Assessment of cognitive function among adults aged ≥ 60 years using the Revised Hasegawa Dementia Scale: cross-sectional study, Lao People’s Democratic Republic

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Abstract

Background: Rapid population ageing remains an important concern for health, social and economics systems; thus, a broader assessment of cognitive decline among adults aged ≥ 60 years is essential. It is important to regularly collect reliable data through validated and affordable methods from people living in different areas and in different circumstances to better understand the significance of this health problem. This study aimed to identify the prevalence of cognitive impairment and the related risk factors by reassessing the scoring of the Revised Hasegawa Dementia Scale among older adults in the Lao People’s Democratic Republic.

Methods: A community-based cross-sectional investigation was conducted in rural and urban settings in six districts of three provinces in the country from January to July 2020. In total, 2206 individuals aged 60–98 years (1110 men and 1096 women) were interviewed in person using a pretested Lao version of the Revised Hasegawa Dementia Scale and the WHO STEPwise approach to noncommunicable disease (NCD) risk factor surveillance (the STEPS survey tool). The adjusted odds ratios (AORs) and 95% confidence intervals (95% CIs) were estimated using a logistic model.

Results: The study found that 49.3% (1088/2206) of respondents (39.7% [441/1110] of men and 59.0% [647/1096] of women) had scores associated with some level of cognitive impairment. In addition to age, the following factors were significantly associated with cognitive impairment: having no formal education (AOR = 9.5; 95% CI: 5.4 to 16.8, relative to those with a university education), living in the northern region of the country (AOR = 1.4; 95% CI: 1.1 to 1.9, relative to living in the central region), living in a rural area (AOR = 1.5; 95% CI: 1.2 to 1.8), needing assistance with self-care (AOR = 1.8; 95% CI: 1.2 to 2.7) and being underweight (AOR = 1.5; 95% CI: 1.1 to 2.2). Factors associated with no cognitive impairment among older adults include engaging in moderate-intensity physical activity lasting for 10 minutes and up to 1 hour (AOR = 0.6; 95% CI: 0.5 to 0.8) and for > 1 hour (AOR = 0.6; 95% CI: 0.4 to 0.8).

Conclusions: Using the Lao version of the Revised Hasegawa Dementia Scale, this study found that more than half of adults aged ≥ 60 years had cognitive impairment, and this impairment was associated with several risk factors. The limitations of this study may include possible overdetection due to the cutoff point for the assessment of cognitive decline used in the Revised Hasegawa Dementia Scale, given that the participants were not familiar with...
Background

Ageing represents a risk factor for chronic diseases, including heart diseases, chronic obstructive pulmonary disease, diabetes, depression and dementia. Dementia is a syndrome, usually of a chronic or progressive nature, that leads to deterioration in cognitive function (i.e. the ability to process thoughts) beyond what might be expected from the usual consequences of biological ageing. While age is the strongest known risk factor for cognitive decline, dementia is not an inevitable consequence of ageing [1]. In 2020, more than 55 million people worldwide were living with dementia. This number will almost double every 20 years, reaching 78 million in 2030 [2]. Data can be collected to strengthen health information systems for health planning and to ensure that policies that aim to ensure universal health coverage consider older adults [3,4].

Increases in the number of people with cognitive decline who need social and healthcare services have been observed not only in high-income countries but also in low- and middle-income countries [5]. Because there is a need for timely detection and for risk factors to be addressed to mitigate the impact of cognitive deterioration, it is essential to regularly collect reliable data through validated and affordable methods from people living in different areas and in different circumstances to better understand this health problem.

The Lao People’s Democratic Republic (Lao PDR) is a country in South-East Asia with around 7 231 000 people, and in 2020, 7.1% of the population was aged ≥ 60 years [6]. The government of the Lao PDR aims to promote healthy ageing and ensure that older adults receive benefits as part of its goal of achieving universal health coverage, and it is introducing reforms to achieve comprehensive social protection for everyone by 2030 [7]. The adoption in 2012 of Prime Minister’s Decree 470 provided the legal framework for the establishment of the National Health Insurance Bureau and the integration of existing social health protection schemes into a single-payer system, under the management of the Ministry of Health and the National Health Insurance Bureau. By the end of 2018, the new National Health Insurance Bureau covered all 17 provinces, except the capital city. In 2019, a new health insurance law was announced [8] to eliminate financial barriers to accessing health services and maximize health benefits for everyone.

As of 2020, the public sector had five central hospitals, three specialist hospitals, 17 provincial hospitals, 135 district hospitals and 1070 health centres [6]. There are few private hospitals, and most private clinics are available only in urban areas. Currently, there are no public or private long-term care facilities for people with dementia, so care is usually provided by the family within the community.

The Lao PDR has committed to achieving the Sustainable Development Goals by 2030 [9]. There is a need to plan for change and for adaptation in light of the country’s demographic and health challenges. In recognition that the Lao population will be ageing and life expectancy will be prolonged (in 2020, it was 68.5 years), the implications for access to and equity in healthcare and for financial protection from healthcare costs for older people should be explicitly identified during each step of the process.

