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Psychological well-being of Ukrainian students three months after the emerge of full-scale war

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Summary

Aim. To depict overall psychological well-being of a large group of students of different universities in Ukraine three months after the emerge of the full-scale war.

Material and methods. A total of 1,142 participants were asked to measure their psychological well-being on a 0–10 scale before and after the onset of full-scale war. Mental health symptoms were measured with questionnaires targeting depression (PHQ-9), anxiety (GAD-7), sleep problems (ISI), eating disorders (SCOFF), alcohol abuse (CAGE), and PTSD symptoms (PC-PTSD-5). To evaluate the connection between variables a $\chi 2$ was conducted. Phi and Cramer's V coefficient were stated to demonstrate the power of the relationships. Additionally, machine learning (the XGBoost regression model) was used to build a predictive model for depressive symptoms.

Results. Of all respondents, 66% screened positive for PTSD symptoms, 45% – moderate and severe anxiety symptoms, 47% – moderate and severe depressive symptoms. Regarding sleep, alcohol use and eating behavior, 19% of surveyed students had signs of moderate and severe insomnia, 15% reported alcohol abuse and 31% disordered eating. The severity of the aforementioned disorders varied depending on gender, year of study, social status, etc. According to the predictive model, lower initial psychological well-being, female gender, younger age, first years of study and any traumatic experience, including multiple trauma, predicted increases in depression score. Return to home after relocation was a protective factor.

Conclusions. The study demonstrated the high prevalence of mental health symptoms among university students in Ukraine during the first months of the full-scale war. The psychological well-being pre-war was the strongest predictor of depressive symptoms in the model.

Key words: warfare and armed conflicts, depression, predictive model

Introduction

On February 24, 2022, the Russian Federation launched a full-scale invasion of Ukraine slaughtering and injuring thousands of civilians, including hundreds of children [1], and forcing more than 10 million people to internal or external displacement [2]. As stated in the United Nations report: "Most of the civilian casualties recorded were caused by the use of explosive weapons with wide area effects, including shelling from heavy artillery and multiple launch rocket systems, missile and air strikes" [3]. The war has not only a tremendous impact on the Ukrainian economy, threatens the physical and mental health of Ukrainians that stay in the country, but also greatly influences the mental health of those people who fled abroad [4]. If the effect on the economy is somewhat measurable [5], the devastating effect of war trauma on mental health is yet to be seen. The impact of war on mental health is dangerous not only for people affected by war today but for future generations as well [6-10].

The prevalence of mental health disorders before the emergence of the full-scale war was already high in Ukraine with relatively low treatment coverage. According to the Global Burden of Disease (GBD) 2017 estimates Ukraine had a similar prevalence to Eastern Europe for severe mental health disorders except major depressive disorder, which had a 3.4% prevalence in Ukraine and 2.9% in Eastern Europe [11]. Other data suggest the estimated prevalence of depression in Ukraine is up to 6.3% in the general population and anxiety is up to 6.1% [12]. Moreover, Ukraine has a higher estimated suicide rate than the Eastern Europe regional average. Treatment coverage for severe mental health disorders was 9.4% in the general population, and among young adults – 6.7% [11]. The war had already increased the risk of developing mental health problems among adolescents who live in affected regions since the first invasion of Ukraine in 2014 [13]. However, the full-scale invasion set new challenges for the well-being of the Ukrainian population and mental health system.

According to the numerous types of research focused on mental health-related problems of civilians due to war traumas [14-17], post-traumatic stress disorder (PTSD), mood disorders (frequently depression), anxiety disorders, and alcohol abuse are the most common to be registered. Some of them affect up to 60% of the population. A meta-analysis by Hoppen and Morina [18] revealed that PTSD and major depression were the most frequent mental disorders diagnosed among war survivors worldwide. Charlson et al. [19] demonstrated that children and adolescents were the most prone to the development of PTSD, while depression was more prevalent among the adult population in the areas of war conflict.

Several studies covered the risk factors of PTSD development, which include: female sex, older age, prior psychological disorders (i.e., depression, manic episode, schizophrenia), traumas (physical or sexual assault, divorce, disabling injury or illness), absence of social support, sleep deprivation (less than 4 hours per day), high

neuroticism, lack of higher education, low income, higher body mass index (obesity), residency in rural areas and low extraversion [20-22]. Furthermore, PTSD can be a strong risk factor for the development of eating disorders, especially bulimia nervosa and binge eating disorder, and sleep disorders, including insomnia, nightmares, periodic limb movement disorder, and parasomnias [23, 24]. Higher levels of eating disorders were found in Syrian refugees living in North Lebanon, with a three times higher risk of having an eating disorder if PTSD symptoms were present [25]. Moreover, an increased level of substance use among refugees and migrants was also observed [26, 27]. Similarly, existing studies on the impact of the war on the mental health of the Ukrainian population show an elevated prevalence of anxiety, depression, sleep disturbances and PTSD symptoms among internally and externally displaced people [28-32].

Our study focused on the evaluation of the mental health of young Ukrainian adults (students) during the war. We examined their well-being in the context of sleep quality, depression, PTSD, anxiety symptoms, eating disorders and alcohol use. Furthermore, we have built a prediction model for depression symptoms among students using machine learning algorithms.

Material and methods

The current study enrolled 1,142 participants, students of universities in Ukraine, including Bachelor's, Master's and PhD students, during April 28 – June 17, 2022. For the convenience of the students, the questionnaires were sent to each of them as a Google form. All participants were informed that this study had a voluntary basis and that they could revoke their data at any time, and acquired data would be anonymous and confidential. All participants signed the informed consent to participate in the study. After consistency check, we excluded 29 responses from the final analysis due to inconsistent answers.

The sociodemographic part of the survey included questions about age, gender, year of study, relocation experience and seeking support before and after the full-scale invasion. All participants were asked to assess their psychological well-being on a 0-10 scale before the invasion and after the full-scale war commenced.

Mental health symptoms were measured with following questionnaires: PC-PTSD-5, PHQ-9, GAD-7, ISI, SCOFF, CAGE.

The Primary Care PTSD Screen for DSM-5 (PC-PTSD-5), a 5-item screen questionnaire, was used to scan for probable PTSD in the individuals. Each question in PC-PTSD-5 has two answer variants: YES or NO, where YES equals 1 point and NO – 0 points. A positive answer to 3 or more questions indicates probable PTSD [33].

The Patient Health Questionnaire-9 (PHQ-9) was applied to evaluate the level of depression. This questionnaire contains 9 items, with answers on a 0-3 scale. The score was interpreted as follows: 0-4 points – none/minimal depression, 5-9 – mild, 10-14 – moderate, 15-19 – moderately severe, ≥20 – severe depression [34].

To assess anxiety levels, we used the General Anxiety Disorder-7 (GAD-7) scale. The scale consists of 7 items that refer to general anxiety symptoms according to diagnostic criteria. Each answer is scored from 0 to 3 points. According to the score, 0-4 indicates minimal anxiety, 5-9 – mild, 10-14 – moderate, and ≥15 – severe anxiety [35].

The presence of sleep disorders was identified using the Insomnia Severity Index (ISI), a 7-item self-report questionnaire. A 5-point Likert scale accesses several sleep quality criteria: severity of sleep onset, sleep maintenance, early morning awakening problems, sleep dissatisfaction, interference of sleep difficulties with daytime functioning, noticeability of sleep problems by others, and distress caused by sleep difficulties. The total score ranges from 0 to 28. A mean score from 1 to 7 stands for the absence of insomnia, 8-14 points – sub-threshold insomnia, 15-21 – moderate insomnia, and 22-28 – severe insomnia [36].

