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Depressive symptoms and associated social and environmental factors among women living in informal settlements in Nairobi, Kenya

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ABSTRACT

Approximately 280 million people around the world suffer from depression, and the rates are higher among women than men. For women living in informal settlements in lower – and middle-income countries (LMICs) the prevalence and associated burden of depressive symptoms may be particularly high. The purpose of this paper was to explore factors associated with possible major depressive disorder (MDD) in a probability sample of women living in Mathare informal settlement in Nairobi, Kenya and to identify potential points for intervention and/or support. Quantitative surveys were conducted with 552 women aged 18–75. Possible MDD was measured using the Patient Health Questionnaire and regressed on individual, household/familial-, and community/interpersonal-level factors. Findings highlight the potential importance of factors such as physical health, economic stress, access to water and sanitation, household and family dynamics, and neighbourhood/village differences in possible MDD among women living in informal settlements. We identify potential points for research, intervention and policy including: providing appropriate tangible assistance or interventions to reduce economic stress/strain; expanding access to water and sanitation and, in doing so, reducing potential burdens to physical health; providing and expanding healthcare to include mental healthcare; and investigating family dynamics and bolstering support for families, particularly for those experiencing conflict.

Introduction

Mental disorders are among the leading contributors to the global burden of disease (Santomauro et al., 2021). Depression is one of the most disabling and is often comorbid with other chronic diseases – worsening health and social outcomes for many with concurrent medical conditions (Moussavi et al., 2007). Approximately 280 million people around the world suffer from depression (Institute for Health Metrics Evaluation, 2019), but the rates are higher among women than men (GBD Mental Disorders Collaborators, 2022; Rehm & Shield, 2019). The burden of depression and the services available for diagnosing and supporting those with depression are not equitably distributed across different communities and populations. While there is still a paucity of literature on depression in Sub-Saharan Africa (SSA), a growing body of research suggests that mood

disorders, especially depression, are common mental health disorders in this region, but are often underdiagnosed and underreported (Gbadamosi et al., 2022). There is also a shortage of mental health specialists and services providing support to those with depressive and other mental health disorders. In Kenya, for example, there are about 100 psychiatrists serving a population of 45 million (Mutiso et al., 2018), and this number is below the 1:10,000 ratio recommended by the World Health Organization (Sainsbury et al., 1986).

For women living in informal settlements the prevalence and associated burden of depressive symptoms may be higher than for those in the general population due to social-cultural marginalization (Gibbs et al., 2018) and gender inequalities (Chant & McIlwaine, 2016; Otieno et al., 2020; Oxfam et al., 2015). A study carried out in informal settlements in South Africa found that 58% of women and 50% of men met a conservative cut-off (20/21) for depressive symptomology on the Centre for Epidemiological Studies on Depression scale (CES-D) (Gibbs et al., 2018) while another study in Nakuru, Kenya found that 75% of women scored within the clinical range for depressive symptoms on the Hopkins Symptom Checklist for depression (Lambert & Denckla, 2021).

In addition to higher prevalence of depressive symptoms among residents of informal settlements in SSA, especially women, there is evidence that histories of marginalization of and government disinvestment in these communities has also led or contributed to a shortage of accessible health – and mental health-related services (Kyobutungi et al., 2008; Solymári et al., 2022). Globally, one billion people live in informal settlements – defined as residential areas lacking durable housing; sufficient living and public spaces; access to basic infrastructure and other services such as water and sanitation; and secure tenancy – and this population is growing (UN-Habitat, 2015, 2016). In Kenya, approximately 20 million people (39% of the national population) live in informal settlements (Toroitich, 2018) and these residents have some of the worst health outcomes of any population in the country (APHRC, 2014). Reports from a 2009 study of three large informal settlements in Nairobi, Kenya suggest that, although there are 503 health clinics serving residents of these settlements, only 6 are public (Fotso & Mukiira, 2011). Additionally, while most of the 100 psychiatrists serving Kenya's population are located in Nairobi (Mutiso et al., 2018), they charge fees well above those affordable to most residents residing in informal settlements (Ondicho, 2018).

There is limited research focused on determinants of depression in the unique physical and social environments of informal settlements. Studies that do exist have shown positive correlations between depressive symptoms and experiences of different forms of violence including intimate partner violence (Lambert & Denckla, 2021; Winter et al., 2020), economic abuse (Kanougiya et al., 2021), childhood abuse (Kanougiya et al., 2021), and sexual violence (Kanougiya et al., 2021) among women in informal settlements in India (Kanougiya et al., 2021) and Kenya (Lambert & Denckla, 2021; Winter et al., 2020). Individual-level characteristics such as age and length of time in country for refugee populations have also been linked to depressive symptoms in informal settlements in Uganda (Logie et al., 2020). Researchers have found positive associations between depressive symptoms and socioeconomic determinants such as lack of work and hunger (Gibbs et al., 2018) and food insecurity (Logie et al., 2020). There is also evidence of negative associations between depressive symptoms and interpersonal factors like family or social support (Kanougiya et al., 2021; Logie et al., 2020) and community connection (Kanougiya et al., 2021) in South Africa (Gibbs et al., 2018), Uganda (Logie et al., 2020), and India (Kanougiya et al., 2021). In addition, experts posit that the living and working conditions in informal settlements predispose residents to stress (Ezeh et al., 2017), and environmental factors such as low-quality housing and infrastructure and lack of access to water, sewage, garbage collection, health care, and other basic services are linked to poor physical health outcomes in these communities (Satterthwaite et al., 2019; Sverdlik, 2011). But many of the factors reflective of the broader social and physical environment in informal settlements have not been explored in research focused on common mental health outcomes in these communities, particularly among women.

