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Generalized and COVID-19 related anxiety among Tanzanian adolescents with HIV and association with HIV outcomes during the COVID-19 pandemic

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Abstract The COVID-19 pandemic resulted in significant disruptions to HIV services globally. The impact of COVID-19 on mental wellbeing and HIV outcomes among adolescents with HIV (AWH) in Tanzania is unknown. We assessed the burden of generalized and COVID-19 related anxiety and associations with adherence to HIV care and treatment and viral load suppression (VLS) among AWH during the peak of the COVID-19 pandemic in Tanzania.

Methods This cross-sectional study was conducted among AWH aged 15–19 years attending 10 clinics in Dar es Salaam from April-December 2022. Trained RAs administered a questionnaire to study participants which included questions on Generalized Anxiety Disorder (GAD), COVID-19 related anxiety, and other psychosocial and physical health and support measures such as self-management and quality of physical health. HIV clinic visit adherence, viral load and sociodemographic data were abstracted from patient health records. Multivariable quasibinomial and logistic regression models examined associations of Generalized and COVID-19 related anxiety with visit adherence (attending all scheduled visits (+/- 3 days) for 12 months prior to September 2019) and HIV virologic suppression (HIV VL < 50 copies/mL), respectively. Data were analyzed using R software.

Results Five hundred sixty seven AWH (48% male, median time on ART 125 (interquartile range (IQR) 79 months)) were included in this analysis. Over half (53%) attended at least 75% of their scheduled clinic visits, and 78% were HIV virologically suppressed (< 50 copies/mL). The median GAD and COVID-19-related anxiety scores were 1 [IQR: 4], and 25 [IQR: 31], respectively. Only 2% scored moderate-severe generalized anxiety (score 10–21). We found no significant associations between COVID-19 related anxiety [adjusted odds ratio (AOR) = 1.00 (95% CI 0.90, 1.00)] or GAD [AOR = 1.03 (0.99, 1.07)] and visit adherence. Higher GAD was inversely associated with VLS [AOR: 0.90 (95% CI 0.81, 0.99]. Female gender [AOR = 1.67 (95% CI 1.05, 2.66)], higher quality of physical life [AOR 1.17 (95% CI 1.04, 1.32)] and living with parents [AOR = 1.61 (1.00, 2.57)] were significantly associated with VLS.

Conclusions Low levels of generalized and COVID-19 related anxiety were reported among Tanzanian AWH. Scaling up integrated screening and management of GAD into HIV care for AWH could improve VLS among this population.

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Keywords Anxiety, Adolescents, COVID-19, HIV, Tanzania

Background

In SSA, approximately six out of seven new HIV infections occur among adolescents aged 10–19. About 100,000 adolescents with HIV (AWH) are currently living with HIV in Tanzania [1, 2]. Between 10 and 27% of AWH in Tanzania have symptoms of depression and anxiety, rates that are significantly higher than in adolescents without HIV [3, 4]. AWH face a wide range of challenges that contribute to these conditions including high levels of stigma, discrimination and lack of social support, in addition to the challenges of normal adolescent development [5, 6]. In Tanzania, as in other neighboring East African countries, depression among AWH has been shown to have significant adverse effects on physical and psychosocial health and adherence to antiretroviral therapy (ART) which in turn is associated with significant morbidity, mortality, lower quality of life and short life expectancy [7–11].

Globally, the COVID-19 pandemic and responses to curb the spread of SARS-CoV-2 led to widespread interruptions to care and treatment for people with HIV (PWH) [12, 13]. These disruptions had significant negative impacts on the wellbeing of adolescents living with HIV. COVID-19 presented a number of additional environmental and social stressors such as isolation, abuse, worsening poverty and food insecurity, further exacerbating the risk of depression and anxiety and lowering physical well-being [14]. Disruptions to ART and provider visits due to clinic shutdowns and staff shortages also exacerbated the risk of non-adherence to care and treatment among AWH during this time [15].

In Tanzania, the government announced the first case of COVID-19 on March 16, 2020. Between March 2020 and April 29th, 2022, over 33,904 people were confirmed with COVID-19 infection, and 803 deaths occurred from COVID-19-related complications [16]. After the first COVID-19 case was reported in 2020, there were several waves of infection. Global and country-level data reported 900 cases by end of April 2020 [17]. The number of cases increased to 9000 by August 2020 and remained constant until June 2021 following the introduction of mitigation measures, but then cases increased to 11,439 by the end of July 2021. Between July 2021 and January 2022 there was a sharp increase of COVID-19 cases from 11,439 to 31,392; thereafter, official reporting of COVID-19 cases ceased. Initial mitigation strategies introduced during COVID-19 included rapid implementation of non-biomedical prevention interventions such as the use of personal protection equipment (PPE), social distancing and a partial lockdown occurring from March to May 2020 [18]. Measures taken by the Tanzanian Government to prevent interruption to care among PWH included prescribing longer courses of ART to reduce clinic visits and overcrowding and psychological support for adolescents coping with COVID-19 and related fears. In July 2021, COVID-19 vaccines were introduced and by April 29th 2022, 3,915,900 of a population of 59 million were fully vaccinated [18]. Despite these interventions, it was widely reported that PWH in Tanzania had significant concerns and fear about their safety given their immunocompromised status, lack of clear information and feelings of being abandoned during the COVID-19 pandemic [19].

