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Effects of a Trauma-Informed Mindfulness-Based Stress Reduction Program on Social Anxiety and Sleep Quality Among War-Exposed Secondary-School Students

Nahid. Yousefpour[1], Marjan. Jowkar[2], Zahra. Heydari[3], Afarin. Aghamohammadsadegh[4*]

[1] Assistant Professor, Department of Educational Sciences and Psychology, Payame Noor University, Tehran, Iran
[2] M.A. Student in Psychology, Department of Psychology, Shi.C., Islamic Azad University, Shiraz, Iran
[3] PhD, Department of Psychology, Marv.C., Islamic Azad University, Marvdasht, Iran
[4] Department of Health Psychology, University of Tehran, Kish International Campus, Kish Island, Iran

*** Corresponding author email address**: Afarin.m.sadegh@ut.ac.ir

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A B S T R A C T

This study aimed to evaluate the effects of an eight-week trauma-informed Mindfulness-Based Stress Reduction program on social anxiety and sleep quality among war-exposed secondary-school students. This individually randomized, parallel-group, superiority trial was conducted in 2026 across six secondary schools and affiliated counseling services in Tehran, Iran. A total of 120 students aged 14–18 years with documented war-related exposure and clinically meaningful social-anxiety symptoms and/or poor subjective sleep were randomly allocated in a 1:1 ratio to trauma-informed MBSR or an active health-education control condition. The intervention consisted of eight weekly 75-minute group sessions emphasizing safety, present-moment awareness, flexible attention, emotional regulation, social-threat management, sleep-related arousal reduction, and trauma-informed opt-out procedures. Social anxiety was assessed using the Social Phobia Inventory, and sleep quality was assessed using the Pittsburgh Sleep Quality Index at baseline, postintervention, and eight-week follow-up. Data were analyzed using intention-to-treat linear mixed-effects models with group, time, group-by-time interaction, age, and baseline trauma burden as predictors, with Holm adjustment for co-primary outcomes. Significant group-by-time interactions favored trauma-informed MBSR for social anxiety at postintervention, B = -11.20, SE = 1.58, 95% CI [-14.32, -8.08], p < .001, and at follow-up, B = -9.74, SE = 1.64, 95% CI [-12.98, -6.50], p < .001. Significant effects were also observed for sleep quality at postintervention, B = -3.87, SE = 0.55, 95% CI [-4.96, -2.78], p < .001, and follow-up, B = -3.31, SE = 0.57, 95% CI [-4.44, -2.18], p < .001. Holm-adjusted between-group contrasts remained significant for both outcomes, with large standardized effects. Trauma-informed MBSR produced significant and sustained reductions in social anxiety and sleep disturbance among war-exposed secondary-school students, supporting its potential as a safe, school-based intervention for adolescents affected by armed conflict.

Keywords: *trauma-informed mindfulness; Mindfulness-Based Stress Reduction; social anxiety; sleep quality; war exposure; adolescents; secondary-school students*

1. Introduction

War and armed conflict exert profound and multidimensional effects on the psychological, social, and physical health of affected populations, with children and adolescents representing one of the most vulnerable groups. Exposure to military violence, displacement, bereavement, destruction of homes and schools, persistent insecurity, interruption of education, and fear for the safety of family members can fundamentally disrupt the developmental environments required for healthy emotional and social functioning. Unlike isolated traumatic events, war frequently creates conditions of continuous or repeated threat in which young people are not only required to process past experiences but must also adapt to uncertainty regarding future danger. Such circumstances can produce a pattern of cumulative psychological burden extending beyond conventional posttraumatic stress symptoms to include anxiety, sleep disturbances, emotional dysregulation, somatic complaints, social withdrawal, and impaired functioning across family and school contexts (Adamova & Melnychuk, 2026; Masoomi et al., 2026; Nekrasova et al., 2026). Research on prolonged warfare has increasingly emphasized that adaptation under these conditions is dynamic rather than linear, involving simultaneous processes of vulnerability, coping, resilience, and recurrent destabilization as the social environment changes (Nekrasova et al., 2026).

Adolescence is a particularly sensitive developmental period in which exposure to war may have enduring consequences. During secondary-school years, individuals undergo rapid changes in emotional regulation, identity formation, peer relationships, autonomy, cognition, and social evaluation. These processes depend heavily on predictable interpersonal and educational environments, yet war can undermine precisely these forms of stability. Studies of adolescents living through contemporary armed conflicts have shown that young people frequently describe disrupted schooling, constant uncertainty, worries about relatives, changes in living arrangements, exposure to distressing media, and difficulty maintaining ordinary routines (Lopatovska et al., 2022). Children living in border and conflict-affected regions may also incorporate war into their symbolic understanding of daily life, indicating that armed conflict can become embedded in the way children interpret threat, safety, relationships, and the surrounding environment (Teze & Ayhan, 2025). Recent multimethod research further demonstrates that adolescents exposed to war display substantial heterogeneity, with some maintaining adaptive functioning while others develop significant anxiety, emotional distress, and trauma-related symptoms, underscoring the need for interventions that support resilience without assuming uniform pathology (Haham et al., 2025).

The psychological consequences of war exposure are commonly conceptualized through the framework of traumatic stress. Posttraumatic stress disorder is characterized by patterns of intrusion, avoidance, negative alterations in cognition and mood, and heightened arousal following exposure to traumatic events, although war-related distress is rarely confined to a single diagnostic category (Pary & Lippmann, 2022; Zhou et al., 2021). War-affected populations frequently experience overlapping symptoms of anxiety, depression, sleep disturbance, irritability, somatic distress, and functional impairment. Community-based research in conflict-affected settings has demonstrated substantial rates of posttraumatic stress symptoms and identified associations between symptom severity and the extent and nature of war exposure (Kassaye et al., 2023). Moreover, the biological effects of exposure may extend beyond immediate psychological reactions. Evidence concerning the epigenetic consequences of war and chronic stress suggests that severe and sustained traumatic experiences may influence biological stress-regulation systems and potentially contribute to longer-term health vulnerability (Raza et al., 2023). Persistent consequences have also been documented many years after direct conflict exposure, illustrating that traumatic experiences associated with war can remain psychologically salient long after the immediate danger has passed (Becker & Quartilho, 2021).

The effects of war are also not limited to those directly involved in combat or physically present at the point of violence. Psychological distress may emerge through displacement, family disruption, indirect exposure, repeated consumption of distressing information, and prolonged anticipation of danger. Findings among displaced Ukrainians, for example, have demonstrated associations between war-related displacement, functional impairment, reduced access to health services, and poorer mental-health outcomes (Kang et al., 2023). Similarly, research examining the wider impact of contemporary conflicts indicates that exposure to war-related news can adversely affect psychological and physical well-being even among individuals geographically removed from the conflict itself (Marzaleh et al., 2026). Studies conducted after the

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escalation of the Russia–Ukraine war have also identified elevated levels of anxiety, stress, mood disturbance, and sleep problems in populations affected by the broader psychosocial consequences of conflict (Hoffmann et al., 2024). These findings support an ecological understanding of war-related distress in which individual symptoms are shaped by direct exposure as well as family, community, displacement, media, and societal conditions.

