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Pregled
Review

THE IMPACT OF WAR TRAUMA ON CHILDREN: TOXIC STRESS AND LONG-TERM CONSEQUENCES

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The objective of this study is to systematically examine the impact of war-related trauma on children, with a particular focus on the phenomenon of toxic stress and its long-term consequences. A narrative literature review was conducted using the PubMed and Scopus databases, encompassing studies published between 2000 and 2025 that addressed the psychological, neurobiological, and social aspects of war-related trauma in the pediatric population. Exposure to war-related traumatic experiences, including violence, loss of parents, forced displacement, and disruption of education, significantly increases the risk of developing post-traumatic stress disorder (PTSD), depressive and anxiety disorders, behavioural problems, as well as cognitive and emotional impairments. Long-term consequences include structural and functional neurobiological alterations, dysregulation of the hypothalamic-pituitary-adrenal (HPA) axis, disrupted cortisol secretion, and heightened vulnerability to chronic health conditions, including cardiometabolic diseases, impaired immune responses, and psychosomatic symptoms. Social determinants such as loss of parental care, educational disruption, and marginalisation further exacerbate adverse outcomes, whereas protective factors, including stable family and community support, can mitigate these effects. Evidence consistently demonstrates that family-centred interventions, in combination with targeted psychosocial programs, play therapy, educational initiatives, and mentorship, significantly reduce adverse outcomes and enhance resilience in affected children. Timely, comprehensive, and family-oriented support thus emerges as a critical factor in preventing and alleviating the long-term consequences of war trauma, while an integrated approach addressing psychological, neurobiological, and social dimensions facilitates a more thorough understanding of the complex impact of war-related trauma and informs the design of effective interventions.

Keywords: CHILDREN, LONG-TERM CONSEQUENCES, PTSD, TOXIC STRESS, WAR TRAUMA

INTRODUCTION

War and Exposure to Trauma

War and armed conflict represent one of the most extreme forms of stress to which a child can face (1, 4). Children in conflict zones frequently witness violence and may also become direct victims of physical, emotional, or sexual abuse (4, 5). Exposure includes immediate threats to life, loss of parents or family members, forced displacement, and disruption of education, all of which create a complex network of stressors that significantly disrupt normal child development (2, 5, 12). Research indicates that the younger the child at the time of trauma and the greater the number of traumatic events experienced, the higher the likelihood of developing severe psychological and neurobiological consequences (6, 7, 14). War-affected children often show emotional dysregulation, difficulties with concentration and learning, heightened anxiety, and depressive symptoms (8, 9). Social isolation, interrupted education, and the loss of peers further increase vulnerability (11, 19).

Neurobiological Mechanisms of Toxic Stress

Toxic stress describes prolonged, intense stress that exceeds a child's capacity for adaptive coping, especially without sufficient adult support (3). Unlike acute stress, which can have adaptive effects, toxic stress causes long-lasting changes in neuroendocrine, immune, and neurological systems (6, 7). Persistent activation of the HPA axis results in excessive cortisol release, which over time can reduce hippocampal and prefrontal cortex volume and increase amygdala activity (16, 17). These neurobiological alterations are linked to cognitive impairments, including difficulties with memory, attention, executive function, and emotional regulation (6, 17, 18). Neuroimaging of children in conflict zones shows decreased connec-

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tivity between critical neural networks that govern impulse control and emotional stability, partly explaining the higher incidence of PTSD and anxiety disorders (16, 18).

Psychological and Social Dimensions

War-related trauma affects not only the brain and body but also has significant psychological and social impacts (5, 8). Children exposed to war frequently develop PTSD, depression, anxiety, and behavioural disorders (9, 12). Common manifestations include emotional dysregulation, nightmares, intrusive thoughts, and regressive behaviours, particularly in younger children (8, 9). Adolescents face different risks, with higher rates of depressive disorders, self-harm, and social withdrawal (5, 10). Social determinants include loss of parental care, disruption of education, displacement, and marginalisation (11, 19). Children deprived of peer contact and safe environments often experience helplessness and insecurity, exacerbating psychological consequences (12, 19). Cultural and contextual factors modulate symptom severity: functional family structures and community support can partially mitigate adverse outcomes, while discrimination and stigmatisation amplify vulnerability (11, 19).