The SCOFF questionnaire was applied to screen for the presence of an eating disorder (ED) among the students. It is a 5-item screening instrument that covers 5 main aspects of ED: sickness (vomiting), control over eating habits, weight shifts, distortion of one's body image, and the role of food in a person`s life. A positive answer to 2 or more questions indicates a likely case of anorexia nervosa or bulimia [37].

To screen for substance abuse, we chose the 4-item CAGE questionnaire which focuses on alcohol consumption and related problems. Each question requires a YES or NO answer. Two or three YES answers suggest heavy alcohol use or alcohol use disorder [38, 39].

Taking into account the lack of data about the validation of SCOFF, CAGE, and PC-PTSD-5 questionnaires on Ukrainian samples, we performed the reliability check with Cronbach's α and McDonald`s Ω for each of these tools.

All statistical analysis was processed using Microsoft Excel v. 16.0.15028.2016 and IBM SPSS v.25. To evaluate the connection between the aforementioned domains of mental health and sociodemographics, a $\chi 2$ was conducted. Phi and Cramer`s V coefficient were stated to demonstrate the power of the relationships. A $p < 0.05$ value was considered statistically significant.

The XGBoost regression models were made for the dependent variable (depression). The extreme gradient boosting (XGBoost) is a supervised machine-learning and data-mining tool, which involves a meta-algorithm, to construct a strong ensemble learner from weak learners, such as regression trees. XGBoost retrofits the tree-learning algorithm for handling sparse data by raising a weighted quantile sketch to approximate an optimization calculation and design a column block structure for parallel learning. The XGBoost algorithm can indicate the contributions of each of the predictors, making it possible to choose the most relevant predictors [40, 41].

Results

The sociodemographic characteristics of participants are presented in Table 1. The majority of respondents (78.4%) were women. The mean age was 21 years (M = 20,

SD = 5.08, *SE* = 0.15). Most of the participants were in the process of getting a Bachelor's degree (61.5%). All respondents resided in Ukraine when the full-scale war emerged. A vast majority of students stated that they changed their place of residence due to the war (70.7%), mostly within Ukraine (63.6%) and 1/3 of them moved abroad (36.4%). A quarter of those who left home and moved within or outside Ukraine have returned back. Only every fifth respondent (21.3%) sought any mental health support before the war. At the time the full-scale invasion began, the percentage of those seeking professional mental health support decreased to 14.6%. A third of respondents (39.2%) asked their parents, relatives, or friends for support. The majority of study participants were living with their parents or relatives (72.8%).

Table 1. **Sociodemographic factors associated with PTSD, depression and anxiety symptoms among students in Ukraine 3 months after the emerge of full-scale war (2022)**

Variables	Categories	Frequency (%)	PTSD symptoms		Chi-square χ^2(df)	Depressive symptoms		Chi-square χ^2(df)	Anxiety symptoms		Chi-square χ^2(df)
			Yes	No		Yes	No		Yes	No	
Gender	Male	21.3	38.4	61.6	106.206 (1)**	34.6	50.3	11.225 (1)**	26.9	73.1	39.122 (1)**
	Female	78.7	26.3	73.3		49.7	62.4		49.4	50.6	
Year of study	1st year Bachelor	28.3	67.7	32.3	18.225 (6)*	50	50	18.737 (6)*	48.1	51.9	8.806 (6)
	2nd year Bachelor	18.1	67.5	32.5		52.9	47.1		46.6	53.4	
	3rd year Bachelor	15.3	74.7	25.3		46	54		47.7	52.3	
	4th year Bachelor	10	69.3	30.7		53.5	46.5		43	57	
	1st year Master	6.9	60.8	39.2		46.8	53.2		40.5	59.5	
	2nd year Master	2.4	70.4	29.6		48.1	51.9		48.1	51.9	
	PhD student	18.9	55.8	44.2		34.9	65.1		36.7	63.3	
History of displacement since the emerge of full – scale war	Yes	71.2	70.4	29.6	21.618 (1)**	49.4	50.6	5.677 (1)**	48.3	33.5	15.442 (1)
	No	28.8	56	44		41.6	58.4		35.5	64.5	

table continued on the next page

Internal/external displacement	Internal	45.5	66	34	11.840 (1)**	47.8	52.2	1.477 (1)	44.3	55.7	7.969 (1)*
	External	25.8	77.5	22.5		52.2	47.8		54.6	45.4	
Current residence (home)	Did not change place of residence	27.2	57.3	42.7	28.861 (3)**	41.7	58.3	11.002 (3)**	35.3	64.7	21.133 (3)**
	Other region in Ukraine	23.9	66.2	33.8		49.6	50.4		44.9	44.9	
	Outside of Ukraine	23.8	78.2	21.8		54.2	45.8		54.2	45.8	
	Returned home	25.1	64.6	35.4		43.9	56.1		45.3	54.7	
Cohabitants	Lived alone	6.9	73.4	26.6	11.428 (6)	50.6	49.4	8.379 (6)	46.8	53.2	3.906 (6)
	Partner	10.6	63.6	36.4		50.4	49.6		43	57	
	Partner and child/ren	2	39.1	60.9		26.1	73.9		30.4	69.6	
	Child/ren	1.2	57.1	42.9		28.6	71.4		42.9	57.1	
	Parents or relatives	72.7	67.1	32.9		46.8	53.2		44.6	55.4	
	Friends	5.5	61.3	38.7		50	50		46.8	53.2	
	Pets	1	72.7	27.3		63.6	36.4		63.6	36.4	

Note: *p<0.05, **p<0.001

A graphic representation of the distribution of the independent variables in our sample can be found in the Appendix (Fig. 1 and 2).

The median score of psychological well-being of respondents before the war was 8 (M = 7.12, SD = 2.34, SE = 0.069), whereas after the war it was 5 (M = 4.84, SD = 2.28, SE = 0.067) points out of 10 (Fig. 3). Therefore, psychological well-being of respondents, according to their self-assessment, decreased since the beginning of the full-scale war, and the difference was statistically significant ($p < 0.001$, $Z = -21.975$, $U = 307683.5$).

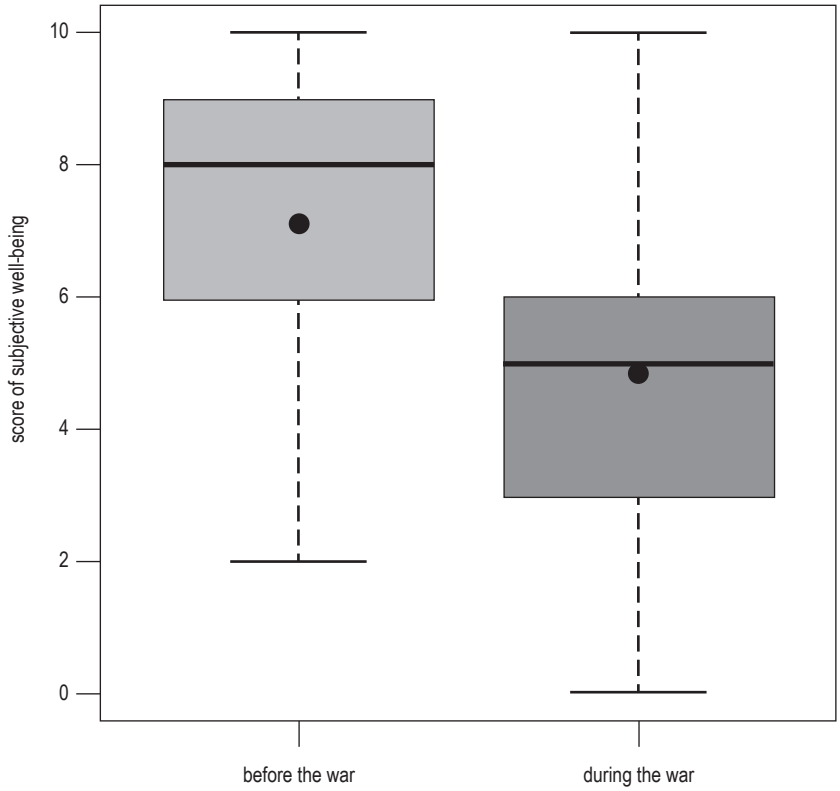

Figure 3. **The mean scores of subjective well-being of respondents measured on a scale from 0 to 10 before and after the emerge of the full-scale war**

