Factors associated with Depression among Older Persons age 60 and over in Nairobi

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Abstract

This study explores the association between physical multi-morbidity, social exclusion, and depression among older persons living in Nairobi, Kenya. Depression is a significant concern, particularly in low and middle-income countries (LMICs), where a large percentage of the elderly population experiences depressive symptoms without access to treatment. The paper aims to identify population groups vulnerable to depression and understand the interplay of factors contributing to its prevalence.

The study utilizes data from a longitudinal survey conducted in Nairobi, Kenya, covering socio-demographic, social engagement, and health status variables. The analysis involves bivariate and multivariate approaches to identify factors associated with depression. Results indicate that being in a marital union, engagement in social activities, and having access to mass media are protective factors against depression. Conversely, the presence of chronic illnesses, extreme difficulties in daily living, and loneliness significantly increase the likelihood of depression.

The findings underscore the importance of addressing social isolation and loneliness as crucial factors contributing to depression in older populations. The study recommends further nationally representative research to determine the magnitude of the problem and associated risk factors. Addressing barriers to mental health care, investing in trained health-care providers, and reducing social stigma associated with mental disorders are crucial steps highlighted for effective intervention. The World Health Organization's Mental Health Action Plan 2013-2030, emphasizing psychological interventions delivered by lay workers, is suggested as a valuable resource in extending mental health care to communities.

Introduction

The Institute for Health Metrics and Evaluation (IHME)estimates that 14 percent of adults aged 60 and over live with a mental disorder (IHME 2021; WHO 2023). The most common mental health conditions for older adults are depression and anxiety (WHO 2023). More than 80 percent of the depression burden is among people living in low and middle-income countries (LMICs) (CORDIS| European Commission, 2021). In Africa, a study in Ghana reported that large numbers of older people experience depression, but very few have access to treatment (Lloyd-Sherlock et. al., 2019).

Depression is an important issue due to rapid aging occurring particularly in LMICs, and the fact that late-life depression is associated with greater risk of morbidity, increased use of hospital and outpatient medical services, and a worse quality of life (WHO 2023; Blazer, 2003). There is limited evidence about the prevalence of depression among older people in sub-Saharan Africa (Lloyd-Sherlock et. al., 2019) because there has been limited research in African settings on the determinants of depression or depressive symptoms among older adults (Baiyewu et. al., 2015). Scholars have therefore urged for the need to identify risk factors of depression in old age in LMICs so as to inform targeted interventions (Smitth et al 2022). Wilby (2011) emphasized the need to better understand the quality and meaning of different types of social relations in old age because depression among older adults are predictive of functional impairment, poor quality of life, increased use of health services, and increased mortality (Cole et. al., 2003; Chan et. al., 2011).

Study objectives

Depressive symptoms are known to be predictive of poor quality of life and increased morbidity and mortality (Chan et. al., 2011; WHO 2023), it is important to identify population groups that may be vulnerable to depression. This study therefore aims at exploring the association between physical multi-morbidity, social exclusion and depression, among older persons living in Nairobi, Kenya.

Brief Review of past studies

The relationship between depression, poverty, social network, and perceived health in Africa are scarce and the magnitude of the problem remains largely unknown (McKinnon et. al.,2013). However, some studies have shown a strong positive association between social engagement and physical and mental health outcomes (Jung et al 2010; Glass et al.,2006). A scoping review by Courtin and Knapp (2017) indicated that social isolation and loneliness which are common among older people, are both negatively associated with mental and physical health, but little is known about causal links.

Studies have shown that depression is a common medical condition among older people and is a major public health concern in both high-and low-income countries (Cole et. al., 2003; Chan et. al., 2011). A systematic review and meta-analysis study recently showed that the prevalence of geriatric depression among older people was nearly 32 percent, with a higher rate in developing countries at about 41 percent (Zenebe et. al., 2021). Another meta-analysis indicated that pooled prevalence of depression among older people in Africa was 26.3 percent (95% CI; 22.2, 30.4%) (Asres 2022). The study further indicated the prevalence may be dependent of the tool used to measure indicators of depression and

could be as high as 43 percent in Africa in studies that used a screening tool to measure depression when compared to studies that used a diagnostic tool (24.2%) (Asres 2022).

Globally, research has showed a higher prevalence of depression among women (Mulat et. al., 2021; Girgus 2015; Lun e.t al., 2017; Kodjebacheva et. al., 2015). McKinnon et. al., (2013) has also showed even in Sub-Saharan countries women were more likely to have depression compared with men. The high risk of depression among older women compared to men could be due to psychosocial mediators such as obesity, perceived interpersonal and behavioural issues (Girgus et. al., 2015). The other reasons that have been suggested include differences in help-seeking behaviour, gender roles, and social and biological factors (Muhamad et. al.,2023; Van de Velde et. al., 2010; Kuehner 2003). Women may also have different ages of onset of depression, disease course, internalizing factors for depression, and symptom profile of mental illnesses (Faravell et. al., 2013). On the other hand, financial dependencies on others or spouses may be another major factor that can lead to increased risk of late-life mental illnesses and depression among older women (Srivastave et. al., 2021; Muhamad et. al., 2021). Parker and Brotchie (2010) explain that women are either differentially exposed to a greater number of life stressors and/or are more vulnerable to them (Kuehner 2003). Women are also more willing to admit and report the symptoms and affective depressed feelings when asked in comparison to men (Faravell et. al., 2013; Kiely 2019). Over time, men are more likely to forget episodes while women are more likely to remember them which can lead to reporting biases (Parker and Brotchie, 2010).

