ORIGINAL ARTICLE

Sleep duration and sarcopenia in adults aged ≥ 65 years from low and middle-income countries

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Abstract

Background Sleep duration may influence risk for sarcopenia but studies on this topic are scarce, especially from low and- middle-income countries (LMICs). Thus, the aim of the present study was to investigate the association between sleep duration and sarcopenia among adults aged ≥ 65 years from five LMICs (China, Ghana, India, Russia, South Africa).

Methods Cross-sectional, community-based data from the WHO study on global ageing and adult health (SAGE) were analysed. Sarcopenia was defined as having low skeletal muscle mass (SMM) and weak handgrip strength, while severe sarcopenia was defined as having low SMM, weak handgrip strength, and slow gait speed. Self-reported sleep duration in the past two nights were averaged and classified as ≤ 6, > 6 to ≤ 9, and ≥ 9 h/day. Multivariable logistic regression analysis was conducted.

Results Data on 13,210 adults aged ≥ 65 years [mean (SD) age 72.6 (11.3) years; 55.0% females] were analyzed. In the overall sample, compared to > 6 to ≤ 9 h/day of sleep duration, > 9 h/day was associated with 1.70 (95% CI 1.15–2.51) and 1.75 (95% CI 1.08–2.84) times higher odds for sarcopenia and severe sarcopenia, respectively. No significant associations were observed among males, but associations were particularly pronounced among females [i.e., OR = 2.19 (95% CI 1.26–3.81) for sarcopenia, and OR = 2.26 (95% CI 1.20–4.23) for severe sarcopenia].

Conclusions Long sleep duration was associated with an increased odds of sarcopenia and severe sarcopenia in LMICs, particularly in females. Future studies should investigate whether addressing long sleep duration among females can lead to lower risk for sarcopenia onset in LMICs.

Keywords Sleep problems · Sarcopenia · Low- and- middle income countries · Older adults

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Introduction

Sarcopenia may be defined as "age-related muscle loss, affecting a combination of appendicular muscle mass, muscle strength, and/or physical performance measures" [1]. The syndrome is most common in older adults. Indeed, a systematic review and meta-analyses of studies including adults aged 55 years and over found that the prevalence of sarcopenia was approximately 10% [2]. However, it should be noted that the prevalence of sarcopenia varies depending on the definition of sarcopenia employed, with 10% being the most conservative estimate [2]. In September 2016, sarcopenia was introduced in the ICD-10-CM [3], which represents a major step forward in the recognition of sarcopenia as a disease. Importantly, sarcopenia is associated with multiple negative health outcomes. In an umbrella review including six meta-analyses with 14 associations, highly suggestive evidence pointed to an association between sarcopenia and premature mortality, disability, and falls [4]. Considering the high prevalence of sarcopenia in older adults and its association with multiple adverse outcomes, risk factors of sarcopenia need to be identified to inform targeted interventions.

To date, studies have identified some risk factors for sarcopenia. Low levels of physical activity has consistently been shown to increase risk of developing sarcopenia [5–7], and so has malnutrition [8–10]. Other identified risk factors include, for example, smoking [11, 12], and excessive alcohol consumption [13, 14]. However, one potentially important but understudied risk factor of sarcopenia is sleep duration. Importantly, greater than 50% of the older adult population complain of sleep problems [15]. Sleep duration may be associated with sarcopenia via, for example, the impact of impaired sleep on the function of endocrine factors and consequent reduction in muscle health [16, 17]. In a systematic review and meta-analyses including just four cross-sectional studies carried out in China, Korea, Netherlands, and Taiwan, it was found that long and short sleep duration were associated with higher risk for sarcopenia, with females being affected by both short and long sleep, while males were only affected by long sleep duration [18]. Furthermore, a recent longitudinal study (not included in the review) found that long sleep duration was associated with an increased risk of progression to sarcopenia over 4-years among 3918 older community-dwelling adults from Japan [19]. However, the existing literature has some important limitations. First, existing studies consist of relatively small sample sizes that are not nationally representative. Second, almost all studies have been carried out in Asian settings with only one study from Europe, while there is only one study from low- and middle income countries (LMICs; i.e., China). It

is important to investigate the present association in other settings, and in particular LMICs, since in such settings, there is a high prevalence of sarcopenia [20, 21], as well as sleep problems [22].