Given the deleterious effects of depression and the disproportionate burden born by women, particularly those in informal settlements, it is critically important for research to explore

gender-specific and context-specific factors associated with depression in these populations to help identify key areas for policy and service support. The purpose of this study, therefore, was to explore social and environmental factors associated with depressive symptoms among women living in informal settlements in Nairobi, Kenya.

Materials and methods

Study site

Data for this study were collected in Mathare Valley (Mathare) informal settlement in Nairobi, Kenya in 2018. Mathare is one of the largest and most densely populated settlements in Kenya. It is home to approximately 206,550 residents living on less than 3-square kilometers of land (Kenya National Bureau of Statistics, 2019a). Census estimates suggest there are approximately 106,522 males to 100,028 females in the settlement (Kenya National Bureau of Statistics, 2019a). Mathare is divided into neighbourhoods or 'villages.' Data for this study were collected from the 11 villages comprising the Mathare informal settlement.

The population in Mathare is diverse. About 18% of women in Mathare are between the ages of 18–24 years, and 24% are between 25 and 34 (Kenya National Bureau of Statistics, 2019b). Just over 52% of women in Mathare are considered to be 'in the labour force' (defined as those who are *not* full-time students, home-makers, retired, or incapacitated persons, and those who are not too young or too old to work), with 75% of those women 'working' and 25% unemployed, but 'seeking work' (Kenya National Bureau of Statistics, 2019c). Most residents in Mathare rely on informal economies for income such as selling fruits and vegetables or mobile phone airtime and basic household necessities or casual labour 'gigs' such as washing clothes and housework (Corburn et al., 2012; Darkey & Kariuki, 2013). Access to water, sanitation, and electricity is inconsistent for residents in informal settlements, with most residents relying on water from sources outside their homes/dwellings (APHRC, 2014; Kenya National Bureau of Statistics, 2019c) and most relying on shared toilets outside their homes/dwellings (Winter et al., 2019b).

Sample

A sample of 552 women was selected using a stratified, random sampling technique. Geographic information systems (GIS) was used to randomly select households – ensuring that at least 50 households were selected from each of Mathare's 11 villages. Subsequently, Kish methodology (Kish, 1965) was used to randomly select one woman from each household to participate in a survey. To be included in this study, women had to be at least 18 years old, speak English or Swahili, and have resided in Mathare for a minimum of six months, i.e. they were not visitors.

Data collection

Surveys took about 60 minutes to complete. They were conducted in women's homes by female-identified community health volunteers (CHVs) in Mathare who were trained on the principles of ethical research, research on sensitive topics (violence against women and mental health), and rigorous and quality data collection. All participants were provided with contact information for an on-call counselor hired as part of the study to provide real-time support to *any* participant throughout and for two weeks following data collection. Study participants were also provided with a contact list for local health-related services, which included services providing support to women experiencing violence and/or mental health challenges. Participants who reported experiencing recent intimate partner or non-partner violence, severe depressive symptoms, or suicidal ideation or attempts, were encouraged by CHVs to contact the on-call counselor for immediate phone counselling, to set up an in-person session, or for referral to other services. CHVs were

also trained and provided phone credit to help women set up appointments for counselling or other services if requested by participants.

Measures

Symptoms of major depressive disorder. A Kiswahili version of the Patient Health Questionnaire-9 Depression Scale (PHQ-9) was used as a screening tool to assess whether respondents' self-reported depression symptoms met the criteria for possible major depressive disorder (MDD) (Manea et al., 2015; Omoro et al., 2006). Respondents were provided with a list of nine symptoms that correspond with diagnostic criteria for major depression and were asked to indicate how often each symptom bothered them over the last 2 weeks from 0 (*not at all*) to 3 (*nearly every day*). A standard cutoff score of 10 or above was used, which has been shown to be an optimal cut-off for screening for possible MDD across multiple studies (Levis et al., 2019), specifically in Kenya (Mwangi et al., 2020) and other low-resource settings in Africa (Akena et al., 2013; Cholera et al., 2014; Gelaye et al., 2013). Based on this cutoff, we dichotomized the variable ('1' = meets criteria for possible MDD; '0' = does not meet criteria for possible MDD). The Cronbach's alpha for the PHQ-9 in this sample was 0.86, suggesting good internal consistency and aligning with results from internal validity checks in other validation studies in Kenya (Green et al., 2018; Mwangi et al., 2020; Omoro et al., 2006; Tele et al., 2022).

