Depression and academic performance in high school students: examining the role of sleep quality and anxiety using structural equation modeling in armed conflict areas

Minale Tareke[1,2]*, Biksegn Asrat Yirdaw[2,6,7], Tilahun Belete Mossie[1], Abebaw Gebeyehu[3], Bizu Gelaye[4] Telake Azale[5]

Email addresses: minale23@gmail.com, biksegnasrat1@gmail.com, tilahunbe100@gmail.com, abebaw.gebeyehu@moh.gov.et, bgelaye@hsph.harvard.edu, atelake07@gmail.com

[1,2]Bahir Dar University, College of Medicine and Health Science, Psychiatry Department, Bahir Dar, Ethiopia

[2]Department of Psychiatry, College of Medicine and Health Sciences, University of Gondar, Ethiopia

[3]JSI-Data Use Partnership, Ministry of Health, Ethiopia

[4]Harvard T. H. Chan School of Public Health, Harvard Medical School and The Chester M. Pierce, MD Division of Global Psychiatry, Department of Psychiatry, Massachusetts General Hospital.

[5]Institute of Public Health, College of Medicine and Health Sciences, University of Gondar, Ethiopia

[6]UK Public Health Rapid Support Team, UK Health Security Agency/London School of Hygiene and Tropical Medicine, Keppel St., London, WC1E 7HT, UK

[7]Centre for Global Mental Health, London School of Hygiene and Tropical Medicine, Keppel St., London, WC1E 7HT, UK.

* Correspondence: E-mail : minale23@gmail.com/ minale.tareke@bdu.edu.et

Tel.: +251 913 395 731; Fax: +251 582205932

Abstract

Background: Adolescents living in war-affected areas are more likely to suffer from depression than adolescents living outside war-affected areas. However, there is limited evidence from Northern Ethiopia that was affected by armed conflicts. This study was conducted to assess the magnitude of depression and to identify inter-related factors with depression and academic performance in armed conflict-affected areas of North Wollo Zone, Ethiopia.

Methods: A **s**chool-based cross-sectional study was conducted among high school students in North Wollo Zone, Ethiopia. A multistage sampling method was used, and the study participants were selected using simple random sampling. The Structural Equation Model was used to verify the hypothesized relationship between various internal and external or mediating factors. The effect size was provided using standardized beta coefficients, 95% CI, and statistical significance defined as a P-value less than 0.05.

Results: Out of 3400 study participants, 48.1% (95% CI: 46.5%, 49.8%) endorsed depressive symptoms. Being female (β=0.05, 95% CI: 0.011, 0.087), far from family because of education (β=0.10, 95% CI: 0.060, 0.134), anxiety (β=0.95, 95% CI: 0.893, 1.011) and alcohol use (β=0.14, 95% CI: 0.108, 0.180) had a significant and positive association with a total direct effect on depression. Conversely, academic performance (β=-0.04, 95% CI: -0.061, -0.011) had a significant and negative association with a total direct effect on depression.

Conclusion: This study found a much higher magnitude of depression among students in conflict-affected areas compared to non-affected areas. High school students, particularly girls in conflict-affected areas, need social support and special protection. Additional efforts are needed to ensure safety and security in high schools and establish student support systems such as student counseling and guidance services.

Introduction

Dealing with mental health among adolescents living in conflict-affected areas is critical for a variety of reasons. Living in conflict-affected areas can cause serious mental health problems like post-traumatic stress disorder (PTSD), anxiety, and depression [1]. It can also impact their education, social interactions, and overall development [2]. Conditions persist long after the conflict has ended, resulting in long-term consequences for an individual's regular life and future generations [3].

According to recent global estimates, depression (280 million people) and anxiety (301 million people) were the most common mental disorders around the world [4], making depression alone the second leading cause of disability [5]. Depression and anxiety were more common among younger age groups in 2020 than older age, with a peak age between 20-24 years, and declined as age increased. The highest prevalence of depressive disorders was in North Africa, the Middle East, and sub-Saharan Africa [6].

According to the World Health Organization's review of 39 countries, nearly one in five (22%) people in war or conflict-affected areas will have depression, PTSD, anxiety, bipolar disorder, or schizophrenia [7]. However, a much higher magnitude of depression that ranges from 34.1% to 72.1% was found among Palestinian secondary school students [8-10]. Adolescents living in the Gaza Strip reported much higher levels of PTSD (56.8%) compared to peacetime North American Populations (6.3%) [10]. Adolescents living in war-affected areas were four times more likely to suffer from PTSD and three times more likely to experience severe anxiety and depression than adolescents living outside war-affected areas [11]. This is because, in conflict-affected regions, adolescents are exposed to sudden losses, atrocities, organized violence, exposure to explosives,

kidnapping of a significant person, financial difficulties, displacement, separation from close families and friends with ongoing stressors during crucial phases of their physical, emotional, social and cognitive development [11, 12].

Various studies reported a high prevalence of depression among high school students in Ethiopia, ranging between 19.8% and 41.4% [13-17]. It has a strong association with suicide that nearly one in six high school students reported both suicidal ideation and attempt [18, 19]. The magnitude of depression was much higher in conflict-affected areas. In south Ethiopia (conflict-affected areas in Guji and Gedio), 59.4% of the students reported mental distress. Conflict-related sexual abuse, witnessed shootings, a threat to security and safety, being female, and poor academic performance were significantly associated factors [20]. The perceived stress in conflict areas of North Shewa communities of the Amhara region was 76.1% [21].

Failure to manage depression among students is associated with a range of problems such as poor academic motivation, school dropout, physical illness, increased substance abuse, interpersonal problems with school staff and peers, negative outlook or poor coping skills, longer disease courses, and recurrent thoughts of death or suicide, or attempt suicide [22-26].

Therefore, understanding the magnitude of depression, including its inter-relationship of factors among high school students in armed conflict-affected areas, would advance scholars in the field to design appropriate culturally acceptable early detection and intervention strategies. Given the coexistence of depression, anxiety, post-traumatic stress disorder, and poor sleep quality, evidence on the magnitude and relationship of these conditions among high school students is essential for adapting and developing early diagnosis and intervention strategies that will guide appropriate management decisions, enhancing preventive measures, and encourage students to engage mental

health-seeking behaviors. Thus, using structural equation modeling approaches, this study investigates the magnitude and inter-relationships of depression with anxiety, sleep quality, PTSD, and academic performance among high school students in armed conflict-affected areas of North Wollo Zone, Ethiopia.

Methods

Study Setting and Design

A multi-centered institution-based cross-sectional study was conducted among high school students in North Wollo Zone, Ethiopia from May 15 to June 15, 2023. Woldia town is the capital city of this zone, located 521 kilometers from Addis Ababa, the capital city of Ethiopia, and 360 kilometers from Bahir-Dar, the capital city of Amhara regional state. Based on the Census conducted by the Central Statistical Agency of Ethiopia in 2007, the total population of North Wollo zone was 1,500,303(752,895 men and 747,408 women) with an area of 12,172.50 square kilometers [27]. According to North Wollo Zonal education report (2023), there are a total of 54 secondary schools that provide education services for 21848 male and 28177 female high school students.