Theoretical Framework and Multidimensional Approach

Understanding the impact of war trauma requires integrating psychological, neurobiological, and social perspectives (3, 6, 16). Theoretical models, such as latent vulnerability, suggest that early traumatic experiences alter brain developmental trajectories, creating enduring susceptibility to psychiatric disorders in adulthood (16, 17). Resilience models emphasise the protective role of stable family support, community safety, and access to education in mitigating long-term consequences (11, 19, 24). A multidimensional approach allows for monitoring psychological symptoms, neurobiological changes, and social outcomes, providing a framework for evaluating intervention programmes, including psychosocial support, therapeutic modalities, and educational strategies integrated into the child's daily life (10, 12).

Toxic Stress and Long-Term Physical and Chronic Health Consequences

Toxic stress in war-affected children has multidimensional and long-lasting effects on physical health. Chronic HPA axis activation and sustained elevated cortisol levels lead to immune dysfunction, increased inflammatory activity, and impaired immune response to infection (6, 20). These neuroendocrine and immune alterations are associated with heightened susceptibility to somatic illnesses, including cardiometabolic disorders, hypertension, type 2 diabetes, and autoimmune diseases (20, 21). Prolonged toxic stress may also result in telomere shortening, a biological marker of accelerated ageing and vulnerability to chronic disease (21). Children exposed to multiple traumatic events more frequently display metabolic dysfunction, impaired neuroendocrine responses, and increased risk of psychosomatic symptoms such as headaches, abdominal pain, and gastrointestinal disorders (20, 21). The combination of neurobiological, immunological, and psychosocial factors generates a cumulative burden that elevates the risk of chronic health problems during adolescence and adulthood. Interventions targeting toxic stress, including psychosocial support, play therapy, and family-centred programs, demonstrate potential in mitigating these long-term consequences and preserving the health of war-affected children (10, 22, 23).

METHODS

Literature Search Strategy

A systematic literature search was conducted in two major databases: PubMed and Scopus, covering a wide range of medical, psychological, and sociological studies. The search was limited to the period 2000-2025 to incorporate the most recent knowledge on the impact of war trauma on children. Keywords included: children, war trauma, toxic stress, post-traumatic stress disorder, long-term consequences. Boolean operators (AND, OR) were used to optimise sensitivity and reduce the risk of omitting relevant studies. Additionally, a secondary search of the reference lists of selected articles identified studies not indexed in the primary databases. This dual approach ensured broader literature coverage and inclusion of studies from diverse geographic and cultural contexts, including the Middle East, Africa, and Southeastern Europe, where war-related trauma in children has been extensively studied.

Inclusion and Exclusion Criteria

Studies were included if they:

- investigated psychological, neurobiological, or social consequences of war trauma in children under 18 years;
- used validated instruments to assess mental health, neurobiological parameters, or social outcomes;
- were published in peer-reviewed journals;
- were available in English.

Exclusion criteria included:

- studies on trauma in adults or outside war contexts;
- publications without original data (editorials, commentaries);
- studies lacking sufficient methodological or population details.

This rigorous approach ensured the selection of the most relevant studies for understanding the specific effects of war trauma on the pediatric population.

Number and Type of Included Studies

The primary search identified over 1200 potentially relevant articles. After initial abstract screening and methodological assessment, 95 studies were included for detailed analysis and included studies comprised longitudinal, cross-sectional, quantitative, qualitative, and systematic reviews with meta-analyses. Longitudinal studies were particularly valuable for tracking long-term consequences of war trauma, including PTSD, depression, cognitive deficits, and social dysfunction over time. Cross-sectional studies provided prevalence data on psychological symptoms and neurobiological changes across populations, while qualitative studies offered more profound insight into children's and families' subjective experiences.