Findings from some of the recent validation studies focused on depression measures in Kenya suggest there may be comprehension, decision process, and response process issues with the Kiswahili version of the PHQ-9 (Green et al., 2018). There may also be different optimal cutoff scores (Tele et al., 2022) or more reliable/valid measures of depression (Green et al., 2018) among different populations in Kenya (we discuss these more in the limitations); however, these studies, and others, have still shown the PHQ-9 to be a valid and reliable measure (acceptable-to-good test-retest reliability, good construct validity, good discriminant validity, etc.) for assessing possible MDD and depression severity among various populations in Kenya including adults living with HIV/AIDS (Monahan et al., 2009; Mwangi et al., 2020), adolescents (Tele et al., 2022), patients with head and neck cancer (Omoro et al., 2006), and pregnant and new mothers in rural Kenya (Green et al., 2018).

Individual-level factors. Individual-level factors in this analysis included variables for education (less than complete primary, completed primary with no secondary education, and at least some secondary education), age (measured as a continuous variable), employment (yes/no), and having a business (yes/no). A dichotomous 'frequent problems with money' variable was generated from women's responses to the following question: 'in the last two weeks, have you had money problems every day or nearly every day?' (yes/no). A variable capturing whether the participant gets drunk often was also included ('0' = doesn't drink/never gets drunk/only gets drunk occasionally; '1' = gets drunk often, but not every day or gets drunk daily).

Several variables capturing information about women's health and health-related behaviours were also included. Participants were asked to rate their health on a five-point scale ranging from 1 (*poor*) to 5 (*excellent*). The self-reported health variable was dichotomized (1 = good/very good/excellent health; 0 = poor/very poor health). A variable capturing information about women's reproductive/gynecological health was also included. Women were asked whether they received medical diagnoses of common conditions such as urinary tract infections, vaginal infections, hemorrhoids, candidiasis/yeast infection, e-coli infection, vaginitis, and/or bacterial vaginosis in the previous 12 months. Frequencies for some of these conditions were not large enough to analyze separately; thus, a single 'reproductive health' variable was created (1' = received medical diagnosis of at least one condition in the last 12 months and '0' = did not receive any diagnosis). A variable capturing past-year diagnosis of tuberculosis (yes/no) was also included. Finally, recent acute diarrhea was captured with a dichotomous variable created from women's answers to the question: 'in the last 2 weeks, have you had diarrhea, defined as passing stool 3 times or more in a 24 hour period – whether watery, bloody, mucoid or water-wash like?' (yes/no).

Household-level factors. A number of household-level variables were included: household monthly income (less than 10,000 KES, between 10,000 and 15,000 KES, or more than 15,000 KES), whether a woman was married, whether the household was headed by a female, number of children, and whether the participant's partner was employed. Access to sanitation was captured with a binary variable ('1' = has access to a toilet for all sanitation needs throughout the day and night; '0' = does not have access at all times). Access to water was captured with a binary variable ('1' = relies on water source inside home/dwelling/building/housing plot; '0' = relies on water source outside home/dwelling/building/plot).

A dichotomous variable for partner's alcohol use was included ('1' = partner gets drunk often/daily; '0' = partner gets drunk occasionally/never). Participants were also asked questions about experiences of common problems residents might face every day or nearly every day in the past two weeks: (1) conflict with family or friends and (2) problems with partner. Individual dichotomous variables (yes/no) pertaining to each question were included. Each participant was also asked four questions about how frequently their partner: (1) spent free time with her, (2) consulted her on different household matters, (3) was affectionate with her, and (4) respected her and her wishes. Possible responses included: '0' = never, '1' = sometimes, '2' = frequently. We took the mean of the responses to all four of these questions to generate a 'relationship support' variable.

Finally, we included a past-year intimate partner violence (IPV) poly-victimization variable. We used a modified version of the domestic violence module used in the Demographic and Health Surveys (DHS) (USAID, 2014). The measure has three sub-scales: psychological, physical and sexual IPV. Psychological IPV was measured with three items, physical IPV with eight, and sexual IPV with three. Dichotomous variables were created for each sub-scale. A participant received a score of '1' on the sub-scale if they answered 'yes' to having experienced any of the items on that sub-scale in the past 12 months. A four-level categorical past-year poly-victimization variable was then created from the dichotomous sub-scale variables ['0' = did not experience past-year IPV, '1' = experienced one type of IPV (psychological, physical, or sexual) in the past year, '2' = experienced two types of IPV, and '3' = experienced all three types of IPV].

Community/interpersonal-level factors. A village/neighbourhood variable was created to distinguish between the 11 villages/neighbourhoods in which data were collected. A dichotomous (yes/no) 'reports frequent problems with authority figures (such as employers, bar owners, police, or government officials)' and a 'health clinic located in village' (yes/no) variable were included. Finally, we included a non-partner violence (NPV) poly-victimization variable in the model. NPV was captured by combining responses from two questions on the survey: 'In the last 12 months has anyone other than your husband/partner: (1) hit, slapped, kicked or done anything else to physically hurt you?' and/or (2) 'forced you to have sex or perform sexual acts when you did not want to?' A three-level categorical past-year NPV poly-victimization variable was created from women's responses to the NPV questions ('0' = did not experience any past-year NPV, '1' = experienced either physical or sexual NPV, and '2' = experienced both physical and sexual NPV).

