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Educational Attainment and Possible Sarcopenia among Community-Dwelling Middle-Aged and Older Adults in Taiwan: A Cross-Sectional Study

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Abstract

Background

Under the 2025 consensus update of the Asian Working Group for Sarcopenia (AWGS), possible sarcopenia is identified by weak handgrip alone, with age-specific thresholds from the age of 50. How far schooling shapes this early stage of muscle decline is poorly documented outside Western populations, and whether it does so as strongly before the age of 65 as after remains largely untested.

Methods

Thirteen of the 57 villages in two districts across New Taipei City and Taoyuan City, Taiwan, were sampled at random, and residents aged 50 years and over were surveyed there between 2024 and 2025, leaving 499 participants for analysis. Handgrip strength below the age-specific AWGS 2025 cutoff placed a participant in the possible sarcopenia group. Educational attainment was self-reported and grouped into three bands. Because those cutoffs differ by age band, each stratum was modeled separately by logistic regression, yielding adjusted odds ratios (ORs) with 95% confidence intervals (CIs).

Results

Participants averaged 70.52 ± 8.05 years of age, and 103 of them (20.6%) fell below the grip threshold. This group was older than the rest (74.47 ± 9.75 against 69.49 ± 7.22 years; p less than 0.001), had a lower body mass index, and was less often physically active (both p less than 0.05), and its educational distribution also differed: 48.5% had gone no further than elementary school, against 30.1% of unaffected participants (p = 0.002). With college graduates as the reference and sex, body size, lifestyle and disease burden held constant, elementary schooling or less was associated with higher odds of possible sarcopenia in both age bands (50 to 64 years: OR = 6.14, 95% CI: 1.10 to 34.24, p = 0.04; 65 years and over: OR = 2.57, 95% CI: 1.24 to 5.33, p = 0.01). Higher body mass index and regular exercise were each associated with lower odds among older participants.

Conclusions

Low educational attainment was associated with higher odds of possible sarcopenia, suggesting a potential role for targeted handgrip screening from age 50, although findings in middle-aged adults remain preliminary.

Background

Skeletal muscle begins to decline in both quantity and quality from midlife onward, and once that decline crosses a critical threshold it presents as sarcopenia, a condition associated with falls, functional

dependence, hospital admission, cardiometabolic disease, dementia and premature death (1). Taiwan is undergoing one of the most rapid demographic transitions worldwide: the proportion of the population aged 65 years and above rose from 7% in 1993 to 14% in 2018 and reached 20% in 2025, completing the transition from an aged to a super-aged society in seven years, compared with 11 years in Japan, 16 in the United States and 28 in France (2). Preventing muscle loss has therefore become a task for primary care and community health services rather than one confined to specialist geriatric practice.

The Asian Working Group for Sarcopenia (AWGS) issued a revised consensus in 2025 that moves the emphasis from diagnosing established disease toward promoting muscle health across the adult life span (1). Three features of that revision bear directly on community work. Diagnostic thresholds were extended downward to adults aged 50 to 64 years, using values validated in Asian cohorts, so that middle age now falls within the scope of assessment. The diagnostic algorithm was simplified, leaving muscle mass and muscle strength as the diagnostic requirements and reclassifying physical performance measures, the five-time chair stand test among them, as outcome indicators. And where muscle mass cannot be measured, weak handgrip on its own identifies possible sarcopenia, which the consensus positions as a trigger for muscle health intervention, not as a diagnosis. For community screening programs without body composition equipment, that category is the practical entry point to muscle health care.

Educational attainment is among the socioeconomic characteristics most consistently tied to muscle health, and it offers two practical advantages as an exposure: it is settled by early adulthood, and it can be recorded in any community survey. The evidence to date comes largely from Western populations. In the Irish Longitudinal Study on Ageing, where socioeconomic position was also defined by educational attainment, probable sarcopenia was more common among adults whose schooling ended at primary level than among those holding a third level qualification (28.9% versus 18.1%), and the difference persisted after adjustment for demographic, lifestyle and health-related covariates (odds ratio [OR] 1.48; 95% confidence interval [CI] 1.17 to 1.87) (3). An analysis of nearly 400,000 UK Biobank participants placed lower education and greater deprivation among the sociodemographic factors associated with sarcopenia, and a Brazilian national study of adults aged 50 years and over found that years of schooling were associated with how many remaining years of life were spent free of dynapenia, defined by low grip strength (4, 5).

Comparable evidence from Asian populations is more limited. A meta-analysis of studies applying the AWGS 2019 criteria across Asia placed the pooled prevalence of possible sarcopenia at 28.7% but did not examine socioeconomic determinants (6). In a Chinese national cohort of adults aged 60 years and above, in which possible sarcopenia was defined by the AWGS 2019 criteria, the odds fell stepwise as educational attainment rose, reaching an odds ratio of 0.25 (95% CI 0.14 to 0.45) among those educated to high school or above when compared with illiterate participants (7). A prospective analysis of the same cohort reported that higher educational attainment predicted lower odds of incident sarcopenia, and that this association was confined to participants aged 45 to 60 years, the interaction between age

and education being statistically significant (8). In Taiwan, to our knowledge, no community-based study has examined educational attainment as the primary exposure for possible sarcopenia.

