

Title: The association of objective visual impairment with suicidal ideation and suicide attempts among adults aged ≥ 50 years in low- and middle-income countries

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Synopsis:

In a sample of 34129 older adults from low-and middle-income countries, moderate and severe visual impairment was significantly associated with greater odds of suicidal ideation and suicide attempts.

ABSTRACT

Background: There is currently limited literature on the association between visual impairment and suicidal thoughts and behavior, especially among older adults from low- and middle-income countries (LMICs). Thus, we aimed to investigate associations of objectively measured distance visual impairment with suicidal ideation and suicide attempts among adults aged ≥ 50 years from six LMICs, and to identify potential mediators.

Methods: Cross-sectional, community-based, nationally representative data from the WHO Study on global AGEing and adult health (SAGE) were analyzed. Objective distance visual acuity was measured using the tumbling E logMAR chart, and vision impairment was categorized as: none, mild, moderate, and severe. Self-reported information on past 12-month suicidal ideation and suicide attempts were also collected. Multivariable logistic regression and mediation analysis were conducted.

Results: Data on 34129 individuals aged ≥ 50 years [mean (SD) age 62.4 (16.0) years; 47.9% males] were analyzed. After adjustment for potential confounders, compared to no visual impairment, severe visual impairment was significantly associated with suicidal ideation (OR=9.50; 95%CI=2.47-36.52). Moderate and severe visual impairment were significantly associated with 2.22 (95%CI=1.14-4.35) and 11.50 (95%CI=1.44-91.88) times higher odds for suicide attempts, respectively. Disability, poor self-rated health, mobility, and loneliness explained 14.0%, 9.3%, 7.2%, and 6.3% of the association between moderate/severe visual impairment and suicide attempts, respectively.

Conclusion: Interventions to reduce suicidal ideation and suicide attempts among older adults with visual impairment in LMICs are required, targeting identified mediators, and using tested strategies for suicide prevention per se in LMICs.

Key words: visual impairment; suicidal ideation; suicide attempts; low- and middle-income countries; older adults

INTRODUCTION

Suicide is the intentional act of causing one's own death. Beyond suicides, a significant portion of the population exhibit suicidal thoughts and behaviors. Suicidal thoughts are termed 'suicidal ideation', and include thinking about or considering suicide [1], while suicidal behaviors include non-fatal attempts at suicide. Although suicide attempts are more frequent among adolescents and young adults, older men and women show the highest suicide rate in almost all countries [2,3]. Moreover, the rate of suicide increases with age among people older than 60 years [4].

Importantly, a prior suicide attempt is the single most important risk factor for suicide in the general population, and suicidal ideation typically precedes a suicide attempt [5]. Suicide attempts can result in negative consequences such as injury, hospitalization, and loss of independence, while they can also impose a significant financial burden on society [6]. Thus, it is important to identify correlates or risk factors of suicidal ideation and suicide attempts in older adults to inform targeted preventive strategies.

To date, several risk factors of suicidal thoughts and behavior have been identified among older adults, and include factors such as mental health complications, sleep problems, mobility problems, lower quality of life, and severe functional impairment [7-15]. One other potential but under-studied risk factor in older adults is that of visual impairment. It is possible for visual impairment to lead to higher risk of suicidal thoughts and behavior via factors such as unemployment, cognitive problems, anxiety, stress, sleep problems, mobility limitations, loneliness, lack of social participation, disability, and poor self-related health [16-19]. However, there are only a few studies on visual impairment and suicidal thoughts or behavior among older people. Specifically, four studies showed that visual impairment is

associated with higher risk for suicidal ideation [20-23], while one study showed that those with visual impairment are at greater risk of death by suicide [24]. Although these previous studies are informative, they have several important limitations. First, all of these studies were carried out in high-income countries and most have utilized small sample sizes. Second, to our knowledge, no multi-country studies exist, and no study has investigated the association between vision impairment and suicide attempt in older adults. Furthermore, none of these previous studies have assessed the mediators in the association. It is important to investigate associations between visual impairment and suicidal thoughts or behavior in multiple LMICs since this setting has the highest burden of visual impairment [25] and suicides per se [26]. Moreover, multi-country studies are important as they provide a platform to investigate between-country differences utilizing standardized data. Furthermore, cultural diversity among LMICs is vast. Thus, just as differences between high-income countries and LMICs are likely due to socioeconomic and cultural differences, so are differences between LMICs.

