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The prevalence and correlates of depression before and after the COVID-19 pandemic declaration among urban refugee adolescents and youth in informal settlements in Kampala, Uganda: A longitudinal cohort study

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ABSTRACT

Purpose: There is scant research examining urban refugee youth mental health outcomes, including potential impacts of the COVID-19 pandemic. We examine prevalence and ecosocial risk factors of depression in the periods before and after the COVID-19 pandemic declaration among urban refugee youth in Kampala, Uganda.

Methods: Data from a cohort of refugee youth ($n = 367$) aged 16–24 years were collected in periods before (February 2020) and after (December 2020) the WHO COVID-19 pandemic declaration. We developed crude and adjusted generalized estimating equation logistic regression models to examine demographic and ecosocial factors (food insecurity, social support, intimate partner violence) associated with depression, and include time-ecosocial interactions to examine if associations differed before and after the pandemic declaration.

Results: The prevalence of depression was high, but there was no significant difference before (27.5%), and after (28.9%) the pandemic declaration ($P = .583$). In adjusted models, food insecurity (aOR: 2.54; 95% CI: 1.21–5.33) and experiencing violence (aOR: 2.53; 95% CI: 1.07–5.96) were associated with increased depression, and social support was associated with decreased depression (aOR: 0.85; 95% CI: 0.81–0.89). **Conclusions:** These findings highlight the urgent need for interventions to address chronic depression, food insecurity, and ongoing effects of violence exposure among urban refugee youth in Kampala.

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Introduction

Mental health disorders, such as depression, are the leading cause of disability among young persons aged 10–24 years [1], and disproportionately impact refugee youth [2,3]. There are more than 79.5 million forcibly displaced persons in the world, and 40% are under 18 years [4]. Recent systematic review findings estimate refugee child and adolescents' overall depression prevalence at 14% [2], which is higher than amongst non-refugees at 2.6% [5]. Psychological stressors among refugee adolescents and youth include trauma, violence, and stigma, key factors associated with depression [6]. There is an urgent need for attention to refugee adolescent and youth mental health to inform mental health promotion.

The global phenomenon of urbanization among refugees has resulted in an estimated 60% of refugees and 80% of internally displaced persons living in urban areas [7]. Despite this refugee urbanization, depression prevalence and correlates are understudied among urban refugee youth. In many instances refugees in urban contexts live in informal settlements [8], often slums, such as in the case of Kampala, Uganda [9]. Kampala hosts more than 88,000 refugee and displaced persons, with 27% being youth aged 15–24 years [10]. Informal settlements in Kampala [11], as in other global regions, are shared social and physical environments characterized by stressors including poverty, violence exposure, and housing insecurity, that converge to contribute to poorer mental health outcomes [12].

Research with conflict-affected youth underscores the importance of daily stressors on the development of adverse mental health outcomes. For instance, a longitudinal study with conflict-affected youth in Sierra Leone reported that daily stressors, comprised of social and material challenges such as food and housing insecurity, mediated the associations between war exposure and depression [13]. Food insecurity in particular has been linked with anxiety and depression across diverse populations and contexts [14–18], and is disproportionately experienced by refugees [17,19,20]. Among internally displaced adults in Uganda, lack of food and water was associated with depression in cross-sectional analyses [21]. The overwhelming majority (80%) of forcibly displaced persons across the world are hosted in countries that experience acute food insecurity [22].

COVID-19 was declared a pandemic by the World Health Organization (WHO) in March 2020 and has had deleterious effects on population health and well-being worldwide. Mental health among urban refugee youth living in informal settlements is understudied at large, including both prior to, and during the COVID-19 pandemic. A cross-sectional study conducted in 2018 with urban refugee youth in Kampala's informal settlements reported that violence exposure, food insecurity, and lower social support were associated with depression and these associations varied by gender [20]. However, there are knowledge gaps on refugee youth health in urban contexts, particularly with longitudinal data [23]. Systematic review findings suggest that COVID-19 and associated lockdowns may increase stress and social isolation and subsequently increase youth mental health challenges such as depression and anxiety [24], but no studies in this review were conducted with refugee youth or in sub-Saharan Africa. There are global calls to action for inclusion of refugees in COVID-19 responses [25], and for mental health science to understand psychological effects of COVID-19 [26].