To date, the impact of the COVID-19 pandemic on AWH in Tanzania on generalized and COVID-19 related anxiety has not been assessed. It is also unknown whether these mental health conditions further affected the ability of AWH to adhere to ART and routine care, independent of the pandemic itself. In this study, we assessed the burden of generalized and COVID-19–related anxiety among AWH during the COVID-19 pandemic in Tanzania and examined the association between these two anxiety measures and adherence to HIV clinic visits and HIV viral load suppression (VLS). Exploring the potential impact of the COVID-19 pandemic on AWH mental health and ability to remain in care is important to inform appropriate interventions at the individual and facility level that further support the care of AWH during future pandemics and other health system shocks.

Methods

Design

This cross-sectional study was conducted between April-December 2022.

Study setting

The study was conducted in 10 HIV Care and Treatment Centers (CTCs) in Dar es Salaam region which is in the east coast of Tanzania. Dar es Salaam is the largest city in Tanzania and is considered the country's richest city and an important economic center of Tanzania. It has a population of 4.4 million people, of which 896,378 (21%) are adolescents. The prevalence of HIV in Dar es Salaam is 4.2%. The CTCs are departments that provide HIV prevention, care and treatment services within health facilities. Our study was conducted at CTCs within the Mwanayamala, Temeke, Amana regional referral hospitals, Sinza, Mbagala rangi tatu, Magomeni, Mnazi Mmoja hospitals, Kigamboni district hospital, and Buguruni and Tandale dispensaries, in Dar es Salaam, Tanzania. The CTCs are high volume with at least 5,000 PWH ever enrolled in HIV care at each clinic.

Study population

Participants were included in this study if they were AWH aged 15–19 years and active in care. Active in care was defined as having attended all scheduled visits (+/- three days) for 12 months prior to September 2019. Participants were excluded if they missed at least one clinic visit in the 12 months prior to September 2019 or were unable to provide consent, assent or parental permission prior to enrollment.

Selection of study participants

Multistage random sampling was used to select the participating sites and participants. Using a random number generator, we randomly selected 10 health facilities that had ever enrolled at least 5000 PWH in CTC for care from each of the 5 districts of Dar es Salaam because these larger sites were more likely to have more numbers of our targeted study population. From each of the selected CTCs we used a random number generator to select AWH eligible for our study from an electronic CTC clinical database available at each of the participating sites. This was determined by the number of eligible adolescents 15–19 years available which ranged from 78 to 204 across the selected sites. 50% of participants were selected from larger sites with a > 150 eligible adolescent pool, 30% from medium size sites with an eligible pool of 100–150 and 20% from smaller sites with a pool of 70 to 100 eligible AWH. We sampled 676 AWH and surveyed 658 who were able to be reached by phone and provide consent.

Standards of care for AWH

AWH attend CTCs every one, three, or six months depending on how clinically stable they are per the 2018 Tanzanian HIV care and treatment national guidelines [20]. Visits are scheduled on Saturdays to allow AWH at school or work to attend on non-weekdays. During CTC visits, AWH receive comprehensive HIV services including health education on HIV prevention, sexual and reproductive health services, ART initiation and counseling, peer-to-peer adherence support, and linkages to other health services when necessary. To support wellness and adherence, AWH can attend 'camps' quarterly which include 3–5 days of sports, testimonies and discussions of some of the challenges that AWH face adhering to ART and coping with school, society, puberty, stigma, and HIV status disclosure issues. AWH with high HIV viral loads (VL > 1000 copies/ml) receive additional interventions including Enhanced Adherence Counseling sessions.

Sample size calculation

Since we selected our participants randomly, we used a probability sample size calculation approach called Cochran's Formula [21] of sample size calculation to obtain the minimum sample required for this study. Assumption: The prevalence of HIV VLS among AWH is 50%. This value was selected based on current HIV VLS rates in Tanzania among AWH which range from 40 to 79% [22]. Using Cochran's Formula: n = [z2p (1-p)]/ ε2, where; n = sample size, z = Standard deviation at 95% confidence level (1.96), $p = 50\%$, ε = margin of error (4%), we calculated that we needed a minimum sample size of 656–676 AWH to detect a statistically significant effect between VLS and GAD score after accounting for 9-12% missing data and/or non-completion of surveys. The CTCs were the clusters in this study which were selected randomly. We did not account for cluster design in the sample.

Study variables and measurements

Primary outcome definitions

We calculated HIV VLS as having a viral load of less than 50 copies per ml at the last visit before the study visit. While we report virologic suppression at both VL < 50 copies/mL and VL < 1000 copies/mL thresholds, the former was utilized for statistical analysis to maximize power. Visit adherence was defined as the proportion of scheduled clinic visits attended in the past 24 months prior to 30th December 2021. Visit adherence was treated as both a binomial variable and as proportions categorized as ≦25%, > 25-≤50%, > 50-≤75% and > 75%.

Other study variables

GAD symptoms were assessed using the GAD-7 item self-report screening scale [23] which has been validated previously in South Africa and Kenya [24, 25]. COVID-19 related anxiety was assessed using a structured questionnaire used in Turkey [26]. Self-management (SM) was assessed using the Adolescents HIV Self-Management (AdHIVSM) tool, developed in South Africa [27]. Perceived social support was measured using the Multidimensional Scale of Perceived Social Support (MSPSS) [28], a 12-item scale developed for use in older adolescents and emerging adults that has previously been validated for use in the East and Southern African context [29, 30]. HIV Stigma was assessed using the 12-item version of the Berger HIV-related stigma scale which has been validated in Swahili in Tanzania [31]. Depression was measured using the Patient Health Questionnaire version 9 (PHQ-9), which has been validated in Tanzania [32, 33]. Quality of physical health was measured by the World Health Organization's quality of life measure for HIV (WHOQoL-BREF-HIV) [34], Details of each study measure and scoring are in Table 1.

