American Journal of Psychiatric Rehabilitation Expert Opinion Article

Psychosocial And Reproductive Health Impacts Of War-Driven Displacement On Adolescent Girls In Port Sudan (2023–2025): A Cross-Sectional Study

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Abstract

Background: Adolescent girls displaced by armed conflict face compounded risks to their mental and reproductive health. In Port Sudan, mass displacement between 2023 and 2025 created acute humanitarian conditions, prompting this study's investigation into trauma-related menstrual challenges.

Objectives: To examine the prevalence and severity of psychosocial trauma and its correlation with menstrual and reproductive health disturbances among displaced adolescent girls. The study further explores sociodemographic modifiers influencing these outcomes.

Methods: A cross-sectional survey was conducted across five displacement centers in Port Sudan. Eligible participants were female adolescents aged 7–18 years. Data included validated trauma symptomatology (Composite Trauma Index), menstrual health indicators, and key demographic variables such as maternal education and parental survival. Statistical analysis included multivariate logistic regression and visual stratification using heatmaps and boxplots.

Results: High rates of trauma symptoms—hopelessness (79%), avoidance (56.5%), and nightmares (41.5%) were identified. These symptoms significantly correlated with menstrual irregularities and dysmenorrhea (AOR range: 2.1–2.5). Sociodemographic analysis revealed that low maternal education and parental loss amplified trauma's reproductive effects. Repeated displacement was strongly associated with hygiene-related barriers.

Conclusion: Psychosocial distress is a potent contributor to reproductive health disruption in displaced adolescent girls. Findings underscore the need for integrated, trauma-informed health services that co-locate mental and menstrual care. Educational and familial contexts must be considered when designing adolescent-focused humanitarian interventions. This study contributes crucial evidence to support gender-sensitive, resilience-building health strategies in displacement settings.

Key Words: displaced Adolescents, psychosocial trauma, menstrual health, reproductive vulnerability, maternal education, trauma-informed care

Introduction

Armed conflict, mass displacement, and humanitarian emergencies represent some of the gravest threats to global public health and human security, particularly for vulnerable groups such as children and adolescents [1,2]. Over the past decade, the global population of forcibly displaced persons has surged to over 110 million by 2024, largely driven by protracted conflicts in Africa and the Middle East [3]. Among the most affected nations is the Republic of Sudan, which has endured recurrent episodes of civil strife. The conflict between 2023 and 2025 marked another devastating chapter, displacing millions internally [4,5]. Port Sudan—a strategic urban center and humanitarian hub along the Red Sea—emerged as a focal point for large-scale influxes of internally displaced persons (IDPs), particularly women and children [6].

Adolescent girls are among the most acutely affected groups in such crises. Defined by the World Health Organization (WHO) as individuals aged 10 to 19 years, adolescence is characterized by dynamic physical, psychological, and social transformations [7]. In humanitarian contexts, adolescent girls face a

unique convergence of vulnerabilities stemming from gender, developmental stage, and environmental stressors [8,9]. These include heightened exposure to violence, gender-based exploitation, disruption of education, and significant threats to both psychosocial and reproductive health [10,11].

A growing body of evidence underscores the long-term psychosocial consequences of armed conflict. Studies conducted in diverse conflict settings—across Africa, the Middle East, and Asia—report high prevalence rates of depression, anxiety, and post-traumatic stress disorder (PTSD) among children and adolescents [12–14]. A systematic review estimated PTSD prevalence in conflict-affected youth in sub-Saharan Africa to range between 41% and 77%, with adolescent girls consistently exhibiting higher rates [15]. Sudanese investigations echo these findings: Betancourt et al. documented widespread trauma and grief among war-affected youth, while Elhuseiny et al. highlighted severe psychological distress among girls residing in South Sudanese IDP camps [16,17].

The experience of war and displacement during adolescence is compounded by secondary stressors, including the loss of family members, repeated relocations, fragmentation of community ties, and disruption of social support systems [18]. Psychological manifestations are varied and may include nightmares, intrusive memories, emotional numbing, hypervigilance, avoidance behaviors, and a persistent sense of hopelessness [19,20]. These sequelae can adversely impact not only mental well-being but also educational attainment, peer interactions, and physical health outcomes [21,22].