Study population

All high school students in conflict-affected areas of North Wollo were the source population. Selected high school students who were registered for the second semester of the 2022/2023 academic year and available during the data collection period were the study population. Meanwhile, students transferred from non-conflict areas were excluded from this study.

Sample size determination

Structural equation modeling (SEM) is a large-sample technique, and the sample size required

is dependent on the complexity of the model. SEM is considered a highly effective technique that helps to examine simultaneously complex inter-relationships among many measured variables and constructs (latent variables). It also looks at the links among numerous latent constructs concurrently [28].

The study used structural equation modeling analysis; thus, we used Daniel Soper's free statistic sample size calculator for SEM [29]. We employed an anticipated effect size of 0.3 (medium), a statistical power level of 0.8, four latent and fifty observable variables in the model, and a type 1 error rate of 0.05, resulting in a recommended minimum sample size of 3491 participants.

Sampling procedure

A multistage stratified sampling method was used and the study participants were selected using simple random sampling. The number of students in each high school was calculated, and the overall sample size was proportionally assigned to each school. The proportionately allotted sample size for grades 10 and 11 was then determined using computer-generated random sampling based on their class identity number.

Variables of the study

Dependent variables: depression, anxiety, sleep quality and posttraumatic stress disorder (latent endogenous variables)

Observed exogenous variables: socio-demographic factors such as sex, age, family residence, far from family and living conditions. Behavioral and academic factors include current alcohol use, and academic performance.

Data Collection Procedure and Instruments

A structured questionnaire was used to collect data through face-to-face interviews by trained data collectors utilizing Epicollect5 (a free and user-friendly smart phone data gathering platform). A

questionnaire was prepared in the Amharic language (national and local language) and subdivided into different categories (sociodemographic, behavioral, academic performance, and psychological factors), and the data were collected over a one-month period.

Patient health questionnaire (PHQ-9)

In this study, depression was assessed using PHQ-9, a self-report instrument comprised of 9 items. Items are rated on a four-point ordinal scale. The total PHQ-9 score for each respondent was calculated by adding all 9 items and scores range from 0 to 27. The total scores were then categorized into 1-4 minimal depression, 5-9 mild depression, 10-14 moderate depression, 15-19 moderately severe depression, and 20-27 severe depression [30]. PHQ 9 score of greater than five and above has good sensitivity (83.3%) and specificity (74.7%) to detect depression in Ethiopia [31]. The tool was used in the previous studies to assess depression among adolescents in Ethiopia [16, 32]. Anxiety symptoms were assessed using the generalized anxiety disorder-7 (GAD-7) scale. It is a 7-item self-reported question with a Likert scale ranging from 0 (not at all) to 4 (nearly every day) that measures the anxiety symptoms in the previous two weeks. The score of all items is summed to give a total score of a minimum of 0 and a maximum of 21 [33]. The scale is validated among university students in Ethiopia [34].

PTSD Checklist – (PCL-5)

The posttraumatic stress disorder checklist (PCL-5) was used to assess the *DSM-5* symptoms of PTSD. The questionnaire has twenty items with a 5-point Likert scale (0 = not at all, 1 = a little bit, 2 = moderately, 3 = quite a bit, 4 = extremely) for participants who endorse experiencing any type of traumatic event. The sum of the scores ranges from 0 to 80 and a score of $\geq$ 33 was considered possible PTSD. The PLC-5, total symptoms severity score (ranges from 0-80) can be obtained by summing the scores for each of the 20 items within a given cluster: reexperiencing

(items 1-5), avoidance (items 6-7), negative alterations (items 8-14), and hyperarousal symptoms (items 15-20) [35, 36]. Although the diagnostic validity of the PCL-5 was not examined in Ethiopia, its psychometric properties have been examined in other sub-Saharan African setting. For instance, the validity of the PCL-5 in Zimbabwe was found to be good, with sensitivity (74.5%) and specificity (70.6%) [37].

The Pittsburgh Sleep Quality Index (PSQI) is the most widely used subjective assessment of sleep quality. The PSQI has seven components related to overall sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbance, use of sleep medicine, and daytime dysfunction. The score for each sleep component ranges from 0 to 3, with 3 indicating the greatest dysfunctionality. The sum of all seven components yields one global score ranging from 0 to 21, a higher global score indicating poor sleep quality. Those with a global score greater than five are classified as having poor sleep quality. Those with a score of 5 or less are classified as having good sleep quality. The psychometric properties of the Amharic version of the PSQI have been evaluated and found to have good construct and factorial validity among Ethiopian college students [38].

Academic performance was measured by using the average score of the first semester for all courses during the academic year (2023). According to Ethiopia's Ministry of Education, academic performance was classified as excellent (90-100%), very good (85-89%), good (70-84%), above average (65-69%), average (50-64%), satisfactory (40-49%) and fail (below 40%) [39].

Data quality management

To ensure the data quality, standardized and validated tools were used to measure latent and observed variables using Epicollect5 (Free mobile data-collection platform). Moreover, the questionnaire was pretested before actual data collection. Data collectors were trained on the ethical conduct, the study's objectives, questionnaire content, how to approach and collect the

necessary data. The data collection processes were carefully supervised by secondary school teachers, and feedback was provided on the spot.

Model building and analysis

The hypothesized model was the starting point for the analysis (Figure 2), and modifications were performed by comparing model fit indices and information criteria for each model fitted. Ultimately, the over-identified model with the lowest information and the best model fit indices was retained (Figure 5). The models were evaluated using goodness-of-fit tests, including the goodness-of-fit index, comparative fit index (CFI), root mean square error approximation (RMSEA), Tucker-Lewis index (TLI), and standard root mean squared residual (SRMR).