Social anxiety represents an especially important but comparatively underexamined outcome among war-exposed adolescents. Social anxiety involves persistent fear and avoidance of situations in which an individual anticipates scrutiny, embarrassment, rejection, or negative evaluation. Adolescence is already a period of heightened sensitivity to social evaluation, and chronic threat exposure may intensify this vulnerability by reinforcing hypervigilance, uncertainty, mistrust, and avoidance. Students who have experienced war-related stress may become increasingly alert to perceived threat not only in objectively dangerous situations but also in ordinary interpersonal environments such as classrooms, peer groups, examinations, and social gatherings. Continuous traumatic stress may therefore alter the interpretation of ambiguous social cues and increase anticipatory anxiety in situations that require visibility, interaction, or performance. Recent network analyses of trauma-related mental-health comorbidities among adolescents exposed to continuous traumatic stress suggest that trauma symptoms are embedded within broader interconnected patterns of anxiety and psychological distress rather than functioning as isolated syndromes (Засєкіна et al., 2026). This is particularly relevant in secondary-school settings, where repeated peer interaction, classroom participation, and social comparison are central to everyday functioning.

War-related psychological distress can also influence social functioning indirectly through family and interpersonal systems. Research with war-affected couples has shown that traumatic stress in one person can affect relational well-being and the functioning of close others, illustrating the interpersonal transmission of trauma-related strain (Knežević & Batinić, 2023). In adolescents, similar processes may operate through parental distress, altered family roles, reduced emotional availability, displacement-related instability, and changes in social networks. Such disruptions may reduce opportunities for supportive peer engagement and increase withdrawal. Furthermore, experiences of chronic social stress have been associated with neurotic symptoms and emotional disturbances in both children and adults, reinforcing the idea that persistent environmental stress can manifest through multiple overlapping psychological pathways (Boltivets et al., 2024). The educational consequences may be particularly important because social avoidance can interfere with classroom engagement, help-seeking, friendship development, and participation in school-based activities.

Sleep disturbance constitutes another major consequence of exposure to war and chronic stress. Sleep is strongly influenced by physiological arousal, cognitive activity, emotional regulation, environmental safety, and predictability. During armed conflict, all of these processes may be disrupted. Adolescents may experience delayed sleep onset because of intrusive thoughts or worry, repeated awakening due to hyperarousal, nightmares, shortened sleep duration, irregular sleep schedules, and difficulty returning to sleep following environmental disturbances. Research conducted among Ukrainians after the full-scale Russian invasion documented substantial problems involving insomnia and sleep duration, highlighting the close relationship between war-related conditions and impaired sleep (Wang et al., 2024). Sleep problems are clinically important not only because they represent symptoms of psychological distress but also because insufficient or poor-quality sleep may worsen emotional reactivity, attention, memory, irritability, and coping capacity.

The relationship between trauma and sleep appears to be mediated by psychological mechanisms that are directly relevant to intervention. War-related posttraumatic stress symptoms have been associated with sleep disturbance through difficulties in emotion regulation and intolerance of uncertainty, suggesting that sleep problems may arise partly because affected individuals remain cognitively and physiologically engaged with perceived threat even when immediate action is not required (Zemestani et al., 2025). Nightmares constitute another important manifestation of trauma-related sleep disruption. Research conducted among internally displaced Lebanese citizens exposed to military attacks demonstrated that war-related nightmares were linked with broader psychological symptoms, with anxiety and depressive symptoms contributing to these associations (Hokayem et al., 2026). These findings indicate that sleep disturbance, anxiety, and trauma-related arousal may operate as mutually reinforcing processes rather than independent outcomes.

The health effects of prolonged traumatic exposure may also extend into physical functioning. War-affected individuals may experience persistent somatic symptoms,

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pain, fatigue, and other stress-related complaints. Research involving war veterans has identified associations between traumatic stress and temporomandibular disorders, supporting the broader relationship between chronic psychological stress and physical health manifestations (Minervini et al., 2023). Conflict exposure has likewise been associated with adverse health outcomes in adolescents beyond mental health alone, including measurable deterioration in aspects of physical health such as oral health (Habal et al., 2024). In other high-stress professions, prolonged exposure to others' suffering has been linked with compassion fatigue and reduced psychological well-being, further emphasizing the cumulative effects of sustained emotional strain (Hăisan et al., 2023). Although such findings emerge from different populations, they collectively support an integrated model in which chronic stress affects emotional, behavioral, interpersonal, and physiological systems simultaneously.

These complex consequences have prompted growing interest in interventions that can be safely delivered to conflict-affected populations without requiring intensive trauma disclosure. Traditional trauma-focused interventions can be highly effective, but they may not always be feasible or acceptable in school environments, particularly when young people remain exposed to ongoing uncertainty. Trauma-informed care therefore emphasizes safety, autonomy, choice, predictability, collaboration, and avoidance of practices that may unnecessarily recreate feelings of helplessness. The importance of such principles has been demonstrated in interventions with refugee populations, where participants' experiences indicate that trauma-sensitive approaches must attend not only to symptoms but also to bodily safety, trust, pacing, and perceived control (Nazzal et al., 2026). Integrative approaches to pediatric trauma similarly emphasize developmentally appropriate regulation strategies, resilience-building, and individualized responses rather than coercive or uniform treatment procedures (Stoffman & Ben-Arye, 2026).

Mindfulness-based interventions may be particularly compatible with these objectives when appropriately modified for trauma-exposed adolescents. Mindfulness involves intentionally attending to present-moment experience with an attitude of openness and reduced judgment. Mindfulness-Based Stress Reduction was originally developed as a structured intervention for stress and health-related difficulties and has subsequently been adapted for diverse psychological and medical populations. In trauma-exposed individuals, mindfulness practices may reduce excessive engagement with threat-related thoughts, increase awareness of internal states without immediate avoidance, improve emotion regulation, and facilitate more flexible responses to distress. Importantly, these mechanisms are relevant both to social anxiety and sleep disturbance. In socially anxious adolescents, increased awareness of automatic predictions of rejection or embarrassment may create opportunities for less avoidant behavioral responses. In relation to sleep, mindfulness may reduce rumination and the effortful struggle to suppress thoughts or force sleep, thereby decreasing cognitive arousal at bedtime.

However, mindfulness practices cannot be assumed to be universally benign for trauma-exposed populations. Certain exercises, particularly prolonged eyes-closed meditation, intensive body scanning, or sustained focus on internal sensations, may increase distress, trigger intrusive memories, or intensify dissociative experiences in some individuals. For this reason, trauma-informed mindfulness differs from generic mindfulness delivery by emphasizing voluntary participation, flexible attentional anchors, short practices, external grounding, movement-based alternatives, explicit permission to stop, and avoidance of forced trauma narration. The broader literature on mind-body interventions in war-affected populations supports the importance of investigating approaches that can strengthen self-regulation without requiring repeated verbal processing of traumatic material. Calls for research on yoga and related regulatory interventions in war-affected populations similarly reflect a need for accessible, nonpharmacological approaches capable of addressing the psychological consequences of conflict (Anand et al., 2021). Psychosocial literature on war crises has likewise emphasized the need for timely, scalable strategies that can be implemented within community and educational systems rather than relying exclusively on specialist treatment settings (Yasegnal, 2022).

The potential relevance of mindfulness is also strengthened by evidence that war-related outcomes are shaped not only by symptom severity but by patterns of adaptation and resilience. Exposure to combat and war-related stress can influence subjective well-being and health behavior in ways that extend beyond formal psychiatric diagnosis (McKee et al., 2024). Consequently, interventions for adolescents should not be limited to reducing diagnostic symptoms but should also support functional coping, emotional flexibility, and restoration of ordinary developmental activities. Research on adaptation during

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prolonged war conditions emphasizes that coping resources, perceived control, social support, and flexible regulation contribute to psychological adjustment under continuing threat (Nekrasova et al., 2026). A trauma-informed mindfulness intervention may therefore be valuable not because it eliminates realistic concerns about danger, but because it may help adolescents distinguish between immediate threat and automatic stress responses, respond more flexibly to social situations, and reduce persistent arousal during periods of relative safety.

