# The association between objectively measured vision impairment and self-reported physical activity among adults aged ≥50 years in six low- and middle-income countries

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**ACKNOWLEDGEMENTS**

This paper uses data from WHO's Study on Global Ageing and Adult Health (SAGE). SAGE is supported by the U.S. National Institute on Aging through Interagency Agreements OGHA 04034785, YA1323–08-CN-0020, Y1-AG-1005–01 and through research grants R01-AG034479 and R21-AG034263.

**Conflicts of Interest:** None.

**Funding:** Dr. Guillermo Felipe López-Sánchez is funded by the Seneca Foundation – Agency for Science and Technology of the Region of Murcia, Spain. [20390/PD/17].

**Abstract**

The authors investigated the association between vision impairment and physical activity among older adults from low- and middle-income countries. Visual acuity was measured using the tumbling ElogMAR chart, and vision impairment was defined as visual acuity worse than 6/18 (0.48 logMAR) in the better seeing eye. Physical activity was assessed by the Global Physical Activity Questionnaire. Multivariable logistic regression and meta-analysis were conducted to assess associations. The sample included 34,129 individuals aged 50–114 years (mean [SD] age 62.4 [16.0] years; 47.9% male). After adjustment for confounders, near vision impairment was not significantly associated with low physical activity, but far vision impairment showed a significant association (odds ratio = 1.32; 95% confidence interval [1.17, 1.49], I2 = 0.0%). Far vision impairment was dose-dependently associated with low physical activity (e.g., severe [<6/10] vs. no [≥6/12] far vision impairment; odds ratio = 1.80; 95% confidence interval [1.03, 3.15]). Interventions to address low levels of physical activity in the visually impaired in low- and middle-income countries should target those with far vision impairment.

## Introduction

Physical activity (bodily movement caused by contraction of skeletal muscle that results in energy expenditure) can be categorized into multiple domains including structured exercise and sport, active travel (walking and cycling), occupational activity, and household chores/gardening (Caspersen, Powell, & Christenson, 1985). Participation in physical activity is beneficial for both the physical and mental health of adults. For example, a recent systematic review of review articles found that physically active older adults are at a reduced risk of cardiovascular mortality, breast and prostate cancer, fractures, recurrent falls, functional limitation, and depression. Moreover, the review found that physically active older adults experience healthier aging trajectories, better quality of life, and improved cognitive functioning (Cunningham, O'Sullivan, Caserotti, & Tully, 2020). Moreover, low levels of physical activity have an important economic burden. For example, in the United Kingdom alone, physical inactivity is expected to cost the National Health Service approximately £1.3 billon by 2030 (Sport England, 2019). In light of this evidence, the World Health Organization (WHO) produced guidance in relation to physical activity levels. The key message from this guidance is that adults including older adults should achieve at least 150 min of moderate physical activity and/or 75 min of vigorous physical activity per week (World Health Organization, 2010). It is therefore important to ensure that all populations maintain adequate levels of physical activity for good health. However, literature shows that as adults' age, levels of physical activity decline. For example, one study in a sample of 5,022 participants (mean age 61 years; 2,114 male) from the United Kingdom observed that there was an overall trend for increasing levels of inactivity and a reduction in vigorous activity over a period of 10 years (Smith, Gardner, Fisher, & Hamer, 2015).

Despite the known benefits, some groups of people engage in low levels of physical activity, jeopardizing health status. One such group are those with visual impairment. Low levels of physical activity in this group may be due to factors such as fear of falling, lack of access to adapted recreational and athletic programs for those with vision impairment, and help or encouragement in developing suitable and safe physical recreation skills and habits specifically tailored for those with visual impairment (CapellaMcDonnall, 2007). A previous study found in a sample of 6,634 U.K. older adults (mean [SD] age 65 [9.2] years) that those with poor vision were twice as likely to be physically inactive than those with good eyesight (Smith et al., 2017). Similar findings have been found in adults residing in the United States and Spain (Lo´pezSánchez, Grabovac, Pizzol, Yang, & Smith, 2019; Smith et al., 2019; Willis, Jefferys, Vitale, & Ramulu, 2012).