Given this background, the aim of the present study was to investigate the association between sleep duration and sarcopenia in a representative sample of 13,210 adults aged ≥ 65 years from China, Ghana, India, Russia, and South Africa. Moreover, since previous literature has identified sex differences in this association, we aimed to investigate whether this association differs by sex.

Methods

The survey

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, all countries were LMICs. Details of the survey methodology have been published elsewhere [23]. Briefly, 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. If a respondent was unable to undertake the interview because of limited cognitive function, then a separate questionnaire was administered to a proxy respondent. These individuals were not included in the current study. 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.

Sarcopenia

Following the criteria of the revised European consensus on the definition and diagnosis of sarcopenia [24], sarcopenia was defined as having low skeletal muscle mass (SMM) as reflected by lower skeletal mass index (SMI) and weak handgrip strength, while severe sarcopenia was defined as having low SMM, weak handgrip strength, and slow gait speed. SMM was calculated based on the equation proposed

by Lee and colleagues: $SMM = 0.244*weight + 7.8*height + 6.6*sex − 0.098*age + race − 3.3$ (where female $= 0$ and male $= 1$; race $= 0$ [White and Hispanic], race $= 1.4$ [Black] and race $= − 1.2$ [Asian]) [25]. SMM was further divided by body mass index (BMI) based on measured weight and height to create a SMI [26]. Low SMM was defined as the lowest quintile of the SMI based on sex-stratified values [27]. Country-specific cut-offs were used to determine low SMI, as this indicator is likely to be affected by racial differences in body composition [28]. Weak handgrip strength was defined as < 27 kg for men and < 16 kg for women using the average value of the two handgrip measurements of the dominant hand [24]. Gait speed was based on a 4 m timed walk and was measured by asking the participant to walk at a normal pace. The interviewer recorded the time to completion of the 4 m walk. Slow gait speed referred to ≤ 0.8 m/s [24].

Sleep duration

Information on sleep duration in the preceding two nights were available. Specifically, the questions were "How many hours did you sleep the night before last?" and "How many hours did you sleep last night?" The respondent provided their answers in hours and minutes. These values were averaged and categorized as 0–6 h/day, > 6 to 9 h/day, and > 9 h/day [29].

Control variables

The selection of the control variables was based on past literature [19], and included age, sex, highest education achieved ($\leq$ primary, secondary, tertiary), wealth quintiles based on income, physical activity, smoking (never, current, past), alcohol consumption in the past 30 days, BMI, angina, chronic lung disease (i.e., emphysema, bronchitis, COPD), diabetes, hypertension, stroke, and depression. Levels of physical activity were assessed with the Global Physical Activity Questionnaire and were classified as low, moderate, and high based on conventional cut-offs [30]. BMI was calculated as weight in kilograms divided by height in meters squared. BMI was categorized as < 18.5 kg/m^2 (underweight), 18.5–24.9 kg/m^2 (normal weight), 25.0–29.9 kg/m^2 (overweight), and ≥ 30.0 kg/m^2 (obesity) [31]. Chronic lung disease, diabetes, and stroke were based solely on lifetime self-reported diagnosis. For angina, the validated Rose questionnaire [32] was used in addition to a lifetime self-reported diagnosis. Hypertension was defined as having at least one of: systolic blood pressure ≥ 140 mmHg; diastolic blood pressure ≥ 90 mmHg; or self-reported diagnosis. Questions based on the World Mental Health Survey version of the Composite International Diagnostic Interview [33] were used for the endorsement of past 12-month DSM-IV depression [34].