Apart from gendered difference, the World Health Organisation (WHO) (2021, 2023) noted that depression results from a complex interaction of social, psychological, and biological factors. In developing countries, studies have noted that the major contributing factors for geriatric depression include having a history of chronic illnesses, poor social support, age, and marital loss (Mulat et. al., 2021), poor quality of life, low income, having low educational status, coming from families prone to mental illness, and cognitive impairments (Anbesaw & Fekadu 2020). Blazer (2003) concluded that common risk factors for depression among older adults are low socioeconomic status, lack of social support, and poor health. However, it has also been reported that people who have gone through adverse life events such as unemployment, bereavement, traumatic events are more likely to develop depression (WHO, 2021).

Loneliness pertains 'to the feeling of missing intimate relationships or missing a wider network', and is 'an individual's subjective evaluation of his or her social participation or isolation' (de Jong et al., 2004). Loneliness is strongly associated with depression (Weeks et al., 1980) however, loneliness and depression frequently co-occur, and measures of the two states are substantially correlated (Weeks et al., 1980). Nevertheless, literature also shows that depression and loneliness are separate entities (Stek et al., 2005) and loneliness is an independent risk factor for depression in old age (Alpass and Neville, 2003; Adams et al., 2004; Paul et al., 2006; Theeke et. al., 2012).

A scoping review by Courtin and Knapp (2017) indicated that social isolation and loneliness which are common among older people, are both negatively associated with mental and physical health, but little is known about causal links. Evidence from longitudinal research shows that even after

controlling for demographic characteristics, marital status, social isolation and psychosocial risk factors, loneliness is still an independent risk factor for depression (Cacioppo et al., 2010).

A study using data from 15 countries in Sub-Saharan Africa reported that older people living in single-generation households reported a higher prevalence of depressive symptoms compared to those living with at least one working-age adult (McKinnon et. al., 2013). The detrimental effect of living alone on depression is more often due to loneliness for men compared to women (Park et al., 2013). A mixed method study of chronic depression in older British Pakistani women found that the persistence of depression was partly explained by social isolation (Gask et al., 2011). However, Wilby (2011) reported that depressed older people were not socially isolated but were, on the contrary, more likely to report contacts than non-depressed respondents.

Smith et. al., (2022) using data from LIMCs report that physical multi-morbidity is associated with increased odds for depression among older adults in LMICs. In particular, factors such as pain/discomfort, sleep/energy, and mobility may be important mediators in this association (Smith et. al., (2022). Smith et. al., (2022) therefore call for future longitudinal and intervention studies to assess possible temporal associations and the effect of addressing the potential mediators on depression in people with multi-morbidity among older people in LMICs.

The burden of geriatric depression has not been properly addressed in Sub-Saharan Africa due to the insufficient data (Steel et. al., 2014). However, it is important to note that the social determinants of late-life depression in Sub Saharan Africa may be different from those in high income countries (Ojagbemi A et al 2020). This directly affects mental health care delivery in different communities (Steel et al 2014). WHO in 2023 noted that mental health conditions among older people are often under recognized and undertreated, and often people are reluctant to seek help (WHO, 2023). In Kenya there are few community-based studies on depression among older people(Samantha et al 2023).

Study setting

According to Kenya Constitution 2010, Kenya is divided into 47 sub regions called counties.Nairobi City County is one of 47 counties with 11 administrative Sub-Counties (Dagoretti, Embakasi, Kamukunji, Kasarani, Kibra, Lang'ata, Makadara, Mathare, Njiru, Starehe and Westlands). This study was conducted in two administrative counties; Kibra and Dagoretti shown in Figure 1.