Table 1 Baseline characteristics of study participants

Characteristic	*n* (%) or Median (IQR)* *N* = 567
Gender	
Male	272 (48)
Female	295 (52)
Age	
> 15-≤18	362 (64)
> 18-≤19	205 (36)
Persons in Household	
Parents	370 (65)
Other Relatives	45 (7.9)
Grandparents	142 (25)
Live Alone	3 (0.5)
Orphanage Centre	7 (1.2)
Education	
Ordinary or advanced secondary school	445 (78)
No school or primary school only	122 (22)
Occupation	
Student	374 (66)
Self-employed/Employed	156 (28)
Unemployed	37 (6.5)
Attendance In:	
Multidisciplinary (MDT) Professional Clinic	33 (5.8)
Youth peer pairing	517 (91)
Saturday Youth Clinic	12 (2.1)
Youth Camp	5 (0.9)
District	
Ilala MC	183 (32)
Kigamboni MC	25 (4.4)
Kinondoni MC	144 (25)
Temeke MC	157 (28)
Ubungo MC	58 (10.2)
Scheduled Visits	11 (8)*
Attended Visits	8 (7)*
Visit Adherence (%)	78 (28)*
Visit Adherence	
< 25%	18 (3.2)
> 25-≤50%	66 (12)
> 50-≤75%	180 (32)
> 75%	303 (53)
Time on Art (Months)	125 (79)
VL Suppression (copies/ml) 50	
>=50	105 (22)
< 50	364 (78)
Unknown	98
VL Suppression (copies/ml) 1000	
>=1000	61 (13)
< 1000	408 (87)
Unknown	98

IQR Interquartile range, *ART* Antiretroviral therapy, *VL* HIV viral load

*Median, IQR

Data collection and management

After providing consent, trained RAs administered the study questionnaires in a face-to-face interview to eligible participants in Swahili which captured Generalized and COVID-19-related anxiety, depression, social support, stigma, self-management, and quality of life (physical health) (Additional Files 1 and 2). All survey measures were translated and culturally adapted using an established process to ensure clarity of the questions among Tanzanian AWH [32]. Two native speakers of Tanzanian Kiswahili who were conversant with the project independently translated the questions from English to Kiswahili (Kiswahili versions 1). An independent team of two native speakers of Tanzanian Kiswahili, not conversant with the study performed a back translation of the two Kiswahili versions to English. This was followed by a review by a panel of experts including a Kiswahili linguist, four translators, a social worker, and the study team, of all the discrepancies between items in the original English and the two English back-translations from Kiswahili. This step was to ensure items and their related concepts have Kiswahili conceptual equivalence. This review exercise resulted in a Kiswahili Version 2 of the measures of interest.

A panel of 12 adolescents was interviewed using the questions in the Kiswahili version 2 tools (6 Males and 6 Females of age range 15–19) and cognitive interviews were conducted immediately after the survey to explore the AWH thinking process when responding to each item. Each item was read aloud to participants, and probes explored how participants had arrived at this response asking them to try to recall what they had been thinking prior to responding, how relevant the item was to their reality and lives, and how they think other people aged 15–19 years living with HIV would have understood the item. To capture the perspectives of adolescents verbatim, cognitive interviews were audio-recorded and transcribed. Feedback from the cognitive interviews was used to finalize a Kiswahili version 3 which was piloted in 10 AWH at five CTCs which were not included in the study. Survey completion took about 60–90 min and was supervised by study research assistants (RAs) who also administered the tools for illiterate AWH. The study RAs were trained on the tool by the research team for 3 days before the study began.

Additional data were collected in the survey on sociodemographic characteristics (age, sex, marital status, education level, residential district, occupation, employment or school status). HIV data were abstracted from participant records by a study team member and included date of HIV diagnosis, duration on ART, most recent HIV VL and visit dates. Study data were collected and managed using Research Electronic Data Capture (REDCap) at Muhimbili University of Health and Allied

Sciences. Data cleaning was performed in REDCap (Version 11.1.5) weekly by the data team. This included checking for incomplete or inaccurate data which was fed back to the study RAs for correction. After completion of data collection, the data were exported into an Excel database for cleaning then imported into R software for analysis.

Statistical analyses

Descriptive statistics (counts and proportions for categorical or median and interquartile range (IQR) for continuous data) were calculated for all demographic, clinical and outcome variables. A 95% Wald confidence interval was calculated for the proportion of participants with mild to severe GAD. A multivariable quasibinomial regression model was generated for visit adherence, while a multivariable logistic regression model was used for VLS. Clinically relevant variables, including demographics (sex, age, education, and residing with parents), time on ART, and psychological outcomes (perceived support, stigma, self-management, depression, COVID-related anxiety, generalized anxiety, and quality of physical life) were included as covariates in both models. The number of covariates was limited so that there would be at least 10 events per variable [35]. A quasibinomial model for adherence was determined necessary to account for overdispersion, which was confirmed by the dispersion parameter in the final model. All patients were assigned equal weight in the adherence model, regardless of their number of scheduled visits. Patients who reported being on ART for less than one year were excluded from the logistic regression model for virologic suppression. Linearity between continuous covariates and the logits of the outcomes was assessed graphically. Multicollinearity was assessed with generalized variance inflation factors (GVIFs), with any $(GVIF^{1/(2\cdot DF)})^2$ >3 raising consideration for removal. Observations were excluded from each respective model if data were missing for any of the included covariates or outcomes. Of the 658 participants, 619 (94%) were included in the multivariable quasibinomial regression model for visit adherence, with 39 removed due to missing values. A total of 515 (78%) participants were included in the multivariable logistic regression model for virologic suppression, with 140 removed due to missing values for viral load. The stigma variable violated the assumption of linearity with log odds for both models and was removed. All other continuous covariates satisfied the assumption of linearity with log odds and no substantial multicollinearity was found in either model. Data analysis was performed in R 4.2.3 [36].