Statistical analysis

The statistical analysis was performed with Stata 14.2 (Stata Corp LP, College station, Texas). The analysis was restricted to those aged ≥ 65 years as sarcopenia is an age-related condition. Furthermore, Mexico was omitted from the analysis as data on sleep duration was not collected. Differences in sample characteristics by sarcopenia or sleep duration were tested by Chi-squared tests for categorical variables and by one-way ANOVA or Student's t-tests for continuous variables. Multivariable logistic regression was conducted to assess the association between sleep duration (exposure) and sarcopenia or severe sarcopenia (outcomes). Analyses using the overall sample and sex-stratified samples were conducted as previous studies have shown that the association between sleep duration and sarcopenia may differ by sex [18].

The regression analyses were adjusted for age, sex, education, wealth, physical activity, smoking, alcohol consumption, diabetes, chronic lung disease, angina, hypertension, stroke, BMI, depression, and country, with the exception of the sex-stratified analysis which was not adjusted for sex. Adjustment for country was done by including dummy variables for each country in the model as in previous SAGE publications [35, 36]. The sample weighting and the complex study design were taken into account in the 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 13,210 adults aged ≥ 65 years (China $n = 5360$; Ghana $n = 1975$; India $n = 2441$; Russia $n = 1950$; South Africa $n = 1484$). The mean (SD) age of the sample was 72.6 (11.3) years and 55.0% were females. The sample characteristics are provided in Table 1. The prevalence of sarcopenia and severe sarcopenia were 12.0% and 7.8%, respectively. Overall, 20.9%, 66.0%, and 13.1% of the sample had sleep durations of ≤ 6 h/day, > 6 to ≤ 9 h/day, and > 9 h/day, respectively. Compared to males, women had higher prevalence of a sleep duration of > 9 h/day (10.5% vs. 15.3%). The difference in sample characteristics by sarcopenia or sleep duration is shown in Table S1 of the Online Appendix. Significant differences were found for factors such as age, wealth, physical activity, and BMI etc. The prevalence of sarcopenia by sleep duration is shown in Fig. 1. Distinct patterns were observed between males and females where the prevalence of sarcopenia was particularly high among females with a sleep duration of > 9 h/day. Similar patterns were observed for severe sarcopenia (Fig. 2). The association between sleep duration and sarcopenia estimated by multivariable logistic regression is shown in Table 2. Compared

**Table 1** Sample characteristics (overall and by sex)

Characteristic	Overall	Male	Female
Sarcopenia			
No	88.0	87.1	88.7
Yes	12.0	12.9	11.3
Severe sarcopenia			
No	92.2	92.5	91.9
Yes	7.8	7.5	8.1
Sleep duration			
≤6 h/day	20.9	21.6	20.3
>6 to ≤9 h/day	66.0	67.9	64.4
>9 h/day	13.1	10.5	15.3
Age (years)			
Mean (SD)	72.6 (11.3)	72.1 (10.9)	72.9 (11.5)
Sex			
Female	55.0		
Male	45.0		
Education			
≤Primary	63.7	58.7	67.7
Secondary	29.9	32.5	27.7
Tertiary	6.4	8.7	4.6
Wealth			
Poorest	21.7	19.1	23.8
Poorer	21.0	20.5	21.5
Middle	20.4	19.6	21.0
Richer	17.5	19.4	15.9
Richest	19.4	21.5	17.7
Physical activity			
High	35.2	37.7	33.2
Moderate	25.2	24.3	25.9
Low	39.6	38.0	40.9
Smoking			
Never	62.2	35.6	84.0
Smoker	29.3	48.4	13.6
Quit	8.5	16.0	2.3
Alcohol consumption			
No	86.1	76.4	94.1
Yes	13.9	23.6	5.9
Diabetes			
No	91.4	92.0	90.9
Yes	8.6	8.0	9.1
Chronic lung disease			
No	89.9	88.3	91.2
Yes	10.1	11.7	8.8
Angina			
No	75.8	80.5	71.9
Yes	24.2	19.5	28.1
Hypertension			
No	36.6	41.8	32.4
Yes	63.4	58.2	67.6
Stroke			
No	95.4	94.7	95.9

