.1055/s-0033-1353821

Hook, K., Ametaj, A., Cheng, Y., Serba, E. G., Henderson, D. C., Hanlon, C., & Ng, L. C. (2021). Psychotherapy in a resource-constrained setting: Understanding context for

adapting and integrating a brief psychological intervention into primary care. *Psychotherapy*, *58*(4), 557–575. https://doi.org/10.1037/pst0000364

Hopewell, S., Chan, A. W., Collins, G. S., Hróbjartsson, A., Moher, D., Schulz, K. F., ... & Boutron, I. (2025). CONSORT 2025 statement: updated guideline for reporting randomised trials. *The Lancet*, *405*(10489), 1633-1640.

Hoppen, T. H., Lindemann, A. S., Höfer, L., Kip, A., & Morina, N. (2025). Efficacy of psychological interventions for adult PTSD in reducing comorbid depression: Systematic review and meta-analysis of randomised controlled trials. *The British Journal of Psychiatry*, 1–11. https://doi.org/10.1192/bjp.2025.10345

Hoppen, T. H., Priebe, S., Vetter, I., & Morina, N. (2021). Global burden of post-traumatic stress disorder and major depression in countries affected by war between 1989 and 2019: A systematic review and meta-analysis. *BMJ Global Health*, *6*(7). https://doi.org/10.1136/bmjgh-2021-006303

Hørlyck, L. D., Bisby, J. A., King, J. A., & Burgess, N. (2019). Wakeful rest compared to vigilance reduces intrusive but not deliberate memory for traumatic videos. *Scientific Reports*, 9(1), 13403.

Hosny, N., Bovey, M., Dutray, F., & Heim, E. (2023). How is trauma-related distress experienced and expressed in populations from the Greater Middle East and North Africa? A systematic review of qualitative literature. *SSM - Mental Health*, *4*, 100258. https://doi.org/10.1016/j.ssmmh.2023.100258

Hox, J., Moerbeek, M., & Schoot, R. van de. (2017). *Multilevel Analysis: Techniques and Applications, Third Edition* (3rd ed.). Routledge. https://doi.org/10.4324/9781315650982

Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal, 6*(1), 1–55. https://doi.org/10.1080/10705519909540118

Hutchison, I. C., & Rathore, S. (2015). The role of REM sleep theta activity in emotional memory. *Frontiers in Psychology*, 6, 1439.

Huynh, P. A., Kindred, R., Perrins, K., de Boer, K., Miles, S., Bates, G., & Nedeljkovic, M. (2025). Prevalence of Complex Post-Traumatic Stress Disorder (CPTSD): A Systematic

Review and Meta-Analysis. *Psychiatry Research*, *351*, 116586. https://doi.org/10.1016/j.psychres.2025.116586

IBM Corp. Released. (2013). *IBM SPSS statistics for Windows, version 22.0.* IBM Corp.

Ibrahim, H., Catani, C., Ismail, A. A., & Neuner, F. (2019). Dimensional Structure and Cultural Invariance of DSM V Post-traumatic Stress Disorder Among Iraqi and Syrian Displaced People. *Frontiers in Psychology*, *10*. https://doi.org/10.3389/fpsyg.2019.01505

Ibrahim, H., Ertl, V., Catani, C., Ismail, A. A., & Neuner, F. (2018a). The validity of Posttraumatic Stress Disorder Checklist for DSM-5 (PCL-5) as screening instrument with Kurdish and Arab displaced populations living in the Kurdistan region of Iraq. *BMC Psychiatry*, *18*(1), 259. https://doi.org/10.1186/s12888-018-1839-z

Ibrahim, H., Ertl, V., Catani, C., Ismail, A. A., & Neuner, F. (2018b). Trauma and perceived social rejection among Yazidi women and girls who survived enslavement and genocide. *BMC Medicine*, *16*(1), 154. https://doi.org/10.1186/s12916-018-1140-5

Ivanov, V.V., Browne, W. (2025). *Slavic languages*. *Encyclopedia Britannica*. https://www.britannica.com/topic/Slavic-languages

Iyadurai, L., Blackwell, S. E., Meiser-Stedman, R., Watson, P. C., Bonsall, M. B., Geddes, J. R., Nobre, A. C., & Holmes, E. A. (2018). Preventing intrusive memories after trauma via a brief intervention involving Tetris computer game play in the emergency department: a proof-of-concept randomized controlled trial. *Molecular Psychiatry*, 23(3), 674–682.

Iyadurai, L., Visser, R. M., Lau-Zhu, A., Porcheret, K., Horsch, A., Holmes, E. A., & James, E. L. (2019). Intrusive memories of trauma: A target for research bridging cognitive science and its clinical application. *Clinical Psychology Review*, *69*, 67–82. https://doi.org/10.1016/j.cpr.2018.08.005

Jacob Sendler, D., Rutkowska, A., & Makara-Studzinska, M. (2016). How the exposure to trauma has hindered physicians' capacity to heal: Prevalence of PTSD among healthcare workers. *The European Journal of Psychiatry*, *30*(4), 321–334. https://scielo.isciii.es/scielo.php?script=sci_abstract&pid=S0213-61632016000400007&lng=es&nrm=iso&tlng=pt

Jacobi, F., Höfler, M., Strehle, J., Mack, S., Gerschler, A., Scholl, L., Busch, M. A., Maske, U., Hapke, U., Gaebel, W., Maier, W., Wagner, M., Zielasek, J., & Wittchen, H.-U. (2014).

[Mental disorders in the general population: Study on the health of adults in Germany and the additional module mental health (DEGS1-MH)]. *Der Nervenarzt, 85*(1), 77–87. https://doi.org/10.1007/s00115-013-3961-y

Jaffe, A. E., DiLillo, D., Hoffman, L., Haikalis, M., & Dykstra, R. E. (2015). Does it hurt to ask? A meta-analysis of participant reactions to trauma research. *Clinical Psychology Review, 40,* 40–56.

James, E. L., Lau-Zhu, A., Clark, I. A., Visser, R. M., Hagenaars, M. A., & Holmes, E. A. (2016). The trauma film paradigm as an experimental psychopathology model of psychological trauma: intrusive memories and beyond. *Clinical psychology review*, *47*, 106–142.

Jelinek, L., Randjbar, S., Seifert, D., Kellner, M., & Moritz, S. (2009). The organization of autobiographical and nonautobiographical memory in posttraumatic stress disorder (PTSD). *Journal of Abnormal Psychology*, *118*(2), 288–298. https://doi.org/10.1037/a0015633

Johnson, H., & Thompson, A. (2008). The development and maintenance of post-traumatic stress disorder (PTSD) in civilian adult survivors of war trauma and torture: A review. *Clinical Psychology Review*, *28*(1), 36–47. https://doi.org/10.1016/j.cpr.2007.01.017

Johnson, C., Radunz, M., Linardon, J., Fuller-Tyszkiewicz, M., Williamson, P., & Wade, T. D. (2025). The impact of patient choice on uptake, adherence, and outcomes across depression, anxiety, and eating disorders: A systematic review and meta-analysis. *Psychological Medicine*, *55*, e32. https://doi.org/10.1017/S0033291725000066

Jones, B. J., & Spencer, R. M. (2019). Sleep preserves subjective and sympathetic emotional response of memories. *Neurobiology of learning and memory*, 166, 107096.

Kalisch, R., Baker, D. G., Basten, U., Boks, M. P., Bonanno, G. A., Brummelman, E., Chmitorz, A., Fernàndez, G., Fiebach, C. J., Galatzer-Levy, I., Geuze, E., Groppa, S., Helmreich, I., Hendler, T. Hermans, E. J., Jovanovic, T., Kubiak, T., Lieb, K., Lutz, B. ... & Kleim, B. (2017). The resilience framework as a strategy to combat stress-related disorders. *Nature human behaviour*, 1(11), 784–790.

Kaniasty, K., & Norris, F. H. (1993). A test of the social support deterioration model in the context of natural disaster. *Journal of Personality and Social Psychology*, *64*(3), 395–408. https://doi.org/10.1037/0022-3514.64.3.395

Kanstrup, M., Singh, L., Leehr, E. J., Göransson, K. E., Pihlgren, S. A., Iyadurai, L., Dahl, O., Falk, A.-C., Lindström, V., Hadziosmanovic, N., Gabrysch, K., Moulds, M. L., & Holmes, E. A. (2024). A guided single session intervention to reduce intrusive memories of work-related trauma: A randomised controlled trial with healthcare workers in the COVID-19 pandemic. *BMC Medicine*, *22*(1), 403. https://doi.org/10.1186/s12916-024-03569-8

Kappelmann, N., Müller-Myhsok, B., & Kopf-Beck, J. (2021). Adapting the randomised controlled trial (RCT) for precision medicine: Introducing the nested-precision RCT (npRCT). *Trials*, *22*(1), 13. https://doi.org/10.1186/s13063-020-04965-0

Kass, R. E., & Raftery, A. E. (1995). Bayes Factors. *Journal of the American Statistical Association*, *90*(430), 773–795. https://doi.org/10.1080/01621459.1995.10476572

Kessler, R. C., Aguilar-Gaxiola, S., Alonso, J., Benjet, C., Bromet, E. J., Cardoso, G., Degenhardt, L., de Girolamo, G., Dinolova, R. V., Ferry, F., Florescu, S., Gureje, O., Haro, J. M., Huang, Y., Karam, E. G., Kawakami, N., Lee, S., Lepine, J.-P., Levinson, D., … Koenen, K. C. (2017). Trauma and PTSD in the WHO World Mental Health Surveys. *European Journal of Psychotraumatology*, *8*(sup5), 1353383. https://doi.org/10.1080/20008198.2017.1353383

Kessler, R. C., Rose, S., Koenen, K. C., Karam, E. G., Stang, P. E., Stein, D. J., Heeringa, S. G., Hill, E. D., Liberzon, I., McLaughlin, K. A., McLean, S. A., Pennell, B. E., Petukhova, M., Rosellini, A. J., Ruscio, A. M., Shahly, V., Shalev, A. Y., Silove, D., Zaslavsky, A. M., … Carmen Viana, M. (2014). How well can post-traumatic stress disorder be predicted from pre-trauma risk factors? An exploratory study in the WHO World Mental Health Surveys. *World Psychiatry: Official Journal of the World Psychiatric Association (WPA)*, *13*(3), 265–274. https://doi.org/10.1002/wps.20150

Kessler, R. C., Sonnega, A., Bromet, E., Hughes, M., & Nelson, C. B. (1995). Posttraumatic stress disorder in the National Comorbidity Survey. *Archives of General Psychiatry*, 52(12), 1048–1060.

Khan, Z., Messiri, N. E., Iqbal, E., Hassan, H., Tanweer, M. S., Sadia, S. R., Taj, M., Zaidi, U., Yusuf, K., Syed, N. I., & Zaidi, M. (2025). On the role of epigenetic modifications of HPA axis in posttraumatic stress disorder and resilience. *Journal of Neurophysiology*. https://doi.org/10.1152/jn.00345.2024

King, D. W., King, L. A., McArdle, J. J., Shalev, A. Y., & Doron-LaMarca, S. (2009). Sequential Temporal Dependencies in Associations Between Symptoms of Depression and Posttraumatic Stress Disorder: An Application of Bivariate Latent Difference Score Structural Equation Modeling. *Multivariate Behavioral Research*, *44*(4), 437–464. https://doi.org/10.1080/00273170903103308

Kip, A., Diele, J., Holling, H., & Morina, N. (2022). The relationship of trauma-related guilt with PTSD symptoms in adult trauma survivors: A meta-analysis. *Psychological Medicine*, *52*(12), 2201–2211. https://doi.org/10.1017/S0033291722001866

Kip, A., Priebe, S., Holling, H., & Morina, N. (2020). Psychological interventions for posttraumatic stress disorder and depression in refugees: A meta-analysis of randomized controlled trials. *Clinical Psychology & Psychotherapy, 27*(4), 489–503. https://doi.org/10.1002/cpp.2446

Kleber, R. J. (2019). Trauma and Public Mental Health: A Focused Review. *Frontiers in Psychiatry*, *10*. https://doi.org/10.3389/fpsyt.2019.00451

Kleim, B., & Ehlers, A. (2008). Reduced autobiographical memory specificity predicts depression and posttraumatic stress disorder after recent trauma. *Journal of Consulting and Clinical Psychology*, *76*(2), 231–242. https://doi.org/10.1037/0022-006X.76.2.231

Kleim, B., Graham, B., Bryant, R. A., & Ehlers, A. (2013). Capturing intrusive re-experiencing in trauma survivors' daily lives using ecological momentary assessment. *Journal of Abnormal Psychology*, 122(4), 998–1009.

Kleim, B., Wilhelm, F. H., Temp, L., Margraf, J., Wiederhold, B. K., & Rasch, B. (2014). Sleep enhances exposure therapy. *Psychological Medicine, 44*(7), 1511–1519.

Kleim, B., Wysokowsky, J., Schmid, N., Seifritz, E., & Rasch, B. (2016). Effects of Sleep after Experimental Trauma on Intrusive Emotional Memories. *Sleep*, 39(12), 2125–2132.

Kliem, S., & Kröger, C. (2013). Prevention of chronic PTSD with early cognitive behavioral therapy. A meta-analysis using mixed-effects modeling. *Behaviour Research and Therapy*, 51(11), 753–761.

Klein, D. J. S., Joseph Zohar, Zeev Kaplan, Soraya Seedat, Arieh Y. Shalev, Leah Fostick, Alzabeta Juven-Wetzler, Hadar Shalev, Gavriel Schreiber, Natalie Miroshnik, Sharain Suliman, Ehud. (2017, July 11). Secondary Prevention of Chronic PTSD by Early and

Short-Term Administration of Escitalopram: A Prospective Randomized, Placebo-Controlled, Double-Blind Trial. *Psychiatrist.Com*. https://www.psychiatrist.com/jcp/prevention-of-ptsd-with-escitalopram/

Kline, A. C., Cooper, A. A., Rytwinski, N. K., & Feeny, N. C. (2021). The Effect of Concurrent Depression on PTSD Outcomes in Trauma-Focused Psychotherapy: A Meta-Analysis of Randomized Controlled Trials. *Behavior Therapy*, *52*(1), 250–266. https://doi.org/10.1016/j.beth.2020.04.015

Knaepen, K., Goekint, M., Heyman, E. M., & Meeusen, R. (2010). Neuroplasticity—Exercise-Induced Response of Peripheral Brain-Derived Neurotrophic Factor. *Sports Medicine, 40*(9), 765–801. https://doi.org/10.2165/11534530-000000000-00000

Knappe, F., Colledge, F., & Gerber, M. (2019). Impact of an 8-Week Exercise and Sport Intervention on Post-Traumatic Stress Disorder Symptoms, Mental Health, and Physical Fitness among Male Refugees Living in a Greek Refugee Camp. *International Journal of Environmental Research and Public Health, 16*(20), Article 20. https://doi.org/10.3390/ijerph16203904

Koç, V., & Kafa, G. (2019). Cross-Cultural Research on Psychotherapy: The Need for a Change. *Journal of Cross-Cultural Psychology*, *50*(1), 100–115. https://doi.org/10.1177/0022022118806577

Koenen, K. C., Ratanatharathorn, A., Ng, L., McLaughlin, K. A., Bromet, E. J., Stein, D. J., Karam, E. G., Ruscio, A. M., Benjet, C., Scott, K., Atwoli, L., Petukhova, M., Lim, C. C. W., Aguilar-Gaxiola, S., Al-Hamzawi, A., Alonso, J., Bunting, B., Ciutan, M., Girolamo, G. de, … Kessler, R. C. (2017). Posttraumatic stress disorder in the World Mental Health Surveys. *Psychological Medicine*, *47*(13), 2260–2274. https://doi.org/10.1017/S0033291717000708

Krans, J., Näring, G., Holmes, E. A., & Becker, E. S. (2009). Tell me more: Can a memory test reduce analogue traumatic intrusions? *Behaviour Research and Therapy*, 47(5), 426–430.

Kremen, W. S., Koenen, K. C., Afari, N., & Lyons, M. J. (2012). Twin studies of posttraumatic stress disorder: Differentiating vulnerability factors from sequelae. *Neuropharmacology*, *62*(2), 647–653. https://doi.org/10.1016/j.neuropharm.2011.03.012

Krüger-Gottschalk, A., Ehring, T., Knaevelsrud, C., Dyer, A., Schäfer, I., Schellong, J., Rau, H., & Köhler, K. (2022). Confirmatory factor analysis of the Clinician-Administered PTSD

Scale (CAPS-5) based on DSM-5 vs. ICD-11 criteria. *European Journal of Psychotraumatology*, *13*(1), 2010995. https://doi.org/10.1080/20008198.2021.2010995

Krüger-Gottschalk, A., Knaevelsrud, C., Rau, H., Dyer, A., Schäfer, I., Schellong, J., & Ehring, T. (2017). The German version of the Posttraumatic Stress Disorder Checklist for DSM-5 (PCL-5): Psychometric properties and diagnostic utility. *BMC Psychiatry, 17*(1), 379. https://doi.org/10.1186/s12888-017-1541-6

Kube, T., Berg, M., Kleim, B., & Herzog, P. (2020). Rethinking post-traumatic stress disorder–a predictive processing perspective. Neuroscience & Biobehavioral Reviews, 113, 448–460.

Kurath, J., Keyan, D., Akhtar, A., Martins, W. V., Komenda, B., Maurer, V., Turgut, K., Bryant, R. A., & Morina, N. (2025). A systematic review on predictors of treatment outcome among forcibly displaced adults receiving psychological and/or psychosocial interventions. *Clinical Psychology Review*, *120*, 102619. https://doi.org/10.1016/j.cpr.2025.102619

Kuriyama, K., Soshi, T., & Kim, Y. (2010). Sleep deprivation facilitates extinction of implicit fear generalization and physiological response to fear. *Biological Psychiatry*, 68(11), 991–998.

Kuznetsova, A., Brockhoff, P. B., & Christensen, R. H. B. (2017). lmerTest Package: Tests in Linear Mixed Effects Models. *Journal of Statistical Software*, *82*, 1–26. https://doi.org/10.18637/jss.v082.i13

Lang, P. J. (1977). Imagery in therapy: An information processing analysis of fear. *Behavior Therapy*, *8*(5), 862–886. https://doi.org/10.1016/S0005-7894(77)80157-3

Lang, P. J. (1979). A Bio-Informational Theory of Emotional Imagery. *Psychophysiology*, *16*(6), 495–512. https://doi.org/10.1111/j.1469-8986.1979.tb01511.x

Langeland, W., & Olff, M. (2024). Sex and gender in psychotrauma research. *European Journal of Psychotraumatology*, *15*(1), 2358702. https://doi.org/10.1080/20008066.2024.2358702

Lanius, R. A., Vermetten, E., Loewenstein, R. J., Brand, B., Schmahl, C., Bremner, J. D., & Spiegel, D. (2010). Emotion Modulation in PTSD: Clinical and Neurobiological Evidence for a Dissociative Subtype. *American Journal of Psychiatry*. https://doi.org/10.1176/appi.ajp.2009.09081168

Lau-Zhu, A., Holmes, E. A., & Porcheret, K. (2018). Intrusive Memories of Trauma in the Laboratory: Methodological Developments and Future Directions. *Current Behavioral Neuroscience Reports*, *5*(1), 61–71. https://doi.org/10.1007/s40473-018-0141-1

Larsen, S. E., Bellmore, A., Gobin, R. L., Holens, P., Lawrence, K. A., & Pacella-LaBarbara, M. L. (2019). An initial review of residual symptoms after empirically supported trauma-focused cognitive behavioral psychological treatment. *Journal of Anxiety Disorders*, *63*, 26–35. https://doi.org/10.1016/j.janxdis.2019.01.008

Larson, O., Schapiro, A. C., & Gehrman, P. R. (2023). Effect of sleep manipulations on intrusive memories after exposure to an experimental analogue trauma: A meta-analytic review. *Sleep medicine reviews*, *69*, 101768. https://doi.org/10.1016/j.smrv.2023.101768

Lee, D. J., Weathers, F. W., Bovin, M. J., & Marx, B. P. (2024). On the concordance between CAPS-5 and PCL-5 scores. *European Journal of Psychotraumatology*, *15*(1), 2407728. https://doi.org/10.1080/20008066.2024.2407728

Leong, C. W. Y., Leow, J. W. S., Grunstein, R. R., Naismith, S. L., Teh, J. Z., D'Rozario, A. L., & Saini, B. (2022). A systematic scoping review of the effects of central nervous system active drugs on sleep spindles and sleep-dependent memory consolidation. *Sleep medicine reviews*, *62*, 101605.