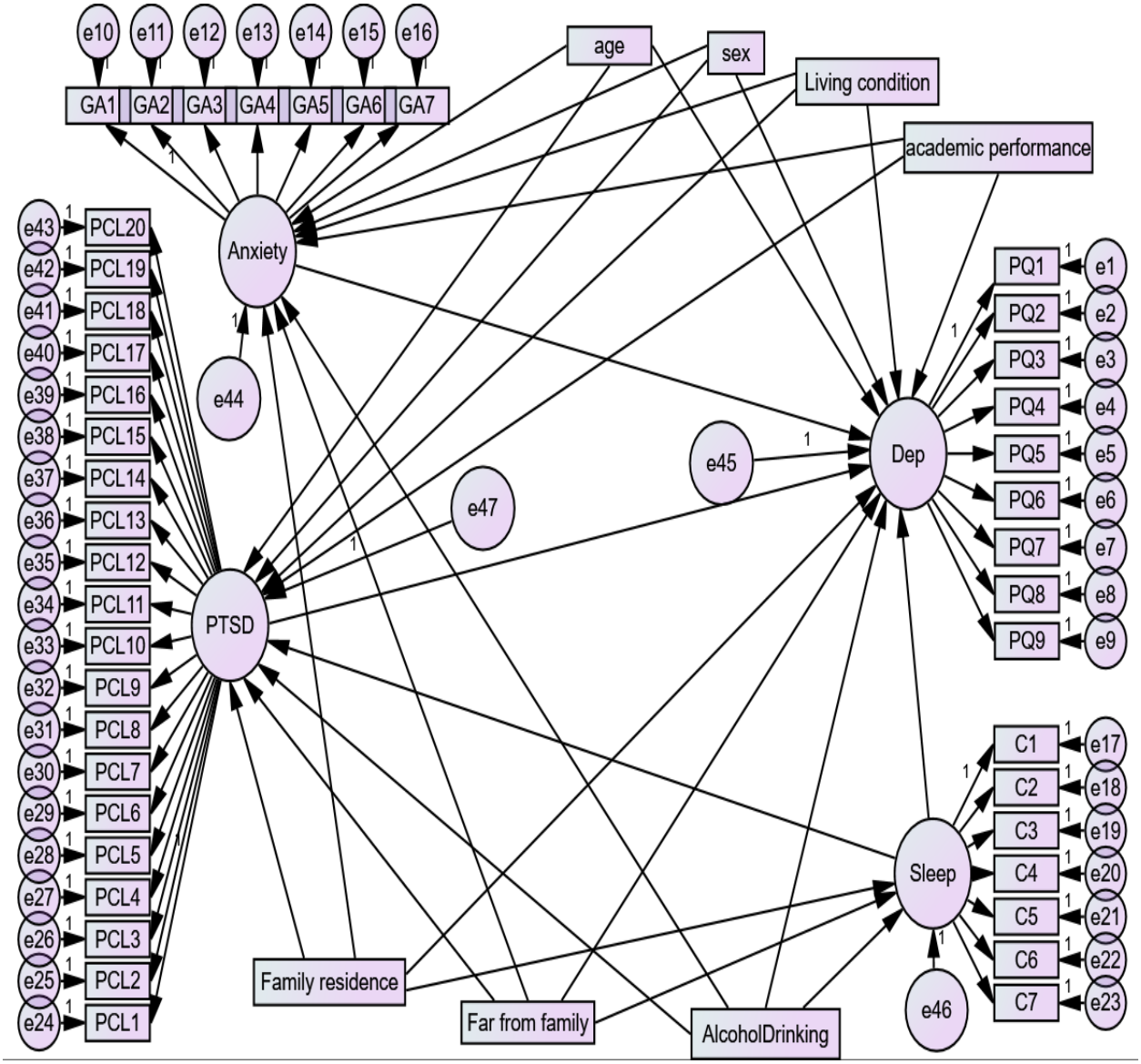

Figure 2. Hypothesized structural model

Circles indicate latent variables or error terms, rectangles indicate observed variables and single arrows indicate factor loadings or regression coefficients. Dep= Depression, PQ1-PQ9 (depression items), GA1-GA7 (generalized anxiety disorder items), PCL1-PCL20 (posttraumatic stress disorder items), C1-C7 (sleep quality items).

Data analysis

The data was exported from Epicollect5 to SPSS version 27 and Amos version 23 for further analysis. For categorical variables, frequency and percentage were presented. The Structural Equation Model (SEM) was used to verify the hypothesized relationship between various

exogenous and endogenous or mediating factors. The effect size was provided using standardized beta coefficients, and statistical significance was defined as a P-value less than 0.05.

Model fitness and model comparison

For each construct in this study, the Kaiser-Meyer-Olkin (KMO) measure was higher than 0.7, and Bartlett's test of sphericity was significant. To assess the reliability of the constructs, Cronbach's Alpha (at least 0.7) and composite reliability (above 0.6) are the recommended minimum required [40]. In the present analysis, Cronbach's Alpha ($\alpha \geq 0.75$) and composite reliability ($CR \geq 0.75$) criteria for all constructs were above the recommended values. Convergent validity of the measurements was assessed using average variance extracted (AVE), and composite reliability (CR) criteria and the values for these were greater than 0.5 for all constructs (Table 1)

Table 1: Loadings, reliability and convergent validity

Items	Standardized factor loadings	Cronbach's Alpha	Composite Reliability (CR)	Average Variance Extracted (AVE)
Depression		0.81	0.84	0.64
Parcel item (DD1)	0.77			
Parcel item (DD2)	0.83			
Parcel item (DD3)	0.80			
Anxiety		0.79	0.81	0.59
Parcel item (Ant1)	0.82			
Parcel item (Ant2)	0.75			
Parcel item (Ant3)	0.73			
PTSD		0.94	0.94	0.80
Parcel item (TT1)	0.91			
Parcel item (TT2)	0.88			
Parcel item (TT3)	0.80			
Parcel item (TT4)	0.91			
Sleep quality		0.75	0.76	0.51
Parcel item (SQ1)	0.72			
Parcel item (SQ2)	0.68			
Parcel item (SQ3)	0.74			

A confirmatory factor analysis (CFA) was performed to assess the models. Model fit measures such as CMIN/DF, CFI, TLI, and RMSEA were used to determine the model's overall goodness of fit. To improve the model fit in the predicted measurement, factorial item parceling was used,

keeping the standard recommendation of three parcels per factor to a minimum [41]. The model fit improved with this modification, resulting CMIN/DF = 1.82, CFI = 0.99, TLI=0.959 and RMSEA = 0.016. Moreover, the standardized factor loadings well improved by greater than 0.7 (Figure 3).