However, the current literature has several limitations. First, only a few studies have used objective measures to record vision status with the majority of studies using self-report (Smith et al, 2019). Self-reported measures of vision are often crude in nature, for example "is your eyesight (using glasses or corrective lenses; if you use them) excellent/very good/good/fair/or poor" (Smith et al., 2017). Thus, these measures are not able to determine acuity and consequently unable to diagnose or confirm visual impairment. Next, while there are a few studies on self-reported measures of visual acuity and physical activity from low- and middle-income countries (LMICs; Smith et al., 2021), there are currently no studies on objectively measured visual acuity and physical activity from LMICs. This is an important omission as visual difficulties have been reported to be more common in LMICs than in high-income countries (Freeman et al., 2013), while it is possible that people with vision impairment may have particular difficulties in engaging in physical activity in LMICs due to factors such as lack of visually impaired accessible facilities. Furthermore, there are only a few studies that have specifically focused on the older population despite the fact that the prevalence of visual impairment and low physical activity increase with age (Klaver, Wolfs, Vingerling, Hofman, & de Jong, 1998; Smith et al., 2015).

Therefore, the aim of the present study was to investigate the association between objectively measured visual impairment and self-reported physical activity among adults aged ≥50 years from six LMICs (China, Ghana, India, Mexico, Russia, and South Africa), which broadly represent different geographical locations and levels of socioeconomic and demographic transition. We hypothesized that those with visual impairment will report lower levels of physical activity.

**Methods**

Publicly available data from the SAGE (http://www.who.int/ healthinfo/sage/en/) were analyzed. This survey was undertaken in China, Ghana, India, Mexico, Russia, and South Africa between 2007 and 2010. All countries were LMICs based on the World Bank classification at the time of the survey.

Details of the SAGE survey methodology have been published previously (Kowal et al., 2012). In brief, 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.

*Physical Activity*

Levels of physical activity was assessed with the validated Global Physical Activity Questionnaire (Bull, Maslin, & Armstrong, 2009). The total amount of moderate to vigorous physical activity in a typical week was calculated based on self-report. Those scoring ≥150 min of moderate- to vigorous-intensity physical activity were classified as meeting the recommended guidelines (coded = 0), and those scoring <150 min (low physical activity) were classified as not meeting the recommended WHO guidelines (coded = 1) (World Health Organization, 2010).

*Visual Impairment*

Visual acuity was measured using the tumbling ElogMAR chart for distance and near acuity separately for each eye. A string was used to measure 40 cm as the test distance for near visual acuity. The interviewer was instructed to check that the vision charts are well lit and to make sure that the surface does 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 WHO definition for moderate vision impairment, which refers to visual acuity worse than 6/18 (0.48 logMAR) in the better seeing eye (Ehrlich, Stagg, Andrews, Kumagai, & Musch, 2019). We also categorized far vision into the following levels of severity: no vision impairment (6/12 or better), mild vision impairment = 6/18 or better but worse than 6/12, moderate vision impairment = 6/60 or better but worse than 6/18, and severe vision impairment = worse than 6/60 (World Health Organization, 2019).

*Control Variables*

The control variables, selected based on past literature (Smith et al., 2019), were age; sex; wealth quintiles based on country-specific income; highest level of education achieved (primary, secondary, and tertiary); smoking (never, current, and former); obesity; and chronic physical conditions (angina, arthritis, diabetes, and stroke). A stadiometer and a routinely calibrated electronic weighting scale were used to measure height and weight, respectively. Obesity was defined as body mass index ≥30 kg/m2. Arthritis, diabetes, and stroke were based on self-reported lifetime diagnosis. For angina, in addition to a self-reported diagnosis, a symptom-based diagnosis based on the Rose questionnaire was also used (Rose, 1962). Chronic physical conditions referred to having at least one of the following: angina, arthritis, diabetes, or stroke.

*Statistical Analysis*

The statistical analysis was performed with Stata (version 14.1; Stata Corp LP, College Station, TX). The analysis was restricted to those aged ≥50 years. The difference in sample characteristics between those with and without near or far vision impairment was tested by chi-squared tests and Student's t tests for categorical and continuous variables, respectively. Country-wise multivariable logistic regression analysis was conducted to assess the association between near or far vision impairment (exposures) and low physical activity (outcome). Interaction analysis was also conducted to assess whether the strength of the association between near or far vision impairment and low physical activity differs by age group (50–64 and ≥65 years) by including the product term of age group × (near or far) visual impairment in the model. In order to assess the between-country heterogeneity that may exist in the association between near or far vision impairment and low physical activity, we calculated the Higgins' I2 based on estimates for each country. The Higgins' I2 represents the degree of heterogeneity that is not explained by sampling error with a value of <40% often considered as negligible and 40–60% as moderate heterogeneity (Higgins & Thompson, 2002). A pooled estimate was obtained by fixed-effect meta-analysis as the level of between-country heterogeneity was low. Finally, we also assessed whether there is a dose-dependent association between severity of far vision impairment and low physical activity with multivariable logistic regression using the overall sample.