Given this background, the aim of the present study was to investigate associations of visual impairment, using objectively measured visual acuity, with suicidal ideation and suicide attempts in a sample of 34129 individuals aged ≥ 50 years from six LMICs. A secondary aim was to investigate whether unemployment, cognition, anxiety, perceived stress, sleep/energy, mobility, loneliness, social participation, disability, and poor self-related health act as mediators in these associations.

METHODS

Data from the Study on Global Ageing and Adult Health (SAGE) were analyzed. These data are publicly available through <http://www.who.int/healthinfo/sage/en/>. This survey was

undertaken in China, Ghana, India, Mexico, Russia, and South Africa between 2007 and 2010. Based on the World Bank classification at the time of the survey, Ghana was the only low-income country, and China and India were lower middle-income countries although China became an upper middle-income country in 2010. The remaining countries were upper middle-income countries.

Details of the survey methodology have been published elsewhere [27]. Briefly, in order to obtain nationally representative samples, a multistage clustered sampling design method was used. The sample consisted of adults aged ≥ 18 years with oversampling of those aged ≥ 50 years. Trained interviewers conducted face-to-face interviews using a standard questionnaire. Standard translation procedures were undertaken to ensure comparability between countries. The survey response rates were: China 93%; Ghana 81%; India 68%; Mexico 53%; Russia 83%; and South Africa 75%. Sampling weights were constructed to adjust for the population structure as reported by the United Nations Statistical Division. Ethical approval was obtained from the WHO Ethical Review Committee and local ethics research review boards. Written informed consent was obtained from all participants.

Suicidal ideation and suicide attempts (dependent variables)

Information on suicidal ideation and suicide attempts were assessed in the same way as in previous SAGE publications [28,29] using an adapted version of the depression module of the WHO Composite International Diagnostic Interview [30]. Those who screened positive in the depression module were further asked about suicidal thoughts and behavior. A positive screen referred to having at least one of the three following conditions for more than two weeks in the past 12 months: sadness, loss of interest, or low energy. Suicidal ideation was assessed by the question “Did you think of death, or wish you were dead?” and suicide

attempts by the question “During this period, did you ever try to end your life?” with ‘yes’ and ‘no’ answer options [31,32].

Objective visual impairment (independent variable)

Visual acuity was measured using the tumbling E logMAR chart for distance vision acuity separately for each eye. The participant was asked to be seated in a chair positioned so that the respondent’s head was 4 meters from the eye chart. The interviewer was instructed to check that the vision charts were well lit and to make sure that the surface did not reflect glare. Furthermore, the respondent was instructed to use glasses or contact lenses if they usually wear them. We defined vision impairment (at distance and near) according to the World Health Organization definition for moderate vision impairment, which refers to visual acuity worse than 6/18 (0.48 logMAR) in the better seeing eye [33]. Visual impairment was also categorized into the following levels of severity: no visual impairment (6/12 or better); mild visual impairment (6/18 or better but worse than 6/12); moderate visual impairment (6/60 or better but worse than 6/18); and severe visual impairment (worse than 6/60) [34].

Mediators

We focused on unemployment, cognition, anxiety, perceived stress, sleep/energy, mobility, loneliness, social participation, disability, and poor self-related health based on the possibility that they can be the consequence of visual impairment, while they can also lead to suicidal thoughts and behavior [35-38]. Unemployment referred to not being engaged in paid work ≥ 2 days in the last 7 days. Sleep/energy, mobility, cognition, and perceived stress were assessed with two questions each. The actual questions can be found in supplementary **Table S1**. Each item was scored on a five-point scale ranging from ‘none’ to ‘extreme/cannot do’ (sleep/energy, mobility, cognition) or ‘never’ to ‘very often’ (perceived stress). For each

separate health status, we used factor analysis with polychoric correlations to obtain a factor score which was later converted to scores ranging from 0-100 with higher values representing worse health function. Those who claimed to have severe/extreme problems with worry or anxiety in the past 30 days were considered to have anxiety [39]. Loneliness was assessed with the question “Did you feel lonely for much of the day yesterday?” with answer options ‘yes’ or ‘no’. Disability was assessed with six questions on the level of difficulty in conducting standard basic activities of daily living (ADL) in the past 30 days (washing whole body, getting dressed, moving around inside home, eating, getting up from lying down, and using the toilet) [40]. Those who answered severe or extreme/cannot do to any of the six questions were considered to have disability [41]. Following a previous SAGE publication [42], a social participation scale was created based on nine questions on the participant’s involvement in community activities in the past 12 months (e.g., attended religious services, club, society, union etc) with answer options ‘never (coded=1)’, ‘once or twice per year (coded=2)’, ‘once or twice per month (coded=3)’, ‘once or twice per week (coded=4)’, and ‘daily (coded=5)’. The answers to these questions were summed and converted to a scale ranging from 0 to 100 with higher scores indicating higher levels of social participation. Those who answered ‘bad’ or ‘very bad’ to the question “In general, how would you rate your health?” were considered to have poor self-rated health.