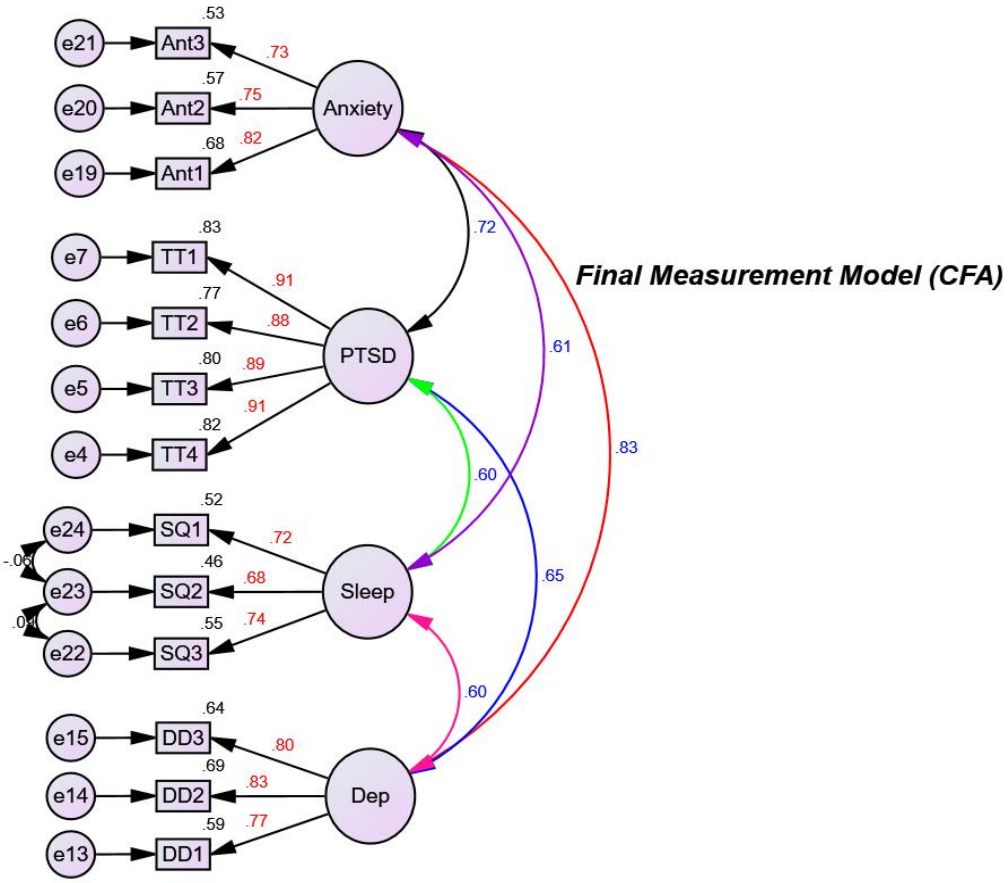

Fig 3. Final measurement model for the constructs of depression, PTSD, generalized anxiety disorder and sleep quality. **Key**: PTSD = posttraumatic stress disorder, Dep = depression, DD1-DD3 =Parcel depression items, Ant1-Ant3 =Parcel generalized anxiety disorder items, TT1-TT4 =Parcel PTSD items, SQ1-SQ3=Parcel sleep quality items, e = error term, and a double arrow indicates covariance.

Assessment of Normality Distribution

To be considered normally distributed, skew values range from -2 to +2, whereas kurtosis ranges from -10 to +10 [42].Therefore, normality distribution were checked using a test of normality in

Amos 23, and the results found that the data were normality distributed since they fall within an acceptable range (0.35 > skew < 1.51 and -0.37 > kurtosis < 1.21).

Assumptions:

Scatter plots, regression line drawings of the independent variables, and correlation coefficients of the independent variables showed almost linear relationship between them. We examined multicollinearity using the variance inflation factor (VIF), tolerance values, and correlation matrix. The findings showed that none of the correlations were higher than 0.85. Every tolerance number was greater than 0.1, and every VIF was lower than 5 (Table 3).

Table 3: Result of multi-collinearity test

Correlations test

			1	2	3	4	5	Collinearity Statistics	
1	Depression	Pearson Correlation	--					Tolerance	VIF
2	GAD	Pearson Correlation	.714**	--				.558	1.791
		Significance level	< 0.001						
3	PTSD	Pearson Correlation	.585**	.642**	--			.539	1.856
		Significance level	< 0.001	< 0.001					
4	Sleep quality	Pearson Correlation	.462**	.469**	.497**	--		.715	1.398
		Significance level	< 0.001	< 0.001	< 0.001				
5	Academic performance	Pearson Correlation	-.059**	-.013	-.025	-.016	--	.999	1.001
		Significance level	.001	.432	.151	.365			

**. Correlation is significant at the 0.01 level (2-tailed).

Ethical Considerations

Ethical clearance was obtained from University of Gondar, College of Medicine and Health Sciences Ethical Review Board (CMHSSH-UOG IRERC/3675/2024). Then, a permission letter was obtained from Amhara Public Health Institute, Zonal and Woreda offices. The parents of students under the age of 18 provided written informed consent. Before starting the data collection, all selected students for the study were provided written informed consent and/or assent describing their participation was voluntary, respecting their needs, the purpose of the study, the responses

were kept confidential, and results used only for research purposes. As soon as a student's data is finished, the epicollect5 alert asks data collectors to link the facility in case the student is suicidal or experiencing severe depression. The study participants were informed that they have the right to refuse and stop participation at any time. No name or other identifying information was included in the questionnaire.

Result

Socio-demographic and psychosocial characteristics

Three thousand four hundred (3400) high school students were involved in the study from Mersa (17.7%), Woldia (37.0%), Kobo (38.6%) and Gashena high school (6.7%) with response rate 97.4%. The mean (standard deviation) age of the respondents was 17.54 (±1.31), ranging from 14 to 28 years. Around fifty-five percent (54.8%) of the respondents were females, and around one from seven respondents were far from their family because of education (Table 4).

Table 4. Distribution of participants by socio-demographic characteristics at high school students in armed conflict affected areas in North Wollo, Ethiopia (n= 3400)

Variable		Number	Percentage (%)
Grade	10	2052	60.4
	11	1348	39.6
Sex	Male	1538	45.2
	Female	1862	54..8
Age	15-19	3168	93.2
	20-25	232	6.8
Far from	Yes	489	14.4
family	No	2811	85.6
Family	Urban	2468	72.6
residence	Rural	932	27.4

Living condition	With parents	2942	86.5
	Sister/bro/relative/alone	458	13.5

Magnitude of depression, anxiety and PTSD among high school students in armed conflict affected areas of North Wollo, Ethiopia

Out of 3400 study participants, 48.1% (95% CI: 46.5%, 49.8%) had depressive symptoms. Based on severity, participants reported mild (23.0%), moderate (15.2%), moderately severe (7.4%), and severe (2.5%) depressive symptoms. Moreover, 51.7% had generalized anxiety disorder, and 59.2% had PTSD. One-fifth of participants reported drinking alcohol within three months before the data collection period, and only 2.0% of the students scored very good and above on their academic performance (Table 5).