All regression analyses were adjusted for age, sex, wealth, education, smoking, obesity, and chronic physical condition. The analysis with near vision impairment as the exposure was additionally adjusted for far vision impairment, while that of far vision impairment was adjusted for near vision impairment. Furthermore, the analysis on severity of far vision impairment and low physical activity was adjusted for country by including dummy variables for each country in the model as in previous SAGE publications (Field, 2013; Koyanagi et al., 2018, 2019). All variables were included in the models as categorical variables with the exception of age (continuous variable). The sample weighting and the complex study design (i.e., strata and primary sampling units) were taken into account in all analyses with the use of the svy command in Stata, which relies on the Taylor linearization method. Results from the regression analyses are presented as odds ratios with 95% confidence intervals (CIs). The level of statistical significance was set at $p < .05$.

## Results

The final sample included 34,129 individuals aged ≥50 years (China 13,175; Ghana 4,305; India 6,560; Mexico 2,313; Russia 3,938; and South Africa 3,838). The sample characteristics are provided in Table 1. Overall, the mean (SD) age of the sample was

62.4 (16.0) and 47.9% were males. The overall prevalence of low physical activity (i.e., not meeting the recommended WHO guidelines), near vision impairment, and far vision impairment were 23.5%, 39.5%, and 15.8%, respectively. Furthermore, 17.1%, 15.4%, and 0.4% had mild, moderate, and severe far vision impairment, respectively. Individuals with near or far vision impairment were more likely to be older, females, poorer, have lower levels of education, and have chronic physical conditions. Overall, the prevalence of low physical activity among those with and without near vision impairment was 25.7% and 21.6%, respectively, while the corresponding figures for far vision impairment were 31.4% and 21.8%, respectively (Figure 1). The country-wise association between near vision impairment and low physical activity estimated by multivariable logistic regression is shown in Figure 2. Near vision impairment was not significantly associated with low physical activity, with the overall estimate based on a meta-analysis being odds ratios = 1.07 (95% CI [0.97, 1.10], I2 = 0.0%). On the other hand, far vision impairment was significantly associated with low physical activity with the pooled estimate being odds ratios = 1.32 (95% CI [1.17, 1.49], I2 = 0.0%; Figure 3). For both near and far vision, there was no significant interaction by age group. Finally, there was a dose-dependent increase in the odds for low physical activity with severity of far vision impairment. Specifically, compared with no far vision impairment, mild, moderate, and severe far vision impairment were associated with 1.09 (95% CI [0.94, 1.26]), 1.31 (95% CI [1.06, 1.61]), and 1.80 (95% CI [1.03, 3.15]) times higher odds for low physical activity, respectively (Figure 4).

**Discussion**

In this large representative sample of older adults from six LMICs across multiple continents, far vision impairment was significantly associated with low physical activity, in a dose-dependent manner. Those with severe far vision impairment (vs. no vision impairment) were

1.80 times more likely to report low physical activity and not meet current physical activity recommendations. The finding that far vision impairment is associated with low physical activity is in line with previous studies using objective (Smith et al., 2019) and subjective measures of visual acuity (Lo´pez-Sánchez et al., 2019; Smith et al., 2017, 2019; Willis et al., 2012) conducted in highincome countries. Our study adds to the previous literature by identifying for the first time that far vision impairment as confirmed by objective measures is associated with low physical activity in older adults in LMICs. Furthermore, we show for the first time that near vision impairment is not associated with low physical activity.