Table 1 (continued)

Characteristic	Overall	Male	Female
Yes	4.6	5.3	4.1
Body mass index			
Underweight	19.3	21.9	17.1
Normal	46.4	51.3	42.3
Overweight	23.9	21.1	26.2
Obese	10.4	5.7	14.4
Depression			
No	93.5	94.2	92.9
Yes	6.5	5.8	7.1

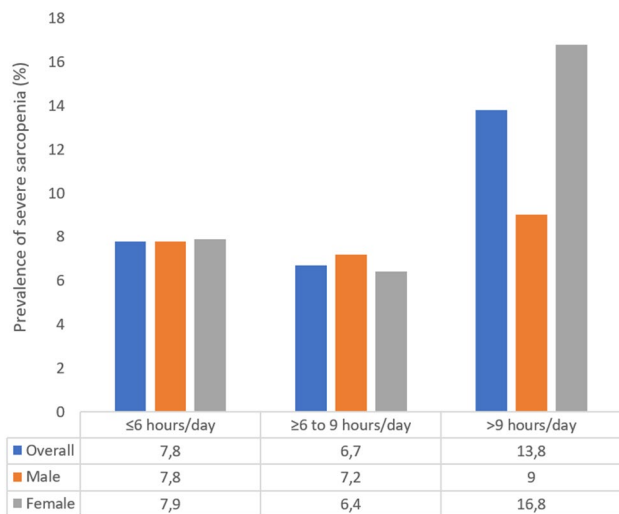Data are % unless otherwise stated

SD standard deviation
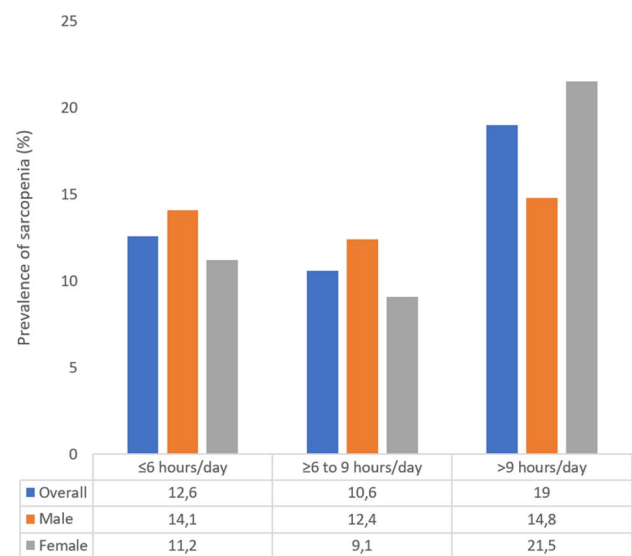
Fig. 1 Prevalence of sarcopenia by sleep duration (overall and by sex)

to >6 to ≤9 h/day of sleep duration, >9 h/day was associated with 1.70 (95% CI 1.15–2.51) times higher odds for sarcopenia in the overall sample. This association was particularly pronounced among females (OR = 2.19; 95% CI 1.26–3.81) but sleep duration was not significantly associated with sarcopenia among males. Similar associations were found for severe sarcopenia with the OR for >9 h/day (vs. >6 to ≤9 h/day) being 1.75 (95% CI 1.08–2.84) in the overall sample and 2.26 (95% CI 1.20–4.23) among females (Table 3).

Discussion

Main findings

In this large representative sample of older adults from five LMICs, it was found that compared to >6 to ≤9 h/

Fig. 2 Prevalence of severe sarcopenia by sleep duration (overall and by sex)

day of sleep duration, > 9 h/day was associated with 1.70 times higher odds for sarcopenia in the overall sample. This association was particularly pronounced among females (OR = 2.19) but sleep duration was not significantly associated with sarcopenia among males. Similar findings were observed for severe sarcopenia.