Control variables

Control variables were selected based on past literature and included age, sex, wealth quintiles based on income, years of education received, marital status (married/cohabiting or else), smoking (never, current, past), alcohol consumption in the past 30 days (yes or no), and number of chronic physical diseases [43]. The total number of 10 chronic physical conditions (angina, arthritis, asthma, stroke, diabetes, edentulism, chronic lung disease, hypertension,

chronic back pain, and hearing problems) was calculated for each participant. The diagnosis was based on the presence of either one of the following: self-reported diagnosis; or symptom-based diagnosis based on algorithms etc. Details on the diagnosis are provided in supplementary **Table S2**. The total number of chronic conditions was summed and categorized as 0, 1, and ≥2 conditions.

Statistical analysis

The statistical analysis was done with Stata 14.2 (Stata Corp LP, College station, Texas). The analysis was restricted to those aged ≥50 years. First, using the pooled sample, multivariable logistic regression analysis was used to assess the association between severity of visual impairment (exposure) and suicidal ideation or suicide attempt (outcomes). Country-wise analysis was also conducted, and this used the dichotomized visual impairment variable (i.e., worse than 6/18 or not) as the exposure variable. In order to assess the degree of between-country heterogeneity in the association between visual impairment and suicidal thoughts or behavior, we calculated the Higgin's I^2 based on country-wise estimates. This represents the degree of heterogeneity that is not explained by sampling error with values of 25%, 50%, and 75% often being considered as low, moderate, and high levels of heterogeneity [44]. Overall estimates were obtained based on country-wise estimates by meta-analysis with random effects.

Next, in order to gain an understanding of the extent to which various factors may explain the relation between visual impairment and suicide attempt, we conducted mediation analysis. We conducted this analysis for suicide attempts given that preliminary analysis showed that this was particularly strongly associated with visual impairment, while suicide attempts are considered more serious conditions than suicidal ideation. We used the *khb* (Karlson Holm

Breen) command in Stata [45] for the mediation analysis. This method can be applied in logistic regression models and decomposes the total effect (i.e., unadjusted for the mediator) of a variable into direct (i.e., the effect of visual impairment on suicide attempts adjusted for the mediator) and indirect effects (i.e., the mediational effect). Using this method, the percentage of the main association explained by the mediator can also be calculated (mediated percentage). Each potential mediator was included in the model individually.

All regression analyses including the mediation analysis were adjusted for age, sex, wealth, education, marital status, smoking, alcohol consumption, number of chronic physical diseases, and country with the exception of the country-wise analysis which was not adjusted for country. Adjustment for country was done by including dummy variables for each country in the model as in previous SAGE publications. Overall, under 4.6% of the data were missing for all variables used in the analysis with the exception of visual impairment (8.5%). Complete case analysis was done. Information on the percentage of missing values by country are presented in **Table S3** of the supplementary material. The sample weighting and the complex study design were taken into account in all analyses. Results from the regression analyses are presented as odds ratios (ORs) with 95% confidence intervals (CIs). The level of statistical significance was set at $P < 0.05$.

RESULTS

The analytical sample consisted of 34,129 individuals aged ≥ 50 years. The mean (SD) age was 62.4 (16.0) years, while 47.9% were males (**Table 1**). Overall, the prevalence of suicidal ideation and suicide attempts were 3.4% and 0.6%, respectively, while the prevalence of each level of severity in visual impairment were: 17.1% (mild); 15.4% (moderate); and 0.4% (severe). The prevalence of suicidal ideation and suicide attempts increased with increasing

severity of visual impairment (**Figure 1**). For example, the prevalence of suicide attempts was 0.4% among those without visual impairment but this increased to 3% among those with severe visual impairment. After adjustment for potential confounders, compared to no visual impairment, severe visual impairment was significantly associated with suicidal ideation (OR=9.50; 95%CI=2.47-36.52) (**Table 2**). Moderate and severe visual impairment were significantly associated with 2.22 (95%CI=1.14-4.35) and 11.50 (95%CI=1.44-91.88) times higher odds for suicide attempts, respectively. Country-wise analysis showed that visual impairment (i.e., worse than 6/18) was significantly associated with suicidal ideation (OR=1.65; 95%CI=1.13-2.41) and suicide attempts (OR=2.69; 95%CI=1.29-5.62) overall although a moderate level of between-country heterogeneity was found (**Figure 2**). Disability, poor self-rated health, mobility, and loneliness explained 14.0%, 9.3%, 7.2%, and 6.3% of the association between visual impairment and suicide attempts, respectively (**Table 3**). Unemployment, cognition, anxiety, perceived stress, sleep/energy, and social participation were not significant mediators.