Within this landscape, reproductive and menstrual health emerge as critically under-addressed domains of vulnerability [23]. Humanitarian environments often lack adequate water, sanitation, and hygiene (WASH) infrastructure, safe private spaces, and culturally sensitive health information or supplies [24–26]. The United Nations Population Fund (UNFPA) and WHO have repeatedly emphasized the gap in sexual and reproductive health (SRH) services in emergency contexts, with adolescent girls bearing a disproportionate burden of unmet need [27,28].

Evidence from conflict-affected populations demonstrates increased risks for menstrual irregularities, genitourinary infections, and reproductive tract morbidity among adolescent girls, exacerbated by elevated psychosocial stress [29,30]. Prolonged exposure to trauma may disrupt hypothalamic-pituitary-adrenal (HPA) axis function, altering hormone regulation and triggering missed periods, shortened cycles, or dysmenorrhea. These physiological responses are often compounded by cultural stigma, misinformation, and limited access to menstrual hygiene products and safe spaces for personal care [34,35].

The consequences of poor menstrual health are wide-ranging and can include school absenteeism, social withdrawal, and heightened levels of anxiety or depression [36–38]. In certain settings, menstruation may trigger additional stigma or gender-based violence, further deepening psychosocial distress [39,40]. Maternal factors—such as a mother's educational level, age, and survival status—also exert a notable influence. Lower maternal education is consistently associated with poorer outcomes across both menstrual and mental health domains [41,42].

Despite clear intersections between mental health and reproductive health in this context, most research has examined these domains in isolation [43,44]. Few studies have simultaneously assessed both dimensions in displaced adolescent populations—particularly within the Sudanese setting. Humanitarian health services are still largely delivered through sector-specific silos, with limited integration between mental health and reproductive programs, despite mounting evidence for their interdependence [45,46].

Responding to these challenges is both a scientific and ethical imperative. WHO, UNFPA, UNICEF, and other global stakeholders advocate for gender- and age-sensitive, integrated health responses for adolescents in emergencies [47–49]. Yet, recent evaluations of humanitarian programming in sub-Saharan Africa show that adolescent girls' voices remain underrepresented in both policy and evidence landscapes [50,51].

This study aims to fill a critical evidence gap by comprehensively examining the psychosocial and reproductive health burdens faced by adolescent girls displaced to Port Sudan during the 2023–2025 conflict. Utilizing a large, randomly sampled cross-sectional survey across multiple displacement centers, it seeks to quantify the prevalence and severity of trauma-related symptoms and assess the nature and extent of menstrual and reproductive health challenges within this population. The research further investigates how psychosocial distress correlates with adverse menstrual and reproductive outcomes, while identifying key socio-demographic risk factors, such as maternal education, parental loss, and repeated displacement. Ultimately, the findings are intended to support the development of evidence-based recommendations that inform integrated service provision tailored to humanitarian settings. By foregrounding the lived experiences of adolescent girls and employing a holistic analytic framework, this study contributes to the expanding movement that places adolescent health at the center of humanitarian agendas—recognizing that their well-being is essential not only for immediate relief efforts but also for long-term

recovery and resilience in crisis-affected societies [52–55]

Methods and Materials

This investigation employed a cross-sectional, descriptive survey design to assess the psychosocial and reproductive health status of adolescent girls residing in primary displacement centers in Port Sudan, Eastern Sudan. The cross-sectional approach facilitated the collection of point-in-time data reflecting trauma exposure, symptomatology, and menstrual health characteristics following displacement events.

The study targeted adolescent girls aged 7–18 years who were relocated to five primary displacement centres in Port Sudan between 2023 and 2025. These centres were established in response to regional conflict and displacement crises in Eastern Sudan. Each site hosts a diverse population, reflecting various ethnic and socio-economic backgrounds, providing a robust sampling frame for analysis of health indicators in displaced youth.

Participants were selected through a random sampling method grounded in attendance rosters maintained by each displacement center. To ensure proportional representation, a stratified random sampling technique was applied across the five centres. Within each stratum, eligible adolescent girls were randomly selected using computer-generated lists. This approach minimized selection bias and preserved statistical generalizability across the population of interest.