Two questions therefore remain open. The first is whether educational attainment is associated with possible sarcopenia in a Taiwanese community population, independently of body size, lifestyle and chronic disease burden. The second is whether that association behaves in the same way in middle age as it does in old age, a comparison that became well defined only once AWGS 2025 supplied separate handgrip thresholds for the two age bands. The present study addresses both questions in a community-based sample of adults aged 50 years and above, recruited from two districts of northern Taiwan. We hypothesized that lower educational attainment is associated with higher odds of possible sarcopenia in this population, as it is in Western cohorts, and we analyzed the 50 to 64 year and 65 year and above bands separately, following the strata set out in the 2025 consensus.

Methods

Study setting and participants

Residents of the Guishan District in Taoyuan City and Linkou District in New Taipei City took part in this cross-sectional survey, which was carried out in the community between 2024 and 2025. The village served as the sampling unit, and 13 were drawn at random from the 57 lying within the two districts. To qualify, a resident had to be at least 50 years of age and to have lived locally for six months or longer. Anyone who could not be reached, whose registered address proved vacant, who depended on others for daily function, or who was living in a long-term care facility was set aside before recruitment began.

Screening produced 1,058 residents who were both mobile and reachable. Enrollment did not proceed for 558 of them: 545 refused, 5 had recently sustained a cardiovascular event, and 8 lacked the communicative capacity to work through the interview. The remaining 500 were interviewed, and one of these was later withdrawn because the record was incomplete, leaving 499 people for analysis. Figure 1 lays out each step of this selection sequence. Ethical approval for the protocol came from the Institutional Review Board of the Chang Gung Medical Foundation (approval number: 202400222B0), and every participant gave written consent before any assessment took place.

Figure 1 The flowchart of sampling selection process. CVD, cardiovascular disease.

Ascertainment of possible sarcopenia

The 2025 consensus of the AWGS supplied the operational criteria for this study. That consensus reserves a formal diagnosis of sarcopenia for people showing low muscle mass together with low muscle strength. Where mass cannot be measured, weak handgrip on its own places a person in the category of possible sarcopenia, a category framed as a trigger for muscle health intervention rather than as a diagnosis; physical performance measures, the five-time chair stand test among them, serve

as outcome indicators under this consensus rather than as diagnostic criteria. The category is intended for community and primary care settings, where measurement of muscle mass is seldom practical.

Possible sarcopenia in the present study rested on handgrip strength, recorded with a Takei T.K.K.5401 GRIP-D handgrip dynamometer, each participant being tested on both hands over two or three attempts, of which the highest reading was carried forward. Thresholds for weak grip followed the age-specific values published in the 2025 consensus. For those between 50 and 64 years the threshold stood at 34 kg in men and 20 kg in women; from 65 years upward, it fell to 28 kg in men and 18 kg in women.

Educational attainment and covariates

Participants reported their own schooling, which supplied the exposure of interest. Three bands were distinguished: elementary school or lower; middle school or high school graduate; and college or higher.

The remaining variables, chosen beforehand for their documented bearing on muscle health, were gathered by interviewers using a structured questionnaire developed by the research team for this survey (see Additional file 1). Height and weight were recorded and combined into body mass index (BMI; kg/m^2), and waist circumference was taken separately. Smoking status and alcohol use were each captured as a yes-or-no response. A participant counted as having an exercise habit when physical activity was undertaken three or more sessions per week. Chronic disease burden was self-reported: participants marked on a structured checklist the conditions a physician had ever diagnosed, covering hypertension, diabetes mellitus, hyperlipidemia, heart disease, kidney disease, fracture, osteoporosis, gout, stroke, hepatitis, cancer, cataract, arthritis, depression, chronic lung disease, anemia, and dementia, with an open item for any other diagnosis. The number of conditions entered the analysis as a count, grouped as none, one, two, or three and above. Long-term pain was recorded as a yes-or-no response and was defined as pain persisting for six months or longer.

Statistical analysis

All analyses were performed using the Statistical Package for the Social Sciences (SPSS), version 20.0 (IBM Corp., Armonk, NY, USA). Continuous variables are reported as means with standard deviations, categorical variables as counts with percentages. Comparisons between participants who met the criterion for possible sarcopenia and those who did not relied on the independent two-sample t test for continuous measures and on the chi-square test for categorical ones. Within each age stratum, the trend in the prevalence of possible sarcopenia across the three ordered educational categories was assessed with a test for linear trend.

The sample was divided beforehand into two age bands, 50 to 64 years and 65 years or above, mirroring the strata for which AWGS 2025 sets separate handgrip thresholds. Logistic regression was then run within each band, taking possible sarcopenia as the outcome and schooling as the predictor, with college or higher held as the reference. Two nested specifications were estimated: the first carried sex

and body mass index as adjustments, and the second added smoking, exercise habit, chronic disease count, and long-term pain. Findings are expressed as odds ratios with accompanying 95% confidence intervals. Significance was set at a two-sided p value below 0.05.

