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Assessment of post-traumatic stress disorder and well-being among Sudanese during the ongoing war: a cross-sectional study

Mohamed Fakhry Hussein[1], Marina Saleeb[2], Basma Tolba[3,4], Yasmine Yousry Mohamed[5], Assem Gebreal[6*], Abuelgasim Osman Alemam Mohamed[7*], Faisal Saeed Al-Qahtani[8], Fatima Mohamed Osman Yasin[9], Omelhassan Abdelgader Alawed[10] and Ramy Mohamed Ghazy[11,12]

Abstract

Background Wars profoundly impact mental health with growing long lasting consequences. This study assessed the prevalence of post-traumatic stress disorder (PTSD) and well-being among Sudanese affected by the ongoing conflict, with a specific focus on healthcare workers (HCWs).

Methods A cross-sectional study was conducted between April 1 and June 30, 2024, using the validated Arabic versions of PTSD Checklist for the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) (PCL-5) and the World Health Organization (WHO)-5 Well-Being Index.

Results A total of 1022 participants were included, and 44% were recruitted through online questionnaire and face-to-face interviews. Their mean age was 31.4 ± 12.5 years, 63.4% were females, 16.3% were HCWs and 83.3% were displaced due to conflict. The mean score of PTSD was 35 ± 21.3 with 56.9% having PTSD. The mean well-being score was 55.0 ± 23.9 with 40% reporting poor well-being. Among HCWs, 60.5% suffered from PTSD and 27.5% experienced poor well-being. A significant negative correlation was observed between PTSD and well-being scores (r=-0.273, $p < 0.001$). Predictors of PTSD were being male [β = -10.91, 95% confidence interval (CI) (-13.44, -8.38); $p < 0.001$], urban area resident [β = -10.38, 95%CI (-18.78, -1.98); $p = 0.016$], non-medical profession [β = 5.07, 95%CI (1.46, 8.67); $p = 0.006$], living with 2 to 10 households [β = 6.69, 95%CI (0.46, 12.91); $p = 0.035$], living with more than 20 households [β = 13.20, 95%CI (4.17, 22.23); $p = 0.004$], insufficient income [β = 4.32, 95% CI (1.84,6.81); $p = 0.001$], living in conflict zones [β = 13.38 95%CI (8.83,17.92); $p < 0.001$], refugee resettlement [β = 13.18, 95%CI (9.98,16.38); $p < 0.001$], and well-being score [β = -0.20, 95%CI (-0.25, -0.15); $p < 0.001$]. Predictors of well-being scores were living with more than 20 households [β = -17.44, 95%CI (-28.83, -6.04); $p = 0.003$], being a HCW [β =-6.22, 95%CI (-11.87, -0.57); $p = 0.031$], being a student [β = -7.55, 95%CI (-12.94, -2.16), $p = 0.006$, insufficient income [β = -5.04, 95%CI (-8.17, -1.90); $p = 0.002$], and living in conflict zones [β = -8.22, 95%CI (-13.96, -2.48); $p = 0.005$].

*Correspondence:
Assem Gebreal
assem.Ahmed1801@alexmed.edu.eg
Abuelgasim Osman Alemam Mohamed
Drabuelgasimmohamed@gmail.com

Full list of author information is available at the end of the article

Conclusions The study highlights an alarmingly high prevalence of PTSD among Sudanese including HCWs, with significant mental health consequences. These findings emphasize the urgent need for mental health interventions and humanitarian support to mitigate the psychological challenges faced by the conflict affected population.

Keywords Armed conflict, Post-traumatic stress disorder, Well-being, Sudanese war, The PTSD checklist for DSM-5 (PCL-5), WHO-5 well-being index

Introduction

War and conflict have been happening throughout centuries of human civilization, with some arguing it is a part of human nature [1, 2]. More than 110 armed conflicts are occurring at this moment [3]. Unfortunately, the impact of war is not limited to the human losses of combat. War affects the economies, health, and well-being of the population involved beyond the frontlines, encompassing those living in war zones, displaced individuals, and refugees. The well-being and subjective quality of life (QOL) deteriorate significantly in war-affected populations [4, 5].

War has a devastating impact on people's health, both physically and mentally. Physical ailments include outbreaks of diarrhea and respiratory infections, along with injuries resulting in a high level of morbidity and mortality, especially in children. Limited access to food due to war also leads to malnutrition, which isanother major cause of death and illness. Moreover, the mental effects of war can't be underestimated, with a two- to three-fold higher prevalence of mental disorders, including anxiety, depression, and post-traumatic stress disorder (PTSD) [5, 6]. During conflicts, healthcare workers (HCWs) particularly face unique challenges that can negatively impact their mental health. Their roles involve caring for the sick and injured under stressful and often dangerous conditions. This constant exposure to trauma, coupled with long hours and high-stress environments, can lead to secondary trauma, affecting their overall well-being. To mitigate these negative impacts and improve patient care, it's essential to provide specific mental health support and resources tailored to their needs [7–9].

PTSD is a mental health condition brought on by watching or experiencing traumatic incidents such as a disaster, a catastrophic accident or attack, or armed conflict [10]. The Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition, Test Revision (DSM-5-TR) outlines the criteria of PTSD as witnessing a traumatic event, having disturbing memories or nightmares, avoiding reminders, persistently avoiding stimuli associated with the stressor, negative changes in mood and cognition related to the stressor, and significant alterations in reactivity and arousal. These symptoms must last longer than a month, resulting in considerable distress, and not be caused by drugs or a primary medical condition [11]. The impact of PTSD beyond its symptoms is more troubling. There is a significant association between PTSD and comorbid mental disorders such as major depressive disorder, anxiety, and alcohol use disorders. It is also associated with physical health problems such as cardiovascular, respiratory, neurological, or musculoskeletal conditions. It is also associated with a lower QOL and both short-term and long-term disabilities [12].

Refugees from war-torn countries often experience significant mental health challenges, particularly PTSD, compared to non-refugees. According to the Norwegian Prescription Database, Straiton et al. [13] reported that refugees have higher rates of mental disorders, greater reliance on mental health services, and higher use of psychiatric medications compared to non-refugees from the same countries. Additionally, refugees, especially those internally displaced, experienced higher levels of PTSD symptoms than non-displaced individuals [14]. Treatment for PTSD can be more difficult for refugees who have experienced war trauma, with slower recovery rates compared to non-refugees with work-related trauma [15]. To measure the severity of PTSD symptoms, the PTSD checklist (PCL-5) extracted from the DSM-5 can be used. This tool asks people about their experiences related to a traumatic event over the past month. They rate how much they've been bothered by each experience, and a higher total score indicates more severe PTSD symptoms [16].