Lehrner, A., & Yehuda, R. (2018). Trauma across generations and paths to adaptation and resilience. *Psychological Trauma: Theory, Research, Practice, and Policy*, *10*(1), 22–29. https://doi.org/10.1037/tra0000302

Leichsenring, F., & Rabung, S. (2008). Effectiveness of Long-term Psychodynamic Psychotherapy: A Meta-analysis. *JAMA*, *300*(13), 1551–1565. https://doi.org/10.1001/jama.300.13.1551

Leichsenring, F., & Rabung, S. (2011). Long-term psychodynamic psychotherapy in complex mentaldisorders: Update of a meta-analysis. *The British Journal of Psychiatry*, *199*(1), 15–22. https://doi.org/10.1192/bjp.bp.110.082776

Leichsenring, F., & Rüger, U. (2004). Psychotherapeutische Behandlungsverfahren auf dem Prüfstand der Evidence Based Medicine (EBM). *Zeitschrift Für Psychosomatische Medizin Und Psychotherapie*, *50*(2), 203–217. https://doi.org/10.13109/zptm.2004.50.2.203

Lely, J. C. G., Smid, G. E., Jongedijk, R. A., W. Knipscheer, J., & Kleber, R. J. (2019). The effectiveness of narrative exposure therapy: A review, meta-analysis and meta-regression analysis. *European Journal of Psychotraumatology*, *10*(1), 1550344. https://doi.org/10.1080/20008198.2018.1550344

Lewis, M., Mathur, M. B., VanderWeele, T. J., & Frank, M. C. (2022). The puzzling relationship between multi-laboratory replications and meta-analyses of the published literature. *Royal Society open science*, *9*(2), 211499.

Lewis, C., Roberts, N. P., Andrew, M., Starling, E., & Bisson, J. I. (2020). Psychological therapies for post-traumatic stress disorder in adults: Systematic review and meta-analysis. *European Journal of Psychotraumatology*, *11*(1), 1729633. https://doi.org/10.1080/20008198.2020.1729633

Lewis, C., Roberts, N. P., Gibson, S., & Bisson, J. I. (2020). Dropout from psychological therapies for post-traumatic stress disorder (PTSD) in adults: Systematic review and meta-analysis. *European Journal of Psychotraumatology*, *11*(1), 1709709. https://doi.org/10.1080/20008198.2019.1709709

Litz, B. T., Contractor, A. A., Rhodes, C., Dondanville, K. A., Jordan, A. H., Resick, P. A., Foa, E. B., Young-McCaughan, S., Mintz, J., Yarvis, J. S., Peterson, A. L., & Consortium, for the S. S. (2018). Distinct Trauma Types in Military Service Members Seeking Treatment for Posttraumatic Stress Disorder. *Journal of Traumatic Stress*, *31*(2), 286–295. https://doi.org/10.1002/jts.22276

Liu, H., Petukhova, M. V., Sampson, N. A., Aguilar-Gaxiola, S., Alonso, J., Andrade, L. H., Bromet, E. J., de Girolamo, G., Haro, J. M., Hinkov, H., Kawakami, N., Koenen, K. C., Kovess-Masfety, V., Lee, S., Medina-Mora, M. E., Navarro-Mateu, F., O'Neill, S., Piazza, M., Posada-Villa, J., … for the World Health Organization World Mental Health Survey Collaborators. (2017). Association of DSM-IV Posttraumatic Stress Disorder With Traumatic Experience Type and History in the World Health Organization World Mental Health Surveys. *JAMA Psychiatry*, *74*(3), 270–281. https://doi.org/10.1001/jamapsychiatry.2016.3783

Liu, P., Wang, L., Cao, C., Wang, R., Zhang, J., Zhang, B., Wu, Q., Zhang, H., Zhao, Z., Fan, G., & Elhai, J. D. (2014). The underlying dimensions of DSM-5 posttraumatic stress

disorder symptoms in an epidemiological sample of Chinese earthquake survivors. *Journal of Anxiety Disorders*, *28*(4), 345–351. https://doi.org/10.1016/j.janxdis.2014.03.008

Liu, Y., Wang, Z., Zhou, C., & Li, T. (2014). Affect and self-esteem as mediators between trait resilience and psychological adjustment. *Personality and Individual Differences*, *66*, 92–97. https://doi.org/10.1016/j.paid.2014.03.023

Lorah, J. (2018). Effect size measures for multilevel models: Definition, interpretation, and TIMSS example. *Large-Scale Assessments in Education*, *6*(1), 8. https://doi.org/10.1186/s40536-018-0061-2

Lorenzoni, G., Petracci, E., Scarpi, E., Baldi, I., Gregori, D., & Nanni, O. (2023). Use of Sequential Multiple Assignment Randomized Trials (SMARTs) in oncology: Systematic review of published studies. *British Journal of Cancer*, *128*(7), 1177–1188. https://doi.org/10.1038/s41416-022-02110-z

Lüder, C. C., Michael, T., Lass-Hennemann, J., Schanz, C. G., Venhorst, A., Meyer, T., & Equit, M. (2023). Moderate-intensity aerobic exercise training as an adjunct to trauma-focused psychotherapy in traumatized refugees and asylum seekers: Study protocol of a randomized controlled trial. *European Journal of Psychotraumatology*, *14*(2), 2251777. https://doi.org/10.1080/20008066.2023.2251777

Luke, S. G. (2017). Evaluating significance in linear mixed-effects models in R. *Behavior Research Methods*, *49*(4), 1494–1502. https://doi.org/10.3758/s13428-016-0809-y

Lunkenheimer, F., Eckert, A. J., Hilgard, D., Köth, D., Kulzer, B., Lück, U., Lüdecke, B., Müller, A., Baumeister, H., & Holl, R. W. (2023). Posttraumatic stress disorder and diabetes-related outcomes in patients with type 1 diabetes. *Scientific Reports*, *13*(1), 1556. https://doi.org/10.1038/s41598-023-28373-x

Lupien, S. J., McEwen, B. S., Gunnar, M. R., & Heim, C. (2009). Effects of stress throughout the lifespan on the brain, behaviour and cognition. *Nature Reviews Neuroscience*, *10*(6), 434–445. https://doi.org/10.1038/nrn2639

Lutz, W. (2002). Patient-Focused Psychotherapy Research and Individual Treatment Progress as Scientific Groundwork for an Empirically Based Clinical Practice. *Psychotherapy Research*, *12*(3), 251–272. https://doi.org/10.1080/713664389

Lutz, W., Deisenhofer, A.-K., Rubel, J., Bennemann, B., Giesemann, J., Poster, K., & Schwartz, B. (2022). Prospective evaluation of a clinical decision support system in psychological therapy. *Journal of Consulting and Clinical Psychology*, *90*(1), 90–106. https://doi.org/10.1037/ccp0000642

Lutz, W., Rubel, J., Deisenhofer, A., & Moggia, D. (2022). Continuous outcome measurement in modern data-informed psychotherapies. *World Psychiatry*, *21*(2), 215–216. https://doi.org/10.1002/wps.20988

Lutz, W., Schaffrath, J., Eberhardt, S. T., Hehlmann, M. I., Schwartz, B., Deisenhofer, A.-K., Vehlen, A., Schürmann, S. V., Uhl, J., & Moggia, D. (2024). Precision Mental Health and Data-Informed Decision Support in Psychological Therapy: An Example. *Administration and Policy in Mental Health and Mental Health Services Research*, *51*(5), 674–685. https://doi.org/10.1007/s10488-023-01330-6

Luz, P. (2019). Osler Centenary Papers: When the diagnosis is futile…. *Postgraduate Medical Journal*, *95*(1130), 669. https://doi.org/10.1136/postgradmedj-2019-136985

Macallin, A., & Wynn, R. (2021). Narrative exposure therapy for refugees and asylum seekers with PTSD: A review of the literature. *European Psychiatry*, *64*(S1), S448–S449. https://doi.org/10.1192/j.eurpsy.2021.1198

Mackoff, J., Lennox, K., & Torchalla, I. (2025). Collaborative, trauma-focused occupational therapy and psychotherapy for work-related PTSD: Two case studies. *Clinical Case Studies*, *24*(3), 215–233. https://doi.org/10.1177/15346501251324531

Maercker, A., & Augsburger, M. (2019). Die posttraumatische Belastungsstörung. In A. Maercker (Ed.), *Traumafolgestörungen* (pp. 13–45). Springer. https://doi.org/10.1007/978-3-662-58470-5_2

Maercker, A., & Hecker, T. (2016). Broadening perspectives on trauma and recovery: A socio-interpersonal view of PTSD. *European Journal of Psychotraumatology*, *7*, 10.3402/ejpt.v7.29303. https://doi.org/10.3402/ejpt.v7.29303

Maercker, A., & Michael, T. (2009). Posttraumatische Belastungsstörungen. In J. Margraf & S. Schneider (Eds), *Lehrbuch der Verhaltenstherapie: Band 2: Störungen im Erwachsenenalter—Spezielle Indikationen—Glossar* (pp. 105–124). Springer. https://doi.org/10.1007/978-3-540-79543-8_6

Maercker, A., & Müller, J. (2004). Social Acknowledgment as a Victim or Survivor: A Scale to Measure a Recovery Factor of PTSD. *Journal of Traumatic Stress*, *17*(4), 345–351. https://doi.org/10.1023/B:JOTS.0000038484.15488.3d

Mahmood, H. N., Ibrahim, H., Goessmann, K., Ismail, A. A., & Neuner, F. (2019). Post-traumatic stress disorder and depression among Syrian refugees residing in the Kurdistan region of Iraq. *Conflict and Health*, *13*(1), 51. https://doi.org/10.1186/s13031-019-0238-5

Makowski, D., Ben-Shachar, M., & Lüdecke, D. (2019). bayestestR: Describing Effects and their Uncertainty, Existence and Significance within the Bayesian Framework. *Journal of Open Source Software*, *4*(40), 1541. https://doi.org/10.21105/joss.01541

Makowski, D., Lüdecke, D., Ben-Shachar, M. S., Patil, I., Wilson, M. D., & Wiernik, B. M. (2019). *bayestestR: Understand and Describe Bayesian Models and Posterior Distributions* (p. 0.14.0). https://doi.org/10.32614/CRAN.package.bayestestR

Mallinckrod†, C. H., Lane, P. W., Schnell, D., Peng, Y., & Mancuso, J. P. (2008). Recommendations for the Primary Analysis of Continuous Endpoints in Longitudinal Clinical Trials. *Drug Information Journal*, *42*(4), 303–319. https://doi.org/10.1177/009286150804200402

Mansouri, F., Leach, M., & Nethery, A. (2009). Temporary Protection and the Refugee Convention in Australia, Denmark, and Germany. *Refuge: Canada's Journal on Refugees*, *26*, 135. https://heinonline.org/HOL/Page?handle=hein.journals/rfgcjr26&id=137&div=&collection=

Marshall, G. N., Miles, J. N. V., & Stewart, S. H. (2010). Anxiety sensitivity and PTSD symptom severity are reciprocally related: Evidence from a longitudinal study of physical trauma survivors. *Journal of Abnormal Psychology*, *119*(1), 143–150. https://doi.org/10.1037/a0018009

Martin, M. M., & Rubin, R. B. (1995). A New Measure of Cognitive Flexibility. *Psychological Reports*, *76*(2), 623–626. https://doi.org/10.2466/pr0.1995.76.2.623

Matheson, K., Foster, M. D., Bombay, A., McQuaid, R. J., & Anisman, H. (2019). Traumatic Experiences, Perceived Discrimination, and Psychological Distress Among Members of Various Socially Marginalized Groups. *Frontiers in Psychology*, *10*. https://doi.org/10.3389/fpsyg.2019.00416

Mathew, T., & Nordström, K. (2010). Comparison of one-step and two-step meta-analysis models using individual patient data. *Biometrical Journal: Journal of Mathematical Methods in Biosciences*, 52(2), 271–287.

Massazza, A., Joffe, H., & Brewin, C. R. (2021). Intrusive memories following disaster: Relationship with peritraumatic responses and later affect. *Journal of abnormal psychology, 130*(7), 727–735.

Massazza, A., Joffe, H., Hyland, P., & Brewin, C. R. (2021). The structure of peritraumatic reactions and their relationship with PTSD among disaster survivors. *Journal of Abnormal Psychology, 130*(3), 248–259.

McAleavey, A. A., de Jong, K., Nissen-Lie, H. A., Boswell, J. F., Moltu, C., & Lutz, W. (2024). Routine Outcome Monitoring and Clinical Feedback in Psychotherapy: Recent Advances and Future Directions. *Administration and Policy in Mental Health and Mental Health Services Research*, *51*(3), 291–305. https://doi.org/10.1007/s10488-024-01351-9

McDermott, K. B., & Roediger , H. L. (2025). Memory (encoding, storage, retrieval). *Understanding Biological Behavior 2nd Edition*.

McDermott, M. M., & Newman, A. B. (2021). Remote Research and Clinical Trial Integrity During and After the Coronavirus Pandemic. *JAMA*, *325*(19), 1935–1936. https://doi.org/10.1001/jama.2021.4609

McDonald, S. D., & Calhoun, P. S. (2010). The diagnostic accuracy of the PTSD Checklist: A critical review. *Clinical Psychology Review*, *30*(8), 976–987. https://doi.org/10.1016/j.cpr.2010.06.012

McEwen, B. S., Nasca, C., & Gray, J. D. (2016). Stress Effects on Neuronal Structure: Hippocampus, Amygdala, and Prefrontal Cortex. *Neuropsychopharmacology*, *41*(1), 3–23. https://doi.org/10.1038/npp.2015.171

McFarlane, A. C., Lawrence-Wood, E., Van Hooff, M., Malhi, G. S., & Yehuda, R. (2017). The Need to Take a Staging Approach to the Biological Mechanisms of PTSD and its Treatment. *Current Psychiatry Reports*, *19*(2), 10. https://doi.org/10.1007/s11920-017-0761-2

McGorry, P. D., Hickie, I. B., Yung, A. R., Pantelis, C., & Jackson, H. J. (2006). Clinical Staging of Psychiatric Disorders: A Heuristic Framework for Choosing Earlier, Safer and more

Effective Interventions. *Australian & New Zealand Journal of Psychiatry*, *40*(8), 616–622. https://doi.org/10.1080/j.1440-1614.2006.01860.x

McNally, G. P., Johansen, J. P., & Blair, H. T. (2011). Placing prediction into the fear circuit. *Trends in Neurosciences*, *34*(6), 283–292. https://doi.org/10.1016/j.tins.2011.03.005

McNally, R. J. (1998). Experimental approaches to cognitive abnormality in posttraumatic stress disorder. *Clinical Psychology Review*, *18*(8), 971–982. https://doi.org/10.1016/S0272-7358(98)00036-1

McNally, R. J. (2006). Cognitive abnormalities in post-traumatic stress disorder. *Trends in Cognitive Sciences*, *10*(6), 271–277. https://doi.org/10.1016/j.tics.2006.04.007

Meade, A. W., Johnson, E. C., & Braddy, P. W. (2008). Power and sensitivity of alternative fit indices in tests of measurement invariance. *Journal of Applied Psychology, 93*(3), 568–592. https://doi.org/10.1037/0021-9010.93.3.568

Mehta, D., & Binder, E. B. (2012). Gene × environment vulnerability factors for PTSD: The HPA-axis. *Neuropharmacology*, *62*(2), 654–662. https://doi.org/10.1016/j.neuropharm.2011.03.009

Melton, A. W. (1963). Implications of short-term memory for a general theory of memory. *Journal of Verbal Learning and Verbal Behavior*, *2*(1), 1–21. https://doi.org/10.1016/S0022-5371(63)80063-8

Metcalf, O., Stone, C., Hinton, M., O'Donnell, M., Hopwood, M., McFarlane, A., Forbes, D., Kartal, D., Watson, L., Freijah, I., & Varker, T. (2020). Treatment augmentation for posttraumatic stress disorder: A systematic review. *Clinical Psychology: Science and Practice*, *27*(1), e12310. https://doi.org/10.1111/cpsp.12310

Michael, T. (2017). Classical conditioning. In A. E. Wenzel (Ed.), *The SAGE Encyclopedia of Abnormal Clinical Psychology* (pp. 660-663). SAGE Publications. https://doi.org/10.4135/9781483365817.n256

Michael, T., Ehlers, A., Halligan, S. L., & Clark, D. M. (2005). Unwanted memories of assault: What intrusion characteristics are associated with PTSD? *Behaviour Research and Therapy*, *43*(5), 613–628. https://doi.org/10.1016/j.brat.2004.04.006

Michael, T., Schanz, C. G., Mattheus, H. K., Issler, T., Frommberger, U., Köllner, V., & Equit, M. (2019). Do adjuvant interventions improve treatment outcome in adult patients with

posttraumatic stress disorder receiving trauma-focused psychotherapy? A systematic review. *European Journal of Psychotraumatology*, *10*(1), 1634938. https://doi.org/10.1080/20008198.2019.1634938

Michael, T., Schanz, C. G., Mattheus, H. K., Issler, T. T., Frommberger, U., Köllner, V., & Equit, M. (2020). Adjuvante Verfahren zur Unterstützung von traumafokussierter Psychotherapie bei Erwachsenen mit Posttraumatischer Belastungsstörung: Welche Evidenz gibt es? *Trauma & Gewalt*, *14*(2), 112–121. https://doi.org/10.21706/tg-14-2-112

Michael, T., Sopp, R., & Maercker, A. (2018). Posttraumatische Belastungsstörungen. In J. Margraf & S. Schneider (Eds), *Lehrbuch der Verhaltenstherapie, Band 2: Psychologische Therapie bei Indikationen im Erwachsenenalter* (pp. 105–124). Springer. https://doi.org/10.1007/978-3-662-54909-4_6

Milad, M. R., Pitman, R. K., Ellis, C. B., Gold, A. L., Shin, L. M., Lasko, N. B., Zeidan, M. A., Handwerger, K., Orr, S. P., & Rauch, S. L. (2009a). Neurobiological Basis of Failure to Recall Extinction Memory in Posttraumatic Stress Disorder. *Biological Psychiatry*, *66*(12), 1075–1082. https://doi.org/10.1016/j.biopsych.2009.06.026

Milad, M. R., Pitman, R. K., Ellis, C. B., Gold, A. L., Shin, L. M., Lasko, N. B., Zeidan, M. A., Handwerger, K., Orr, S. P., & Rauch, S. L. (2009b). Neurobiological Basis of Failure to Recall Extinction Memory in Posttraumatic Stress Disorder. *Biological Psychiatry*, *66*(12), 1075–1082. https://doi.org/10.1016/j.biopsych.2009.06.026

Milanak, M. E., Zuromski, K. L., Cero, I., Wilkerson, A. K., Resnick, H. S., & Kilpatrick, D. G. (2019). Traumatic Event Exposure, Posttraumatic Stress Disorder, and Sleep Disturbances in a National Sample of U.S. Adults. *Journal of Traumatic Stress*, *32*(1), 14–22. https://doi.org/10.1002/jts.22360

Milfont, T. L., & Fischer, R. (2010). Testing measurement invariance across groups: Applications in cross-cultural research. *International Journal of psychological research*, *3*(1), 111-130.