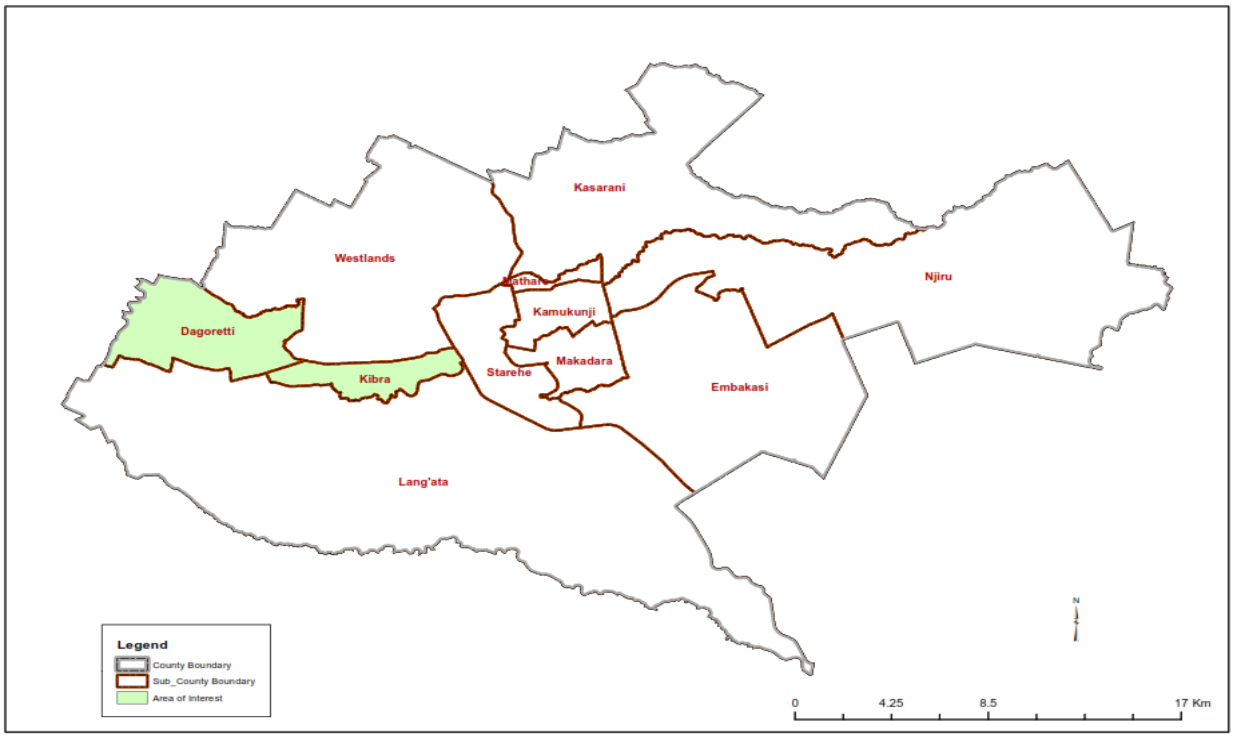

Figure 1: Map of study sites of Dagoretti and Kibra (in green shade) within Nairobi County

According to latest population census (2019 population and housing census), Nairobi had a population of 4,396,828 with the study sites Kibra and Dagoretti (North and South) having a population of 383,240 and 434,177 respectively. Kibra had a total population of 14,660 older persons age 60 and over while Dagoretti (North and South) had 9,145. There were slightly more males living in the regions relative to women.

Table 1: Distribution of population in the study sites

	Total Population	Population age 60 and over	Share of older persons to total population(%)	Sex ratio (Males per 100 females)
Nairobi	4,396,828	101, 127	2.3	114
Kibra	383,240	14,660	3.8	120
Dagoretti (North and South)	434,177	9,145	2.1	110

Source: KNBS 2022

Data and methods

Data

The data comes from the first wave of a longitudinal study carried out by Help Age International and the Population Studies and Research Institute of the University of Nairobi, that was conducted in

selected sub-counties (administrative regions) of Nairobi City in March 2021. At the preliminary stage, a listing of all households in the study site was done (including all household members by age and sex). The households selected for the longitudinal study was made based on the criteria that it had at least one older person age 60 and over who must have lived in the area continuously for at least 6 months.

The number of households that participated in the surveys was 2,458 with 7,819 household members listed. There were 2,609 individuals age 60 years and above who had lived in the sub-counties for at least 6 months. The breakdown of the households, household members and older persons covered by sub-county is shown in Table 2.

Table 2: Number of households, household members and older persons by study site reached

Sub-county	Number of households	Members in the households	Number of older persons
Dagoretti North	489	1,643	522
Dagoretti South	721	2,293	805
Kibra	1,248	3,883	1,282
Total	**2,458**	**7,819**	**2,609**

Data was collected using two survey instruments: household and individual older person questionnaires. The household questionnaire had six modules namely; household members, household characteristics, water and sanitation, food insecurity, food consumption and expenditure, and household expenditure. The individual questionnaire had 11 modules which included; age, sex, marriage and family, work, social protection, decision making, social and community engagement, self-reported health status, chronic conditions, lifestyle/health behaviour, health utilization, intergenerational care and subjective wellbeing.

Data collection took a total of 12 days and was captured using computer-assisted personal interviews (CAPI) designed in android smart phones/tablets installed with Survey CTO. This, tool enables automatic upload of survey data to a secure, password protected server.

Analysis method

Study utilized logistic regression analysis method with depression as the response variable and the predictor variables were grouped into three broad areas namely: socio-demographic, social engagement and health status.

Response (Dependent) variable

The response variable was obtained from responses to a series of items shown Table 3. Hoyle et al (1999) evaluation the reliability of the items found them to be suitable for determining individuals who were more likely to depressed.

Table 3: The 5-item Question items for determining whether and individual is likely to be depressed (GDS) (5 -point geriatric scale)

	Question Item	GDS score based on response categories
1	Are you basically satisfied with your life?	No=1 else 0
2	Do you often get bored?	Yes =1, else 0
3	Do you often feel helpless?	Yes =1, else 0
4	Do you prefer to stay at home rather than going out and doing new things?	Yes =1, else 0
5	Do you feel pretty worthless the way you are now?	Yes =1, else 0

Figure 2 shows the distribution of respondents by responses to the geriatric depression scale items. The distribution of persons by item responses to the geriatric depression scale indicate that feeling bored was cited by the highest proportion of older persons while feeling of worthlessness was least cited. The final number of respondents was 2607, while 2 respondents were dropped because they did not complete the interview.