Results

Baseline characteristics of study population

There were 567 AWH (48% male) included in this analysis. 85% were from larger health centers in Ilala (32%) Temeke (28%), and Kinondoni (25%), and 78% had attained an ordinary level or advanced secondary school education (Table 2). 91% participated in a youth peer pairing intervention routinely delivered in HIV CTCs to help adolescents living with HIV stay on their medication and in care. Just over half (53%) attended at least 75% of their scheduled clinic visits with a median [IQR] adherence of 78% (27%), and 78% were HIV virologically suppressed (HIV VL < 50 copies/mL).

Participants scored a median GAD score of 1 [IQR: 4]. The score distribution had one peak at the minimum possible scores (Fig. 1A) with 81% of participants scoring between 0 and 4. 18% scored between 5 and 9 (mild anxiety), while 2% reported moderate-to-severe generalized anxiety (10–21) (Table 1). The median COVID-19-related anxiety score was 25 [IQR: 31], with scores following a bimodal distribution with peaks at the minimum and maximum possible scores (Fig. 1B). The highest scoring COVID-19-related anxiety subdomain, with a median score 5 [IQR: 8], was 'The *likelihood of a country running short of ARVs due to disruption of production*' (Table 3). Participants reported a median PHQ-9 score of 2 [IQR: 5] with 25% of scores reflecting mild and 6% reflecting moderate-severe symptoms of depression. The median score for perceived social support was 68 [IQR: 16]; and the highest median subscale score was 26 [IQR: 4] for family support. The median stigma score was 26 [IQR: 9], and the highest median subscale score was for disclosure concerns with a median score of 9 [IQR: 2]. The median scores for self-management and quality of life were 86 [IQR: 18] and 15 [IQR: 3], respectively (Table 3).

Factors associated with visit adherence and HIV VLS

Visit adherence

In the bivariate analysis, only depression [OR = 0.97 (95% Confidence Interval (CI) 0.95, 1.00), $p = 0.036$] and quality of physical health [OR = 1.05 (1.00, 1.09), $p = 0.028$] were significantly associated with adherence to visits. After adjusting for sociodemographic, clinical, and HIV treatment-related factors, there was no association between COVID-19-related anxiety [adjusted odds ratio (AOR) = 1.00 (95% CI 0.99, 1.00); $p = 0.574$] or GAD [AOR = 1.03 (0.99, 1.07); $p = 0.109$] and visit adherence. Participants with higher vs. lower depression scores were less likely to adhere to visits [AOR = 0.97 (0.94, 1.00), $p = 0.049$]. Females were more likely to adhere to visits than males [AOR = 1.16 (0.97, 1.39); $p = 0.113$], though this result was not statistically significant. No other factors showed any significant association with visit adherence (Table 4).

Table 2 Study measures

Construct	Measure		Scoring
Generalized anxiety disorder (GAD)	GAD-7	7 item self-report screening scale [27] which has been validated previously in South Africa and Kenya [26, 28]. GAD-7 assesses past two-week symptoms of Generalized Anxiety Disorder based on the Diagnostic and Statistical Manual version 4.	4-point Likert scale with a summed scores range of 0–21. Summed scores were categorized as minimal symptoms (0–4), mild symptoms (5–9), moderate symptoms (10–14) and severe symptoms (15–21).
COVID-19 related anxiety	Questionnaire developed and deployed in Turkey	Questions included COVID-19 knowledge, precautions, and potential changes of behavior that could negatively impact ART adherence during the COVID-19 pandemic.	Likert scale ranging from 1 to 10 for each question. Total possible scores range from 6–60.
Self-management (SM)	Adolescents HIV Self-Management (AdHIVSM) Tool	35-item measure of 5 components of AdHIVSM including believing and knowing, goals and facilitation, participation, HIV biomedical management, and coping and self-regulation.	4-point Likert scale ranging from strongly agree to strongly disagree. Total scores range from 21–105.
Perceived social support	Multidimensional Scale of Perceived Social Support (MSPSS)	12-item scale developed for use in older adolescents and emerging adults, with three dimensions: Significant Other, Family, Friends, each comprising 4-item subscales of the instrument.	Response options range from 1–7 (from very strongly disagree to very strongly agree) with a summed possible score range of 32–84.
HIV Stigma	Berger HIV-Related Stigma Scale	12-item scale measuring 4 subscales: personalized stigma, disclosure concerns, negative self-image, and concerns with public attitudes	4-point Likert scale with a summed possible score range of 12–48
Depression	Patient Health Questionnaire version 9 (PHQ-9)	9-item scale measuring the frequency of major depressive symptoms experienced	Likert-type scale ranging from 0 'not at all' to 3 'nearly every day.' Total possible score range of 0 to 27.
Quality of Physical Health.	World Health Organization Quality of Life Measure for HIV (WHOQoL-BREF-HIV)	Utilized the Physical Functioning domain, which measures mobility, impairment of daily activities, energy, pain, and sleep.	Likert-type scale ranging from 1 (not at all) to 5 (an extreme amount), summed scores range from 4–25.