According to the World Health Organization (WHO), well-being is a good state that individuals can feel. It is essential for day-to-day living and is influenced by social, economic, and environmental factors [17]. The WHO developed a short questionnaire to measure the individual's current well-being status. It involves five questions about how much mental health and feelings have affected the person over the past two weeks. This tool helps researchers and HCWs understand mental health trends and identify potential areas of concern [18]. War has a devastating impact on well-being. Exposure to violence, displacement, and loss can lead to a range of mental and physical health problems that affect individuals' well-being. Furthermore, war disrupts social support networks, increases poverty, and limits access to healthcare, further worsening well-being. The long-term consequences of war on well-being can extend for generations, affecting both individuals and communities [19, 20].

Sudan has been affected by an ongoing conflict that started on April 15, 2023, resulting in the displacement of more than 8.6 million people (nearly one-fifth of the

Sudanese population), with 6.5 million displaced internally and more than 2 million displaced outside Sudan. More than 25 million individuals need humanitarian aid and are facing shortages of basic amenities such as food, water, and healthcare access and resources [21]. This study aimed to investigate the prevalence of PTSD and overall well-being among Sudanese individuals affected by the ongoing conflict in Sudan, with a specific focus on HCWs. With this information, we can better guide international aid efforts to address the health consequences of the war, improve living conditions, and provide the support people truly need.

Methodology

Study setting and design

A cross-sectional study was conducted in Sudan through an online survey and face-to-face interviews during the period April 1, to June 30, 2024.

Sample size and study population

The percentage of PTSD scores among Sudanese people was reported to be 58.8% based on the study of Bilal et al. [22], the total number of people needed to achieve a 95% confidence interval and a 5% alpha error, and if we considered only a 40% response rate, would be 933 participants, according to the following equation:

$$N = (Z^2 * P * (1 - P)) / E^2$$

$$N = (1.96^2 * 0.588 * 0.412)/0.05^2$$

N (after considering a response rate of 40%) = 373 /0.4 = 933.

Where N refers to the minimum sample size accepted for the study, P for the estimated proportion of Sudanese people who had PTSD, Z for the critical value at a 95% confidence interval, and E for the margin of error (the maximum acceptable difference between the sample proportion and the population proportion). To account for the missing data and the incorrect answers, we increased the sample size by 10%. We recruited adult Sudanese persons who were 18 years of age or older, living inside Sudan and had witnessed the war either until the study or for a period before being internally displaced to another area. The exclusion criteria for this study included individuals with a history of mental illnesses before the war, as their pre-existing conditions could confound the assessment of PTSD and its association with the ongoing conflict. Additionally, participants who provided incomplete or inconsistent survey responses or whose answers were deemed incorrect during data collection were excluded.

Sampling technique

A non-random sampling design was used to recruit the required sample size (convenience and snowball sampling techniques). People were requested to participate in the study via social media platforms like Facebook (Meta Company, USA) and some electronic communication applications such as WhatsApp (Meta Company, USA), Messenger (Meta Company, USA), etc., or by face-to-face interview in areas where there was no internet access. The responses were successively recorded until the required sample size was reached. The co-author (AG) was responsible for recruiting collaborators from Sudan via the Global Researcher Club—an international, voluntary, and non-profit scientific research community.

Research model

The research model is presented in Fig. 1.

Data collection tools

The questionnaire (Supplementary file I) consists of three sections: The first section focused on socio-demographic characteristics (age, sex, nationality, residence, whether they migrated away from the conflict area or not, marital status, education, and occupation).

The second section assessed the presence and severity of symptoms of PTSD using the validated Arabic version of PCL-5 [23], which consists of 20 items that ask about different symptoms and experiences related to trauma. According to the DSM-5, to confirm the presence of PTSD, a person must have at least 1 criterion B item (questions 1–5), 1 criterion C item (questions 6–7), 2 criterion D items (questions 8–14), and 2 criterion E items (questions 15–20). Participants rated each experience on a scale from 0 (no symptoms) to 4 (severe symptoms). By adding up all the scores, a total score between 0 and 80 is obtained. A total score of 31 or higher suggests the person lived with PTSD. The higher the score, the more severe the PTSD symptoms of the participants [11, 24].

The third section assessed human well-being using the Arabic version of the WHO-5 Well-Being Index [18]. This index consists of five questions, each rated on six-points Likert scale. Responses range from 0 (never feeling well) to 5 (always feeling well). The total score is calculated by summing the responses then multiplying by 4, resulting in a range of 0 to 100. High scores indicate better well-being. A score of ≤ 50 indicates poor well-being, while a score of 28 or below indicates the presence of depressive symptoms [18, 25].

Pilot study

A pilot study was conducted before the main study to evaluate the survey's practicality, accessibility, question clarity, and estimated completion time, which ranged from 5 to 10 min. Minor revisions were made to improve