Use of generative artificial intelligence

Claude (Anthropic) and Codex (OpenAI) were used during manuscript preparation to assist with drafting, language revision, and discussion of the literature.

Results

Derivation of the study sample

Figure 1 traces how the analytical sample was assembled. Community screening across the selected villages produced 1,058 ambulatory residents who were available for enrollment. Among them, 545 declined to take part, 5 had sustained a recent cardiovascular event, and 8 were unable to communicate well enough for the interview to proceed, leaving 500 who completed the assessment. One further record was dropped for incomplete data, so that 499 individuals entered the analysis.

Participants averaged 70.52 ± 8.05 years of age. Of the 499 participants, 369 (73.9%) were women and 130 (26.1%) were men. Under the AWGS 2025 handgrip criteria, 103 participants met the threshold for possible sarcopenia, a prevalence of 20.6%. Of these, 18 fell in the middle-aged stratum and 85 in the older stratum, which comprised 102 and 397 participants respectively.

Comparison of participants with and without possible sarcopenia

Table 1 compares the two groups. Participants with possible sarcopenia were older, with a mean age of 74.47 ± 9.75 years, against 69.49 ± 7.22 years among the remainder ($p < 0.001$). Body mass index was lower in the possible sarcopenia group (23.49 ± 3.73 versus 24.54 ± 3.80 kg per square meter; $p = 0.012$), whereas waist circumference did not differ between the groups (85.23 ± 10.29 versus 86.35 ± 9.83 cm; $p = 0.308$).

Regular exercise was reported less often by participants with possible sarcopenia (73.8% versus 84.1%; $p = 0.015$). Educational attainment likewise diverged ($p = 0.002$). Nearly half of the possible sarcopenia group, 48.5%, had progressed no further than elementary school, whereas the corresponding share among unaffected participants was 30.1%. At the opposite end of the distribution, college graduates made up 19.4% of affected participants and 28.5% of the rest.

The remaining characteristics were distributed comparably. Neither sex ($p = 0.644$), current smoking ($p = 0.578$), alcohol consumption ($p = 0.068$), long-term pain ($p = 0.141$), nor the number of chronic conditions ($p = 0.253$) differed between the groups.

Table 1
Baseline characteristics of participants by possible sarcopenia status

Variables	Total (n = 499)	No possible sarcopenia (n = 396)	Possible sarcopenia (n = 103)	p value
Age (years)	70.52 ± 8.05	69.49 ± 7.22	74.47 ± 9.75	< 0.001
BMI (kg/m²)	24.33 ± 3.80	24.54 ± 3.80	23.49 ± 3.73	0.012
Waist circumference (cm)	86.12 ± 9.93	86.35 ± 9.83	85.23 ± 10.29	0.308
Men	130 (26.1)	105 (26.5)	25 (24.3)	0.644
Current smoking	16 (3.2)	13 (3.3)	3 (2.9)	0.578
Alcohol consumption	14 (2.8)	13 (3.3)	1 (1.0)	0.068
Exercise habit	409 (82.0)	333 (84.1)	76 (73.8)	0.015
Education level				0.002
Elementary school or lower	169 (33.9)	119 (30.1)	50 (48.5)	
Middle school or high school graduate	197 (39.5)	164 (41.4)	33 (32.0)	
College or higher	133 (26.7)	113 (28.5)	20 (19.4)	
Long-term pain				0.141
Pain	109 (21.8)	81 (20.5)	28 (27.2)	
No pain	390 (78.2)	315 (79.5)	75 (72.8)	
Number of chronic diseases				0.253
0	131 (26.3)	111 (28.0)	20 (19.4)	
1	175 (35.1)	138 (34.8)	37 (35.9)	
2	101 (20.2)	79 (19.9)	22 (21.4)	
3 or more	92 (18.4)	68 (17.2)	24 (23.3)	

Continuous variables are presented as mean ± SD and categorical variables as n (%). Between-group comparisons used independent-samples t tests for continuous variables and chi-square tests for categorical variables. BMI, body mass index; SD, standard deviation.

Age-stratified regression analyses

Table 2 reports the regression models fitted separately within each age stratum.

Among middle-aged participants, those whose schooling ended at elementary level had higher odds of possible sarcopenia than college graduates after adjustment for sex and body mass index (OR 6.88; 95% CI 1.28 to 37.10; p = 0.03). The estimate changed little after further adjustment for smoking, exercise habit, chronic disease count, and long-term pain (OR 6.14; 95% CI 1.10 to 34.24; p = 0.04). Middle school and high school graduates did not differ significantly from the reference category in either model (Model 1: OR 1.37; 95% CI 0.41 to 4.60; p = 0.61. Model 2: OR 1.24; 95% CI 0.33 to 4.61; p = 0.75). Body mass index approached but did not reach significance in the first model (OR 0.83; 95% CI 0.69 to 1.00; p = 0.05), and no further covariate attained significance within this stratum.