Moggia, D., Lutz, W., Brakemeier, E.-L., & Bickman, L. (2024). Treatment Personalization and Precision Mental Health Care: Where are we and where do we want to go? *Administration and Policy in Mental Health and Mental Health Services Research*, *51*(5), 611–616. https://doi.org/10.1007/s10488-024-01407-w

Momartin, S., Silove, D., Manicavasagar, V., & Steel, Z. (2004). Comorbidity of PTSD and depression: Associations with trauma exposure, symptom severity and functional impairment in Bosnian refugees resettled in Australia. *Journal of Affective Disorders, 80*(2), 231–238. https://doi.org/10.1016/S0165-0327(03)00131-9

Morath, J., Gola, H., Sommershof, A., Hamuni, G., Kolassa, S., Catani, C., Adenauer, H., Ruf-Leuschner, M., Schauer, M., Elbert, T., Groettrup, M., & Kolassa, I.-T. (2014). The effect of trauma-focused therapy on the altered T cell distribution in individuals with PTSD: Evidence from a randomized controlled trial. *Journal of Psychiatric Research*, *54*, 1–10. https://doi.org/10.1016/j.jpsychires.2014.03.016

Morina, N., Stam, K., Pollet, T. V., & Priebe, S. (2018). Prevalence of depression and posttraumatic stress disorder in adult civilian survivors of war who stay in war-afflicted regions. A systematic review and meta-analysis of epidemiological studies. *Journal of Affective Disorders*, *239*, 328–338. https://doi.org/10.1016/j.jad.2018.07.027

Morina, N., Wicherts, J. M., Lobbrecht, J., & Priebe, S. (2014). Remission from post-traumatic stress disorder in adults: A systematic review and meta-analysis of long term outcome studies. *Clinical Psychology Review*, *34*(3), 249–255. https://doi.org/10.1016/j.cpr.2014.03.002

Morris, C. D., Bransford, J. D., & Franks, J. J. (1977). Levels of processing versus transfer appropriate processing. *Journal of Verbal Learning and Verbal Behavior*, *16*(5), 519–533. https://doi.org/10.1016/S0022-5371(77)80016-9

Mueller, J., Moergeli, H., & Maercker, A. (2008). Disclosure and social acknowledgement as predictors of recovery from posttraumatic stress: A longitudinal study in crime victims. *The Canadian Journal of Psychiatry*, *53*(3), 160-168. https://doi.org/10.1177/070674370805300306

Müller-Engelmann, M., Schnyder, U., Dittmann, C., Priebe, K., Bohus, M., Thome, J., Fydrich, T., Pfaltz, M. C., & Steil, R. (2020). Psychometric Properties and Factor Structure of the German Version of the Clinician-Administered PTSD Scale for *DSM-5*. *Assessment*, *27*(6), 1128–1138. https://doi.org/10.1177/1073191118774840

Murphy, S. A. (2005). An experimental design for the development of adaptive treatment strategies. *Statistics in Medicine*, *24*(10), 1455–1481. https://doi.org/10.1002/sim.2022

Muthén, B., & Christoffersson, A. (1981). Simultaneous factor analysis of dichotomous variables in several groups. *Psychometrika, 46*(4), 407–419. https://doi.org/10.1007/BF02293798

Nakagawa, S., & Schielzeth, H. (2013). A general and simple method for obtaining R2 from generalized linear mixed-effects models. *Methods in Ecology and Evolution*, *4*(2), 133–142. https://doi.org/10.1111/j.2041-210x.2012.00261.x

Nappi, C. M., Drummond, S. P. A., & Hall, J. M. H. (2012). Treating nightmares and insomnia in posttraumatic stress disorder: A review of current evidence. *Neuropharmacology*, *62*(2), 576–585. https://doi.org/10.1016/j.neuropharm.2011.02.029

National Institute for Health and Care Excellence. (2018). *Post-traumatic stress disorder (NICE guideline NG116)*. Retrieved from https://www.nice.org.uk/guidance/ng116

National Institute for Health and Care Excellence (2022). *Depression in adults: treatment and management (NICE Guideline 222).* Retrieved from https://www.nice.org.uk/guidance/ng222

Nazia, J. C. M., Kevin B. Meehan, Eva Petkova, Page E. Van Meter, Yuval Neria, Yihong Zhao, Hayley Pessin, Yasmin. (2016, March 23). Treatment Preferences of Psychotherapy Patients With Chronic PTSD. *Psychiatrist.Com*. https://www.psychiatrist.com/jcp/treatment-preferences-psychotherapy-patients-chronic/

Nesterko, Y., Jäckle, D., Friedrich, M., Holzapfel, L., & Glaesmer, H. (2020). Prevalence of post-traumatic stress disorder, depression and somatisation in recently arrived refugees in Germany: An epidemiological study. *Epidemiology and Psychiatric Sciences*, *29*, e40. https://doi.org/10.1017/S2045796019000325

Neuner, F., Elbert, T., & Schauer, M. (2018). Narrative Exposure Therapy (NET) as a Treatment for Traumatized Refugees and Post-conflict Populations. In N. Morina & A. Nickerson (Eds), *Mental Health of Refugee and Conflict-Affected Populations: Theory, Research and Clinical Practice* (pp. 183–199). Springer International Publishing. https://doi.org/10.1007/978-3-319-97046-2_9

Neylan, T. C., Kessler, R. C., Ressler, K. J., Clifford, G., Beaudoin, F. L., An, X., Stevens, J. S., Zeng, D., Linnstaedt, S. D., Germine, L. T., Sheikh, S., Storrow, A. B., Punches, B. E., Mohiuddin, K., Gentile, N. T., McGrath, M. E., van Rooij, S. J. H., Haran, J. P., Peak, D. A., Domeier, R. M., … McLean, S. A. (2021). Prior sleep problems and adverse post-

traumatic neuropsychiatric sequelae of motor vehicle collision in the AURORA study. *Sleep*, *44*(3), zsaa200.

Nguyen, T.-L., Collins, G. S., Landais, P., & Le Manach, Y. (2020). Counterfactual clinical prediction models could help to infer individualized treatment effects in randomized controlled trials—An illustration with the International Stroke Trial. *Journal of Clinical Epidemiology*, *125*, 47–56. https://doi.org/10.1016/j.jclinepi.2020.05.022

Nishida, M., Pearsall, J., Buckner, R. L., & Walker, M. P. (2008). REM sleep, prefrontal theta, and the consolidation of human emotional memory. *Cerebral Cortex*, 19(5), 1158–1166.

Nickerson, A., Steel, Z., Bryant, R., Brooks, R., & Silove, D. (2011). Change in visa status amongst Mandaean refugees: Relationship to psychological symptoms and living difficulties. *Psychiatry Research*, *187*(1), 267–274. https://doi.org/10.1016/j.psychres.2010.12.015

Nicolas, G., Wheatley, A., & Guillaume, C. (2015). Does one trauma fit all? Exploring the relevance of PTSD across cultures. *International Journal of Culture and Mental Health*, *8*(1), 34–45. https://doi.org/10.1080/17542863.2014.892519

Nijdam, M. J., Vermetten, E., & McFarlane, A. C. (2023). Toward staging differentiation for posttraumatic stress disorder treatment. *Acta Psychiatrica Scandinavica*, *147*(1), 65–80. https://doi.org/10.1111/acps.13520

Niles, B. L., Mori, D. L., Polizzi, C., Pless Kaiser, A., Weinstein, E. S., Gershkovich, M., & Wang, C. (2018). A systematic review of randomized trials of mind-body interventions for PTSD. *Journal of Clinical Psychology*, *74*(9), 1485–1508. https://doi.org/10.1002/jclp.22634

Nilsson, H., Saboonchi, F., Gustavsson, C., Malm, A., & Gottvall, M. (2019). Trauma-afflicted refugees' experiences of participating in physical activity and exercise treatment: a qualitative study based on focus group discussions. *European journal of psychotraumatology*, 10(1), 1699327.

Noor, N. M., Pett, S. L., Esmail, H., Crook, A. M., Vale, C. L., Sydes, M. R., & Parmar, M. K. B. (2020). Adaptive platform trials using multi-arm, multi-stage protocols: Getting fast answers in pandemic settings. *F1000Research*, *9*, 1109. https://doi.org/10.12688/f1000research.26253.2

Nordbrandt, M. S., Sonne, C., Mortensen, E. L., & Carlsson, J. (2020). Trauma-affected refugees treated with basic body awareness therapy or mixed physical activity as augmentation to treatment as usual—A pragmatic randomised controlled trial. *PLOS ONE, 15*(3), e0230300. https://doi.org/10.1371/journal.pone.0230300

Norrholm, S. D., Jovanovic, T., Gerardi, M., Breazeale, K. G., Price, M., Davis, M., Duncan, E., Ressler, K. J., Bradley, B., Rizzo, A., Tuerk, P. W., & Rothbaum, B. O. (2016). Baseline psychophysiological and cortisol reactivity as a predictor of PTSD treatment outcome in virtual reality exposure therapy. *Behaviour Research and Therapy*, *82*, 28–37. https://doi.org/10.1016/j.brat.2016.05.002

Nosè, M., Ballette, F., Bighelli, I., Turrini, G., Purgato, M., Tol, W., Priebe, S., & Barbui, C. (2017). Psychosocial interventions for post-traumatic stress disorder in refugees and asylum seekers resettled in high-income countries: Systematic review and meta-analysis. *PLOS ONE, 12*(2), e0171030. https://doi.org/10.1371/journal.pone.0171030

Oakley, L. D., Kuo, W., Kowalkowski, J. A., & Park, W. (2021). Meta-Analysis of Cultural Influences in Trauma Exposure and PTSD Prevalence Rates. *Journal of Transcultural Nursing*, *32*(4), 412–424. https://doi.org/10.1177/1043659621993909

Olatunji, B. O., Cisler, J. M., & Tolin, D. F. (2007). Quality of life in the anxiety disorders: a meta-analytic review. *Clinical Psychology Review*, 27(5), 572–581.

Olff, M. (2017). Sex and gender differences in post-traumatic stress disorder: An update. *European Journal of Psychotraumatology*, *8*(sup4), 1351204. https://doi.org/10.1080/20008198.2017.1351204

Ovuga, M., PhD, Emilio. (2012). *Post Traumatic Stress Disorders in a Global Context*. BoD – Books on Demand.

Ozer, E. J., Best, S. R., Lipsey, T. L., & Weiss, D. S. (2003). Predictors of posttraumatic stress disorder and symptoms in adults: A meta-analysis. *Psychological Bulletin*, *129*(1), 52–73. https://doi.org/10.1037/0033-2909.129.1.52

Pacella, M. L., Hruska, B., & Delahanty, D. L. (2013). The physical health consequences of PTSD and PTSD symptoms: a meta-analytic review. *Journal of anxiety disorders*, 27(1), 33–46.

Pace-Schott, E. F., Seo, J., & Bottary, R. (2023). The influence of sleep on fear extinction in trauma-related disorders. *Neurobiology of stress*, *22*, 100500.

Pace-Schott, E. F., Shepherd, E., Spencer, R. M., Marcello, M., Tucker, M., Propper, R. E., & Stickgold, R. (2011). Napping promotes inter-session habituation to emotional stimuli. *Neurobiology of learning and memory*, 95(1), 24–36.

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., … Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ*, 372.

Pallmann, P., Bedding, A. W., Choodari-Oskooei, B., Dimairo, M., Flight, L., Hampson, L. V., Holmes, J., Mander, A. P., Odondi, L., Sydes, M. R., Villar, S. S., Wason, J. M. S., Weir, C. J., Wheeler, G. M., Yap, C., & Jaki, T. (2018). Adaptive designs in clinical trials: Why use them, and how to run and report them. *BMC Medicine*, *16*(1), 29. https://doi.org/10.1186/s12916-018-1017-7

Park, C. L. (2013). The meaning making model: A framework for understanding meaning, spirituality, and stress-related growth in health psychology. *European Health Psychologist*, *15*(2), 40–47. https://www.ehps.net/ehp/index.php/contents/article/download/ehp.v15.i2.p40/1041

Patterson, G. T. (2001). The relationship between demographic variables and exposure to traumatic incidents among police officers. *The Australasian Journal of Disaster and Trauma Studies*, *2*(1), 1–9.

Pebole, M., Gobin, R. L., & Hall, K. S. (2021). Trauma-informed exercise for women survivors of sexual violence. Translational behavioral medicine, 11(2), 686-691.

Perkonigg, A., Pfister, H., Stein, M. B., Höfler, M., Lieb, R., Maercker, A., & Wittchen, H. U. (2005). Longitudinal course of posttraumatic stress disorder and posttraumatic stress disorder symptoms in a community sample of adolescents and young adults. *American Journal of Psychiatry*, 162(7), 1320–1327.

Perumean-Chaney, S. E., Morgan, C., McDowall, D., & Aban, I. (2013). Zero-inflated and overdispersed: What's one to do? *Journal of Statistical Computation and Simulation*, 83(9), 1671–1683.

Peters, J. L., Sutton, A. J., Jones, D. R., Abrams, K. R., & Rushton, L. (2008). Contour-enhanced meta-analysis funnel plots help distinguish publication bias from other causes of asymmetry. *Journal of Clinical Epidemiology*, 61(10), 991–996.

Pettrich, A., Friedrich, M., Nesterko, Y., & Glaesmer, H. (2024). The German PCL-5: Evaluating structural validity in a large-scale sample of the general German population. *European Journal of Psychotraumatology, 15*(1), 2317055. https://doi.org/10.1080/20008066.2024.2317055

Pettrich, A., Schellong, J., Dyer, A., Ehring, T., Knaevelsrud, C., Krüger-Gottschalk, A., Nesterko, Y., Schäfer, I., & Glaesmer, H. (2025). Beyond one-cutoff-fits-all: determining cutoff values for the PTSD checklist for DSM-5 (PCL-5). *European Journal of Psychotraumatology*, *16*(1), 2514878. https://doi.org/10.1080/20008066.2025.2514878

Petzold, M., & Bunzeck, N. (2022). Impaired episodic memory in PTSD patients—A meta-analysis of 47 studies. *Frontiers in Psychiatry*, *13*. https://doi.org/10.3389/fpsyt.2022.909442

Pfaltz, M. C., Michael, T., Meyer, A. H., & Wilhelm, F. H. (2013). Reexperiencing symptoms, dissociation, and avoidance behaviors in daily life of patients with PTSD and patients with panic disorder with agoraphobia. *Journal of Traumatic Stress*, 26(4), 443–450.

Ploski, J. E., & Vaidya, V. A. (2021). The Neurocircuitry of Posttraumatic Stress Disorder and Major Depression: Insights Into Overlapping and Distinct Circuit Dysfunction—A Tribute to Ron Duman. *Biological Psychiatry, 90*(2), 109–117. https://doi.org/10.1016/j.biopsych.2021.04.009

Pitman, R. K., Rasmusson, A. M., Koenen, K. C., Shin, L. M., Orr, S. P., Gilbertson, M. W., Milad, M. R., & Liberzon, I. (2012). Biological studies of post-traumatic stress disorder. *Nature Reviews Neuroscience*, *13*(11), 769–787. https://doi.org/10.1038/nrn3339

Pittig, A., van den Berg, L., & Vervliet, B. (2016). The key role of extinction learning in anxiety disorders: Behavioral strategies to enhance exposure-based treatments. *Current Opinion in Psychiatry*, *29*(1), 39. https://doi.org/10.1097/YCO.0000000000000220

Polanco-Roman, L., Ebrahimi, C. T., Satinsky, E. N., Benau, E. M., Martins Lanes, A., Iyer, M., & Galán, C. A. (2024). Racism-Related Experiences and Traumatic Stress Symptoms in Ethnoracially Minoritized Youth: A Systematic Review and Meta-Analysis. *Journal of*

Clinical Child & Adolescent Psychology, *53*(4), 690–707. https://doi.org/10.1080/15374416.2023.2292042

Porcheret, K., Holmes, E. A., Goodwin, G. M., Foster, R. G., & Wulff, K. (2015). Psychological Effect of an Analogue Traumatic Event Reduced by Sleep Deprivation. *Sleep*, 38(7), 1017–1025.

Porcheret, K., Iyadurai, L., Bonsall, M. B., Goodwin, G. M., Beer, S. A., Darwent, M., & Holmes, E. A. (2020). Sleep and intrusive memories immediately after a traumatic event in emergency department patients. *Sleep, 43*(8), zsaa033.

Porcheret, K., van Heugten – van der Kloet, D., Goodwin, G. M., Foster, R. G., Wulff, K., & Holmes, E. A. (2019). Investigation of the impact of total sleep deprivation at home on the number of intrusive memories to an analogue trauma. *Translational Psychiatry*, *9*(1), 104.

Powers, M. B., Medina, J. L., Burns, S., Kauffman, B. Y., Monfils, M., Asmundson, G. J. G., Diamond, A., McIntyre, C., & Smits, J. A. J. (2015). Exercise Augmentation of Exposure Therapy for PTSD: Rationale and Pilot Efficacy Data. *Cognitive Behaviour Therapy*, *44*(4), 314–327. https://doi.org/10.1080/16506073.2015.1012740

Priebe, S., Omer, S., Giacco, D., & Slade, M. (2014). Resource-oriented therapeutic models in psychiatry: Conceptual review. *The British Journal of Psychiatry*, *204*(4), 256–261. https://doi.org/10.1192/bjp.bp.113.135038

Purgato, M., Gastaldon, C., Papola, D., Ommeren, M. van, Barbui, C., & Tol, W. A. (2018). Psychological therapies for the treatment of mental disorders in low- and middle-income countries affected by humanitarian crises. *Cochrane Database of Systematic Reviews*, *7*. https://doi.org/10.1002/14651858.CD011849.pub2

Purgato, M., Singh, R., Acarturk, C., & Cuijpers, P. (2021). Moving beyond a 'one-size-fits-all' rationale in global mental health: Prospects of a precision psychology paradigm. *Epidemiology and Psychiatric Sciences*, *30*, e63. https://doi.org/10.1017/S2045796021000500

Putnick, D. L., & Bornstein, M. H. (2016). Measurement invariance conventions and reporting: The state of the art and future directions for psychological research. *Developmental Review*, *41*, 71–90. https://doi.org/10.1016/j.dr.2016.06.004

Qi, W., Gevonden, M., & Shalev, A. (2016). Prevention of Post-Traumatic Stress Disorder After Trauma: Current Evidence and Future Directions. *Current Psychiatry Reports*, *18*(2), 20. https://doi.org/10.1007/s11920-015-0655-0

Quillan, M. R. (1966). *Semantic memory*. https://apps.dtic.mil/sti/html/tr/AD0641671/

Quosh, C., Eloul, L., & Ajlani, R. (2013). Mental health of refugees and displaced persons in Syria and surrounding countries: A systematic review. *Intervention Journal of Mental Health and Psychosocial Support in Conflict Affected Areas*, *11*(3), 276. https://journals.lww.com/invn/abstract/2013/11030/mental_health_of_refugees_and_displaced_persons_in.6.aspx

Raise-Abdullahi, P., Meamar, M., Vafaei, A. A., Alizadeh, M., Dadkhah, M., Shafia, S., Ghalandari-Shamami, M., Naderian, R., Afshin Samaei, S., & Rashidy-Pour, A. (2023). Hypothalamus and Post-Traumatic Stress Disorder: A Review. *Brain Sciences*, *13*(7), 1010. https://doi.org/10.3390/brainsci13071010

Rasch, B., & Born, J. (2013). About Sleep's Role in Memory. *Physiological Reviews*, *93*(2), 681–766. https://doi.org/10.1152/physrev.00032.2012

Rasmussen, A., Verkuilen, J., Jayawickreme, N., Wu, Z., & McCluskey, S. T. (2019). When did posttraumatic stress disorder get so many factors? Confirmatory factor models since DSM–5. *Clinical Psychological Science,* *7*(2), 234–248. https://doi.org/10.1177/2167702618809370

Rauch, S. L., Shin, L. M., & Phelps, E. A. (2006). Neurocircuitry Models of Posttraumatic Stress Disorder and Extinction: Human Neuroimaging Research—Past, Present, and Future. *Biological Psychiatry*, *60*(4), 376–382. https://doi.org/10.1016/j.biopsych.2006.06.004

Ravi, M., Powers, A., Rothbaum, B. O., Stevens, J. S., & Michopoulos, V. (2023). Neighborhood poverty prospectively predicts PTSD symptoms six-months following trauma exposure. *Mental Health Science*, *1*(4), 213–221. https://doi.org/10.1002/mhs2.35

Ravi, M., Stevens, J. S., & Michopoulos, V. (2019). Neuroendocrine pathways underlying risk and resilience to PTSD in women. *Frontiers in Neuroendocrinology*, *55*, 100790. https://doi.org/10.1016/j.yfrne.2019.100790

R Core Team (2020). R: A language and environment for statistical computing. R Foundation for Statistical Computing. https://www.R-project.org/.