Table 1 Sample characteristics (overall and by country)

Characteristic		Overall (N=34129)	China (N=13175)	Ghana (N=4305)	India (N=6560)	Mexico (N=2313)	Russia (N=3938)	South Africa (N=3838)
Suicidal ideation	Yes	3.4	0.7	4.0	6.7	7.6	2.7	1.9
Suicide attempt	Yes	0.6	0.3	0.8	1.2	4.6	0.3	0.9
Visual impairment ^a	Yes	15.8	10.0	12.2	18.7	17.4	25.5	11.0
Age (years)	Mean (SD)	62.4 (16.0)	62.6 (16.7)	64.4 (19.9)	61.5 (13.7)	63.0 (18.9)	63.9 (15.4)	61.6 (18.4)
Sex	Male	47.9	49.8	52.4	51.0	46.8	38.9	44.1
Education (years)	Mean (SD)	6.0 (8.9)	5.6 (8.2)	4.2 (9.9)	3.7 (7.4)	5.0 (8.0)	11.1 (5.3)	6.0 (10.1)
Marital status	Married/cohabiting	75.5	85.0	59.3	76.9	73.0	58.3	55.9
Smoking	Never	58.6	64.1	75.1	45.3	60.7	69.6	66.8
	Current	34.9	29.3	10.7	50.0	20.3	21.3	23.8
	Past	6.6	6.6	14.2	4.7	19.1	9.0	9.4
Alcohol consumption	Yes	18.7	22.9	30.6	6.8	24.8	32.7	13.7
Number of chronic conditions	0	25.2	23.8	25.4	32.5	14.6	16.1	12.8
	1	34.9	40.7	47.2	32.4	48.1	25.3	47.7
	≥2	39.9	35.5	27.4	35.1	37.3	58.6	39.5

Abbreviation: SD Standard deviation

Data are % unless otherwise stated.

^a Visual acuity worse than 6/18.

Table 2 Association between different levels of visual impairment or covariates and suicidal ideation/suicide attempts (outcomes) estimated by multivariable logistic regression

Characteristic		Suicidal ideation			Suicide attempt		
		OR	95%CI	P-value	OR	95%CI	P-value
Visual impairment	None	1.00			1.00		
	Mild	1.37	[1.00,1.87]	0.050	1.46	[0.75,2.88]	0.267
	Moderate	1.41	[0.97,2.05]	0.072	2.22	[1.14,4.35]	0.020
	Severe	9.50	[2.47,36.52]	0.001	11.50	[1.44,91.88]	0.021
Age (years)		0.99	[0.97,1.01]	0.249	1.01	[0.97,1.05]	0.617
Sex	Female	1.00			1.00		
	Male	0.44	[0.31,0.61]	<0.001	0.37	[0.16,0.86]	0.022
Wealth	Poorest	1.00			1.00		
	Poorer	1.28	[0.84,1.96]	0.253	1.18	[0.57,2.46]	0.654
	Middle	0.90	[0.57,1.40]	0.630	0.74	[0.37,1.46]	0.383
	Richer	0.62	[0.37,1.03]	0.066	0.91	[0.39,2.10]	0.816
	Richest	0.61	[0.41,0.89]	0.011	0.61	[0.30,1.26]	0.183
Education (years)		1.02	[0.98,1.07]	0.352	1.00	[0.92,1.08]	0.924
Married/cohabiting	No	1.00			1.00		
	Yes	1.21	[0.92,1.60]	0.180	1.37	[0.77,2.43]	0.286
Smoking	Never	1.00			1.00		
	Current	1.12	[0.82,1.52]	0.477	1.41	[0.68,2.92]	0.352
	Past	2.00	[1.21,3.30]	0.007	3.28	[1.49,7.22]	0.003
Alcohol consumption	No	1.00			1.00		
	Yes	1.02	[0.62,1.69]	0.930	1.89	[0.80,4.46]	0.147
No. of chronic conditions	0	1.00			1.00		
	1	1.37	[0.85,2.22]	0.194	0.68	[0.32,1.42]	0.303
	≥2	3.06	[1.69,5.54]	<0.001	1.62	[0.87,3.03]	0.129

Abbreviation: OR Odds ratio; CI Confidence interval

Models are mutually adjusted for all variables in the respective column and country.