Analysis strategy

Analyses were conducted in Stata statistical software (version 15; StataCorp, 2015). Descriptive statistics were calculated to provide information about the study sample and the prevalence of depressive symptoms (possible MDD). The first step in exploring factors associated with possible MDD was to run Pearson's Chi-Squared tests (for categorical variables) and bivariate logistic regressions (for continuous variables). If cell size was below five in categorical bivariate analyses we used a Fisher's exact test. Subsequently, a multivariable logistic regression was run to explore factors associated with possible MDD while controlling for covariates. We followed the guidance of Hosmer et al. (2013) for purposeful selection of covariates to build our logistic regression model. Akaike Information Criterion (AIC) and Bayes Information Criterion (BIC) were also used to assess model fit (Faraway, 2002). Variance inflation factors (VIFs) were used to assess multicollinearity of all

independent variables included in the multivariable logistic regression. All VIFs were below the acceptable value of 4.0 (Hair et al., 2010).

Ethics approval

The study was approved by ethics committees at Rutgers, The State University of New Jersey and the National Commission on Science, Technology, and Innovation (NACOSTI/P/18/7495/23034) in Nairobi, Kenya.

Results

Participant characteristics

Descriptive statistics for the sample are presented in Table 1. About 19% of participants in this sample met the criteria for possible MDD based on a cutoff score of 10 on the PHQ-9. The average age for participants was 35 years (SD = 9.8 years). About 58% were employed but some had businesses too. Regardless of being employed, 34% of the total respondents had a business. Although over half of the women reported monthly household incomes of less than 10,000 KES (about US $100), 89% reported having frequent problems with money. Almost 70% reported having good/very good/excellent health, but 44% of all respondents reported having been treated for at least one reproductive or gynecological issue in the past year and 11% reported having been treated for tuberculosis in the past year. About 25% of women reported having acute diarrhea in the past two weeks. Approximately 7% of the women reported that they get drunk often. Close to half (46%) of the sample were married, over 52% lived in a female-headed household, and over 87% had at least one child. Only 40% of the sample reported having access to a toilet at all times and just under 40% had access to water within their home, building, or housing plot. About half of the women reported having experienced any past-year IPV, and 38% reported having experienced at least two types (psychological, physical, or sexual).

Bivariate tests

Results from bivariate tests are presented in Table 1.

Individual-level factors. Age [OR = 1.05, 95% CI [1.027, 1.070], p = 0.000], frequent problems with money [$\chi2$ (1, N = 551) = 8.53, p = 0.003], having good/excellent self-reported health [$\chi2$ (1, N = 551) = 63.84, p = 0.000], acute diarrhea [$\chi2$ (1, N = 551) = 43.41, p = 0.000], and having been treated for tuberculosis [$\chi2$ (1, N = 551) = 16.39, p = 0.000] were all significantly associated with possible MDD.

Family/household factors. Number of children [$\chi2$ (3, N = 549) = 22.65, p = 0.000], partner being employed [$\chi2$ (1, N = 551) = 5.35, p = 0.021], participant's partner gets drunk often [$\chi2$ (1, N = 551) = 6.67, p = 0.010], IPV poly-victimization [$\chi2$ (3, N = 549) = 32.60, p = 0.000], relationship support [OR = 0.4, 95% CI [0.288, 0.590], p = 0.000], frequent problems with family or friends [$\chi2$ (1, N = 551) = 15.45, p = 0.000], and not having access to a toilet at all times [$\chi2$ (1, N = 551) = 8.71, p = 0.003] were significantly associated with possible MDD.

Community-level factors. At the community-level, only village/neighbourhood was significantly associated with possible MDD [$\chi2$ (10, N = 543) = 50.16, p = 0.000].

Multivariable logistic regression

Results from multivariable logistic regressions are presented in Table 2. Results suggest that increasing age is associated with higher odds of possible MDD (aOR = 1.04, 95% CI [1.014, 1.072]). Having good/excellent health was associated with 80% lower odds (aOR = 0.20, 95% CI [0.111, 0.343]).

Table 1. Descriptive statistics.

	Frequency	%	No Possible MDD	Yes Possible MDD	Chi-squared (*Fisher's Exact)
Dependent variable					
Meets criteria for possible major depressive disorder	103	18.7	449	103	–
Individual-level factors					
Education					χ2 (2, N = 550) = 3.97, p = 0.137
less than primary	247	44.7	193	54	
completed primary	129	23.4	105	24	
at least some secondary	176	31.9	151	25	
Age	35(9.8)				OR = 1.05, 95% CI [1.027, 1.070], p = 0.000
18–24	5	11.8	57	8	
25–34	218	39.5	190	28	
35–44	205	37.1	165	40	
45+	64	11.6	37	27	
Employed					χ2 (1, N = 551) = 0.82, p = 0.366
no	230	41.7	183	47	
yes	322	58.3	266	56	
Has a business					χ2 (1, N = 551) = 2.55, p = 0.111
no	364	65.9	303	61	
yes	188	34.1	146	42	
Frequent or daily problems with money					χ2 (1, N = 551) = 8.53, p = 0.003*
no	61	11.1	58	3	
yes	491	88.9	391	100	
Self-reported health is good-excellent					χ2 (1, N = 551) = 63.84, p = 0.000
no	168	30.4	103	65	
yes	384	69.6	346	38	
Participant gets drunk often					χ2 (1, N = 551) = 7.00, p = 0.008
no	511	92.6	422	89	
yes	41	7.4	27	14	
Participant has been treated for recent reproductive health issue					χ2 (1, N = 551) = 1.32, p = 0.250
no	312	56.5	259	53	
yes	240	43.5	190	50	
Participant has had recent acute diarrhea					χ2 (1, N = 551) = 34.41, p = 0.000
no	414	75.0	360	54	
yes	138	25.0	89	49	
Participant has been treated recently for TB					χ2 (1, N = 551) = 16.39, p = 0.000
no	491	88.9	411	80	
yes	61	11.1	38	23	
Family/household-level factors					
Household income					χ2 (2, N = 550) = 9.24, p = 0.010
less than 10k	291	52.7	223	68	
10,000–14,999k	160	29.0	137	23	
more than 15k	101	18.3	89	12	
Participant is aware of household finances					χ2 (1, N = 551) = 0.00, p = 0.967
no	37	6.7	30	7	
yes	515	93.3	419	96	
Married					χ2 (1, N = 551) = 1.50, p = 0.221
no	297	53.8	236	61	
yes	255	46.2	213	42	