HIV VLS

In bivariate analyses only GAD [OR = 0.91 (0.84, 0.98), $p = 0.014$], depression [OR = 0.94 (0.88, 1.00), $p = 0.042$] and quality of physical health [OR = 1.17 (1.06, 1.29), $p = 0.003$] were significantly associated with HIV VLS. In adjusted models, higher GAD was associated with lower odds of VLS [AOR = 0.90 (0.81, 0.99); $p = 0.030$]; however, no associations were observed between COVID-19-related anxiety [AOR = 1.01 (1.00, 1.03); $p = 0.152$] and VLS. Higher quality of physical health [AOR = 1.17 (1.04, 1.32); $p = 0.008$] and female sex [AOR = 1.67 (1.05, 2.66); $p = 0.031$] were associated with higher odds of VLS. An association was also found between VLS and living with one's parents [AOR = 1.61 (1.00, 2.57); $p = 0.048$]. There were no significant associations between VLS and perceived support, self-management, or any other covariate (Table 5).

Discussion

In this Tanzanian study exploring COVID-related and GAD and its association with HIV outcomes among AWH in care, we observed overall low proportions of moderate-severe generalized and COVID-19 related anxiety. Importantly, there was no association between COVID-19 related anxiety and either visit adherence or VLS. However, higher GAD was associated with lower odds of VLS, after adjusting for multiple factors. Maintaining VLS is critical to reducing transmission and HIV-related morbidity and mortality in this vulnerable population.

The low rates of both COVID-19 related and GAD among AWH during COVID-19 in this study were surprising given the multiple challenges and widespread disruptions caused by the pandemic in Tanzania [37]. Several countries in SSA as well as globally have reported adverse effects of the COVID-19 pandemic on health care services, the environment and social support networks in adolescents with and without HIV [38, 39]. In a study conducted by the Adolescent HIV Prevention and Treatment Implementation Science Alliance (AHISA) in 2021, teams from multiple countries in SSA reported interruptions to prevention programs, diagnostic testing, and access to ART during COVID-19. Individual-level impacts included feelings of social isolation, loneliness, loss to follow-up, food insecurity, poverty, and increases in adolescent pregnancies and sexually transmitted infections [10]. Many studies have also reported an increased risk of anxiety, depression, feeling lonely, and a reduction in the quality of life among AWH during the COVID-19 lockdown because of these stressors [40–42].

There are several possible explanations of the lower rates of COVID-19 related anxiety in our study including low perceived risk of COVID-19, high levels of social support and short periods of lockdown in Tanzania which could have prevented isolation and anxiety as a result. It is notable that the highest COVID-19 anxiety score in our study was in the individual domain

