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Dominant correlates of depressive disorders and effects on quality of life among older adults in low- and middle-income countries: Further analysis of WHO study on Global Ageing and Adult Health

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Abstract

Background: Poor quality of life (QoL) disrupts social functioning, fulfilment of basic needs, and is associated with depressive disorder (DD).

Objective: This study identified common risk factor for DD across six low- and middle-income countries (LMICs) and determined whether this risk factor can be ranked consistently as the most important predictor of DD in all six LMICs. We estimated the effect of DD on QoL for each country and meta-analyzed the results to generate a pooled effect estimate of DD on QoL in the six LMICs.

Methods: We used data from the WHO Study on Global Ageing and Adult Health (SAGE). This study involved a total of 35,164 older adults aged ≥ 50 yr. in six LMICs: China, 13,408; Ghana, 4,305; India, 7,108; Mexico, 2,309; Russian Federation, 3,763; and South Africa, 3,842. We conducted an extensive literature review to select the list of 58 potential risk factors associated with DD. We used double selection Least Absolute Shrinkage and Selection Operator Poisson regression model to identify country-specific risk factors associated with DD. Weighted dominance analysis (WDA) was performed to determine the most important risk factor of DD. To estimate the effect of DD on QoL, we used inverse probability weighting Poisson regression adjustment for each country, and meta-analysis to generate a pooled estimate of the overall effect.

Results: The risk factors for DD were generally country specific. However, asthma was the most common and the most important predictor of DD across all six SAGE countries. In Ghana, the prevalence of DD among older adults who have been diagnosed with asthma or have experienced symptoms of asthma in the 12 months preceding the survey was 14 times that among those without asthma or asymptomatic of asthma [Adjusted Prevalence Ratio (aPR), 14.46, 95% confidence interval (CI): 10.47 - 19.97; $p < 0.001$]. Similarly, it was 14 times in South Africa (aPR, 14.60; 95% CI: 8.18 - 26.14; $p < 0.00$) but in Mexico, it was 4 times (aPR, 4.39; 95% CI: 3.00 - 6.42; $p < 0.001$) and in China (aPR, 5.99; 95% CI: 4.32 - 8.31; $p < 0.001$) and Russian Federation (aPR, 5.90; 95% CI: 3.9 - 9.0; $p < 0.001$), it was 6 times. In India, it was 5 times (aPR=5.10; 95% CI: 4.30 - 6.00; $p < 0.001$. Generally, there was evidence of 8% increase in poor QoL due to the presence of DD (Pooled estimate, 0.08; 95% CI: 6.00 – 12.00; $p < 0.001$). Specifically, in China, there was evidence of 12% increase in poor QoL that could be attributed to DD (prevalence difference (PD), 0.12; 95% CI: 0.07 - 0.18; $p < 0.001$). In India (PD, 0.08; 95% CI: 0.04 - 0.13; $p < 0.01$) and Russian Federation (PD, 0.08; 95% CI: 0.01 - 0.15; $p < 0.01$), there was evidence of 8% increase in poor QoL. Although, there was some increase in poor QoL in Mexico, Ghana, and South Africa due to DD, the increase was not statistically significant.

Conclusion: Although different factors could explain the prevalence of DD among older adults in the six LMICs, it was evident that asthma patients amongst this population were at a higher risk of DD. Clinical evaluation and potential diagnosis and treatment of DD among older adults who present with asthma could potentially enhance their QoL

Keywords: Depressive disorder, poor quality of life, risk factors, Ghana

INTRODUCTION

Available evidence suggests that low-middle-income countries (LMICs) contribute to more than 80% of people who have mental disorders, and the proportions of people with mental disorders who receive evidence-based treatments are likely to be even lower [1]. Depressive disorders (DD) lead to poor quality of life (QoL), disrupt social functioning and fulfilment of basic needs [2]. There are an estimated 350 million people affected by DD each

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year; it is the fifth leading cause of global disease burden, accounting for approximately 12% of years of life lived with disabilities (YLDs) in 2016 [3]. Clearly, a relevant public health goal is to design and deliver a comprehensive intervention targeting community population in addition to individuals in clinical settings. Several studies [4-7] have attempted to identify factors such as obesity, asthma and alcohol consumption that are independently associated with DD, but these studies focused on a limited set of potential correlates of DD. These studies have shown that the risk factors for DD vary across countries and is dependent largely on the target population. Some studies [8,9], although country-specific, in most cases have also investigated the effect of DD on QoL but the inconsistencies in the instruments used in measuring QoL and the range of different definitions of QoL in those studies make a direct comparison and estimation of the true effect of DD on QoL complicated.

In addition, the identification of common and important risk factors to target intervention is complicated especially in older adults since several other age-related comorbid conditions play a key role in defining their general well-being and QoL. The statistical methods for addressing these complications associated with identifying important predictors in the presence of multiple correlated predictors [10] becomes more difficult in the context of binary outcome measures [11]. Application of modern statistical techniques, based on machine learning algorithms to nationally representative survey data in settings with varied population dynamics could potentially provide answers to these important questions.