There are several plausible pathways that may explain the association between far vision impairment and low physical activity levels. First, to participate in many sporting activities, optimal vision is required and having far vision impairment will likely hinder one's ability to perform at optimal levels. For example, in relation to ball sports, not being able to see a ball until it is up close will significantly impair one's ability to respond. Moreover, if correctives (spectacles) are worn, it is possible that one would be put off playing particular sports in fear of the corrective being damaged. Although this could be overcome through contact lenses wear, in LMICs, it is likely that a small proportion of the population wear contact lenses. For example, in a study of adults from Ghana, just 34.8% of the sample were aware of contact lens wear for vision correction (Abokyi, Manuh, Otchere, & Ilechie, 2017). In relation to this, it is also possible that people with visual difficulties may lack access to recreational and athletic programs, especially in LMICs where these types of programs may be scarce. Next, some areas of LMICs have a high crime rate and can be hostile environments (Wolf, Gray, & Fazel, 2014). Thus, those who have far vision impairment may be concerned about their personal safety when carrying out free-living physical activity, such as walking to a destination, as they may not be able to clearly see signs of danger ahead and may therefore choose to stay at home more or use alternative modes of motorized transport that may be perceived to be safer. Also, it is possible that those with far visual impairment are more likely to be unemployed, while they may also have difficulty in engaging in social activities (Royal National Institute of Blind People, 2020). Thereby, they may lose the opportunity to engage in occupational physical activity and incidental physical activity acquired during social activities.

Given these plausible pathways in terms of the link between far vision impairment and low physical activity, it may not be of surprise that near vision impairment was not associated with low physical activity. It is possible that, although not investigated in the present study, near vision impairment is less likely to interfere with the previously mentioned factors that may lead to low physical activity. Future research of a qualitative nature is now required to identify barriers and facilitators to physical activity participation in older adults with vision impairments residing in LMICs.

It has previously been suggested that to increase levels of physical activity for those who have a disability in LMICs, awareness of the benefits of physical activity needs to be increased among health care providers in this setting. This could be achieved through continued medical education in relation to the importance of assessing levels of and promoting participation in physical activity. Moreover, it is stated that physical activity promotion in this setting should utilize cognitive behavior principles (e.g., goal setting and problem solving). Finally, it would be prudent to increase ophthalmic infrastructure in relation to visual impairment and implement health policies in terms of glasses and contact lens awareness and distribution.

The use of a large nationally representative data set across multiple LMICs is a clear strength of the present study. However, findings must be interpreted in light of the study limitations.

First, physical activity was assessed using self-report, and this may have introduced some level of bias (e.g., recall bias). Future studies using device-based data (e.g., accelerometers) on physical activity from LMICs are warranted. Second, our study included six LMICs with large populations, but our study cannot be considered to be representative of all LMICs. Finally, the study is of a cross-sectional nature, and it is not known whether lower levels of physical activity precede far vision impairment or whether far vision impairment precedes low levels of physical activity. For example, some studies have shown that those who engage in high levels of physical activity may be less likely to develop myopia (Suhr Thykjær, Lundberg, & Grauslund, 2017).

In conclusion, in this large representative sample of older adults from multiple LMICs, those with objectively measured far vision impairment reported lower levels of physical activity. Future studies should aim to identify the factors that lead to low physical activity in people with far vision impairment in this setting. Interventions to address low levels of physical activity in the visually impaired in LMICs should target those with far vision impairment and tailor interventions to this population's specific needs. Such interventions may include medical education on the benefits of participation in physical activity, goal setting, and problem solving. Moreover, a recent systematic review and metaanalysis on interventions to promote physical activity among those with vision impairment concluded that physical activity interventions in individuals with visual impairment incorporating activities such as tai chi, yoga, and dance can have positive results, particularly in physical measures such as mobility and balance (Sweeting et al., 2020).

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**Table 1** Sample characteristics (overall and by near and far vision impairment)