Table 3 Mediators in the association between visual impairment and suicide attempt

Mediator	Effect	OR [95%CI]	P-value	Mediated %
Unemployment	Total	2.06 [1.16,3.64]	0.013	NA
	Direct	2.03 [1.14,3.62]	0.016	
	Indirect	1.01 [0.99,1.04]	0.307	
Cognition	Total	2.04 [1.15,3.62]	0.015	NA
	Direct	1.97 [1.10,3.53]	0.022	
	Indirect	1.03 [1.00,1.07]	0.058	
Anxiety	Total	2.14 [1.22,3.75]	0.008	NA
	Direct	2.12 [1.21,3.71]	0.009	
	Indirect	1.01 [0.98,1.04]	0.524	
Perceived stress	Total	2.02 [1.13,3.58]	0.017	NA
	Direct	2.00 [1.13,3.56]	0.018	
	Indirect	1.01 [0.97,1.04]	0.701	
Sleep/energy	Total	1.95 [1.07,3.55]	0.029	NA
	Direct	1.92 [1.05,3.52]	0.034	
	Indirect	1.01 [0.97,1.06]	0.583	
Mobility	Total	2.00 [1.12,3.57]	0.019	7.2
	Direct	1.90 [1.05,3.44]	0.033	
	Indirect	1.05 [1.01,1.10]	0.027	
Loneliness	Total	2.00 [1.11,3.59]	0.021	6.3
	Direct	1.91 [1.06,3.45]	0.031	
	Indirect	1.04 [1.00,1.09]	0.031	
Social participation	Total	2.05 [1.16,3.63]	0.014	NA
	Direct	2.05 [1.16,3.65]	0.014	
	Indirect	1.00 [0.97,1.03]	0.848	
Disability	Total	1.90 [1.02,3.53]	0.042	14.0
	Direct	1.74 [0.93,3.25]	0.083	
	Indirect	1.09 [1.04,1.15]	<0.001	
Poor self-rated health	Total	2.05 [1.15,3.65]	0.014	9.3
	Direct	1.92 [1.06,3.47]	0.031	
	Indirect	1.07 [1.02,1.12]	0.004	

Abbreviation: OR Odds ratio; CI Confidence interval

Visual impairment referred to visual acuity worse than 6/18.

Models are adjusted for age, sex, wealth, education, marital status, smoking, alcohol consumption, number of chronic physical diseases, and country.

Mediated percentage was only calculated in the presence of a significant indirect effect ($P < 0.05$).

DISCUSSION

In this large sample of older adults from six LMICs, we observed a large variation in the prevalence of suicidal ideation and suicide attempts between countries. The reason for this variability can only be speculated but it is likely to be the result of a complex interplay of factors such as culture, religion, economic events, unemployment, accessibility to means of suicide, and distribution of risk factors such as mental illness and substance use, which can vary substantially between regions [46]. Furthermore, we found that compared to no visual impairment, severe visual impairment was associated with a 9.50 times greater odds of suicidal ideation. Moreover, moderate and severe visual impairment were associated with a 2.22 and 11.50 times greater odds for suicide attempts, respectively. A moderate level of between-country heterogeneity was observed in relation to these associations. Between 6.3% to 14.0% of the variation in the association between visual impairment and suicide attempts was explained by disability, poor self-rated health, mobility, and loneliness. No other investigated variables were found to significantly mediate the studied association.

Taken together, the findings from the present study support and add to existing literature on this topic. It supports existing literature on suicidal thoughts or completed suicides [47-50] through further confirming that an association exists between visual impairment and suicidal ideation or suicide attempts in older adults from multiple LMICs.

There may be several mechanisms underlying the association between visual impairment and suicidal thoughts or behavior. First, in our study, disability, mobility, and poor self-rated health were significant mediators for suicide attempts, suggesting that limitations in activities or perceptions of poor health due to visual impairment may increase risk for suicidal behavior. As for loneliness, previous studies have shown that people with visual impairment

are more likely to suffer from loneliness possibly due to factors such as difficulties in interpersonal interactions and social communication [51]. Loneliness in turn, can increase the risk of suicidal thoughts and behavior [52].

