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Title: Health, social, and economic variables associated with depression among older people in Low and Middle Income Countries: WHO Study on global AGEing and adult health

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Abstract

Objective: Although depression among older people is an important public health problem worldwide, systematic studies evaluating its prevalence and determinants in low and middle income countries (LMICs) are sparse. Biopsychosocial model of depression and prevailing socioeconomic hardships for older people in LMICs have provided the impetus to determine the prevalence of geriatric depression, to study its associations with health, social, and economic variables, and to investigate socioeconomic inequalities in depression prevalence in LMICs.

Methods: We accessed World Health Organisation-Study on global AGEing and adult health (WHO-SAGE) wave-1 data that studied nationally representative samples from six large LMICs (N=14,877). A computerised algorithm derived depression diagnoses. We assessed hypothesised associations using survey multivariate logistic regression models for each LMIC, and pooled their risk estimates by meta-analyses. We investigated related socioeconomic inequalities using concentration indices.

Results: Cross-national prevalence of geriatric depression was 4.7% (95% CI 1.9-11.9%). Women, illiteracy, poverty, indebtedness, past informal-sector occupation, bereavement, angina, and stroke had significant positive associations, while pension support and health insurance showed significant negative associations with geriatric depression. We documented pro-poor inequality of geriatric depression in five LMICs.

Conclusions: Socioeconomic factors and related inequalities may predispose, precipitate, or perpetuate depression among older people in LMICs. Relative absence of health safety net places socioeconomically disadvantaged older people in LMICs at risk. The need for

population-based public health interventions and policies to prevent and to manage geriatric depression effectively in LMICs cannot be overemphasised.

Key words: Depression; Geriatric psychiatry; Developing countries; Socioeconomic factors.

Introduction:

Depression is the fourth leading cause of disability and the foremost cause of non-fatal disease burden (1). Depression in older people is more challenging because of incomplete recovery (2) and frequent relapses (3). It is associated with increased risk of morbidity (4) and mortality (5), and with increased healthcare utilisation (6). Moreover, population ageing increases the prevalence of geriatric depression, and its contribution to the global disease burden (7). Although depression among older people is an important public health problem worldwide (8), systematic research on its prevalence and determinants remains sparse in low and middle income countries (LMICs) (9).

Considering the biopsychosocial model of depression (10-12) and socioeconomic hardships in LMICs (13), relative contributions of social and economic factors to geriatric depression may be more in LMICs than in high-income countries (14). Poverty (14-16), economic inequality (17,18), and catastrophic out-of-pocket health expenditures (OOPHE) (19,20) have been associated with depression among older people in LMICs. Besides, women (15,16,21), less education (16), and chronic medical illnesses (14,15) have been reported as correlates of geriatric depression in LMICs. Moreover, explanatory models of depression among women in LMICs have emphasised their economic and interpersonal difficulties (22).

Older people, especially those, who lack formal education and were employed in the informal-sector, often do not have access to pension and insurance schemes in LMICs. When they develop chronic medical illnesses, and disability, they should either minimise their

health service utilisation, or risk OOPHE that may lead to indebtedness, and poverty-determined hunger. Such adverse health, social, and economic situations may make them vulnerable to develop depression. However, relationships between geriatric depression and important economic variables, such as pension support, medical insurance, and indebtedness, have not been systematically studied in LMICs yet. Available studies from LMICs are mostly small, and have not employed nationally representative sampling strategies. Hence, we aimed to estimate the prevalence of geriatric depression, to investigate its associations with pertinent health, social, and economic variables, and to quantify socioeconomic inequalities in the prevalence of geriatric depression using nationally representative samples of older people in six large LMICs.

Methods:

***Study on global AGEing and adult health (SAGE)*:** We accessed multi-country cross-sectional data from SAGE wave-1 surveys, conducted by the World Health Organization (WHO) in six large LMICs (23). These surveys were conducted using identical methodology in China (2008-10), Ghana (2008-09), India (2007-08), Mexico (2009-10), South Africa (2007-08), and in Russia (2007-10). Nearly half of the world population live in these six LMICs (24). The SAGE surveys provide comprehensive information, comparable to ageing studies in high-income countries, on health and well-being of older people in LMICs. They were approved by local ethical committees in each country, and by the WHO ethical review committee. As their methodology has been described in detail elsewhere (23), it is only briefly mentioned here.

***Sampling strategy*:** SAGE wave-1 population-based surveys employed multistage, stratified, cluster sampling design to recruit nationally representative samples of 34,159 adults, older than 50 years, and comparative groups of 8,340 young adults, aged 18-49 years (25). Selection of sampling strata was uniquely defined for each country on the basis of their

economic development and geographic locations. Enumeration areas were selected within each stratum, and household enumerations provided the final sampling units of all respondents, aged 50 years and above, within each household. We considered all participants, aged 65 years and above (N=15,268), for this study. As we had to exclude 391 (2.6%) participants that had incomplete data, we analysed data from 14,877 older people to investigate our study objectives.

Data collection: SAGE survey questionnaires were translated into native languages of the participants, and were back-translated to English using standard WHO protocols. Field interviewers and supervisors were recruited, and were trained in individual countries prior to the SAGE surveys. Training of personnel included general interview skills, conventions in questionnaire, and guide to health measurements. Later, written or verbal informed consent was obtained from all participants, and face-to-face interviews were conducted individually. Besides, we extracted the economic inequality index (Gini coefficient) and Gross National Income (GNI) per-capita, based on purchasing power parity (PPP), in current international $ of China (2010), Ghana (2005), India (2009), Mexico (2010), South Africa (2008), and Russia (2010), from the World bank database (26).