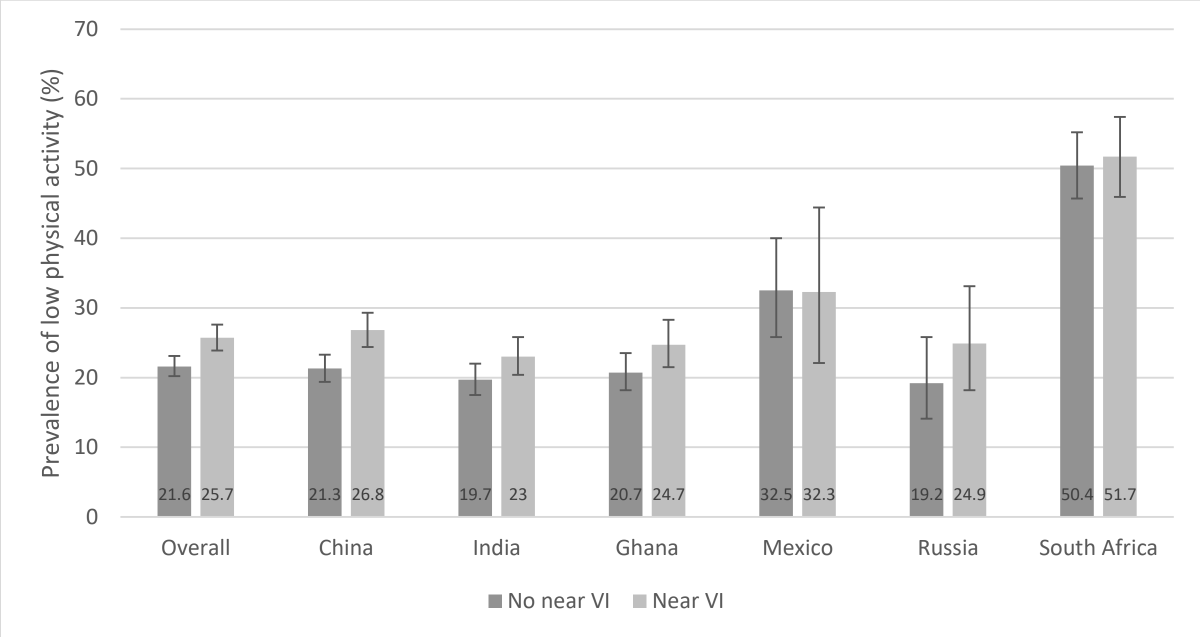
| | | | Near vision impairment | | | Far vision impairment | | |
|---|---|---|---|---|---|---|---|---|
| Characteristic | | Overall | No | Yes | P-value[a] | No | Yes | P-value[a] |
| Age (years) | Mean (SD) | 62.4 (16.0) | 61.1 (15.5) | 63.8 (16.6) | <0.001 | 61.2 (15.4) | 67.1 (17.0) | <0.001 |
| Sex | Male | 47.9 | 51.2 | 44.1 | <0.001 | 49.8 | 40.6 | <0.001 |
| | Female | 52.1 | 48.8 | 55.9 | | 50.2 | 59.4 | |
| Wealth | Poorest | 17.1 | 16.3 | 18.9 | <0.001 | 15.9 | 24.8 | <0.001 |
| | Poorer | 19.0 | 18.3 | 20.7 | | 18.9 | 21.2 | |
| | Middle | 19.5 | 19.6 | 19.8 | | 19.2 | 22.4 | |
| | Richer | 21.3 | 22.1 | 20.3 | | 22.3 | 16.2 | |
| | Richest | 23.1 | 23.7 | 20.3 | | 23.7 | 15.3 | |
| Education | Primary | 57.4 | 55.9 | 66.5 | <0.001 | 58.8 | 67.6 | 0.033 |
| | Secondary | 35.2 | 36.4 | 28.5 | | 34.1 | 28.2 | |
| | Tertiary | 7.4 | 7.8 | 5.0 | | 7.1 | 4.2 | |
| Smoking | Never | 58.6 | 57.5 | 58.4 | 0.621 | 57.8 | 58.9 | 0.811 |
| | Current | 34.9 | 36.1 | 35.0 | | 35.7 | 34.8 | |
| | Former | 6.6 | 6.4 | 6.6 | | 6.5 | 6.2 | |
| Obesity | No | 88.5 | 90.0 | 89.9 | 0.910 | 90.0 | 90.3 | 0.776 |
| | Yes | 11.5 | 10.0 | 10.1 | | 10.0 | 9.7 | |
| Chronic physical condition | No | 62.0 | 65.0 | 59.8 | <0.001 | 64.7 | 53.6 | <0.001 |
| | Yes | 38.0 | 35.0 | 40.2 | | 35.3 | 46.4 | |

Abbreviation: SD Standard deviation

Data are % unless otherwise stated.

P-value was calculated by Chi-squared tests and Student's *t*-tests for categorical and continuous variables, respectively.