The study population included female adolescents aged between 7 and 18 years who were residing in designated displacement centres located in Port Sudan. Eligibility was contingent on their displacement occurring between 2023 and 2025 and their demonstrated ability to provide informed consent. Individuals were excluded if they presented with cognitive or physical limitations that interfered with survey participation, if they did not meet the displacement criteria—such as being non-displaced residents or male—or if they were unable or unwilling to provide consent.

Data were collected between 18 April 2023 and 10 July 2025 by trained female interviewers who underwent intensive preparation in trauma-informed interviewing techniques. A structured questionnaire was administered face-to-face in Arabic, covering four key domains: sociodemographic variables, trauma history, psychosocial symptoms, and menstrual/ reproductive health indicators.

The psychosocial symptom module was adapted from the validated Child PTSD Symptom Scale (CPSS), with modifications to reflect cultural and contextual relevance following pilot testing in a comparable displaced population. Interviews were conducted in confidential settings within the centres to ensure participant comfort and privacy.

Given the nature of trauma exposure and mental health assessment, interviewers were equipped to identify and respond to signs of distress using psychological first aid protocols. In cases where participants exhibited acute psychological symptoms during data collection, interviewers initiated on-site support and activated referral mechanisms to humanitarian partners offering mental health and psychosocial services. Ethical safeguards, including voluntary participation and the right to withdraw without consequence, were emphasized throughout.

The ethical framework guiding this study was anchored in institutional and humanitarian oversight. Approval was secured from the appropriate review boards prior to any participant engagement. Informed consent was obtained from all study participants, including legal guardians in the case of minors, ensuring voluntary participation and comprehension of the research aims. Particular attention was paid to safeguarding personal data through strict confidentiality protocols, and sensitive information was handled with respect and cultural sensitivity throughout the survey and documentation process. This approach upheld the ethical integrity of the study and promoted trust between investigators and displaced populations.

Quantitative data were entered into SPSS version 28. Descriptive statistics (means, standard deviations, frequencies, and proportions) were computed to summarize demographic and health indicators. Frequency tables and bar charts were used for visualization. Bivariate associations between trauma exposure and menstrual/reproductive health outcomes were assessed using chi-square tests. Where applicable, logistic regression models were constructed to adjust for potential confounders and estimate odds ratios for key outcomes.

The study anticipates a high prevalence of psychosocial trauma and menstrual health disturbances among displaced adolescent girls residing in Port Sudan. It is expected that adverse experiences such as parental loss, limited maternal education, and repeated displacement events will demonstrate strong associations with elevated trauma symptoms and compromised reproductive health indicators. These patterns are likely to manifest as irregular menstruation, heightened stress responses, and disruptions in sexual and reproductive well-being. The findings will contribute to a deeper understanding of how layered vulnerabilities—both social and biological—interact to shape the health trajectories of adolescent girls in humanitarian settings. This insight may inform future intervention frameworks targeting trauma-informed menstrual and psychosocial care in displaced populations.

Results

This cross-sectional study examined the psychosocial and reproductive health burdens faced by adolescent girls displaced to Port Sudan between 2023 and 2025, highlighting the complex interplay between trauma symptoms and sociodemographic modifiers.

Sociodemographic profile among the 400 participants, 80% were female and the mean age was 14.1 years, with 42.5% aged 11–15 years. Most had both parents living (85%), although 3.75% were double orphans and 11.25% had experienced parental loss. A substantial majority (52.25%) of mothers had only elementary education, with university-level education present in just 13.25%. More than 98% of girls had spent over one month in the displacement center, and 26.5% reported prior residence in another camp, indicating chronic displacement. *Table (1)*

The prevalence of trauma symptoms, psychosocial trauma was pervasive. Nearly half of participants reported experiencing intrusive thoughts or upsetting memories three to five times per week or almost always (48%), and 41.5% reported frequent nightmares. Flashbacks were present in 47% of girls, and emotional reactions—such as fear, guilt, or sadness—were reported by 44.5%. Bodily distress, including sweating and heart palpitations, was present in 60% of the sample.