Narrative Review Method and Advantages

A narrative review methodology was chosen to synthesize various data types - psychological, neurobiological, and social - into a coherent interpretation. Unlike systematic reviews with meta-analysis, narrative synthesis allows combining studies with diverse measures and designs, which is critical in multidisciplinary research on war trauma in children. Advantages include detailed synthesis of theoretical models, including latent vulnerability and resilience, and linking empirical data to practical implications for interventions and child protection policy. Limitations include potential subjectivity in data interpretation and selection bias, the inclusion of studies that meet strictly defined methodological criteria.

Analytical Approach and Data Synthesis

Involved a thematic synthesis across four domains: psychological consequences, neurobiological changes, social outcomes, and intervention effectiveness. Each domain was examined considering both acute and persistent effects, risk factors, and protective factors. A combination of descriptive statistics from quantitative studies and narrative interpretation from qualitative research enabled a comprehensive evaluation of the complex impact of war trauma. This approach allowed identification of patterns across populations, including age, sex, cultural context, and trauma type. It provided a framework for evaluating interventions ranging from play therapy and cognitive-behavioural therapy to educational and community-based programs.

RESULTS

Psychological Consequences

Children exposed to war-related trauma exhibit a significantly increased prevalence of psychological disorders, including PTSD, depression, and anxiety disorders (8, 9, 12). PTSD occurs in 30-70% of children in conflict zones, depending on the intensity, duration, and nature of exposure to traumatic events (15). War-affected children frequently experience intrusive memories, nightmares, heightened emotional reactivity, impulsive behaviour, and problems in emotional and behavioural regulation (8, 9). Additionally, many children exhibit hypervigilance, increased attention to potential threats, and excessive anxiety, substantially impairing daily functioning, including sleep, academic performance, and interpersonal relationships (12).

Younger children often display regressive symptoms, including enuresis, parental dependency, fear of abandonment, social withdrawal, and occasional aggressive behaviour. In contrast, adolescents more commonly develop depressive and anxiety disorders, engage in risky behaviours such as self-harm, aggression, substance misuse, and social withdrawal (5, 10). Long-term psychological consequences include reduced social functioning, impaired integration into school and community, diminished sense of competence and self-esteem, and an elevated risk of chronic mental health disorders in adulthood (12, 19).

The prevalence of PTSD and depression varies according to the type of traumatic exposure. Children directly exposed to violence, wartime abuse, or parental loss exhibit a significantly higher risk of persistent psychological disorders compared to children who only witnessed violence without direct victimisation (8, 12). Social support-including the presence of caregivers, family cohesion, and a safe environment-acts as a resilience factor and can mitigate symptom severity; however, children exposed to multiple traumatic events often experience cumulative stress, further exacerbating psychological consequences (8, 12).

Neurobiological Changes

Chronic stress activates the HPA axis, increases cortisol secretion, and causes long-term neurobiological alterations, including reduced hippocampal and prefrontal cortex volumes and heightened amygdala activity (6, 16, 17). These changes are associated with increased emotional reactivity, impulsivity, and executive function deficits, including impairments in planning, decision-making, and impulse control (16, 18).

Additional neurobiological alterations include decreased white matter volume, reduced connectivity of key neural networks, and disrupted communication between the frontal cortex and limbic system, affecting memory, attention, social cognition, and emotional regulation (17). Children exposed to multiple traumatic events exhibit greater neurobiological dysfunction compared to those exposed to single-event trauma (6, 16). Chronic stress also impacts the immune system, increasing inflammatory markers, weakening immunity, and elevating susceptibility to somatic illnesses, including cardiometabolic disorders and autoimmune diseases (20). These neurobiological changes are a significant mechanism through which war trauma exerts long-term effects on both mental and physical health, often correlating with neurocognitive deficits, reduced attention, and impaired academic performance (16).