The same educational contrast held among older participants (Model 1: OR 2.75; 95% CI 1.34 to 5.64; p = 0.006. Model 2: OR 2.57; 95% CI 1.24 to 5.33; p = 0.01). Middle school or high school education was again not associated with significantly higher odds (Model 1: OR 1.31; 95% CI 0.63 to 2.74; p = 0.48. Model 2: OR 1.24; 95% CI 0.59 to 1.95; p = 0.58). Two covariates were associated with lower odds in this stratum. Each unit increase in body mass index was associated with lower odds of possible sarcopenia (Model 1: OR 0.91; 95% CI 0.85 to 0.98; p = 0.009. Model 2: OR 0.90; 95% CI 0.83 to 0.96; p = 0.003), and participants reporting a regular exercise habit had roughly half the odds of those who did not, once all covariates were included (OR 0.51; 95% CI 0.27 to 0.96; p = 0.04). Smoking, chronic disease burden, and long-term pain did not reach significance in either stratum, nor did sex among older participants (Model 2: OR 1.06; 95% CI 0.58 to 1.95; p = 0.85). Among middle-aged participants, men had higher odds than women, although the difference was not statistically significant (Model 1: OR 3.23; 95% CI 0.83 to 12.53; p = 0.09. Model 2: OR 4.25; 95% CI 0.92 to 19.70; p = 0.06).

Table 2
Age-stratified associations between participant characteristics and possible sarcopenia

Variables	OR	95% CI	p value
50 to 64 years			
Model 1			
Education level			
College or higher	1	Reference	
Middle school or high school graduate	1.37	0.41 to 4.60	0.61
Elementary school or lower	6.88	1.28 to 37.10	0.03
Sex (men versus women)	3.23	0.83 to 12.53	0.09
BMI (kg/m²)	0.83	0.69 to 1.00	0.05
Model 2			
Education level			
College or higher	1	Reference	
Middle school or high school graduate	1.24	0.33 to 4.61	0.75
Elementary school or lower	6.14	1.10 to 34.24	0.04
Sex (men versus women)	4.25	0.92 to 19.70	0.06
BMI (kg/m²)	0.83	0.68 to 1.01	0.06
Current smoking (yes versus no)	1.28	0.08 to 21.77	0.86
Exercise habit (yes versus no)	0.49	0.14 to 1.68	0.26
Number of chronic diseases			
0	1	Reference	
1	2.84	0.54 to 14.87	0.22
2	2.82	0.47 to 16.73	0.26
3 or more	3.57	0.54 to 23.65	0.19
Long-term pain			
No pain	1	Reference	
Pain	1.47	0.28 to 7.88	0.65
65 years and over			

Variables	OR	95% CI	p value
50 to 64 years			
Model 1			
Model 1			
Education level			
College or higher	1	Reference	
Middle school or high school graduate	1.31	0.63 to 2.74	0.48
Elementary school or lower	2.75	1.34 to 5.64	0.006
Sex (men versus women)	0.99	0.55 to 1.77	0.96
BMI (kg/m²)	0.91	0.85 to 0.98	0.009
Model 2			
Education level			
College or higher	1	Reference	
Middle school or high school graduate	1.24	0.59 to 1.95	0.58
Elementary school or lower	2.57	1.24 to 5.33	0.01
Sex (men versus women)	1.06	0.58 to 1.95	0.85
BMI (kg/m²)	0.90	0.83 to 0.96	0.003
Current smoking (yes versus no)	0.50	0.09 to 2.68	0.41
Exercise habit (yes versus no)	0.51	0.27 to 0.96	0.04
Number of chronic diseases			
0	1	Reference	
1	1.42	0.72 to 2.82	0.32
2	1.54	0.71 to 3.34	0.27
3 or more	1.72	0.80 to 3.70	0.16
Long-term pain			
No pain	1	Reference	
Pain	1.25	0.70 to 2.23	0.45

Adjusted ORs and 95% CIs were estimated using logistic regression within each age group. Model 1 included educational attainment, sex, and BMI. Model 2 additionally included current smoking, exercise habit, number of chronic diseases, and long-term pain. College or higher was the reference category for educational attainment. BMI, body mass index; CI, confidence interval; OR, odds ratio.

Educational gradient in prevalence

Figure 2 displays prevalence by educational category within each age stratum. Among middle-aged participants, prevalence was 15.20% in both upper educational categories and 40.00% among those with elementary schooling or less. A test for linear trend across the three educational categories was not statistically significant within this stratum (p for trend = 0.183).

Among older participants, prevalence increased as educational attainment decreased, from 14.90% among college graduates, to 17.20% among middle school and high school graduates, and to 28.90% among those with elementary schooling or less. Here the linear trend was statistically significant (p for trend = 0.005).