(*Continued*)

Table 1. Continued.

	Frequency	%	No Possible MDD	Yes Possible MDD	Chi-squared (*Fisher's Exact)
Male-headed household					χ2 (1, N = 551) = 2.39, p = 0.122
no	263	47.6	221	42	
yes	289	52.4	228	61	
Number of children					χ2 (3, N = 549) = 22.65, p = 0.000
none	71	12.9	60	11	
1–2 children	240	43.5	208	32	
3–4 children	177	32.1	142	35	
5+	64	11.6	39	25	
Partner is employed					χ2 (1, N = 551) = 5.35, p = 0.021
no	223	40.4	171	52	
yes	329	59.6	278	51	
Partner drinks often					χ2 (1, N = 551) = 6.67, p = 0.010
no	428	77.5	358	70	
yes	124	22.5	91	33	
IPV poly-victimization					χ2 (3, N = 549) = 32.60, p = 0.000
No IPV	278	50.4	233	45	
1 form of IPV	66	12.0	61	5	
2 forms of IPV	100	18.1	87	13	
3 forms of IPV	108	19.6	68	40	
Relationship support	.7(.7)				OR = 0.4, 95% CI [.288, .590], p = 0.000
below median	263	47.6	195	68	
median and above	289	52.4	254	35	
Frequent or daily problems with family or friends					χ2 (1, N = 551) = 15.45, p = 0.000
no	433	78.4	367	66	
yes	119	21.6	82	37	
Frequent or daily problems with partner					χ2 (1, N = 551) = 2.35, p = 0.125
no	383	69.4	318	65	
yes	169	30.6	131	38	
Has access to a toilet at all times					χ2 (1, N = 551) = 8.71, p = 0.003
no	331	60.0	256	75	
yes	221	40.0	193	28	
Primary drinking water source					χ2 (1, N = 551) = 0.19, p = 0.664
water inside home/building/plot	220	39.9	177	43	
water outside home/building/plot	332	60.1	272	60	
Community-level factors					
Non-partner violence					χ2 (1, N = 551) = 0.01, p = 0.907
No NPV	463	83.9	377	86	
Experienced NPV	89	16.1	72	17	
Frequent of daily problems with authority					χ2 (1, N = 551) = 0.07, p = 0.766*
no	533	96.6	434	99	
yes	19	3.4	15	4	
Health clinic in village					χ2 (1, N = 551) = 0.79, p = 0.374
no	97	17.6	82	15	
yes	455	82.4	367	88	
Village/neighbourhood					χ2 (10, N = 543) = 50.16, p = 0.000
1	50	9.1	38	12	
2	50	9.1	42	8	
3	50	9.1	33	17	

(*Continued*)

Table 1. Continued.

	Frequency	%	No Possible MDD	Yes Possible MDD	Chi-squared (*Fisher's Exact)
4	50	9.1	29	21	
5	50	9.1	47	3	
6	50	9.1	40	10	
7	52	9.4	46	6	
8	50	9.1	47	3	
9	50	9.1	37	13	
10	50	9.1	49	1	
11	50	9.1	41	9	

Table 2. Results from logistic regression.

	Adj. Odds Ratio	$P>|z|$	LCI[95%]	UCI[95%]
Individual-level factors				
Age	1.04	0.003	1.014	1.072
Self-reported health is good-excellent	0.20	0.000	0.111	0.343
Participant drinks often	3.26	0.012	1.301	8.181
Participant has had recent acute diarrhea	2.15	0.007	1.233	3.740
Family/household-level factors				
Married	2.01	0.157	0.764	5.289
Lives in a female-headed household	2.65	0.029	1.104	6.338
Number of children				
1–2 children	0.32	0.013	0.128	0.789
3–4 children	0.48	0.128	0.187	1.235
5 + children	0.59	0.338	0.202	1.733
Partner is employed	0.32	0.011	0.133	0.770
Relationship support score	0.44	0.012	0.234	0.836
Past-year IPV poly-victimization (ref: no IPV)				
1 form of IPV	1.45	0.550	0.428	4.908
2 forms of IPV	4.63	0.004	1.614	13.285
3 forms of IPV	12.16	0.000	4.702	31.468
Has access to a toilet at all times	0.55	0.049	0.307	0.999
Primary water source is outside the home/plot	0.49	0.010	0.284	0.842
Constant	0.17	0.027	0.034	0.818