Together this literature signals the urgent need for an ecosocial approach [27] to mental health among refugee youth that considers the embodiment of adverse social inequities and traumas, hazardous environments, and poverty. An ecosocial approach considers how "societies' epidemiologic profiles are shaped by the ways of living afforded by their current and changing societal arrangements of power, property, and the production and reproduction of

both social and biological life, involving people, other species, and the biophysical world in which we live" (p. 937) [27]. Our study aims to address these knowledge gaps on factors associated with depression among urban refugee youth aged 16–24 years living in Kampala's informal settlements. Our specific research objectives were to: 1) describe depression symptoms in periods before and after the COVID-19 pandemic declaration; 2) identify sociodemographic and ecosocial factors associated with depression; and 3) assess if ecosocial associations differ before and after the COVID-19 pandemic declaration.

Material & methods

Study design and setting

This longitudinal cohort study uses data collected as part of the Tushirikiane cluster randomized control trial among displaced and refugee adolescent youth in Kampala, Uganda. The primary aim of the trial was to assess the effect of HIV testing strategies on HIV testing outcomes; detailed study procedures have been described elsewhere [28]. In brief, displaced and refugee adolescent youth aged 16–24 years were eligible for inclusion if they lived in one of three clustered informal settlements (Kabalagala and/or Kansanga, Katwe and/or Nsambya, and Rubaga) selected for convenience, spoke one of the study languages (English, French, Swahili, Luganda, Kinyarwanda, Kirundi), and had access to a mobile phone. We report on data collected at Wave-1 (February 2020) and Wave-2 (December 2020).

Participants & data collection

Participants were recruited using purposive sampling methods with the support of peer navigators, who are self-identified refugees with experience working as peer educators. Data regarding demographics, HIV testing knowledge and frequency, ecosocial factors, and health outcomes were collected using standardized questionnaires administered by trained research assistants. Interviews were conducted in all study languages (i.e. English, French, Swahili, Luganda, Kinyarwanda, Kirundi) as per the participant's preference and data were recorded on tablets using Quick-TapSurvey (Formstack, Toronto, Canada) in Wave-1 and SurveyCTO (Dobility, Cambridge, MA) in Wave-2.

Ethics

Research Ethics Board approval was granted from the University of Toronto (Protocol Number: 37496), Mildmay Uganda Research Ethics Committee (Ref: 0806–2019), and Uganda National Council for Science & Technology (Ref: HS2716). The Tushirikiane trial is registered at ClinicalTrials.gov (NCT04504097). All participants provided written informed consent with the support from a peer navigator. Our study aligns with Uganda's HIV and AIDS Prevention and Control Act (2014) that pronounces the age of consent for voluntary HIV testing and counselling in Uganda is 12 years and above.

Outcome measure

Depression was assessed using the Patient Health Questionnaire-9 (PHQ-9) [29] assessment tool (Cronbach's α : baseline cohort = 0.89), which has been validated in youth aged 16–24 years and individuals residing in sub-Saharan Africa [30–32]. Summed scores ranging from 0–27 were calculated, with higher scores corresponding to greater depression severity. For individuals with three or fewer missing PHQ-9 items, we used participant mean imputation by assigning the mean of the answered items to the missing items. Participant mean imputation

has been shown to be valid and produce unbiased results when implemented for missing scale items, including for depression [33]. We used a standard cut-off score of greater than or equal to 10 to define presence of depression, which has been found to be highly sensitive and specific for clinically diagnosing depression, including in Uganda [34,35].

Exposures and covariates

Demographic covariates of interest included age, gender, highest level of education, length of time living in Uganda, and relationship status. Given that recruitment occurred across three clustered informal settlements, this was also included in all analyses as a covariate. Time period, defined as before (February 2020) and after (December 2020) the WHO COVID-19 pandemic declaration, was evaluated as a potential effect modifier.

Guided by an ecosocial approach [27] and prior research with this population [20], we examined the following factors collected at each time point: food insecurity, experiences of lifetime physical or sexual intimate partner violence (IPV), and social support. Food insecurity was assessed using a single item question about how often participants went to sleep hungry because they did not have enough food to eat [20]. Experiences of physical or sexual IPV were assessed using an adapted short form of the Conflict Tactics Scale [36] as measured in the Ugandan Demographic and Health Surveys [37]. Participants were categorized as “yes” if they reported ever experiencing, as opposed to solely perpetrating, any physical and/or sexual IPV, otherwise they were categorized as “no.” Social support was assessed using the 24-item Social Provisions Scale [38], which measures support and interpersonal connection provided by family, friends, and partners (Cronbach’s α : baseline cohort = 0.79). Scores can range from 24–96, with higher scores indicating greater support. Participant mean imputation was used for individuals with eight or fewer missing social support items.