Table 5: Distribution of psychological and behavioral factors among high school students in armed conflict affected areas in North Wollo, Ethiopia (n= 3400)

Variable Name		Frequency	Percent
Depression	yes	1635	48.1
	No	1765	51.9
Generalized anxiety	Yes	1757	51.7
	No	1643	48.3
Post traumatic stress disorder	yes	2012	59.2
	No	1388	40.8
Sleep quality	poor	824	24.4
	good	2572	75.6
Drinking alcohol in the past three months	Yes	714	21.0
	No	2686	79.0
Chat chewing in the past three months	Yes	97	2.9
	No	3303	97.1
Semester academic performance	Excellent (90-100%)	32	0.9
	Very Good (85-89%)	39	1.1
	Good (70-84%)	382	11.2
	Above Average (65-69%)	373	11.0

Average (50-64%)	2351	69.1
Satisfactory (40-49%)	223	6.6

Structural Model

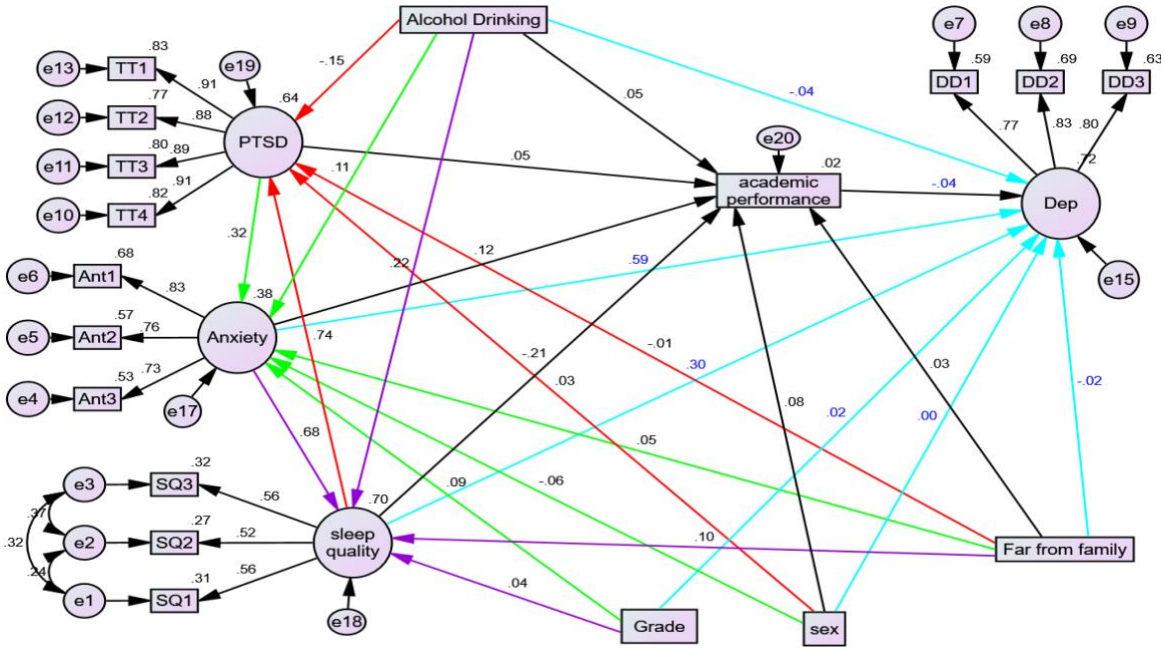

Figure 5: Structural equation modeling for depression, anxiety, PTSD, sleep quality and others factors among high school students in North Wollo Zone, Ethiopia. **Model Fit Statistics**: Comin/Df= 2.69, CFI=0.99, TLI=0.99, RMSEA= 0.022, standardized RMR=0.017

Model selection

Insignificant variables were removed from the model before independent predictors could be correlated. Following that, error terms for indicators in the same construct were introduced. We compared models using fit indices and information criteria (Table 6).

Table 6. Model selection for predictors of depression, anxiety, and posttraumatic stress disorders and sleep quality among high school students in North Wollo, Ethiopia.

Models	AIC	CMIN/DF	CFI	TLI	RMSEA	Remark
A model with all predictors after the parcel	2917	18.98	0.91	0.88	0.07	
A model with significant variables after the parcel	**418**	**2.69**	**0.99**	**0.99**	**0.02**	**selected**

Factors associated with depression

Our SEM revealed that being female (β=0.05, 95% CI: 0.011, 0.087), far from family because of education (β=0.10, 95% CI: 0.060, 0.134), anxiety (β=0.95, 95% CI: 0.893, 1.011), drinking alcohol (β=0.14, 95% CI: 0.108, 0.180) and grade 10th students (β=0.13, 95% CI: 0.091, 0.165) were positively associated with depression. Academic performance (β=-0.04, 95% CI: -0.061, -0.011) was negatively associated with depression (Table 7).

Table 7. Direct, indirect, and total effects of factors on depression among high school students: standardized estimate.

Variables	Direct effect	Indirect effect	Total effect
DV: Depression	Estimate (95%CI)	Estimate (95%CI)	Estimate (95%CI)
Sex	<0.01(-0.025, 0.030)	0.05(0.017, 0.075)*	0.05(0.011, 0.087)*
Far from family	-0.02(-0.048, 0.013)	0.10(0.060, 0.134)*	0.08(0.042, 0.119)*
Anxiety	0.59(0.479, 0.678)*	0.36(0.284, 0.463)*	0.95(0.893, 1.011)*
Sleep quality	0.30(0.195, 0.411)*	0.23(-0.483,0.288)	0.53(-0.139, 0.625)
Alcohol drinking	-0.04(-0.076, -0.002)*	0.18(0.144, 0.222)*	0.14(0.108, 0.180)*
Grade	0.02(-0.007, 0.044)	0.11(0.076, 0.141)*	0.13(0.091, 0.165)*
Academic Performance	-0.04(-0.061, -0.011)*	-------	-0.04(-0.061, -0.011)*
PTSD	--------	0.30 (-0.515, 0.445)	0.30(-0.515, 0.445)

Factors associated with Academic performance

Keeping the effect of other covariates in the SEM model constant, being female (β=-0.08, 95% CI: -0.116, -0.050) and sleep quality (β= -0.18, 95% CI: -0.422, -0.070), were negatively associated on academic performance (Table 8).

Table 8. Direct, indirect, and total effects of factors on academic performance among high school students: standardized estimate.

Variables	Direct effect	Indirect effect	Total effect
Academic Performance	Estimate (95%CI)	Estimate (95%CI)	Estimate (95%CI)
Sex	-0.08(-0.114, -0.047)*	<0.01(-0.012, 0.002)	-0.08(-0.116, -0.050)*
Far from family	0.03(-0.007, 0.068)	-0.02(-0.059, -0.007)*	0.01(-0.022,0.041)

Anxiety	0.11(0.028, 0.348)*	-0.12(-0.391, -0.048)*	-0.01(-0.051, 0.045)
Sleep quality	-0.21(-0.607, -0.064)*	0.03(-0.017, 0.202)	-0.18(-0.422, -0.070)*
Alcohol drinking	0.048(0.000, 0.139)	-0.047(-.0142, -0.015)*	<0.01(-0.034, 0.035)
Grade	--------	-0.01(-0.020, -0.001)	0.01(-0.020, 0.000)
PTSD	0.05(-0.032, 0.202)	<0.01(-0.023, 0.017)	0.05(-0.029, 0.203)

Discussion

We found that 48.1% of high school students had depressive symptoms, 51.7% GAD, and 59.2% PTSD in conflict-affected areas of North Wollo, Ethiopia. Our structural equation modeling showed that being female, far from family because of education, drinking alcohol, anxiety, sleep quality, drinking alcohol, and academic performance were significantly related to direct or indirect effects on depression. Finally, keeping the effects of other covariates in the model constant, being female, far from family because of education, GAD, and drinking alcohol were also found to be significantly related to with total direct effect positively on depression. Academic performance, on the other hand, was found to be highly associated negatively with depression.