Discussion

In this community-based sample of 499 adults aged 50 years and over, one in five met the AWGS 2025 criterion for possible sarcopenia. Educational attainment was associated with that criterion independently of sex, body mass index, smoking, exercise habit, chronic disease burden and long-term pain, and the association was evident within both age strata. Among participants aged 65 years and over, those whose schooling ended at elementary level had 2.57 times the odds of possible sarcopenia of college graduates. Among those aged 50 to 64 years the corresponding estimate was 6.14, although the confidence interval was correspondingly wide.

Within the older stratum, prevalence fell monotonically across the three educational categories, from 28.9% to 17.2% and then to 14.9%. That shape repeats what has been described in Irish and Brazilian community samples, and the present study extends it to an Asian population assessed under age-specific criteria (3, 5). The magnitude, however, differs. Our adjusted estimates of 2.57 in older participants and 6.14 in middle-aged participants exceed those obtained in Ireland and the United Kingdom (3, 4). Three differences between the studies are more plausible explanations than a genuinely stronger association in this population. The Irish analysis adjusted for age, physical activity, comorbidity and osteoarthritis, a wider set of covariates than was available here. The UK Biobank estimate rests on a definition that also requires low muscle mass, derived by bioimpedance from equations that contain body weight, in a cohort its authors acknowledge is not representative of the general population. The present sample is far smaller than either, so its point estimates are correspondingly less stable. A separate question is whether schooling is the right socioeconomic marker to use at all. In an Australian community cohort in which education, occupation and area-level disadvantage were examined side by side, the apparent association between occupational class and sarcopenic obesity disappeared once educational attainment was considered, whereas education itself remained associated with both obesity

and sarcopenic obesity after adjustment for occupation (9). In the one cohort in which these two dimensions have been separated directly, it was schooling rather than occupation that carried the association, although the outcomes there were obesity and sarcopenic obesity rather than muscle strength. This supports the choice of schooling as the socioeconomic indicator in the present study, although the evidence comes from a single cohort.

Taiwanese data on this question remain scarce, and the one urban cohort in which possible sarcopenia has been described merits closer examination. In 712 adults aged 50 years and over living in a district of Taipei, possible sarcopenia was common and was accompanied by poorer cognitive performance, although the prevalence reported there is not comparable with ours: participants younger than 65 years were classified by the lowest quintile of grip strength and gait speed within the sample rather than by absolute thresholds, and those aged 65 and over were classified under the AWGS 2019 criteria, which admit slow gait as well as weak grip (10). Educational attainment in that cohort did not differ between participants with and without possible sarcopenia in any age stratum, and its distribution explains why: about half of those aged 50 to 64 years had more than 12 years of schooling and only 6% had six years or fewer, whereas a third of the present sample left school at elementary level (10). A gradient can be detected only where the range of attainment is wide, and the communities sampled here retain that range. Another comparison concerns age. Our estimate among middle-aged participants exceeded that among older participants, an ordering that matches the pattern reported in the Chinese prospective cohort (8). The same ordering can be recovered from the Brazilian data: calculated from the prevalences that study reports, the ratio between the two educational groups falls from about 1.5 in the sixth decade of life to near unity beyond the age of 80 (5). Two mechanisms plausibly produce such convergence. Age-related loss eventually reaches everyone, progressively diluting differences established earlier in life, and selective survival removes the most disadvantaged participants from the oldest strata. Neither can be examined in the present data, and the middle-aged estimate rests on few events, so this finding is best read as consistent with external evidence rather than as independent confirmation of an age difference.

A further observation from the Chinese cohort helps to interpret the cross-sectional nature of our own data. Education was strongly associated with the prevalence of possible sarcopenia in that cohort but showed no association with its four-year incidence (7). That cohort enrolled adults aged 60 years and over throughout, which is the age range in which the prospective study found no educational effect (8). Its criteria were those of AWGS 2019, however, and about two thirds of the cases were identified by slow physical performance rather than by weak grip. These observations suggest that educational attainment shapes the level of muscle function a person carries into later life rather than the rate at which that function is subsequently lost. If so, the disparity detected by a cross-sectional survey such as ours was probably established well before the survey took place. In practical terms, the group at risk could be identified before the age of 65.

Several pathways plausibly connect schooling to muscle health. Higher educational attainment is associated with the adoption of healthier lifestyles, greater use of health services and more effective

management of chronic disease, all of which bear on muscle function (5). Adding smoking, exercise habit, chronic disease count and long-term pain to the model changed the ORs for elementary schooling or less only modestly, from 2.75 to 2.57 among older adults and from 6.88 to 6.14 among middle-aged adults. The association persisted after adjustment for these covariates, but comparing the two models does not quantify mediation. The measures were coarse and could not capture lifetime exposure, and use of health services was not recorded. Other unmeasured factors, including dietary protein intake, occupational physical demands, health literacy and early-life circumstances, may also be relevant to the observed association. Evidence from other populations supports considering these possible pathways. Among older adults in one Chinese city whose nutrition literacy was measured with a validated scale, those in the highest quartile had about half the odds of screening positive for possible sarcopenia as those in the lowest, although the outcome there was ascertained by the strength, assistance walking, rise from a chair, climb stairs, and falls combined with calf circumference (SARC-CalF) questionnaire rather than by measured grip strength (11). In that study the association was significant among participants whose schooling had ended at primary level or below, where the odds ratio was 0.21, and average daily protein intake was higher in the upper quartiles of the literacy scale, 63.2 against 51.9 grams per day in the lowest. In a European cohort of 24,179 adults aged 50 years and over, low educational attainment was itself associated with low grip strength in women, with an odds ratio of 2.13 when education first entered the model and 1.43 after full adjustment, and disadvantaged socioeconomic circumstances in early life carried a similar association, evident in women but largely not in men (12). Educational attainment may therefore serve as a practical marker of social circumstances relevant to muscle health, although the pathways underlying the observed association remain uncertain.