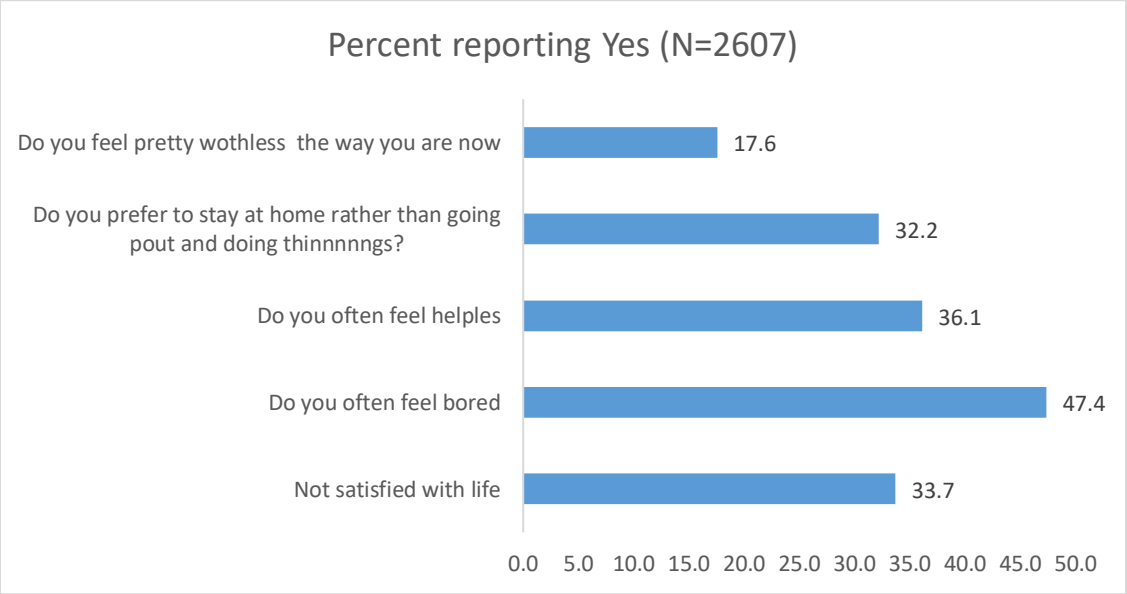

Figure 2: Percent distribution of sampled population by items related to depression symptoms. (note there are multiple responses)

The analysis was also done using Item responses theory (brief is provided in the appendix 1). A simple score was obtained by summing up the scores for the 3 items for each individual. The total scores vary from zero (0) to five (5). A sum of 2 or more was considered as suggestive of a depression (see also

Hoyle et. al., 1999). This was also validated using results of the Item Response Theory (IRT) shown in appendix 1. A binary variable was obtained based on the sum of GDS score where 1 coded for those who scored 2 or more and 0 for a score of 1 or 0 (Hoyle et. al., 1999).

Explanatory variables

The socio-demographic variable included: sex, age, marital status, educational attainment, and working status. The second group of variables were constructed from individual responses to questions on social engagement. These were social participation and social isolation. Social participation refers to a person's involvement in activities providing interactions with others in the community. Social isolation was measured by a loneliness index.

Loneliness index was generated from the University of California-Los Angeles (UCLA) scale (Russel, 1996). This scale comprises 3 questions that measure three dimensions of loneliness: relational connectedness, social connectedness and self-perceived isolation[1]. The UCLA items are :1) how often an individual feel that he or she lacks companionship; 2) how often an individual feels left out, and 3) how often an individual feels isolated from others. The responses to each of the items were categorized as: 1) hardly ever or never; 2) some of the time; and 3) often. Russell, (1996) indicated that UCLA items are highly reliable. The UCLA 3-item version has been validated in several countries, such as Canada, Turkey, Italy, Persia, and Japan (Bottaro et al 2023).

The loneliness index is obtained by summing up responses for each individual. The lowest possible combined score was 3 (no incidence of loneliness) and the highest was 9 (frequent loneliness). In this study, the average score was obtained and those whose sum of scores for the three items was higher than the average, loneliness index was code as 1 while those whose sum of scores the three items was average or lower was coded as 0. There other suggestions that a score of 3-5 denoted as not lonely and 6-9 as lonely[2].

The final group of variables were indicators of health status that is physical chronic illnesses and difficulties of daily living.

Bivariate analysis of factors associated with depression

Cross classification of the presence of depression symptoms and the predictor variables are shown in Table 4. About 48 percent of the sampled population are likely to have depressive symptoms, with slightly more females (49.9%) than males (45. 5%).

The chances of having depression is highest among persons' age 60-64, thereafter it declines up to age 75-79 with slight rise among those age 80 and over. The chances of having depressive symptoms is lowest among those currently married and highest among those who were either divorced or

[1] See www.sense.org.uk/content/communicating-people-who-are-deafblind

[2] See www.sense.org.uk/content/communicating-people-who-are-deafblind

separated. Having depressive symptoms appears to decline with an increase in the level of education but the differences are not statistically significant.

Social participation and social isolation are important factor. Persons engaged in some economic activity or are socially active are less likely to be lonely. Nearly 3 out of every 4 persons who are lonely are likely to have depressive symptoms. The risk of depression increases with the number of chronic conditions and also with difficulties in the instrumental activities of daily life (IADL).

Table 4: Cross classification of the explanatory factors and indicator of depression (N=2607)

Broad group	Variable	Variable Category	Percent with depressive symptoms	P- value
		Overall	47.9	
Socio demographic	Sex	Male	45.5	P< 0.05
		Female	49.9	
	Age group	60-64	51.7	P<0.01
		65-69	49.0	
		70-74	41.8	
		75-79	41.6	
		80+	47.3	
	Current Marital Status	Never married	52.0	P<0.01
		Currently married	42.0	
		Widowed	53.4	
		Divorced/Separated	57.2	
	Current Economic Activity	Does not work	50.7	P<0.01
		Works	44.5	
	Highest level of education reached	Never been to school	50.5	P=0.135
		Primary	48.2	
		Secondary+	44.8	
Social Engagement	Media	No access to media	57.7	P<0.01
		Have access to media	45.7	
	Loneliness	Not lonely	33.2	P<0.01
		Lonely	74.2	
	Social activity	Not active	52.1	P<0.01
		Socially active	39.9	
Health Status	Instrumental activities of daily life (IADL)	0(None)	37.2	P<0.01
		1	51.1	
		2	48.4	
		3 or more	65.2	
	Number Physical Chronic	0(None)	35.4	P<0.01
		1	46.0	

	Conditions	2	52.4	
		3 or more illnesses	58.8	

Multivariate Analysis of Factors associated with depression

This section presents the results of exploration of factors associated with having depressive symptoms. The analysis was done in five steps (indicated as models 1 to 5) shown in Tables 5 and 6. Some variables were recoded to avoid situations of sparse data after review.