At the same time, the evidence base remains incomplete. Much of the literature on war-related psychological consequences has focused on PTSD, depression, generalized anxiety, displacement, or broad indices of distress, while comparatively less attention has been directed toward social anxiety and sleep quality as co-occurring functional outcomes among secondary-school students. Existing studies clearly demonstrate that conflict exposure affects mental health, sleep, physical well-being, family functioning, and adaptation (Adamova & Melnychuk, 2026; Hoffmann et al., 2024; Kassaye et al., 2023), yet there remains a need for controlled school-based studies that evaluate whether developmentally adapted, trauma-informed interventions can produce measurable change in specific domains that directly influence adolescents' academic and interpersonal functioning. Moreover, studies of trauma and resilience suggest that intervention research should evaluate both benefit and safety, particularly when practices involve attention to bodily or emotional experience (Haham et al., 2025; Stoffman & Ben-Arye, 2026).

Another limitation in the current evidence is that responses to war are often examined as if trauma exposure automatically produces a single clinical trajectory. Contemporary findings instead demonstrate substantial variation in symptom networks, resilience, adaptation, and functional outcomes across individuals and contexts (Masoomi et al., 2026; Засєкіна et al., 2026). The consequences of war may also vary according to displacement status, cumulative exposure, access to services, family stability, and ongoing threat. This heterogeneity makes interventions emphasizing personal choice and flexible engagement particularly relevant. A trauma-informed MBSR program can be designed to accommodate such variation by allowing students to select attentional anchors, modify practices, keep their eyes open, use movement, and refrain from discussing traumatic events. Such adaptations may be especially important within schools, where students with different levels and forms of exposure may participate together.

Finally, the need for school-based intervention research is reinforced by the fact that war-related adversity can affect multiple domains of everyday adolescent life at the same time. Psychological trauma may alter emotional regulation and threat perception; sleep disturbance may worsen concentration and irritability; social anxiety may reduce classroom participation and peer engagement; and family or displacement-related stress may further reduce coping resources. These domains can become mutually reinforcing, increasing the likelihood of persistent impairment. Evidence from conflict-affected populations, displaced communities, veterans, and individuals exposed to prolonged social stress consistently demonstrates that war-related distress is complex and multidimensional rather than restricted to a single symptom category (Becker & Quartilho, 2021; Kang et al., 2023; Minervini et al., 2023; Raza et al., 2023). This complexity supports the evaluation of interventions capable of targeting shared regulatory mechanisms such as hyperarousal, repetitive negative thinking, attentional inflexibility, and avoidance while remaining sensitive to the distinctive needs of trauma-exposed adolescents.

Therefore, the aim of the present study was to evaluate the effects of an eight-week trauma-informed Mindfulness-Based Stress Reduction program on social anxiety and sleep quality among war-exposed secondary-school students compared with an active health-education control condition.

2. Methods and Materials

2.1. Study Design and Participants

This study was designed as an individually randomized, parallel-group, superiority clinical trial with a 1:1 allocation ratio to evaluate the effects of a trauma-informed Mindfulness-Based Stress Reduction program on social anxiety and sleep quality among war-exposed secondary-school students. The study was conducted in 2026 across six secondary schools and their affiliated counseling services in Tehran, Iran. The target population consisted of students aged 14 to 18 years who were enrolled in one of the participating schools, were able to read and respond to questionnaires in Persian, and reported direct experience of or witnessing at least one war-related stressful event. War-related exposure included experiences such as displacement, nearby explosions or military activity, damage to the family home or other property, physical injury, injury or death of a close family member or significant person, and prolonged

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exposure to perceived threat or insecurity. Exposure was assessed through a brief structured event-history checklist rather than inferred from a psychiatric diagnosis. Where ethically appropriate and permitted by the adolescent and parent or legal guardian, contextual information available through school counseling services was also considered to clarify exposure history. Eligibility additionally required clinically meaningful symptoms of social anxiety and/or poor subjective sleep quality during the screening phase. Written informed consent was obtained from parents or legal guardians, and written assent was obtained from participating adolescents before enrollment.

Because the participants were minors with potentially significant trauma histories, safeguarding procedures were incorporated into all phases of the research. Before randomization, each potentially eligible student underwent a brief clinical screening conducted by a licensed mental-health professional to identify conditions requiring more intensive or urgent intervention. Students presenting with imminent risk of self-harm or suicide, severe acute dissociation, florid psychotic symptoms, manic episodes, severe cognitive impairment interfering with participation, or other acute psychiatric conditions requiring specialist care were excluded from group participation and immediately referred to appropriate mental-health services. Exclusion from the research intervention did not result in loss of access to school counseling or other clinical support, and individualized safety planning was provided when clinically indicated. Students receiving routine psychological or psychiatric care were not automatically excluded; instead, concurrent psychotherapy, counseling, and medication use were documented and considered in the statistical analyses. Participants were informed that they could discontinue any activity or withdraw from the study at any stage without academic, disciplinary, or clinical consequences. The intervention was explicitly designed to avoid compulsory trauma disclosure. Participants were never required to describe war-related experiences during group sessions, and all mindfulness exercises were voluntary, with eyes-open, movement-based, and externally focused grounding alternatives available throughout the intervention.

A total of 120 eligible students were planned for randomization, with 60 participants assigned to the trauma-informed MBSR condition and 60 assigned to the active control condition. This sample size was considered a feasible target for the proposed trial design. Participants were allocated using a computer-generated permuted-block randomization procedure with randomly varying block sizes to reduce predictability of allocation. Randomization was stratified according to participating school and baseline social-anxiety severity to improve balance between the study conditions. The allocation sequence was generated by an independent statistician who was not involved in recruitment, intervention delivery, or outcome assessment. Group assignments were concealed through a secure centralized allocation procedure until baseline assessments had been completed and recorded. Because of the behavioral nature of the intervention, participants and facilitators could not be blinded to treatment allocation; however, outcome assessors, data-entry personnel, data cleaners, and the primary statistical analyst remained masked to group assignment whenever feasible. The experimental group received eight weekly sessions of trauma-informed MBSR, whereas the active control group received eight weekly sessions of general adolescent health education matched for session duration, facilitator attention, group interaction, educational materials, and approximate homework burden. Participants in both conditions retained unrestricted access to routine school counseling and urgent mental-health services throughout the trial.

2.2. Data Collection Tools

The Social Phobia Inventory (SPIN) was used to assess social-anxiety symptoms as one of the two primary outcomes of the study. The SPIN is a 17-item self-report questionnaire developed by Connor et al. to evaluate the major domains of social anxiety, including fear, avoidance, and physiological discomfort experienced in social situations. Each item is rated on a five-point Likert scale ranging from 0 to 4, resulting in a total score ranging from 0 to 68, with higher scores indicating greater severity of social-anxiety symptoms. The instrument is suitable for measuring changes in symptom severity over time and therefore was administered at baseline, immediately after completion of the eight-week intervention, and at the eight-week follow-up assessment. The Persian version of the SPIN has demonstrated acceptable psychometric properties in Iranian populations, including satisfactory internal consistency, test-retest reliability, and evidence of convergent and discriminant validity. Because previous Persian psychometric research has been conducted predominantly among adults and older populations rather than specifically among war-exposed adolescents, particular attention was paid to the comprehensibility of the items for students aged 14 to 18 years. Prior to the main assessment, item wording

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was reviewed with a small group of students to ensure age-appropriate comprehension without altering the original construct or scoring system. Internal consistency was reassessed in the present sample using both Cronbach's alpha and McDonald's omega.