(A) Near vision impairment




(B) Far vision impairment

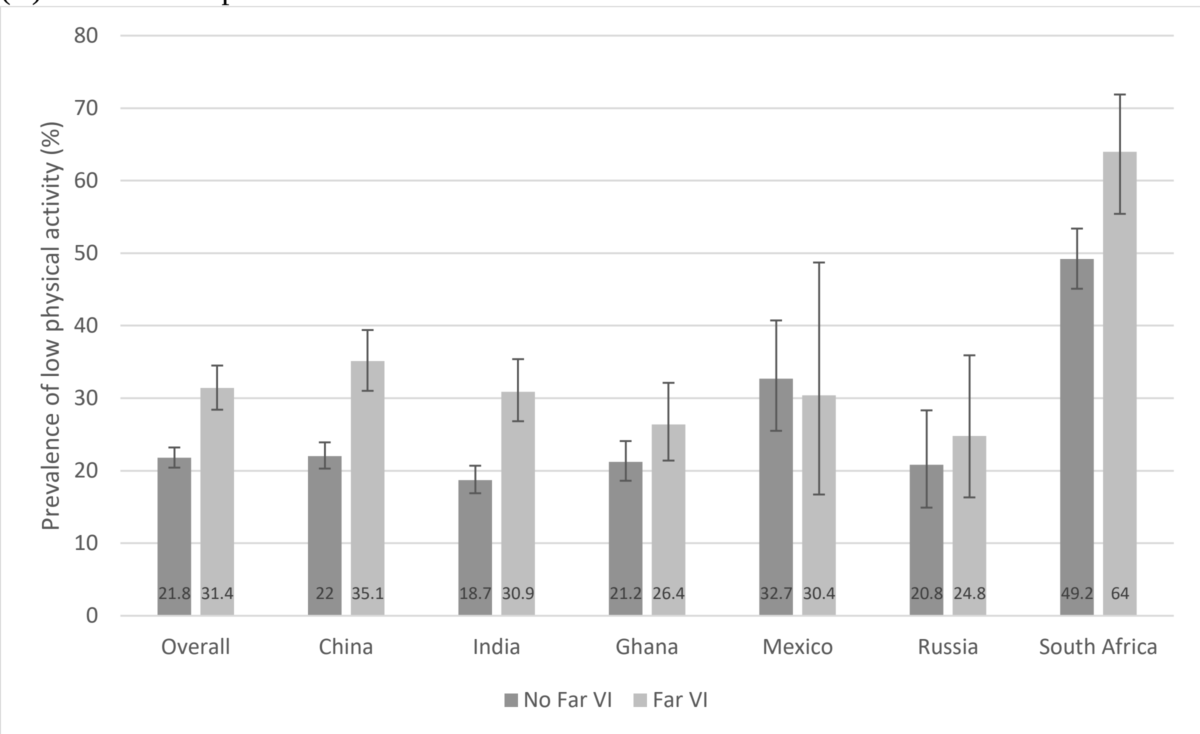



**Figure 1** Prevalence of low physical activity by presence of absence of (A) near or (B) far vision impairment (overall and by country)

Abbreviation: VI Vision impairment

Bars denote 95% confidence interval.