Table 5 presents the results for models 1 to 3. In model 1, only demographic variables (sex and age) were included. In model 2, current union status was added while in model 3 other social variables were included.

The results from model 1 show that there exists higher risk of having depression among females compared with men even after controlling for age. However, in model 2, after controlling for marital status the sex effect reverses. All other factors remain the same except that the age 80 and over becomes significant. It appears that being in union modifies the effect of sex and age on depression, respectively. In model 3, when social and economic characteristics of the individuals are included, the number of cases in the analysis reduced by 38 since the analysis model drops cases listwise. The effect of demographic factors remains the same as in model 2 but the magnitude of the odds ratios changed. There are no significant differences by level of education. Those who are currently working and those who are socially active are less likely to show symptoms of depression.

Table 5: Logistic regression results on factors associated with likelihood of having depression (models 1 to 3)

	Model 1			Model 2			Model 3		
	Odds ratio	S.E.	Z	Odds ratio	S.E.	Z	odds ratio	S.E.	Z
Sex (ref=male)									
Female	1.20*	0.10	2.32	0.80*	0.08	-2.21	0.76**	0.08	-2.61
Age group (ref=60-64)									
65-69	0.90	0.09	-1.08	0.86	0.09	-1.48	0.86	0.09	-1.44
70-74	0.67**	0.08	-3.52	0.62**	0.07	-4.14	0.57**	0.07	-4.66
75-79	0.66**	0.10	-2.82	0.58**	0.09	-3.68	0.49**	0.08	-4.58
80+	0.81	0.11	-1.48	0.66**	0.10	-2.86	0.51**	0.08	-4.29
Marital status (ref=not in union									
in union				0.50**	0.05	-6.71	0.51**	0.05	-6.3
Education (ref=none)									
Primary							0.99	0.11	-0.14
Secondary							0.91	0.12	-0.68

Higher							0.79	0.21	-0.91
Economic Activity (ref=none)									
Work							0.73**	0.06	-3.61
Socially active (ref=not active)									
Active							0.62**	0.05	-5.46
_constant	0.97	0.07	-0.36	1.83**	0.22	4.94	2.76**	0.46	6.02
Number of cases	2607			2607			2,569		
Likelihood Ratio chi2(19)	22.32			68.34			115.33		
Prob > chi2	0.0005			0.0005			0.0005		
Log likelihood	-1793.5972			-1770.59			-1720.8		
Pseudo R^2	0.0062			0.0189			0.0324		

*In model 3, the number of observations with complete information was 2569, other cases were dropped from the analysis.

The results of model 4 and 5 are presented in Table 6. Model 4 contains, demographic, economic, social engagement and reported health status variables except loneliness. In model 5, education was dropped but loneliness was included. Model 5 explains greatest variation as shown by the value of Pseudo R^2 which increased from 0.036 to 0.17. The general direction of the differentials remains the same as in model 3 and 4 except the changing magnitude of the odds ratios.

In Model 5, there is a strong positive association between social engagement variables (being socially, loneliness and engagement in some economic activity), physical health outcomes (chronic illness and extreme difficulty) and depression. Older persons who are lonely are 5 times likely to be depressed compared with those who are not lonely.

Table 6: Logistic regression results on factors associated with likelihood of having depression

	Model 4			Model 5		
	odds ratio	S.E.	Z	odds ratio	S.E.	Z
Sex (ref=male)						
Female	0.76*	0.08	-2.53	0.75*	0.09	-2.5
Age group (ref=60-64)						
65-69	0.86	0.09	-1.4	0.83	0.09	-1.65
70-74	0.58**	0.07	-4.52	0.54**	0.07	-4.56
75-79	0.50**	0.08	-4.41	0.43**	0.07	-4.87
80+	0.52**	0.08	-4.16	0.42**	0.07	-5.02
Current status (ref=not in union)						
in union	0.54**	0.06	-5.86	0.76**	0.09	-2.27
Education (ref=none)						
Primary	1.00	0.11	0.02			
Secondary	0.94	0.13	-0.44			
Higher	0.82	0.22	-0.75			
Economic Activity (ref=no work)						
Work	0.71**	0.06	-3.9	0.77**	0.08	-2.67

Socially active (ref=not active)						
Active	0.63**	0.05	-5.31	0.64**	0.06	-4.58
Any media access (ref=none)						
Yes	0.67**	0.07	-3.72	0.69**	0.08	-3.13
No of chronic illnesses(ref=none)						
1				1.46**	0.19	2.95
2				1.68**	0.23	3.8
3 or more chronic conditions				2.23**	0.34	5.27
No of Extreme difficulties (ref=none)						
1				1.54**	0.23	2.91
2				1.37	0.26	1.63
3 or more extreme difficulties				2.34**	0.26	7.58
Loneliness (ref=not lonely)						
Yes				5.17**	0.51	16.76
_cons	3.64**	0.68	6.96	0.81	0.16	-1.06
Number of cases	2,569			2569		
Likelihood Ratio chi2(19)	129.24			607.75		
Prob > chi2+	0.0005			0.0005		
Log likelihood	-1713.8444			-1474.59		
Pseudo R^2	0.0363			0.1709		

In model 4 and 5, the number of observations with complete information was 2569, other cases were dropped from the analysis.