Identifying the most important risk factors from the pool of critical correlates of DD could provide useful insight into designing a more targeted, efficient, and cost-effective country-specific interventions that could potentially address the problem of DD for improved QoL. Inarguably, several studies [12-16] have examined the association between DD and QoL but there is a knowledge gap in the medical literature on whether the magnitude of the effect significantly varies across different LMICs settings, particularly in older adult population. A further gap in existing evidence is that most of these studies were based on data from a single country and were restricted to a few specific targeted geographic areas of the country or among disease-specific patients [17-19], making the findings not generally representative of the national population. The SAGE data were collected with the same standardized data collection instrument on similar target population (adults who are ≥ 50 yr.)

This study relied on data from the WHO study on global ageing and adult health (SAGE) in six LMICs to address two major research questions. First, we provide a more robust estimate of the effect of DD on QoL using Inverse Probability Weighted Poisson Regression Adjustment (IPWRA) and identify the most important risk factor of DD from a holistic pool of potential correlates of DD.

MATERIALS AND METHODS

Study design and participants

The WHO SAGE survey was designed as a multi-wave panel study representative of the population aged ≥ 50 yr. with a smaller cohort of respondents aged 18 – 49 yr. for comparative purposes. The objective of SAGE was to generate valid, reliable, and comparable information on a range of health and well-being outcomes of public health importance in adult and older adult populations [20]. SAGE wave 1 was conducted between 2007 and 2010 in six LMICs namely: China (2008–2010), Ghana (2008–2009), India (2007–2008), Mexico (2009–2010), the Russian Federation (2007–2010) and South Africa (2007–2008). The sampling design was a multi-stage stratified cluster sampling. Briefly, each country was stratified into mutually exclusive strata. In the first stage of sampling, enumerations areas (EAs), referred to as clusters, were drawn from each stratum using probability proportional to size. In the second stage, households with at least one person aged ≥ 50 yr. within each EA were randomly selected and interviewed. A smaller sample of adults aged 18 – 49 yr. were also selected. Ghana, India, Mexico, and Russia used the Wave 0 (2002-2004) sampling frame and re-interviewed at least 50 percent of the Wave 0 respondents. China used a new sampling frame based on a national health surveillance system, and South Africa did not collect follow-up interviews but used the same Wave 0 sampling frame. The average response rate for the individual in Wave is as follows: China (93%), Ghana (81%), India (68%), Russian Federation (83%), Mexico (53%) and South Africa (75%). The low response rate in Mexico could partly be attributed to the short time available for the fieldwork which did not allow sufficient time for multiple revisits if the respondent were not at home at the initial visit [21]. The details of the sampling technique have been described elsewhere [20].

Procedures

The field data collection was conducted in the six LMICs using a standardized survey instrument. The interviewers and their field supervisors were given a more rigorous and in-depth training on the content of the questionnaire and translation protocols. The interviews were completed using either a computer-assisted personal interview, paper, and pencil format or both. The SAGE household questionnaire consists of a household roster and modules about the dwelling, income, transfers in and out of the household, assets, and expenditures [21].

Variables

The individual questionnaire has modules on sociodemographic factors: age, marital status, education, ethnicity/background, religion, language spoken, area of residence, employment and education of parents, childhood residence, migration, health and its determinants, disability, work history, risk factors, chronic conditions, caregiving, subjective well-being and quality of life, health care utilization and health systems responsiveness, health functioning, chronic conditions and health care utilization, anthropometric measurements (height, weight, waist and hip circumferences), blood pressure measure, blood sample via finger prick, performance tests including near and distant vision, a timed 4 min walk, grip strength, lung function, and cognition. The global positioning system was used to record the location coordinates of every household in the study. The household and the individual data were linked based on unique household and individual identifiers. Kowal et al. (2012) has provided details of the different indicators that were measured [21].

Outcome measures

The primary outcomes were the proportion of participants who self-reported higher QoL. The participants were asked to rate their overall QoL using five-point Likert scale response categories "very bad = 5, bad =4, moderate = 3, good = 2 and very good = 1". The very bad, bad, and moderate quality of life categories were merged as "lower with poorer quality of life" and were coded as 1, whereas the good and very good categories were merged as "higher quality of life" and were coded as 0. This method of re-categorizing the outcome as binary has been used elsewhere [22]. Although DD was the primary outcome variable of interest when investigating social and health determinants of DD, it was the main exposure of interest when we investigated the relationship between DD and QoL. The presence of major depressive disorder was based on the International Classification of Diseases, Tenth Revision (ICD 10) diagnostic criteria, and was derived from an algorithm that considered respondent reporting symptoms during the previous 12 mos. Depression was diagnosed when the participants had a minimum of four depressive symptoms after admitting to experiencing at least one of these: depressed mood, loss of interest and enjoyment, and reduced energy leading to increased tiredness and diminished activity as listed in ICD-10 and lasting most of the day and almost every day for at least 2 weeks. We included those who have previously been diagnosed with depression (either on treatment or not) to the prevalent cases obtained from the ICD10 diagnostic criteria. Using the key words "depression" and (depressive disorders "or "mental" or "Psychosis" or "anxiety" or "psychiatric", or "risk factors", "determinants", quality of life"), we searched the following bibliographic databases for the last 20 yr. to guarantee adequate and efficient coverage of factors associated with depressive disorders and quality of life: Google Scholar, Web of science, Embase, and MEDLINE Pubmed. We considered covariates including sociodemographic factors, economic instability, education, social cohesion, neighbourhood and adult built environment, chronic health conditions, healthcare factors, lifestyle factors, injuries, disability, oral health, and deaths in the household 24 mos preceding the survey (Supplementary Figure 1).