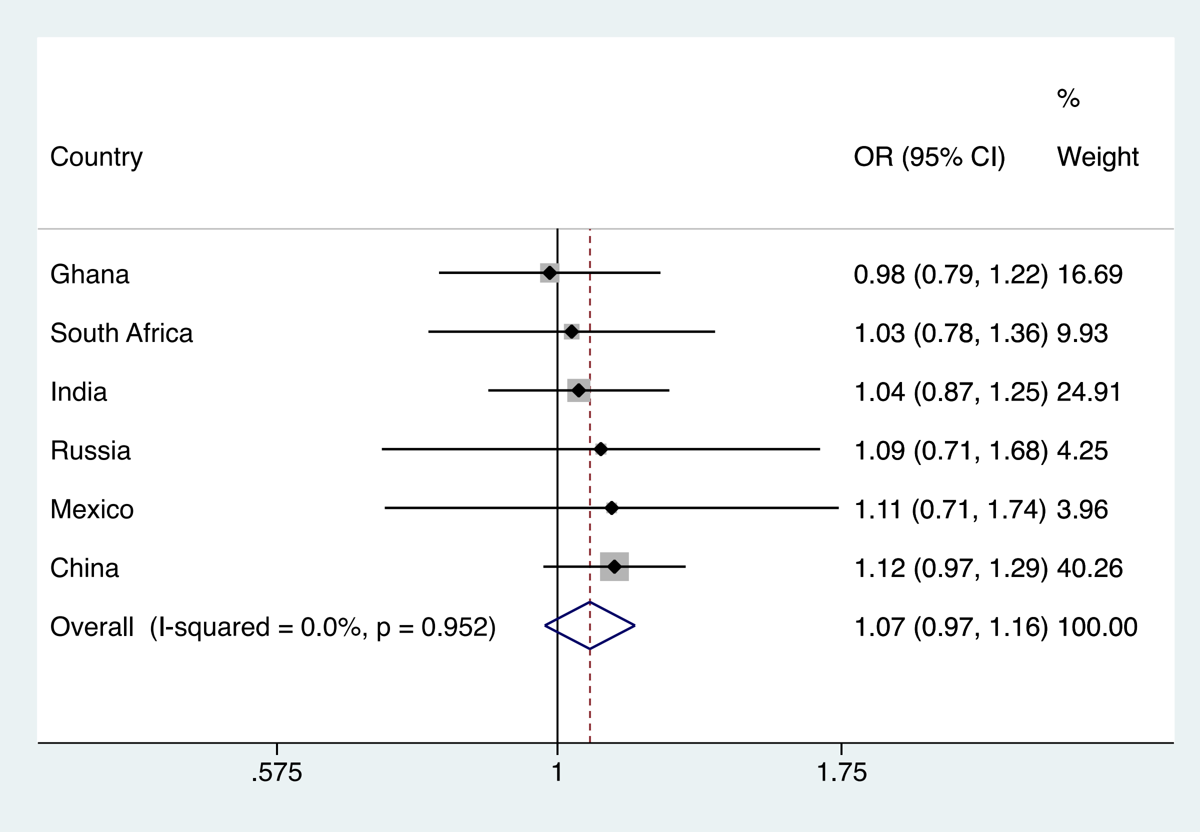



**Figure 2** Country-wise association between near vision impairment and low physical activity (outcome) estimated by multivariable logistic regression

Abbreviation: OR Odds ratio; CI Confidence interval

Models are adjusted for age, sex, wealth, education, smoking, obesity, chronic physical conditions, and far vision impairment.

Overall estimate was obtained by meta-analysis with fixed effects.

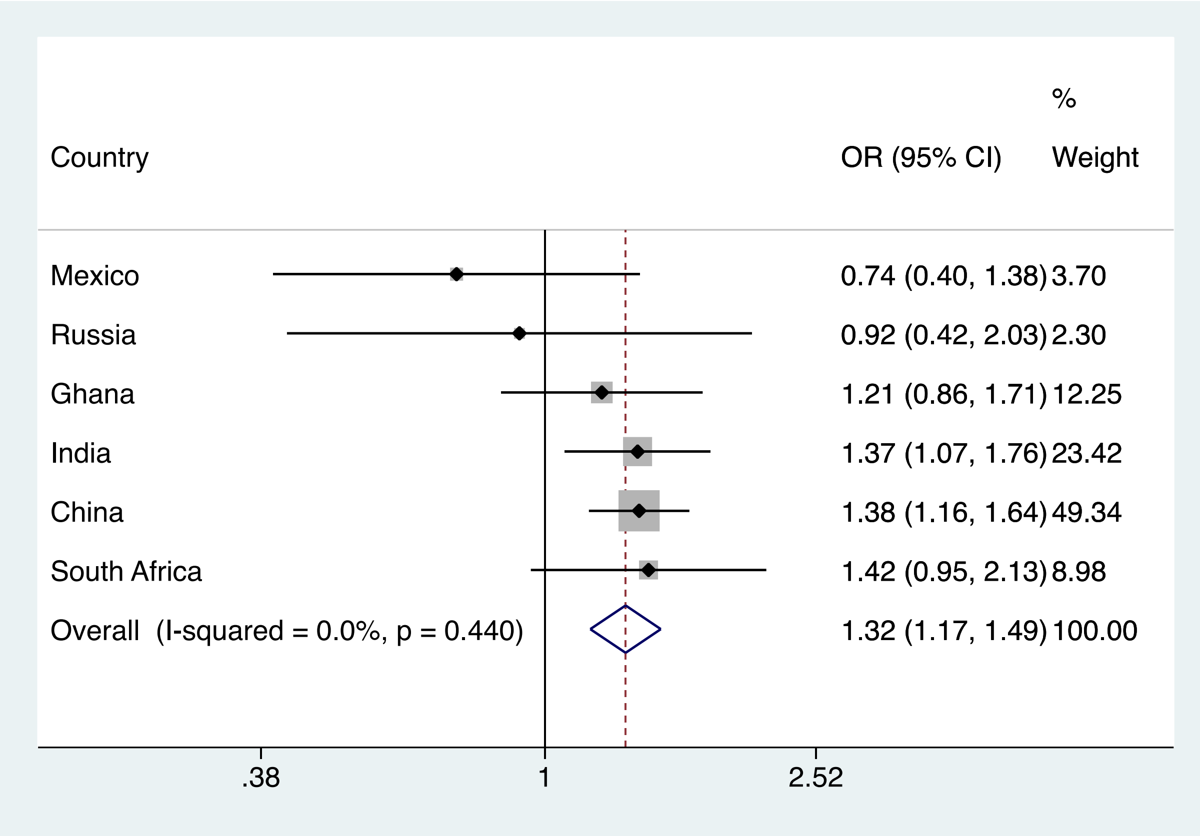



**Figure 3** Country-wise association between far vision impairment and low physical activity (outcome) estimated by multivariable logistic regression