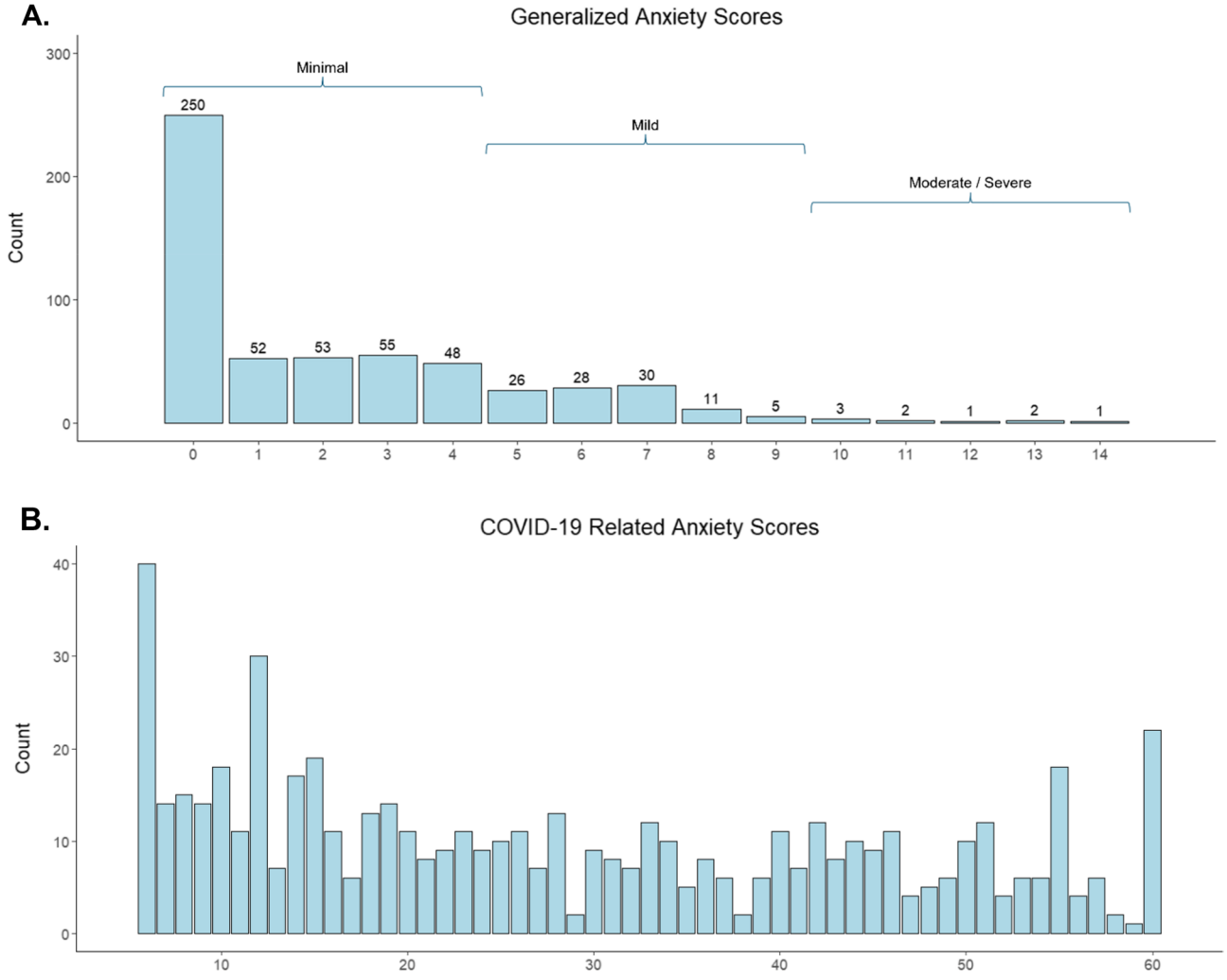

Fig. 1 Distribution of Generalized Anxiety (**A**) and COVID-19 Related Anxiety (**B**) Scores Among Participants. **A**. Distribution of summed scores from GAD-7 instrument, with summed score values on the horizontal axis and frequencies on the vertical axis. Summed scores were calculated as the sum of 7 Likert scale items scored from 0–3, resulting in a summed score range of 0–21. Clinical categorizations of anxiety levels based on scores are also indicated. *N* = 567 **B**. Distribution of summed scores from COVID-19 related anxiety questionnaire, with summed score values on the horizontal axis and frequencies on the vertical axis. Summed scores were calculated as the sum of 10 Likert scale items scored from 1–10, resulting in a summed score range of 6–60. *N* = 567

'The likelihood of a country running short of ARVs due to disruption of production' suggesting adolescents are more concerned about care interruptions than the risk of COVID-19 to themselves. In contrast, the ratings for self-perceived risk from COVID-19 infection were low. This concern has been reflected in other studies from Tanzania and other settings and is being explored in ongoing qualitative work by our team. In a survey of knowledge and risk perception conducted among Tanzanians > 18 during the COVID-19 pandemic, the proportion of persons who perceived themselves as low risk for COVID-19 was significantly higher than those who perceived themselves as high risk. Also, 4 in every 10 AWH believed the hot climate prevented COVID-19 spread [43]. In a study in Lebanon during COVID-19, among the 18% of adolescents who were found to have severe social anxiety, no correlation was found between having anxiety and acknowledging or fearing COVID-19 morbidity [44].

The high rates of perceived social support, parental support and other socio-environmental factors reported among study participants, all of which are strongly associated with positive mental health in AWH, could have also contributed to low rates of both COVID-19 related anxiety and GAD [45, 46]. In a recent systematic review of mental health conditions among AWH by Too et al., higher social support, family cohesion and positive parenting were all associated with lower rates of anxiety and depression [45]. This high level of social support could have also contributed to the low rates of depression

Table 3 Psychosocial outcomes study participants

Outcome (score range)	*n* (%) or Median (IQR)* *N* = 567
Generalized anxiety	
Total score (0–21)	1 (4)*
Minimal (0–4)	458 (80.8)
Mild (5–9)	100 (17.6)
Moderate/Severe (10–21)	9 (1.6)
COVID-19 anxiety*	
Total score (6–60)	25 (31)*
Spread of COVID-19 in Tanzania (1–10)	3 (6)*
The risk of acquiring covid-19 (1–10)	4 (7)*
The risk of acquiring covid-19 and becoming seriously sick (1–10)	4 (8)*
The likelihood of a country running short of ARVs due disruption of production (1–10)	5 (8)*
The risk of poor adherence to ARVs in the era of COVID-19 (1–10)	3 (6)*
The risk of transmitting COVID-19 virus to another person (1–10)	3 (7)*
Depression[1]	
Total score (0–21)	2 (5)*
None (0–4)	395 (69.7)
Mild (5–9)	139 (24.5)
Moderate (10–14)	28 (4.9)
Severe (15–21)	5 (0.9)
Perceived social support[2]	
Overall (32–84)	68 (16)*
Significant others (4–28)	24 (6)*
Family (4–28)	26 (4)*
Friends (4–28)	19 (11)*
Self- management[3]	
Overall (21–105)	86 (18)*
Believing and knowing (7–24)	23 (3)*
Goals and facilitation (6–24)	23 (4)*
Participation (5–27)	23 (6)*
Biomedical management (0–15)	7 (6)*
Copying and Self-regulation (0–15)	12 (6)*
Stigma*	
Overall (12–48)	26 (9)*
Personalized stigma (3–12)	4 (3)*
Disclosure concerns (3–12)	9 (2)*
Concerns about public attitudes (3–12)	6 (5)*
Negative self-image (3–12)	5 (4)*
WHOQOL Physical Health[5] Domain	
Overall (7–16)	15 (3)*