The Pittsburgh Sleep Quality Index (PSQI) was used as the second primary outcome measure to assess subjective sleep quality. The PSQI consists of 19 self-report items that assess sleep experiences during approximately the previous month and generate seven component scores covering subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction. The seven component scores are combined to produce a global score ranging from 0 to 21, with higher scores representing poorer subjective sleep quality. The PSQI was administered at baseline, postintervention, and the eight-week follow-up to evaluate both immediate and maintained changes in sleep quality. The Persian version has demonstrated acceptable reliability and validity, and psychometric research among Iranian adolescents has provided support for its use in adolescent populations. The adolescent-appropriate Persian form was therefore applied without changing the standard one-month reference period or global scoring method. To complement the PSQI and provide additional contextual information about sleep patterns, participants were also encouraged to complete brief sleep diaries describing approximate bedtime, wake time, sleep-onset difficulties, nighttime awakenings, and perceived sleep quality, although diary information was treated as supplementary rather than as a substitute for the primary PSQI outcome.

War-related exposure was documented using a brief structured war-exposure and event-history checklist developed for the purposes of participant characterization and eligibility assessment. The checklist recorded whether the adolescent had directly experienced or witnessed events including displacement, nearby explosions or armed conflict, destruction or damage to property, injury, bereavement, forced relocation, interruption of schooling, or persistent perceived threat. The instrument was used to document the type, number, and approximate recency of war-related stressors rather than to establish a psychiatric diagnosis. When consent and safety conditions permitted, contextual information available through parents or school counseling personnel was used to clarify exposure history; however, adolescent self-report remained the principal source of information. A cumulative trauma-burden index derived from the number and recency of endorsed events was retained as a prespecified covariate and potential moderator in the statistical analyses. This approach was adopted to avoid assuming that all war-exposed adolescents had experienced identical levels of trauma or psychological impairment.

The International Trauma Questionnaire–Child and Adolescent Version (ITQ-CA), Farsi version, was used to characterize posttraumatic stress and complex posttraumatic stress symptomatology and to support clinical referral decisions when needed. The ITQ-CA assesses symptoms associated with posttraumatic stress disorder as well as disturbances in self-organization, including affective dysregulation, negative self-concept, and interpersonal difficulties. The Farsi version has demonstrated acceptable internal consistency among Iranian trauma-exposed children and adolescents. In the present study, the questionnaire was used as a dimensional measure of trauma-related symptoms rather than as a substitute for a clinician-administered diagnostic interview. Scores were used to describe the psychological characteristics of the sample, assist clinicians in identifying students who might require additional evaluation, and examine whether baseline trauma severity moderated intervention outcomes. The instrument was not used to require participants to narrate traumatic experiences, and students retained the right to omit questions that generated distress.

A demographic, clinical, adherence, and adverse-events form was also completed to collect contextual information relevant to treatment response and participant safety. Demographic variables included age, sex, grade level, household composition, recent displacement, and selected indicators of family and school disruption. Clinical information included previous or current mental-health treatment, psychiatric medication use, school counseling utilization, recent major life events, and baseline trauma burden. Intervention implementation data included attendance at each group session, voluntary engagement in home practice, estimated number of practice days between sessions, and use of alternative grounding exercises. Facilitators additionally recorded any distress occurring during or following mindfulness exercises, early discontinuation of a practice because of discomfort, worsening nightmares, marked increases in anxiety, dissociative reactions, symptom exacerbation, and referrals to additional mental-health services. These variables were monitored throughout the trial to ensure that evaluation of effectiveness was accompanied by systematic assessment of feasibility, tolerability, and potential harms.

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2.3. Intervention

The experimental intervention consisted of an eight-week trauma-informed adaptation of Mindfulness-Based Stress Reduction specifically modified for adolescents with war-related exposure. Participants attended one 75-minute group session each week, with approximately eight to ten students in each intervention group. Sessions were led by a mental-health clinician trained in both mindfulness-based interventions and trauma-responsive clinical practice. The program retained the central MBSR principles of present-moment awareness, nonjudgmental attention, recognition of stress responses, and intentional behavioral choice while modifying practices that could be difficult for trauma-exposed adolescents. The program therefore excluded an all-day retreat, prolonged silent meditation, compulsory eyes-closed practice, extended body scans, and forced attention to internal sensations. During the first session, participants received psychoeducation about stress and the nervous system, established collaborative group safety agreements, practiced orientation to visible objects and environmental sounds, and learned explicit procedures for opting out of exercises. The second session emphasized flexible attention through brief eyes-open mindfulness exercises, student-selected attentional anchors, and noticing distraction without self-criticism. The third session focused on recognizing stress and alarm reactions, distinguishing current conditions from automatic threat responses, using the STOP pause, practicing gentle movement, and developing an individualized stabilization strategy. The fourth session addressed emotions and self-directed thinking through emotion labeling, awareness of socially anxious predictions, and compassionate, nonjudgmental responses to difficult internal experiences. The fifth session concentrated on perceived social threat and flexible behavior, helping students notice anxious predictions in ordinary peer and classroom interactions and select small values-consistent actions without requiring public speaking or compulsory exposure exercises. The sixth session addressed sleep-related arousal by teaching brief evening attention practices, methods for disengaging from repetitive thinking, acceptance of wakefulness without forcing sleep, and optional use of short audio practices before bedtime. The seventh session emphasized application of mindfulness and grounding skills during school transitions, peer interactions, examinations, and family situations, while helping students identify triggers and effective coping choices. The final session consolidated previously learned skills, reviewed helpful and unhelpful experiences with the practices, developed an individualized menu of preferred strategies, and included relapse-prevention planning, follow-up resources, and referral information. Students were invited, but never required, to complete short home practices lasting approximately 5 to 15 minutes on most days. All exercises could be stopped without explanation, and participants could choose eyes-open observation, movement, grounding through external sensory information, or temporary withdrawal from the activity. Intervention delivery followed a written manual, facilitators completed fidelity checklists after each session, and a prespecified proportion of sessions was independently reviewed to evaluate adherence to the intervention protocol and trauma-informed safeguards. The active control condition consisted of eight weekly 75-minute group sessions covering general adolescent health topics such as balanced nutrition, everyday physical activity, digital citizenship, creative interests, healthy routines, communication with school resources, and general well-being. The control program deliberately excluded formal mindfulness practice, structured sleep intervention, exposure-based social-anxiety techniques, and trauma processing. Fidelity checklists specific to each study arm were used to monitor intervention differentiation and minimize cross-condition contamination.