Two covariates behaved consistently with the wider literature. Body mass index was inversely associated with possible sarcopenia among older adults, an association that persisted after full adjustment, and the same direction has been reported in Ireland and in UK Biobank (3, 4). Skeletal muscle is itself a component of body weight, so a low body mass index may register the loss of muscle rather than cause it, and a cross-sectional design cannot separate the two; the finding should not be read as evidence that adiposity protects muscle. Comparisons of effect size across these studies also warrant caution, because those that define sarcopenia partly by bioimpedance-derived muscle mass estimate that mass from equations containing body weight, which exaggerates the apparent advantage of a heavier body. Among older adults, a regular exercise habit was associated with approximately half the odds of possible sarcopenia, consistent with the inverse associations reported for physical activity in both UK Biobank and the Chinese cohort (4, 7). Under AWGS 2025, measures of physical performance serve as outcome indicators rather than as diagnostic criteria, so the exercise finding here relates to muscle strength itself and not to the performance measures that would previously have contributed to case definition (1).

These results carry a practical implication for community screening, and one that the 2025 consensus itself anticipates: its concluding recommendation is that extending the diagnostic criteria to adults aged 50 to 64 years should enable earlier intervention and prevention (1). The algorithm itself, however, admits adults of that age only once something has already drawn attention to their muscle health: a concern the

person reports, an observation made by a clinician, or a condition such as functional decline or malnutrition (1). We measured grip strength in every participant from the age of 50 irrespective of symptoms, and the odds among those whose schooling ended at elementary level were already raised at that age, if imprecisely estimated. An approach that waits for a concern to be raised cannot identify such a group in advance, which is what an education-based entry criterion would allow. Screening from the age of 50, prioritized toward adults with low educational attainment, would therefore reach a group at measurable risk, using an instrument that costs little. Prioritization by social position already has a precedent within AWGS, whose nutrition consensus advises that community-dwelling older adults of low socioeconomic status be screened for malnutrition more often than once a year (13). For those identified, both consensuses recommend resistance training combined with adequate nutrition (1, 13). The nutrition consensus specifies structured exercise two to three times a week and a dietary protein intake of at least 1.0 gram per kilogram of body weight obtained through diet wherever possible, although its statements were framed for adults aged 60 years and over and their extension to middle age has yet to be tested (13). The association we observed was with a regular exercise habit, and in an analysis of 15,819 adults aged 40 years and over drawn from a Korean national survey, leisure-time moderate to vigorous activity was associated with lower odds of possible sarcopenia whereas occupational activity was not (14). Occupational physical activity therefore cannot be assumed to substitute for deliberate exercise, a distinction that matters particularly for a group in which manual work has been common, and advice to that effect should form part of what is offered to the group this study identifies.

Health education may also be part of the response for this group. In a Chinese community sample of 942 adults aged 60 years and over, awareness of sarcopenia rose with schooling (15). If a similar pattern holds in Taiwan, the group at highest risk in this study may also be the least aware of the condition. Health education of this kind has been tested directly in that population: in a single-arm feasibility study, 35 Chinese adults aged 60 to 69 years with possible sarcopenia received a week of health education delivered through a short-video social media platform followed by six weeks of home-based exercise, and the program proved safe and highly acceptable, with exploratory analyses suggesting gains in sarcopenia-related knowledge, self-efficacy and muscle function (16). Whether such a program is equally feasible and acceptable for adults with little schooling has not yet been examined.

This study has several strengths. Sampling was cluster-randomized across two districts, participants were enrolled from the age of 50 rather than 65, and case ascertainment followed the current AWGS 2025 criteria with age-specific handgrip thresholds, which allowed the two age bands defined by that consensus to be analyzed separately. Certain limitations should be acknowledged. The design is cross-sectional, so temporal ordering cannot be established; although educational attainment is fixed long before muscle strength declines, early-life circumstances may influence both, and residual confounding by unmeasured social and nutritional factors is likely. The middle-aged stratum contained only 10 participants whose schooling ended at elementary level, of whom four met the criterion, which accounts for the width of that confidence interval. The middle-aged model included ten terms but few events, a ratio well below the ten events per variable usually recommended, and the very wide intervals for

smoking and chronic disease count in that stratum reflect it. Although the village was the unit of sampling, the analysis treated participants as independent, so the standard errors reported here may be too narrow. Of the 1,058 residents who were mobile and reachable, 545 declined to take part, and because educational attainment itself predicts survey participation, those who enrolled may differ systematically from those who did not. Women made up 73.9% of the sample, which further limits extension to men, particularly in middle age. Finally, participants were drawn from two districts of one metropolitan area, and the findings should be extended to other Taiwanese populations with caution.