Data analysis

The analytical cohort included data from 367 participants who were still in active follow-up in December 2020 and who had PHQ-9 scores at both time points. Individuals identifying as transgender were excluded due to small sample size and concerns about participant anonymity. We compared demographic and ecosocial characteristics and depression scores between participants included in the analytical cohort and those lost to follow-up or excluded using χ^2 tests or Fisher’s exact tests for categorical variables and t test or ANOVA for continuous variables.

Baseline demographic and ecosocial factors of participants in the analytical cohort were summarized using means and standard deviations (SD) for continuous variables and frequencies and proportions for categorical variables. Using a PHQ-9 cut-off score of greater than or equal to 10 for presence of depression, the number and proportion of participants with depression were summarized for each participant characteristic by time period, before, and after the COVID-19 pandemic declaration. McNemar’s test was used to assess if there was a significant difference in depression scores between time periods.

We used generalized estimating equation (GEE) logistic regression models with robust standard errors to examine longitudinal associations between ecosocial factors and depression across both time periods, adjusting for demographic covariates. The GEE models accounted for correlation among responses from multiple time points per participant with an exchangeable correlation matrix. Crude odds ratios (ORs) and 95% confidence intervals (CIs) were calculated for depression by each factor controlling for settlement a priori. In multivariable models, time, gender, and settlement, which were entered a priori, as well as all significant crude

demographic and ecosocial factors were carried forward to obtain adjusted ORs and 95% CIs. We assessed the potential for effect modification by time period by fitting time-ecosocial interaction terms separately for each factor in adjusted models and reporting stratified estimates obtained from linear combinations. In sensitivity analyses, we restricted analyses to participants who only reported complete PHQ-9 scores—excluding imputed outcome values. All analyses were conducted in Stata 16.1 (StataCorp, College Station, TX).

Results

In February 2020, 450 Tushirkiane participants were enrolled into the cohort, of which 75 (16.7%) were lost to follow-up by December 2020, and 5 (1.1%) had missing PHQ-9 scores. Ecosocial and depression characteristics between those included in the analytical cohort and those excluded were generally similar; however, those excluded reported lower social support (Supplementary Table 1). In terms of demographics, those excluded had lower education levels and were more likely to have been from the Democratic Republic of Congo (Supplementary Table 1). Three participants (0.7%) identified as transgender (Supplementary Table 1). Our analytical cohort population was 50.4% adolescent boys and young men, with a mean age of 20.0 years (SD: 2.4), and the majority (54.0%) had been living in Uganda between 1 and 5 years. At baseline, the prevalence of food insecurity and IPV were high, with 58.3% reporting being sometimes food insecure and 6.5% reporting always being food insecure, and 10.6% reporting having experienced physical and/or sexual IPV (Table 1). The mean social support score at baseline was 66.8 (SD: 5.9).

The overall prevalence of depression before the COVID-19 pandemic declaration, was 27.5% (Table 1), with 19.6% reporting moderate depression, 7.1% reporting moderately severe depression, and 0.8% reporting severe depression (Supplementary Table 2). In the time period after the COVID-19 pandemic declaration, depression prevalence was slightly higher at 28.9% (Table 1); however, there was no significant difference between overall depression in the population between time periods ($P = .583$).

In crude GEE models, there were strong associations between depression and demographic and ecosocial factors including age, length of time in Uganda, food insecurity, IPV, and social support (Table 2). After adjustment for these factors, as well as gender, settlement, and time period in multivariable models, the associations between ecosocial factors with depression remained strong. In particular, the odds of depression among those who always experience food insecurity was 2.54 (95% CI: 1.21, 5.33; $P = .048$) times higher than those who never experienced food insecurity. Refugee and displaced adolescents and youth who had experienced physical and/or sexual IPV had more than double the odds of depression (aOR: 2.53; 95% CI: 1.07, 5.96; $P = .034$) as compared to those who had not experienced IPV. Additionally, greater social support was associated with reduced odds of depression (aOR: 0.85; 95% CI: 0.81, 0.89; $P < .001$). Older age was associated with increased odds of depression, while associations between length of time in Uganda, and depression were variable (Table 2).