Dependent variable: SAGE surveys included a symptom-based questionnaire to diagnose depression within the past 12 months (27). We have developed an algorithm to derive International Classification of Diseases-10th revision Diagnostic Criteria for Research (ICD-10 DCR) (28) diagnoses of depression from SAGE data. Depression was diagnosed, when the participants had a minimum of four depressive symptoms, listed in ICD-10 DCR (F32), lasting most of the day and almost every day for at least two weeks. Those depressive symptoms included at least two of the following three symptoms, depressed mood, loss of interest, and decreased energy. Hence, our geriatric depression diagnosis included ICD-10 DCR diagnoses of mild to severe depressive episodes (F32.0-32.2). Further details of

administered questions and of our diagnostic algorithm are available as supplementary online material (SOM-1). SAGE surveys included a question on suicidal ideation that elicited both active suicidal ideas and passive death wishes within the past 12 months.

Health variables: Considering the vascular hypothesis of geriatric depression (29), we extracted the following four health variables, cerebrovascular accident (stroke), hypertension, diabetes, and angina. Stroke and diabetes were self-reported by the participants. WHO Rose questionnaire (30) was used to diagnose angina. Automated sphygmomanometers were used to record three sequential readings of blood pressure, which were taken ≤1 minute apart (31). Hypertension was diagnosed on the basis of mean systolic blood pressure ≥140 mmHg and/or diastolic blood pressure ≥90 mmHg (32). SAGE surveys used WHO Disability Assessment Scale-II (WHODAS-II) (33) to assess disability. They recorded information on health service utilisation over the past 12 months (19).

Social and economic variables: SAGE individual questionnaires documented sociodemographic data, educational level, social, and economic characteristics including availability of pension support and medical insurance. SAGE household questionnaires provided data on bereavement, social isolation, and indebtedness. As household asset ownership is a predictive indicator of socioeconomic status in LMICs, we constructed a wealth index using household data on ownership of durable assets, house dwelling characteristics, type of toilet access, and source of drinking water (34). This wealth index was divided into quintiles within each country, and was used as a proxy measure for socioeconomic status of the participants. We constructed this wealth index using principal component analysis (PCA). Scoring factors were derived from the first principal component that was a linear index of variables with common information.

***Statistical analyses*:** We estimated the prevalence of geriatric depression in six LMICs, and calculated their 95% confidence intervals, while accounting for the survey design effects.

Standard errors were computed on the basis of first-order Taylor series linear approximation. Kaiser-Meyer-Olkin test was performed to assess the adequacy of correlation matrices for PCA. Multivariate survey logistic regression models were employed to assess the associations between geriatric depression and various health, social, and economic variables. We calculated country-specific adjusted odds ratios (AOR) after accounting for the effects of age and gender of the participants. All analyses were weighted to account for sampling errors and post-stratification factors. We combined the AOR of six LMICs using fixed or random effect meta-analyses, after assessing their degree of heterogeneity using Cochrane's Q statistics and Higgin's I^2. Socioeconomic inequalities in the prevalence of geriatric depression were estimated using concentration index (CI) that was derived from concentration curve (CC) (35). CI was computed as a weighted covariance between geriatric depression and fractional rank of a living standards measure, the wealth index. If the prevalence of geriatric depression is equal among the participants irrespective of their wealth, the CC will form a hypothetical 45-degree line of equality. The CI represents twice the area between the CC and line of equality. A negative CI indicates that geriatric depression is more concentrated among the socio-economically disadvantaged (36). We standardised all CI using age and gender of the participants. All analyses were performed using statistical software STATA 13.1 (StataCorp, Texas, USA) and ADePT 5.5 (37).

Results:

***Participant Characteristics*:** We present socio-demographic, social, economic, and health characteristics of all participants (N=14,877) in Table-1. They did not differ significantly from those, who were excluded because of incomplete data (n=391), on their gender (χ^2=3.73; df=1; p>0.05), and age (t=-0.74; df=15,266; p=0.46). More than half of older people lacked formal education in all LMICs, except Russia where 79.3% of older people had completed secondary education. Almost all older people had health insurance in Russia,

while only 4% of them had it in India. Similarly, nearly three-fourths of older people received pension support in Russia, while less than one-sixths received it in Mexico. We observed a significant negative correlation (Spearman's r=-0.88; p=0.02) between the prevalence of health insurance and the prevalence of indebtedness in the LMICs (SOM-2). Per-capita GNI, based on PPP, (Gini coefficients) of China, Ghana, India, Mexico, Russia, and South Africa were $9,200 (42.1), $2,970 (42.8), $4,320 (33.9), $14,420 (48.1), $19,860 (40.9), and $11,590 (63.0), respectively (26). Income levels were relatively higher in Russia and Mexico than in other four LMICs, while economic inequality was worse in South Africa and Mexico than in others.

***Prevalence of geriatric depression*:** Prevalence of depression in older people was 1.4% (95%CI 1.1-1.9%) in China, 9.7% (95%CI 6.7-13.9%) in Ghana, 15.0% (95%CI 12.8-17.5%) in India, 6.3% (95%CI 4.4- 9.0%) in Mexico, 4.4% (95%CI 2.5-7.5%) in Russia, and 2.0% (95%CI 1.0-4.0%) in South Africa. Cross-national prevalence of geriatric depression was 4.7% (95%CI 1.9-11.9%). Depression was significantly more prevalent among older people than among corresponding comparative groups of general adults, aged 18-64 years, in China (1.1%; χ^2=4.94; df=1; p=0.03), Ghana (3.8%; χ^2=35.86; df=1; p<0.001), India (8.5%; χ^2=44.62; df=1; p<0.001), Mexico (5.8%; χ^2=7.14; df=1; p=0.01), and in Russia (3.7%; χ^2=8.48; df=1; p=0.003).