Conclusions

Low educational attainment was associated with higher odds of possible sarcopenia, suggesting a potential role for targeted handgrip screening from age 50, although findings in middle-aged adults remain preliminary.

Abbreviations

AWGS
Asian Working Group for Sarcopenia
BMI
Body mass index
CI
Confidence interval
CVD
Cardiovascular disease
OR
Odds ratio
SARC-CalF
Strength, assistance walking, rise from a chair, climb stairs, and falls combined with calf circumference
SD
Standard deviation
SPSS
Statistical Package for the Social Sciences

Declarations

Ethics approval and consent to participate:

This study was approved by the Institutional Review Board of the Chang Gung Medical Foundation (approval number: 202400222B0). All participants provided written informed consent before participation. The study was conducted in accordance with the Declaration of Helsinki and its later amendments.

Consent for publication:

Not applicable.

Competing interests:

The authors declare that they have no competing interests.

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Author Contribution

W.-H.L. reviewed the literature, interpreted the findings, and prepared the initial manuscript. J.-Y.C. developed the study design, conducted the statistical analyses, and directed the research project. Y.-H.L. and L.-H.C. contributed to the interpretation of the findings and revised the manuscript for substantive intellectual content. J.-Y.C., Y.-H.L., and L.-H.C. jointly recruited participants, administered the questionnaires, measured handgrip strength, and performed data entry, organization, and verification. All authors have approved the manuscript for submission to BMC Public Health.

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Data Availability

The study data are not publicly available because they contain information that could compromise participant privacy. De-identified data may be obtained from the corresponding author upon reasonable request and with the necessary permissions.