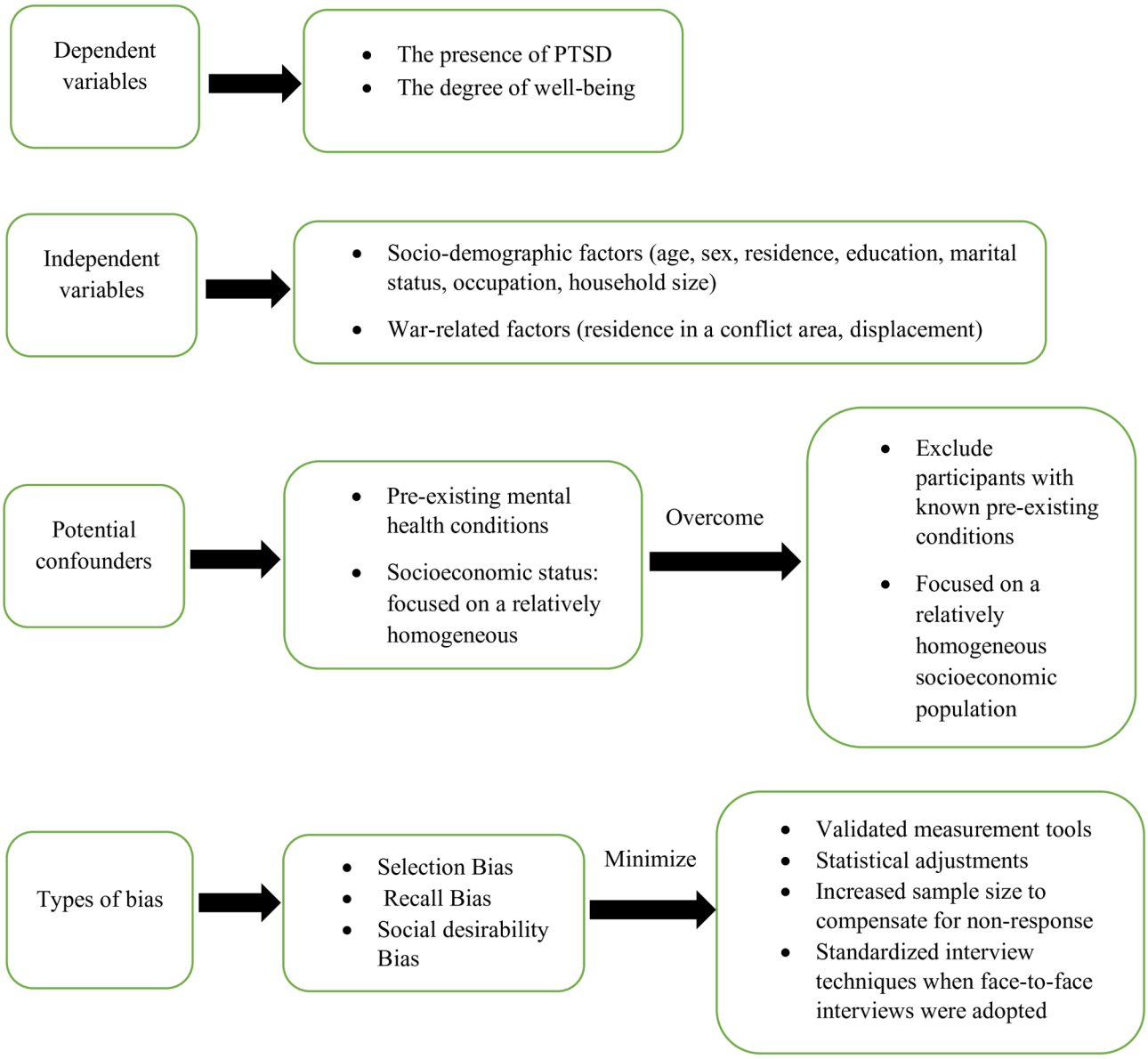

Fig. 1 Q2

sentence clarity. Each researcher recruited five to ten participants, resulting in a total of 30 responses. These participants were excluded from the final analysis.

Ethical considerations

The researchers sought the approval of the Ethics Committee of the High Institute of Public Health, Alexandria University, Egypt, for conducting the research (IRB number: 00013692). The study also had permission for data collection from the Sudanese Ministry of Health and Social Development (Humanitarian Aid Commission). The researchers complied with the International Guidelines for Research Ethics. After being told about the objectives and benefits of the research, every participant provided their informed consent. The subjects were free to withdraw from the study at any time, and their participation was completely voluntary. Anonymity and confidentiality were assured and maintained.

Statistical analysis

The data was uploaded to Google form (Alphabet, USA) to be extracted to an Excel sheet. The statistical analysis was performed by using R version 4.2.3 (R Core Team, 2024, New Zealand). The Shapiro-Wilk test tested the normality of data. For continuous data, normally distributed data was expressed by mean ± standard deviation (SD), and skewed data was presented as median and interquartile range (IQR). Categorical data were

described by their counts and percentages. The Pearson correlation coefficient (r) between PTSD and well-being domains was calculated. The sign and the value of r reflect the direction and magnitude of the relationship significantly. A p-value of less than 0.05 was considered statistically significant for an inferential analysis. Finally, a multi-variable linear regression model was performed to explore the potential predictors of both PTSD and well-being. The assumptions of the developed models, including the normality of the residuals, the absence of heteroskedasticity, and the absence of influential outliers, were checked to ensure the performance of the models (Supplementary file II: Figures 1 and 2).

Table 1 Socio-demographic characteristics of the study Sudanese participants ($N = 1,022$)

Variable	Category	$N = 1,022$[1]
Gender	Female	648 (63.4%)
	Male	374 (36.6%)
Age (years)	Mean ± SD	31.4 ± 12.5
	≤ 30 years	624 (61.0%)
	More than 30	398 (39.0%)
Residence	Desert area	20 (2.0%)
	Rural area	317 (31.0%)
	Urban area	685 (67.0%)
Education level	Did not complete any educational level	38 (3.7%)
	Elementary education	82 (8.0%)
	Secondary education	303 (29.6%)
	Bachelor degree	464 (45.4%)
	Postgraduate	135 (13.3%)
Marital status	Single	567 (55.5%)
	Married	406 (39.7%)
	Divorced	19 (1.9%)
	Widow	30 (2.9%)
Profession	Not working	160 (15.7%)
	Medical field	167 (16.3%)
	Student	305 (29.8%)
	Other	390 (38.2%)
Number of people you live with	Alone	37 (3.6%)
	From 2 to 10	777 (76.0%)
	From 11 to 20	176 (17.3%)
	More than 20	32 (3.1%)
Do you reside in a conflict area?	No	945 (92.5%)
	Yes	77 (7.5%)
I relocated because of the conflict	No	171 (16.7%)
	Yes	851 (83.3%)
Income	Enough	381 (37.3%)
	Not enough	641 (62.7%)
PTSD score	Median (IQR)	36 (16, 52)
	Mean ± SD	35 ± 21.3
	Suffering from PTSD	582 (56.9%)
Well-being score	Median (IQR)	60 (40, 76)
	Mean ± SD	55 ± 23.9
	Good well-being	615 (60.0%)
	Poor well-being	278 (27.0%)
	Depression	129 (13.0%)

[1]n (%); IQR: Interquartile range

Results

The study recruited 1022 participants through two methods: an online survey (56% of the participants) and face-to-face interviews (44% of the participants), 63.4% were females, their mean age was 31.4 ± 12.5 years old, 67.0% resided in urban areas, 45.4% completed their bachelor's degree, 39.7% were married, 16.3% of respondents were HCWs, 76.0% stated that they were living in households with 2 to 10 persons, 92.5% weren't currently in conflict zones, 83.3% had been displaced due to the conflict, 62.7% did not have enough income, 56.9% suffered from PTSD with a mean score of 35.0 ± 21.3, and the mean well-being score was 55.0 ± 23.9. Two-fifths (40%) of respondents had poor well-being, and 13% of the participants had very low scores (≤ 28), indicating the possibility of suffering from depression (Table 1).

Most participants (65.0%) originally lived in Khartoum State, while another 20% came from Island State. After displacement, a significant portion (32.0%) ended up in Gedaref State, followed by Northern State (26.0%) and Nile River State (12.0%) (Fig. 2).

Figure 3 demonstrates the responses of the participants to each question in the PTSD questionnaire. The responses "Quite a bit" and "Extremely" indicated higher PTSD symptoms. The percentage of people who chose "quite a bit" or "extremely" ranged from 30 to 40% for almost all the questions. However, the percentages of people who chose "not at all" for questions Q2, Q5, Q15, Q16, and Q17 were 36.0%, 37.9%, 35.5%, 47.1%, and 35.9%, respectively.

Figure 4 demonstrates the responses of the participants to each question in the well-being questionnaire. The responses: "At no time", "Some of the time", "less than half of the time" indicated lower well-being scores. The percentages of the participants who chose "At no time", "Some of the time", and "Less than half of the time" were 38.7%, 41.0%, 40.8%, 42.7%, and 43.5% for the questions from 1 to 5.