2.4. Data Analysis

Statistical analyses were conducted according to the intention-to-treat principle, whereby all randomized participants were analyzed according to their originally assigned study condition regardless of intervention adherence or session attendance. The two co-primary outcomes were total SPIN scores representing social-anxiety severity and total PSQI scores representing subjective sleep quality. Descriptive statistics were first calculated for demographic, clinical, trauma-exposure, adherence, and outcome variables. Continuous variables were summarized using means, standard deviations, medians, and ranges where appropriate, whereas categorical variables were summarized using frequencies and percentages. Baseline comparability of the intervention and active control groups was examined descriptively rather than through reliance on significance testing of randomization balance. The principal intervention effects were evaluated using linear mixed-effects models with repeated observations nested within participants. Separate models were fitted for SPIN and PSQI scores. Each model included fixed effects for treatment

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group, assessment time, and the group-by-time interaction, together with age and baseline trauma-burden score as prespecified covariates. Time was treated as a categorical variable representing baseline, immediate postintervention, and eight-week follow-up. A participant-specific random intercept was included to account for within-person correlation across repeated assessments. The primary estimand was the adjusted between-group difference in change from baseline to postintervention, represented by the treatment-group-by-postintervention interaction. The corresponding follow-up interaction was used to examine maintenance of intervention effects eight weeks after completion of the program.

Model assumptions were evaluated through inspection of residual distributions, residual-versus-fitted plots, influential observations, and the plausibility of linearity and homoscedasticity. Because participants were recruited from multiple schools and received the intervention in small groups, sensitivity analyses were planned to examine potential clustering attributable to school and intervention group where supported by the available sample structure. Missing outcome data were handled primarily through likelihood-based estimation within the mixed-effects framework under a missing-at-random assumption. Patterns and reasons for missingness were examined, and sensitivity analyses using multiple imputation or alternative missing-data assumptions were considered when the extent or pattern of missingness suggested potential departure from the missing-at-random assumption. Because SPIN and PSQI were specified as co-primary outcomes, multiplicity was controlled for the two primary postintervention treatment contrasts using the Holm procedure. Statistical tests were two-sided, and adjusted treatment estimates were reported with 95% confidence intervals and corresponding p values. In addition to unstandardized model-based coefficients, postintervention between-group Hedges' g values were calculated as descriptive standardized effect-size estimates; however, these standardized contrasts were not used as substitutes for the primary adjusted longitudinal treatment estimates. Follow-up comparisons, symptom subdomains, associations between practice adherence and outcomes, and potential moderating effects of trauma burden, displacement, concurrent treatment, and household disruption were considered secondary or exploratory analyses. Internal consistency of the SPIN, PSQI, and trauma-related measures was evaluated within the study sample using Cronbach's alpha and, where appropriate, McDonald's omega. Statistical significance was set at an alpha level of .05 following the prespecified multiplicity adjustment, and all analyses were accompanied by reporting of effect estimates, confidence intervals, attrition, intervention adherence, protocol deviations, adverse events, and clinically relevant changes regardless of statistical significance.

3. Findings and Results

A total of 120 war-exposed secondary-school students who met the eligibility criteria were randomized equally to the trauma-informed Mindfulness-Based Stress Reduction group (n = 60) and the active health-education control group (n = 60). The mean age of the total sample was 16.08 years (SD = 1.21; range = 14–18 years). Of the participants, 64 (53.3%) were female and 56 (46.7%) were male. In terms of school grade, 27 students (22.5%) were in Grade 9, 31 (25.8%) were in Grade 10, 34 (28.3%) were in Grade 11, and 28 (23.3%) were in Grade 12. Regarding living arrangements, 101 participants (84.2%) were living with both parents at the time of enrollment, 13 (10.8%) were living with one parent, and 6 (5.0%) were living with another primary family caregiver. Thirty-eight students (31.7%) reported a history of temporary or prolonged displacement related to war or security-related events, while 82 (68.3%) had remained in their usual residential area despite exposure to other war-related stressors. The most frequently reported war-related experiences included prolonged perceived threat or insecurity, reported by 87 students (72.5%); exposure to nearby explosions or armed activity, reported by 69 students (57.5%); damage to residential or family property, reported by 41 students (34.2%); displacement or forced relocation, reported by 38 students (31.7%); and injury or loss of a close person, reported by 29 students (24.2%). Multiple exposures were common, and 76 students (63.3%) reported two or more war-related stressful experiences. At baseline, 23 participants (19.2%) were receiving some form of routine school-based or outpatient psychological support, and 11 (9.2%) reported current use of prescribed psychotropic medication. These treatments were distributed across both groups and were documented throughout the study rather than discontinued.

The demographic and baseline clinical characteristics of the intervention and control groups were broadly comparable after randomization. The mean age was 16.12 years (SD = 1.18) in the trauma-informed MBSR group and 16.03 years (SD = 1.25) in the control group. Females constituted 55.0% of the intervention group and 51.7% of the

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control group. Similarly, no meaningful imbalance was observed between groups in grade level, displacement history, number of war-related stressors, ongoing counseling, medication use, or baseline symptom severity. Of the 120 randomized participants, 115 completed the immediate postintervention assessment, including 58 students in the intervention group and 57 in the control group. At the eight-week follow-up, outcome data were available for 111 students, including 56 intervention participants and 55 control participants. Thus, overall retention was 95.8% at postintervention and 92.5% at follow-up. The intention-to-treat mixed-effects analyses nevertheless included all 120 randomized participants through likelihood-based estimation. Reasons for missing follow-up assessments included school absence, change of school, inability to contact the family, and voluntary discontinuation of research assessments. There was no evidence that attrition was concentrated in one treatment arm, and no participant was removed from the analysis because of incomplete attendance or nonadherence to home practice.

Table 1

Descriptive Statistics for Social Anxiety and Sleep Quality Across the Three Assessment Points

Outcome	Assessment	Trauma-Informed MBSR, M (SD)	Active Control, M (SD)
SPIN total score	Baseline	42.18 (8.11)	41.67 (8.37)
SPIN total score	Postintervention	28.43 (7.66)	39.12 (8.55)
SPIN total score	Eight-week follow-up	29.31 (7.84)	38.54 (8.63)
PSQI global score	Baseline	11.43 (2.91)	11.18 (2.84)
PSQI global score	Postintervention	6.72 (2.63)	10.34 (2.78)
PSQI global score	Eight-week follow-up	7.02 (2.71)	10.08 (2.86)

As shown in Table 1, the two study groups demonstrated highly similar mean levels of social anxiety and sleep disturbance before treatment, supporting the effectiveness of random allocation in achieving baseline comparability on the primary outcomes. At baseline, the mean SPIN score was 42.18 (SD = 8.11) in the trauma-informed MBSR group and 41.67 (SD = 8.37) in the active control group, indicating substantial social-anxiety symptoms in both groups. Following the eight-week intervention, the mean SPIN score in the trauma-informed MBSR group decreased markedly to 28.43 (SD = 7.66), representing an unadjusted mean reduction of 13.75 points from baseline. In contrast, the control group showed only a modest decrease from 41.67 (SD = 8.37) at baseline to 39.12 (SD = 8.55) after the health-education program, corresponding to an unadjusted reduction of 2.55 points. At the eight-week follow-up, the intervention group's mean SPIN score was 29.31 (SD = 7.84), indicating that most of the improvement observed immediately after treatment had been maintained. The corresponding control-group mean was 38.54 (SD = 8.63), which remained substantially higher than that of the intervention group. A similar pattern was observed for sleep quality. The baseline PSQI global scores were 11.43 (SD = 2.91) in the intervention group and 11.18 (SD = 2.84) in the control group, reflecting substantial subjective sleep disturbance in both groups. At postintervention, the mean PSQI score decreased to 6.72 (SD = 2.63) in the trauma-informed MBSR group, whereas the control-group mean decreased only to 10.34 (SD = 2.78). The corresponding unadjusted baseline-to-postintervention reductions were 4.71 points in the intervention group and 0.84 points in the control group. At the eight-week follow-up, the intervention group's mean PSQI score remained comparatively low at 7.02 (SD = 2.71), whereas the control group had a mean of 10.08 (SD = 2.86). Therefore, the descriptive findings indicated substantial reductions in both social-anxiety symptoms and sleep problems among students receiving trauma-informed MBSR, with only modest changes observed among students receiving general adolescent health education.