Discussion

This study explored the association between physical multi-morbidity, social exclusion and depression, among older persons living in Nairobi, Kenya. We used multiple linear logistic regression to determine the strongest factors associated with depression amongst older persons living in Nairobi, Kenya from Dagoreti North, Dagoretti South and Kibra sub-Counties.

A unique result in this study is that although women had higher prevalence of depression, men are more likely to be depressed compared to women after controlling for other factors. This finding is contrary to results of a systematic review of studies from sub–Saharan Africa that find higher rates of depression among older women compared to men (Mangipudi et. al., 2020; Chan et. al., 2011). The chances of being depressed is lower among those in marital union compared to those not in union. It appears that the differences between males and females depends on marital status. It is possible that sex differentials in risk of depression may be context dependent. Secondly, the extent to which women are more likely to remember events in life or reporting biases compared to men is unknown (Parker and Brotchie, 2010).

Younger older persons (age 60-69) are more likely to be depressed compared to older persons (age 70 and over) even after controlling for other factors. However, this study cannot disentangle the possible reasons why risk of depression may be declining with age.

Having chronic conditions and extreme difficulties in daily life increases the chances of being depressed even after controlling for other factors. Being lonely has the greatest effect on chances of being depressed and is consistent with the evidence from other studies (Cacioppo et al., 2010). Literature shows that although depression and loneliness often coexist; loneliness is an independent risk factor for depression in old age (Alpass and Neville, 2003; Adams et al., 2004; Paul et al., 2006; Theeke et al., 2012).

Study strengths and Limitations

This is the first study to our knowledge that utilized community-based approach to obtain information on factors associated with depression. However, this study is not without limitations. First, our study was limited to older persons living in the Nairobi City County and therefore cannot be generalized to all or other urban centers. Secondly, the nature of study necessitated that the instrument used to obtain measures of depression was the short form of Geriatric Depression Score. However, such instruments have not been sufficiently validated for use in community studies in sub–Saharan Africa. It should be noted that social determinants of depression in old age Sub Saharan Africa may be different from those in high income countries (Ojagbemi et al., 2020). There are a number of limitations in the use of scales. They only give a snapshot of how someone is feeling on a particular day because feelings of loneliness can fluctuate.

Finally, this was a preliminary analysis that did not consider the interactions among factors to determine mediating and moderating factors of depression amongst older persons. The World Health Organization (WHO,2023) reported that depression results from a complex interaction of social, psychological, and biological factors. We concur with McKinnon et al., (2013) that the complex relationship between living arrangements, support systems, and depressive symptoms in older persons need to be understood in order to generate policies that can be put in place to mitigate the potential detrimental effects of solitary living on the mental health of older persons in sub-Saharan Africa.

Conclusions and implications for policy

The results of this study may be indicative of the hidden large numbers of older people in urban Kenya who may be at risk of severe depression. It therefore suggests for the need for further nationally representative studies to determine the magnitude of the problem.. This study reinforces the call for the identification of risk factors of depression in old age so as to inform targeted interventions (Smith et al., 2022). This study further highlights that loneliness is strongly associated with depression in older persons. It should be noted that although loneliness and depression are associated with decreases in health status and quality of life for older persons, the causal links are difficult to determine (Nyqvist et al., 2013, Tilvis et al., 2011).

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Appendix 1. Item Response Theory

Item response theory (IRT)is a set of mathematical models that helps researchers to study abilities, personality traits, and other unobservable characteristics (latent traits) of an individual. IRT models describe the relationship between an individual's 'ability' or 'trait' and how they respond to a given set of items. The objective is to combine a series of individual responses to a set of variables into a single composite index. Each person answering the items is assigned a value on the scale. The interest is in how each individual item relates to the trait (which is unobserved or latent) and how the group of items as a whole relates to this trait.

IRT comes from a family of latent trait models used to establish psychometric properties of items and scales. In this paper we use graded response model notably the 3-parameter logistic model whose cumulative distribution functions given by:

$$P(X=1|\theta, a, b, c) = c+(1-c)\exp[a(\theta-b)]/\{1+\exp[a(\theta-b)]\}.$$

The typical graphic display is shown in Figure A1 and 1B.