***Socioeconomic inequality in geriatric depression*:** Figure-1 presents the CC and their indices measuring the socioeconomic inequalities in the prevalence of geriatric depression in these LMICs (SOM-3). Negative concentration indices of South Africa, China, Mexico, and India established that geriatric depression was more prevalent among the socioeconomically poor older people than among the rich in these countries. Such pro-poor socioeconomic inequality in the prevalence of geriatric depression was more pronounced in South Africa than in other LMICs. There was pro-poor inequality in Ghana, but the CC was close to the hypothetical

line of equality. The CC of Russia demonstrated pro-rich inequality in the prevalence of geriatric depression. When we combined the risk estimates of these LMICs using meta-analysis, we found that socioeconomically poorest older people belonging to the lowest wealth-quintile were significantly at higher risk for depression (Meta-analysis pooled adjusted odds ratio (POR)=1.47; 95%CI 1.12-1.93) than other older people, after accounting for the effects of their age and gender.

***Health variables associated with geriatric depression*:** We present the associations between geriatric depression and relevant health, social, and economic variables in Table-2. Cerebrovascular accidents (POR=2.56; 95%CI 1.70-3.88) and angina (POR=1.96; 95%CI 1.15-3.35) showed significant positive associations with geriatric depression in these LMICs. Diabetes (POR=0.93; 95%CI 0.60-1.43) and hypertension (POR=1.04; 95%CI 0.79-1.36) were not significantly associated with geriatric depression. Significant positive association between WHODAS-II total scores and depression (POR=1.04; 95%CI 1.03-1.05) indicated a bidirectional relationship between depression and disability among older people in LMICs. However, depression was not significantly associated with increased number of health visits (POR=1.02; 95%CI 0.98-1.05) within the past 12 months.

***Social and economic variables associated with geriatric depression*:** Figure-2 illustrates pooled risk estimates of health, social, and economical variables, and their heterogeneity between these LMICs. Women, lack of formal education, past informal-sector occupation, indebtedness, and bereavement within the past 12 months showed significant positive associations with geriatric depression. Older people, who had experienced hunger because of poverty, were at higher risk for geriatric depression. Receiving regular pension support, having health insurance coverage, and medical insurance benefits, provided by past formal-sector employers, had significant negative associations with geriatric depression in these LMICs.

***Prevalence and correlates of suicidal ideation*:** Prevalence of suicidal ideation within the past 12 months among older people was 0.5% (95%CI 0.3-1.0%) in China, 1.1% (95%CI 0.5-2.1%) in South Africa, 3.1% (95%CI 1.9- 4.9%) in Mexico, 3.8% (95%CI 2.0-6.9%) in Russia, 5.2% (95%CI 3.6-7.3%) in Ghana, and 7.4% (95%CI 6.0-9.1%) in India. Women (POR=1.94; 95%CI 1.45-2.60), lack of formal education (POR=1.84; 95%CI 1.28-2.63), indebtedness (POR=1.71; 95%CI 1.22-2.40), experiencing hunger because of poverty (POR=2.88; 95%CI 1.03-8.05), social isolation (POR=2.66; 95%CI 1.13-6.28), and past history of stroke (POR=2.45; 95%CI 1.55-3.89) were significantly positively associated with suicidal ideation among older people, after accounting for the effects of their age and gender. Receiving pension support (POR=0.46; 95%CI 0.23-0.93), and medical insurance benefits, provided by past employers in formal-sector, (POR=0.46; 95%CI 0.26-0.80) showed significant negative associations with suicidal ideation among older people after accounting for the effects of their age and gender in these LMICs.

Discussion:

This study has established that geriatric depression is widely prevalent in LMICs, and that older people are significantly more vulnerable to depression than younger adults in five LMICs, excluding South Africa. It has documented pro-poor inequality in the prevalence of geriatric depression in five LMICs, excluding Russia. LMICs are heterogeneous, and their ground realities differ. However, this study has identified important health, social, and economic variables that are significantly associated with geriatric depression in LMICs using pooled analyses. It has highlighted statistically significant negative association between geriatric depression and health insurance coverage of older people in LMICs. Strengths of this study include a relatively larger sample size, nationally representative sampling, high response rates, investigating health, social, and economic variables together, and assessing socioeconomic status by asset-based wealth index. Major limitations of this study are its

cross-sectional design that precludes causal interpretations and diagnosing depression on the basis of a symptom-based questionnaire (27). Besides, WHO-SAGE surveys did not collect data on cognitive impairment, and other neuropsychiatric disorders. Cultural differences in reporting depressive symptoms might have partly contributed to the cross-national variability in the prevalence of geriatric depression.

Prevalence and correlates of geriatric depression in LMICs: Prior knowledge on the prevalence and correlates of geriatric depression is principally derived from studies from high-income countries (38) and from studies that are not specific to older people (39). Our prevalence estimate in LMICs was comparable to the reported prevalence estimates of geriatric depression in high-income countries (38,40). A previous cross-national study that did not employ nationally representative sampling in LMICs has reported that depression was significantly more prevalent in older people than in younger adults (41). Our results confirmed this finding except for South Africa. Consistent with the vascular hypothesis of depression (29) and with the findings from high-income countries (42), stroke and angina were significantly associated with geriatric depression in LMICs. However, the reported positive association between depression and diabetes (43) in high-income countries was not observed in these LMICs. Socioeconomic determinants of dietary patterns (44) and ongoing demographic shifts in the prevalence of diabetes (45) in LMICs may explain this finding. Our results confirmed previously reported relationship between poverty and geriatric depression in LMICs (14-16). Moreover, we quantified socioeconomic inequalities in the prevalence of geriatric depression using concentration indices. Consistent with previous studies from LMICs, women (15,16,21) and lack of formal education (16) were significantly associated with geriatric depression. Akin to the studies from high-income countries, bereavement (46) and indebtedness (47) were significantly associated with geriatric depression in LMICs.