Table 2

Linear Mixed-Effects Models for SPIN and PSQI Scores Across Assessment Points

Outcome	Predictor	B	SE	95% CI	t	p
SPIN	Intervention group at baseline	0.51	1.50	-2.45 to 3.47	0.34	.735
SPIN	Postintervention time	-2.55	1.15	-4.82 to -0.28	-2.22	.028

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SPIN	Eight-week follow-up time	-3.13	1.19	-5.48 to -0.78	-2.63	.010
SPIN	Intervention × Postintervention	-11.20	1.58	-14.32 to -8.08	-7.09	< .001
SPIN	Intervention × Follow-up	-9.74	1.64	-12.98 to -6.50	-5.94	< .001
SPIN	Age	0.38	0.42	-0.45 to 1.21	0.91	.365
SPIN	Baseline trauma burden	1.26	0.31	0.65 to 1.87	4.06	< .001
PSQI	Intervention group at baseline	0.25	0.52	-0.78 to 1.28	0.48	.631
PSQI	Postintervention time	-0.84	0.39	-1.61 to -0.07	-2.15	.034
PSQI	Eight-week follow-up time	-1.10	0.41	-1.91 to -0.29	-2.68	.009
PSQI	Intervention × Postintervention	-3.87	0.55	-4.96 to -2.78	-7.04	< .001
PSQI	Intervention × Follow-up	-3.31	0.57	-4.44 to -2.18	-5.81	< .001
PSQI	Age	0.09	0.12	-0.15 to 0.33	0.75	.453
PSQI	Baseline trauma burden	0.28	0.08	0.12 to 0.44	3.50	.001

The linear mixed-effects analyses presented in Table 2 confirmed that the descriptive improvements in the trauma-informed MBSR group represented statistically significant treatment-related changes rather than merely general change over time. For social anxiety, there was no significant baseline difference between the intervention and control conditions after accounting for age and trauma burden, B = 0.51, SE = 1.50, p = .735, indicating that the groups began the study at statistically comparable levels of social-anxiety severity. The control group demonstrated a small but statistically significant reduction in SPIN scores at postintervention, B = -2.55, SE = 1.15, 95% CI [-4.82, -0.28], p = .028, and at the eight-week follow-up, B = -3.13, SE = 1.19, 95% CI [-5.48, -0.78], p = .010. However, the intervention-by-time interactions were substantially larger. The group-by-postintervention coefficient was B = -11.20, SE = 1.58, 95% CI [-14.32, -8.08], p < .001, demonstrating that the decrease in social-anxiety symptoms from baseline to the immediate postintervention assessment was approximately 11 points greater in the trauma-informed MBSR condition than in the active control condition after adjustment for the covariates included in the model. The significant intervention-by-follow-up interaction, B = -9.74, SE = 1.64, 95% CI [-12.98, -6.50], p < .001, further indicated that the treatment advantage remained evident eight weeks after completion of the intervention. Baseline trauma burden was positively associated with SPIN scores across observations, B = 1.26, p < .001, suggesting that students reporting greater cumulative war-related exposure tended to show higher levels of social anxiety. Age was not independently associated with SPIN scores. The model for sleep quality demonstrated the same overall pattern. No significant baseline difference in PSQI scores was identified between groups, B = 0.25, SE = 0.52, p = .631. Although students in the control group demonstrated modest improvement over time, the additional reduction associated with assignment to trauma-informed MBSR was considerably larger. The intervention-by-postintervention interaction was B = -3.87, SE = 0.55, 95% CI [-4.96, -2.78], p < .001, indicating an adjusted reduction in PSQI score approximately 3.9 points greater than that occurring in the control condition. The intervention-by-follow-up interaction also remained significant, B = -3.31, SE = 0.57, 95% CI [-4.44, -2.18], p < .001, demonstrating maintenance of the intervention-related sleep benefit. Greater baseline trauma burden was associated with poorer sleep quality, B = 0.28, p = .001, whereas age was not significantly related to PSQI scores. Overall, the longitudinal models therefore supported significant and sustained intervention effects on both co-primary outcomes.

Table 3

Adjusted Between-Group Contrasts and Standardized Effect Sizes at Postintervention and Follow-up

Outcome	Assessment	Adjusted Mean Difference, MBSR − Control	SE	95% CI	Holm-Adjusted p	Hedges' g
SPIN total score	Postintervention	-10.97	1.36	-13.66 to -8.28	< .001	-1.31
SPIN total score	Eight-week follow-up	-9.58	1.40	-12.35 to -6.81	< .001	-1.12
PSQI global score	Postintervention	-3.76	0.47	-4.68 to -2.84	< .001	-1.36
PSQI global score	Eight-week follow-up	-3.17	0.47	-4.10 to -2.24	< .001	-1.10

As presented in Table 3, the adjusted between-group contrasts demonstrated substantial intervention effects for both social anxiety and sleep quality, and all primary postintervention comparisons remained statistically significant after Holm correction for the two co-primary outcomes. Immediately following the eight-session

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program, the adjusted SPIN score in the trauma-informed MBSR condition was 10.97 points lower than that in the active control condition, SE = 1.36, 95% CI [-13.66, -8.28], Holm-adjusted $p < .001$. The corresponding standardized effect size was Hedges' g = -1.31, indicating a large between-group difference favoring trauma-informed MBSR. Although the magnitude of the treatment difference was somewhat smaller at the eight-week follow-up, it remained substantial and statistically significant, with an adjusted between-group difference of -9.58 points, SE = 1.40, 95% CI [-12.35, -6.81], $p < .001$, and a large standardized effect size of g = -1.12. The sleep-quality findings were similarly pronounced. At postintervention, the adjusted PSQI score was 3.76 points lower in the trauma-informed MBSR group than in the active control group, SE = 0.47, 95% CI [-4.68, -2.84], Holm-adjusted $p < .001$, corresponding to Hedges' g = -1.36. At the eight-week follow-up, the adjusted difference remained significant at -3.17 points, SE = 0.47, 95% CI [-4.10, -2.24], $p < .001$, with a standardized effect size of g = -1.10. The persistence of large standardized effects at follow-up suggests that the intervention benefits were not limited to the immediate period following treatment. Intervention implementation was also generally acceptable. Students assigned to trauma-informed MBSR attended a mean of 7.12 of the eight sessions (SD = 1.08), and 51 of 60 participants (85.0%) attended at least six sessions. Among students providing home-practice information, the median reported frequency was four practice days per week, with shorter grounding and attention exercises used more consistently than longer audio-guided practices. Seven participants temporarily stopped an exercise because of discomfort or increased arousal during at least one session; all were able to use an alternative eyes-open, movement-based, or externally focused grounding strategy, and none required emergency intervention as a direct consequence of the mindfulness program. Three intervention participants and two control participants were referred for additional mental-health evaluation during the study because of clinically significant distress identified through routine safeguarding procedures. No suicide attempt, psychiatric hospitalization, psychotic episode, or other serious adverse event judged to be caused by the intervention was recorded. Taken together, the findings indicate that trauma-informed MBSR produced statistically significant, clinically substantial, and largely sustained reductions in social-anxiety symptoms and subjective sleep disturbance among war-exposed secondary-school students compared with an attention-matched general health-education condition.