The associations between ecosocial factors and depression varied slightly before and after the COVID-19 pandemic declaration. In the period after the pandemic declaration, there were stronger associations between higher levels of food insecurity (aOR: 2.88; 95% CI: 1.16, 7.15) with increased depression, and greater social support (aOR: 0.82; 95% CI: 0.77–0.88) with lower depression. However, interactions for each factor with time period were not statistically significant (Table 3). Findings remained robust in sensitivity analyses using a complete case analysis approach (Supplementary Table 3).

Table 1

Baseline socio-demographic characteristics and prevalence of depression before and after the COVID-19 pandemic declaration among Tushirikiane participants, Kampala, Uganda, 2020 (n = 367)

	Baseline Sample Frequency N (%) or Mean (SD)	PHQ-9 Depression Symptoms	
		Before COVID-19 Pandemic Declaration N (%)	After COVID-19 Pandemic Declaration N(%)
<i>Demographic Factors</i>			
Age, y	20.0 (2.4)	101 (27.5)	106 (28.9)
Gender			
Man	185 (50.4)	50 (27.0)	50 (27.0)
Woman	182 (49.6)	51 (28.0)	56 (30.7)
Highest Level of Education*			
Less than secondary	81 (22.1)	18 (22.2)	16 (19.8)
Some secondary	152 (41.4)	47 (30.9)	50 (32.9)
Secondary +	130 (35.4)	34 (26.2)	38 (29.2)
Length of time in Uganda			
<1 y	11 (3.0)	5 (45.5)	3 (27.3)
1–5 y	198 (54.0)	43 (21.7)	50 (25.3)
6–10 y	107 (29.1)	38 (35.5)	40 (37.4)
>10 y	51 (13.9)	15 (29.4)	13 (25.5)
Relationship Status*			
No current partner	157 (42.8)	50 (31.9)	52 (33.1)
Dating one partner and/or married	152 (41.4)	41 (27.0)	41 (26.3)
Casual dating and/or multiple partners	55 (15.0)	10 (18.2)	14 (25.5)
<i>Ecosocial Factors</i>			
Food Insecure*			
Never	126 (34.3)	27 (21.4)	32 (25.4)
Sometimes	214 (58.3)	61 (28.5)	58 (27.1)
Always	24 (6.5)	12 (50.0)	16 (62.5)
Experienced any physical and/or sexual IPV			
No	328 (89.4)	81 (24.7)	92 (28.1)
Yes	40 (10.6)	20 (51.3)	14 (35.9)
Social Provisions Scale	66.8 (5.9)	101 (27.5)	106 (28.9)

Note: SD = standard deviation; PHQ-9 = patient health questionnaire; IPV = intimate partner violence.

* Missing values for education n = 4 (1.1%); relationship status n = 3 (0.8%); food insecure n = 3 (0.8%).

Table 2

Crude and adjusted models for depression among Tushirikiane participants, Kampala, Uganda, 2020 (n = 367)

	Crude Model*		Adjusted Model†	
	OR (95% CI)	P-value‡	aOR (95% CI)	P-value‡
Time Period		.583		.443
Before COVID-19 declaration	ref		ref	
After COVID-19 declaration	1.08 (0.82, 1.44)		1.16 (0.80, 1.67)	
<i>Demographic Factors</i>				
Age, y	1.19 (1.10, 1.30)	<.001	1.10 (1.00, 1.21)	.047
Gender		.350		.155
Man	ref		ref	
Woman	1.21 (0.81, 1.82)		1.37 (0.89, 2.12)	
Highest Level of Education		.157		
Less than secondary	ref		---	
Some secondary	1.62 (0.96, 2.75)			
Secondary +	1.18 (0.70, 2.03)			
Length of time in Uganda		<.001		.009
<1 y	ref		ref	
1–5 y	0.27 (0.09, 0.80)		0.55 (0.21, 1.41)	
6–10 y	0.64 (0.21, 1.92)		1.18 (0.44, 3.16)	
>10 y	0.51 (0.15, 1.69)		0.93 (0.31, 2.81)	
Relationship Status		.632		
No current partner	ref		---	
Dating one partner and/or married	0.97 (0.62, 1.50)			
Casual dating and/or multiple partners	0.73 (0.38, 1.40)			
<i>Ecosocial Factors</i>				
Food Insecure		.003		.048
Never	ref		ref	
Sometimes	1.44 (0.95, 2.19)		1.31 (0.82, 2.10)	
Always	3.36 (1.69, 6.69)		2.54 (1.21, 5.33)	
Experienced any physical and/or sexual IPV		.003		.034
No	ref		ref	
Yes	2.66 (1.40, 5.07)		2.53 (1.07, 5.96)	
Social Provisions Scale	0.83 (0.80, 0.87)	<.001	0.85 (0.81, 0.89)	<.001