Additionally, our findings have identified some hitherto unknown socioeconomic correlates of geriatric depression in LMICs.

Importance of social and economic factors: Although the biopsychosocial model of depression has gained wide acceptance (10-12), relative contributions of neurobiology and psychosocial adversity towards etiopathogenesis of depression remain debatable. Strict biomedical disease models of depression often fail to explain the complex interplay between poverty, social relationships, and mental health (48). Approaching geriatric depression with such narrow medical perspectives may lead to ineffective management and incomplete recovery (49). Moreover, differentiating geriatric depression from psychosocial distress among community dwelling older people is difficult (14). Symptom-based questionnaires, used in large community surveys, do not document psychosocial contexts, and they may diagnose emotional distress secondary to psychosocial hardships as mild to moderate depression. Hence, social and economic factors play an important role in the etiopathogenesis, diagnosis, management, and prevention of geriatric depression in all cultures. Socioeconomic hardships (13), rising economic inequality, non-medical explanatory models of illness (22), and relative absence of functional social services (50) enhance the importance of social and economic factors further in LMICs.

Health economic challenges for older people in LMICs: More than two thirds of total health expenditures are paid directly by the service users and their families as OOPHE in many LMICs (19). When these OOPHE exceed a household's ability to pay, they turn into catastrophic health expenditures (CHE), and can lead to indebtedness, poverty, and hunger (20). Older people with disability should either minimise using health services, or risk such CHE in LMICs (51). This can explain our finding that geriatric depression was significantly associated with high disability, but not with increased health service utilisation in these LMICs. A substantial proportion of older people in this study, especially those who lacked

formal education, had been employed in the informal-sector, and they could not afford investing in private health insurance schemes. When they could no longer work, they lost their source of income, and they did not get pension support or medical benefits from their past employers or Governments. Such older people were financially dependent on their families, and their families were burdened by increasing care needs and increasing OOPHE (19).

A cross-sectional study cannot clarify potential causal pathways linking depression and material deprivation. However, we may hypothesise a plausible pathway linking geriatric depression and relative absence of health safety net in LMICs on the basis of our findings and available literature. Firstly, health insurance coverage, and medical insurance benefits, provided by past employers in the formal-sector, showed significant inverse association with geriatric depression in the LMICs. Secondly, indebtedness significantly increased the risk of geriatric depression, while there was significant inverse correlation between the prevalence of health insurance coverage and the prevalence of indebtedness in the LMICs. Thirdly, we documented pro-poor inequality in the prevalence of geriatric depression, and significant positive associations of geriatric depression with poverty and hunger in the LMICs. Consequent OOPHE add to the misery of starving socioeconomically disadvantaged older people. Fourthly, CHE have been reported to be associated with geriatric depression in India (19,20). A longitudinal study, not specific to older people, from Northwest China has reported that participants without health insurance developed significantly more depressive symptoms during their follow-up (52).

Understanding depression within the broader socio-political context in LMICs: There is evidence suggesting that psychological distress and illness are linked to social determinants of health (53). Failure to meet basic needs and human rights due to poverty impacts physical and mental health of older people in LMICs (54). Low education and lack of formal

employment often lead to psychosocial distress in LMICs. Structural violence, discrimination, social exclusion, political oppression, and forced migration are not uncommon in LMICs. These risk factors for poor mental health work through insecurity, hopelessness, risk of violence, and poor physical health (55). The disparate environments under which distress and depression exist are often brought together, de-contextualized, and unified into disease labels (56). Despite evidence that social determinants produce substantial psychological morbidity, most prevailing intervention strategies in LMICs favour post-hoc individual treatments over population-based public health approaches that are useful in reducing structural violence and in empowering large disadvantaged sections of society (56). Progressive medicalisation of psychosocial distress have shifted the focus from the responsibilities of the states for poverty and structural violence, and transferred pathology and burden to individuals in LMICs (56). This is compounded by increasing individualism in society (57,58), reduction in community supports, and expanding profit-oriented private medical sectors in LMICs. Consequently, psychiatric labels are often used to justify medical input and OOPHE in such situations. The political economy of health within the context of recently developing capitalistic economic and social systems in LMICs undergirds these formulations (56). Moreover, the poverty-growth-inequality triangle hypothesis suggests that absolute poverty cannot be reduced without addressing economic inequality (59). Hence, medical experts cannot manage geriatric depression effectively in LMICs without substantial contribution of governmental administration, responsible for managing social security, stability, and equitable economic growth (60).

Perspectives: Socioeconomic adversity may predispose, precipitate, or perpetuate depression in older people. In a wider perspective, our findings and available literature suggest that the following should be considered,

1. Socioeconomic correlates indicate the need to adopt holistic biopsychosocial model to understand geriatric depression. Curative healthcare interventions without holistic public health initiatives to improve living standards may fail to achieve the desired goals regarding geriatric depression in LMICs (61).
2. Specialist old age psychiatry services that treat severe depression and depression with suicidal risk in high-income countries are virtually absent, and may not be feasible in the foreseeable future in many LMICs. Hence, there is an urgent need to implement WHO's recommendation for integrating mental health services into existing primary care facilities, and for building effective community mental health teams in LMICs (62).
3. Integrating mental health services into existing primary care facilities cannot be achieved in LMICs, as long as their primary care facilities have poor infrastructure, inefficient systems, and inappropriate training. Restructuring medical and nursing education, and strengthening general infrastructure of primary care facilities are essential initial steps towards providing appropriate care to depressed older people in LMICs (63).
4. Past history of stroke was associated with geriatric depression and suicidal ideation. Health services in LMICs should not stop with acute medical management of cerebrovascular accidents, and should improve their long-term care and rehabilitation services. Older people that had stroke should be periodically screened for depression and anxiety.
5. Reported health and socioeconomic correlates may help identifying older people at risk for depression, diagnosing geriatric depression early, providing early interventions, and prioritising resource allocation in LMICs.
6. We documented socioeconomic inequalities in the prevalence of geriatric depression. As public sector health services often fall short of timeliness and hospitality, economically poor service users risk OOPHE and less evidence-informed care in LMICs' profit-

oriented private health sector (64). Improving the quality of public health services may reduce the need for OOPHE and the risk of geriatric depression in LMICs.