According to reliability analysis, PTSD PC-5 showed low reliability with Cronbach's α = 0.582, SCOFF`s α = 0.52, for CAGE α = 0.657, for ISI α = 0.879, McDonald`s Ω = 0.886, for GAD-7 α = 0.877, McDonald`s Ω = 0.88, for PHQ-9 α = 0.846, McDonald`s Ω = 0.848.

Overall, results were good for questionnaires using Likert scaling and significantly low for those using the binary answer system (i.e., YES or NO). It should be mentioned that tools using binary answers were shorter, containing fewer questions.

According to mental health screening questionnaires, 66% of all respondents screened positive for PTSD symptoms (PC-PTSD-5), 45% – moderate and severe anxiety symptoms (GAD-7), 47% – moderate and severe depressive symptoms (PHQ-9). Regarding sleep, alcohol use and eating behavior, 19% of surveyed students had signs of moderate and severe insomnia (ISI), 15% reported alcohol abuse (CAGE) and 31% disordered eating (SCOFF) (Fig. 4).

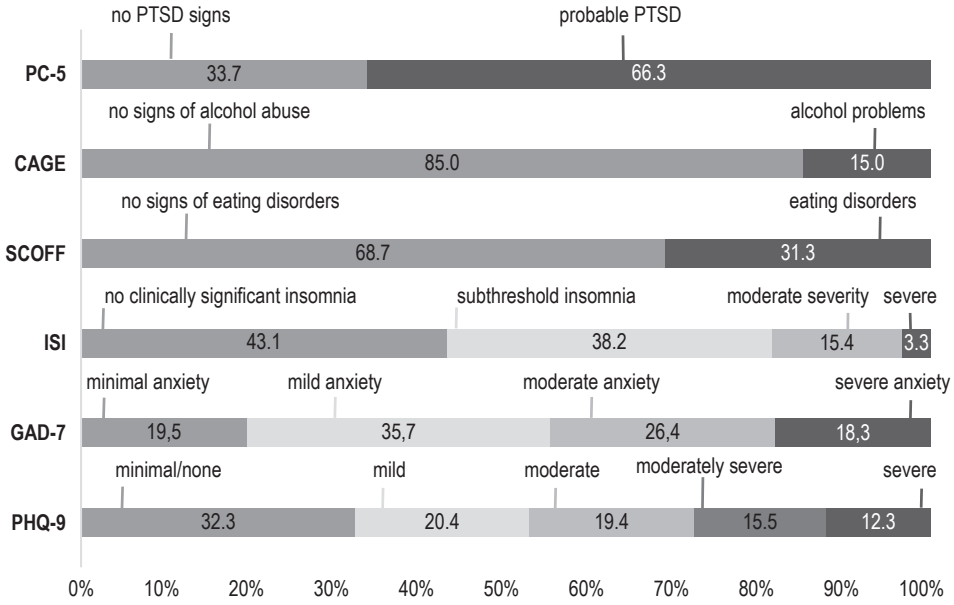

Figure 4. **Graphical representation of mental health symptoms experienced by students in Ukraine 3 months after the emerge of full-scale war**

Only 14% of respondents have sought professional mental health support from psychiatrists and 14.6% – psychological support from psychologists or hotlines after the full-scale war started. Along with that, 16% of respondents used medications to cope with stress: 4% – prescribed by professionals, 11.1% – not prescribed by professionals (derived from personal stocks, friends, relatives or purchased in pharmacies [over-the-counter medications]), 0.6% – both groups.

According to the PC-5, participants were asked about experiencing one or more specific traumatic events (data is represented in Table 2). Most of the participants (67.26%) reported that they experienced traumatic events since the emerge of the full-scale war. The most frequently selected category of trauma was loss of loved one

due to homicide or suicide, given that 40% of all students mentioned experiencing it. Moreover, 27.5% of those who experienced traumatic events have marked experiencing two types of traumas, and 16.3% – three and more.

Table 2. **Traumatic events experienced among students in Ukraine 3 months after the emerge of full-scale war (2022)**

Traumatic event	*N* = 1142	Frequency (%)
Serious accident or fire	129	10.01
Physical assault or abuse	149	11.56
Sexual assault or abuse	91	7.06
Witnessing someone being killed or seriously injured	182	14.12
Loss of loved one due to homicide or suicide	516	40.03
Being close to the warzone, being under fire	222	17.22
n of people who did not experience traumatic events	374	32.74

A chi-square test of independence revealed a statistically significant association between PTSD symptoms and gender ($\chi 2$ (1.1137) = 106.206, Phi = 0.3, $p < 0.001$), education ($\chi 2$ (2.1137) = 13.437, Cramer's V= 0.1, $p = 0.01$), year of study ($\chi 2$ (6.1137) = 18.225, Cramer's V= 0.127, $p = 0.006$), history of displacement ($\chi 2$ (1.1137) = 21.618, Phi = 0.138, $p < 0.001$), internal/external displacement ($\chi 2$ (1.1137) = 11.840, Phi 0.121, $p = 0.01$) and current residence ($\chi 2$ (3.1137) = 28.861, Cramer's V= 0.159, $p < 0.001$) (Table 1). Therefore, PTSD symptoms were more common among women, students in their third year of study, and people with a history of displacement who were living alone. A large number of people who obtained a score above the cut-off were living outside of Ukraine.

Additionally, a statistically significant association was found between symptoms of PTSD and history of seeking psychological support before the full-scale war ($\chi 2$ (1.1137) = 14.008, Phi = 0.111, $p < 0.001$), seeking psychological support since the full-scale war emerged ($\chi 2$ (1.1137) = 9.439, Phi = 0.091, $p = 0.003$), seeking professional mental health support ($\chi 2$ (1.1137) = 29.417, Phi = 0.161, $p < 0.001$) and psychological support from loved ones ($\chi 2$ (1.1137) = 49.795, Phi = 0.209, $p < 0.001$) (Table 3).