4. Discussion

The present study examined the effects of an eight-week trauma-informed Mindfulness-Based Stress Reduction program on social anxiety and sleep quality among war-exposed secondary-school students. The findings demonstrated that students who received the trauma-informed MBSR intervention experienced substantially greater reductions in both social-anxiety symptoms and sleep disturbance than students who participated in the active health-education control condition. The intervention group showed a marked decrease in SPIN scores from baseline to postintervention, and this improvement remained largely sustained at the eight-week follow-up. A similar pattern emerged for sleep quality, with PSQI scores decreasing considerably following the intervention and remaining significantly lower than those of the control group at follow-up. The mixed-effects analyses further confirmed significant group-by-time interactions for both outcomes, while the adjusted between-group contrasts indicated large standardized effect sizes at both postintervention and follow-up. These findings suggest that a trauma-informed adaptation of MBSR may have meaningful short-term and sustained benefits for two clinically important domains of functioning among adolescents exposed to war-related stress.

The reduction in social anxiety observed in the intervention group is consistent with a broader literature showing that war-related psychological distress often extends beyond classical posttraumatic stress symptoms and includes anxiety, interpersonal difficulties, heightened vigilance, and social withdrawal. Adolescents exposed to continuous traumatic stress may develop tightly interconnected patterns of anxiety and trauma-related symptoms, rather than isolated forms of psychopathology (Засєкіна et al., 2026). This is particularly relevant during adolescence, when peer evaluation, classroom participation, and social belonging assume increasing developmental importance. The present findings can therefore be interpreted within a framework in which war-related threat sensitizes adolescents to cues of danger and negative evaluation, potentially increasing avoidance of ordinary social situations. Recent research on adolescents affected by war has similarly shown that vulnerability and resilience coexist, with some students maintaining functioning while others experience substantial psychological impairment in response to conflict exposure (Haham et al., 2025). The significant reduction in social anxiety following trauma-

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informed MBSR suggests that increasing present-moment awareness and reducing automatic threat-based responding may help adolescents engage more flexibly with peer and school environments.

One possible mechanism underlying this improvement is the reduction of hypervigilant attention to perceived interpersonal threat. War exposure can create enduring patterns of heightened alertness in which ambiguous social cues are more likely to be interpreted as potentially dangerous, rejecting, or humiliating. Such patterns may become reinforced through avoidance, self-monitoring, and repetitive negative thinking. A trauma-informed mindfulness approach may interrupt this cycle by helping students notice anxious predictions without automatically responding to them as facts. In the present intervention, students practiced identifying stress responses, choosing attentional anchors, noticing self-critical thoughts, and taking small values-consistent actions in everyday social contexts without being forced into formal exposure exercises. This emphasis on flexibility may be especially important for trauma-exposed adolescents because coercive or overly intensive techniques may reproduce feelings of loss of control. The broader literature on adaptation under prolonged war-related stress likewise emphasizes psychological flexibility, coping resources, and regulation as central components of adjustment (Nekrasova et al., 2026).

The findings are also consistent with evidence showing that war exposure is associated with wide-ranging psychological and functional impairment. Studies among war-affected populations have reported substantial rates of posttraumatic stress, anxiety, functional disability, and reduced well-being (Kang et al., 2023; Kassaye et al., 2023). War-related distress can also affect family and relational functioning, indicating that trauma symptoms are embedded within broader interpersonal systems (Knežević & Batinić, 2023). For adolescents, this may translate into reduced emotional availability within families, instability in caregiving arrangements, and diminished access to supportive peer relationships. The decrease in social anxiety observed in the present study may therefore reflect more than a narrow reduction in fear of social evaluation; it may represent improved regulatory capacity in contexts where students previously experienced both internal and interpersonal threat. This interpretation is compatible with the view that psychological interventions for conflict-exposed youth should support broader adaptation rather than focus exclusively on diagnostic symptoms.

The results regarding sleep quality were similarly notable. Students in the trauma-informed MBSR condition demonstrated a pronounced reduction in PSQI scores immediately after treatment, and the difference remained significant at follow-up. This finding is consistent with previous research documenting substantial sleep problems in populations affected by war and chronic insecurity. Research among Ukrainians after the full-scale invasion identified high levels of insomnia and disrupted sleep duration, demonstrating the close association between war-related stress and impaired sleep (Wang et al., 2024). Likewise, studies conducted in populations exposed to the wider psychological effects of armed conflict have documented elevated sleep disturbance alongside anxiety and mood symptoms (Hoffmann et al., 2024). These patterns suggest that poor sleep in war-affected adolescents is likely influenced by both direct trauma-related arousal and broader uncertainty about safety, family stability, and future threat.

The mechanisms linking trauma and sleep are particularly relevant to understanding why mindfulness may have produced improvement. War-related posttraumatic stress symptoms have been associated with sleep disturbance through difficulties in emotion regulation and intolerance of uncertainty (Zemestani et al., 2025). Adolescents who remain cognitively engaged with possible danger at bedtime may experience difficulty disengaging from repetitive thoughts, bodily arousal, and threat monitoring. The sleep-focused components of the present intervention were designed specifically to address these processes without encouraging students to force sleep. Instead, they were taught to notice arousal, disengage from rumination, and use brief attention-based or grounding practices during the evening. Such strategies may reduce the struggle with wakefulness and thereby lower cognitive and physiological arousal. The persistence of improved PSQI scores at follow-up suggests that these skills may have become incorporated into students' everyday routines rather than functioning only during the active intervention period.

Nightmares and trauma-related nocturnal distress may provide another explanation for the observed sleep improvements. Research among internally displaced individuals exposed to armed attacks has shown that war-related nightmares are closely associated with broader anxiety and depressive symptoms (Hokayem et al., 2026). Although the present study did not identify nightmares as a primary outcome, adverse-event monitoring included new or worsening nightmares, and the intervention incorporated trauma-sensitive safeguards intended to prevent excessive

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internal activation. This is important because mindfulness practices are not uniformly beneficial if they are delivered without attention to trauma history. Practices that involve prolonged eyes-closed attention or intense focus on bodily sensations may, in some individuals, increase distress or trigger intrusive experiences. By using brief exercises, allowing eyes-open practice, offering movement-based alternatives, and permitting students to stop at any time, the intervention may have improved regulation while minimizing the risk of intensifying trauma-related arousal.

The large effect sizes observed for both social anxiety and sleep quality also support the value of adapting mindfulness interventions specifically for trauma-exposed youth rather than applying standard adult MBSR protocols without modification. The broader literature on integrative and body-based interventions in war-affected populations emphasizes the importance of safety, pacing, choice, and individualized regulation (Nazzal et al., 2026; Stoffman & Ben-Arye, 2026). Similarly, calls for yoga and other mind-body interventions in war-affected populations have highlighted the potential value of nonpharmacological approaches that strengthen self-regulation and can be implemented in community settings (Anand et al., 2021). The present findings extend this rationale to a school-based adolescent population and suggest that mindfulness can be adapted in ways that preserve its core attentional principles while avoiding practices that may be inappropriate for individuals with significant trauma histories.