Statistical analysis

For each country, we summarized the background characteristics of participants using proportions for categorical variables and mean for continuous variables. To prepare the data for analyses, we pooled the six SAGE countries' data, and the standard sampling weight was de-normalized. To de-normalize the adult sampling weight, we divided the standard sampling weight of the adults aged ≥ 50 yr. by the sampling fraction of adults aged ≥ 50 yr. The sampling fraction of adults aged ≥ 50 yr. is the ratio of the total number of adults interviewed in the survey over the total number of adults aged ≥ 50 yr. in the country at the time of the survey. The total number of adults aged ≥ 50 yr. interviewed within this period was 35,164 and distributed as follows: China, 13,408; Ghana, 4,305; India, 7,108; Mexico, 2,309; Russian Federation, 3,763; and South Africa, 3,842. Using items response theory (rating scale models), we constructed latent variables such as mobility, self-care, pain and discomfort, cognition, interpersonal activity, sleep and energy, and vision based on some observed characteristics. The Rao-Scott Chi-square test (a design-adjusted version of the Pearson Chi-square test) and a design-adjusted one-way analysis of variance were used to test the relationship between each covariate and how they vary among the six countries.

To identify factors independently associated with prevalence of DD, we used the double selection Least Absolute Shrinkage and Selection Operator Poisson regression model (DSLASSOPM). This model was appropriate because it obtained unbiased and efficient estimates by addressing the problems of multicollinearity that arose from many highly correlated predictor variables. Based on the literature, we identified 58 variables a priori from the dataset and were grouped into nine main domains namely: sociodemographic, educational, economic, neighborhood, lifestyle, social cohesion, healthcare, chronic conditions, and injuries or deaths in the last 12 mos preceding the survey. We assumed that the variables selected from DSLASSOPM are the only known independent predictors of DD and therefore applied weighted dominance regression analysis [23] to determine the relative importance of these predictors. Dominance analysis is an ensemble method that ranks the predictors in terms of importance by aggregating results across multiple models. The general dominance statistics were derived as a weighted average marginal incremental contribution to the overall fit statistic that a predictor variable makes across all models in which the predictor variable was included.

To determine the causal effect of DD on QoL, we used IPWRA model. One of the important characteristics of IPWRA is double robustness even if one of the models (treatment or outcome) is mis-specified, the estimator is still consistent). To achieve the goal of reducing bias in the differences in covariate distributions between subjects with DD and those without DD, we chose matched samples of the original treated (individuals with DD) and control groups (individuals without DD). The reduction in bias in terms of covariate imbalance between the two groups increases the likelihood of estimating the causal effect of depression on QoL. To satisfy the assumption of ignorable treatment assignment, we included in the matching procedure, all variables known to be related to both treatments (DD) assignment, and the outcome measures [24,25]. This assumption states that in the absence of the