7. Health insurance coverage showed significant inverse relationship with indebtedness and geriatric depression. Building efficient mandatory health insurance systems may protect older people from depression in LMICs.
8. Past employments in the informal sector and consequent lack of pension support and of medical benefits were significantly associated with geriatric depression. Formalising informal activities and ensuring labour rights in LMICs may prevent depression in old age.
9. Health services cannot help several social problems associated with depression among older people in LMICs. Developing functional social services is inevitable for providing appropriately care for depressed older people in LMICs.

Future studies should investigate pertinent differences between the LMICs, and within each LMIC. Such research will help to develop locally appropriate and effective policies for preventing and managing geriatric depression in LMICs. Longitudinal studies to confirm our findings and complex intervention trials to test the efficacy and relative effectiveness of abovementioned suggestions in LMICs are desired. Psychosocial hardships, socioeconomic inequalities, and relative absence of health safety net contribute to geriatric depression in LMICs. Approaching depression among older people in LMICs with narrow biomedical models that fail to consider their psychosocial contexts leads to suboptimal health services and policies (49). There is a crying need for population based holistic preventive approaches rather than individual curative treatments in LMICs (54).

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References:

1. Ustun TB, Ayuso-Mateos JL, Chatterji S, et al: Global burden of depressive disorders in the year 2000. Br J Psychiatry 2004; 184:386-392
2. Jhingan HP, Sagar R,Pandey RM: Prognosis of late-onset depression in the elderly: a study from India. Int Psychogeriatr 2001; 13:51-61
3. Mitchell AJ,Subramaniam H: Prognosis of depression in old age compared to middle age: a systematic review of comparative studies. Am J Psychiatry 2005; 162:1588-1601
4. Moussavi S, Chatterji S, Verdes E, et al: Depression, chronic diseases, and decrements in health: results from the World Health Surveys. Lancet 2007; 370:851-858
5. Blazer DG, Hybels CF,Pieper CF: The association of depression and mortality in elderly persons: a case for multiple, independent pathways. J Gerontol A Biol Sci Med Sci 2001; 56:M505-509
6. Welch CA, Czerwinski D, Ghimire B, et al: Depression and costs of health care. Psychosomatics 2009; 50:392-401
7. Chapman DP,Perry GS: Depression as a major component of public health for older adults. Prev Chronic Dis 2008; 5:A22
8. WHO: The global burden of disease: 2004 update, Geneva, Switzerland, World Health Organization, 2008
9. Collins PY, Insel TR, Chockalingam A, et al: Grand challenges in global mental health: integration in research, policy, and practice. PLoS medicine 2013; 10:e1001434
10. Murphy E: Social origins of depression in old age. Br J Psychiatry 1982; 141:135-142

11. Billings AC,Rudolf HM: Psychosocial theory and research on depression: An integrative framework and review. Clin Psychol Rev 1984; 2:213-237
12. Kessler RC: The effects of stressful life events on depression. Annu Rev Psychol 1997; 48:191-214
13. Jenkins R, Baingana F, Ahmad R, et al: Social, economic, human rights and political challenges to global mental health. Ment Health Fam Med 2011; 8:87-96
14. Rajkumar AP, Thangadurai P, Senthilkumar P, et al: Nature, prevalence and factors associated with depression among the elderly in a rural south Indian community. Int Psychogeriatr 2009; 21:372-378
15. Yunming L, Changsheng C, Haibo T, et al: Prevalence and risk factors for depression in older people in Xi'an China: a community-based study. Int J Geriatr Psychiatry 2012; 27:31-39
16. Leggett A, Zarit SH, Nguyen NH, et al: The influence of social factors and health on depressive symptoms and worry: a study of older Vietnamese adults. Aging Ment Health 2012; 16:780-786
17. Fernandez-Nino JA, Manrique-Espinoza BS, Bojorquez-Chapela I, et al: Income Inequality, Socioeconomic Deprivation and Depressive Symptoms among Older Adults in Mexico. PLoS One 2014; 9:
18. Hosseinpoor AR, Bergen N, Mendis S, et al: Socioeconomic inequality in the prevalence of noncommunicable diseases in low- and middle-income countries: results from the World Health Survey. BMC Public Health 2012; 12:474
19. Brinda EM, Kowal P, Attermann J, et al: Health service use, out-of-pocket payments and catastrophic health expenditure among older people in India: The WHO Study on global AGEing and adult health (SAGE). J Epidemiol Community Health 2015; 69:489-494