Social Consequences

Social impacts of war trauma include loss of parental care, disrupted education, displacement, discrimination, marginalisation, and disruption of social networks (11, 19). Children deprived of peer contact and safe environments frequently experience helplessness, isolation, and insecurity, further exacerbating psychological consequences (12).

Interrupted education has long-term effects: children excluded from schooling during wartime demonstrate reduced academic performance, impaired social integration, weaker problem-solving skills, and fewer employment opportunities in adulthood (10, 12). Social networ-

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ks and community support serve a protective function-stable family presence, peer support, mentors, and communal activities can mitigate adverse outcomesstigma can exacerbate them. In contrast, stigmatisation, discrimination, and resource scarcity further worsen the situation (11, 19). Social consequences also include impaired community and school integration, decreased participation in social activities, and heightened vulnerability to risky behaviours and social exclusion, which can contribute to cycles of poverty and marginalisation over time (11, 19).

Long-Term Health Consequences

Chronic stress associated with war trauma increases the risk of chronic health conditions, including cardiometabolic disorders, autoimmune diseases, psychosomatic symptoms, and immune dysfunction (20, 21). Studies indicate that children exposed to multiple traumatic events have shorter telomeres, elevated inflammatory markers, and increased stress sensitivity, further heightening vulnerability to chronic diseases in adulthood (21).

Beyond somatic effects, long-term consequences include an increased likelihood of psychiatric disorders in adolescence and adulthood,such as depression, PTSD, anxiety, behavioural disorders, and reduced stress resilience (12, 15). Long-term impacts on social functioning and education further worsen cumulative stress and diminish children's capacity for adaptive functioning in adulthood (10, 11).

Interventions and Support Programs

Research consistently demonstrates that targeted psychosocial programs and family-focused interventions reduce PTSD, depression, and anxiety symptoms while improving emotional regulation and social functioning in children (10, 22, 23). Play therapy, cognitive-behavioural therapy, group therapy, and educational programmes significantly reduce intrusive thoughts, nightmares, and social isolation (10, 22).

Programs incorporating educational support further enhance school reintegration, reduce social isolation, and increase competence and resilience (11, 12). Family support serves as a critical protective factor-stable parental supervision, emotional support, and cohesive family structures significantly diminish the prevalence of PTSD and depression, improve emotional regulation, and strenghten children's capacity to cope with cumulative stress (24).

DISCUSSION

Toxic Stress as a Central Mechanism

The literature consistently demonstrates that war-related trauma in children induces toxic stress, acting as a central mechanism for long-term psychological, neurobiological, and social consequences (1, 3, 6, 7). Chronic activation of the hypothalamic-pituitary-adrenal (HPA) axis results in excessive cortisol secretion, leading to structural and functional alterations in key brain regions, including the hippocampus, amygdala, and prefrontal cortex (6, 16, 17). These changes account for the increased prevalence of PTSD, anxiety, depression, and cognitive deficits among war-affected children (8, 9, 12, 18).

Neurobiological effects of toxic stress do not occur in isolation; they interact continuously with psychological and social factors, such as loss of parental care, educational disruption, displacement, and marginalisation, further amplifying vulnerability (5, 11, 19). Cumulative stress from multiple traumatic events may result in persistent brain alterations, including impaired neuroplasticity and reduced adaptive capacity to novel stressors, explaining enduring psychological symptoms (16, 18).

Furthermore, toxic stress influences the development of emotional regulation and social functioning through environmental interactions-absence of a safe, stable environment worsens feelings of insecurity. In contrast, supportive contexts confer protective effects, mitigating both neurobiological and psychological outcomes (11, 24).

Psychological Outcomes and Social Dimensions

Findings indicate that PTSD, depression, and anxiety are the most common psychological outcomes of war-related trauma (8, 9, 12). Young children, particularly under seven years of age, often exhibit regressive symptoms, including enuresis, parental dependency, withdrawal, occasional aggression, and heightened separation anxiety. In contrast, adolescents are more likely to develop depressive disorders, anxiety, risky behaviours such as self-harm and substance abuse, and social isolation (5, 10).