Figure 5 illustrates the prevalence of PTSD and well-being among different professional categories. A high percentage of HCWs suffered from PTSD (60.5%). Over a quarter of HCWs experienced poor well-being (27.5%), and 18.0% of them possibly suffered from depression. The differences between various categories were statistically significant ($p < 0.05$).

Figure 6 shows that a significant negative correlation exists between the PTSD scores and well-being scores, with a correlation coefficient of -0.273 ($p < 0.001$). Furthermore, we can notice a weak negative correlation between age and PTSD score (r = -0.085, $p < 0.01$) and a

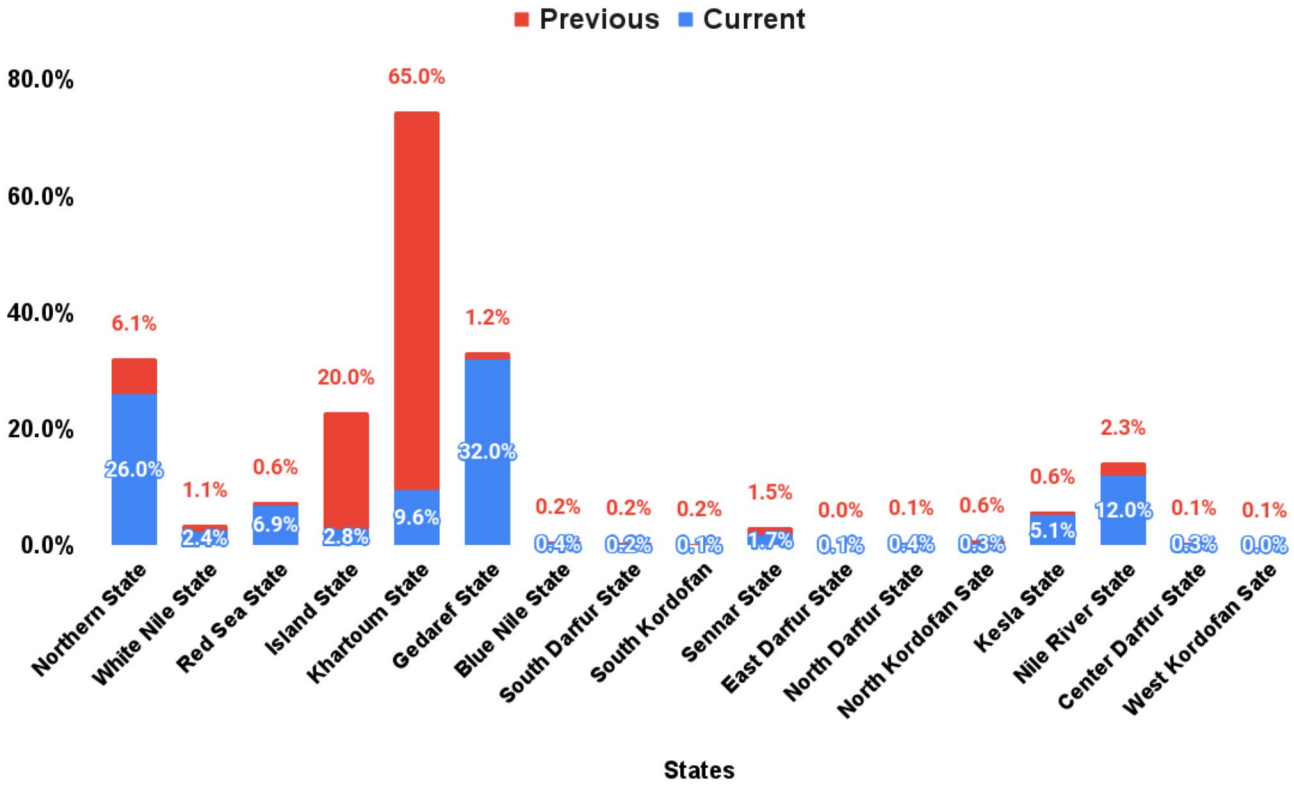

Fig. 2 The percentage of people in their current and previous locations due to the conflict

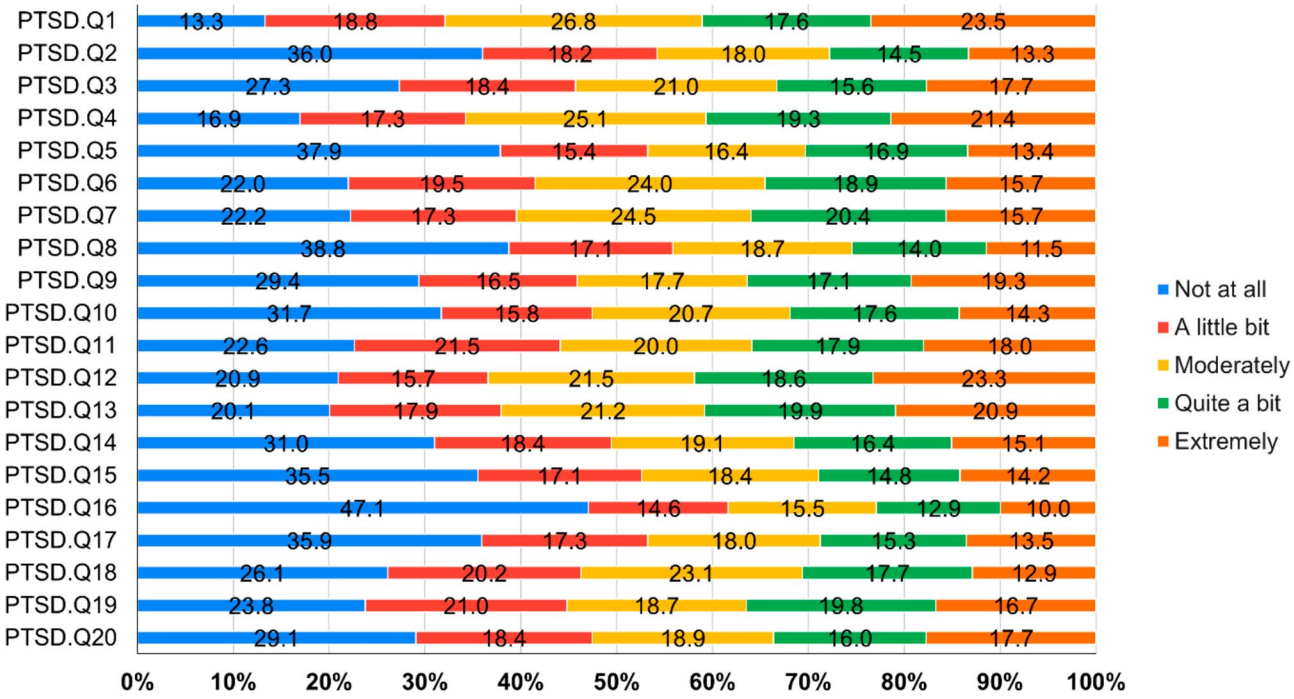

Fig. 3 Likert plot showing the percentage of the response of the participants to the PTSD questionnaire