Another important finding was the positive association between baseline trauma burden and both social anxiety and sleep disturbance. Students with greater cumulative exposure to war-related stressors tended to report more severe symptoms across the assessment period. This result is consistent with evidence demonstrating that the psychological effects of war are often dose-related and cumulative. Greater exposure to conflict, displacement, bereavement, and threat has been associated with increased posttraumatic stress and broader mental-health problems (Kassaye et al., 2023; Masoomi et al., 2026). Biological models also suggest that repeated or prolonged trauma exposure can influence stress-regulatory systems and potentially contribute to longer-term vulnerability (Raza et al., 2023). The present finding therefore reinforces the importance of considering trauma burden as a continuous variable rather than treating war exposure as a simple yes-or-no category.

The association between trauma burden and poorer outcomes may also reflect the cumulative disruption of daily developmental systems. War exposure can interfere with schooling, family functioning, access to healthcare, social networks, and routines, all of which contribute to adolescent psychological stability. Reports from displaced Ukrainian adolescents have highlighted disruptions in education, family life, safety, and social connection during conflict (Lopatovska et al., 2022). Research on border-region children has likewise shown that war can become integrated into the symbolic and emotional landscape of childhood itself (Teze & Ayhan, 2025). These findings help explain why adolescents with greater exposure histories may experience both heightened social threat sensitivity and greater sleep disturbance. The intervention's effectiveness despite variation in trauma burden is therefore encouraging, although more research is needed to determine whether students with the highest exposure levels require additional or more intensive support.

The present results also fit with evidence that war-related stress affects domains beyond conventional psychiatric symptoms. Chronic stress exposure has been associated with neurotic symptoms and broader emotional disturbance in both children and adults (Boltivets et al., 2024). War-related trauma has also been linked with somatic and physical consequences, including temporomandibular disorders among veterans and poorer oral-health outcomes among conflict-exposed adolescents (Habal et al., 2024; Minervini et al., 2023). Furthermore, indirect exposure to conflict-related information can negatively affect health even among individuals not directly located within the conflict zone (Marzaleh et al., 2026). These studies collectively support the interpretation that war-related stress operates through interconnected psychological and physiological pathways. The improvement in both social anxiety and sleep in the present study may therefore reflect a broader reduction in stress-system activation rather than two entirely separate treatment effects.

The retention and adherence findings also support the feasibility of the intervention. Most students attended at least six of the eight sessions, and home-practice engagement was acceptable given that practice was voluntary. Importantly, several participants experienced transient discomfort during specific mindfulness exercises, but these responses were managed through alternative grounding or movement-based strategies, and no serious adverse event was attributed to the intervention. This finding reinforces the importance of trauma-informed implementation. Adolescents affected by war should not be expected to tolerate prolonged internal attention or disclosure simply because an intervention is

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labeled as mindfulness-based. Instead, programs should preserve autonomy and continuously monitor for distress. This approach is consistent with broader trauma-responsive principles and with evidence emphasizing the need for integrative interventions that support resilience while avoiding unnecessary reactivation of traumatic stress (Nazzal et al., 2026; Stoffman & Ben-Arye, 2026).

The significant treatment effects relative to an active health-education control are particularly important because they suggest that the observed improvements cannot be explained solely by group contact, facilitator attention, or participation in a structured school activity. The control condition was matched for duration, group interaction, materials, and general educational engagement, yet the trauma-informed MBSR group demonstrated substantially greater improvement. This strengthens the interpretation that the specific attentional, regulatory, and trauma-sensitive components of the intervention contributed meaningfully to the outcomes. At the same time, the modest improvement observed in the control group suggests that supportive group participation and health education may themselves have some beneficial effects, which is consistent with the general importance of psychosocial support during periods of crisis (Yasegnal, 2022).

5. Conclusion

The present findings should also be understood within the broader literature on war-related adaptation and resilience. War exposure does not inevitably produce chronic dysfunction, and individuals may show substantial variability in psychological outcomes. Research has demonstrated both vulnerability and resilience among adolescents exposed to military conflict (Haham et al., 2025), while other work has shown that combat exposure can affect subjective well-being and health behavior in complex ways (McKee et al., 2024). The goal of trauma-informed mindfulness should therefore not be conceptualized as eliminating all distress in the face of objectively difficult circumstances. Rather, it may help adolescents respond more flexibly to internal stress reactions, reduce unnecessary physiological arousal, and preserve participation in important developmental activities despite ongoing uncertainty. In this sense, the present findings support a resilience-oriented rather than pathology-centered interpretation of the intervention.

Several limitations should be considered when interpreting the findings. First, the study relied primarily on self-report measures of social anxiety and sleep quality, which may be influenced by response bias, expectancy effects, and participants' interpretations of symptom change. Second, the follow-up period was limited to eight weeks after intervention completion, and therefore the long-term durability of the observed effects remains uncertain. Third, participants were recruited from a limited number of secondary schools, which may restrict generalizability to adolescents living in different geographic, socioeconomic, or conflict contexts. Fourth, although the control condition was designed to match attention and contact time, participants and facilitators could not be blinded to intervention assignment, creating potential expectancy effects. Fifth, war exposure was heterogeneous, and students differed in the type, recency, and cumulative severity of stressful experiences. Finally, although adverse events were monitored systematically, the study was not powered to detect rare negative responses to mindfulness practice, and the findings should therefore not be interpreted as establishing complete safety for all trauma-exposed adolescents.

Future studies should include larger and more diverse samples drawn from multiple regions and should examine whether intervention effects differ according to type of war exposure, displacement status, trauma severity, sex, age, and baseline psychiatric symptoms. Longer follow-up periods are needed to determine whether improvements in social anxiety and sleep are maintained over six months or one year. Future trials should also incorporate objective or multimethod assessments where feasible, such as actigraphy, sleep diaries, clinician-rated anxiety measures, ecological momentary assessment, or teacher and parent reports. Mediation analyses could clarify whether improvements are explained by reductions in rumination, hyperarousal, intolerance of uncertainty, or emotion-regulation difficulties. Research should also compare trauma-informed MBSR with other active psychological interventions, including cognitive-behavioral, acceptance-based, or school counseling approaches, in order to determine relative efficacy. Finally, future studies should examine intervention dose, optimal session length, implementation fidelity, and the specific mindfulness practices most acceptable and beneficial for war-exposed adolescents.

In practice, school-based trauma-informed mindfulness programs should be delivered only by facilitators who understand both adolescent development and trauma-responsive care. Participation should remain voluntary, and

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students should always be offered alternatives to eyes-closed meditation, prolonged stillness, or intense body-focused exercises. Schools should establish clear referral pathways for students who display severe distress, suicidal risk, dissociation, psychosis, or other conditions requiring specialist treatment. Mindfulness should be presented as a regulation and coping tool rather than as a replacement for trauma-focused psychotherapy or psychiatric care when these are clinically indicated. Short, flexible practices that can be used during classroom transitions, examinations, peer interactions, and bedtime may be especially practical. Programs should also involve ongoing communication with school counselors and, where appropriate, families so that improvements in coping can be supported across settings. Most importantly, implementation should prioritize psychological safety, choice, and respect for individual differences in readiness to engage with mindfulness-based practices.

Authors' Contributions

Authors equally contributed to this article.

Declaration

In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

Transparency Statement

Data are available for research purposes upon reasonable request to the corresponding author.

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Declaration of Interest

The authors report no conflict of interest.

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Ethical Considerations

The study protocol adhered to the principles outlined in the Helsinki Declaration, which provides guidelines for ethical research involving human participants.

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