Social factors further exacerbate psychological outcomes. Loss of peers, educational disruption, displacement, and social isolation increase feelings of helplessness, insecurity, and stress, increasing the risk for chronic mental disorders (11, 12). Children lacking stable family or community support often develop reduced self-esteem, poorer social skills, and impaired emotional regulation (11, 19).

Family and community support function as critical protective factors, reducing symptom severity and enhancing resilience (11, 24). Intervention programs, including play therapy, cognitive-behavioural therapy, and educational programs, demonstrate long-term benefits on emotional regulation, social functioning, and academic reintegration (10, 22, 23).

Long-Term Neurobiological Consequences

Chronic toxic stress leads to reduced hippocampal and prefrontal cortex volumes, heightened amygdala activity, alterations in white matter, and HPA axis dysregulation (16-18). These neurobiological changes are associated with increased risk for chronic mental disorders, cognitive deficits, and emotional dysregulation during adolescence and adulthood (6, 16, 20).

Studies also show that chronic stress elevates inflammatory markers, impairs immune function, and shortens telomeres, further increasing vulnerability to somatic illnesses, including cardiometabolic disorders, autoimmune diseases, and psychosomatic symptoms (20, 21). Neurobiological alterations, therefore, represent a key mechanism by which war trauma exerts cumulative, long-term, multidimensional effects on child health (6, 16).

These changes may have epigenetic consequences, modulating the expression of genes effects (6, 16). Moreover, neurobiological alterations often exacerbate psychological symptoms and social difficulties, creating an interlinked cycle of vulnerability (6, 16, 18).

Limitations of Existing Research

Significant limitations exist in the literature. Most studies are cross-sectional, limiting understanding of long-term symptom trajectories and the efficacy of interventions (12, 14). Longitudinal studies are scarce, and methodological approaches vary, including differences in PTSD definitions, psychological symptom assessment, and measurement instruments, complicating direct comparisons and synthesis (12, 15).

Furthermore, most studies were conducted in specific geographic and cultural contexts, limiting generalisability (5, 12). Cultural norms, family structure, and local resources significantly influence children's trauma responses, adaptive mechanisms, and intervention effectiveness (12, 15). Small sample sizes and variations in experimental design further impede understanding of individual differences in resilience, vulnerability, and developmental trajectories of psychological and neurobiological symptoms (14).

Practical Implications and Recommendations

Despite these limitations, the evidence clearly indicates that early, targeted, and comprehensive intervention can substantially mitigate the adverse effects of war trauma. Key approaches include family-based interventions, psychosocial programs, and educational and community strategies (10, 11, 22, 24).

A multidimensional approach integrating psychological, neurobiological, and social perspectives enables a better understanding of the complex consequences of war trauma and supports the development of effective interventions. Further longitudinal research is required to monitor long-term outcomes, identify individual resilience factors, and tailor interventions to the specific needs of children and communities (10, 22).

CONCLUSION

Children exposed to war trauma face multidimensional consequences encompassing psychological, neurobiological, and social domains, with toxic stress serving as the central mechanism for long-term effects. Prolonged activation of the HPA axis leads to excessive cortisol secretion, which induces structural and functional changes in the hippocampus, amygdala, and prefrontal cortex. These alterations reduce neural plasticity, impair network connectivity, and negatively impact emotional regulation, cognitive function, social interaction, and learning capacity.

Toxic stress also drives chronic neuroendocrine dysregulation, manifested by persistent inflammatory activity, weakened immune responses, and metabolic imbalance. These neurobiological changes are associated with long-term physical consequences, including heightened risk for cardiometabolic diseases such as hypertension, type 2 diabetes, obesity, and dyslipidemia. Chronic stress further increases susceptibility to autoimmune disorders, including rheumatoid arthritis and multiple sclerosis, as well as psychosomatic symptoms such as gastrointestinal disturbances, chronic fatigue, and headaches. Shortened telomeres and persistently elevated inflammatory markers exacerbate organismal vulnerability, creating a lasting predisposition to chronic disease in adulthood.