20. Brinda EM, Rajkumar AP, Enemark U, et al: Nature and determinants of out-of-pocket health expenditure among older people in a rural Indian community. Int Psychogeriatr 2012; 24:1664-1673
21. Gibson RC, Neita SM, Abel WD, et al: Sociodemographic factors associated with depressive symptoms among elderly persons from two communities in Kingston, Jamaica. West Indian Med J 2013; 62:615-619
22. Pereira B, Andrew G, Pednekar S, et al: The explanatory models of depression in low income countries: listening to women in India. J Affect Disord 2007; 102:209-218
23. Kowal P, Chatterji S, Naidoo N, et al: Data resource profile: the World Health Organization Study on global AGEing and adult health (SAGE). Int J Epidemiol 2012; 41:1639-1649
24. WHO. World health statistics 2011 [Available from: http://www.who.int/whosis/whostat/EN_WHS2011_Full.pdf].
25. Naidoo N: WHO Study on global AGEing and adult health (SAGE) Waves 0 and 1 Sampling information for China, Ghana, India, Mexico, Russia and South Africa, World Health Organization
26. World-Bank. Indicators 2016 [Available from: http://data.worldbank.org/indicator].
27. Peltzer K,Phaswana-Mafuya N: Depression and associated factors in older adults in South Africa. Glob Health Action 2013; 6:1-9
28. WHO: The ICD-10 Classification of Mental and Behavioural Disorders-Diagnostic criteria for research, Geneva, Switzerland, World Health organization, 1992
29. Sneed JR,Culang-Reinlieb ME: The vascular depression hypothesis: an update. Am J Geriatr Psychiatry 2011; 19:99-103
30. Cook DG, Shaper AG,MacFarlane PW: Using the WHO (Rose) angina questionnaire in cardiovascular epidemiology. Int J Epidemiol 1989; 18:607-613

31. Basu S,Millett C: Social epidemiology of hypertension in middle-income countries: determinants of prevalence, diagnosis, treatment, and control in the WHO SAGE study. Hypertension 2013; 62:18-26
32. Chobanian AV, Bakris GL, Black HR, et al: Seventh report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure. Hypertension 2003; 42:1206-1252
33. WHO: WHODAS II Disability Assessment Schedule: 12-Item interviewer administered version, Geneva, World Health Organization, 2001
34. Filmer D,Pritchett LH: Estimating wealth effects without expenditure data - Or tears: An application to educational enrollments in states of India. Demography 2001; 38:115-132
35. O'Donnell OV, E. Wagstaff, A. Lindelow, M: Analyzing health equity using household survey data: a guide to techniques and their implementation., Washinton D.C, World Bank, 2008
36. Konings P, Harper S, Lynch J, et al: Analysis of socioeconomic health inequalities using the concentration index. Int J Public Health 2010; 55:71-74
37. Wagstaff AB, M. Sajaia, Z. Lokshin, M.: Health Equity and Financial Protection, Washington, D.C, World Bank, 2011
38. Luppa M, Sikorski C, Luck T, et al: Age- and gender-specific prevalence of depression in latest-life--systematic review and meta-analysis. J Affect Disord 2012; 136:212-221
39. Kessler RC,Bromet EJ: The epidemiology of depression across cultures. Annu Rev Public Health 2013; 34:119-138
40. Djernes JK: Prevalence and predictors of depression in populations of elderly: a review. Acta Psychiatr Scand 2006; 113:372-387
41. Bromet E, Andrade LH, Hwang I, et al: Cross-national epidemiology of DSM-IV major depressive episode. BMC Med 2011; 9:90

42. Loerbroks A, Bosch JA, Mommersteeg PMC, et al: The association of depression and angina pectoris across 47 countries: findings from the 2002 World Health Survey. Eur J Epidemiol 2014; 29:507-515
43. Roy T,Lloyd CE: Epidemiology of depression and diabetes: a systematic review. J Affect Disord 2012; 142 Suppl:S8-21
44. Mayen AL, Marques-Vidal P, Paccaud F, et al: Socioeconomic determinants of dietary patterns in low- and middle-income countries: a systematic review. Am J Clin Nutr 2014; 100:1520-1531
45. Mendenhall E, Norris SA, Shidhaye R, et al: Depression and type 2 diabetes in low- and middle-income countries: a systematic review. Diabetes Res Clin Pract 2014; 103:276-285
46. Cole MG,Dendukuri N: Risk factors for depression among elderly community subjects: A systematic review and meta-analysis. Am J Psychiatry 2003; 160:1147-1156
47. Turunen E,Hiilamo H: Health effects of indebtedness: a systematic review. BMC Public Health 2014; 14:489
48. Kuruvilla A,Jacob KS: Poverty, social stress & mental health. Indian J Med Res 2007; 126:273-278
49. Jacob KS: The cultures of depression. Natl Med J India 2006; 19:218-220
50. Brinda EM, Rajkumar AP, Enemark U, et al: Cost and burden of informal caregiving of dependent older people in a rural Indian community. BMC Health Serv Res 2014; 14:207
51. Albanese E, Liu Z, Acosta D, et al: Equity in the delivery of community healthcare to older people: findings from 10/66 Dementia Research Group cross-sectional surveys in Latin America, China, India and Nigeria. BMC Health Serv Res 2011; 11:153

52. Tian D, Qu Z, Wang X, et al: The role of basic health insurance on depression: an epidemiological cohort study of a randomized community sample in northwest China. BMC Psychiatry 2012; 12:151

53. WHO,Calouste-Gulbenkian-Foundation: Social determinants of mental health, Geneva, World Health Organization, 2014

54. Jacob KS: Depression: a major public health problem in need of a multi-sectoral response. Indian J Med Res 2012; 136:537-539

55. Patel V,Kleinman A: Poverty and common mental disorders in developing countries. Bull World Health Organ 2003; 81:609-615

56. Jacob KS: Psychosocial adversity and mental illness: Differentiating distress, contextualizing diagnosis. Indian J Psychiatry 2013; 55:106-110

57. Steele LG,Lynch SM: The Pursuit of Happiness in China: Individualism, Collectivism, and Subjective Well-Being during China's Economic and Social Transformation*. Soc Indic Res 2013; 114:

58. Tu Y, Lin S,Chang Y: A Cross-Cultural Comparison by Individualism/Collectivism among Brazil, Russia, India and China. International Business Research 2011; 4:175-182

59. Bourguignon F. The Poverty-Growth-Inequality Triangle: World-Bank; 2004 [Available from: http://siteresources.worldbank.org/INTPGI/Resources/342674-1206111890151/15185_ICRIER_paper-final.pdf].