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Figures

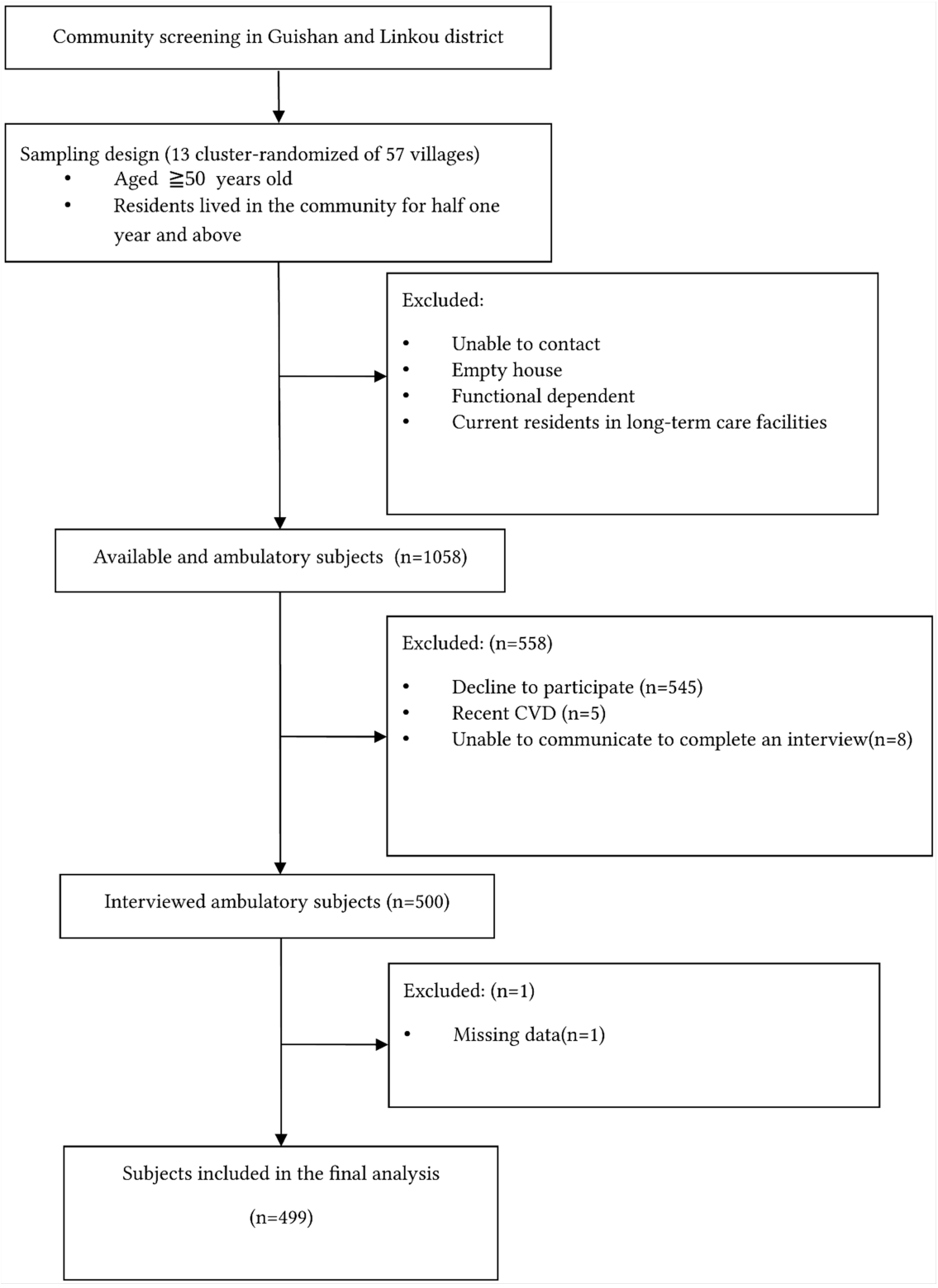


Figure 1

The flowchart of sampling selection process. CVD, cardiovascular disease.

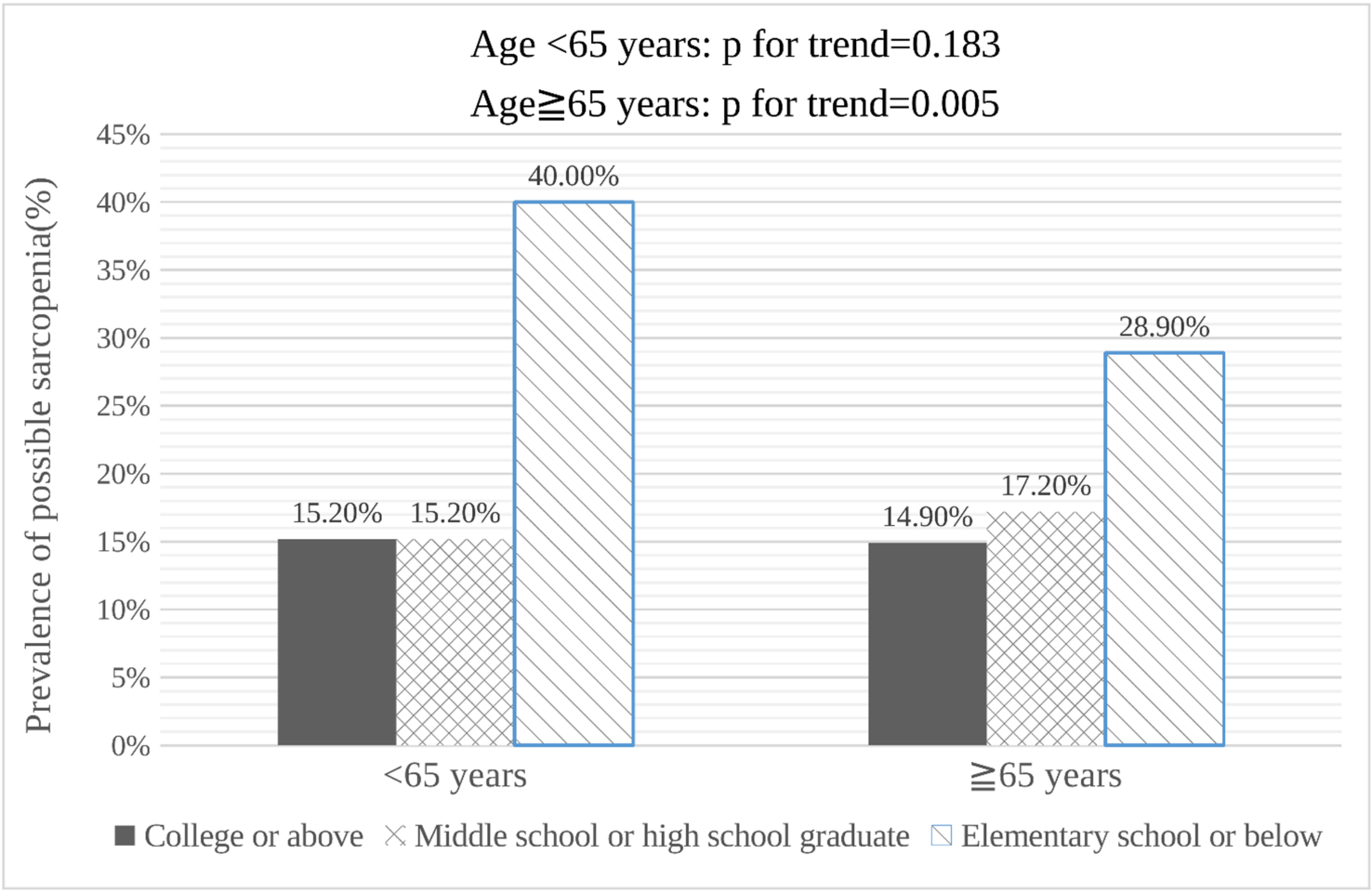


Figure 2

Prevalence of possible sarcopenia by education level and different age groups. P values indicate tests for trend across educational categories within each age group.

Supplementary Files

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