Abbreviation: OR Odds ratio; CI Confidence interval

Models are adjusted for age, sex, wealth, education, smoking, obesity, chronic physical conditions, and near vision impairment.

Overall estimate was obtained by meta-analysis with fixed effects.

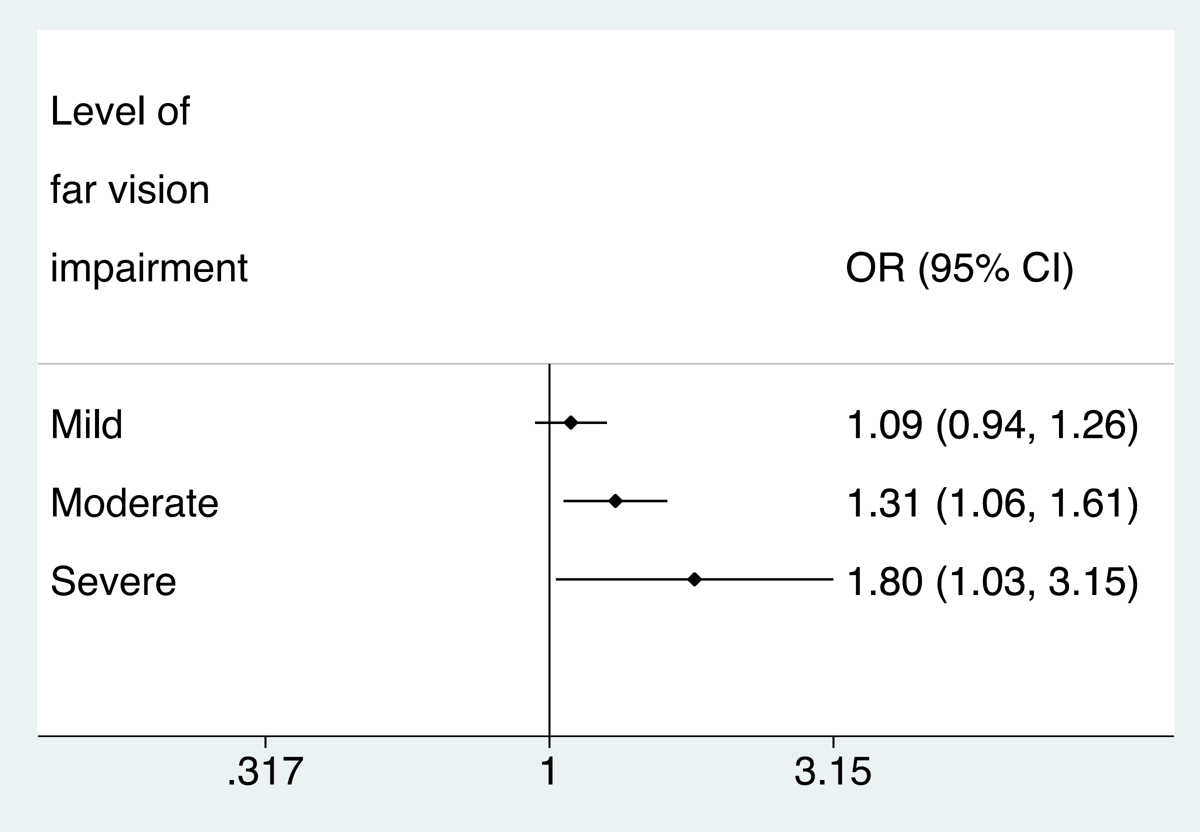



**Figure 4** Association between severity of far vision impairment and low physical activity (outcome) estimated by multivariable logistic regression

Reference category is no vision impairment (6/12 or better). Mild vision impairment = 6/18 or better but worse than 6/12; Moderate vision impairment = 6/60 or better but worse than 6/18; Severe vision impairment = worse than 6/60.

Models are adjusted for age, sex, wealth, education, smoking, obesity, chronic physical conditions, near vision impairment, and country.