WHOQOL World Health Organization Quality of Life

*Median, IQR

Table 4 Factors associated with adherence to visits among study participants (*N* = 567)

	Visit Adherence			
	Crude OR	Crude p	Adjusted OR	Adjusted p
Gender: Male	Ref	Ref	Ref	Ref
Gender: Female	1.17 (0.98, 1.40)	0.087	1.16 (0.97, 1.39)	0.113
Age: 15–17	Ref	Ref	Ref	Ref
Age: 18–19	1.03 (0.86, 1.25)	0.752	0.99 (0.82, 1.20)	0.929
Ordinary/Secondary School	Ref	Ref	Ref	Ref
No School	0.98 (0.79, 1.23)	0.884	1.04 (0.83, 1.30)	0.757
Live without parents	Ref	Ref	Ref	Ref
Live with parents	1.08 (0.89, 1.30)	0.447	1.06 (0.88, 1.28)	0.538
Time on ART (months)	1.00 (1.00, 1.00)	0.094	1.00 (1.00, 1.00)	0.102
Perceived Support	1.01 (1.00, 1.02)	0.082	1.01 (1.00, 1.02)	0.225
Self-Management	1.00 (1.00, 1.01)	0.563	1.00 (0.99, 1.01)	0.471
Depression	0.97 (0.95, 1.00)	0.036*	0.97 (0.94, 1.00)	0.049*
Covid Anxiety	1.00 (0.99, 1.00)	0.374	1.00 (0.99, 1.00)	0.574
Generalized Anxiety	1.00 (0.97, 1.04)	0.870	1.03 (0.99, 1.07)	0.109
Quality of Physical Health	1.05 (1.00, 1.09)	0.028*	1.04 (0.99, 1.09)	0.089

OR Odds Ratio, *ART* Antiretroviral Therapy

*$p < 0.05$

observed in our cohort, a mental health condition highly correlated with anxiety in this population [47, 48].

Lockdowns introduced by COVID-19 severely restricted social interactions and several studies have reported the negative impacts of lockdown on adolescent mental health including feelings of isolation and separation from family and friends [49, 50]. In Tanzania, stringent nationwide lock downs introduced during COVID-19 were significantly shorter than in other countries (2–3 months) [16, 51, 52]. Disruptions to social support systems and levels of anxiety among AWH as a result, could have been minimized and support from the family or other non-healthcare related support may have also remained constant or even increased. This high level of support and continuity of care could have also contributed to the low rates of HIV stigma observed in this study population.

Although we did not observe any association between COVID-19 related anxiety or GAD and visit adherence in this study, it is notable that visit adherence overall was

Table 5 Factors associated with viral load suppression (< 50) among study participants (*N* = 469)

	VL Suppression Logistic Regression Model			
	Crude OR	**Crude p**	**Adjusted OR**	**Adjusted p**
Gender: Male	Ref	Ref	Ref	Ref
Gender: Female	1.39 (0.9,2.15)	0.137	1.67 (1.05,2.66)	0.031*
Age: 15–17	Ref	Ref	Ref	Ref
Age: 18–19	1.16 (0.73,1.82)	0.531	1.09 (0.68,1.74)	0.735
Ordinary/Secondary School	Ref	Ref	Ref	Ref
No School	0.79 (0.47,1.32)	0.37	0.94 (0.54,1.65)	0.829
Live without parents	Ref	Ref	Ref	Ref
Live with parents	1.50 (0.96, 2.35)	0.073	1.61 (1.00, 2.57)	0.048*
Time on ART (months)	1.00(1.00,1.01)	0.497	1.00 (1.00,1.01)	0.452
Perceived Support	1.02 (0.99,1.04)	0.167	1.02 (0.99,1.04)	0.267
Self-Management	1.00 (0.98,1.02)	0.929	0.98 (0.96,1)	0.103
Depression	0.94 (0.88,1.00)	0.042*	0.99 (0.91,1.08)	0.858
Covid Anxiety	1.00 (0.99,1.02)	0.678	1.01 (1.00,1.03)	0.152
Generalized Anxiety	0.91 (0.84,0.98)	0.014*	0.90 (0.81,0.99)	0.030*
Quality of Physical Health	1.17 (1.06,1.29)	0.003*	1.17 (1.04,1.32)	0.008*

VL Viral Load, *OR* Odds Ratio, *ART* Antiretroviral Therapy

*$p < 0.05$

< 75% in almost half of the study population, presumably due to the impact of the COVID-19 pandemic on routine HIV services [53]. Despite suboptimal visit adherence, > 80% of participants were virologically suppressed. Both low GAD and high physical health scores were associated with VLS in this study. In Tanzania, during COVID-19, the government allowed the dispensing of extra ART to minimize physical contact during routine in-person clinic visits which likely protected against significant interruptions to treatment and virologic non-suppression. These program adaptations during COVID-19 may have also accounted for the lack of association observed between COVID-19 related and generalized anxiety and visit adherence. Our findings are similar to studies from the Congo and other SSA countries which also showed stable or improved VLS during COVID-19 for many of the same reasons [54–56]. High ratings in social support and self-management also likely contributed to the high proportion with VLS, although associations between these factors and VLS were not significant after adjusting for other potential confounders. High levels of social support and high self-management among AWH have also been shown to be associated with improved HIV outcomes in several other studies [57, 58].