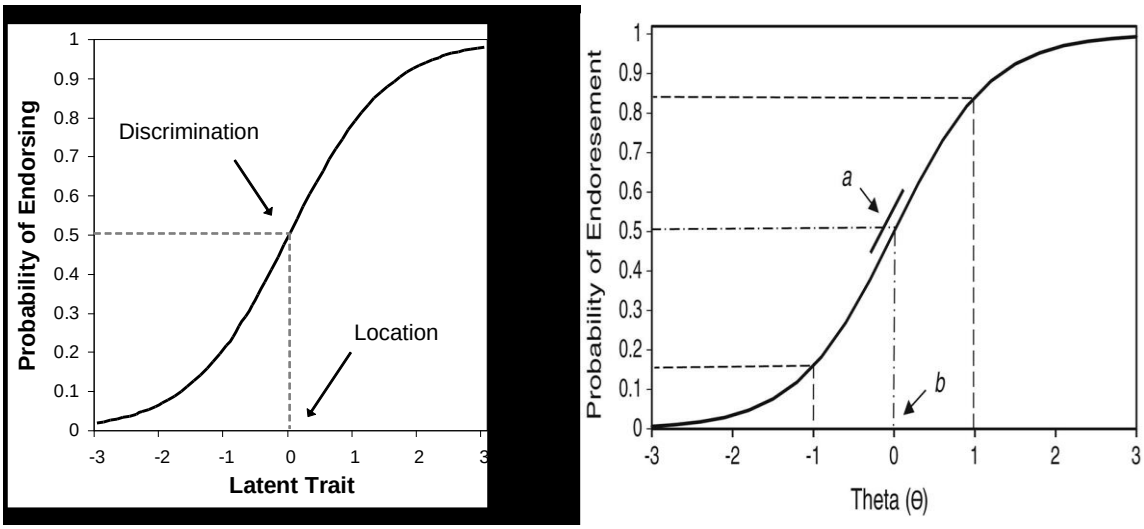


Figure A1: A graph of a typical response model. Figure 1B: A graph showing key parameter

Theta (θ) measures the latent trait and expresses an individual's underlying trait level (shown along the *x*-axis). Higher values of θ are associated with greater levels of the underlying trait and typically varies from -3 to +3 given certain mathematical assumptions. The *y* axis indicates the probability of endorsing an item and is scaled from 0.0 to 1.0.

Figure besides figure 1A shows a typical curve. For example, an individual with a trait level of say −1 has a lower probability, 0.16 or 16 %, of endorsing an item compared with an individual with a trait level of 1, who has a probability of 0.84 or 84 %.

Parameters

i)Location (b)

The key parameters in item response theory are; location, discrimination, guessing, and trait score respectively. The Item location, (or difficulty in psychometric testing), denoted as b in Figure 1B. In the binary case, b is the location on the latent trait where the probability of endorsing an item is 50 %

(or 0.5). Items with lower b values are considered to be 'easier' and expected to be endorsed at lower trait levels.

ii) Discrimination(a)

Item discrimination, denoted 'a' in Figure 1B, describes how well an item can differentiate between individuals at different trait levels. In the binary case, it is defined as the slope of the ICC at b. The steeper the curve, the better the item can discriminate between individuals with different levels of the trait. The verbal labeling used to describe an item's discrimination can be related to ranges of values of the parameter non-technical description (see Table 1A below):

Table 1A: Labels for item discrimination parameter values under the logistic model for the item characteristic curve

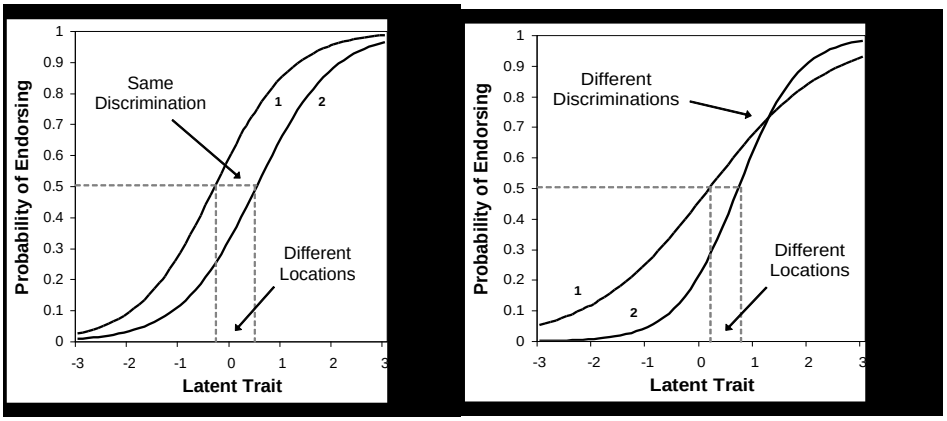
	Verbal label	Value of parameter 'a' (discrimination)
1	None	0
2	Very low	0.01-0.34
3	Low	0.35-0.64
4	Moderate	0.65-1.34
5	High	1.35-1.69
6	Very high	>1.70
7	Perfect	Perfect infinity (∞)

Source Baker 2001

iii) Guessing (c)

This parameter is denoted as c, describes the probability that the response to an item is due to guessing, and can range from 0.0 to 1.0 along the y axis. Items with c > 0.35 are traditionally viewed as unacceptable.

The Figures A3 below show different scenarios.



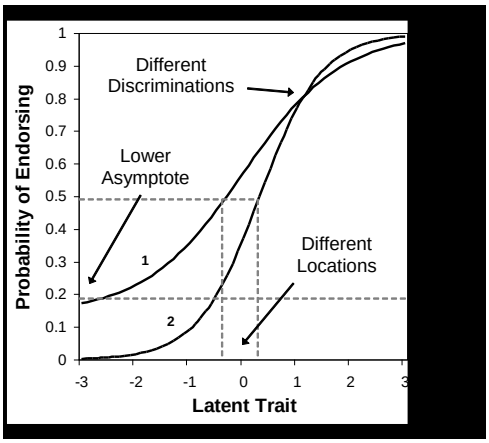


Figure A3: Graphs showing different scenarios of discrimination and location parameters.

IRT applied to items on depression

The results of IRT analysis are presented in Table A2 arranged in order of discrimination. The discrimination coefficients range from 0.43 to 5.4. Meaning that feeling of hopelessness was highly distinguishing followed by feeling pretty worthless. The least distinguishing item was that associated with preference to stay at home. All the items were highly significant.