However, given that a relatively small proportion of the association between visual impairment and suicide attempts was explained by these factors, other factors which were not measured in our study may also be playing a role. For example, previous research has linked the response to onset of visual impairment to a grief reaction, in which patients mourn the loss of the sighted self. In some cases, this reaction is complicated to the point of precipitating suicide [53]. Moreover, in one recent review of case studies, it was concluded that foreseeable loss of sight may induce severe psychological distress that can lead to suicide [54]. Future research of a qualitative nature is needed to understand the role of reaction to sight loss and fear of becoming blind in the visual impairment and suicidal thought/behavior association.

When considering the findings from this study that visual impairment is associated with suicidal ideation and suicide attempts in older adults in LMICs, and the fact that LMICs have the highest prevalence of visual impairment and suicide [55,56], interventions and policies are urgently needed to combat suicidal behavior in visually impaired older adults. In addition to targeting mediating variables identified in this study, the following measures have been suggested as appropriate strategies to prevent suicide in LMICs per se: restricting access to means, responsible media reporting, introducing mental health and alcohol policies, early identification and treatment, training of health workers, and follow-up care and community support following a suicide attempt [57]. Finally, although study participants were asked to use corrective lenses during the optical assessment, it is likely that participants were not

wearing updated lenses or they did not have corrective lenses. It is important to note that globally, uncorrected and undercorrected refractive error is the number one cause of vision impairment [58]. Thus, in the context of LMICs, there might be visual impairments, which can be easily addressed. Also, if the reason for visual impairment is cataracts, there is the possibility to conduct surgery. Further research is now warranted to determine whether interventions to improve vision also result in improvements in behavioral and psychological health.

The large sample of older adults from multiple LMICs and the objective measure of visual impairment are clear strengths of the present study. However, findings must be interpreted in light of the study limitations. First, most of the information used in this study was based on self-report, and therefore, reporting bias may exist. Relatedly, it is possible that some questions such as those on suicidal ideation and suicide attempts were interpreted differently across different cultures. Second, the present measure of suicidal ideation was related to wish to die, which has been differentiated from active suicidal ideation. However, the presence of wishes to die has been reported as clinically important as the presence of active suicidal ideation [59]. Third, suicidal ideation and suicide attempts were only assessed among those who had depressive symptoms (i.e., sadness, loss of interest, or low energy). This may have led to an underestimate of those with suicidal ideation and suicide attempts but it is worth noting that depressive symptoms are common in people with suicidal behavior [60]. Relatedly, the fraction of the visual impairment-suicide attempt association explained by depression could not be evaluated in the present study since suicide attempts was assessed only among those with depressive symptoms. Given that visual impairment has been reported to be associated with depression [61], future studies should assess the extent to which the visual impairment-suicidal behavior association is mediated by depression. Next, although

the percentage of missing values was overall relatively low, it is possible that some level of bias was introduced. In particular, the pattern of missingness differed slightly between countries and this may have had some impact especially on the country-wise associations. Finally, the study was cross-sectional in nature and thus the direction of the association cannot be established. Future studies of a longitudinal nature are now required.

In conclusion, in this large sample of older adults from six LMICs, it was found that visual impairment was associated with a higher odds of suicidal ideation and suicide attempts. Moreover, the present study found that the association between visual impairment and suicide attempts may partly be explained by disability, poor self-rated health, mobility, and loneliness. Interventions to reduce suicidal ideation and suicide attempts among older adults with visual impairment in LMICs are required, targeting the identified mediators, while using tested strategies for suicide prevention per se in LMICs may yield beneficial outcomes.

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Figure 1

Prevalence of suicidal ideation and suicide attempts by different levels of visual impairment.