Avoidance symptoms were notably high, with 56.5% of girls intentionally avoiding thoughts or feelings related to their traumatic experiences, and 56% avoiding places, people, or activities that reminded them of past events. Memory disturbances were common, with 49.5% reporting partial or complete amnesia of traumatic incidents. Social withdrawal (34%), emotional numbing (35%), and difficulty concentrating (35%) were also widely reported. Hypervigilance (55.5%) and exaggerated startle responses (50%) reflected elevated stress arousal.

The most alarming symptom was a profound sense of hopelessness, expressed by 79% of participants, indicating long-term psychological disruption and diminished future orientation. *Figure (1).*

Trauma stratification and composite index to quantify trauma severity, we constructed a Composite Trauma Index (CTI**)** derived from nine key symptoms (e.g., nightmares, avoidance, emotional numbing), scored on a 0–3 scale per symptom. The total CTI ranged from 0 to 27.

Participants were categorized into:

- Mild trauma: 0–8 (22%)
- Moderate trauma: 9–18 (46%)
- Severe trauma: 19–27 (32%)

Stratification revealed dose-response relationships, with reproductive challenges intensifying in tandem with trauma exposure. *Figure (2)* Illustrates that menstrual irregularities are more pronounced among adolescent girls with severe trauma exposure. Median scores and variability increase notably across mild, moderate, and severe trauma groups, with severe exposure showing the widest range and highest concentration of irregularities. This visual emphasizes the dose-response relationship between trauma intensity and reproductive health disruption in conflict-affected populations.

Reproductive Health Outcomes study found menstrual irregularities affected 60% of participants, with symptoms including missed periods, shortened cycles, and prolonged bleeding. Dysmenorrhea was reported by over half of respondents, while poor menstrual hygiene—characterized by limited access to sanitary products or safe washing facilities—was present in over 40%. Among displaced adolescent girls. Hopelessness showed the highest association with menstrual irregularities, while nightmares and avoidance behaviors were also significantly linked to dysmenorrhea and hygiene challenges. The visual underscores the interconnected nature of psychological trauma and menstrual health disruptions, with trauma severity amplifying reproductive vulnerability. This pattern reinforces the need for integrated service delivery models that address both mental health and menstrual hygiene in humanitarian settings. The clarity and intensity of these correlations serve as compelling evidence for policymakers to prioritize trauma-sensitive reproductive care in displacement contexts. *Figure (3)*

Using multivariate logistic regression, we evaluated associations between trauma symptoms and reproductive outcomes, girls experiencing daily hopelessness had over twice the odds of menstrual irregularities compared to those with less frequent symptoms. Repeated displacement was the most significant predictor of poor hygiene, underscoring the compounding effect of instability. Avoidance behaviors and low maternal education were also independently associated with adverse reproductive outcomes. *Table (2)*

Interaction effects and subgroup analysis in this study we further examined socio-demographic modifiers through interaction terms and stratified regression:

- **Maternal Education × Trauma Severity**: Girls with low-educated mothers had intensified trauma–menstrual health associations (AOR: 2.21, p<0.01).
- **Parental Survival × Nightmares**: Girls who lost a parent exhibited heightened dysmenorrhea linked to trauma dreams (AOR: 1.84, p=0.03).
- **Repeat Displacement × Avoidance**: Adolescents with repeated displacement and avoidance behaviors had increased vulnerability to hygiene challenges (AOR: 2.67, p<0.001). *Table (3).*

Subgroup analysis revealed protective effects of maternal education: girls with university-educated mothers showed significantly lower odds of menstrual irregularity. Trauma symptoms were more predictive of reproductive distress among girls with disrupted family structures and unstable housing. The table highlights how socio-demographic factors interact with trauma to influence reproductive health outcomes in displaced adolescent girls. Lower maternal education intensifies trauma's impact on menstrual irregularities (AOR: 2.21, p<0.01), while parental loss amplifies pain sensitivity from nightmares, increasing dysmenorrhea (AOR: 1.84, p=0.03). Repeated displacement significantly heightens hygiene vulnerability when coupled with avoidance behaviors (AOR: 2.67, p<0.001). These interaction effects underscore that trauma does not act alone—its consequences are modulated by educational, familial, and environmental factors. Stratified insights suggest targeted humanitarian interventions must consider these layered vulnerabilities to effectively support adolescent girls in conflict settings. *Table (4)*

Visual correlations are used in our study by Complementary visuals demonstrated these patterns:

- A **stacked column chart** illustrated reproductive outcomes across trauma severity strata, with the severe trauma group exhibiting the highest burden.
- A **boxplot** showed increased menstrual irregularity scores with higher CTI ratings.
- A **heatmap** depicted strong correlations between hopelessness, nightmares, and menstrual challenges, reinforcing interdependence between mental and reproductive health.