R Core Team (2021). R: A language and environment for statistical computing. R Foundation for Statistical Computing. *https://www.R-project.org/.*

R Core Team. (2025). *R: A language and environment for statistical computing (R version 4.4.3).* R Foundation for Statistical Computing. https://www.Rproject.org/

Reffi, A. N., Drake, C. L., Kalmbach, D. A., Jovanovic, T., Norrholm, S. D., Roth, T., Casement, M. D., & Cheng, P. (2023). Pre-pandemic sleep reactivity prospectively predicts distress during the COVID-19 pandemic: The protective effect of insomnia treatment. *Journal of sleep research*, *32*(1), e13709.

Repantis, D., Wermuth, K., Tsamitros, N., Danker-Hopfe, H., Bublitz, J. C., Kühn, S., & Dresler, M. (2020). REM sleep in acutely traumatized individuals and interventions for the secondary prevention of post-traumatic stress disorder. *European Journal of Psychotraumatology*, *11*(1), 1740492.

Resick, P. A., Monson, C. M., & Chard, K. M. (2024). *Cognitive processing therapy for PTSD: A comprehensive therapist manual*. Guilford Publications. https://books.google.de/books?hl=de&lr=&id=P4ABEQAAQBAJ&oi=fnd&pg=PP1&dq=Resick+et+al.,+2024+cognitive+processing&ots=H2ugHMxaQK&sig=XpGMg3DJ8pCPtVvJ-IJth_-vsC4

Rizopoulos, D. (2019). *GLMMadaptive: Generalized linear mixed models using adaptive Gaussian quadrature. R Package Version 0.5-1.* Retrieved from https://CRAN.R-project.org/package=GLMMadaptive

Rio, C. J., & Saligan, L. N. (2023). Understanding physical activity from a cultural-contextual lens. *Frontiers in Public Health*, *11*. https://doi.org/10.3389/fpubh.2023.1223919

Roberts, N. P., Kitchiner, N. J., Kenardy, J., Lewis, C. E., & Bisson, J. I. (2019). Early psychological intervention following recent trauma: A systematic review and meta-analysis. *European Journal of Psychotraumatology*, *10*(1), 1695486. https://doi.org/10.1080/20008198.2019.1695486

Robinaugh, D. J., Marques, L., Traeger, L. N., Marks, E. H., Sung, S. C., Gayle Beck, J., Pollack, M. H., & Simon, N. M. (2011). Understanding the relationship of perceived social

support to post-trauma cognitions and posttraumatic stress disorder. *Journal of Anxiety Disorders*, *25*(8), 1072–1078. https://doi.org/10.1016/j.janxdis.2011.07.004

Robjant, K., & Fazel, M. (2010). The emerging evidence for Narrative Exposure Therapy: A review. *Clinical Psychology Review*, *30*(8), 1030–1039. https://doi.org/10.1016/j.cpr.2010.07.004

Roediger, H. L. (1990). Implicit memory: Retention without remembering. *American Psychologist*, *45*(9), 1043–1056. https://doi.org/10.1037/0003-066X.45.9.1043

Roediger, H. L., Weldon, M. S., & Challis, B. H. (1989). Explaining Dissociations Between Implicit and Explicit Measures of Retention: A Processing Account. In *Varieties of Memory and Consciousness*. Psychology Press.

Rollmann, I., Gebhardt, N., Stahl-Toyota, S., Simon, J., Sutcliffe, M., Friederich, H.-C., & Nikendei, C. (2023). Systematic review of machine learning utilization within outpatient psychodynamic psychotherapy research. *Frontiers in Psychiatry*, *14*. https://doi.org/10.3389/fpsyt.2023.1055868

Rose, S. C., Bisson, J., Churchill, R., & Wessely, S. (2002). Psychological debriefing for preventing post traumatic stress disorder (PTSD). *Cochrane Database of Systematic Reviews*, *2*. https://doi.org/10.1002/14651858.CD000560

Rosenbaum, S., Sherrington, C., & Tiedemann, A. (2015). Exercise augmentation compared with usual care for post-traumatic stress disorder: A randomized controlled trial. *Acta Psychiatrica Scandinavica, 131*(5), 350–359. https://doi.org/10.1111/acps.12371

Rosenbaum, S., Vancampfort, D., Steel, Z., Newby, J., Ward, P. B., & Stubbs, B. (2015). Physical activity in the treatment of Post-traumatic stress disorder: A systematic review and meta-analysis. *Psychiatry Research*, *230*(2), 130–136. https://doi.org/10.1016/j.psychres.2015.10.017

Rosseel, Y. (2012). lavaan: An R package for structural equation modeling. *Journal of Statistical Software, 48*(2), 1–36. https://doi.org/10.18637/jss.v048.i02

Saad, B., George, S. A., Bazzi, C., Gorski, K., Abou-Rass, N., Shoukfeh, R., & Javanbakht, A. (2022). Research With Refugees and Vulnerable Populations in a Post-COVID World: Challenges and Opportunities. *Journal of the American Academy of Child & Adolescent Psychiatry*, *61*(11), 1322–1326. https://doi.org/10.1016/j.jaac.2022.04.024

Salleh, M. N. B. M., Ismail, D. H. B., & Yusoff, D. H. B. M. (2020). Prevalence and Predictors for PTSD among Firefighters. A Systematic Review. *International Journal of Public Health Research*, *10*(1). https://spaj.ukm.my/ijphr/index.php/ijphr/article/view/259

Salthouse, T. (2012). Consequences of Age-Related Cognitive Declines. *Annual Review of Psychology*, *63*(Volume 63, 2012), 201–226. https://doi.org/10.1146/annurev-psych-120710-100328

Salthouse, T. A. (2010). Selective review of cognitive aging. *Journal of the International Neuropsychological Society*, *16*(5), 754–760. https://doi.org/10.1017/S1355617710000706

Samuelson, K. W. (2011). Post-traumatic stress disorder and declarative memory functioning: A review. *Dialogues in Clinical Neuroscience*, *13*(3), 346–351. https://doi.org/10.31887/DCNS.2011.13.2/ksamuelson

Samuelson, K. W., Bartel, A., Valadez, R., & Jordan, J. T. (2017). PTSD symptoms and perception of cognitive problems: The roles of posttraumatic cognitions and trauma coping self-efficacy. *Psychological Trauma: Theory, Research, Practice, and Policy*, *9*(5), 537–544. https://doi.org/10.1037/tra0000210

Satorra, A., & Bentler, P. M. (2001). A scaled difference chi-square test statistic for moment structure analysis. *Psychometrika*, *66*(4), 507–514. https://doi.org/10.1007/BF02296192

Schäfer, I., Gast, U., Hofmann, A., Knaevelsrud, C., Lampe, A., Liebermann, P., Lotzin, A., Maercker, A., Rosner, R., & Wöller, W. (Eds). (2019). *S3-Leitlinie Posttraumatische Belastungsstörung*. Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-662-59783-5

Schäfer, S. K., Becker, N., King, L., Horsch, A., & Michael, T. (2019). The relationship between sense of coherence and post-traumatic stress: A meta-analysis. *European Journal of Psychotraumatology*, *10*(1), 1562839. https://doi.org/10.1080/20008198.2018.1562839

Schäfer, S. K., Lüder, C. C., Porcheret, K., Hu, X., Margraf, J., Michael, T., Holmes, E. A., Werner, G. G., Wilhelm, I., Woud, M. L., Zeng, S., Friesen, E., Haim-Nachum, S., Lass-Hennemann, J., Lieb, K., Kunzler, A. M., Wirth, B. E., & Sopp, M. R. (2023). To sleep or not to sleep, that is the question: A systematic review and meta-analysis on the effect of post-trauma sleep on intrusive memories of analog trauma. *Behaviour Research and Therapy*, *167*, 104359. https://doi.org/10.1016/j.brat.2023.104359

Schäfer, S. K., Wirth, B. E., Staginnus, M., Becker, N., Michael, T., & Sopp, M. R. (2020). Sleep's impact on emotional recognition memory: A meta-analysis of whole-night, nap, and REM sleep effects. *Sleep Medicine Reviews, 51*, 101280.

Schauer, M., Neuner, F., & Elbert, T. (2011). *Narrative exposure therapy: A short-term treatment for traumatic stress disorders.* Cambridge, MA: Hogrefe-Verlag.

Schenker, M. T., Ney, L. J., Miller, L. N., Felmingham, K. L., Nicholas, C. L., & Jordan, A. S. (2021). Sleep and fear conditioning, extinction learning and extinction recall: A systematic review and meta-analysis of polysomnographic findings. *Sleep Medicine Reviews, 59*, 101501.

Schenker, M. T., Theoswin, P. M., Qian, H., Jordan, A. S., Nicholas, C. L., & Felmingham, K. L. (2023). Sleep and day-to-day PTSD symptom variability: an ecological momentary assessment and actigraphy monitored study in trauma-exposed young adults. *European journal of psychotraumatology*, *14*(2), 2202058.

Schick, M., Morina, N., Mistridis, P., Schnyder, U., Bryant, R. A., & Nickerson, A. (2018). Changes in Post-migration Living Difficulties Predict Treatment Outcome in Traumatized Refugees. *Frontiers in Psychiatry*, *9*. https://doi.org/10.3389/fpsyt.2018.00476

Schmacke, N. (2006). Evidenzbasierte Medizin und Psychotherapie: Die Frage nach den angemessenen Erkenntnismethoden. *PPmP - Psychotherapie · Psychosomatik · Medizinische Psychologie*, *56*(5), 202–209. https://doi.org/10.1055/s-2006-932609

Schmitt, T. A., Sass , D. A., Chappelle ,W., & and Thompson, W. (2018). Selecting the "Best" Factor Structure and Moving Measurement Validation Forward: An Illustration. *Journal of Personality Assessment*, *100*(4), 345–362. https://doi.org/10.1080/00223891.2018.1449116

Schneider, J., Rukundo-Zeller, A. C., Bambonyé, M., Muhoza, J.-A., Ndayikengurukiye, T., Nitanga, L., Rushoza, A. A., & Crombach, A. (2025). Preventing Childhood Sexual Abuse Related Mental Health Deterioration Using a Narrative Family Intervention in Burundi. *Research on Child and Adolescent Psychopathology*, *53*(7), 1061–1076. https://doi.org/10.1007/s10802-025-01328-8

Schnyder, U., Bryant, R. A., Ehlers, A., Foa, E. B., Hasan, A., Mwiti, G., Kristensen, C. H., Neuner, F., Oe, M., & Yule, W. (2016). Culture-sensitive psychotraumatology. *European Journal of Psychotraumatology*, *7*(1), 31179. https://doi.org/10.3402/ejpt.v7.31179

Schnyder, U., Ehlers, A., Elbert, T., Foa, E. B., Gersons, B. P. R., Resick, P. A., Shapiro, F., & Cloitre, M. (2015). Psychotherapies for PTSD: What do they have in common? *European Journal of Psychotraumatology*, *6*(1), 28186. https://doi.org/10.3402/ejpt.v6.28186

Schouler-Ocak, M., & Kastrup, M. C. (2019). *Intercultural Psychotherapy: For Immigrants, Refugees, Asylum Seekers and Ethnic Minority Patients*. Springer Nature.

Schramm, E., Elsaesser, M., Jenkner, C., Hautzinger, M., & Herpertz, S. C. (2024). Algorithm-based modular psychotherapy vs. cognitive-behavioral therapy for patients with depression, psychiatric comorbidities and early trauma: A proof-of-concept randomized controlled trial. *World Psychiatry*, *23*(2), 257–266. https://doi.org/10.1002/wps.21204

Schuch, F. B., Vancampfort, D., Richards, J., Rosenbaum, S., Ward, P. B., & Stubbs, B. (2016). Exercise as a treatment for depression: A meta-analysis adjusting for publication bias. *Journal of Psychiatric Research, 77*, 42–51. https://doi.org/10.1016/j.jpsychires.2016.02.023

Schünemann, H. J., Vist, G. E., Higgins, J. P., Santesso, N., Deeks, J. J., Glasziou, P., Akl, E. A., Guyatt, G.H., & Cochrane GRADEing Methods Group. (2022). Interpreting results and drawing conclusions. In J. P. Higgins, J. Thomas, J. Chandler, M. Cumpston, T. Li, M. J. Page & V. A. Welch (Eds.), *Cochrane Handbook for Systematic Reviews of Interventions* (pp. 403–431). Cochrane Collaboration. doi:10.1002/9781119536604.ch10

Schultebraucks, K., Sijbrandij, M., Galatzer-Levy, I., Mouthaan, J., Olff, M., & van Zuiden, M. (2021). Forecasting individual risk for long-term Posttraumatic Stress Disorder in emergency medical settings using biomedical data: A machine learning multicenter cohort study. *Neurobiology of Stress*, *14*, 100297. https://doi.org/10.1016/j.ynstr.2021.100297

Schultebraucks, K., Qian, M., Abu-Amara, D., Dean, K., Laska, E., Siegel, C., Gautam, A., Guffanti, G., Hammamieh, R., Misganaw, B., Mellon, S. H., Wolkowitz, O. M., Blessing, E. M., Etkin, A., Ressler, K.J., Doyle, F. J., Jett, M., & Marmar, C. R. (2021). Pre-deployment risk factors for PTSD in active-duty personnel deployed to Afghanistan: a machine-learning approach for analyzing multivariate predictors. *Molecular psychiatry*, 26(9), 5011–5022.

Schwartz, B., Cohen, Z. D., Rubel, J. A., Zimmermann, D., Wittmann, W. W., & Lutz, W. (2021). Personalized treatment selection in routine care: Integrating machine learning and

statistical algorithms to recommend cognitive behavioral or psychodynamic therapy. *Psychotherapy Research*, *31*(1), 33–51. https://doi.org/10.1080/10503307.2020.1769219

Scrivani, K., & Fu, J. S. (n.d.). A Systematic Review of Post-Traumatic Stress Disorder Communication Research: Implications for Resilience Communication and Organizing. *Health Communication*, *0*(0), 1–27. https://doi.org/10.1080/10410236.2025.2490315

Seibt, J., Aton, S. J., Jha, S. K., Coleman, T., Dumoulin, M. C., & Frank, M. G. (2008). The non-benzodiazepine hypnotic zolpidem impairs sleep-dependent cortical plasticity. *Sleep*, *31*(10), 1381–1391.

Shalev, A. Y., Ankri, Y., Israeli-Shalev, Y., Peleg, T., Adessky, R., & Freedman, S. (2012). Prevention of Posttraumatic Stress Disorder by Early Treatment: Results From the Jerusalem Trauma Outreach and Prevention Study. *Archives of General Psychiatry*, *69*(2), 166–176. https://doi.org/10.1001/archgenpsychiatry.2011.127

Shalev, A. Y., Freedman, S., Peri, T., Brandes, D., Sahar, T., Orr, S. P., & Pitman, R. K. (1998). Prospective Study of Posttraumatic Stress Disorder and Depression Following Trauma. *American Journal of Psychiatry*. https://doi.org/10.1176/ajp.155.5.630

Shapiro, F. (1989). Efficacy of the eye movement desensitization procedure in the treatment of traumatic memories. *Journal of Traumatic Stress*, *2*(2), 199–223. https://doi.org/10.1002/jts.2490020207

Shi, C., Ren, Z., Zhao, C., Zhang, T., & Chan, S. H.-W. (2021). Shame, guilt, and posttraumatic stress symptoms: A three-level meta-analysis. *Journal of Anxiety Disorders*, *82*, 102443. https://doi.org/10.1016/j.janxdis.2021.102443

Shin, L. M., Rauch, S. L., & Pitman, R. K. (2006). Amygdala, Medial Prefrontal Cortex, and Hippocampal Function in PTSD. *Annals of the New York Academy of Sciences*, *1071*(1), 67–79. https://doi.org/10.1196/annals.1364.007

Sibrava, N. J., Bjornsson, A. S., Pérez Benítez, A. C. I., Moitra, E., Weisberg, R. B., & Keller, M. B. (2019). Posttraumatic stress disorder in African American and Latinx adults: Clinical course and the role of racial and ethnic discrimination. *American Psychologist*, *74*(1), 101–116. https://doi.org/10.1037/amp0000339

Siehl, S., Robjant, K., & Crombach, A. (2021). Systematic review and meta-analyses of the long-term efficacy of narrative exposure therapy for adults, children and perpetrators.

Psychotherapy Research, *31*(6), 695–710. https://doi.org/10.1080/10503307.2020.1847345

Silove, D., Baker, J. R., Mohsin, M., Teesson, M., Creamer, M., O'Donnell, M., Forbes, D., Carragher, N., Slade, T., Mills, K., Bryant, R., McFarlane, A., Steel, Z., Felmingham, K., & Rees, S. (2017). The contribution of gender-based violence and network trauma to gender differences in Post-Traumatic Stress Disorder. *PLOS ONE*, *12*(2), e0171879. https://doi.org/10.1371/journal.pone.0171879

Silove, D., Sinnerbrink, I., Field, A., Manicavasagar, V., & Steel, Z. (1997). Anxiety, depression and PTSD in asylum-seekers: Assocations with pre-migration trauma and post-migration stressors. *The British Journal of Psychiatry: The Journal of Mental Science*, *170*, 351–357. https://doi.org/10.1192/bjp.170.4.351

Silove, D., Ventevogel, P., & Rees, S. (2017). The contemporary refugee crisis: An overview of mental health challenges. *World Psychiatry: Official Journal of the World Psychiatric Association (WPA)*, *16*(2), 130–139. https://doi.org/10.1002/wps.20438

Silverman, M. N., & Deuster, P. A. (2014). Biological mechanisms underlying the role of physical fitness in health and resilience. *Interface Focus*, *4*(5), 20140040. https://doi.org/10.1098/rsfs.2014.0040

Simms, L. J., Watson, D., & Doebbelling, B. N. (2002). Confirmatory factor analyses of posttraumatic stress symptoms in deployed and nondeployed veterans of the Gulf War. *Journal of Abnormal Psychology, 111*(4), 637–647. https://doi.org/10.1037/0021-843X.111.4.637

Skeffington, P. M., Rees, C. S., Mazzucchelli, T. G., & Kane, R. T. (2016). The Primary Prevention of PTSD in Firefighters: Preliminary Results of an RCT with 12-Month Follow-Up. *PLOS ONE*, *11*(7), e0155873. https://doi.org/10.1371/journal.pone.0155873

Slavish, D. C., Briggs, M., Fentem, A., Messman, B. A., & Contractor, A. A. (2022). Bidirectional associations between daily PTSD symptoms and sleep disturbances: A systematic review. *Sleep Medicine Reviews*, *63*, 101623. https://doi.org/10.1016/j.smrv.2022.101623

Sobin, L., Brierley, J. D., Gospodarowicz, M., O'Sullivan, B., & Wittekind, C. (2015). Principles of cancer staging. In *UICC Manual of Clinical Oncology* (pp. 34–39). John Wiley & Sons, Ltd. https://doi.org/10.1002/9781119013143.ch4

Solomon, D. H., Ruppert, K., Habel, L. A., Finkelstein, J. S., Lian, P., Joffe, H., & Kravitz, H. M. (2021). Prescription medications for sleep disturbances among midlife women during 2 years of follow-up: a SWAN retrospective cohort study. *BMJ open*, *11*(5), e045074.