60. O'Farrell C: Michel Foucault, London, SAGE, 2005

61. Jacob KS: Public health in India and the developing world: beyond medicine and primary healthcare. J Epidemiol Community Health 2007; 61:562-563

62. Prince M, Livingston G,Katona C: Mental health care for the elderly in low-income countries: a health systems approach. World Psychiatry 2007; 6:5-13

63. Jacob KS: Repackaging mental health programs in low- and middle-income countries. Indian J Psychiatry 2011; 53:195-198

64. Basu S, Andrews J, Kishore S, et al: Comparative performance of private and public healthcare systems in low- and middle-income countries: a systematic review. PLoS Med 2012; 9:e1001244

Supplementary online materials:

The following materials are available as online only supplements,

1. **SOM 1:** Employed diagnostic criteria for depression among older people in LMICs
2. **SOM 2**: Correlation between health insurance coverage and prevalence of indebtedness among older people in six LMICs (n=14,877)
3. **SOM 3:** Distributions of geriatric depression by asset-based wealth index quintiles in six LMICs
4. **SOM 4:** Health, social, and economic variables associated with suicidal ideation among older people in LMICs (n=14, 877)

Figure legends:

Figure 1: Concentration curves and their concentration indices measuring the socioeconomic inequalities in the prevalence of geriatric depression in six LMICs.

Negative concentration indices convey that geriatric depression was more prevalent among the socioeconomically poor older people than among the rich in these LMICs.

Figure 2: Pooled risk estimates of health and socioeconomic variables for geriatric depression, and their heterogeneity estimates between six LMICs (n=14,877)

Adjusted odds ratios were calculated from multivariate survey logistic regression models including the dependent variable, geriatric depression, investigated explanatory variable, and covariates, age and gender; POR= Pooled odds ratios that were estimated by fixed or random effects meta-analyses; Any health insurance: Voluntary and/or mandatory health insurance coverage; Hypertension was diagnosed using automated sphygmomanometer; Bereavement: Death of any household member within the past 12 months; Social isolation: Self-reported lack of social relations and of participation in community activities; Angina was diagnosed using WHO Rose questionnaire; All heterogeneity χ^2 statistics, presented in the figure, have five degrees of freedom; 95%CI= 95% confidence intervals

Table 1: Characteristics of participants from six low and middle income countries (n=14,877) [a]:

Characteristics	China n (%)	Ghana n (%)	India n (%)	Mexico n (%)	Russia n (%)	South Africa n (%)
Age in years (mean (SD))	72.9 (5.9)	73.6 (6.8)	71.2 (6.1)	74.5 (7.2)	73.9 (6.1)	72.6 (6.9)
Women	2868 (52.9)	1014 (51.8)	1095 (45.4)	824 (59.9)	1333 (68.4)	1076 (61.1)
Level of Education:						
Lack of formal education	3042 (56.1)	1532 (78.3)	1666 (69.0)	949 (69.0)	109 (5.6)	1017 (57.8)
Primary education	924 (17.0)	164 (8.4)	329 (13.6)	256 (18.6)	294 (15.1)	389 (22.1)
Secondary education	1141 (21.1)	49 (2.5)	327 (13.6)	75 (5.5)	1272 (65.2)	308 (17.5)
Graduation/post-graduation	314 (5.8)	212 (10.8)	92 (3.8)	95 (6.9)	275 (14.1)	46 (2.6)
Past occupation in informal sector [b]	2826 (42.8)	1737 (88.8)	1401 (58.0)	602 (43.8)	56 (2.9)	682 (38.8)
Receiving pension support	2842 (52.4)	334 (17.1)	418 (17.3)	210 (15.3)	1442 (73.9)	518 (29.4)
Any health insurance [c]	4613 (85.1)	890 (45.5)	96 (4.0)	1019 (74.2)	1943 (99.6)	298 (16.9)
Experienced hunger [d]	9 (0.2)	162 (8.3)	212 (8.8)	95 (6.9)	50 (2.6)	117 (6.6)
Indebtedness	377 (6.9)	325 (16.6)	1144 (47.4)	188 (13.7)	118 (6.0)	385 (21.9)
Bereavement [e]	142 (2.6)	32 (1.6)	136 (5.6)	151 (10.9)	49 (2.5)	3 (0.02)
Social isolation [f]	234 (4.3)	284 (14.5)	288 (11.9)	61 (4.4)	133 (6.8)	135 (7.7)
Angina [g]	605 (10.9)	110 (5.3)	161 (7.3)	142 (10.0)	268 (16.1)	134 (7.4)
Hypertension [h]	2947 (59.1)	1107 (57.1)	398 (16.2)	205 (18.0)	785 (41.9)	1247 (69.9)
Diabetes mellitus	445 (8.7)	73 (3.5)	164 (6.3)	259 (17.1)	189 (10.2)	178 (8.5)
Past history of stroke	217 (3.4)	97 (3.5)	71 (2.4)	106 (9.2)	206 (8.7)	86 (5.2)

[a] Number of participants from China, Ghana, India, Mexico, Russia, and South Africa was 5421, 1957, 2414, 1375, 1950, and 1760, respectively; [b] Percentage within the parentheses was calculated only for the participants who had participated in their country's work force; [c] Voluntary and/or mandatory health insurance coverage; [d] Experienced hunger within the past 12 months because of poverty; [e] Death of any household member within the past 12 months; [f] Self-reported lack of social relations and of participation in community activities; [g] Angina was diagnosed using WHO Rose questionnaire; [h] Hypertension was diagnosed using automated sphygmomanometer. SD= Standard deviation.