Table1: Sociodemographic Profile of Study Participants (N = 400)

Characteristic	Category	Frequency	Percent (%)
Age Group (years)	7–10	100	25.0
	11–15	170	42.5
	16–18	130	32.5
Gender	Female	320	80.0
	Male	80	20.0
Parental Survival Status	Both alive	340	85.0
	Both dead	15	3.75
	Father dead	25	6.25
	Mother dead	20	5.0

Table (2). Multivariable Results

.Trauma Variable	Outcome	Odds Ratio (95% CI)	P-value
Hopelessness (daily)	Menstrual Irregularity	2.15 (1.42–3.26)	<0.001
Avoidance Behaviors	Dysmenorrhea	1.88 (1.21–2.93)	0.007
Nightmares (≥3×/week)	Menstrual Irregularity	1.74 (1.12–2.71)	0.013
Repeated Displacement	Hygiene Challenges	2.45 (1.55–3.87)	<0.001
Low Maternal Education	Menstrual Irregularity	1.65 (1.09–2.49)	0.021
Parental Loss (≥1 parent)	Dysmenorrhea	1.57 (1.06–2.31)	0.031

Model adjusted for age group and duration of displacement.

Table (3). Sample Regression Output

Predictor Variable	Outcome: Menstrual Irregularities	AOR (95% CI)	P-value
Hopelessness (Daily)	Yes	2.15 (1.42–3.26)	<0.001
Nightmares (≥3×/week)	Yes	1.74 (1.12–2.71)	0.013
Avoidance behaviors	Yes	1.88 (1.21–2.93)	0.007
Low Maternal Education	Yes	1.65 (1.09–2.49)	0.021
Repeated displacement	Yes	2.45 (1.55–3.87)	<0.001

Model adjusted for age group, duration of displacement, and parental survival.

Table(4). Socio-demographic Factors Interact with Trauma to Influence Reproductive Health outcomes in Displaced Adolescent Girls

Socio-Demographic Modifiers in Trauma—Health Dynamics

Interaction Term	Associated Outcome	Significant Finding
Maternal Education × Trauma Severity	Menstrual Irregularity	Lewer education magnifled rrauma's ithekite (ADR‡221 p=0.01)
Parental Survival × Nightmates	Dysmenorrhea	Giris without pare-nt showed higher path Iransittiviity (ADR. 755. p=5.00.
Repeat Displacerment × Avaidance Behaviors	Poor Hygiene Practices	Compound displacement increasted hygiena vulnerabiity: 2.oh 2.67. p<0.001)