Interpretation of the findings

Findings from the present study support, contradict and add to previous literature. They support previous literature through confirming that an association exists between long sleep duration and sarcopenia [18, 19, 37], and add to this through showing such an association holds in a large representative sample across five LMICs. However, the present findings contradict previous literature by showing that long sleep duration was only associated with females whereas previous work has found such an association in males [18].

There are several plausible mechanisms that may explain why long sleep duration is associated with a higher risk of sarcopenia. It is important to highlight that the onset of sleep problems has been found to be the transition point for short or long sleep duration [38]. First, sleep problems impact on testosterone and anabolic hormones such as insulin-like growth factor-1 that regulate protein synthesis and thus maintain skeletal muscle mass [39]. Second, insulin resistance associated with sleep problems can cause loss of muscle mass and function in older adults [40]. Third, chronic sleep problems may dysregulate the hypothalamopituitary-adrenal axis resulting in endocrine changes [41]. Fourth, sleep problems may result in excessive daytime sleepiness that will likely increase sedentary time, which is a risk factor for sarcopenia [37, 42]. Finally, sarcopenia may cause sleep

problems owing to muscle strength/function decline and thus, it is possible that the relationship is bidirectional [43].

It is important to note that when stratified by sex, the present study found a significant association between long sleep duration and sarcopenia only in females and not males. Although the reason for this is unclear, the differences may be owing to different daily sleep duration and/or requirements between the sexes due to their different hormone levels. Indeed, sex hormones regulate muscle mass and function and differ between sexes [18]. Interestingly, the only meta-analysis on this topic including four studies found a significant association among males only [18]. The reason why previous studies found the opposite to the present is not known and future research is required. However, these differences may be partly explained by the social and cultural settings of the countries studied, and the fact that previous studies used non-representative samples.

Public health implications and areas for future research

Findings from the present study suggest that targeting long sleep duration may aid in the prevention of sarcopenia, at least in females. It may be shrewd to utilize physical activity interventions to achieve this aim as physical activity per se reduces risk of sarcopenia and improves sleep quality [44]. Moreover, clinicians should be aware of the sleep-sarcopenia relationship and consider prescribing lifestyle changes to those who present with long sleep duration to aid in the prevention of sarcopenia. Future studies should assess the mechanisms that link long sleep duration and sarcopenia, and also examine whether modifications in sleep duration or addressing sleep problems can lead to lower risk for sarcopenia onset.

Strengths and limitations

The use of large representative samples of older adults from five LMICs is a clear strength of the present paper. However, findings should be interpreted in light of the study limitations. First, the study is cross-sectional in nature and thus, it is not known whether sleep duration causes sarcopenia or vice versa; the relationship is likely bidirectional. Second, the survey did not include a robust dietary assessment, and thus, the role of diet could not be considered in the investigated associations. Third, sleep duration was based on self-report and previous studies have shown that some people tend to overestimate sleep duration. Next, we were unable to adjust for factors such as obstructive sleep apnea and heart failure due to lack of data. Thus, it is possible for residual confounding to exist. Finally, it would have been beneficial to have additional contextual data related with sleeping behavior (e.g., quality of sleep, nocturnal awakenings,

Table 2 Association between sleep duration or covariates and sarcopenia (outcome) estimated by multivariable logistic regression