Table 3. **Help-seeking factors associated with PTSD, depression and anxiety symptoms among students in Ukraine 3 months after the emerge of full-scale war (2022)**

Variables	Categories	Frequency (%)	PTSD symptoms		Chi-square χ^2(df)	Depressive symptoms		Chi-square χ^2(df)	Anxiety symptoms		Chi-square χ^2(df)
			Yes	No		Yes	No		Yes	No	
History of seeking psychological support before full-scale war	Yes	21.2	76.3	23.7	14.008 (1)**	54.8	45.2	7.145 (1)*	53.9	46.1	10.823(1)*
	No	78.8	63.5	36.5		45.1	54.9		42.1	57.9	
Seeking psychological support since the full-scale war emerged	Yes	14.1	84.8	15.2	29.417 (1)**	71.3	28.7	45.040 (1)**	70.7	29.3	53.003 (1)**
	No	85.6	63.1	36.9		43.1	56.9		40.2	59.8	
Seeking professional mental health support	Yes	14.1	76.9	23.1	9.439(1)*	58.1	41.9	9.014(1)*	61.3	38.8	20.915(1)**
	No	85.9	64.5	35.5		45.3	54.7		41.9	58.1	
Seeking psychological support from relatives	Yes	39.3	78.5	21.5	49.795(1)**	53	47	10.215(1)**	57.5	42.5	49.636(1)**
	No	60.7	58.3	41.7		43.3	56.7		36.2	63.8	

Note: *p<0.05, **p<0.001

Regarding alcohol abuse, we found out a significant relationship with gender ($\chi 2$ (1.1137) = 5.532, Phi = 0.07, p = 0.019) as male respondents had higher levels of alcohol abuse compared to females. Likewise, the results have shown an association between alcohol abuse and living with cohabitants ($\chi 2$ (6.1137) = 16.193, Cramer's V= 0.119, p = 0.013). Lower levels of alcohol abuse were found among those who stayed with relatives or parents, and higher – among those, who lived with pets (Table 4).

The presence of symptoms of eating disorders was associated with gender ($\chi 2$ (1.1137) = 40.213, Phi = – 0.188, $p < 0.001$), education degree ($\chi 2$ (2.1137) = 12.640, Cramer's V= 0.105, p = 0.002) and year of study ($\chi 2$ (6.1137) = 19.557, Cramer's V= 0.131, p = 0.003) (Table 4). Levels of disordered eating among females were as twice as high as in males. Furthermore, PhD students had relatively lower levels of eating disorder symptoms compared to Bachelor's and Master's students. Moreover, students who were seeking psychological support before and during the full-scale war had higher levels of disordered eating ($\chi 2$ (1.1137) = 13.002, Phi = 0.107, $p < 0.001$; $\chi 2$ (1.1137) = 3.988, Phi = – 0.059, p = 0.046) (Table 5).

Insomnia symptoms were associated with gender ($\chi 2$ (1.1137) = 17.649, Cramer's V = – 0.125, $p < 0.001$) (Table 4). Women had more problems with sleep, but they were less severe, compared to men. Additionally, a statistically significant association was found between symptoms of insomnia and history of seeking psychological support before the full-scale war ($\chi 2$ (1.1137) = 6.546, Cramer's V = 0.76, p = 0.001), seeking psychological support since the full-scale war emerged ($\chi 2$ (1.1137) = 20.521, Cramer's V = 0.134, $p < 0.001$), seeking professional mental health support ($\chi 2$ (1.1137) = 20.862, Cramer's V = 0.135, $p < 0.001$) and psychological support from loved ones ($\chi 2$ (1.1137) = 36.891, Cramer's V = 0.180, $p < 0.001$) (Table 5).

Table 4. **Sociodemographic factors associated with alcohol abuse, disordered eating and sleep problems among students in Ukraine 3 months after the emerge of full-scale war (2022)**

Variables	Categories	Frequency (%)	Alcohol abuse		Chi-square χ^2(df)	Eating disorder		Chi-square χ^2(df)	Insomnia		Chi-square χ^2(df)
			Yes	No		Yes	No		Yes	No	
Gender	Male	21.3	19.8	80.2	5.532 (1)*	14.5	26.5	40.213 (1)**	33.9	66.1	17.649 (1)**
	Female	78.7	13.7	86.3		35.8	64.2		49.1	50.9	
Year of study	1st year Bachelor	28.3	12.4	87.6	7.494 (6)	37.6	62.4	19.557 (6)*	43.5	56.5	10.230 (6)
	2nd year Bachelor	18.1	18.4	81.6		34	66		51.5	48.5	
	3rd year Bachelor	15.3	14.4	85.6		30.5	69.5		47.7	52.3	
	4th year Bachelor	10	20.2	79.8		30.7	69.3		53.5	46.5	
	1st year Master	6.9	17.7	82.3		32.9	67.1		39.2	80.8	
	2nd year Master	2.4	14.8	85.2		22.2	77.8		48.1	51.9	
	PhD student	18.9	12.6	87.4		20.5	79.5		40.5	59.5	
History of displacement since the emerge of full – scale war	Yes	71.2	15.9	84.1	1.732 (1)	32.7	67.3	2.926 (1)	47	53	1.674 (1)
	No	28.8	12.8	87.2		27.5	72.5		42.8	57.2	

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Internal/external displacement	Internal	45.5	15.9	84.1	0.038 (1)	31.5	68.5	0.737 (1)	46	54	0.327 (1)
	External	25.8	16.4	83.6		34.5	65.5		48.1	51.9	
Current residence	Did not change place of residence	27.2	12	88	3.268 (3)	27.2	72.8	3.734 (3)	42.7	57.3	1.990 (3)
	Other region in Ukraine	23.9	15.8	84.2		32.4	67..6		47.4	52.6	
	Outside of Ukraine	23.8	15.9	84.1		34.3	65.7		48	52	
	Returned home	25.1	16.8	83.2		31.6	68.4		45.6	54.4	
Cohabitants	Lived alone	6.9	17.7	82.3	16.193 (6)*	30.4	69.6	4.623 (6)	53.2	46.8	5.688 (6)
	Partner	10.6	14	86		36.4	63.6		50.4	49.6	
	Partner and child/ren	2	17.4	82.6		21.7	78.3		30.4	69.6	
	Child/ren	1.2	21.4	78.6		14.3	85.7		42.9	57.1	
	Parents or relatives	72.7	13.4	86.6		31.2	68.8		45	55	
	Friends	5.5	29	71		299	71		43.5	56.5	
	Pets	1	36.4	63.6		36.4	63.6		54.5	45.5	

Note: *p<0.05, **p<0.001

Table 5. **Help-seeking factors associated with alcohol abuse, disordered eating and sleep problems among students in Ukraine 3 months after the emerge of full-scale war (2022)**

Variables	Categories	Frequency (%)	Alcohol abuse		Chi-square χ^2(df)	Eating disorder		Chi-square χ^2(df)	Insomnia		Chi-square χ^2(df)
			Yes	No		Yes	No		Yes	No	
History of seeking psychological support before full-scale war	Yes	21.2	18.7	81.3	3.158 (1)	36.5	63.5	3.988 (1)*	53.1	46.9	6.546 (1)*
	No	78.8	14.1	85.9		29.8	70.2		43.9	56.1	
Seeking psychological support since the full-scale war emerged	Yes	14.4	16.5	83.5	0.304 (1)	43.3	56.7	13.002 (1)**	67.7	32.3	36.891 (1)**
	No	85.6	14.8	85.2		29.2	70.8		42.1	57.9	
Seeking professional mental health support	Yes	14.1	20	80	3.586 (1)	35	65	1.237 (1)	62.5	37.5	20.862 (1)**
	No	85.9	14.2	85.8		30.6	69.4		43.1	56.9	
Seeking psychological support from relatives	Yes	39.3	15.2	84.8	0.017 (1)	33.1	66.9	1.222 (1)	54.1	45.9	20.521 (1)**
	No	60.7	14.9	85.1		30	70		40.4	59.6	

Note: *p<0.05, **p<0.001

The relationship between dependent variables (PHQ-9, PC-PTSD-5, GAD-7, ISI, SCOFF, CAGE) is shown in Figure 5. The thickness of the connecting edges corresponds to the strength of the correlation between the dependent variables. The distance between nodes also attempts to reflect this correlation, but given only two dimensions, it cannot precisely track it. Therefore, a strong correlation between PHQ-9, GAD-7, ISI and PC-5 is observed, while SCOFF and CAGE correlate less with all other dependent variables.