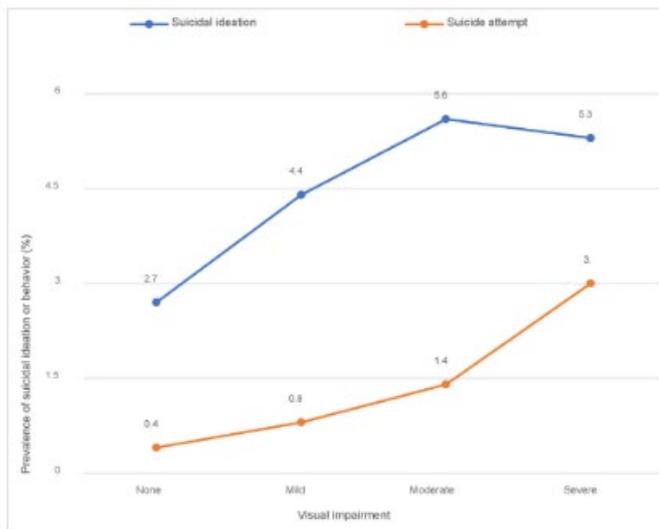
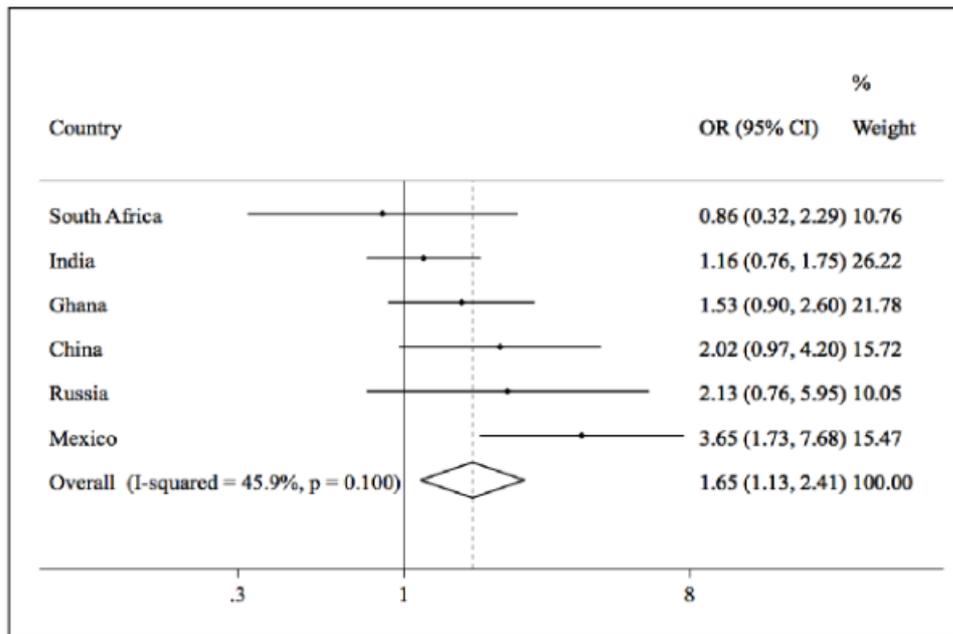


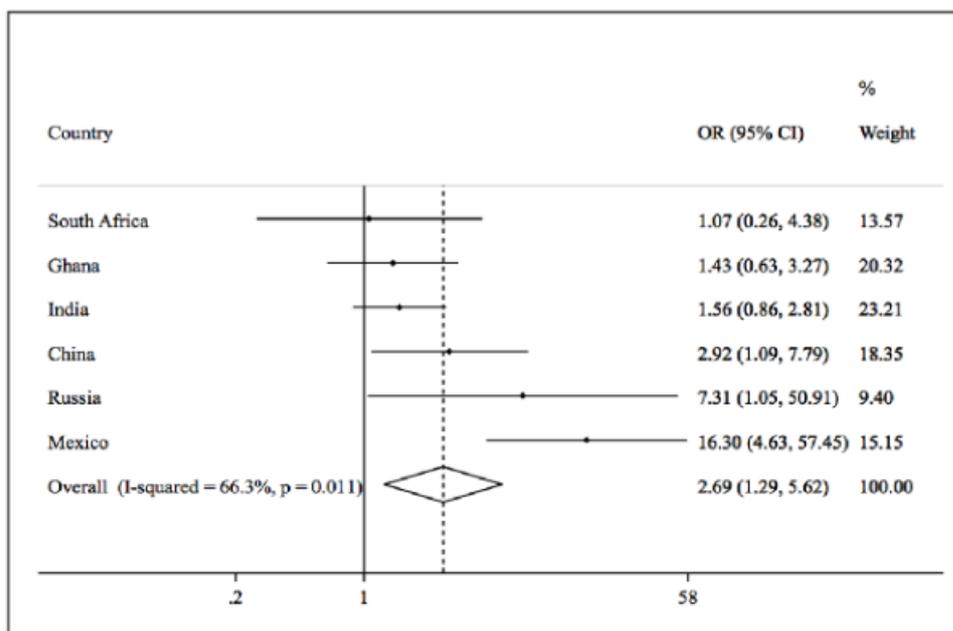
Figure 2

Country-wise association of visual impairment with (A) suicidal ideation and (B) suicide attempt estimated by multivariable logistic regression. Visual impairment referred to acuity worse than 6/18. Models are adjusted for age, sex, wealth, education, marital status, smoking, alcohol consumption and number of chronic physical diseases.