In general, the level of depression among high school students in this study was found to be much higher in conflict-affected areas compared to the previous studies conducted in Ethiopia during peacetime, where the prevalence ranged from 19.8% to 34.3% [13-15, 43-45]. Exposure to various adversities and armed conflict increases the likelihood of developing mental illnesses, most commonly depression, PTSD, and anxiety. This was supported by the results of prior studies, including cross-sectional studies among Palestinian secondary school students where the prevalence of depression ranged from 34.1% to 72.1% [8-10]. Adolescents living in war zones, particularly children and girls, are the most vulnerable groups to armed conflict, with a prevalence estimate of anxiety, depression, and PTSD being two to three times greater among those exposed to armed conflict than among those who had not [46].

328 Bing female and living apart from family as a high school student were more likely to have
329 depression (adjusted β =0.08, 95% CI: 0.042, 0.119). There are several plausible reasons that
330 contribute to the vulnerability of girls to depression in conflict affected areas. In the absence of
331 security, women, particularly girls, are subjected to sexual violence, physical abuse, threats, and
332 being held captive by rebel groups or members of their community [47, 48].

333 A gender-based study conducted in seven war-affected zones and one city administration in
334 Ethiopia's Amhara Region found that survivors highlighted stigma, prejudice, suicidal ideation,
335 nightmares, and hopelessness. They left their homes, isolated themselves, remained silent, and
336 dropped out of school in order to cope with the severe stress, which made their depression worse
337 [47]. The American Psychological Association conducted a large-scale study in 2017 from over 90
338 different nations and found that gender disparities begin to emerge at age 12, with girls and women
339 being twice as likely as males to suffer depression [49].

340 Being far apart from family because of education had a direct effect on depression. This could be
341 due to a lack of family support, leading to loneliness and social isolation, increasing the likelihood
342 of developing mental health conditions such as anxiety and depression [50]. Another possible
343 explanation is that they relocate to new areas and are separated from their families. This results in
344 a struggle to adjust to new settings and financial, social, and structural issues when dealing with
345 life changes. Furthermore, while students are alone, they are no longer protected by their families
346 and are vulnerable to bullying and violence. Others may find that being away from family allows
347 them to use drugs and alcohol more freely.

348 After controlling other factors, GAD was linked significantly with a higher level of depression
349 (adjusted β = 0.59, 95% CI: 0.48, 0.68) in this study. This finding is similar to the previous studies
350 in Northwest Ethiopia [51, 52]. Comorbidity involving depression and anxiety is the most common

epidemiological finding among students [53]. The high comorbidity between the two may be due to a substantial overlap in the symptoms and assessment tools used to evaluate these distinct illnesses, shared etiological factors linked to the onset of each condition, and the detrimental effects of anxiety that raise the risk of developing depression [54]. Anxiety and depression overlap certain symptoms, such as mood changes that occur rapidly and unexpectedly [55].

Drinking alcohol was significantly associated with depression in this study, which in turn indirectly linked to low academic performance. This is supported consistently with previous findings [56, 57]. Previous studies in Ethiopia found that students in high school who reported using alcohol had higher odds of experiencing thoughts about suicide, feelings of depression or anxiety, and being hyperactive or inattentive[51, 58]. The Danish National Youth Study a large prospective cohort study (65,233 Adolescents) showed that alcohol was associated with a higher dropout from school and a lower grade point average over the entire span of intake [59]. This might be related to students with depression being more prone to drinking alcohol to relieve themselves from the low mood as self-medication or because drinking alcohol can lead to depression [60]. Both alcohol use disorder and depression are among the most common mental illnesses and frequently co-occur, regardless of which emerged first. Besides, drinking alcohol is linked to a decline in cognitive abilities such as learning, attention, and executive functioning [61].

Lastly, the current study findings indicated that academic performance was negatively related to depression. This result was consistent with other studies in Ethiopia [62, 63], Morocco [64] and China [65]. This could be due to depression manifested as low self-esteem, inferior feelings, lack of motivation for learning, feelings of hopelessness in their future life, and poor relationships with their classmate due to the social withdrawal nature of depressive symptoms.

Implication

The results of our findings indicated that high school students in armed conflict areas are suffering from not only depression but also many other interrelated psychiatric illnesses that have an impact on their future academic performance. This underscores the need to design culturally acceptable, easily accessible, and cost-effective interventions for most adolescents in educational settings. Adolescents may ultimately benefit from the interventions by reversing several negative effects, including poorer academic performance, issues with peer relationships, and increased risky behavior. Education and health policymakers can work together in psychological intervention programs in school settings delivered by teachers in sustainable conditions. It is important to note that the teachers may also be experiencing mental distress.

Strengths and limitations of the study

This is one of the first studies estimating the overall magnitude of depression and examining inter-relationships with GAD, PTSD, and sleep quality among high school students in conflict-affected areas of North Wollo Zone using structural equation modeling. Additional strengths include a large sample of data and the use of tools with demonstrated cross-cultural validity. However, here are a few limitations to this study. First, our study did not include adolescents not at school or those at night school programs. Thus, the results might not be generalized to all youth. Future studies that include other youth are warranted. Second, our use of a self-administered survey that relied on subjective measures of psychiatric outcomes might have led to some degree of misclassification. Lastly, we used a cross-sectional data collection design, which does not allow for the temporal delineation between exposure to conflict and reports of psychopathology and academic performance. A longitudinal study design would better allow the determination of the long-term mental health impacts of conflict.

Conclusion

In conclusion, this study found a higher magnitude of depression among students in conflict-affected areas. Our final SEM demonstrated a different relationship with anxiety, PTSD, sleep quality, and academic performance significantly related to total direct effect positively or negatively on depression. High school students, particularly girls in conflict-affected areas, need social support and special protection. Additional efforts are needed to ensure safety and security in high schools as well as establishing student support systems such as student counselling and guidance services to improve their mental health, better academic performance, and lower the overall prevalence of depression. It is preferable to think that students' cognitions about learning, perception of the world, and their achievement are related to their current mental health.

Abbreviations

AVE= Average Variance Extracted

α =Cronbach Alpha

CMIN/df = chi-square value/ degree of freedom

CFI= Comparative Fit Index

CR= Composite Reliability

GAD-7= Generalized Anxiety Disorder

PCL-5= Posttraumatic Stress Disorder Checklist for DSM-5

PHQ-9= Patient Health Questionnaire-9

PSQI= Pittsburgh Sleep Quality Index

RMSEA =Root Mean Square Error Approximation

SRMR= Standard Root Mean Squared Residual

SEM =Structural Equation Modeling

TLI= Tucker-Lewis Index

Authors' contributions

MT conceived the study, designed, collected, analyzed, interpreted data, and drafted the manuscript for important intellectual content. TB, BAY, AG, BG, and TA critically reviewed the draft manuscript for important intellectual content. All authors contributed to the critical revision of the manuscript for important intellectual content and approved the publication of the final version.