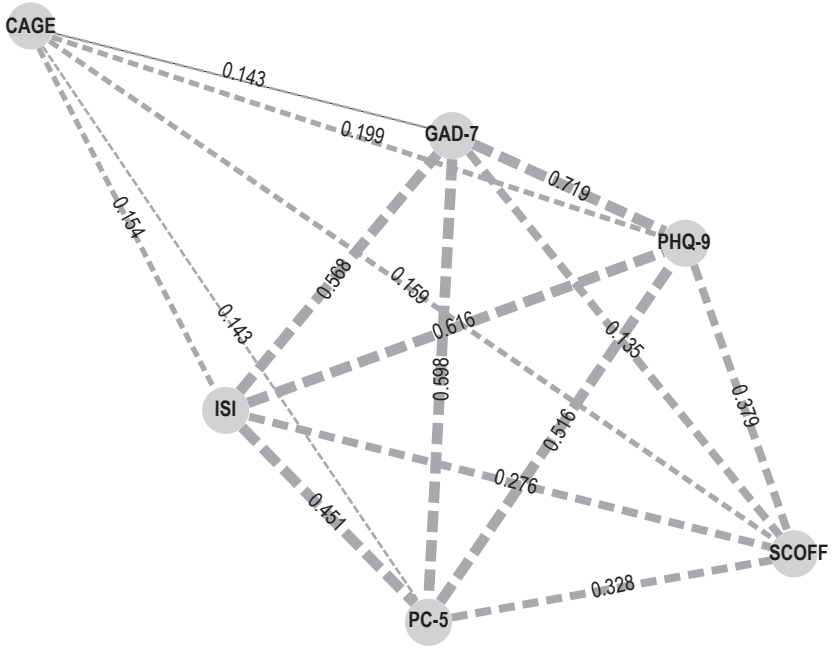


Figure 5. **The correlation between dependent variables**

Taking into account: a) the abovementioned strong correlation between some dependent variables, b) low internal consistency of CAGE, SCOFF and PC-5 questionnaires, and c) limits of the publication, it was decided to build the XGBoost prediction model only for the depression variable (PHQ-9) as it showed the highest internal consistency and relatively equal distribution in the sample.

The XGBoost model can be loosely described as a set of decision trees. Each tree can take into account a subset of the data columns in order to make a prediction. These predictions are ultimately combined together to create a more complex and accurate model. For a more detailed explanation of the XGBoost algorithm please refer to https://xgboost.readthedocs.io/en/stable/.

The XGBoost model has a large number of parameters that can be modified in order to change the model behavior. Crucially, most of these relate to the bias vs. variance trade-off, where we want to ensure that the model is sufficiently expressive to explain the data, but not so much as to overfit to our training data and end up generalizing poorly to new samples.

Therefore, we chose to optimize a set of 4 key hyperparameters that each relate to the above bias/variance trade-off. Namely:

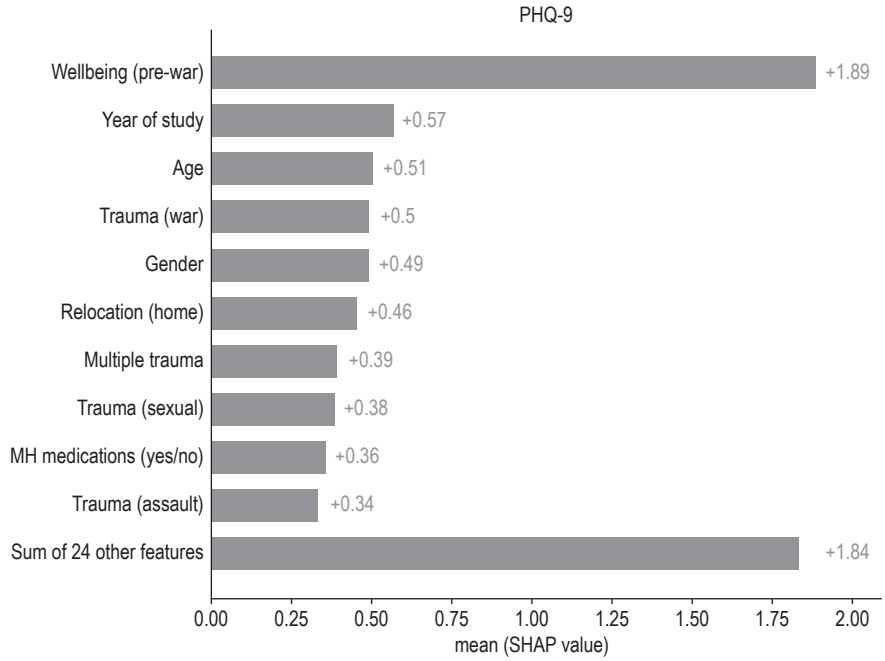
- max_depth: limiting the maximum depth of a decision tree within the model (larger values making the model more expressive, but also more liable to overfit);
- alpha: reflecting the L1 regularization term on the model weights (a larger value making the model more conservative and less likely to overfit the data; at the same time, too large a value may result in a model that is not expressive);
- lambda: reflecting the L2 regularization term on the model weights (similarly protecting from overfitting);
- gamma: the minimum loss reduction required to make a partition on a leaf node of a decision tree (larger values make the model more conservative).

In order to be able to accurately estimate how well our model was performing, we required the definition of a training sample and a test sample. Rather than splitting our data into two arbitrary partitions, we instead used a K-fold split procedure, where we defined 10 folds of approximately equal size, and such that at each time 9 folds could be used for training the prediction and the remaining fold used for testing the prediction accuracy on an effectively independent sample. Given that we wanted to ensure that the distribution of our dependent variable was roughly equal across the 10 folds, we used a stratified K-fold procedure (for details see the documentation of Scikit-Learn sklearn.model_selection.StratifiedKFold).

To estimate optimal parameters for the model, we ran a hyperoptimization procedure using Ray Tune and the NevergradSearch algorithm. Briefly, we used Bayesian optimization to find the optimal model, by running 4092 different models, whose parameters were dynamically selected for trial based on all previous runs of the model. This resulted in a set of optimal parameters as follows: max_depth = 2, alpha = 5, lambda = 9, gamma = 1.9562.

The mean predictive accuracy of the final XGBoost regression model reached 0.425 as measured by the *R* coefficient of correlation between actual delta and predicted delta, and a RMSE score of 6.725 between prediction and true PHQ-9 across the 10 folds. Finally, we ran the XGBoost model once using these optimal parameters on the whole dataset with the aim of exploring the explainability of the model as described below.

The top 10 important features of the regression model are presented in the bar chart in Figure 6. The SHAP summary of the model presents the ranking of important features and their influence on predicting outcomes (Fig. 7). As can be seen in Figure 4,



Od góry: dobrostan psychiczny przed wojną, rok studiów, wiek, trauma (wojenna), płeć, powrót do miejsca zamieszkania po relokacji, trauma złożona, trauma (seksualna), leki, trauma (napaść), suma 24 pozostałych czynników

Figure 6. **Horizontal bar plots for the top 10 important features of XGBoost regression model**

the psychological well-being pre-war is the strongest predictor in the model. Other important features influencing changes in depression scores are: age and year of study, experience of war-related trauma, gender, return to the previous place of residence after relocation, multiple traumatic experiences and sexual trauma. Namely, the SHAP summary suggests that lower initial well-being, female gender, younger age, first years of study and any traumatic experience, including multiple trauma, predicted increases in the depression score. Return to home after relocation was a protective factor.