Somaraju, A. V., Nye, C. D., & Olenick, J. (2022). A review of measurement equivalence in organizational research: What's old, what's new, what's next? *Organizational Research Methods, 25*(4), 741–785. https://doi.org/10.1177/10944281211056524

Sopp, M. R., Brueckner, A. H., Schäfer, S. K., Lass-Hennemann, J., & Michael, T. (2019). Differential effects of sleep on explicit and implicit memory for potential trauma reminders: Findings from an analogue study. *European Journal of Psychotraumatology*, *10*(1), 1644128. https://doi.org/10.1080/20008198.2019.1644128

Sopp, M. R., Friesen, E., Schäfer, S. K., Brueckner, A. H., Wirth, B. E., Weber, J., Lass-Hennemann, J., & Michael, T. (2021). Wakefulness impairs selective consolidation of relevant trauma-associated memories resulting in more frequent intrusions. *Behaviour Research and Therapy*, 136, 103776.

Sopp, M. R., Haim-Nachum, S., Braun, M. N., Lass-Hennemann, J., Schäfer, S. K., & Michael, T. (2025). How we see the world: Inflexible interpretation updating as a predictor and moderator of PTSD symptoms in high-risk occupations. *Psychological Trauma: Theory, Research, Practice, and Policy*. https://doi.org/10.1037/tra0001819

Sopp, M. R., Kirsch, A., & Michael, T. (n.d.). *1. Trauma und Gedächtnis*.

Sopp, M. R., Michael, T., & Mecklinger, A. (2018). Effects of early morning nap sleep on associative memory for neutral and emotional stimuli. *Brain Research*, 1698, 29–42.

Sopp, M. R., Michael, T., Weess, H. G., & Mecklinger, A. (2017). Remembering specific features of emotional events across time: The role of REM sleep and prefrontal theta oscillations. *Cognitive, Affective, & Behavioral Neuroscience*, 17(6), 1186–1209.

Southwick, S. M., Litz, B. T., Charney, D., & Friedman, M. J. (2011). *Resilience and Mental Health: Challenges Across the Lifespan*. Cambridge University Press.

Spear, L. P. (2009a). Heightened stress responsivity and emotional reactivity during pubertal maturation: Implications for psychopathology. *Development and Psychopathology*, *21*(1), 87–97. https://doi.org/10.1017/S0954579409000066

Spear, L. P. (2009b). Heightened stress responsivity and emotional reactivity during pubertal maturation: Implications for psychopathology. *Development and Psychopathology*, *21*(1), 87–97. https://doi.org/10.1017/S0954579409000066

Squire, L. R. (1992). Declarative and Nondeclarative Memory: Multiple Brain Systems Supporting Learning and Memory. *Journal of Cognitive Neuroscience*, *4*(3), 232–243. https://doi.org/10.1162/jocn.1992.4.3.232

Squire, L. R., Genzel, L., Wixted, J. T., & Morris, R. G. (2015). Memory Consolidation. *Cold Spring Harbor Perspectives in Biology*, *7*(8), a021766. https://doi.org/10.1101/cshperspect.a021766

Sripada, R. K., Smith, K., Walters, H. M., Ganoczy, D., Kim, H. M., Grau, P. P., Nahum-Shani, I., Possemato, K., Kuhn, E., Zivin, K., Pfeiffer, P. N., Bohnert, K. M., Cigrang, J. A., Avallone, K. M., & Rauch, S. A. M. (2023). Testing adaptive interventions to improve PTSD treatment outcomes in Federally Qualified Health Centers: Protocol for a randomized clinical trial. *Contemporary Clinical Trials*, *129*, 107182. https://doi.org/10.1016/j.cct.2023.107182

Stanton, R., & Reaburn, P. (2014). Exercise and the treatment of depression: A review of the exercise program variables. *Journal of Science and Medicine in Sport*, *17*(2), 177–182. https://doi.org/10.1016/j.jsams.2013.03.010

Stathopoulou, G., Powers, M. B., Berry, A. C., Smits, J. A. J., & Otto, M. W. (2006). Exercise Interventions for Mental Health: A Quantitative and Qualitative Review. *Clinical Psychology: Science and Practice*, *13*(2), 179–193. https://doi.org/10.1111/j.1468-2850.2006.00021.x

Steel, Z., Chey, T., Silove, D., Marnane, C., Bryant, R. A., & van Ommeren, M. (2009). Association of Torture and Other Potentially Traumatic Events With Mental Health Outcomes Among Populations Exposed to Mass Conflict and Displacement: A Systematic Review and Meta-analysis. *JAMA*, *302*(5), 537–549. https://doi.org/10.1001/jama.2009.1132

Stein, J. Y., Wilmot, D. V., & Solomon, Z. (2016). Does one size fit all? Nosological, clinical, and scientific implications of variations in PTSD Criterion A. *Journal of Anxiety Disorders*, *43*, 106–117. https://doi.org/10.1016/j.janxdis.2016.07.001

Stenmark, H., Catani, C., Neuner, F., Elbert, T., & Holen, A. (2013). Treating PTSD in refugees and asylum seekers within the general health care system. A randomized controlled multicenter study. *Behaviour Research and Therapy*, *51*(10), 641–647. https://doi.org/10.1016/j.brat.2013.07.002

Sterne, J. A. C., White, I. R., Carlin, J. B., Spratt, M., Royston, P., Kenward, M. G., Wood, A. M., & Carpenter, J. R. (2009). Multiple imputation for missing data in epidemiological and clinical research: Potential and pitfalls. *BMJ*, *338*, b2393. https://doi.org/10.1136/bmj.b2393

Steuwe, C., Blaß, J., Herpertz, S. C., & Drießen, M. (2023). Personalisierte Psychotherapie der posttraumatischen Belastungsstörung. *Der Nervenarzt*, *94*(11), 1050–1058. https://doi.org/10.1007/s00115-023-01549-6

Stewart, L. A., & Tierney, J. F. (2002). To IPD or not to IPD? Advantages and disadvantages of systematic reviews using individual patient data. *Evaluation & the health professions*, *25*(1), 76–97.

Stewart, L. A., Clarke, M., Rovers, M., Riley, R. D., Simmonds, M., Stewart, G., Tierney, J. F., for the PRISMA-IPD Development Group (2015). Preferred Reporting Items for a Systematic Review and Meta-analysis of Individual Participant Data: The PRISMA-IPD statement. *JAMA*, 313(16), 1657–1665.

Stirling, N. S., Nixon, R. D., & Takarangi, M. K. (2023). No more than discomfort: the trauma film paradigm meets definitions of minimal-risk research. *Ethics & Behavior*, *33*(1), 1–17.

Stoddard Jr, F. J., Benedek, D. M., Milad, M. R., & Ursano, R. J. (2018). *Trauma-and stressor-related disorders*. Oxford University Press.

Streb, M., Conway, M. A., & Michael, T. (2017). Conditioned responses to trauma reminders: How durable are they over time and does memory integration reduce them? *Journal of Behavior Therapy and Experimental Psychiatry*, 57, 88–95.

Streb, M., Mecklinger, A., Anderson, M. C., Lass-Hennemann, J., & Michael, T. (2016). Memory control ability modulates intrusive memories after analogue trauma. *Journal of Affective Disorders*, *192*, 134–142. https://doi.org/10.1016/j.jad.2015.12.032

Sündermann, O., Hauschildt, M., & Ehlers, A. (2013). Perceptual processing during trauma, priming and the development of intrusive memories. *Journal of Behavior Therapy and Experimental Psychiatry*, *44*(2), 213–220. https://doi.org/10.1016/j.jbtep.2012.10.001

Sun, R. W., & Cheung, S. F. (2020). The influence of nonnormality from primary studies on the standardized mean difference in meta-analysis. *Behavior Research Methods, 52*(4), 1552–1567.

Swift, J. K., & Callahan, J. L. (2009). The impact of client treatment preferences on outcome: A meta-analysis. *Journal of Clinical Psychology*, *65*(4), 368–381. https://doi.org/10.1002/jclp.20553

Swift, J. K., Callahan, J. L., & Vollmer, B. M. (2011). Preferences. *Journal of Clinical Psychology*, *67*(2), 155–165. https://doi.org/10.1002/jclp.20759

Syed, S., Ashwick, R., Schlosser, M., Jones, R., Rowe, S., & Billings, J. (2020). Global prevalence and risk factors for mental health problems in police personnel: A systematic review and meta-analysis. *Occupational and Environmental Medicine*, *77*(11), 737–747. https://doi.org/10.1136/oemed-2020-106498

Terr, L. C. (1991). Childhood Traumas: An Outline. *Annual Progress in Child Psychiatry and Child Development 1992*, 165.

Terr, L. C. (2003). Childhood traumas: An outline and overview. *Focus*, *1*(3), 322-334.

Tierney, J. F., Stewart, L. A., Clarke, M. (2022). Chapter 26: Individual participant data. In: Higgins, J. P. T., Thomas, J., Chandler, J., Cumpston, M., Li, T., Page, M. J., Welch, V. A. (eds). *Cochrane Handbook for Systematic Reviews of Interventions* version 6.3 (updated February 2022). Available from www.training.cochrane.org/handbook.

The MathWorks Inc. (2025). *MATLAB* (Version 25.1.0.2973910, R2025a). The MathWorks Inc. https://www.mathworks.com

Thompson, C. T., Vidgen, A., & Roberts, N. P. (2018). Psychological interventions for post-traumatic stress disorder in refugees and asylum seekers: A systematic review and meta-analysis. *Clinical Psychology Review*, *63*, 66–79. https://doi.org/10.1016/j.cpr.2018.06.006

Tol, W. A., Barbui, C., Bisson, J., Cohen, J., Hijazi, Z., Jones, L., Jong, J. T. V. M. de, Magrini, N., Omigbodun, O., Seedat, S., Silove, D., Souza, R., Sumathipala, A., Vijayakumar, L., Weissbecker, I., Zatzick, D., & Ommeren, M. van. (2014). World Health Organization

Guidelines for Management of Acute Stress, PTSD, and Bereavement: Key Challenges on the Road Ahead. *PLOS Medicine*, *11*(12), e1001769. https://doi.org/10.1371/journal.pmed.1001769

Tol, W. A., Barbui, C., & van Ommeren, M. (2013). Management of Acute Stress, PTSD, and Bereavement: WHO Recommendations. *JAMA*, *310*(5), 477–478. https://doi.org/10.1001/jama.2013.166723

Tolin, D. F., & Foa, E. B. (2006). Sex differences in trauma and posttraumatic stress disorder: A quantitative review of 25 years of research. *Psychological Bulletin*, *132*(6), 959–992. https://doi.org/10.1037/0033-2909.132.6.959

Torchalla, I., & Lennox, K. (2025). Tailoring PTSD Treatment for First Responders: Clinical Applications and Practice Considerations. *Journal of Contemporary Psychotherapy*. https://doi.org/10.1007/s10879-025-09711-8

Tortella-Feliu, M., Fullana, M. A., Pérez-Vigil, A., Torres, X., Chamorro, J., Littarelli, S. A., Solanes, A., Ramella-Cravaro, V., Vilar, A., González-Parra, J. A., Andero, R., Reichenberg, P. A., Mataix-Cols, P. D., Vieta, E., Fusar-Poli, P., Ioannidis, P. J. P. A., Stein, P. M. B., Radua, J., & Fernández de la Cruz, L. (2019). Risk factors for posttraumatic stress disorder: An umbrella review of systematic reviews and meta-analyses. *Neuroscience and Biobehavioral Reviews*, *107*, 154–165. https://doi.org/10.1016/j.neubiorev.2019.09.013

Trautmann, S., Goodwin, L., Höfler, M., Jacobi, F., Strehle, J., Zimmermann, P., & Wittchen, H.-U. (2017). Prevalence and severity of mental disorders in military personnel: A standardised comparison with civilians. *Epidemiology and Psychiatric Sciences*, *26*(2), 199–208. https://doi.org/10.1017/S204579601600024X

Tsai, J., Harpaz-Rotem, I., Armour, C., Southwick, S. M., Krystal, J. H., & Pietrzak, R. H. (2014). Dimensional structure of DSM-5 posttraumatic stress disorder symptoms: Results from the National Health and Resilience in Veterans Study. *The Journal of clinical psychiatry*, *76*(5), 4513.

Tulving, E. (1983). Ecphoric processes in episodic memory. *Philosophical Transactions of the Royal Society of London. B, Biological Sciences*, *302*(1110), 361–371. https://doi.org/10.1098/rstb.1983.0060

United Nations High Commissioner for Refugees UNHCR (2021). Global Report. Available at https://reporting.unhcr.org/globalreport2021/pdf (Accessed 03 December 2021)

United Nations High Commissioner for Refugees UNHCR (2022). Refugee Data Finder - Data Insights. Available at https://www.unhcr.org/refugee-statistics/insights/explainers/100-million-forcibly-displaced.html (Accessed 20 October 2022)

Vallières, F., Hyland, P., & Murphy, J. (2021). Navigating the who, where, what, when, how and why of trauma exposure and response. *European Journal of Psychotraumatology*, *12*(1), 1855903. https://doi.org/10.1080/20008198.2020.1855903

van Buuren, S. van, & Groothuis-Oudshoorn, K. (2011). mice: Multivariate Imputation by Chained Equations in R. *Journal of Statistical Software*, *45*, 1–67. https://doi.org/10.18637/jss.v045.i03

Vancampfort, D., Stubbs, B., Richards, J., Ward, P. B., Firth, J., Schuch, F. B., & Rosenbaum, S. (2017). Physical fitness in people with posttraumatic stress disorder: A systematic review. *Disability and Rehabilitation, 39*(24), 2461–2467. https://doi.org/10.1080/09638288.2016.1226412

van den Bergh, D., Wagenmakers, E.-J., & Aust, F. (2023). Bayesian Repeated-Measures Analysis of Variance: An Updated Methodology Implemented in JASP. *Advances in Methods and Practices in Psychological Science*, *6*(2), 25152459231168024. https://doi.org/10.1177/25152459231168024

van den Noortgate, W., López-López, J. A., Marín-Martínez, F., & Sánchez-Meca, J. (2015). Meta-analysis of multiple outcomes: A multilevel approach. *Behavior Research Methods*, 47(4), 1274-1294.

van der Helm, E., & Walker, M. P. (2009). Overnight therapy? The role of sleep in emotional brain processing. *Psychological Bulletin, 135*(5), 731–748.

VanderWeele, T. J. (2017). Religious Communities and Human Flourishing. *Current Directions in Psychological Science*, *26*(5), 476–481. https://doi.org/10.1177/0963721417721526

van de Schoot, R., Depaoli, S., King, R., Kramer, B., Märtens, K., Tadesse, M. G., Vannucci, M., Gelman, A., Veen, D., Willemsen, J., & Yau, C. (2021). Bayesian statistics and modelling. *Nature Reviews Methods Primers*, *1*(1), 1. https://doi.org/10.1038/s43586-020-00001-2

van Marle, H. (2015). PTSD as a memory disorder. *European Journal of Psychotraumatology*, *6*(1), 27633. https://doi.org/10.3402/ejpt.v6.27633

van Minnen, A., & Hagenaars, M. (2002). Fear activation and habituation patterns as early process predictors of response to prolonged exposure treatment in PTSD. *Journal of Traumatic Stress*, *15*(5), 359–367. https://doi.org/10.1023/A:1020177023209

van Someren, E. J. W. (2021). Brain mechanisms of insomnia: new perspectives on causes and consequences. *Physiological Reviews, 101*(3), 995–1046.

Viechtbauer, W. (2010). Conducting meta-analyses in R with the metafor package. J*ournal of statistical Software, 36*(3), 1–48.

Viechtbauer, W., & Cheung, M. W.-L. (2010). Outlier and influence diagnostics for meta-analysis. *Research Synthesis Methods, 1*(2), 112–125.

Vindbjerg, E., Makransky, G., Mortensen, E. L., & Carlsson, J. (2019). Cross-Cultural Psychometric Properties of the Hamilton Depression Rating Scale. *The Canadian Journal of Psychiatry, 64*(1), 39–46. https://doi.org/10.1177/0706743718772516

Vindegaard, N., & Benros, M. E. (2020). COVID-19 pandemic and mental health consequences: Systematic review of the current evidence. *Brain, Behavior, and Immunity*, *89*, 531–542. https://doi.org/10.1016/j.bbi.2020.05.048

Vogt, D. S., King, D. W., & King, L. A. (2007). Risk pathways for PTSD. *Handbook of PTSD: Science and Practice*, 99–115. Guilford Press.

von Hippel, P. T. (2007). 4. Regression with Missing Ys: An Improved Strategy for Analyzing Multiply Imputed Data. *Sociological Methodology*, *37*(1), 83–117. https://doi.org/10.1111/j.1467-9531.2007.00180.x

von Hippel, P. T. (2015). The heterogeneity statistic I^2 can be biased in small meta-analyses. *BMC medical research methodology, 15*(1), 1–8.

Wallace, M. L., Frank, E., & Kraemer, H. C. (2013). A Novel Approach for Developing and Interpreting Treatment Moderator Profiles in Randomized Clinical Trials. *JAMA Psychiatry*, *70*(11), 1241–1247. https://doi.org/10.1001/jamapsychiatry.2013.1960

Wang, Y., Chung, M. C., Wang, N., Yu, X., & Kenardy, J. (2021). Social support and posttraumatic stress disorder: A meta-analysis of longitudinal studies. *Clinical Psychology Review*, *85*, 101998. https://doi.org/10.1016/j.cpr.2021.101998

Weathers, F. W., Blake, D. D., Schnurr, P. P., Kaloupek, D. G., Marx, B. P., & Keane, T. M. (2013a). *The Life Events Checklist for DSM-5 (LEC-5)*. U.S. Department of Veterans

Affairs. https://www.ptsd.va.gov/professional/assessment/te-measures/life_events_checklist.asp

Weathers, F. W., Blake, D. D., Schnurr, P. P., Kaloupek, D. G., Marx, B. P., & Keane, T. M. (2013). *The Clinician- Administered PTSD Scale for DSM-5 (CAPS-5).*

Weathers, F. W., Bovin, M. J., Lee, D. J., Sloan, D. M., Schnurr, P. P., Kaloupek, D. G., Keane, T. M., & Marx, B. P. (2018a). The Clinician-Administered PTSD Scale for DSM–5 (CAPS-5): Development and initial psychometric evaluation in military veterans. *Psychological Assessment*, *30*(3), 383–395. https://doi.org/10.1037/pas0000486

Weber, S. R., & Pargament, K. I. (2014). The role of religion and spirituality in mental health. *Current Opinion in Psychiatry*, *27*(5), 358. https://doi.org/10.1097/YCO.0000000000000080

Weiss, D. S. (2007). The Impact of Event Scale: Revised. In J. P. Wilson & C. S.-k. Tang (Eds.), *Cross-cultural assessment of psychological trauma and PTSD* (pp. 219–238). Springer Science.

Wegerer, M., Blechert, J., Kerschbaum, H., & Wilhelm, F. H. (2013). Relationship between fear conditionability and aversive memories: Evidence from a novel conditioned-intrusion paradigm. *PLoS ONE*, *8*(11), e79025.

Wegner, M., Helmich, I., Machado, S., E. Nardi, A., Arias-Carrion, O., & Budde, H. (2014). Effects of Exercise on Anxiety and Depression Disorders: Review of Meta- Analyses and Neurobiological Mechanisms. *CNS & Neurological Disorders - Drug Targets, 13*(6), 1002–1014. https://doi.org/10.2174/1871527313666140612102841

Werner, G. G., Schabus, M., Blechert, J., & Wilhelm, F. H. (2021). Differential effects of rem sleep on emotional processing: initial evidence for increased short-term emotional responses and reduced long-term intrusive memories. *Behavioral Sleep Medicine, 19*(1), 83–98.

Wiers, R. W., Boffo, M., & Field, M. (2018). What's in a trial? On the importance of distinguishing between experimental lab studies and randomized controlled trials: The case of cognitive bias modification and alcohol use disorders. *Journal of Studies on Alcohol and Drugs, 79*(3), 333–343.