Table 1: Characteristics of the older adult population in SAGE countries

Sociodemographic and economic factors	All six countries n = 34735	China n = 13408	Ghana n = 4305	India n = 7108	Mexico n = 2309	Russia n = 3763	South Africa n = 842	Rao-Scott Designed based Pearson Chi-square
Mean age in yr. ±SD	62.21 ±15.95	62.55 ±16.64	64.22 ±19.58	61.53 ±13.75	63.04 ±18.94	63.91 ±15.39	61.61 ±18.41	17.65***¥
Age categories in years								6.52***
50-59	46.78	45.07	48.82	48.05	45.19	49.87	40.38	
60-69	30.58	31.75	30.53	25.59	24.62	30.61	27.31	
70-79	17.59	18.55	15.84	17.79	21.77	13.99	22.75	
> 80	5.04	4.63	4.81	8.57	8.42	5.54	9.56	
Sex								27.83***
Male	49.42	49.81	51.10	46.64	38.88	44.05	49.75	
Female	50.58	50.19	48.90	53.36	61.12	55.95	50.25	
Marital status								122.79***
Never/single	3.50	2.90	1.39	14.84	16.40	25.72	14.32	
Married	78.43	84.90	76.71	69.79	54.45	50.41	59.81	
Widowed	18.06	12.21	21.89	15.38	29.15	23.87	25.87	
Place of residence								14.58***
Urban	41.71	47.56	29.44	78.95	72.74	64.87	40.59	
Rural	58.29	52.44	70.56	21.05	27.26	35.13	59.41	
The educational level of respondent								188.8***
None	33.47	24.06	51.21	17.14	0.70	23.56	53.93	
Primary/JHS/JSS	46.00	59.02	35.04	72.42	27.03	62.26	25.36	
> Secondary	20.53	16.92	13.75	10.43	72.27	14.18	20.71	
Always lived in this village/town/city								8.91***
Yes	58.72	55.02	64.24	68.13	51.54	68.12	66.06	
No	41.28	44.98	35.76	31.87	48.46	31.88	33.94	
Socioeconomic status (wealth quintile)								0.94
Poorest	17.08	16.37	17.94	15.24	16.21	20.70	18.39	
Poor	18.82	18.18	19.33	24.77	19.58	19.88	19.39	
Average	19.63	20.57	18.79	17.09	19.12	18.23	20.70	
Rich	21.33	23.29	19.49	16.48	20.54	19.82	20.03	
Richest	23.13	21.59	24.46	26.42	24.55	21.37	21.49	
Age respondent started working								10.51***
<18 yr.	49.01	53.29	45.96	69.47	39.99	26.19	21.41	
> 18 yr.	50.99	46.71	54.04	30.53	60.01	73.81	78.59	
Currently working								13.27***
Yes	51.17	47.81	59.10	60.75	40.39	35.24	70.23	
No	48.83	52.19	40.90	39.25	59.61	64.76	29.77	
Number of living rooms								21.88***
One	7.01	2.59	11.76	2.80	5.61	9.48	17.06	
Two	18.91	12.20	25.01	19.07	23.36	12.87	21.51	
Three	23.08	23.72	20.91	27.68	31.61	13.53	15.82	
Four	20.38	23.73	16.54	18.60	22.65	19.88	13.35	
> Five	30.62	37.76	25.77	31.86	16.76	44.24	32.25	
Improve water source								12.31***
Not improved	7.03	3.61	11.35	0.71	2.96	5.22	15.90	
Improved	92.97	96.39	88.65	99.29	97.04	94.78	84.10	
Improve toilet facility								281.42***
Not improved	31.10	7.56	58.51	2.01	15.07	17.08	34.12	
Improved	68.90	92.44	41.49	97.99	84.93	82.92	65.88	

¥: Estimates from One Way Analysis of variance but we adjusted for survey design characteristics (weighting, clustering, and stratification). ***, $p < 0.001$; **, $p < 0.01$; *, $p < 0.05$; CI, confidence interval

Table 2: Prevalence of depressive disorders and poor quality of life

	All Six Countries	China	Ghana	India	Mexico	Russia	South Africa	Rao-Scott Designed based Pearson Chi-square
Depressive Disorders: % [95% CI]	10.86 [9.57-12.30]	2.25 [1.85-2.75]	20.25 [18.25-22.41]	17.62 [12.41-24.41]	8.59 [6.64-11.04]	5.62 [4.59-6.87]	9.03 [7.63-10.66]	267.8***
Poor quality of life: % [95% CI]	65.47 [63.76-67.14]	64.97 [62.56-67.3]	69.79 [67.64-71.86]	64.16 [61.50-66.74]	43.46 [38.23-48.83]	74.32 [67.94-79.80]	67.22 [63.62-70.63]	4.65**

***, $p < 0.001$; **, $p < 0.01$; *, $p < 0.05$; CI, confidence interval

Table 3: Risk factors for depressive disorders

Chronic conditions	China aPR[95% CI]	Ghana aPR[95% CI]	India aPR[95% CI]	Mexico aPR[95% CI]	Russia *aPR*[95% CI]	South Africa aPR[95% CI]
Presence of stroke or symptoms (yes)	1.05 [0.69-1.60]	1.37* [1.03-1.83]	0.98 [0.80-1.21]	1.45* [1.01-2.09]	1.37* [1.03-1.81]	0.56 [0.27-1.30]
Presence of angina or symptoms (yes)	1.14 [0.85-1.54]	0.90 [0.71-1.13]	0.92 [0.82-1.04]	1.22 [0.93-1.63]	1.11 [0.85-1.46]	1.24 [0.68-2.27]
Diagnosed with diabetes or symptoms (yes)	0.66 [0.39-1.12]	0.92 [0.67-1.27]	1.08 [0.87-1.35]	1.33 [0.97-1.83]	1.09 [0.81-1.48]	0.65 [0.36-1.21]
Diagnosed with lung disease or symptoms (yes)	0.97 [0.72-1.31]	1.21 [0.88-1.67]	0.89 [0.79-1.01]	0.90 [0.69-1.18]	0.98 [0.78-1.24]	1.32 [0.64-2.75]
Diagnosed with hypertension or symptoms (yes)	0.91 [0.67-1.24]	0.99 [0.80-1.22]	1.04 [0.90-1.21]	1.01 [0.76-1.34]	1.04 [0.80-1.34]	2.99*** [1.81-4.92]
Diagnosed with cataract (yes)	0.97 [0.74-1.28]	1.10 [0.94-1.29]	1.23** [1.06-1.43]	1.56** [1.11-2.20]	1.21 [0.94-1.55]	0.84 [0.43-1.65]
Current memory (Good)	0.81 [0.50-1.29]	1.05 [0.83-1.34]	1.08 [0.95-1.23]	1.34 [0.97-1.83]	0.89 [0.94-1.55]	1.08 [0.63-1.87]
Oral health (Good)	0.96 [0.70-1.35]	0.98 [0.73-1.30]	0.99 [0.88-1.12]	1.26 [0.95-1.67]	1.14 [0.64-1.24]	1.51 [0.67-3.39]
Asthma or related symptoms (yes)	5.99*** [4.32-8.31]	14.46*** [10.47-19.97]	5.09*** [4.28-6.01]	4.39*** [3.00-6.42]	5.92*** [3.91-8.98]	14.6*** [8.18-26.14]
Presence of arthritis or symptoms	1.47** [1.10-1.96]	1.16 [0.91-1.48]	1.37*** [1.21-1.56]	0.92 [0.67-1.25]	0.70* [0.53-0.92]	1.71 [1.05-2.80]