Psychological and social factors further compound the effects of toxic stress. Loss of parental care, Loss of parental care disrupted education, displacement, and marginalisation often lead to helplessness, low self-esteem, emotional dysregulation, and social isolation, cumulatively increasing physical and psychological burden. Conversely, stable family support, parental emotional availability, community integration, and continuity of education serve as powerful protective factors. These elements not only improve emotional regulation and social functioning but also modulate neuroendocrine and immune responses, reducing the risk of chronic disease.

Intervention programs, including play therapy, cognitive-behavioural therapy, educational and social programs, and targeted family-based models, have been shown to reduce PTSD, depression, and anxiety symptoms while enhancing emotional stability, social engagement, and cognitive function. Early identification of risk factors, monitoring of neurobiological biomarkers, and continuous evaluation of support programs are essential to prevent the cumulative effects of toxic stress and minimise long-term physical and chronic health consequences.

In conclusion, effective prevention and treatment of war trauma in children require a multidimensional approach that integrates neurobiological, psychological, and social dimensions, with particular focus on mitigating toxic stress and reducing the risk of chronic physical diseases. Longitudinal research is crucial for monitoring long-term outcomes, identifying individual differences in trauma responses, and optimising personalised support programs. Comprehensive, family- and community-based interventions facilitate resilience-building, reduce cumulative stress, protect neurobiological and immune health, and promote healthy development despite exposure to war-related trauma.

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Sažetak

UTJECAJ RATNE TRAUME NA DJECU: TOKSIČNI STRES I DUGOROČNE POSLJEDICE

Malik Burić

Cilj ovog rada je sustavno analizirati utjecaj ratne traume na djecu, s posebnim naglaskom na fenomen toksičnog stresa i njegove dugoročne posljedice. Proveden je narativni pregled literature korištenjem baza podataka PubMed i Scopus koji je obuhvatio studije objavljene u razdoblju od 2000. do 2025. godine, a koje se bave psihološkim, neurobiološkim i socijalnim aspektima ratnih trauma u dječjoj populaciji. Izloženost ratnim traumatskim iskustvima, uključujući nasilje, gubitak roditelja, prisilno raseljavanje i prekid obrazovanja, značajno povećava rizik od razvoja posttraumatskog stresnog poremećaja (PTSP), depresivnih i anksioznih poremećaja, poremećaja u ponašanju te kognitivnih i emocionalnih poteškoća. Dugoročne posljedice uključuju strukturne i funkcionalne neurobiološke promjene, disregulaciju hipotalamo-hipofizno-adrenalne osi, poremećaje lučenja kortizola te povećanu ranjivost za razvoj kroničnih zdravstvenih stanja uključujući kardiometaboličke bolesti, oslabljen imunološki odgovor i psihosomatske simptome. Socijalni faktori poput gubitka roditeljskog nadzora, prekida obrazovanja i marginalizacije, dodatno pojačavaju negativne ishode, dok zaštitni faktori poput stabilne obiteljske i zajedničke podrške mogu ublažiti učinke. Istraživanja dosljedno ukazuju da intervencije usmjerene na obitelj, u kombinaciji s ciljno oblikovanim psihosocijalnim programima, terapiju igrom, edukacijom i mentorstvom, značajno ublažavaju nepovoljne ishode i doprinose otpornosti djece. Pravovremena, sveobuhvatna i obiteljski utemeljena podrška stoga se ističe kao ključan čimbenik u prevenciji i ublažavanju dugoročnih posljedica ratne traume, a integrirani pristup, koji uključuje psihološke, neurobiološke i socijalne dimenzije, omogućava bolje razumijevanje kompleksnog utjecaja ratnih trauma i planiranje učinkovitih intervencija.

Ključne riječi: DJECA, DUGOROČNE POSLJEDICE, PTSP, RATNA TRAUMA, TOKSIČNI STRES

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