Wiggs, C. L., & Martin, A. (1998). Properties and mechanisms of perceptual priming. *Current Opinion in Neurobiology*, *8*(2), 227–233. https://doi.org/10.1016/S0959-4388(98)80144-X

Williams, D. R., & Mohammed, S. A. (2009). Discrimination and racial disparities in health: Evidence and needed research. *Journal of Behavioral Medicine*, *32*(1), 20–47. https://doi.org/10.1007/s10865-008-9185-0

Wilhelm, I., Azza, Y., Brennwald, K., Ehrt-Schäfer, Y., Seifritz, E., & Kleim, B. (2021). Investigating the effect of a nap following experimental trauma on analogue PTSD symptoms. *Scientific Reports*, *11*(1), 4710.

Wisco, B. E., Baker, A. S., & Sloan, D. M. (2016). Mechanisms of Change in Written Exposure Treatment of Posttraumatic Stress Disorder. *Behavior Therapy*, *47*(1), 66–74. https://doi.org/10.1016/j.beth.2015.09.005

Wittmann, J., Groß, M., Catani, C., Schmidt, T., Neldner, S., Wilker, S., May, T., Ertl, V., Rosner, R., Zindler, A., Odenwald, M., & Neuner, F. (2022). The efficacy of Narrative Exposure Therapy for Children (KIDNET) as a treatment for traumatized young refugees versus treatment as usual: Update to the study protocol for the multi-center randomized controlled trial YOURTREAT. *Trials*, *23*(1), 360. https://doi.org/10.1186/s13063-022-06288-8

Wojujutari, A. K., Idemudia, E. S., & Ugwu, L. E. (2024). The assessment of reliability generalisation of clinician-administered PTSD scale for DSM-5 (CAPS-5): A meta-analysis. *Frontiers in Psychology*, *15*. https://doi.org/10.3389/fpsyg.2024.1354229

Woodward, A., Fuhr, D. C., Barry, A. S., Balabanova, D., Sondorp, E., Dieleman, M. A., Pratley, P., Schoenberger, S. F., McKee, M., Ilkkursun, Z., Acarturk, C., Burchert, S., Knaevelsrud, C., Brown, F. L., Steen, F., Spaaij, J., Morina, N., de Graaff, A. M., Sijbrandij, M., … Roberts, B. (2024). Health system responsiveness to the mental health needs of Syrian refugees: Mixed-methods rapid appraisals in eight host countries in Europe and the Middle East. *Open Research Europe*, *3*, 14. https://doi.org/10.12688/openreseurope.15293.2

World Health Organization. (2018). *International Statistical Classification of Diseases and Related Health Problems,* (11th ed., rv.).

World Health Organization. (2022). *Global Recommendations on Physical Activity for Health.* World Health Organization.

Wortmann, J. H., Jordan, A. H., Weathers, F. W., Resick, P. A., Dondanville, K. A., Hall-Clark, B., Foa, E. B., Young-McCaughan, S., Yarvis, J. S., Hembree, E. A., Mintz, J., Peterson, A. L., & Litz, B. T. (2016). Psychometric analysis of the PTSD Checklist-5 (PCL-5) among treatment-seeking military service members. Psychological Assessment, 28(11), 1392–1403. https://doi.org/10.1037/pas0000260

Woud, M. L., Cwik, J. C., Blackwell, S. E., Kleim, B., Holmes, E. A., Adolph, D., Zhang, H., & Margraf, J. (2018). Does napping enhance the effects of Cognitive Bias Modification-Appraisal training? An experimental study. *PLoS ONE*, *13*(2), e0192837.

Woud, M. L., Blackwell, S. E., Shkreli, L., Würtz, F., Cwik, J. C., Margraf, J., ... & Kessler, H. (2021). The effects of modifying dysfunctional appraisals in posttraumatic stress disorder using a form of cognitive bias modification: results of a randomized controlled trial in an inpatient setting. *Psychotherapy and Psychosomatics*, *90*(6), 386–402.

Wright, L., Horstmann, L., Holmes, E. A., & Bisson, J. I. (2021). Consolidation/reconsolidation therapies for the prevention and treatment of PTSD and re-experiencing: A systematic review and meta-analysis. *Translational Psychiatry*, *11*(1), 453. https://doi.org/10.1038/s41398-021-01570-w

Wright, S. L., Karyotaki, E., Sijbrandij, M., Cuijpers, P., Bisson, J. I., Papola, D., Witteveen, A. B., Back, S. E., Bichescu-Burian, D., Capezzani, L., Cloitre, M., Devilly, G. J., Elbert, T., Mello, M. F., Ford, J. D., Grasso, D., Gray, R., Haller, M., Hunt, N., … Seedat, S. (2025). Efficacy of cognitive behavioral therapies with a trauma focus for posttraumatic stress disorder: An individual participant data meta-analysis. *Journal of Consulting and Clinical Psychology*, *93*(6), 401–426. https://doi.org/10.1037/ccp0000942

Wright, A., Reisig, A., & Cullen, B. (2020). Efficacy and cultural adaptations of narrative exposure therapy for trauma-related outcomes in refugees/asylum-seekers: A systematic review and meta-analysis. *Journal of Behavioral and Cognitive Therapy,* 30(4), 301-314. https://doi.org/10.1016/j.jbct.2020.10.003

Xue, C., Ge, Y., Tang, B., Liu, Y., Kang, P., Wang, M., & Zhang, L. (2015). A Meta-Analysis of Risk Factors for Combat-Related PTSD among Military Personnel and Veterans. *PLOS ONE*, *10*(3), e0120270. https://doi.org/10.1371/journal.pone.0120270

Yehuda, R. (2002). Post-Traumatic Stress Disorder. *New England Journal of Medicine*, *346*(2), 108–114. https://doi.org/10.1056/NEJMra012941

Yehuda, R. (2004). Risk and resilience in posttraumatic stress disorder. *Journal of Clinical Psychiatry*, *65*, 29-36.

Yehuda, R., Hoge, C. W., McFarlane, A. C., Vermetten, E., Lanius, R. A., Nievergelt, C. M., Hobfoll, S. E., Koenen, K. C., Neylan, T. C., & Hyman, S. E. (2015). Post-traumatic stress disorder. *Nature Reviews Disease Primers*, *1*(1), 1–22. https://doi.org/10.1038/nrdp.2015.57

Yonelinas, A. P. (2002). The nature of recollection and familiarity: A review of 30 years of research. *Journal of Memory and Language*, 46(3), 441–517.

Youssef, N. A., Lockwood, L., Su, S., Hao, G., & Rutten, B. P. F. (2018). The Effects of Trauma, with or without PTSD, on the Transgenerational DNA Methylation Alterations in Human Offsprings. *Brain Sciences*, *8*(5), 83. https://doi.org/10.3390/brainsci8050083

Zeng, S., Lau, E. Y. Y., Li, S. X., & Hu, X. (2021). Sleep differentially impacts involuntary intrusions and voluntary recognitions of lab-analogue traumatic memories. *Journal of Sleep Research*, *30*(3), e13208.

Ziegler, M., & Bensch, D. (2013). Lost in Translation: Thoughts Regarding the Translation of Existing Psychological Measures Into Other Languages. *European Journal of Psychological Assessment*. https://econtent.hogrefe.com/doi/10.1027/1015-5759/a000167

Zlotnick, C., Rodriguez, B. F., Weisberg, R. B., Bruce, S. E., Spencer, M. A., Culpepper, L., & Keller, M. B. (2004). Chronicity in posttraumatic stress disorder and predictors of the course of posttraumatic stress disorder among primary care patients. *The Journal of Nervous and Mental Disease*, *192*(2), 153–159.

Appendices

Appendix A. Supplementary Materials for *Study 1*

A1 Differences From the Protocol of the Review (OSF identifier: 10.17605/OSF.IO/4DH2V)

Table A1

Changes From Protocol to Final Review

	Protocol	**Final review**
Review design	no changes	
Review question	What are the effects of post-trauma sleep versus wakefulness on the frequency of intrusive memories after analog trauma? Is sleep versus wakefulness also related to intrusion-related distress?	Additional focus on the effects of post-trauma sleep on implicit and explicit trauma memory and associations of intrusion frequency/distress with sleep physiology
Eligibility criteria	no changes	
Search strategy	no changes	
Data Extraction	no changes	
Risk of bias	no changes	
Certainty of evidence	no changes	
Qualitative synthesis	Qualitative synthesis on study populations, experimental manipulations and measurement of intrusion frequency and intrusion distress	As specified in the protocol plus synthesis on effects of post-trauma sleep on explicit and implicit trauma memory and summary of evidence for physiological correlates of intrusive memories
Meta-Analysis on aggregated data	no changes	
Individual participant data	Intrusion-related distress will be defined as quotient (i.e., intrusion-related distress = total score of reported distress / frequency of intrusions).	For the final review, we divided the severity of reported distress levels by the number of intrusions, whose result was further divided by the range of distress assessment (i.e., intrusion distress = [total score of reported distress / frequency of intrusions] / range of distress assessment). → This has been done to facilitate between-study comparisons and had no impact on our results.
Analysis of subgroups and subsets	Potential moderators: […] nap design vs. whole night design, home-based vs. lab-based studies	Due to a small number of studies moderator analyses on categorical variables could not be performed. Moreover, we examined the number of follow-up assessments as moderator, which has not been specified in the protocol.

Table A1 (continued.)

	Protocol	**Final review**
Assessment of heterogeneity	Forest plots (95% CIs), I^2, Cochran's Q statistic,	We additionally used 95% prediction intervals as indicator of heterogeneity.
Assessment of publication bias	Not specified	Visual inspection of (contour-enhanced) funnel plots and visual inspection of funnel plots and rank correlation tests (Kendall's τ) to examine their symmetry (Egger et al., 1997)
Sensitivity analyses	no changes	

A2 Search Strategy

1. EBSCOhost

#	Component	**Query**
4		#1 AND #2 AND #3
3	analog	TI (film OR clip OR movie OR video OR "picture stor*" OR "photo stor*" OR "analogue" OR "analog") OR AB (film OR clip OR movie OR video OR "picture stor*" OR "photo stor*" OR "analogue" OR "analog") OR SU (film OR clip OR movie OR video OR "picture stor*" OR "photo stor*" OR "analogue" OR "analog")
2	trauma	TI (intrusi* OR trauma* OR PTSD OR "post-traumatic stress" OR "post traumatic stress" OR "posttraumatic stress" OR "posttraumatic stress disorder") OR AB (intrusi* OR trauma* OR PTSD OR "post-traumatic stress" OR "post traumatic stress" OR "posttraumatic stress" OR "posttraumatic stress disorder") OR SU (intrusi* OR trauma* OR PTSD OR "post-traumatic stress" OR "post traumatic stress" OR "posttraumatic stress" OR "posttraumatic stress disorder")
1	sleep	TI sleep OR AB sleep OR SU sleep
Results (2022/05/16)		79

2. PTSDPubs

#	Component	**Query**
4		#1 AND #2 AND #3
3	analog	ti(film OR clip OR movie OR video OR „picture stor*“OR „photo stor*“ OR „analogue“ OR „analog“) OR ab(film OR clip OR movie OR video OR „picture stor*“OR „photo stor*“ OR „analogue“ OR „analog“) OR su(film OR clip OR movie OR video OR „picture stor*“OR „photo stor*“ OR „analogue“ OR „analog“)
2	trauma	ti(intrusi* OR trauma* OR PTSD OR „post-traumatic stress“ OR „post traumatic stress“ OR „posttraumatic stress“ OR „posttraumatic stress disorder“) OR ab(intrusi* OR trauma* OR PTSD OR „post-traumatic stress“ OR „post traumatic stress“ OR „posttraumatic stress“ OR „posttraumatic stress disorder“) OR su(intrusi* OR trauma* OR PTSD OR „post-traumatic stress“ OR „post traumatic stress“ OR „posttraumatic stress“ OR „posttraumatic stress disorder“)
1	sleep	ti(sleep) OR ab(sleep) OR su(sleep)
Results (2022/05/16)		28

3. PubMed

#	Component	**Query**
4		#1 AND #2 AND #3
3	analog	((((((((((film[Title/Abstract]) OR (clip[Title/Abstract])) OR (movie[Title/Abstract])) OR (video[Title/Abstract])) OR ("picture stor*"[Title/Abstract])) OR ("photo stor*"[Title/Abstract]) OR (film[Other Term])) OR (clip[Other Term])) OR (movie[Other Term])) OR (video[Other Term])) OR ("picture stor*"[Other Term])) OR ("photo stor*"[Other Term]) "analogue"[Title/Abstract]) OR (analog[Title/Abstract]) OR (analogue[Other Term]) OR (analog[Other Term])
2	trauma	((((((((((((intrusi*[Title/Abstract]) OR (trauma*[Title/Abstract])) OR (PTSD[Title/Abstract])) OR ("posttraumatic stress"[Title/Abstract])) OR ("post-traumatic stress"[Title/Abstract])) OR ("post traumatic stress"[Title/Abstract])) OR (ptsd[MeSH Terms])) OR (posttraumatic stress disorder[MeSH Terms])) OR (intrusi*[Other Term])) OR (trauma*[Other Term])) OR (ptsd[Other Term])) OR ("posttraumatic stress"[Other Term])) OR ("post-traumatic stress"[Other Term])) OR ("post traumatic stress"[Other Term])
1	sleep	((sleep[Title/Abstract]) OR (sleep[Other Term])) OR (sleep[MeSH Terms])
Results (2022/05/16)		35

4. Scopus

#	Component	**Query**
4		#1 AND #2 AND #3
3	analog	(TITLE-ABS-KEY ("film" OR "clip" OR "movie" OR "video" OR "picture stor*" OR "photo stor*" OR "analogue" OR "analog"))
2	trauma	(TITLE-ABS-KEY ("intrusi*" OR "trauma*" OR "ptsd" OR "post-traumatic stress" OR "post traumatic stress" OR "posttraumatic stress" OR "posttraumatic stress disorder"))
1	sleep	(TITLE-ABS-KEY ("sleep"))
Results (2022/05/16)		308

5. Web of Science

#	Component	**Query**
4		#1 AND #2 AND #3
3	analog	film OR clip OR movie OR video OR "picture stor*" OR "photo stor*" OR "analogue" OR "analog”(Topic)
2	trauma	intrusi* OR trauma* OR PTSD OR "post-traumatic stress" OR "post traumatic stress" OR "posttraumatic stress" OR "posttraumatic stress disorder" (Topic)
1	sleep	Sleep (Topic)
Results (2022/05/16)		174

A3 Details on Model Selection

All models were examined to fit our data based on residual distributions (i.e., under- and overdispersion, zero-inflation, normal distribution [Kolmogorov-Smirnov]; Borhan et al., 2020; Perumean-Chaney et al., 2013). For intrusion frequency as count variable, our analyses started with a Poisson model, which was checked for overdispersion. Due to overdispersal residuals, we decided to use zero-inflated negative binominal models, which model the occurrence and absence of intrusions separately. Specifically, the zero part of the model provides information on the occurrence of any (vs. no) intrusions, and the count part of the model estimates the severity of intrusions. In contrast to (negative binominal) hurdle models, zero-inflated negative binominal models assume that zeros may result from two processes: One specific to the occurrence of zeros (as assumed in hurdle models) and as the lower end of the severity distribution (Feng, 2021; Gurmu & Trivedi, 1996). As it is not yet clear what model suits (analog) PTSD symptoms best (Jaffe et al., 2017; Rehder & Bowen, 2019), we based our model choice on model fit (Akaike information criterion [AIC], Bayesian information criterion [BIC]), and residual diagnostics. For intrusion distress as a continuous variable, we started with a Gaussian distribution and checked residual distributional assumptions. Due to significant zero inflation, intrusion distress was modeled using a hurdle model for semi-continuous data, which was found to be superior to similar zero-inflated gamma distribution models. Moreover, all models allowed for random intercepts per study. The inclusion of random slopes per study was evaluated based on the change in model fit using a likelihood ratio test (LRT).

A4 The Relationship Between Sleep Physiology and Intrusions

Four studies assessed polysomnography and reported correlation analyses between sleep physiology and intrusions. Of these studies, one study provided support for a role of slow wave sleep (SWS) in modulating intrusive memories. Sopp et al. (2021) examined Non-REM sleep duration, SWS duration, slow wave activity as well as sleep spindles, and found that only SWS duration (% and min) was significantly and negatively correlated with intrusion frequency. Another study found support for an involvement of REM sleep. Werner et al. (2021) examined REM sleep duration and found evidence for a consistent pattern of negative correlations between REM sleep duration (% and min) and delayed (day 3) intrusion frequency, duration, and aversiveness. Finally, two studies provided evidence for the involvement of both Non-REM

and REM sleep. Kleim et al. (2016) examined all sleep stages, sleep spindles, and rapid eye movements during REM sleep. They found evidence for negative correlations between stage 2 sleep and parietal fast sleep spindles (13–15 Hz) and intrusion frequency. By contrast, they found that stage 1 sleep, more time spent awake after sleep onset, and rapid eye movements were positively correlated with intrusion frequency. Wilhelm et al. (2021) examined REM sleep duration, REM sleep theta activity, slow wave activity, and spindle activity. They found that REM sleep and slow wave activity were negatively correlated with intrusion distress. REM theta activity was negatively correlated with intrusion frequency. However, the latter correlation did not survive correction for multiple comparisons.

A5 Details on Effects on Explicit and Implicit Trauma Memory

Our summary the effects of sleep on trauma memory follows the differentiation of explicit and implicit trauma memory proposed by Kuriyama et al. (2010).

Effects of Sleep on Explicit Trauma Memory.

Two studies investigated the impact of sleep as opposed to sleep deprivation during the nighttime on explicit trauma memory using a *visual* recognition memory test. Porcheret et al. (2019) examined visual recognition memory at day 2 after a night of sleep in both groups using 11 images from the trauma film and 11 new images. Participants were asked to indicate for each image whether the image had been shown in the trauma film or not. Analyses indicated that participants of the sleep group recognized significantly more images from the trauma film than participants from the sleep deprivation group, with no evidence for a difference in correctly rejected new images. Zeng et al. (2021) conducted an immediate (day 1; morning-after sleep / sleep deprivation) and delayed (day 8) visual recognition memory test using 60 screenshots from the trauma film as old stimuli, with half of them containing aversive scenes and the other half depicting neutral scenes. Sixty new screenshots (30 negative, 30 neutral) were selected from similar, but unwatched films. Analyses revealed that participants of the sleep group had better recognition memory than participants of the sleep deprivation group on day 1. These differences emerged because the sleep group showed a higher rate of correct rejections to new neutral pictures. No evidence for between-group differences emerged on day 8.

Two studies investigated the impact of sleep as opposed to wakefulness during the day- or nighttime on explicit trauma memory using a *visual* recognition memory test that differentiated between divergent retrieval processes. That is, studies differentiated between recollection- and familiarity-based retrieval, which is important since only recollection is linked to episodic contextually rich memories (Yonelinas, 2002). Sopp et al. (2019) assessed explicit memory of traumatic picture stories by presenting 30 objects that had been embedded into the picture stories and 30 new objects. After awakening or sleep deprivation in the second night half, participants were asked to indicate for each object whether it had been presented in the picture stories or not. For each object that they identified as 'old', they were additionally asked to indicate whether their recognition judgement was based on remembering details of its previous presentation ("Remember") or on a feeling of "knowing" ("Know"). Analyses revealed that participants of the sleep group showed higher recollection-based recognition memory than participants of the partial sleep deprivation group. No evidence for a difference emerged for familiarity-based recognition memory. In a follow-up study, Sopp et al. (2021) investigated explicit memory for relevant and irrelevant objects that were presented in traumatic picture stories. Participants were exposed to picture stories that contained 48 relevant and 48 irrelevant objects, which were supplemented with 96 new items during a recognition test at baseline (after viewing the picture stories) and after sleep or wakefulness during daytime. Again, recollection and familiarity-based recognition were differentiated during the test phase. Results revealed higher recognition memory for relevant objects in the sleep as compared to the wake group. There was no evidence of a difference for irrelevant objects.