***, $p < 0.001$, **, $p < 0.01$, *, $p < 0.05$; aPR: Adjusted Prevalence Ratio; CI, confidence interval. The prevalence ratios were obtained from the double selection Least Absolute Shrinkage and Selection Operator (Lasso) Poisson regression model adjusted for sociodemographic factors, economic instability, education, social cohesion, neighborhood and adult built environment, healthcare factors, lifestyle factors, injuries, disability, oral health, and deaths in the household 24 mos preceding the survey.

covariates studied, including DD, there are no unobserved factors that could influence the outcome measures (QoL). Meta-analysis was used to obtain a single estimate of the effect of DD on QoL from the six LMICs. We achieved this by computing a weighted average of the studies' individual estimates of DD effect on the QoL. Random-effects meta-analysis models using DerSimonian and Laird [26] estimation of the random-effects variance was used. This approach incorporates an estimate of between-study variation (heterogeneity) in the weighting. We further applied the Knapp–Hartung adjustment to the overall effect size standard error. All analyses were performed in Stata 16 (StataCorp, College Station, Texas, USA) and a $p < 0.05$ was considered statistically significant. All parameter estimates were obtained after we adjusted for design characteristics such as sampling weight, stratification, and clustering.

RESULTS

Demographic characteristics

A total of 34,735 adults with a mean age of 62.21 yr. and approximately 1:1 male to female ratio were involved in this study (Table 1). Approximately 58% of all older adults lived in the rural areas, and the proportional rural inhabitants were higher in the two African countries compared to the remaining countries [Ghana, 70.60%; South Africa, 59.40%] (Table 1). Among the six LMICs, Ghana recorded the lowest proportion of households with improved toilet facilities [41.51% (Table 1). Approximately, 36% of the adult households were classified as poor (Table 1). The detailed percentage distribution of the sociodemographic/economic factors in the six countries can be found in Table 1. The results from the Rao-Scott Chi-square test of independence showed that except socioeconomic status, there was a statistically significant (p < 0.05) association between all the other sociodemographic and economic factors, and country of origin (Table 1).

Depressive disorders and poor quality of life

The overall prevalence of DD among the adult population was approximately 10.90% (95% CI: 9.61 - 12.31) (Table 2). Ghana recorded the highest prevalence of DD (20.3%; 95% CI: 18.32 - 22.41) while China had the lowest prevalence of 2.30% (95% CI:1.90 - 2.80. The prevalence of poor QoL in the six countries was 65.5% (95% CI: 65.51 - 67.13). Russian Federation recorded the highest prevalence of poor QoL with a prevalence of 74.32% (95% CI: 67.94 -79.80).

Risk factors for depressive disorders

The determinants of DD were generally country specific. However, asthma was the common risk factor of DD across all six LMICs. In Ghana, the prevalence of DD among older adults who have been diagnosed with asthma or have experienced symptoms of asthma in the 12 mos preceding the survey was 14 times compared to those without asthma or asymptomatic of asthma (Adjusted Prevalence Ratio (aPR), 14.46; 95% CI: 10.47 - 19.97, p < 0.001) (Table 3). Similarly, the prevalence poor QoL was 14 times in South Africa among asthmatic older adult population compared non-asthmatic patients (aPR, 14.60; 95% CI: 8.18 - 26.14; p < 0.001). The prevalence of DD in Mexico was 4 times among asthmatic patients compared with adults with no asthma (aPR, 4.39; 95% CI: 3.00 - 6.42, p < 0.001) and in China it was approximately 6 times (aPR, 5.99; 95% CI: 4.32 - 8.31, p < 0.001 (Table 3). On average, the prevalence of DD among asthmatic patients in Russia was approximately 6 times as high as the prevalence of DD among non-asthmatic patients (aPR, 5.90; 95% CI: 3.90 - 9.00; p < 0.001) (Table 3). The prevalence of DD in India among asthmatic patients was approximately 5 times as high as the prevalence of DD among non-asthmatic patients (aPR, 5.10, 95% CI: 4.30- 6 .00, p < 0.001 (Table 3).