(A) Suicidal ideation



(B) Suicide attempt



APPENDIX

Table S1 Questions used to assess mobility, cognition, sleep/energy, and perceived stress

Mobility	<p>(1) Overall in the last 30 days, how much difficulty did you have with moving around?</p> <p>(2) Overall in the last 30 days, how much difficulty did you have in vigorous activities, such as running 3 km (or equivalent) or cycling?</p>
Cognition	<p>(1) Overall in the last 30 days, how much difficulty did you have with concentrating or remembering things?</p> <p>(2) Overall in the last 30 days, how much difficulty did you have in learning a new task (for example, learning how to get to a new place, learning a new game, learning a new recipe etc.)?</p>
Sleep and energy	<p>(1) Overall in the last 30 days, how much of a problem did you have with sleeping, such as falling asleep, waking up frequently during the night or waking up too early in the morning?</p> <p>(2) Overall in the last 30 days, how much of a problem did you have due to not feeling rested and refreshed during the day (e.g. feeling tired, not having energy)?</p>
Perceived stress	<p>(1) How often have you felt that you were unable to control the important things in your life?</p> <p>(2) How often have you found that you could not cope with all the things that you had to do?</p>

Table S2 Details on the diagnosis of chronic conditions

Condition	(a) Self-reported diagnosis	(b) Symptom-based algorithm or other method of diagnosis
Angina	Have you ever been diagnosed with angina or angina pectoris (a heart disease)?	Rose questionnaire [1]
Arthritis	Have you ever been diagnosed with/told you have arthritis (a disease of the joints, or by other names rheumatism or osteoarthritis)?	NA
Asthma	Have you ever been diagnosed with asthma (an allergic respiratory disease)?	NA
Chronic back pain	NA	Chronic back pain was defined as having had back pain everyday during the last 30 days.
Chronic lung disease	Have you ever been diagnosed with chronic lung disease (emphysema, bronchitis, COPD)?	NA
Diabetes	Have you ever been diagnosed with diabetes (high blood sugar)? (not including diabetes associated with a pregnancy)	NA
Edentulism	NA	Have you lost all of your natural teeth?
Hearing problems	NA	The interviewer observed this condition during the survey
Hypertension	Have you ever been diagnosed with high blood pressure (hypertension)?	Blood pressure was measured three times with a one-minute interval with the use of a wrist blood pressure monitor (Medistar Wrist Blood Pressure Model S) and the mean value of the three measurements was calculated. Hypertension was defined as having at least one of the following: systolic blood pressure ≥ 140 mmHg; diastolic blood pressure ≥ 90 mmHg.
Stroke	Have you ever been told by a health professional that you have had a stroke?	NA

For all chronic conditions, we assumed that the individual had the condition if they fulfilled at least one of the following: (a) affirmative answer to self-reported diagnosis or (b) symptom-based algorithm or other method of diagnosis.

[1] Rose GA. The diagnosis of ischaemic heart pain and intermittent claudication in field surveys. Bull World Health Organ. 1962;27: 645-658.

Table S3 Percentage of missing values for the variables used in the analysis by country

Variable	China	Ghana	India	Mexico	Russia	South Africa
Suicidal ideation	2.8	0.5	0.1	4.5	1.5	4.8
Suicide attempt	2.8	0.5	0.1	4.5	1.5	4.9
Visual impairment	7.6	0.9	5.8	19.5	22.3	3.9
Age	0.0	0.0	0.0	0.0	0.0	0.0
Sex	0.0	0.0	0.0	0.3	0.0	0.0
Education	0.0	0.5	0.0	4.4	0.1	14.9
Wealth	0.5	0.1	0.6	0.2	0.1	0.5
Marital status	0.1	0.5	0.0	4.4	0.3	1.9
Smoking	2.0	0.7	0.1	4.5	1.2	5.2
Alcohol consumption	1.8	0.4	0.0	4.5	1.1	4.7
Number of chronic conditions	6.5	1.5	0.2	4.7	2.5	10.3
Unemployment	2.0	0.4	0.0	4.7	0.4	2.4
Cognition	1.9	0.2	0.0	4.9	5.4	2.4
Anxiety	1.8	0.4	0.4	4.4	2.1	2.3
Perceived stress	3.5	0.7	0.1	4.9	6.7	5.6
Sleep/energy	2.1	0.1	0.1	4.9	6.3	2.5
Mobility	1.9	0.1	0.6	4.9	6.2	2.5
Loneliness	2.3	0.6	0.2	4.7	3.2	5.6
Social participation	0.0	0.0	0.0	0.0	0.0	0.0
Disability	2.3	0.8	1.2	4.6	2.6	2.7
Poor self-rated health	1.8	0.1	0.0	4.4	0.5	2.1