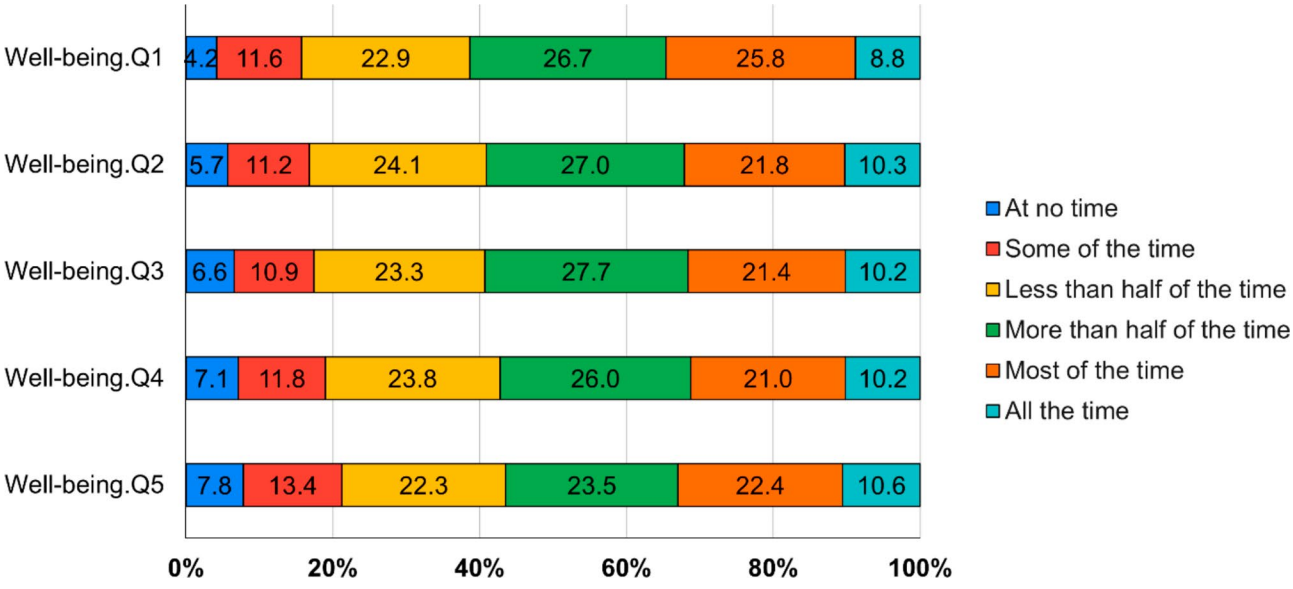

Fig. 4 Likert plot showing the percentage of the response of the participants to each question in the well-being questionnaire

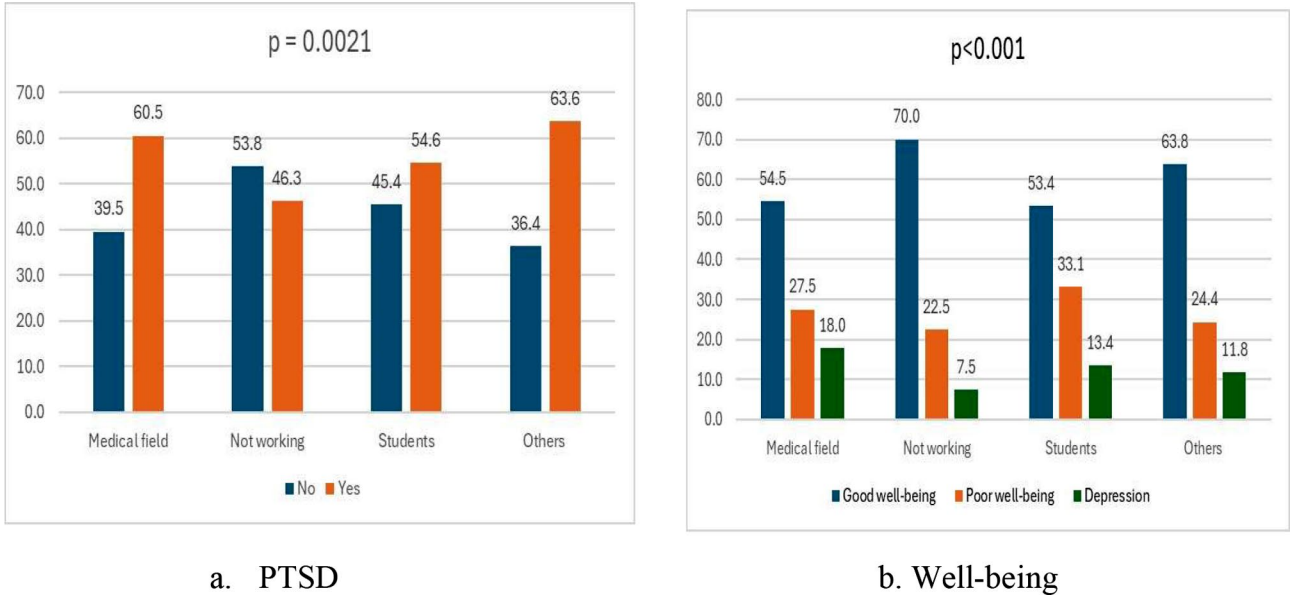

Fig. 5 (**a** and **b**) The PTSD and well-being distribution among medical field workers and other categories

weak positive correlation between age and well-being score ($r = 0.074$, $p < 0.05$).

Table 2 shows that the PTSD score is significantly different across almost all the socio-demographic characteristics of the participants except for the education level ($p = 0.120$). Regarding well-being score, it was significantly different across age groups ($p = 0.044$), marital status ($p = 0.007$), residence in conflict areas ($p = 0.003$), profession ($p = 0.001$), and finally monthly income ($p = 0.028$).