Importance of risk factors for depressive disorders

The results from the weighted dominance analysis showed that having been diagnosed with asthma or having symptoms of asthma in the 12 mos preceding the survey was the most important risk factor for DD across the six countries. For example, in China, asthma alone contributed approximately 53% of the share of the coefficient of variation (Weighted Standardized Dominance Statistic; WSDS, 0.53; Table 4). In Ghana, asthma contributed approximately 74% of the share of the coefficient of variation (WSDS, 0.74). In India, Mexico, the Russian Federation, and South Africa, asthma or symptoms of asthma contributed approximately 59%, 50%, 63% and 83% of the share of the coefficient of variation, respectively (Table 4).

Effects of depressive disorders on poor quality of life

Generally, there was evidence of 8% increase in poor QoL that could be attributed to DD (Pooled estimate, 0.08; 95% CI: 6.0 – 12; p < 0.001) (Table 5). Specifically, in China, there was evidence of 12% increase in poor QoL among older adults with DD [prevalence difference (PD), 0.12; 95% CI: 0.07 - 0.18; p < 0.001). In India (PD, 0.08; 95% CI: 0.04 - 0.13, p < 0.01) and Russian Federation (PD, 0.08; 95% CI: 0.01 - 0.15, p < 0.01), there was evidence of 8% increase in poor QoL (Table 5). Although, there was some increase in poor QoL in Mexico, Ghana, and South Africa due to DD, the increase was not statistically significant (Table 4).

DISCUSSION

This study identified the most common and most important risk factor for DD and estimated the effect of DD on QoL in six LMICs. We found that, although the risk factors were country-specific, having been diagnosed with asthma or having symptoms of asthma in the last 12 mos preceding the survey was the common and the most dominant risk factor for DD across the six SAGE countries. Our finding is consistent with the results of a previous study that systematically reviewed studies between the periods of 1966 – 1999 [27]. The authors found that depressive symptoms are more common in asthma patients than in the general population and even more common than in some other general medical conditions. Kuehn [28] indicated that individuals with asthma appeared to have about twofold higher risk of having DD, and in adults with asthma, DD problems are also associated with poor asthma control [29], but the biological mechanism underlying the relationship between asthma and DD is not well understood [30]. In fact, the relationship between asthma and DD can be bidirectional as indicated by a few cases in the literature and thus, pointing to the possibility that the two complex chronic illnesses could share common pathophysiological pathways and susceptibility genes [31]. The first multi-national study of the relationship between asthma and mental disorders in 17 countries confirms that a range of common mental disorders occurs with greater frequency among persons with asthma [32]. Again, Ortega et al. [33] corroborated our findings when they studied 2,554 American latinos and found that among patients diagnosed

Table 4: Relative predictor importance of depressive disorders in six low and middle- income countries

China		Ghana		India		Mexico		Russian Federation		South Africa	
Key predictors of DD obtained from double selection Lasso	WSDS Statistic (rank)	Key predictors of DD obtained from double selection Lasso	WSDS Statistic (rank)	Key predictors of DD obtained from double selection Lasso	WSDS Statistic (rank)	Key predictors of DD obtained from double selection Lasso	WSDS Statistic (rank)	Key predictors of DD obtained from double selection Lasso	WSDS Statistic (rank)	Key predictors of DD obtained from double selection Lasso	WSDS Statistic (rank)
Asthma (1)	0.5334 (1)	Asthma (1)	0.7365 (1)	Asthma (1)	0.5873 (1)	Asthma (1)	0.5016 (1)	Asthma (1)	0.6281 (1)	Asthma (1)	0.8329 (1)
Sleep and energy	0.1479 (2)	Sleep and energy	0.1506 (2)	Pain and discomfort	0.0850 (2)	Sex	0.2437 (2)	Sleep and energy	0.1168 (2)	Hypertension	0.0645 (2)
Current health condition	0.1060 (3)	Self-care	0.0324 (3)	Arthritis	0.0681 (3)	Sleep and energy	0.1464 (3)	Self-care	0.1053 (3)	Cognition	0.0354 (3)
Interpersonal activities	0.0908 (4)	Social cohesion	0.0201 (4)	Mobility	0.0519 (4)	Cataract	0.0441 (4)	Sex	0.0896 (4)	Age of respondent	0.0274 (4)
Arthritis	0.0692 (5)	Fruits	0.0176 (5)	Self-care	0.0485 (5)	Stroke	0.0288 (5)	Age	0.0180 (5)	Currently working	0.0142 (5)
Safety in the neighbourhood	0.0234 (6)	Stroke	0.0139 (6)	Cognition	0.0442 (6)	Vegetable intake per day	0.0157 (6)	Vision	0.0136 (6)	Vegetable intake per day	0.0095 (6)
Injuries	0.0156 (7)	Sports	0.0131 (7)	Cataract	0.0418 (7)	Safety in the n'gbrhood [a]	0.0126 (7)	Arthritis	0.0102 (7)	Always lived in this village/town	0.0095 (7)
Age of respondent	0.0025 (8)	Interpersonal activities	0.0068 (8)	Improve toilet facility	0.0149 (8)	Improved water source	0.0039 (8)	Victim of a crime	0.0098 (8)	Tobacco use	0.0053 (8)
Receive support from community	0.0007 (9)	Health service utilization	0.0038 (9)	Fathers education level	0.0138 (9)	Marital status	0.0032 (9)	Stroke	0.0060 (9)	Place of residence	0.0015 (9)
		Number of living rooms	0.0028 (10)	Social cohesion	0.0120 (10)			Alcohol intake	0.0022 (10)		
		Mothers education	0.0015 (11)	Injury	0.0106 (11)			Father's educational level	0.0003 (11)		
		Improved toilet facility	0.0009 (12)	Deaths in household in the last 24 months	0.0070 (12)						
				Provide support to community	0.0055 (13)						
				Safety in the n'gbrhood [a]	0.0045 (14)						
				Currently working	0.0034 (15)						
				Mothers educational level	0.0010 (16)						