Drinking alcohol often (aOR = 3.26, 95% CI [1.301, 8.181]) and recent acute diarrhea (aOR = 2.15, 95% CI [1.233, 3.740]) were associated with higher odds of possible MDD. Living in a female-headed household was significantly associated with higher odds of possible MDD (aOR = 2.65, 95% CI [1.104, 6.338]). Having children, especially 1–2 children, compared to not having children, was associated with 78% lower odds of possible MDD (aOR = 0.32, 95% CI [0.128, 0.789]). Having more than 2 children was not associated with significantly higher odds of possible MDD. Having a partner who is employed was associated with lower odds (aOR = 0.32, 95% CI [0.133, 0.770]). Each one-unit increase on the relationship support scale was associated with lower odds of possible MDD (aOR = 0.44, 95% CI [0.234, 0.836]). Past-year IPV, especially IPV poly-victimization, was associated with higher odds of possible MDD (aOR$_{one-form}$ = 1.45, aOR$_{two-forms}$ = 4.63, aOR$_{three-forms}$ = 12.16). Having access to a toilet at all times (aOR = 0.55, 95% CI [0.307, 0.999]) and relying on water from a source outside one's home, housing plot, or building (aOR = 0.49, 95% CI [0.284, 0.842]) were associated with lower odds of possible MDD.

Discussion

The purpose of this paper was to explore social and environmental factors associated with possible MDD in a probability sample of women in a large informal settlement in Nairobi, and, in doing so, to identify potential points for intervention and/or support. Findings from the study suggest that physical health and economic stress factors at the participant-level; household and relationship

dynamics and demographics as well as differing access to water and sanitation at the household/familial-level; and village/neighbourhood at the community-level are all important factors associated with possible MDD in this settlement. We will discuss these findings and the insights they provide into possible responses for health promotion and interventions in informal settlements.

At the participant-level, physical health-related factors have an important association with possible MDD. Many studies have shown that physical and mental health are directly and indirectly linked (Ohrnberger et al., 2017). Findings from this study suggest that positive self-reported health may be inversely associated with possible MDD, which corroborates findings from another study that suggest this self-reported health measure is associated with possible MDD in adults living with HIV/AIDS in Western Kenya (Monahan et al., 2009).

Several other health-related variables emerged as factors associated with possible MDD. Increasing age was associated with higher odds of possible MDD in bivariate and multivariable analyses. In bivariate tests, reports of recent acute diarrhea, having been seen/treated for tuberculosis, and getting drunk often were also significantly associated with possible MDD, but only acute diarrhea and getting drunk often remained significantly associated with possible MDD in the multivariable model. The association and co-morbidity of alcohol use, abuse, and dependency and MDD is well established in the literature (Sullivan et al., 2005). There is, however, a lot less literature exploring the relationship between infectious diseases and depression (Canli, 2014; Müller, 2014). In one notable exception, Ballou et al. (2019) found that chronic diarrhea was significantly more prevalent in depressed individuals than non-depressed individuals in a large sample of the general US population. The associations between health-related factors and possible MDD may be especially evident in informal settlements where access to healthcare is limited and often too expensive for community members (Fotso & Mukiira, 2011) and where the physical and built environment can add additional challenges for residents with health conditions, chronic illness, or disability (Barbareschi et al., 2020).

Largely due to the racial segregation that influenced where most native African migrants to Nairobi could settle and who was given access to formal services during the colonial period, today's informal settlements in the city are mostly located in valleys, floodplains, waste dumps, and industrial sites and have limited access to formal water, sanitation, electricity, sewerage, and garbage collection services (Darkey & Kariuki, 2013). Only about 40% of women in this study, for example, have access to a toilet at all times throughout the day and night, and most of these toilets are located outside homes, housing plots, and buildings (Winter et al., 2019c). About three-quarters of the women in this study also rely on public taps or wells or shared taps or wells outside of their homes, housing plots, or buildings. Given the challenges of navigating the physical and built environment and accessing consistent, adequate, and safe water and sanitation, physical health and perceptions of health may play particularly important roles in mental health in these communities. Findings from this study suggest, for example, that having access to a toilet at all times is associated with lower odds of possible MDD. Relying on a primary water source outside of one's home, housing plot, or building was also associated with lower odds of possible MDD. Findings from other studies focused on women in informal settlement contexts suggest that access to a toilet at all times and collecting water from public or community taps outside the home is associated with better health-related quality of life measures (Winter et al., 2019c) and reduced odds of experiencing interpersonal violence (Barchi et al., 2022; Winter et al., 2022). We hypothesize this may be because water taps outside the home can be spaces for women to come together, do laundry, fill jerry cans and socialize, which may be associated with positive psychosocial health outcomes (Winter et al., 2019c). Regularly visiting water sources outside the home may also provide women with an acceptable opportunity to get away from perpetrators of violence who reside at or near women's homes (Winter et al., 2022), which may also be associated with better mental health outcomes. Finally, studies suggest that relying on in-home water taps or wells may be associated with higher rates of diarrhea – another health-related factor in this study associated with higher odds of possible MDD (Winter et al., 2019a).