Table 2: Health, social, and economic variables associated with depression among older people in LMICs (n=14, 877)

Explanatory variables	China AOR[a] (95%CI)	Ghana AOR (95%CI)	India AOR (95%CI)	Mexico AOR (95%CI)	Russia AOR (95%CI)	South Africa AOR (95%CI)	(I^2)[b]	POR[c] (95%CI)
Years after 65 years of age	1.0 (0.9-1.1)	1.0 (0.9-1.1)	1.0 (1.0-1.1)	1.0 (0.9-1.0)	1.0 (0.9-1.0)	0.9 (0.8-1.0)	61.6	0.99 (0.96-1.02)[d e]
Being women	1.6 (1.0-2.7)	1.4 (0.7-2.9)	1.3 (0.9-1.8)	1.4 (0.7-2.9)	1.8 (0.5-6.9)	1.4 (0.3-6.7)	0.0	**1.42 (1.12-1.80)[f]**
Lack of formal education	1.9 (1.1-3.2)	2.8 (1.1-7.2)	2.2 (1.4-3.3)	1.3 (0.6-2.9)	2.2 (0.8-6.0)	1.4 (0.3-6.7)	0.0	**1.98 (1.51-2.61)**
Past occupation in informal sector [g]	1.6 (0.9-3.2)	2.8 (1.2-7.0)	1.3 (0.9-1.7)	1.6 (0.7-3.9)	1.4 (0.4-5.5)	3.2 (0.9-11.1)	0.0	**1.49 (1.15-1.93)**
Receiving pension support	0.7 (0.4-1.2)	0.2 (0.1-0.5)	0.9 (0.5-1.5)	0.5 (0.2-1.3)	0.6 (0.2-1.6)	0.7 (0.2-2.4)	44.6	**0.61 (0.45-0.83)**
Medical insurance by past employers	0.5 (0.3-1.1)	0.2 (0.1-0.8)	0.7 (0.3-1.7)	0.4 (0.1-1.3)	0.7 (0.2-1.9)	0.7 (0.2-2.7)	0.0	**0.52 (0.35,0.79)**
Any health insurance [h]	0.5 (0.3-1.0)	0.8 (0.4-1.6)	1.5 (0.5-4.2)	0.9 (0.4-2.2)	0.1 (0.0-1.3)	0.2 (0.0-0.7)	44.4	**0.66 (0.46-0.96)**
Experienced hunger [i]	12.5 (2.4-66.6)	3.4 (0.7-17.9)	2.8 (1.7-4.7)	1.3 (0.5-3.8)	2.2 (0.6-8.7)	1.7 (0.3-8.3)	9.5	**2.66 (1.80-3.94)**
Indebtedness	2.1 (0.9-4.8)	3.1 (1.3-7.4)	2.3 (1.6-3.3)	0.8 (0.3-2.5)	1.5 (0.6-4.1)	1.1 (0.3-4.1)	5.0	**2.09 (1.59-2.75)**
Bereavement [j]	3.7 (1.3-10.5)	1.8 (0.7-4.5)	1.3 (0.7-2.5)	0.9 (0.3-2.6)	2.1 (0.6-7.5)	15.5 (0.4-572)	12.4	**1.66 (1.12-2.47)**
Social isolation [k]	5.7 (3.0-10.7)	0.7 (0.4-1.4)	1.9 (1.2-3.1)	1.3 (0.4-4.7)	4.2 (1.1-15.7)	0.4 (0.1-1.8)	80.2	1.70 (0.79-3.68)[d]
Angina [l]	1.6 (0.9-3.0)	0.8 (0.4-1.7)	1.5 (0.9-2.8)	1.9 (0.9-4.3)	4.6 (2.2-9.3)	7.9 (1.4-45.7)	64.5	**1.96 (1.15-3.35)[d]**
Diabetes mellitus	1.5 (0.6-4.4)	0.5 (0.2-1.5)	1.00 (0.5-2.2)	0.4 (0.2-1.0)	4.5 (0.9-22.7)	3.7 (0.4-30.6)	52.5	0.93 (0.60-1.43)
Hypertension [m]	1.0 (0.5-2.0)	1.8 (1.0-3.5)	0.9 (0.6-1.3)	0.8 (0.4-1.6)	1.2 (0.3-4.7)	1.1 (0.3-3.8)	0.0	1.04 (0.79-1.36)
Past history of Stroke	3.2 (1.4-7.6)	2.3 (1.0-5.0)	0.9 (0.4-2.2)	4.5 (1.4-14.8)	3.7 (1.0-14.1)	9.8 (2.0-48.6)	46.5	**2.56 (1.70-3.88)**

[a] AOR= Adjusted odds ratios. Each cell represents a multivariate survey logistic regression model including the dependent variable, geriatric depression, investigated explanatory variable, and covariates, age and gender; [b] Between-site heterogeneity was estimated using Higgin's I^2; [c] POR= Pooled odds ratios that were estimated by fixed or random effects meta-analyses; [d] POR was estimated by random effects meta-analyses; [e] Multivariate survey logistic regression model included only gender as covariate; [f] Multivariate survey logistic regression model included only age as covariate; [g] These models included only the participants who had participated in their country's work force; [h] Voluntary and/or mandatory health insurance coverage; [i] Experienced hunger within the past 12 months because of poverty; [j] Death of any household member within the past 12 months; [k] Self-reported lack of social relations and of participation in community activities; [l] Angina was diagnosed using WHO Rose questionnaire; [m] Hypertension was diagnosed using automated sphygmomanometer; 95%CI= 95% confidence intervals; Statistical significance of POR was assessed by z tests, and statistically significant results ($p<0.05$) have been presented in bold.