Table A2: IRT analysis results for item indicators of the construct on likely chances of having depression symptoms

	Discrimination(slope a)						
	Item	Coefficient.	Std error	Z	P>Z	95% confidence interval	
Do you often feel helpless? (Helplessness)	Q1100C	5.41	0.97	5.58	0.0001	3.51	7.30
Do you feel pretty worthless the way you are now? (Worthless)	Q1100E	2.36	0.17	13.53	0.0001	2.02	2.70
Do you often feel bored? (bored)	Q1100B	1.89	0.12	15.42	0.0001	1.65	2.13
Not satisfied with life	Q1100A	1.16	0.08	15.09	0.0001	1.01	1.31
Do you prefer to stay at home rather than going out and doing things?	Q1100D	0.43	0.05	7.85	0.0001	0.32	0.54
	Difficulty(location b)						
Helpless	Q1100C	0.38	0.03	14.5	0.0001	0.33	0.43
Worthless	Q1100E	1.16	0.05	24.21	0.0001	1.06	1.25
Bored	Q1100B	0.10	0.03	2.97	0.003	0.03	0.16
Not satisfied with life	Q1100A	0.74	0.05	13.67	0.0001	0.63	0.85

Prefer home stay	Q1100D	1.81	0.24	7.7	0.0001	1.35	2.27
	Pseudo Guess	0.001	0.001			0.001	0.001

The location parameters range from 0.10 to 1.81. The likelihood of the prominence of guessing is small and therefore item can be evaluated in terms of slope and location parameters.

Figure A4 summarizes item characteristics for each of the items. The item Q1100D, (Do you prefer to stay at home rather than going out and doing things?) is almost flat while item Q1100C (Do you often feel helpless (Helplessness)?) has steepest slope at the point 0.5 on the y axis. This is most discriminative item while item Q1100D is the least discriminative.

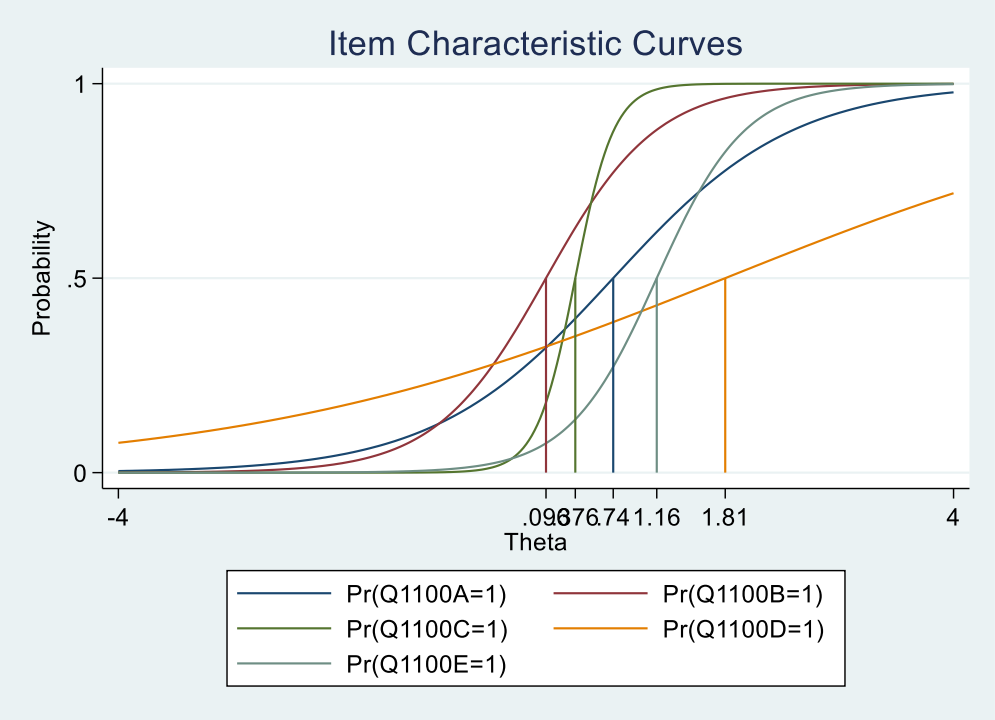


Figure A4: Item characteristic curves for items related to depression symptoms

Figure A5 is the final figure showing a composite of the test characteristic curve of all the 5 items. The items for depression well discriminates individuals with conditions that are likely to be associated with depression. The curve shows that a summary GDS score of 2 or higher can be used to distinguish those who are likely to have depression symptoms.

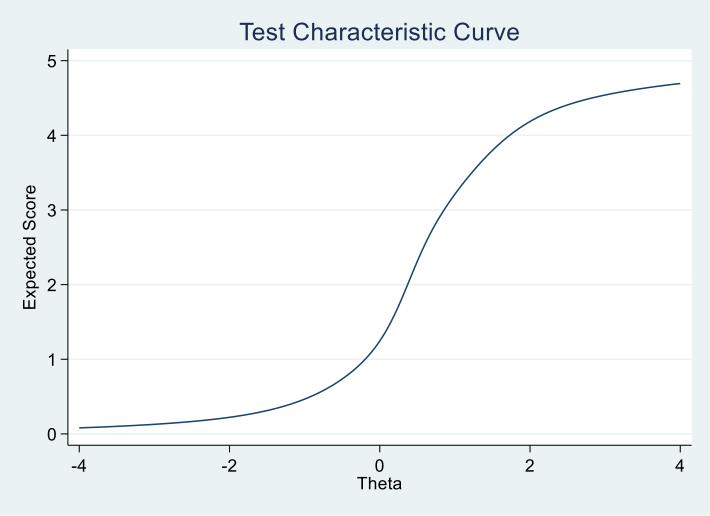


Figure A5: Test characteristic curve