Acknowledgments

We would like to express our gratitude and thanks to Bahir Dar University and University of Gondar Colleges of Medicine and Health Sciences for providing research facilities and funding. We are grateful to all data collectors, supervisors, and study participants for their important contributions to this study.

Competing interests

The authors declare that they have no competing interests

References

1. Frounfelker, R.L., et al., *Living through war: Mental health of children and youth in conflict-affected areas*. International Review of the Red Cross, 2019. **101**(911): p. 481-506.
2. Haddad, N., E. Hanson, and P.N. Koyiet, *The silent pandemic: the impact of the COVID-19 pandemic on the mental health and psychosocial well-being of children in conflict-affected countries*. World Vision and War Child Holland, 2020.
3. Lopez, M.A., *Scars Unseen: The Enduring Effects of War on Children's Mental Health*. Psychiatry Advisor, 2024: p. NA-NA.
4. WHO, *Mental disorders (accessed at https://www.who.int/news-room/fact-sheets/detail/mental-disorders)*. 2022.
5. Weir, K., *APA offers new guidance for treating depression*. Monitor on Psychology, American Psychological Association, 2019.

6. Santomauro, D.F., et al., *Global prevalence and burden of depressive and anxiety disorders in 204 countries and territories in 2020 due to the COVID-19 pandemic*. The Lancet, 2021. **398**(10312): p. 1700-1712.
7. Charlson, F., et al., *New WHO prevalence estimates of mental disorders in conflict settings: a systematic review and meta-analysis*. The Lancet, 2019. **394**(10194): p. 240-248.
8. Radwan, E., et al., *Prevalence of depression, anxiety and stress during the COVID-19 pandemic: a cross-sectional study among Palestinian students (10–18 years)*. BMC psychology, 2021. **9**(1): p. 1-12.
9. Qeshta, H., A. Hawajri, and A. Thabet, *The relationship between war trauma, PTSD, anxiety and depression among adolescents in the Gaza Strip*. Health Science Journal, 2019. **13**(1): p. 621.
10. Kolltveit, S., et al., *Risk factors for PTSD, anxiety, and depression among adolescents in Gaza*. Journal of traumatic stress, 2012. **25**(2): p. 164-170.
11. Osokina, O., et al., *Impact of the Russian invasion on mental health of adolescents in Ukraine*. Journal of the American Academy of Child & Adolescent Psychiatry, 2023. **62**(3): p. 335-343.
12. Bell, V., et al., *Characteristics of the Colombian armed conflict and the mental health of civilians living in active conflict zones*. Conflict and health, 2012. **6**(1): p. 1-8.
13. Tarecha, D., et al., *Depressive Symptoms and Associated Factors Among Youth Attending Public High School in Bahir Dar City, Northwest Ethiopia: A Cross-Sectional Study*. J Dep Anxiety, 2022. **11**: p. 478.
14. Gebreegziabher, Z.A., R. Eristu, and A. Molla, *Depression, Anxiety, Somatic symptom and their determinants among High School and Preparatory School Adolescents in Gondar Town, Northwest Ethiopia, 2022. Non-recursive Structural Equation Modeling*. medRxiv, 2023: p. 2023.01. 27.23285096.
15. Girma, S., et al., *Depression and its determinants among adolescents in Jimma town, Southwest Ethiopia*. Plos one, 2021. **16**(5): p. e0250927.
16. Tirfeneh, E. and M. Srahbzu, *Depression and its association with parental neglect among adolescents at governmental high schools of Aksum town, Tigray, Ethiopia, 2019: a cross sectional study*. Depression research and treatment, 2020. **2020**.
17. Nakie, G., et al., *Prevalence and associated factors of depression, anxiety, and stress among high school students in, Northwest Ethiopia, 2021*. BMC psychiatry, 2022. **22**(1): p. 1-12.
18. Bete, T., et al., *Suicidal ideation, attempt and associated factor among secondary school students in Harari regional state, Eastern Ethiopia. A multi-center cross-sectional study*. Frontiers in psychiatry, 2023. **14**.
19. Kassa, M.A., et al., *Suicidal ideation and attempts among high school students of war-affected area at Woldia town, Northeast, Ethiopia, 2022*. BMC Psychiatry, 2023. **23**(1): p. 1-12.
20. Madoro, D., N. Mengistu, and W. Molla, *Association of Conflict-Affected Environment on Ethiopian Students' Mental Health and Its Correlates During COVID-19 Era*. Neuropsychiatric Disease and Treatment, 2021: p. 3283-3292.

21. Tadese, M., et al., *Perceived stress and its associated factors among people living in post-war Districts of Northern Ethiopia: A cross-sectional study.* Plos one, 2022. **17**(12): p. e0279571.
22. Moukaddam, N., et al., *Depression and its impact on adolescents.* Psychiatric Annals, 2019. **49**(6): p. 256-262.
23. Chang, K. and K.R. Kuhlman, *Adolescent-onset depression is associated with altered social functioning into middle adulthood.* Scientific Reports, 2022. **12**(1): p. 17320.
24. Pascoe, M.C., S.E. Hetrick, and A.G. Parker, *The impact of stress on students in secondary school and higher education.* International Journal of Adolescence and Youth, 2020. **25**(1): p. 104-112.
25. McArdle, J.J., et al., *Longitudinal dynamic analyses of depression and academic achievement in the Hawaiian High Schools Health Survey using contemporary latent variable change models.* Structural equation modeling: a multidisciplinary journal, 2014. **21**(4): p. 608-629.
26. Dar, R.A. and B.A. Lone, *Impact of depression, stress and anxiety on academic achievement of Higher Secondary students*.
27. Population, E.O.o.t. and H.C. Commission, *Summary and statistical report of the 2007 Population and Housing Census: population size by age and sex*. 2008: Federal Democratic Republic of Ethiopia, Population Census Commission.
28. Thakkar, J.J., *Structural equation modelling.* Application for Research and Practice, 2020.
29. Soper, D.S., *A-priori sample size calculator for structural equation models [Software]*. 2020.
30. Kroenke, K., R.L. Spitzer, and J.B. Williams, *The PHQ-9: validity of a brief depression severity measure.* Journal of general internal medicine, 2001. **16**(9): p. 606-613.
31. Hanlon, C., et al., *Validity of brief screening questionnaires to detect depression in primary care in Ethiopia*. Journal of affective disorders, 2015. **186**: p. 32-39.
32. Tsehay, M., M. Necho, and W. Mekonnen, *The Role of Adverse Childhood Experience on Depression Symptom, Prevalence, and Severity among School Going Adolescents*. Depression Research and Treatment, 2020. **2020**: p. 5951792.
33. Doi, S., et al., *Factorial validity and invariance of the 7-item generalized anxiety disorder scale (GAD-7) among populations with and without self-reported psychiatric diagnostic status.* Frontiers in Psychology, 2018. **9**: p. 1741.
34. Manzar, M.D., et al., *Psychometric properties of the Generalized Anxiety Disorder-7 Scale in Ethiopian university students.* Bulletin of the Menninger Clinic, 2021. **85**(4): p. 405-427.
35. Schnurr, P.P., *The ptsd checklist for dsm-5 (pcl-5).* Consulté sur, 2013.
36. Blevins, C.A., et al., *The posttraumatic stress disorder checklist for DSM-5 (PCL-5): Development and initial psychometric evaluation.* Journal of traumatic stress, 2015. **28**(6): p. 489-498.
37. Verhey, R., et al., *Validation of the posttraumatic stress disorder checklist–5 (PCL-5) in a primary care population with high HIV prevalence in Zimbabwe.* BMC psychiatry, 2018. **18**: p. 1-8.