Two studies investigated the impact of (nap) sleep as opposed to wakefulness during the day- or nighttime on explicit trauma memory using a *verbal* recognition memory test. Woud et al. (2018) used seven questions about aspects of the film to assess explicit memory of the trauma film seven days post-sleep intervention. Each question was followed by two answers and participants had to choose one. Analyses did not reveal any significant differences between the nap and wake group. Porcheret et al. (2019) asked participants to perform a verbal explicit memory task, which required them to rate if 32 written statements relating to the trauma film were true or false. The test took place on day 2 after a night of sleep in both groups. No differences were evident between the sleep and sleep deprivation group.

Effects of Sleep on Implicit Trauma Memory.

One study investigated the impact of sleep as opposed to partial sleep deprivation on implicit trauma memory, assessed in terms of *processing fluency*. Prior to conducting the explicit memory test described above, Sopp et al. (2019) presented half of the objects from the traumatic picture stories and 20 distractor objects in a blurred picture identification task. Participants were asked to label the blurred objects as soon as they recognized them. No evidence for a between-group difference emerged.

Four studies investigated the impact of (nap) sleep as opposed to wakefulness on implicit trauma memory, assessed in terms of *fear ratings*. Porcheret et al. (2019) measured fearfulness on a visual analog scale for images from the trauma film and for neutral pictures of similar content that were not used in the recognition task. Participants gave their ratings immediately before the trauma film, after the trauma film, and on day 2 after a night of sleep in both groups. No evidence for reliable differences emerged between groups. During the recognition memory test in the study by Zeng et al. (2021), participants were additionally asked to provide a fear rating for each old and new image. Analyses revealed a decline in fear ratings over time in the wake group, but not in the sleep group. However, no evidence for group differences was found neither at immediate nor at delayed test and the decline of fear ratings over time in the wake group was driven by heightened fear ratings in the sleep deprivation group in the immediate test. In the study of Werner et al. (2021), 20 aversive and 20 neutral pictures were rated prior to sleep (i.e., no REM sleep, REM awakening, REM sleep), immediately after (+ 15 min), and after a longer delay (+ 1 hour). Aversiveness was rated on a visual analog scale. There was no evidence for reliable between-group differences. Finally, Wilhelm et al. (2021) used 11 pictures from the trauma film to assess emotional responses 8 days after exposure to the traumatic material. Before and after viewing aversive pictures, subjective mood and arousal were measured by two visual analog scales as well as current affective state using a questionnaire. Analyses revealed that mood generally decreased across presentation and that this effect was less pronounced in the nap group as compared to the wake group. There was no evidence for other between-group differences.

A6 Certainty of Evidence Domains and Justifying Downgrading or Upgrading

		Intrusion frequency		Intrusion distress
Domains	**Decision**	**Reasons for downgrading/upgrading certainty of evidence**	**Decision**	**Reasons for downgrading/upgrading certainty of evidence**
Risk of bias (checklist based on previous research)	↓	Downgraded for the inclusion of non-randomized studies. However, high experimental control in all studies.	↓	Downgraded for the inclusion of non-randomized studies. However, high experimental control in all studies.
Inconsistency	–	Not downgraded due to low proportion of variability related to true heterogeneity rather than chance as indicated by I^2 = 9.95% and an insignificant Q statistic.	–	Not downgraded due to low proportion of variability related to true heterogeneity rather than chance as indicated by I^2 = 0.94% and an insignificant Q statistic.
Indirectness	–	Not downgraded as all studies addressed the review question.	–	Not downgraded as the majority of included studies addressed the review question.
Imprecision	–	Not downgraded as $n > 500$ and the calculation of optimal information size ($\alpha = .05$, $\beta = .90$, $SMD = .31$) resulted in a total sample size of 454 participants (compared to n = 531/479 in our analyses).	↓↓	Downgraded as fewer than 400 participants in the meta-analysis (n = 348/329). Moreover, insufficient power based on optimal information size ($\alpha = .05$, $\beta = .90$, $SMD = .20$) to detect an at least small effect.
		Intrusion frequency	**Intrusion distress**	
Domains	**Decision**	**Reasons for downgrading/upgrading certainty of evidence**	**Decision**	**Reasons for downgrading/upgrading certainty of evidence**
Publication bias	–	Not downgraded as the exploratory inspection of funnel plots did not provide any evidence for the presence of a substantial publication bias.	–	Not downgraded as the exploratory inspection of funnel plots did not provide any evidence for the presence of a substantial publication bias.
Overall rating		⊕⊕⊕◯ **Moderat**		⊕◯◯◯ **Very low**

Note. Certainty of evidence ratings based on GRADE (Grading of Recommendations, Assessment, Development and Evaluations; Schünemann et al., 2019). Criteria for upgrading of certainty were not applicable.

↓ Downgrading of certainty

– No downgrading of certainty

Appendix B. Supplementary Materials for *Study 2*

B1 Table B1

Item Mapping of Common PTSD Models

		DSM-5 model	Dysphoria model	Dysphoric arousal model	Anhedonia model	Externalizing behavior model	Hybrid model
PTSD symptoms		Four factors	Four factors	Five factors	Six factors	Six factors	Seven factors
Items of the PCL-5							
1	Intrusive memories	R	R	R	R	R	R
2	Disturbing dreams	R	R	R	R	R	R
3	Flashbacks	R	R	R	R	R	R
4	Cued emotional distress	R	R	R	R	R	R
5	Cued strong physiological responses	R	R	R	R	R	R
6	Avoidance of memories, thoughts, or feelings	AV	AV	AV	AV	AV	AV
7	Avoidance of external reminders	AV	AV	AV	AV	AV	AV
8	Selective memory impairment	NACM	D	NACM	NA	N	NA
9	Negative beliefs	NACM	D	NACM	NA	N	NA
10	Blaming	NACM	D	NACM	NA	N	NA
11	Negative emotions	NACM	D	NACM	NA	N	NA
12	Loss of interest	NACM	D	NACM	AN	N	AN
13	Social withdrawal	NACM	D	NACM	AN	N	AN
14	Difficulty experiencing positive emotions	NACM	D	NACM	AN	N	AN
15	Irritability or aggression	AAR	D	DA	DA	EB	EB
16	Risky or self-destructive behaviors	AAR	AAR	DA	DA	EB	EB
17	Hypervigilance	AAR	AAR	AA	AA	AA	AA
18	Increased startle response	AAR	AAR	AA	AA	AA	AA
19	Concentration problems	AAR	D	DA	DA	DA	DA
20	Sleep disturbances	AAR	D	DA	DA	DA	DA

Note. AAR: alterations in arousal and reactivity; AA: anxious arousal; AN: anhedonia; AV: avoidance; D: dysphoria; DA: dysphoric arousal; EB: externalizing behavior; N: numbing; NA: negative affect; NACM: negative alterations in cognitions and mood; R: re-experiencing.

B2 Table B2

Overview of Exposure to Traumatic Life Events: Frequency and Distribution

	German subsample $n = 233$		Arabic subsample $n = 261$		Total sample $n = 494$	
	Count	%	Count	%	Count	%
Traumatic life event[1]	818	32.62	1683	67.38	2508	-
Natural disaster	44	5.38	73	4.34	117	4.67
Fire or explosion	41	5.01	176	10.46	217	8.65
Transport accident	118	14.43	153	9.09	271	10.81
Serious accident at work or home, or during a recreational activity	56	6.85	109	6.48	165	6.58
Exposure to a toxic substance	11	1.34	43	2.55	54	2.15
Physical assault	88	10.76	139	8.26	227	9.05
Assault with a weapon	32	3.91	147	8.73	179	7.14
Sexual assault	28	3.42	27	1.60	55	2.19
Other unwanted or uncomfortable sexual experience	81	9.90	31	1.84	112	4.47
Combat or exposure to a war zone	4	0.49	174	10.34	178	7.10
Captivity (e.g., being kidnapped, abducted, held hostage, held as a prisoner of war)	2	0.24	93	5.53	95	3.79
Life-threatening illness or injury	108	13.20	72	4.28	180	7.18
Severe human suffering	83	10.15	154	9.15	237	9.45
Sudden violent death (e.g., homicide, suicide)	18	2.20	68	4.04	86	3.43
Sudden accidental death	17	2.08	77	4.58	94	3.75
Serious injury, harm, or death you caused to someone else	7	0.86	39	2.32	46	1.83
Any other highly stressful event or experience	80	9.78	108	6.42	195	7.78

Table B2 (continued.)

Cumulative number of trauma types	German subsample $n = 233$		Arabic subsample $n = 261$		Total sample $n = 494$	
	Count	%	Count	%	Count	%
One trauma type	49	21.03	20	7.66	69	13.97
Two trauma types	48	20.60	22	8.43	70	14.17
More than two trauma types	136	58.37	219	83.91	355	71.86

Note. [1]Traumatic events experienced or witnessed, according to the LEC-5.

B3 Participant Informed Consent Form, English Version

Participants' Declaration of Consent

Study on the cross-cultural validation of a questionnaire on post-traumatic stress disorder

Dear Participants,

we appreciate your participation in this study, which is being conducted by the Division of Clinical Psychology and Psychotherapy at Saarland University (chair: Prof. Dr. Tanja Michael) and the Department of Medical Psychology and Medical Sociology at the University of Leipzig (chair: Prof. Dr. Anja Mehnert-Theuerkauf). The objective of this study is to assess the validity of the Posttraumatic Stress Disorder Checklist for DSM-5 (PCL-5; Weathers et al., 2013). The following survey includes questions about personal information, gender, age, country of origin, family and educational background, migration/refugee status, as well as specific questions about your psychological well-being. The questions about your psychological well-being are taken from established questionnaires.

---- At this point, the participants were given detailed information about the background of the study----

(detailed version on request to charina.lueder@unisaarland.de)

Your participation in this (online) survey is voluntary. By giving your consent, you are not entering into any obligations. Your participation is free of charge. You can withdraw from the survey at any time without giving reasons and without any disadvantages. However, we would like to point out that data analyses will only be conducted on fully completed questionnaires. All personal information will be kept strictly confidential. The data collected will be processed and published in an anonymized form, ensuring that no conclusions can be drawn about the subject's identity. The data will be used for research purposes only. The study has been submitted and approved by the Ethics Committee of Saarland University. The objectives, planning, proposed practical implementation, safety measures and clarification fully meet the requirements for such a project.

Declaration of Consent

To consent to voluntary participation in the study, please check the following two statements:

- o I hereby confirm that I have carefully read and understood the preceding information, including the subject information and the declaration on the handling of collected data. I

am aware of the aim, procedure, and conduct of the study. I was given time to reconsider my participation, and I am aware that I can ask further questions at any time. I understand that I can withdraw at any time or refuse to answer any question without giving a reason and without consequences of any kind.

- o I hereby agree to voluntarily participate in the study on the cross-cultural validation of the PCL-5.

If you have any questions, do not hesitate to contact *charina.lueder@uni-saarland.de.*

Appendix C. Supplementary Materials for *Study 3*

C1 Psychological Assessment

Posttraumatic Stress Disorder

PTSD Checklist for DSM-5

The PCL-5 is a 20 item self-report questionnaire assessing the 20 DSM-5 PTSD criteria on a five-point Likert scale ranging from 'not at all' to 'extremely'. A score higher than 33 is indicative of probable PTSD (Blevins et al., 2015; Krüger-Gottschalk et al., 2017; Nesterko et al., 2020). Previous studies in refugee samples reported Cronbach's α from α = .93 - .97 for different language versions (Ibrahim et al., 2018a, Nesterko et al., 2020). The questionnaire serves to screen for inclusion criteria and precedes the detailed assessment of PTSD symptoms.

Clinician-Administered PTSD Scale

PTSD symptom severity is assessed with the Clinician-Administered PTSD Scale for DSM-V (CAPS; Weathers et al., 2013a). The CAPS is a structured interview, which is the gold standard in the diagnosis of PTSD. The German version of the CAPS, which is translated by Interpreters during the interview, shows sound psychometric properties (Müller-Engelmann et al., 2020).

War and Adversity Exposure Checklist

Experienced traumatic events are examined using the War and Adversity Exposure Checklist (WAEC; Ibrahim et al., 2018b), which consists of 26 items assessing different traumatic events. The WAEC combines items from various instruments that examine traumatic events such as the Life Events Checklist for DSM-5 (Weathers et al., 2013b) and the War Exposure Scale (Ibrahim et al., 2018b). The WAEC shows good internal consistency (Cronbach's α = .88) (Ibrahim et al., 2019).

Depression

Hopkins Symptom Checklist-25

The HSCL-25 (based on Derogatis et al., 1974) is a 25 item self-report questionnaire assessing depression (15 items) and anxiety (10 items) on two subscales. Each item is answered on a four-point Likert scale ranging from 'not at all' to 'extremely'. A subscore for depression, anxiety, and a total score (measuring general psychological distress due to anxiety and depression

symptoms) can be determined. Both subscales and the total score show good internal consistencies with Cronbach's α = .84 - .94 (Glaesmer et al., 2014). The HSCL-25 has already been successfully implemented in a sample of refugees (Lavik et al., 1999) and asylum seekers (Jakobsen et al., 2011).

Hamilton Depression Scale

The HAM-D (Hamilton, 1960; 1967) is the most widely used clinician administered depression assessment scale, that is cross-culturally validated (Vindbjerg et al., 2019). The HAM-D has been used to examine depressive symptoms in refugees (e.g., Stenmark et al., 2013). The main part of the clinical interview consists of 17 items. Four further items have been added to the interview to assess subtype of depression. The assessment of mild depressive symptoms leads to inclusion.

General Mental Distress

Brief Symptom Checklist

General mental distress is measured using the Brief Symptom Checklist (BSCL; Franke, 2017), the German version of the Brief Symptom Inventory (BSI; Derogatis & Melisaratos, 1983; Derogatis, 1993). The BSCL is a self-report questionnaire comprising 53 items on nine subscales (hostility/aggression, anxiety, depression, paranoia, phobic anxiety, psychotecism, somatisation, interpersonal sensitivity, and compulsivity). The global severity index shows Cronbach's α = .97 with the reliability of the subscales ranging from Cronbach's α = .72 for hostility and phobic anxiety to Cronbach's α = .88 for depression (Franke et al., 2019).

Structured Clinical Interview for DSM-5 Clinician Version

The Structured Clinical Interview for DSM-5 Clinician Version (SCID-5-CV; First et al., 2016) is conducted to assess further comorbid psychological disorders in a semi-structured interview at T0. The SCID-5-CV's reliability varies depending on study design, rate of disorders and study sample. A reliability of at least .70 can be assumed (First et al., 2016). Symptoms of PTSD and depression, which are already explored by CAPS, WAEC and HAM-D, are not assessed with the SCID-5-CV.

Agoraphobia and Somatoform Complaints

Questionnaire on Body-Related Anxieties, Cognitions and Avoidance

Agoraphobic symptoms and somatoform complaints are assessed with the Questionnaire on Body-Related Anxieties, Cognitions and Avoidance (*Fragebogen zu körperbezogenen Ängsten, Kognitionen und Vermeidung* AKV; Ehlers et al., 2001), a self-report measure, which is a compilation of the Body Sensations Questionnaire (BSQ; Chambless et al., 1984), the Agoraphobic Cognitions Questionnaire (ACQ; Chambless et al., 1984) and the Mobility Inventory (MI; Chambless et al., 1985). The ACQ consists of 14 items and measures dysfunctional cognitions in relation to potential catastrophic consequences arising from panic or anxiety on two subscales: loss of control and physical concerns. The BSQ comprises 17 items on a five-point scale from 1 = 'not at all' to 5 = 'extremely'. The MI assesses self-reported agoraphobic avoidance behavior in 27 situations. The internal consistencies of the subscales vary from sufficient reliability of Cronbach's α = .78 (ACQ) to Cronbach's α = .88 and very good reliability Cronbach's α = .94 (MI, avoidance behavior alone) (Geue et al., 2016).

Sleep Quality

Pittsburgh Sleep Quality Index

The Pittsburgh Sleep Quality Index (PSQI; Buysse et al., 1989) is a self-report measure assessing sleep quality and sleep disturbances over the past month. It consists of 19 items assessing sleep quality, sleep latency, sleep duration, sleep efficiency and sleep disturbances, medication intake for sleep, and daytime sleepiness. A total score of 5 or higher indicates low sleep quality (Buysse et al., 1989). Satisfactory reliability (Cronbach's α = 0.65) has been shown for the arabic version of the PSQI (Suleiman et al., 2010)

C2 Medical Assessment

Resting Electrocardiogram

The 12-lead resting Electrocardiogram (ECG) is part of the medical diagnostics and performed to screen for cardiac disease. It is performed at T0, T1 and T2. During the resting ECG participants are asked to lay down quietly for 5 minutes in ambient conditions. Resting heart rate is derived from ECG recordings.

Spiroergometry

Spiroergometry is used to determine the eligibility for participation and performed at T0, T1 and T2 to further assess the training effect during MAET. Spiroergometry is carried out on the

bicycle (Lode Excalibur Sport, Lode Medical Technology, Groningen, Netherlands) using a step-wise protocol to determine maximum aerobic capacity. Individual seat and handlebar position is maintained throughout. Depending on age, gender, and body weight, participants started cycling at 25 W or 50 W and workload was increased every 3 min by 25 W or 50 W until exhaustion. Gas exchange parameters are measured continuously with a MetaMax II metabolic test system (Cortex Biophysik, Leipzig, Germany; mixing chamber; sampling frequency 10 s). Time courses of oxygen consumption (VO2) and respiratory minute ventilation (VE) were calculated using the mean of 3 contiguous values at exhaustion for the determination of maximal oxygen consumption. Based on an untrained sample of refugees, exercising to maximum exhaustion cannot always be assumed. Thus, in addition blood lactate concentrations are measured for the determination of lactate thresholds, which represent submaximal aerobic performance parameters that are independent of maximal exhaustion. Arterialized capillary blood is obtained from the hyperemised earlobe for analyzing blood lactate (BLa; enzymatic-amperometric method, Greiner, Flacht, Germany) at rest, at the end of each step, at cessation and 1, 3, and 5 min post-exercise. Blood pressure is measured manually at rest, at the end of each step, and 1, 3, 5 min post-exercise.

Stress Electrocardiogram

The 12-lead stress ECG is recorded during spiroergometry at T0, T1 and T2. Maximum heart rate is derived from ECG recordings. Based on the resting heart rate and the maximal heart rate during incremental exercise to voluntary exhaustion, the individual heart rate zones for MAET (60% heart rate reserve (+/- 5 bpm)) are determined.

Blood Parameters

A Complete Blood Count (CBC) by obtaining venous blood samples from the antecubital vein (following the general medical examination and prior to spiroergometry at T0) gives an overview of possible impairments that may lead to exclusion (see *Participants and eligibility criteria)*

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Participants' Declaration of Consent

Study on Moderate-intensity Aerobic Exercise Training as an Adjunct to Narrative Exposure Therapy in Traumatized Refugees and Asylum Seekers

Study objectives and planned measures

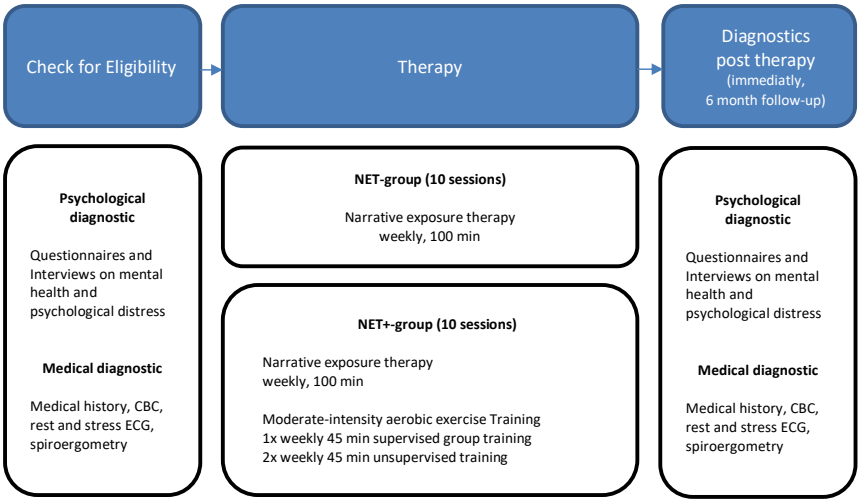
Dear participants, the Department of Clinical Psychology and Psychotherapy at Saarland University (Chair Prof. Dr. Tanja Michael) is conducting a trial on the psychotherapeutic treatment of traumatized refugees in collaboration with the Institute of Sports and Preventive Medicine (Chair Prof. Dr. Tim Meyer). We would like to invite you to participate in the study and support our research.