The internal interaction strength between independent variables in the final predictive model is shown in Figure 8. After assessing the strongest interactions (see Appendix, Fig. 9 and 10), it was found that low psychological well-being pre-war predicted higher depression scores in younger age and in people who experienced more traumatic events (multiple trauma). And, correspondingly, people with high psychological well-being before the war, even when exposed to multiple trauma, did not demonstrate high levels of depression. Interestingly, sexual trauma alone predicted higher levels of depression compared to cases where sexual trauma was part of a multiple trauma experience. Furthermore, experience of war-related trauma predicted

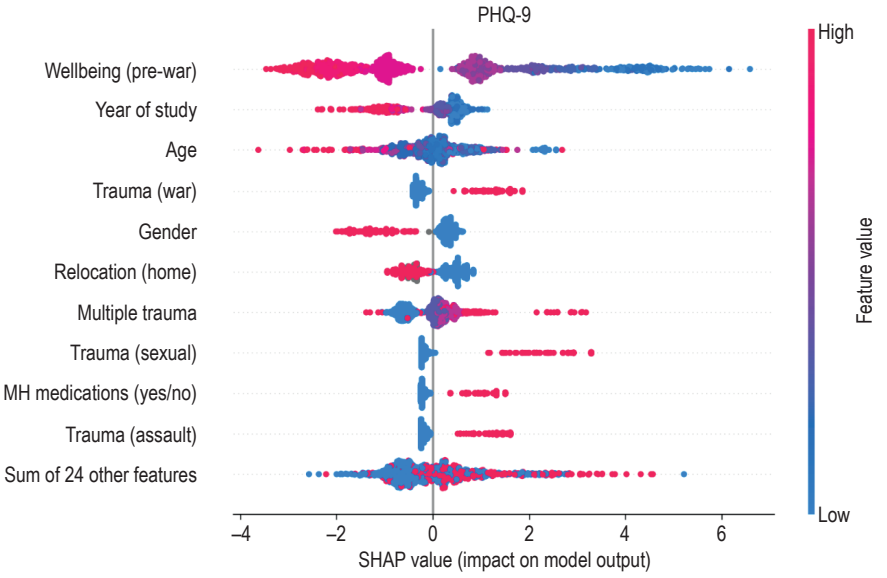


Figure 7. **SHAP summary**

higher levels of depression compared to those without such an experience. Moreover, those who experienced war-related trauma and had to leave their home demonstrated higher levels of depression compared to those who stayed in their place of residence. As for the age, younger age predicted higher depression scores among men. Women, in general, had higher depression scores than men, but for them younger age had the opposite effect, predicting a lower depression rate compared with relatively older female students. Additionally, living with relatives during the war was more protective for older students than for younger ones.

Discussion

As it was expected, our study demonstrated increased levels of symptoms of depression, anxiety, PTSD, insomnia, eating disorders and alcohol use among university students during the first months of the full-scale war. This is in line with other research that shows elevated levels of mental health symptoms after humanitarian crises [42-47], or during military conflicts [48-51]. Moreover, our results are consistent with other studies on the mental health of Ukrainians during the war, which show high levels of anxiety, depression, sleep disturbances and PTSD in the early period of the full-scale invasion [30-32, 52]. According to Fujii et al. [52], the burden of mental health symptoms among the Ukrainian population was the highest in the first month of the full-scale war and then tended to decrease, but six months later it was still much higher than the pre-war level.

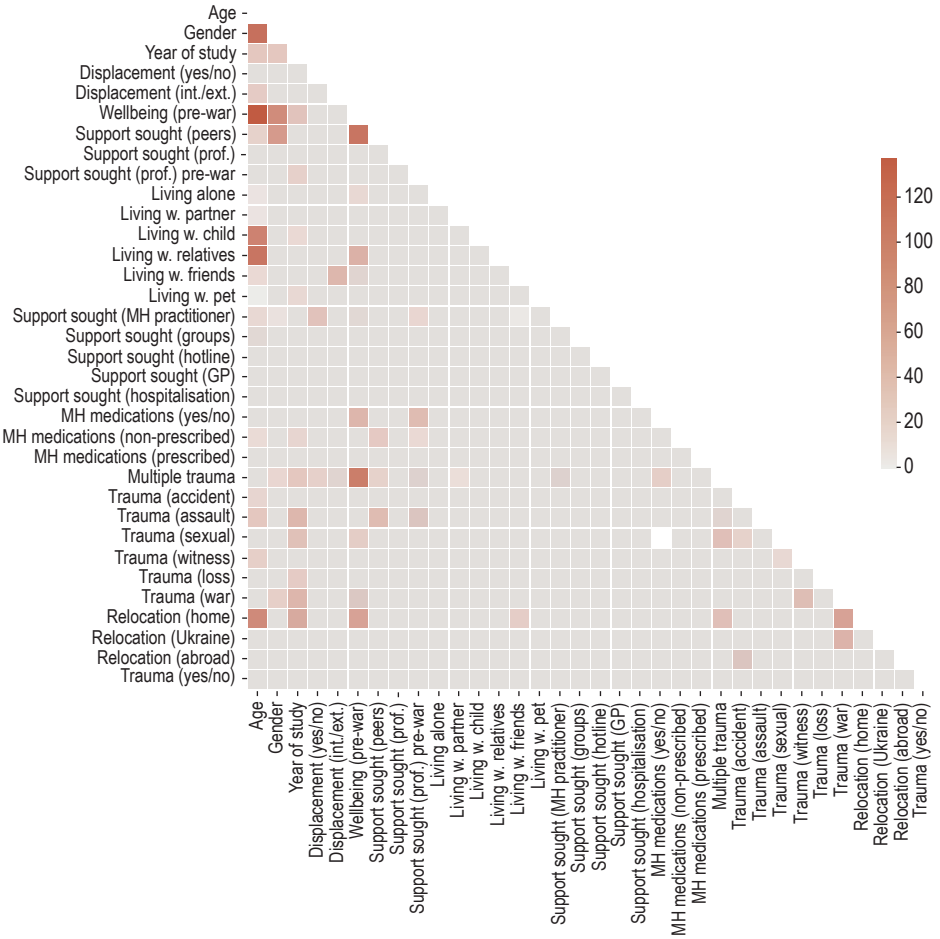


Figure 8. **SHAP interaction strength between independent variables in the XGBoost regression model for PHQ-9**

In a recent meta-analysis on the prevalence of anxiety, depression and PTSD symptoms resulting from experiencing conflict and violence, Lim et al. [49] compared both military and civilian populations. They point out that civilians are more at risk of developing anxiety and depressive symptoms (but not PTSD symptoms) than the military, as a result of e.g., rapid changes of life situation, being exposed to war-trauma without earlier training or taking up volunteer military tasks. They also showed that the prevalence of anxiety and depression symptoms, along with alcohol misuse, in the population is higher during the war as compared to post-war.

The main predictors of depressive symptoms among university students in our study were well-being pre-war, age and year of study, experience of war-related

trauma, gender, return to home after relocation, multiple traumatic experiences and sexual trauma. According to previous research, conflict-related PTSD and depressive symptoms are associated with numerous factors, such as time since conflict, exposure to war-related events [19], tortures and number of potentially traumatic events [53], sexual violence [54], previous trauma experience [55], female gender [20, 21], age [19, 56], socioeconomic status, employment, education and social support [57, 58], independence [59], childhood maltreatment (as defined by the World Health Organization, WHO), previous academic performance and drug use [60], post-migration stress [61], and treatment stigma [62]. In our predictive model the impact of multiple trauma on depressive symptoms was mediated by well-being before the war. Moreover, in our study the relocation was not an important predictive factor for depression, which is in line with studies reporting high levels of symptoms both in relocated people and in those who did not leave home [48]. At the same time, our study showed that returning home may play a protective role in relation to depressive symptoms.