Characteristic	Overall		Male		Female	
	OR	95% CI	OR	95% CI	OR	95% CI
Sleep duration						
≤ 6 h/day	1.19	[0.86, 1.65]	1.17	[0.76, 1.79]	1.20	[0.81, 1.79]
> 6 to ≤ 9 h/day	1.00		1.00		1.00	
> 9 h/day	1.70**	[1.15, 2.51]	1.00	[0.69, 1.43]	2.19**	[1.26, 3.81]
Age (years)	1.13***	[1.11, 1.15]	1.11***	[1.09, 1.14]	1.16***	[1.12, 1.19]
Sex						
Male vs. Female	1.48**	[1.15, 1.91]				
Education						
≤ Primary	1.00		1.00		1.00	
Secondary	0.70*	[0.51, 0.95]	0.54***	[0.38, 0.77]	0.68	[0.34, 1.34]
Tertiary	0.52*	[0.29, 0.93]	0.46**	[0.25, 0.82]	0.22	[0.03, 1.66]
Wealth						
Poorest	1.00		1.00		1.00	
Poorer	0.72*	[0.52, 1.00]	0.66	[0.42, 1.03]	0.82	[0.48, 1.42]
Middle	0.67*	[0.47, 0.94]	0.58*	[0.37, 0.93]	0.82	[0.50, 1.33]
Richer	0.53***	[0.40, 0.71]	0.48**	[0.30, 0.77]	0.56**	[0.38, 0.82]
Richest	0.36***	[0.26, 0.51]	0.29***	[0.18, 0.48]	0.43**	[0.25, 0.75]
Physical activity						
High	1.00		1.00		1.00	
Moderate	1.17	[0.91, 1.52]	1.40	[0.93, 2.13]	0.87	[0.59, 1.27]
Low	1.14	[0.89, 1.47]	1.25	[0.85, 1.83]	0.96	[0.62, 1.49]
Smoking						
Never	1.00		1.00		1.00	
Smoker	0.93	[0.68, 1.27]	0.75	[0.53, 1.06]	1.38	[0.85, 2.26]
Quit	1.12	[0.75, 1.68]	1.06	[0.67, 1.66]	1.04	[0.45, 2.38]
Alcohol consumption						
Yes vs. No	0.76	[0.51, 1.14]	0.73	[0.47, 1.14]	0.92	[0.53, 1.61]
Diabetes						
Yes vs. No	0.66*	[0.47, 0.94]	0.71	[0.44, 1.15]	0.63	[0.35, 1.12]
Chronic lung disease						
Yes vs. No	1.17	[0.82, 1.66]	1.05	[0.65, 1.70]	1.37	[0.90, 2.09]
Angina						
Yes vs. No	0.97	[0.72, 1.32]	1.14	[0.76, 1.73]	0.87	[0.54, 1.38]
Hypertension						
Yes vs. No	0.96	[0.78, 1.17]	1.06	[0.77, 1.46]	0.83	[0.58, 1.18]
Stroke						
Yes vs. No	1.26	[0.79, 2.01]	1.22	[0.66, 2.28]	1.18	[0.61, 2.29]
Body mass index						
Underweight	0.59**	[0.41, 0.85]	0.30***	[0.18, 0.50]	1.19	[0.72, 1.94]
Normal	1.00		1.00		1.00	
Overweight	1.53**	[1.14, 2.04]	2.23***	[1.62, 3.08]	1.01	[0.66, 1.56]
Obese	2.09***	[1.39, 3.14]	6.88***	[3.56, 13.29]	1.01	[0.63, 1.64]
Depression						
Yes vs. No	0.82	[0.48, 1.38]	0.49	[0.24, 1.00]	1.02	[0.49, 2.14]

Models are adjusted for all variables in the respective columns and country

OR odds ratio, *CI* confidence interval

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Table 3 Association between sleep duration or covariates and severe sarcopenia (outcome) estimated by multivariable logistic regression