In addition to health-related variables, economic stress seems to be an important factor in women's mental health in this context. Research has demonstrated that living in economically disadvantaged neighbourhoods (Schulz et al., 2006), socioeconomic status (Peltzer & Pengpid, 2020), income (Huato & Chavez, 2021), and financial stress/strain (Starkey et al., 2013) are associated with mental health outcomes in different contexts (Das et al., 2008; Nduna & Jewkes, 2012), including in informal settlements in sub-Saharan Africa (Gibbs et al., 2018; Peltzer & Pengpid, 2020). Gibbs et al. (2018) found that borrowing food or money weekly or more because of not having enough was associated with greater depressive symptoms for women in informal settlements in South Africa. Findings from our study suggest a similar association. Although income did not emerge as a significant factor, frequent or daily problems with money (economic stress) did. Although the frequency distribution across categories of our binary depressive symptoms variable did not allow for us to include the frequent or daily problems with money variable in the multivariable analysis, we believe this limitation actually highlights the importance of this factor. Of the 103 women in the sample who met the criteria for possible MDD, 97% (n = 100) reported that they had frequent or daily problems with money. This finding suggests that financial or economic stress or strain are important factors to consider when responding to mental health needs in these communities. In previous studies, tangible assistance, including housing, food, medical insurance, utility assistance, money, childcare, disposable diapers, formula, loan forgiveness/debt relief, education assistance, and transportation assistance, have been identified as helping women experiencing financial difficulties in Global North contexts (Starkey et al., 2013). We assume that interventions offering tangible assistance might also benefit women experiencing financial hardship in informal settlements; however, the form of tangible assistance might differ. For example, some literature suggests that microfinance can improve mental health in Global South contexts (Goodman et al., 2020; O'Malley & Burke, 2017; Rao et al., 2011). Other studies, however, have also shown no significant, direct effects of microfinance on depression (Yount et al., 2021). This suggests there is a need for more research into the sources of economic stress for women in informal settlements and the types of tangible assistance that might reduce that stress.

At the interpersonal/household level, household and relationship dynamics and demographics, including number of children, living in a female-headed household, relationship support, partner employment and IPV poly-victimization, emerged as significant factors associated with possible MDD. Having children, compared to not having children was associated with lower odds of possible MDD. This finding may reflect a joy of having children and/or the accomplishment and acceptance of meeting social and community expectations about being a mother; however, only having 1–2 children, compared to none, was associated with lower odds of possible MDD. Having more children was not. This could, perhaps, reflect the potential economic stress of having more children in this context. The negative association between partner being employed and the positive association between living in a female-headed household and possible MDD may also reflect the role of economic stress or strain in depressive symptoms in informal settlements. Although female-headed households are not homogeneous in nature (Schatz et al., 2011), most literature suggests that female-headed households in informal settlements often have higher rates of unemployment and less access to formal financial and other resources (Gaisie et al., 2021).

In addition to household demographic variables, relationship dynamics emerged as important factors in this study. In particular, increasing levels of relationship support from a partner was associated with lower odd of possible MDD. On the other hand, IPV, especially IPV poly-victimization, was associated with increased odds of possible MDD. The effects of poly-victimization on poor physical and mental health, psychopathological and psychosomatic symptoms, trauma and behavioural problems across the lifespan have been explored in a number of studies (Barnes et al., 2016; Chan, 2017; Charak et al., 2016; Richmond et al., 2009; Sabina & Straus, 2008; Turner et al., 2017; Wolfe, 2018). Additionally, research suggests that IPV, unequal gender roles and responsibilities, and control by family and parents may exacerbate women's vulnerability and economic stress in informal settlements and may also be associated with economic abuse (Kanougiya

et al., 2021; Maclin et al., 2022). This may have additional or compounding effects on mental health for women in these communities. For example, findings from a study carried out in informal settlements in Mumbai, India suggests that economic abuse – a form of violence in which a partner exerts control over a victim's ability to aquire, use, or mantain access to economic resources with the intention of limiting the victim's economic self-sufficiency – is not only prevalent (23%), but is also associated with other forms of IPV and higher levels of depressive symptoms (Kanougiya et al., 2021). There is, however, limited research focused on exploring these links between gender norms and responsibilities, family or partner control, IPV, economic stress or strain, and depression in these informal settlement communities – highlighting an important area for future research. In addition, despite clear associations between IPV and depressive symptoms in this study and others, there are few interventions focused on preventing and/or providing specific forms of support to women experiencing IPV, especially economic abuse and poly-victimization, in informal settlements. Findings from this study suggest that these forms of support may be particularly important for women in these communities.

Village/neighbourhood also emerged as an important factor associated with possible MDD. Again, the frequency distribution across categories of the binary possible MDD variable did not allow for us to include village/neighbourhood in the multivariable analysis. However, the bivariate findings suggest that possible MDD may vary considerably between villages/neighbourhood. It is hard to know the specific reasons for these geographical differences, but several studies have shown associations between neighbourhood disadvantage and mental health in the Global North (Kim, 2010) and Global South (Nduna & Jewkes, 2012). Findings from this literature suggest that factors in the neighbourhood, such as concentration of poverty, female-headed households, social relationships, and perceived neighbourhood disorder or financial hardships, unemployment, and negative home dynamics influence residents' mental health. Findings from this study highlight a need for more research focused on possible neighbourhood – or village-level factors associated with depressive symptoms in informal settlements in particular.