Finally, compared to male AWH, females were 1.67 times likely to have HIV virologic suppression and although not significant, 1.2 times more likely to adhere to visits. This may be due to poor health seeking behavior reported among the male adolescents with HIV which has been reported in other parts of SSA [59]. It is an important finding to note considering the disproportionate effect COVID-19 had on adolescent girls' mental health and well-being generally, in addition to increased exposure to gender-based violence, school exclusion and economic hardships [60, 61].

To our knowledge this is one of the largest studies examining COVID-19 related anxiety and its association with health outcomes in AWH in Tanzania. However, our study had some limitations. The study only included AWH who were active care defined as attending all of their scheduled visits. It may be that AWH who did not meet these inclusion criteria could have had higher rates of anxiety and fear of COVID-19, or there were other differences in sampled population. In addition, only AWH from clinics in the Dar es Salaam region were included, thus results may not be generalizable to other settings in Tanzania or neighboring regions where experiences during COVID-19 may have been different. The COVID-19 related anxiety questionnaire adopted was one of the few published scales at the time of the study and had not been validated in Tanzania or other LMIC settings during the early phases of the pandemic. Questions mostly focused on perceived risk of COVID-19 and concerns about COVID-19 transmission. The survey did not include questions on impacts on health and memory; financial wellbeing and lifestyle; social support; general health; coping strategies; and self-care. However, many of these areas were assessed in other validated questionnaires that were administered as part of this study which provided important insight into these areas in times of stress even if the questions were not COVID-19 specific. This study was also performed after COVID-19 surveillance and mitigation measures in Tanzania were halted in June 2020, only 3 months after the onset of the pandemic. Thus, these findings may not necessarily be generalizable to other settings, where mitigation measures were more stringent and general awareness of COVID-19 perhaps higher. GAD and COVID-19 related anxiety could have also been underestimated due to the possibility of recall bias from the height of the pandemic. However, there were still some prevention measures in place at the start of the study, reflecting ongoing COVID-19 cases still being reported [62]. Given the dynamic situation of COVID-19, prompting a range of different responses from individual to policy levels, the results may not be reflective of other times during the pandemic.

Conclusion

Our study found low levels of COVID-19 related anxiety and GAD among Tanzanian AWH in care. While COVID-19 related anxiety was not associated with treatment outcomes during the pandemic, an inverse association observed between GAD and VLS was observed, suggesting a need to test if targeted anxiety screening and interventions can improve ART adherence in adolescent clinics and continuity of these services, especially in times of stress. In addition, interventions focused on improving physical health and supporting family and social support networks may also have the potential to optimize HIV health and outcomes in this vulnerable population.

Abbreviations

AdHIVSM	Adolescents HIV Self-Management tool
AHISA	Adolescent HIV Prevention and Treatment Implementation Science Alliance
AOR	Adjusted Odds ratio
ART	Antiretroviral Therapy
AWH	Adolescent living with HIV
COVID	Corona virus Disease of 2019
CTC	Care and Treatment Clinic
GAD	Generalized Anxiety Disorder
GVIFs	Generalized variance inflation factors
HIV	Human Immunodeficient Virus
IQR	Interquartile range
LMIC	Low- and Middle-Income countries
MSPSS	Multidimensional Scale of Perceived Social Support
PHQ	Patient Health Questionnaire
PWH	People living with HIV
SSA	Sub Saharan Africa
VL	Viral Load
VLS	Viral Load suppression
WHOQoL-BREF-HIV	World Health Organization Quality of Life brief questionnaire for persons living with HIV

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Authors' contributions

HS: Contributed to the design and conduct of the study, data analysis and interpretation, and writing the initial and subsequent drafts. DG: Contributed to the design and conduct of the study and reviewed all final drafts of the manuscript. SK: Contributed to the design of the study, data interpretation, and reviewing and revising all final drafts of the manuscript. MC: Led and contributed to data analysis and interpretation, and manuscript writing, prepared final tables and figures. LRH: Contributed to the design of the study, data interpretation, and reviewing and revising all final drafts of the manuscript. TN: Contributed to the design of the study, data interpretation, and reviewing and revising all final drafts of the manuscript. RM: Contributed to the design of the study and cultural adaptation of the survey measures. CF: Contributed to data cleaning, preliminary data analysis and interpretation, and manuscript writing. CH: Contributed to the design of the study, data interpretation, reviewing and revising all drafts of the manuscript. All authors reviewed the manuscript.

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Data availability

The data that support the findings of this study are available from the authors but restrictions apply to the availability of these data, which were stored in REDCap database saver for under the licence of Muhimbili University of Health and Allied Sciences(MUHAS) and therefore are only available on request (neemasiril@gmail.com).

Declarations

Ethics approval and consent to participate

Ethical approval for the study was provided by the Muhimbili University (DA: 282/298/01.C) and the National Institute of Medical Research (NIMR/HQ/R.8a/Vol. IX/4054) Institutional Review Boards in Tanzania.

Ethical considerations: All participants provided a signed written informed consent, which was obtained from literate participants ≥ 18 and legal guardian(s) for participants < 18 yrs. The illiterate participants or guardians put thumb prints on their consent forms after the study research assistants had read the consent to them and they had agreed to participate. Participants ≥ 18 and those 15–17 years who came alone to the clinic, were married, and classified by the clinic as emancipated minors provided informed consent on their own. Participants aged 15–17 years, who came with parents/guardians to the clinic, provided assent to participate after their parents/guardians provided a signed or thumb printed informed consent.

Competing interests

The authors declare no competing interests.

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