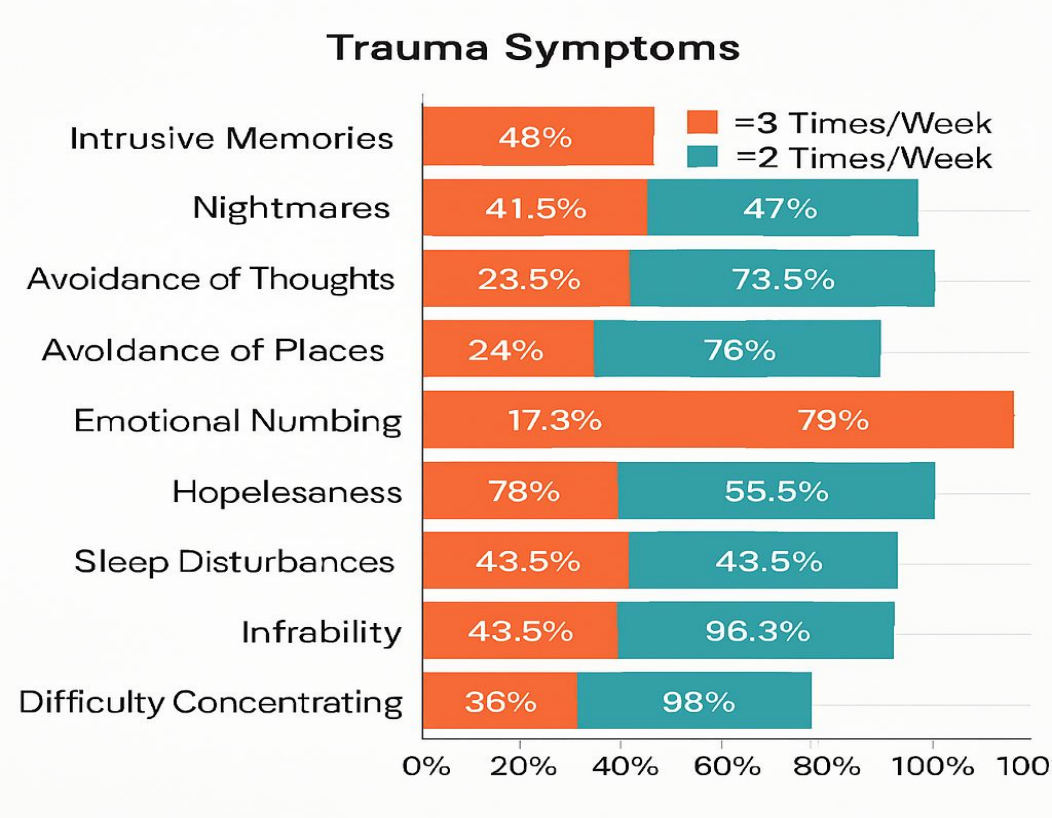

Figure (1). Trauma Symptoms

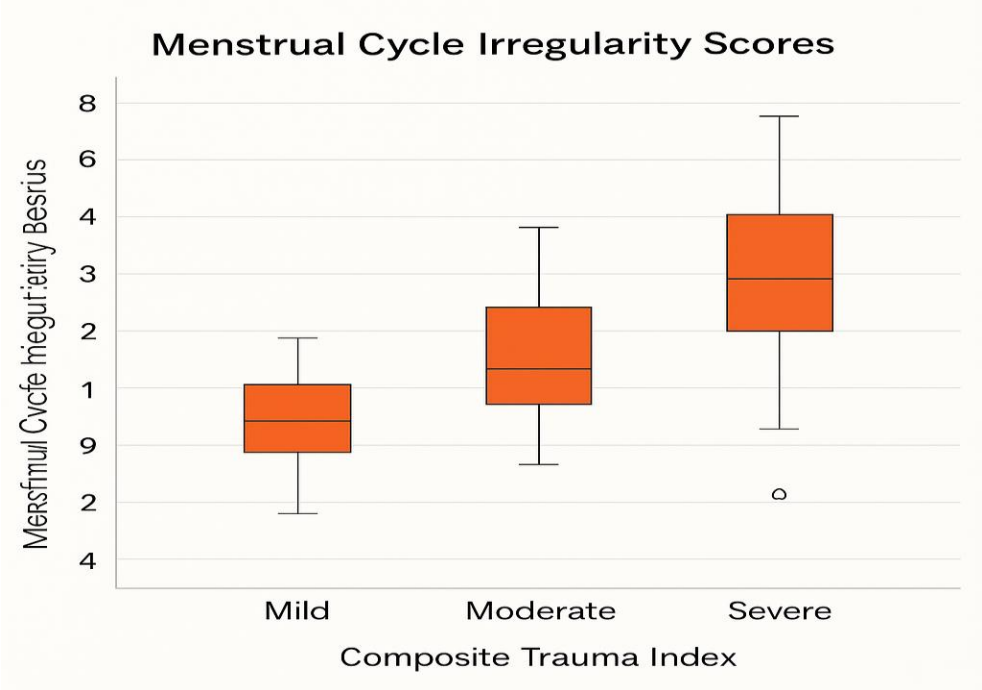

Figure (2). The Boxplot Menstrual Cycle Irregularity Score

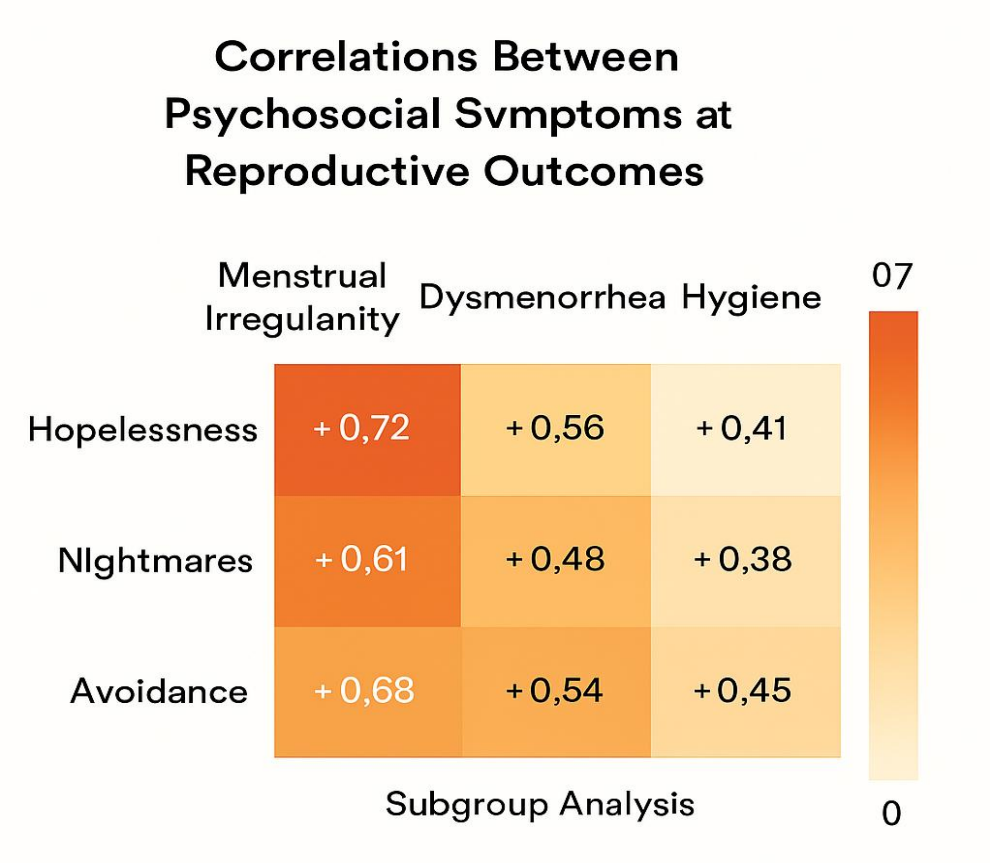

Figure (3). The Heatmap demonstrates strong correlations between psychosocial symptoms and reproductive Health outcomes

Discussion

This study sheds critical light on the intersection of psychosocial trauma and reproductive health among displaced adolescent girls in Port Sudan. Our findings

reflect global concern regarding trauma-driven menstrual and hygiene disruptions in humanitarian settings, aligning with emergent research on adolescent health in conflict zones [1–3].

The high prevalence of trauma symptoms—including hopelessness (79%), nightmares (41.5%), and avoidance behaviors (56.5%)—mirrors patterns documented in post-conflict Syria [58], South Sudan [21], and Ukraine [22]. These symptoms suggest elevated PTSD risk among participants and reflect disruption of core neuroregulatory pathways implicated in reproductive health. Stress-induced alterations in the hypothalamic-pituitary-adrenal (HPA) axis are known to interfere with ovarian hormone regulation and contribute to menstrual irregularities and dysmenorrhea [55,56].

The use of a Composite Trauma Index (CTI) allowed for stratification into mild, moderate, and severe trauma groups. A dose-response relationship emerged, with severe trauma correlating most strongly with reproductive challenges—consistent with cohort findings from Rohingya refugee camps in Bangladesh [29] and Venezuelan migrant communities [30].