38. Gelaye, B., et al., *Construct validity and factor structure of the pittsburgh sleep quality index and epworth sleepiness scale in a multi-national study of African, South East Asian and South American college students.* PloS one, 2014. **9**(12): p. e116383.
39. *Ethiopia Grading System: High School Grade (accessed at: https://gradecalculator.io/ethiopia/)*.
40. Muhamad Safiih, L. and N. Azreen, *Confirmatory Factor Analysis Approach: A Case Study of Mathematics Students' Achievement in TIMSS.* Malaysian journal of mathematical sciences, 2016. **10**.
41. Matsunaga, M., *Item parceling in structural equation modeling: A primer.* Communication methods and measures, 2008. **2**(4): p. 260-293.
42. Collier, J., *Applied structural equation modeling using AMOS: Basic to advanced techniques*. 2020: Routledge.
43. Tirfeneh, E. and M. Srahbzu, *Depression and its association with parental neglect among adolescents at governmental high schools of Aksum town, Tigray, Ethiopia, 2019: a cross sectional study.* Depression research and treatment, 2020. **2020**(1): p. 6841390.
44. Melkam, M., G. Nenko, and D. Demilew, *Common mental disorders and associated factors among high school students in Debre Markos Town, Northwest Ethiopia: an institutional-based cross-sectional study.* BMJ open, 2022. **12**(11): p. e059894.
45. Amare, F., et al., *Depression and associated factors in adolescent high school pupils in Hossana, central Ethiopia*. 2024.
46. Carpiniello, B., *The Mental Health Costs of Armed Conflicts—A Review of Systematic Reviews Conducted on Refugees, Asylum-Seekers and People Living in War Zones*. International journal of environmental research and public health, 2023. **20**(4): p. 2840.
47. Tewabe, D.S., et al., *Gender-based violence in the context of armed conflict in Northern Ethiopia.* Conflict and health, 2024. **18**(1): p. 1.
48. Workie, K., et al., *Gender-based violence and its associated factors among internally displaced women in Northwest Ethiopia: a cross-sectional study.* BMC women's health, 2023. **23**(1): p. 166.
49. Salk, R.H., J.S. Hyde, and L.Y. Abramson, *Gender differences in depression in representative national samples: Meta-analyses of diagnoses and symptoms*. Psychological bulletin, 2017. **143**(8): p. 783.
50. Xiang, M., S. Yamamoto, and T. Mizoue, *Depressive symptoms in students during school closure due to COVID-19 in Shanghai.* Psychiatry and Clinical Neurosciences, 2020. **74**(12): p. 664.
51. Gebreegziabher, Z.A., R. Eristu, and A. Molla, *Determinants of adolescents' depression, anxiety, and somatic symptoms in Northwest Ethiopia: A non-recursive structural equation modeling.* PLoS one, 2024. **19**(4): p. e0281571.
52. Kassa, M.A., et al., *Investigating war trauma, its effects, and associated risk factors on anxiety among high school students in Woldia town, northeast Ethiopia, 2022*. Frontiers in psychiatry, 2024. **15**: p. 1368285.

53. Zhiguo, W. and F. Yiru, *Comorbidity of depressive and anxiety disorders: challenges in diagnosis and assessment*. Shanghai archives of psychiatry, 2014. **26**(4): p. 227.
54. Garber, J. and V.R. Weersing, *Comorbidity of anxiety and depression in youth: implications for treatment and prevention.* Clinical Psychology: Science and Practice, 2010. **17**(4): p. 293.
55. Organization, W.H., *Guidelines on mental health promotive and preventive interventions for adolescents: helping adolescents thrive*. 2020: World Health Organization.
56. Chow, M.S., et al., *Alcohol consumption and depression among university students and their perception of alcohol use.* East Asian archives of psychiatry, 2021. **31**(4): p. 87-96.
57. Fentahun, S., et al., *Prevalence of depression and its associated factors among Ethiopian students: a systematic review and meta-analysis*. BMJ open, 2024. **14**(6): p. e076580.
58. Tilahun, W.M., et al., *Magnitude, relationship and determinants of attention deficit hyperactivity disorder and depression among University of Gondar undergraduate students, Northwest Ethiopia, 2022: Non-recursive structural equation modeling*. Plos one, 2023. **18**(10): p. e0291137.
59. Hjarnaa, L., et al., *Alcohol intake and academic performance and dropout in high school: a prospective cohort study in 65,233 adolescents.* Journal of Adolescent Health, 2023. **73**(6): p. 1083-1092.
60. Fergusson, D.M., J.M. Boden, and L.J. Horwood, *Tests of causal links between alcohol abuse or dependence and major depression.* Archives of general psychiatry, 2009. **66**(3): p. 260-266.
61. Sullivan, E.V., et al., *Cognitive, emotion control, and motor performance of adolescents in the NCANDA study: Contributions from alcohol consumption, age, sex, ethnicity, and family history of addiction.* Neuropsychology, 2016. **30**(4): p. 449.
62. Bitew, T. and W. Birhan, *The potential effect of depression on academic outcomes of students in higher educational institutions of northwest Ethiopia: A cross-sectional study.* Educational research and reviews, 2021. **16**(1): p. 9-15.
63. Abera, A., et al., *Psychological problems and associated factors among high school students during COVID-19 pandemic in Sawla town, Gofa zone, southern Ethiopia*. Heliyon, 2023. **9**(6).
64. Meskini, N., et al., *Relationship Between Academic Achievement And Depressive Syndrome Among Middle School Students In Kenitra*. Community Practitioner, 2024. **21**: p. 308-318.
65. Peng, X., et al., *Prevalence and associated factors of depression, anxiety and suicidality among Chinese high school E-learning students during the COVID-19 lockdown*. Current Psychology, 2023. **42**(34): p. 30653-30664.