Note: OR = odds ratio; aOR = adjusted odds ratio; CI = confidence interval; IPV = intimate partner violence.

* Crude model conducted using general estimating equation logistic regression with robust standard errors to account for clustering controlling for settlement as a *a priori* covariate.

† Adjusted model conducted using general estimating equation logistic regression with robust standard errors to account for clustering, controlling for settlement, time period, gender, and all significant factors from crude models.

‡ P-values calculated from Wald test.

Table 3

Adjusted models for ecosocial factors and depression before and after the COVID-19 pandemic declaration among Tushirikiane participants, Kampala, Uganda, 2020 (n = 367)

	Adjusted ORs (95% CI)*		
	Before COVID-19 Pandemic Declaration	After COVID-19 Pandemic Declaration	P-value for time interaction†
Food Insecure			.665
Never	ref	ref	
Sometimes	1.48 (0.82, 2.69)	1.16 (0.63, 2.16)	
Always	2.00 (0.62, 6.44)	2.88 (1.16, 7.15)	
Experienced any physical and/or sexual IPV			.112
No	ref	ref	
Yes	3.95 (1.45, 10.8)	1.11 (0.30, 4.11)	
Social Provisions Scale	0.87 (0.83, 0.93)	0.82 (0.77, 0.88)	.126

Note: OR = odds ratio; CI = Confidence Interval.

Bold values indicate statistically significant effect estimates at $P < .05$.

* Each adjusted model is calculated from general estimating equation logistic regression with robust standard errors to account for clustering, adjusting for age, gender, length of time in Uganda, food insecurity, intimate partner violence, social provisions, time period, settlement, and interaction term between time and ecosocial factor, separately. Effect estimates obtained using linear combinations.

† P-value for two-way interaction between each ecosocial factor and time calculated from Wald's test.

Discussion

In this cohort study with urban refugee adolescents and youth in Kampala more than one-quarter (27%–29%) of participants reported moderate-severe depression symptoms. Depression was associated with age, length of time in Uganda, and ecosocial (food insecurity, IPV, lower social support) factors. There were no significant changes in depression prevalence, or in the factors associated with depression, before and after the COVID-19 pandemic declaration. Together these findings suggest that depression may be a chronic experience for a substantial proportion of urban refugee adolescents and youth, and this may be in part due to “the psychological toll of slum living” [39].

Our findings corroborate and extend prior research on socio-environmental stressors associated with depression among urban refugee youth. The depression prevalence in our study is similar to that reported among adolescents attending primary care in Kampala (18%) [40]; however it is not directly comparable due to different depression measures and scoring. Similar to a cross-sectional study with urban refugee youth in Kampala's informal settlements, that used different scoring methods and found two-thirds reported any depression symptoms, we found that violence exposure, food insecurity, and lower social support were associated with depression [20]. Violence exposure is a stressor associated with a sequelae of poor health outcomes, including mental health disorders, in internally displaced communities in Northern Uganda [41], rural refugee settlements in Uganda and Rwanda [42], with adolescents in Kampala [40], and in urban informal settlements in Kenya [43] and South Africa [44,45].

Our findings document widespread and chronic food insecurity—impacting two-thirds of participants—associated with depression among urban refugee youth in Kampala. This aligns with systematic review findings [18] of the mental health sequelae of stress resulting from the uncertainty of obtaining food, shame, and awareness of social inequities. Our findings also corroborate associations between food insecurity and depression documented in longitudinal research with adults living with HIV in rural Uganda [46], and in cross-sectional research with internally displaced adults in Uganda [21]. In addition to producing mental health stressors, food insecurity also contributes to nutrition-related harms, and elevates risks of gender-based violence and gender disempowerment [15].