According to the regression model, predictors of PTSD scores were being male [β = -10.91, 95% confidence interval (CI) (-13.44, -8.38); $p < 0.001$], urban area-residents [β = -10.38, 95% CI (-18.78, -1.98); $p = 0.016$], working in professions other than the medical field [β = 5.07, 95% CI (1.46, 8.67); $p = 0.006$], living with 2 to 10 households [β = 6.69, 95% CI (0.46, 12.91); $p = 0.035$], participants who lived with more than 20 households [β = 13.20, 95% CI (4.17, 22.23); $p = 0.004$], insufficient income [β = 4.32, 95% CI (1.84,6.81); $p = 0.001$], living in conflict zones [β = 13.38 95% CI (8.83,17.92); $p < 0.001$], refugee resettlement [β = 13.18, 95% CI (9.98,16.38); $p < 0.001$], and well-being score [β = -0.20, 95% CI (-0.25, -0.15); p = < 0.001]. Predictors of well-being scores were

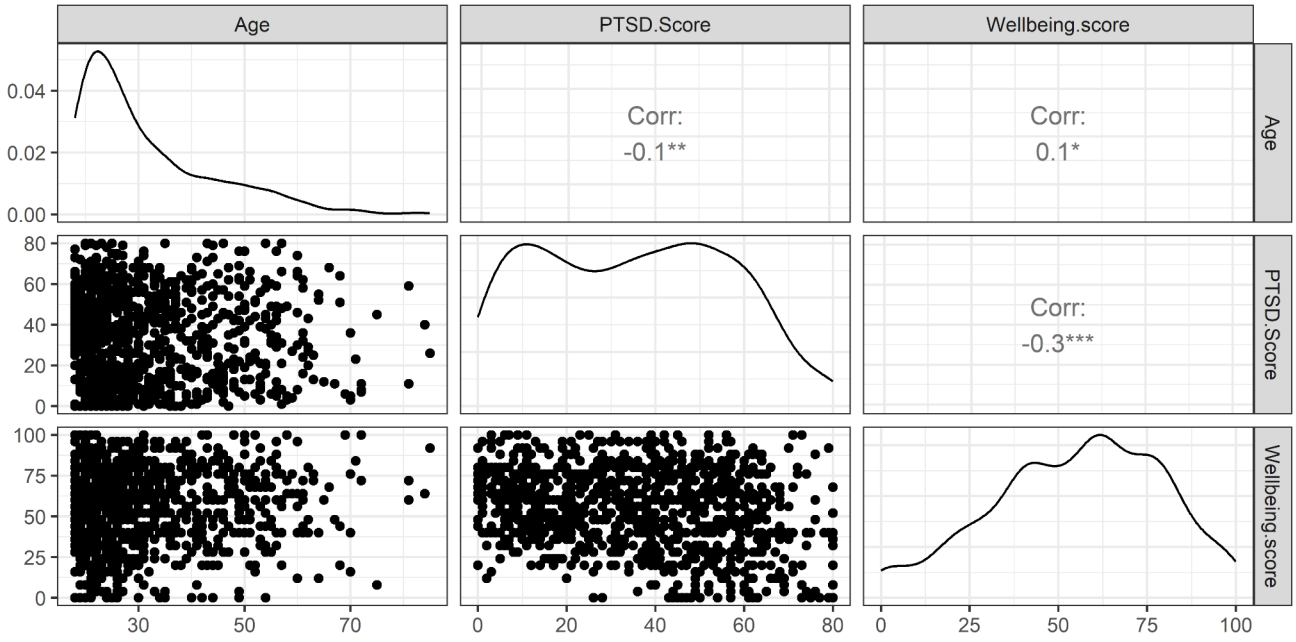

Fig. 6 Correlation matrix showing the correlation between age, well-being score, and PTSD score. * p-value < 0.05, ** p-value < 0.01, ***p-value < 0.001

Table 2 Distribution of PTSD and well-being scores across the socio-demographic characteristics of the participants

Socio-demographic characteristics	Level	*N*(%)	PTSD score Mean ± SD	*p*-value#	Well-being score Mean ± SD	*p*-value#
Age in years	≤ 30	624(61.0%)	37 ± 21	**0.004**	54 ± 24	**0.044**
	> 30	398 (39.0%)	33 ± 22		57 ± 23	
Gender	Female	648 (63.4%)	40 ± 20	**< 0.001**	55 ± 25	0.474
	Male	374 (36.6%)	27 ± 21		55 ± 25	
Education level	Bachelor's degree or more	599 (59.0%)	36 ± 22	0.120	55 ± 23	0.462
	Secondary education or less	423 (41.0%)	34 ± 21		56 ± 25	
Marital status	Married	406 (40.0%)	32 ± 22	**< 0.001**	58 ± 24	**0.007**
	Not married	616 (60.0%)	37 ± 21		54 ± 24	
Do you reside in a conflict area?	No	945 (92.5%)	34 ± 21	**< 0.001**	56 ± 24	**0.003**
	Yes	77 (7.5%)	46 ± 20		47 ± 25	
Did you relocate because of the conflict?	No	171 (16.7%)	24 ± 23	**< 0.001**	55 ± 22	0.985
	Yes	851 (83.3%)	37 ± 20		55 ± 24	
Income	Enough	381 (37.3%)	32 ± 20	**< 0.001**	57 ± 23	**0.028**
	Not enough	641 (62.7%)	37 ± 22		54 ± 24	
Profession	Not working	160 (15.7%)	32 ± 20	**0.0352**	61 ± 23	**0.001**
	Medical field	167 (16.3%)	38 ± 22		54 ± 24	
	Student	305 (29.8%)	36 ± 20		52 ± 24	
	Other	390 (38.2%)	34 ± 22		57 ± 24	

#P–value for t–test and ANOVA test

living with more than 20 households [β = -17.44, 95% CI (-28.83, -6.04); $p = 0.003$], being HCWs [β =-6.22, 95%CI (-11.87, -0.57); $p = 0.031$], being student [β = -7.55, 95% CI (-12.94, -2.16), $p = 0.006$, insufficient income [β = -5.04, 95% CI (-8.17, -1.90); $p = 0.002$], and living in conflict zones [β = -8.22, 95% CI (-13.96, -2.48); $p = 0.005$] (Table 3).

Discussion

Conflict can lead to a wide range of mental health consequences, including PTSD, resulting from violence, displacement, and multiple losses commonly experienced during war. These factors significantly contribute to poor well-being [26]. In 2019, an estimated 316 million adult war survivors worldwide suffered from PTSD and/or depression, highlighting the severity of the issue and the urgent need for international cooperation to prevent