However, our predictive model has average predictive power, which means that the factors that we included in the model cannot precisely explain the changes in the level of depression. Other important predictive factors that we did not take into account and that can influence the outcome include: personality characteristics, previous life events, health status and health-related behaviors, economic status, current life stressors, including the COVID-19 pandemic [63, 64], health beliefs and family history of trauma and mental health problems. One of the most important predictive factors, mental health well-being before the war, was measured with a 10-point subjective well-being scale, which may not necessarily reflect the factual situation in the period preceding the full-scale invasion.

Another limitation of our study is the use of self-report questionnaires. It is known that the results of such surveys may differ from clinical interviews, with self-assessment tools showing more symptoms [65]. Additionally, recruiting volunteers to the survey may pose another bias to the study. And taking into account that some clinical symptoms may not have had time to develop and others may disappear with time, the obtained results should be interpreted with caution.

It should be highlighted that we have studied only university students and can generalize our predictive model only to this population. Mental status and predictive factors for other age groups may differ significantly. And, finally, screening questionnaires for symptoms of PTSD, alcohol use, and eating disorders showed low internal consistency, which can also affect the reliability of the results.

Conclusions

The study demonstrated a high prevalence of mental health symptoms among university students in Ukraine during the first months of the full-scale war. The majority of respondents reported symptoms of depression, insomnia, PTSD and anxiety,

while eating disorders and alcohol abuse were present in a significantly lower number of students. Higher depressive scores were more probable in students who reported lower psychological well-being before the war, women, younger individuals, during the first years of studies, and those who experienced any traumatic event, including multiple trauma. All of the abovementioned highlights the need for immediate action to support the mental health and psychological well-being of students (young adults). As we found that return to home after relocation was a protective factor against depressive symptoms, we believe that support from loved ones was a factor which cannot be overlooked. At the same time, it should be remembered that it may be insufficient in cases of more severe or prolonged symptoms of depression and that would require professional intervention, adjusted to the dynamic situation of the Ukrainian mental healthcare system [66, 67].

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Declarations

Ethics approval and consent to participate*: Ethics approval was obtained from the Ethics Committees of the Institute of Psychiatry at the Taras Shevchenko National University of Kyiv (No. 4/A/21/03/2022). Electronic informed consent to participate was obtained from all participants.*

Availability of data and materials*: To protect the privacy of the participants, the datasets generated and/or analyzed during the current study will not be publicly available.*