DD, Depressive Disorders; WSDS, Weighted Standardized Dominance Statistic. The smaller the number in parenthesis the higher the rank in terms of its contribution to Depressive Disorders.
[a], neighbourhood

with cardiovascular disease, diabetes, and asthma, only patients with asthma had an increased risk of depressive disorder. The comorbidity between asthma and the affective traits may, in part, be due to shared genetic influences between asthma and depression [34]. Thus, our study largely agrees with the findings from previous studies and even provides more convincing evidence on the need to understand the biological mechanism that explains the relationship between asthma and DD for better treatment outcomes [35]. We also found that older adults with DD have poor QoL compared to those without DD in China, India, and the Russian Federation. The overall effect from the meta-analysis showed a statistically significant effect of DD on QoL. This finding is consistent with what was found in a systematic review conducted by Sivertsen et al. [36] and a prospective cohort study in the case of Hasche et al. [37]. The former showed that an increase in DD among older persons had poorer global and generic health related QoL than non-depressed individuals independent of the instrument used in measuring QoL. The DD significantly impairs the proper functioning in several areas, including work functioning, social functioning, and health in general

[38]. Although the biological mechanism that explains exactly how DD influences QoL may not be known, some authors are of the view that sleep quality may act as a mediator between depression and the QoL in older adults and evidence suggests that there is a close link between impaired sleep and aging-related cognitive decline [39,40]. It is possible that there may be some older adults on treatments such as pharmacotherapy and/or psychotherapy, might have enhanced their QoL. Farabaugh et al. [41] found little evidence to support the potential benefit of these treatment options. Anecdotal evidence, however, shows that psychotherapy is a preferred means to addressing QoL since that directly targets the overall well-being, unlike psychopharmacology that indirectly targets QoL by focusing on symptoms. The use of nationally representative data that originate from the same data collection instrument makes our findings generalizable to the entire adult population in the six LMICs. The use of a standardized tool to measure the same outcomes of interest and covariates ensures that our results are generalizable to LMICs. We have applied a more rigorous statistical technique to assess several variables that explain the dynamics of DD, and we have identified the single most important predictor of DD based on the variables that were studied. To the best of our knowledge, it remains the first study that has identified common and most important predictor of DD in six LMICs. The scope of the number of risk factors that were studied reduces the likelihood of omitted variable bias. Not much has been done in the application of inverse probability weighting Poisson regression adjustment technique to quantify the effect of DD on QoL in each country using data that originate from an observational study. To reduce bias in our effect estimates, we highlighted the need to apply doubly robust procedures in assessing key risk factors on the health outcome of interest, especially when the data originate from cross-sectional study design instead of the more preferred and robust experimental study design.

The study has some limitations. Although our multivariable analysis was adjusted for several confounders and we conducted our matching procedure based on these observed confounders, we anticipate that there could be some unmeasured covariates that are common risk factors for DD and QoL. Future studies could evaluate the actual contribution of asthma in explaining the dynamics of DD controlling for the confounding effect of genetic and other biological factors using a more rigorous prospective cohort study design. The use of findings from cross-sectional study design to infer causality should be interpreted with caution, although a more rigorous statistical procedure was employed. This is because inferring causality from cross-sectional data could lead to reverse causality bias. For instance, asthma was found to be associated with an increase in the prevalence of DD, but we do not know whether the person had asthma before being diagnosed with DD or vice versa.

Conclusion

Although different factors could explain the prevalence of DD among older adults in the six LMICs, it was evident that adults who have been diagnosed with asthma or are experiencing symptoms of asthma in the last 12 mos preceding the survey were at a higher risk of DD. Clinical evaluation and potential diagnosis and treatment of DD among older adults who present with asthma could potentially enhance their QoL. The findings emphasized the need to improve access to mental healthcare.