Table 3 Linear regression model showing the predictors of PTSD and well-being

Predictors	PTSD score			Well-being score		
	β	95% CI	*p*	β	95% CI	*p*
(Intercept)	33.92	21.17–46.67	**< 0.001**	64.02	48.36–79.68	**< 0.001**
Gender [Male vs. female]	-10.91	-13.44 – -8.38	**< 0.001**	0.72	-2.49–3.93	0.661
Age	0.01	-0.11–0.13	0.832	0.02	-0.13–0.17	0.756
Residence [Rural area vs. Desert area]	-7.36	-15.88–1.16	0.090	3.65	-7.15–14.44	0.508
Residence [Urban area vs. Desert area]	-10.38	-18.78 – -1.98	**0.016**	4.33	-6.31–14.97	0.425
Education [Secondary education or less vs. bachelor education or more]	-1.52	-4.06–1.03	0.243	1.21	-2.01–4.44	0.460
Marital status [Not married vs. married]	2.00	-1.05–5.05	0.198	-1.28	-5.15–2.58	0.515
Profession [Medical field vs. not working]	3.83	-0.64–8.30	0.093	-6.22	-11.87 – -0.57	**0.031**
Profession [Student vs. not working]	2.66	-1.61–6.93	0.222	-7.55	-12.94 – -2.16	**0.006**
Profession [Other vs. not working]	5.07	1.46–8.67	**0.006**	-4.45	-9.02–0.11	0.056
Number of people you live with [From 2 to 10 vs. alone]	6.69	0.46–12.91	**0.035**	-4.69	-12.57–3.19	0.243
Number of people you live with [From 11 to 20 vs. alone]	5.69	-1.04–12.42	0.098	-6.41	-14.93–2.11	0.140
Number of people you live with [More than 20 vs. alone]	13.20	4.17–22.23	**0.004**	-17.44	-28.83 – -6.04	**0.003**
Do you reside in a conflict area? [Yes vs. No]	13.38	8.83–17.92	**< 0.001**	-8.22	-13.96 – -2.48	**0.005**
I relocated because of conflict [Yes vs. No]	13.18	9.98–16.38	**< 0.001**	0.66	-3.40–4.71	0.751
Income [Not enough vs. Enough]	4.32	1.84–6.81	**0.001**	-5.04	-8.17 – -1.90	**0.002**
Well-being score	-0.20	-0.25 – -0.15	**< 0.001**			

and address the psychological impact of war [27]. This study examined the mental health impact of the ongoing war in Sudan with special focus on HCWs, focusing on PTSD and overall well-being. The results revealed a high prevalence of PTSD (56.9%) among Sudanese civilians while 60.5% of HCWs had PTSD. This rate was comparable to other studies conducted in conflict zones in Darfur, Sudan. For example, Hamid et al. [28] found a similar prevalence (54%) among internally displaced persons, while Badri et al. [29] reported a significantly higher rate (80.9%) among displaced female university students. However, our results remain substantially higher than global PTSD prevalence (3.9%) [30] and exceed estimates for conflict-affected populations (15.3–36.9%) [31, 32]. These findings highlight the severe mental health crisis in Sudan and emphasize the urgent need for targeted interventions to address the psychological toll of the conflict.

Our study found that women were more likely to experience PTSD than men. Initially, younger individuals (under 31 years) appeared to have higher PTSD rates than older adults, but this association did not hold in the regression analysis. In the same vein, a systematic review conducted by Tortella-Feliu et al. [33] in 2019, identified female gender as a risk factor for PTSD. Kongshøj and Berntsen [34] also stated that younger individuals were more susceptible to PTSD than older adults. Women are at greater risk due to higher exposure to high-impact trauma, such as sexual violence, often at a younger age [30, 35]. While some studies suggest that older adults may be more vulnerable to PTSD due to declining health, cognitive decline, and social isolation [36–38], others support our finding that younger individuals may struggle more with the overwhelming stress of war. Their limited coping experience can make it harder to manage the emotional and psychological consequences of trauma [11, 35].

The current study found that people living in urban areas like Khartoum were less likely to experience PTSD compared to those in desert areas. This may be due to better access to healthcare, stronger social support networks, and improved infrastructure in urban areas [39]. However, the ongoing war has severely disrupted these resources, particularly in Khartoum.

Several factors may contribute to the lower PTSD rates in urban areas, including larger and more diverse social support systems, potentially reduced direct exposure to trauma, and different cultural coping mechanisms. In contrast, rural and desert areas often face more intense and prolonged exposure to violence and displacement, which is frequently underreported in media. This sustained exposure to conflict may lead to more severe and persistent trauma, contributing to higher rates of PTSD [40–42].

The current work showed that the employed population experienced PTSD more than those who were unemployed. This contrasts with previous research, where unemployment was identified as a risk factor for PTSD [43, 44]. One possible explanation is that certain professions involve direct exposure to the violence of war, such as soldiers and emergency responders, placing them at higher risk. Additionally, civilian jobs that require emotional resilience or involve exposure to suffering, such as HCWs and social workers, may also contribute to elevated PTSD risk [45].

As shown in this study, housing overcrowding increases mental illness and aggravates PTSD. While extended

family living arrangements are a significant aspect of Sudanese culture, often providing social support and helping to buffer against the negative effects of trauma and PTSD [46–49], our study suggests that the specific context of war and displacement can weaken these protective factors.

Overcrowding, a common consequence of displacement, can lead to increased stress, limited privacy, and heightened interpersonal conflict. Lack of privacy also can make it harder for people with PTSD to cope with symptoms like flashbacks or nightmares. Additionally, war and displacement can disrupt strong family bonds, leading to isolation and reduced social support. In addition, living in crowded conditions may increase exposure to traumatic events, such as violence or the suffering of others, and can limit opportunities for relaxation and self-care [50–52].

In the present study, living in a conflict area and refugee resettlement significantly increased the risk of developing PTSD. These findings align with the results of a previous research carried out in Syria, which identified living in a conflict zone and being displaced due to war, along with exposure to battle sounds, as the primary contributors to PTSD experienced by participants [32]. Witnessing violence, experiencing injuries or threats, and losing loved ones are all common during war, and these traumas can trigger PTSD. The constant stress and fear of war can also increase PTSD symptoms. Refugee resettlement during war can be a necessary way to escape immediate violence, providing some safety and reducing the risk of witnessing traumatic events. However, the forced displacement itself can be stressful and disruptive, leading to feelings of loss, isolation, and uncertainty. Additionally, resettling in a new area often means unfamiliar surroundings, limited social support networks, and potential cultural or language barriers [27, 53].

People with insufficient incomes were more likely to suffer from PTSD, as shown in our study. Low economic stability can worsen the psychological impact of war. Poverty can lead to further stress and insecurity, especially concerning housing or basic needs. The ongoing stress can make it harder for individuals to cope with the emotional triggers and flashbacks associated with PTSD. So, those struggling financially may have limited access to mental health care, making it harder to get treatment for PTSD symptoms [10, 54, 55].

The prevalence of PTSD among HCWs in our study (60.5%) was significantly higher than reported in many other studies. For instance, a meta-analysis by Jacob Sendler et al. [56] found a 14.8% prevalence of PTSD among physicians, while a cross-sectional study among Chinese HCWs during the coronavirus diseases 2019 (COVID-19) pandemic reported a prevalence of 9.3% [57]. These findings highlight the profound impact of traumatic experiences on HCWs' mental health and consequently their ability to provide effective patient care [56, 57]. The notably higher PTSD prevalence in our study is likely attributable to the more severe and frequent traumatic events faced by HCWs in a war context, as opposed to the challenges faced during the COVID-19 pandemic or in non-war settings. This highlights the unique and heightened psychological burden on HCWs in conflict zones.