Competing interests*: The authors report no competing interests.*

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Appendix

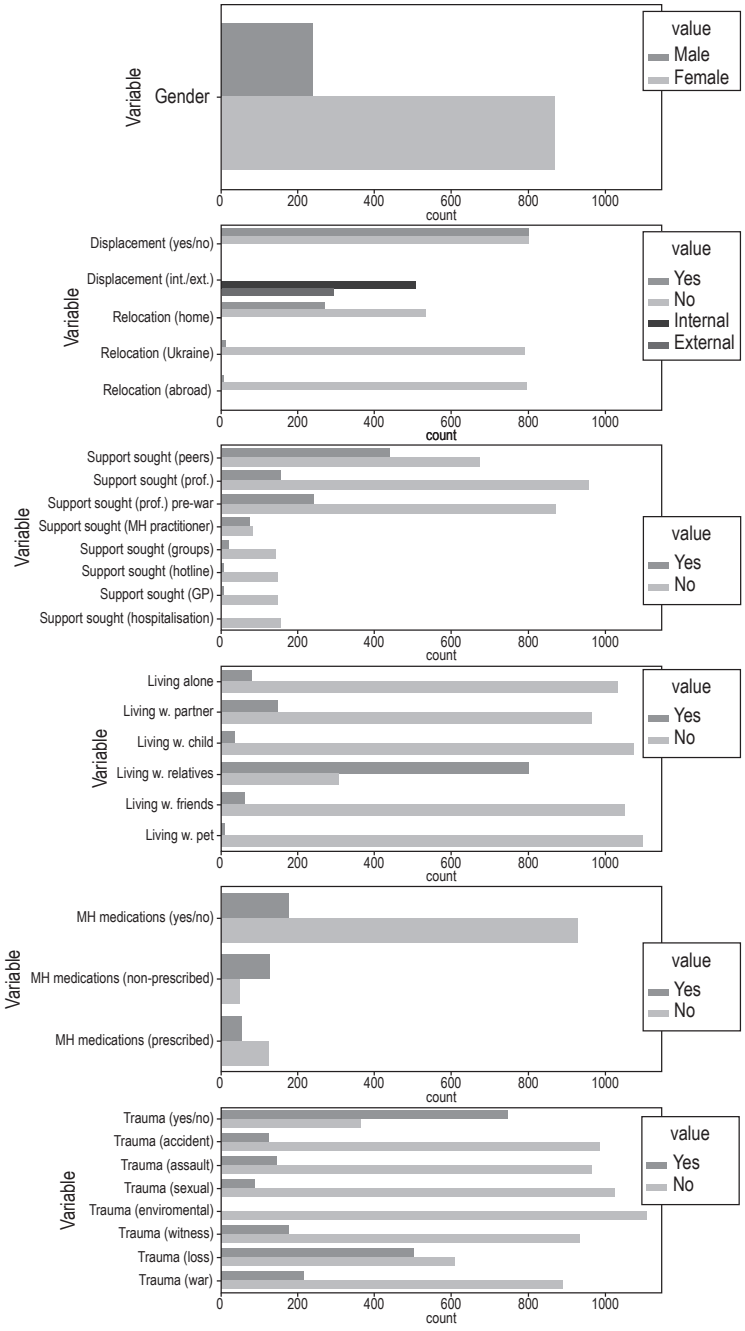

Figure 1. **Distribution of binary independent variables in the sample**

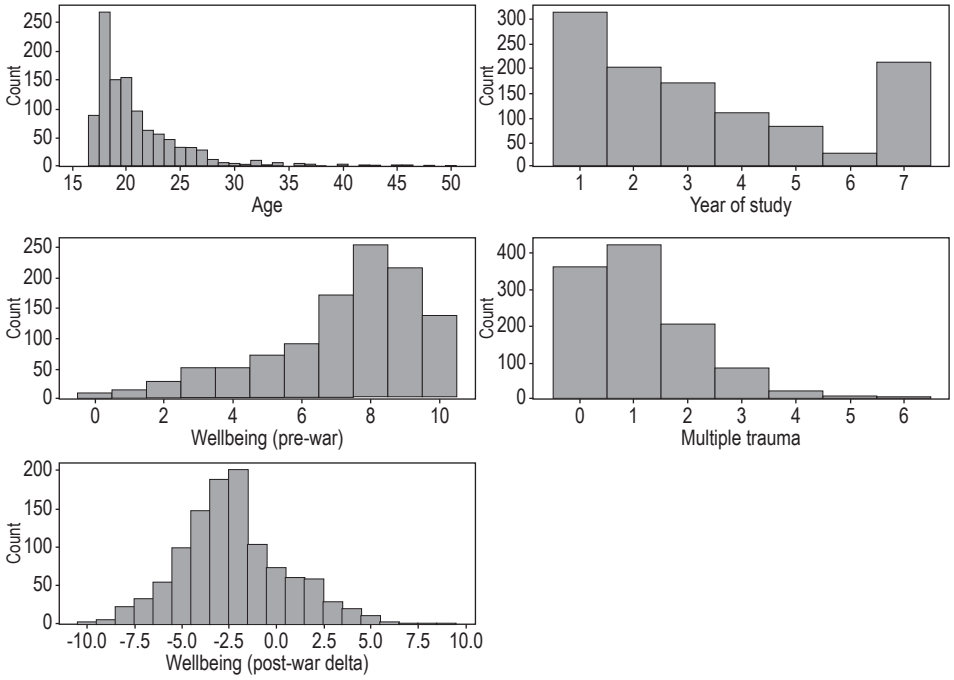

Figure 2. **Distribution of scalar variables in the sample**

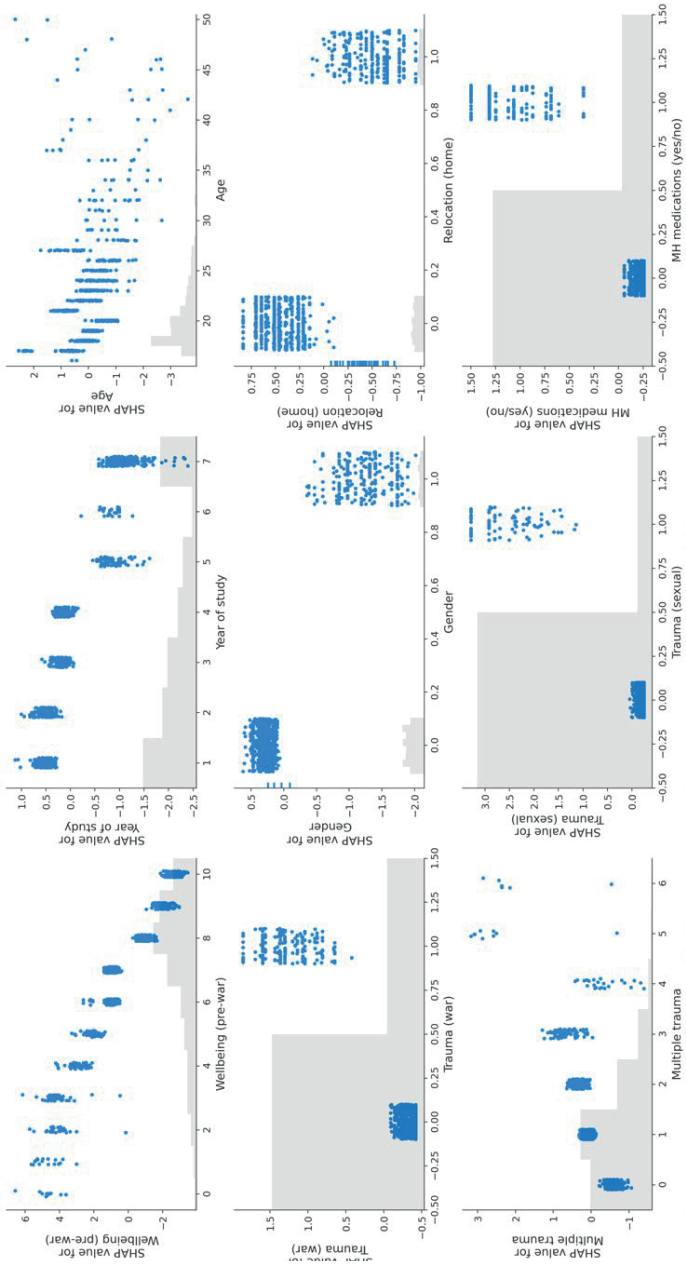

Figure 9. **Relationship between key independent variables and the effect on the SHAP value, predicting model output**

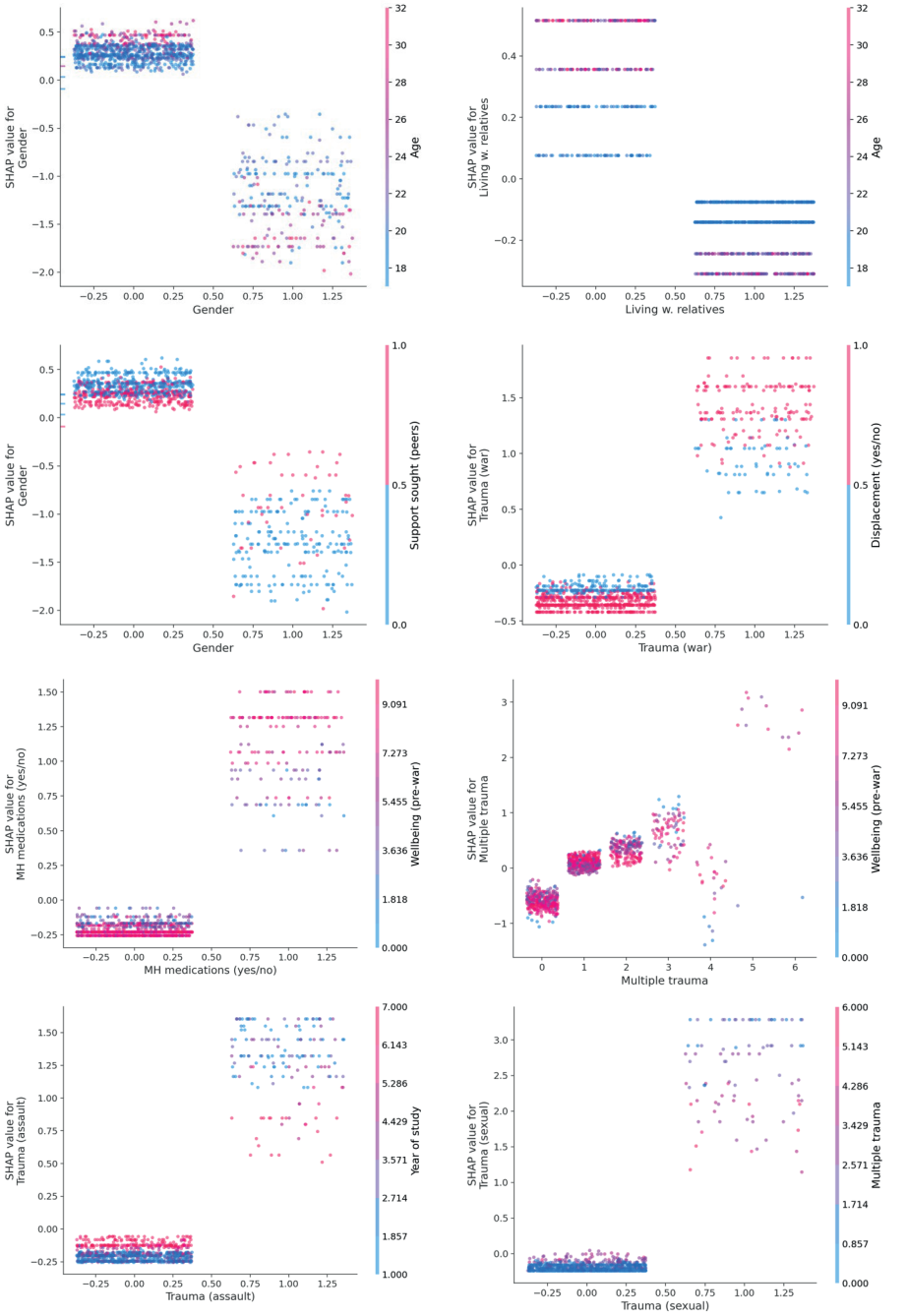

Figure 10. **SHAP dependence plots to help visualise the interaction between two independent variables on the SHAP value, predicting model output**