DECLARATIONS

Ethical considerations

The study used an anonymized publicly available secondary data set with permission from the WHO SAGE. No ethical approval was required for analysis.

Consent to publish

All authors agreed to the content of the final paper.

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None

Competing Interests

No potential conflict of interest was reported by the authors.

Author contributions

DD conceived the idea, conducted the statistical analysis, and writing of the first draft of the manuscript. SB reviewed the statistical methods. DD, GI, EA, SAA, JT, SB, AEY, contributed to the literature review, discussion of the findings, interpretation, and revision of the manuscript drafts, supported the data validation and data management. All authors have access to the data, read, and approved the final manuscript.

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Availability of data

SAGE is committed to the public release of study instruments, protocols, and meta-and micro-data: Access is provided upon completion of a User's Agreement available through WHO's SAGE website (www.who.int/healthinfo/systems/sage) and WHO's archive using the National Data Archive application (http://apps.who.int/healthinfo/systems/surveydata).

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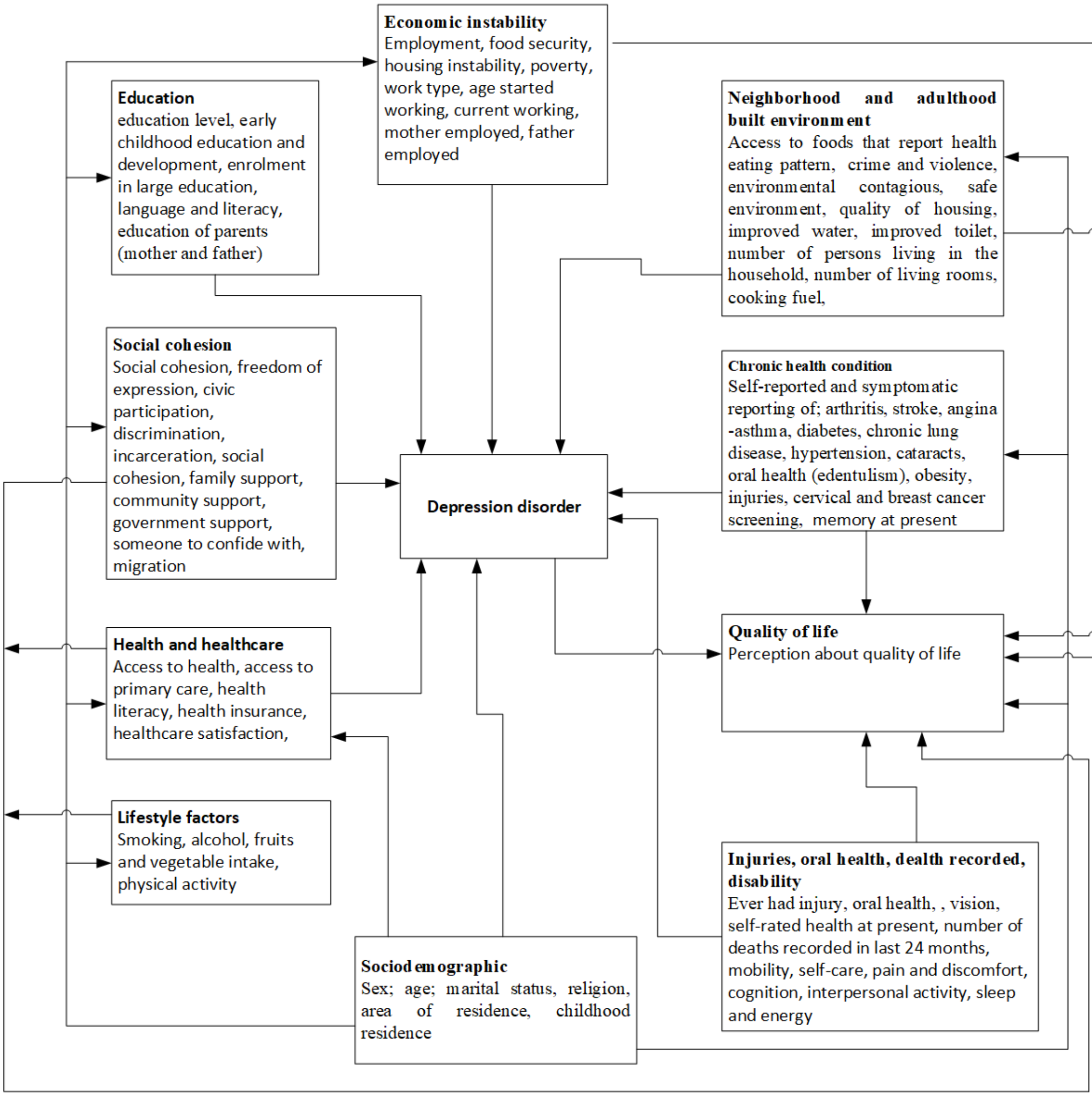

Supplementary Figure 1: Factors associated with Depressive Disorders-Author's construction