Characteristic	Overall		Male		Female	
	OR	95% CI	OR	95% CI	OR	95% CI
Sleep duration						
≤ 6 h/day	1.14	[0.78, 1.68]	1.07	[0.61, 1.90]	1.23	[0.79, 1.93]
> 6 to ≤ 9 h/day	1.00		1.00		1.00	
> 9 h/day	1.75*	[1.08, 2.84]	1.07	[0.58, 1.95]	2.26*	[1.20, 4.23]
Age (years)	1.14***	[1.11, 1.16]	1.12***	[1.08, 1.15]	1.16***	[1.12, 1.20]
Sex						
Male vs. Female	1.06	[0.76, 1.48]				
Education						
≤ Primary	1.00		1.00		1.00	
Secondary	0.87	[0.59, 1.29]	0.82	[0.54, 1.24]	0.72	[0.33, 1.59]
Tertiary	0.56	[0.25, 1.23]	0.48	[0.22, 1.08]	0.32	[0.05, 2.23]
Wealth						
Poorest	1.00		1.00		1.00	
Poorer	0.76	[0.47, 1.21]	0.54	[0.29, 1.03]	0.97	[0.49, 1.91]
Middle	0.71	[0.49, 1.04]	0.45*	[0.25, 0.83]	1.08	[0.58, 1.98]
Richer	0.53**	[0.36, 0.78]	0.40**	[0.22, 0.73]	0.58*	[0.36, 0.94]
Richest	0.39***	[0.25, 0.61]	0.23***	[0.12, 0.46]	0.57	[0.30, 1.07]
Physical activity						
High	1.00		1.00		1.00	
Moderate	1.39*	[1.00, 1.94]	2.58**	[1.46, 4.57]	0.81	[0.52, 1.25]
Low	1.35	[0.94, 1.92]	2.00**	[1.19, 3.36]	0.94	[0.54, 1.64]
Smoking						
Never	1.00		1.00		1.00	
Smoker	1.09	[0.76, 1.57]	0.76	[0.48, 1.21]	1.87*	[1.09, 3.19]
Quit	1.26	[0.78, 2.03]	1.08	[0.65, 1.79]	1.52	[0.60, 3.85]
Alcohol consumption						
Yes vs. No	0.72	[0.42, 1.24]	0.74	[0.37, 1.48]	0.87	[0.50, 1.51]
Diabetes						
Yes vs. No	0.73	[0.47, 1.13]	0.62	[0.33, 1.18]	0.86	[0.46, 1.60]
Chronic lung disease						
Yes vs. No	1.21	[0.82, 1.79]	1.27	[0.70, 2.30]	1.20	[0.72, 1.99]
Angina						
Yes vs. No	1.11	[0.75, 1.64]	1.43	[0.80, 2.55]	0.89	[0.50, 1.59]
Hypertension						
Yes vs. No	1.05	[0.80, 1.38]	1.19	[0.79, 1.80]	0.93	[0.59, 1.47]
Stroke						
Yes vs. No	1.11	[0.63, 1.97]	1.50	[0.69, 3.26]	0.76	[0.32, 1.83]
Body mass index						
Underweight	0.66	[0.43, 1.01]	0.38***	[0.22, 0.66]	1.19	[0.63, 2.22]
Normal	1.00		1.00		1.00	
Overweight	1.52*	[1.05, 2.20]	2.35***	[1.57, 3.52]	0.99	[0.61, 1.60]
Obese	1.96**	[1.21, 3.18]	6.50***	[3.37, 12.53]	0.96	[0.49, 1.85]
Depression						
Yes vs. No	0.62	[0.35, 1.11]	0.65	[0.29, 1.46]	0.50	[0.22, 1.15]

Models are adjusted for all variables in the respective columns and country

OR odds ratio, *CI* confidence interval

*p < 0.05, **p < 0.01, ***p < 0.001

skipping breakfast, morning stiffness) to further elucidate on the association between long sleep duration and risk of sarcopenia; however, such data was not collected in the present study. Future studies with more detailed data on the reasons for long sleep duration are likely to shed light on the underlying mechanisms of the investigated associations.

Conclusion

In conclusion, long sleep duration was associated with an increased odds for sarcopenia among older adults in LMICs, particularly in females. Contextualized and tailored interventions to address long sleep duration in females may aid in the prevention of sarcopenia, pending more longitudinal research.

Declarations

Conflict of interest None.

Ethical approval Ethical approval was obtained from the WHO Ethical Review Committee and local ethics research review boards.

Informed consent Written informed consent was obtained from all participants.

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