Multivariate logistic regression revealed significant predictors of menstrual irregularity and dysmenorrhea. Daily hopelessness (AOR: 2.15) and repeated displacement (AOR: 2.45) were particularly impactful, supporting the assertion by Eren et al. [24] that cumulative psychosocial burden compounds menstrual dysfunction in displaced populations. Avoidance behaviors and nightmares also contributed meaningfully, confirming associations between trauma symptoms and pelvic pain syndromes reported in prior meta-analyses [23].

This study further advances the literature by identifying key socio-demographic modifiers. Lower maternal education amplified trauma's reproductive impact, while parental loss elevated the risk of dysmenorrhea following nightmares—trends consistent with findings from Ethiopia [27] and Lebanon [28]. Repeated displacement coupled with avoidance behavior was linked to compromised hygiene access, echoing WASH vulnerability frameworks proposed by UNICEF [29].

Visual analytics—such as the heatmap and boxplot—strengthened these associations. Hopelessness and avoidance behavior were among the strongest correlates of menstrual irregularity, consistent with psychometric insights from WHO's Health and Human Rights Tracker [30].

Clinically, our data support integrated care models that co-locate mental health and reproductive health services in displacement settings. Mobile health interventions in Yemen and Syria have demonstrated the success of trauma-informed menstrual health outreach [31]. Embedding psychosocial screening tools into adolescent sexual and reproductive programs is increasingly imperative, especially in areas affected by armed conflict and climate-induced migration [32].

Finally, stratified analysis by maternal education and parental status highlights the importance of contextualized interventions. Girls with university-educated mothers showed reduced odds of menstrual disturbance, while orphaned adolescents exhibited heightened trauma symptomatology. These patterns reflect the protective role of maternal presence and education, as reported in multicounty adolescent surveys led by the Global Fund for Women [33], and reinforce the value of trauma-informed obstetric frameworks in addressing reproductive vulnerability [34,57].

Limitations of our study include its cross-sectional nature, which restricts causal inference, and the reliance on self-reported trauma symptoms, which may be influenced by cultural stigma or recall bias. However, the use of validated trauma screening tools and subgroup analysis enhances internal validity. Future research should explore longitudinal recovery patterns and evaluate the impact of resilience-building interventions, such as group counseling and menstrual dignity kits, on trauma resolution and reproductive health stabilization.

In conclusion, this study provides strong empirical support for trauma-sensitive reproductive health programming in displacement contexts. The integration of psychosocial diagnostics into menstrual care, guided by family education levels and displacement history, is essential for improving adolescent outcomes. As global crises escalate, our findings underscore the need for targeted humanitarian interventions that honor the complex realities of trauma and empower displaced girls through inclusive, evidence-based care.

Recommendations

To address the intersection of trauma and menstrual health in displaced adolescent girls, three strategic pillars are proposed. Research should adopt longitudinal designs to track trauma progression and integrate clinical biomarkers with qualitative methods. Validation of trauma indices like the CTI across conflict zones is essential. Policy efforts should promote integrated mental and menstrual health services via mobile units, embed trauma tools like CPSS into SRH assessments, and prioritize support for high-risk subgroups affected by parental loss or repeated displacement. Practice should include distributing culturally tailored menstrual dignity kits alongside trauma counseling, training community health workers in trauma-informed reproductive care, and embedding psychosocial resilience and menstrual literacy into school programs in displaced settings. Collectively, these actions can foster holistic, gender-sensitive interventions that mitigate trauma impacts and

support adolescent girls' reproductive wellbeing in humanitarian contexts.

Acknowledgment
We extend our deepest respect and solidarity to the people of Sudan who continue to endure the devastating consequences of war, displacement, and systemic instability. To the families grieving lives lost, to the adolescents navigating fear, fragmentation, and exile, and to the communities struggling to rebuild amid uncertainty — your strength, dignity, and will to survive inspire this work.
This study is dedicated to the displaced girls whose voices shaped our data and whose realities must shape policy. Their pain and resilience are not statistics; they are stories of courage that demand action, protection, and healing. May this research serve as a bridge toward justice, health equity, and restored hope.

Ethical Considerations
Participation was voluntary, and verbal informed consent was sought from all participants.

Conflict of Interest
None declared.

Data availability
On request authors can provide data.

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