According to the present study, there is a clear association between PTSD and well-being. This aligns with a German study conducted by Eiche et al. [58] who found that people with PTSD reported significantly lower well-being. PTSD symptoms like flashbacks and nightmares can significantly disrupt a person's ability to function and feel good in their daily life. Regarding well-being, our study found that overall 27% of participants reported poor well-being while 27.5% of HCWs had poor well-being, with 13% scoring very low on the WHO-5 Well-Being Index (indicating possible depression). This is in line with similar studies on war-affected populations. For example, a study by Rizkalla and Segal [59] found that 42.5% of Syrian refugees in Jordan showed poor well-being. Research suggests depression rates can be as high as 27% for civilians living in war zones [43, 60]. The lower prevalence of depression in our study may be because the WHO 5 Questions of Well-Being questionnaire is not specific to depression, and the cultural norms in Sudan might influence how people express or perceive depression. Social support networks or coping mechanisms within the community could be playing a protective role [60, 61].

Our study found that factors such as overcrowding, low income, and living in a war zone were associated with poor well-being. Similarly, Rizkalla and Segal [59] highlighted the negative impact of poverty and poor health and living conditions on the well-being among refugees. Overcrowding, in particular, can lead to stress, and privacy issues, and makes social interactions within the household difficult, which in turn contributes to poor well-being [62]. However, it's important to note that living with others can also have positive effects on well-being. Strong social connections and support networks can buffer against stress and improve mental health [63, 64]. The impact of living with others depends on various factors, including the quality of relationships, the level of social support, and individual differences. In the context of war and displacement, the quality of social interactions within crowded living situations can significantly influence mental health outcomes [65, 66].

We found that HCWs suffered from lower well-being compared to other professions or unemployed people. This result was supported by several studies carried out during catastrophic events like the COVID-19 pandemic

or war, where HCWs were among the most affected categories by these disasters. Disasters place a unique burden on HCWs' well-being. They witness trauma and suffer directly while providing care in often chaotic conditions. Second, HCWs themselves may be personally affected by the disaster, experiencing displacement, loss, or property damage [67, 68].

This study provides key insights and novel contributions to understanding the mental health impact of war. By quantifying the prevalence of PTSD and poor well-being among Sudanese civilians, including HCWs, our findings offer valuable data to help policymakers and aid organizations assess the scale of the problem and allocate resources effectively. Identifying key risk factors—such as living in conflict zones, displacement, low income, and overcrowded housing—enables targeted interventions and support services for vulnerable populations. Additionally, our study highlights the unique mental health challenges faced by HCWs during conflict, emphasizing the need for specialized support systems. These findings can guide future research on the long-term consequences of war and inform effective strategies to promote mental health and well-being in conflict-affected regions.

Strength and limitations

A major strength of this study lies in its use of face-to-face interviews (44.0% responses) alongside online data collection. This approach was particularly valuable in the challenging context of the ongoing conflict. A face-to-face interview goes beyond online surveys by allowing us to pick up on non-verbal clues, build trust with participants, clarify questions and ensure their understanding, and observe participants' behavior during the interview. This enhances response rate and provides deeper insight into participants' experiences. The mixed-method approach and relatively large sample size enhance the study validity. However, several limitations apply to this study. First, as a cross-sectional study, it only captures the short-term psychological effects of the ongoing Sudanese conflict limiting conclusions about long-term impacts. Second, confounding factors such as lifestyle and genetic predisposition, could not be assessed due to the challenging circumstances. Moreover, our analysis did not account for military personnel, who may be exposed to more severe mental stress and, as a result, are at a higher risk of developing PTSD. Finally, some important variables, such as having chronic medical conditions or a previous history of psychiatric problem, were not assessed. These limitations necessitate cautious interpretation of the results, as they may not fully capture the complexity of factors influencing PTSD and well-being in conflict settings.

Conclusions

War has a devastating effect on mental health, as evidenced by the high rates of PTSD, depression, and poor well-being among Sudanese civilians affected by the current conflict. A significant proportion of HCWs suffered from PTSD and experienced poor well-being and depression. Several factors increase the risk of PTSD: being employed (likely in high-risk professions), living in crowded housing, having low income, residing in a war zone, and experiencing forced relocation. Similarly, factors like working in healthcare system (exposed to trauma), overcrowded housing, living in a conflict zone, and low income were associated with poor well-being. Furthermore, those suffering from PTSD also reported lower overall well-being. Reducing mental illness and improving well-being during war requires an integrated approach encompassing increased access to mental health services, strengthened social support networks, provision of basic needs, and ultimately, conflict resolution to prevent violence and displacement [39].

Abbreviations

CI	Confidence Interval
COVID-19	Coronavirus disease 2019
DSM-5-TR	The Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition, Test Revision
HCWs	Health care workers
IQR	Interquartile range
P	p-value
PCL-5	The post-traumatic stress disorder checklist for DSM-5
PTSD	Post-traumatic stress disorder
QOL	Quality of life
r	Pearson correlation coefficient
SD	Standard Deviation
WHO	World Health Organization

Supplementary Information

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Supplementary Material 1: Study questionnaire

Supplementary Material 2: Supplementary figures.

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Author contributions

Conceptualization, M.F.H, R.M.G.; Methodology, M.F.H., R.M.G.; Validation, M.F.H., B.T., Y.Y.M.; Formal analysis, M.S.; Data collection: A.O.A., F.M.O., O.A.A., A.G.; Writing—original draft preparation, M.F.H., R.M.G; Writing—review and editing, R.M.G., M.F.H., B.T., Y.Y.M., A.G.; Visualization, M.S.; Supervision, M.F.H.; Project administration, A.G. All authors have read and agreed to the published version of the manuscript.

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Data availability

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethical approval
The study was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Committee of the High Institute of Public Health, Alexandria University, Egypt (I.R.B. number: 00013692, date of approval 30/1/2024). The study also had permission for data collection from the Sudanese Ministry of Health and Social Development (Humanitarian Aid Commission).

Consent to participate
Informed consent to participate in the study was obtained from all participants.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

Author details
[1]Department of Occupational Health and Industrial Medicine, High Institute of Public Health, Alexandria University, Alexandria, Egypt
[2]Biostatistician, Mars-Global, London, UK
[3]Harvard Medical School Associated Almuni, Boston, USA
[4]Neuropsychiatry Department, Ain Shams University, Cairo, Egypt
[5]Maternal and Child Health, High Institute of Public Health, Alexandria University, Alexandria, Egypt
[6]Faculty of Medicine, Alexandria University, Alexandria, Egypt
[7]Al Neelain University - Faculty of Medicine, Khartoum, Sudan
[8]Department of Family and Community Medicine, College of Medicine, King Khalid University, Abha, Saudi Arabia
[9]Histopathology and Cytopathology Department, Faculty of Medical Laboratory Sciences, University of Gadarif, Algadarif, Sudan
[10]Faculty of Medicine and Health Sciences, Omdurman Islamic University, Khartoum, Sudan
[11]Family and Community Medicine Department, College of Medicine, King Khalid University, Abha, Saudi Arabia
[12]Tropical Health Department, High Institute of Public Health, Alexandria University, Alexandria, Egypt

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