Limitations and Reflections on Research and Researchers. Findings from this study help provide insights into factors associated with possible MDD in informal settlements; however, the study had a number of limitations. First, the data are cross-sectional; thus, inferences cannot be made about the directionality of associations between specific factors and possible MDD. Future longitudinal studies would be advantageous in exploring temporal relationships between these factors and possible MDD as well as programs, interventions, and factors in women's physical and social environment that might reduce risk or symptoms of possible MDD.

Second, we chose to use a screening tool (the PHQ-9) as opposed to a diagnostic tool in this study. Although using a screening tool like the PHQ-9, rather than a diagnostic tool, may overestimate prevalence of possible MDD in this population (Fekadu et al., 2022), the screening tool had several advantages for us including not requiring specialists to administer and helping us to detect participants who might need to be referred to services (e.g. on-call or in-person counselling). However, it should be made clear that our findings reflect only symptoms of depression or possible MDD, not diagnosis or clinical detection of MDD. In addition, the PHQ-9 was developed as a screening tool for use largely in clinical settings in the US and Global North; thus, there may be limitations to using this tool in a different population, language, and social-cultural context. Recent studies have illustrated, for example, that there may be some comprehension-, decision process, and response process issues with the Kiswahili version of the PHQ-9 (Green et al., 2018) and that there may be more reliable/valid measures of depression among certain populations in Kenya (Green et al., 2018). These studies also suggest that the PHQ-9 is still a reasonably reliable and valid measure of depressive symptoms in Kenya and that small adjustments to the instructions and item wording of the PHQ-9 can improve its validity, specifically among women (Velloza et al., 2020). Unfortunately, the publication of these adjustments came out after the design and data collection of this study; thus, they were not included. However, they should be considered in future implementation of the PHQ-9.

Studies taking place in Kenya and other sub-Saharan African contexts have also used varying cutoffs for measuring possible MDD on the PHQ-9. Some have used lower cutoffs of ≥9 (Tele et al., 2022) or ≥10 (Akena et al., 2013; Cholera et al., 2014; Gelaye et al., 2013; Monahan et al., 2009; Mwangi et al., 2020). Others have used a higher cutoff of ≥14 (Velloza et al., 2020); however, there is limited guidance around clinically relevant cut-off scores for the PHQ-9 in Kenya (Velloza et al., 2020), and there is no research focused on the optimal cutoff scores to identify possible MDD without too many false positives among adult women living in informal settlements in Kenya. This highlights a need for more research focused on identifying the most appropriate depression screening tools and optimal cutoffs or scoring algorithms for this population and setting. Additionally, there is a need for research that looks at co-occurring or related mental health conditions, including anxiety and post-traumatic stress, among women in informal settlements.

Limited variability in responses to the income and frequent problems with money variables used in this study highlight the need for measures that better capture economic stress and strain, socio-economic status, and wealth. Because possible MDD is a relatively rare event, we had to dichotomize several variables or collapse the number of response categories for others to ensure there was an adequate distribution of possible MDD frequencies across all categories of the independent variables. For some variables, the use of indicator variables helped clarify relationships between potential factors and possible MDD (e.g. number of children); however, dichotomizing continuous, ordinal, or nominal variables and collapsing response categories of multi-category nominal variables can lead to a loss of information and power.

Finally, study design was developed and overseen by a foreign-born white woman and a Kenyan-born Black woman who had never lived in an informal settlement. Although both researchers lived in Nairobi before, during, and after data collection for this study, had carried out previous research in this informal settlement, and could speak both Swahili and English, they were none-the-less outsiders to the community. Researchers worked with a team of women who lived in Mathare who contributed to development, review, editing, and translation throughout the study. Authors include a foreign-born white woman who was part of the original research team and two Kenyan-born Black women and a Kenyan-born Black man who are experts in mental health in Kenya. Findings and our interpretations should be viewed in light of the positionality and approaches of the researchers, authors, and study team (Jafar, 2018).

Conclusion

Findings from this study highlighted the potential importance of physical health and/or perceptions of health, economic stress, access to water and sanitation, household and family dynamics, and village/neighbourhood differences in women's possible depression in informal settlements. These findings highlight potential points for research, intervention and policy including: (1) providing appropriate tangible assistance or other interventions, e.g. consistent and well-paying employment opportunities, to reduce economic stress/strain; (2) expanding access to water and sanitation and, in doing so, potentially reducing burdens to physical health such as infectious diseases; (3) providing and expanding healthcare services to include mental healthcare and increasing access to existing services; and (4) more research, policy and intervention efforts focused on addressing violence against women as well as investigating family dynamics and bolstering support for families and survivors of IPV in informal settlements. Overall, findings from this study highlight that, given the continued growth of informal settlements, there is a critical need for more research and effective strategies for preventing and providing support to residents experiencing depressive symptoms in these communities.

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