Prior to your participation in the study, you will be asked to respond to screening questionnaires concerning personal information, general mental health symptoms, and psychological distress.
If you are experiencing psychological distress based on the screening questionnaires, you will be invited to participate in a clinical interview, followed by psychological diagnostic sessions (conducted at the Psychotherapeutic Outpatient Clinic of Saarland University) and medical diagnostic sessions (held at the Institute of Sports and Preventive Medicine at Saarland University).
Psychological assessment involves the diagnostic evaluation of posttraumatic stress disorder symptoms, depressive symptoms, and general psychopathology.
Medical assessment will evaluate your physical suitability for the study. We will assess your medical history, resting and stress Electrocardiogram (ECG), spiroergometry, and complete blood count (CBC).
Throughout the entire diagnostic process, a qualified professional will be present. Should you have any inquiries, concerns, or experience any discomfort, please feel free to approach them.

After successfully completion of the initial diagnostic sessions and meeting the inclusion criteria, you will receive a sealed envelope for randomized group assignment.
If the randomization indicates that you are in the NET-group, you will receive 10 weekly sessions of 100 minutes Narrative exposure therapy (NET), with a total estimated duration ranging from 10 to 15 weeks, starting after the initial psychological and medical assessment.
If you are randomly assigned to the NET^{+}-group, you are additionally required to participate in three weekly outdoor sessions of moderate-intensity aerobic endurance training (MAET). These sessions consist of 45 minutes of running at 60% of your heart rate reserve, including one supervised MAET group session and two unsupervised exercise sessions per week. The location and timing of the unsupervised MAET sessions are flexible and can be chosen freely. During the MAET sessions, you are required to wear a mobile heart rate monitor and a compatible heart rate belt. This setup serves to monitor and record physical parameters and characteristics of the running route. The MAET will take place close to your place of residence.
NET takes place at the Psychotherapeutic Outpatient Clinic of Saarland University. In order to ensure treatment fidelity, NET sessions will be audio recorded. Psychological assessment and psychotherapy are conducted with the help of interpreters who are fluent in the participants' native speech and in German.

Psychological and medical assessment will be repeated following the completion of therapy and at the six-month follow-up.

Overview of the treatment



Risks:
The study is conducted under the guidance of trained personnel. As with any psychotherapeutic intervention, there is a possibility of a temporary increase in psychological symptoms while processing stressful life events during therapy sessions. However, research supports the efficacy of this therapeutic approach, with numerous studies demonstrating significant long-term improvement in symptoms. Regarding the physical stress encountered in the running group, the intensity is adapted to individual participants. Although short-term occurrences of sore muscles or similar effects may arise, these are harmless. A qualified professional will be readily available to address any concerns throughout the study.

Costs
There will be no expenses for you. The psychotherapeutic sessions are paid for by your health insurance company. The running groups as well as the psychological and medical diagnostics are free of charge for you.

Rights
Participation in the study is voluntary. You have the right to withdraw at any time or refuse to answer any question without giving a reason and without consequences of any kind.

Data privacy
All information you provide for this trial will be treated confidentially. The data and personal information (including physical and psychological data) will only be used for research purposes and will not be made available to third parties. Research data will only be documented, stored, evaluated and, if necessary, published using a participants' code consisting of letters and numbers. This code will insure that your identity remains anonymous.

Declaration of consent
I have been informed in detail and comprehensively about the study and I have had the opportunity to ask questions. I was given time to reconsider my participation. I understand that I can withdraw at any time or refuse to answer any question without giving a reason and without consequences of any kind.

The trial was submitted to and approved by the Ethics Committee of the University of Saarland. The objectives, study design, proposed practical implementation, safety measures, and the declaration of consent fully comply with the requirements to be met by a clinical trial.

I voluntarily agree to participate in this research study.

_____

Participants' signature

If you have any questions, please do not hesitate to contact us.

Best regards,

The NET-Team

C4 Interview on Motivation in Moderate-intensity Aerobic Exercise Training

Participants' motivation during moderate-intensity aerobic exercise training (MAET) is evaluated at T1. Participants are asked to indicate their motivation for MAET post hoc for the start of the training and at present (after the end of the training) on a five-point scale ranging from 1 = 'Very unmotivated' to 5 = 'Very motivated'. The change in motivation during the MAET is also recorded on a five-point scale, the extremes of which range from 1 = 'Motivation has decreased a lot' to 5 = 'Motivation has increased a lot'. In addition, further motivational aspects of the MAET are assessed with 9 items, such as 'The expected effect of exercise on physical health'; 'Social contact'; 'Exercise outdoors/ in nature' regarding their motivating character for MAET on a five-point Likert scale from 1 = 'very motivating' to 5 = 'not at all motivating'.

Interviewers' instruction:

Use the scale with the smileys or the arrows for each question with given answer options. When reading out the answer options, always point to the corresponding smiley/arrow. When the patient has given the answer (by pointing to the smiley/arrow or verbally), repeat the answer to avoid misunderstandings and then code participants' response.

In the following I will ask you some questions about your motivation to participate in our sports program. Please note that there are no correct or incorrect answers. Please respond spontaneously.

How motivated were you to participate in the aerobic exercise group training? Were you...

❍	*not motivated*	*(red smiley)*	
❍	*rather unmotivated*	*(orange smiley)*	
❍	*neither especially motivated nor unmotivated*	*(yellow smiley)*	
❍	*rather motivated*	*(light green smiley)*	
❍	*very motivated*	*(green smiley)*	

How has your motivation to participate in the aerobic exercise group training changed over the course of the trial?

❍	*Has your motivation decreased significantly*	*(two downward pointing arrows)*	
❍	*Has your motivation decreased slightly*	*(one downward pointing arrow)*	
❍	*Has your motivation stayed the same*	*(horizontal arrow)*	
❍	*Has your motivation increased slightly*	*(an upward pointing arrow)*	
❍	*Has your motivation increased significantly*	*(two upward pointing arrows)*	

How motivated were you to participate in the aerobic exercise single training?? Were you...

❍	*not motivated*	*(red smiley)*	
❍	*rather unmotivated*	*(orange smiley)*	
❍	*neither especially motivated nor unmotivated*	*(yellow smiley)*	
❍	*rather motivated*	*(light green smiley)*	
❍	*very motivated*	*(green smiley)*	

How has your motivation to participate in the aerobic exercise single training *changed over the course of the trial?*

❍	*Has your motivation decreased significantly*	*(two downward pointing arrows)*	
❍	*Has your motivation decreased slightly*	*(one downward pointing arrow)*	
❍	*Has your motivation stayed the same*	*(horizontal arrow)*	
❍	*Has your motivation increased slightly*	*(an upward pointing arrow)*	
❍	*Has your motivation increased significantly*	*(two upward pointing arrows)*	

How motivated are you to continue the aerobic exercise training after the trial?

❍	*not motivated*	*(red smiley)*	
❍	*rather unmotivated*	*(orange smiley)*	
❍	*neither especially motivated nor unmotivated*	*(yellow smiley)*	
❍	*rather motivated*	*(light green smiley)*	
❍	*very motivated*	*(green smiley)*	

There are different factors that can have a positive or negative impact on the motivation to participate in the aerobic exercise training.

Please tell me if the factors listed below have affected your motivation or if these factors have made you more or less motivated to continue the aerobic exercise training.

		 very motivated	 rather motivated	 neither especially motivated nor unmotivated	 less motivated	 not motivated
1.	Being outdoors					
2.	Having social contact/ feeling a sense of belonging (in group training)					
3.	The competitive nature of sports					
4.	Common goals (group training)					
5.	Being alone/ having time for yourself (single training)					
6.	The positive effect of exercise on physical health					
7.	The positive effect of exercise on physical fitness					
8.	The positive effect of exercise on mood					
9.	The positive effect of exercise on subjective stress level					
10.	The positive effect of exercise on day structure					

Appendix D. Supplementary Materials for *Study 4*

D1 Table D1

Exposure to Traumatic Events: An Overview of Prevalence and Distribution

Traumatic life event[1]	NET *n* = 15		NET+ *n* = 15		Total sample *n* = 30	
	n	%	n	%	n	%
Witnessed physical assault	13	86.67	13	86.67	26	86.67
Experienced physical assault by others	13	86.67	12	80.00	25	83.33
Family separation due to war	13	86.67	11	73.33	24	80.00
Loss of a family member in war	12	80.00	11	73.33	23	76.67
Witnessed weapon attack	10	66.67	13	86.67	23	76.67
Exposure to corpses	12	80.00	10	66.67	22	73.33
Experienced weapon attack	10	66.67	11	73.33	21	70.00
Witnessed life-threatening illness or injury	11	73.33	10	66.67	21	70.00
Witnessed explosions, fire or destruction	10	66.67	8	53.33	18	60.00
Deprivation of food or water	9	60.00	8	53.33	17	56.67
Witnessed murder	8	53.33	9	60.00	17	56.67
Experienced armed conflict	9	60.00	6	40.00	15	50.00
Imprisonment or kidnapping	8	53.33	7	46.67	15	50.00
Experienced fire or explosion	10	66.67	5	33.33	15	50.00
Experienced transport accident	7	46.67	7	46.67	14	46.67

Table D1 (continued.)

Traumatic life event[1]	NET *n* = 15		NET^{+} *n* = 15		Total sample *n* = 30	
	n	%	n	%	n	%
Witnessed transport accident	7	46.67	6	40.00	13	43.33
Experienced physical assault by family member	7	46.67	5	33.33	12	40.00
Experienced life-threatening illness or injury	7	46.67	4	26.67	11	36.67
Witnessed execution	5	33.33	5	33.33	10	33.33
Experienced torture	3	20.00	6	40.00	9	30.00
Experienced sexual abuse by others	5	33.33	4	26.67	9	30.00
Witnessed sexual abuse	4	26.67	5	33.33	9	30.00
Experienced unwanted sexual events	7	46.67	2	13.33	9	30.00
Experienced natural disaster	3	20.00	4	26.67	7	23.33
Witnessed unwanted sexual events	4	26.67	2	13.33	6	20.00
Experienced sexual abuse by family member	1	6.67	2	13.33	3	10.00

Note.[1]assessed by War and Adversity Exposure Checklist (WAEC, Ibrahim et al., 2018b).

D2 Table D2

Mixed-effects Models predicting PCL-5 Scores with Treatment×Time×Covariate Interactions

Model	Predictor	*β*	SE	*t*	*p*
Age	Intercept	37.50	14.13	2.65	.011*
	Treatment	8.22	19.14	0.43	.670
	Time	−21.06	15.55	−1.35	.187
	Age	0.59	0.50	1.17	.250
	Treatment×Time	25.95	21.06	1.23	.229
	Treatment×Age	−0.27	0.67	−0.40	.690
	Time×Age	0.04	0.55	0.07	.944
	Time×Treatment×Age	−0.81	0.74	−1.09	.284
Sex	Intercept	63.25	7.15	8.85	<.001***
	Treatment	−7.96	8.96	−0.89	.379
	Time	−20.25	8.25	−2.46	.021*
	Sex	−13.43	8.35	−1.61	.114
	Treatment×Time	1.39	10.34	0.13	.894
	Treatment×Sex	12.02	11.15	1.08	.287
	Time×Sex	0.34	9.63	0.04	.972
	Treatment×Time×Sex	4.14	12.87	0.32	.750
Culture group	Intercept	56.71	5.56	10.21	<.001***
	Treatment	−3.96	9.21	−0.43	.670
	Time	−20.43	6.08	−3.36	.003**
	Culture: Central Asian vs. Arabic	−8.88	8.18	−1.09	.285
	Culture: Eastern European vs. Arabic	−3.71	15.71	−0.24	.814
	Treatment×Time	18.18	10.09	1.80	.086
	Treatment×Central Asian	8.13	12.81	0.63	.530
	Treatment×Eastern European	3.46	18.84	0.18	.855
	Time×Central Asian	3.10	8.95	0.35	.733
	Time×Eastern European	1.43	17.20	0.08	.935
	Treatment×Time×Central Asian	−16.65	14.02	−1.19	.249
	Treatment×Time×Eastern European	−26.68	20.62	−1.29	.210

Table D2 (continued.)

Model	Predictor	*β*	SE	*t*	*p*
Residence permit	Intercept	62.51	13.92	4.49	<.001***
	Treatment	−23.29	17.28	−1.35	.186
	Time	−33.44	13.57	−2.46	.021*
	Residence permit	−3.02	4.94	−0.61	.545
	Treatment×Time	46.30	16.85	2.75	.011*
	Treatment×Residence permit	9.40	6.34	1.48	.147
	Time× Residence permit	4.88	4.82	1.01	.322
	Treatment×Time× Residence permit	−17.10	6.18	−2.77	.011*

Note. PCL-5 = PTSD Checklist for DSM-5; Reference categories: treatment = NET, time = t_0, culture = Arabic, sex = female; *β* = unstandardized fixed-effect estimate; SE = standard error; *t* = t-statistic. * *p* < *.05,* ** *p* <*.01,* *** *p* <*.001.*

D3 Table D3

Mixed-effects Models predicting PCL-5 within NET$^+$ Group with Time×Covariate Interactions

Model	Predictor	*β*	SE	*t*	*p*
MAET sessions	Intercept	106.34	27.90	3.81	.002**
	Time	−56.73	39.46	−1.44	.172
	Number of MAET sessions	−1.81	1.03	−1.76	.100
	Time×Number of MAET sessions	1.37	1.45	0.94	.362
Heart rate difference	Intercept	45.26	14.77	3.07	.010*
	Time	−17.48	20.88	−0.84	.419
	Heart rate difference	−0.39	0.52	−0.76	.463
	Time×Heart rate difference	0.06	0.74	0.09	.933
Incline	Intercept	58.19	9.20	6.32	<.001***
	Time	−17.14	13.02	−1.32	.212
	Incline	−0.15	0.39	−0.39	.704
	Time×Incline	−0.11	0.56	−0.20	.842

Note. PCL-5 = PTSD Checklist for DSM-5; Reference categories: time = t_0, culture = Arabic, sex = female; *β* = unstandardized fixed-effect estimate; SE = standard error; *t* = t-statistic. * *p* < *.05,* ** *p* <*.01,* *** *p* <*.001.*

D4 Table D4

Mixed-effects Models predicting HAMD Scores with Treatment×Time×Covariate Interactions

Model	Predictor	*β*	SE	*t*	*p*
Age	Intercept	15.39	7.97	1.93	.061
	Treatment	14.05	10.80	1.30	.201
	Time	−11.14	7.54	−1.48	.152
	Age	0.30	0.28	1.05	.300
	Treatment×Time	8.80	10.21	0.86	.397
	Treatment×Age	−0.44	0.38	−1.17	.249
	Time×Age	0.21	0.27	0.79	.437
	Time×Treatment×Age	−0.36	0.36	−1.01	.324
Sex	Intercept	26.75	3.94	6.78	<.001***
	Treatment	−0.04	4.94	−0.01	.994
	Time	−1.00	3.68	−0.27	.788
	Sex	−4.48	4.61	−0.97	.337
	Treatment×Time	−3.00	4.61	−0.65	.521
	Treatment×Sex	2.01	6.16	0.33	.745
	Time×Sex	−6.00	4.30	−1.40	.174
	Treatment×Time×Sex	1.38	5.74	0.24	.813
Culture	Intercept	24.29	3.13	7.76	<.001***
	Treatment	3.71	5.19	0.72	.480
	Time	−2.71	2.60	−1.04	.308
	Culture: Central Asian vs. Arabic	−2.45	4.61	−0.53	.598
	Culture: Eastern European vs. Arabic	3.71	8.85	0.42	.678
	Treatment×Time	−2.29	4.31	−0.53	.601
	Treatment×Central Asian	−2.75	7.22	−0.38	.706
	Treatment×Eastern European	−8.96	10.61	−0.84	.405
	Time×Central Asian	−7.79	3.83	−2.04	.055
	Time×Eastern European	0.71	7.35	0.10	.924
	Treatment×Time×Central Asian	4.39	5.99	0.73	.472
	Treatment×Time×Eastern European	2.04	8.81	0.23	.820

Table D4 (continued.)

Model	Predictor	β	SE	t	p
Residence permit	Intercept	29.44	8.34	3.53	.001**
	Treatment	−4.50	10.35	−0.43	.667
	Time	−11.18	7.45	−1.50	.146
	Asylum status	−1.88	2.96	−0.63	.530
	Treatment×Time	7.58	9.26	0.82	.421
	Treatment× Residence permit	2.07	3.80	0.54	.589
	Time× Residence permit	1.87	2.65	0.71	.487
	Treatment×Time× Residence permit	−3.06	3.40	−0.90	.377

Note. HAMD = Hamilton Depression Scale; Reference categories: treatment = NET, time = t_0, culture = Arabic, sex = female; *β* = unstandardized fixed-effect estimate; SE = standard error; *t* = t-statistic. $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$.

D5 Table D5

Mixed-effects Models predicting HAMD within NET^{+} Group with Time×Covariate Interactions

Model	Predictor	*β*	SE	*t*	*p*
MAET sessions	Intercept	31.25	11.78	2.65	.019*
	Time	−24.50	16.66	−1.47	.163
	Number of MAET sessions	−0.23	0.43	−0.53	.604
	Time×Number of MAET sessions	0.56	0.61	0.92	.373
Heart rate difference	Intercept	21.18	5.42	3.91	.002**
	Time	2.01	7.66	0.26	.798
	Heart rate difference	−0.10	0.19	−0.54	.596
	Time×Heart rate difference	0.39	0.27	1.43	.178
Incline	Intercept	28.36	3.03	9.36	<.001***
	Time	−9.66	4.29	−2.25	.044
	Incline	−0.26	0.13	−1.98	.071
	Time×Incline	0.09	0.18	0.52	.615

Note. HAMD = Hamilton Depression Scale; Reference categories: time = t_0, culture = Arabic, sex = female; *β* = unstandardized fixed-effect estimate; SE = standard error; *t* = t-statistic. $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$.

Appendix E. Angaben zu verwendeten Hilfmitteln und Eigenständigkeitserklärung

Verwendete Hilfsmittel

- Verwendung eines Literaturverwaltungsprogramms (z.B. Zotero)
- KI-gestützte Tools (z.B. DeepL) zur sprachlichen Überarbeitung (Übersetzung/ Sprachglättung einzelner Passagen); keine inhaltliche Generierung.

Eidesstattliche Erklärung

nach §5 Abs. 4 der Promotionsordnung Fakultät HW der Universität des Saarlandes für die Promotion zum Doktor der Naturwissenschaften vom 18. Oktober 2017

Hiermit versichere ich an Eides statt, dass

a) ich mich bis jetzt keinem Promotionsverfahren unterzogen habe,
b) ich meine Dissertation selbst verfasst und keine anderen als die von mir angegebenen Quellen und Hilfsmittel benutzt sowie die den benutzten Werken wörtlich oder inhaltlich entnommenen Stellen kenntlich gemacht habe, und
c) ich bei der Auswahl und Auswertung von Material und bei der inhaltlich-materiellen Anfertigung der Dissertation nur von den genannten Personen in der jeweils angegebenen Weise Hilfe erfahren und insbesondere nicht die entgeltliche Hilfe von Vermittlungs- und Beratungsdiensten in Anspruch genommen habe.

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