We did not find significant gender differences in depression. This contrasts with a 2018 cross-sectional survey with urban refugees aged 16–24 years in Kampala that found a higher prevalence of depression among young women than young men [20], yet only included a small sample ($n = 112$) of young men. Our finding

is similar to a study with youth in informal settlements in Durban [47] which found no significant gender differences in depression prevalence. Gibbs et al. (2018) suggest that there may be substantial burden of undiagnosed mental health disorders with youth at large in informal settlements. This may be in part due to traditional masculine norms, and the challenges socio-economically marginalized young men in urban informal settlements experience trying to realize these ideals, and these experiences may reduce young men's engagement with depression care.

Social support is health promoting and linked with reduced depression [40,46]. Social support is a complex and multi-faceted construct, including emotional, instrumental, appraisal, and informational elements that can be acquired from both informal (e.g., family, friends) and formal (e.g., organizational) sources [48,49]. Our finding that increased social support, assessed with a multi-dimensional measure that included availability of different types of support [38], was associated with reduced odds of depression aligns with this research. Supportive relationships can buffer the effects of stressful events and circumstances [50,51]. Fostering social support is therefore an urgent priority to advance mental health among young urban refugees in Kampala. This may be particularly important for youth in informal settlements at large, as these environments can include social disorganization, weaker social ties, high mobility, and smaller social networks [52]—these may be exacerbated for urban refugees. Qualitative research noted the ways in which urban refugee youth in Kampala access support from peer educators [53] and religious communities [54]. Tsai et al. identified instrumental social support was a stronger buffer than emotional support in the relationship between food insecurity and depression among people living with HIV in Uganda [46], signaling the need to further disentangle the mechanisms through which social support dimensions can buffer the effect of stressors on depression with urban refugee youth.

There were several study limitations. Due to the socioeconomic effects of the COVID-19 pandemic and lockdowns, many urban refugees in Kampala faced extreme hunger and left the city for countries of origin or refugee settlements [55]. As a result, we experienced 20% loss to follow up, and those lost to follow up (Supplementary Table 1) had lower social support. It is plausible that persons with lower social support who are not included in Wave-2 may experience higher depression and could have experienced a significant increase in depression prevalence. The study was not powered to detect interactions. We did not use random sampling, as urban refugees are often hard to locate and underrepresented in research [23] and in Kampala's city planning [11]. The non-random sampling limits the generalizability of findings. Despite these limitations, this study is unique in providing a longitudinal assessment

of depression among urban refugee adolescents and youth before and after the COVID-19 pandemic declaration.

Findings can inform practice and policy to address the mental health and wellbeing of urban refugee and adolescents and youth. Uganda's funding for refugees largely focuses on refugee settlements [11]. This can be particularly challenging during the COVID-19 pandemic where food insecurity and economic precarity have increased [14,56,57] and may be exacerbated for urban refugees [55]. Ecosocial frameworks can inform research questions and subsequent interventions with refugee youth in Ugandan and other low-income contexts, enhancing "social epidemiologists ability to analyze and provide evidence useful for addressing the myriad ways we both embody and transform the co-mingled social and biological world in which we live love, work, play, fight, ail and die" (p. 674) [58]. Structural interventions that address the root causes of food insecurity for urban refugees, and foster communities where multidimensional facets of social support are nurtured, hold the potential to "break the intergenerational nexus of poverty, trauma, and health" (p. 79) [45].

Conclusions

Although depression scores and severity did not significantly change before and after the pandemic declaration, this work signals a need for urgent attention to chronic levels of depression, food insecurity, and the ongoing mental health effects of violence exposure among urban refugee adolescents and youth in Kampala's informal settlements.

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Ethics approval

Research Ethics Board approval was granted from the University of Toronto (Protocol Number: 37,496), Mildmay Uganda Research Ethics Committee (Ref: 0806–2019), and Uganda National Council for Science & Technology (Ref: HS2716). The Tushirikiane trial is registered at ClinicalTrials.gov (NCT04504097).

Consent to participate

All participants provided written informed consent with the support from a peer navigator prior in both time periods.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.annepidem.2021.11.005.

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