Cognitive function has not been widely investigated in the Lao PDR, and until recently, there was no nationally standardized method that could be used to measure it. Accordingly, the Revised Hasegawa Dementia Scale has been adapted for use in Lao PDR [10]. The Revised Hasegawa Dementia Scale is a simple questionnaire-based scale consisting of nine questions. The Revised Hasegawa Dementia Scale examines the main areas of cognitive function, including orientation, attention, language and memory. The Revised Hasegawa Dementia Scale questionnaire has been translated into Lao and validated through back-translation into English [10]. The Lao version of the Revised Hasegawa Dementia Scale was then used to assess the cognitive function of 414 older adults living in Vientiane Capital and Khammouane Province in 2017. This initial study revealed that a relatively high percentage (43.5%) of respondents had impaired cognitive function [11]. However, several factors can influence the Revised Hasegawa Dementia Scale score, and more detailed comparisons were needed to compare populations living in different areas and in different circumstances.

This study aimed to identify the prevalence of cognitive impairment and its risk factors by reassessing the scoring of the Revised Hasegawa Dementia Scale
among older adults living in three regions (north, central and south) in the Lao PDR. Studies conducted in other countries have identified numerous sociodemographic, physical and mental conditions associated with cognitive impairment, including older age [12, 13], lower educational level [14, 15], gender [16, 17], tobacco smoking [18, 19], drinking alcohol [18, 20], having only a low level of activity [21, 22], being overweight or obese [23, 24], having hypertension [25] and having diabetes [26, 27]. Therefore, this study used the Revised Hasegawa Dementia Scale Lao version and the WHO STEPwise approach to noncommunicable disease (NCD) risk factor surveillance (STEPS) instrument (core and expanded) [28] to examine the prevalence and distribution of cognitive impairment in the Lao PDR and their relationship to older people’s household characteristics, health and socioeconomic status.

Methods

Study area and participants

This community-based cross-sectional study surveyed adults aged ≥60 years who resided in six districts of three provinces in the Lao PDR: Luangprabang in the north, Vientiane Capital in the central region and Champassak in the south. In each province, two districts (one rural and one urban) were purposively selected: Nambak and Nakhone Luangprabang districts in Luangprabang Province, Sikhottabong and Xaythany districts in Vientiane Capital, and Nakhone Champassak and Khong Island districts in Champassack Province (Fig. 1). Simple random sampling was used for selecting target villages, households and the individual target population. Among a total of 81 villages, 13–14 villages per target district, and based on the family registry at local government authorities, we identified households where adults aged ≥60 years resided from each village, and we selected 30 households per village and at the household level; only one individual adult aged ≥60 years was selected.
All adults aged ≥ 60 years who had lived in the selected study areas for more than 6 months and consented to participate in the study were recruited. Those who did not understand the Lao language or had physical disorders or severe illness at the time of the interview were excluded. Although the total sample size required 2500 adults aged ≥ 60 years, 2320 subjects (92.8%) were recruited.

**Data collection**

*Interviews with heads of households with older adults*

Face-to-face interviews were performed with heads of households using a tablet computer to record the answers. An identification and listing form and household information questionnaire were used to collect information about any older adults living in the household. The questionnaire was used to collect information related to demographic factors (age, gender, education, income, current job and type of current or last job) and about the main caregivers for older adults with low cognitive ability.

*Interviews with the older adults*

The WHO STEPS survey tool was used for the household survey. The STEPS survey tool is a standardized method for collecting, analysing and disseminating information about risk factors related to NCDs in WHO Member States [29]. The survey includes questions about health conditions (previously diagnosed diseases, health services received during the previous month and reason for the services, current medications, and membership in social health protection schemes) and lifestyle (alcohol drinking, smoking, use of chewing tobacco), physical activities and dietary habits.

*Measuring cognitive function in adults aged ≥ 60*

The Revised Hasegawa Dementia Scale Lao version questionnaire was delivered verbally during a face-to-face interview to assess the cognitive ability of the older adults living in the households. The Revised Hasegawa Dementia Scale is a screening tool for age-associated dementia that has a total score of 30 points. It consists of nine questions: question 1 on age (one point), 2 on temporal orientation (four points), 3 on spatial orientation (two points), 4 on registration (words) (i.e., repetition of three familiar words; three points), 5 on attention/calculation (i.e., subtracting 7 from 100 for twice; two points), 6 on counting backwards or backward repetition of three words and four digits (two points), 7 on recall of the three words memorized in question 4 (six points), 8 on registration (objects) (i.e., as confrontational naming and immediate recall of five objects; five points) and 9 on a category fluency test (i.e., word fluency; five points). The cutoff point of ≤ 20 was applied for dementia based on a study of the Revised Hasegawa Dementia Scale that reported this had 0.90 sensitivity and 0.82 specificity [29]. A score of ≤ 20 points is considered to be an indicator of cognitive impairment [30]. To accurately measure cognitive function, an Revised Hasegawa Dementia Scale manual previously developed [10] was used to standardize the skills of examiners.

*Health checkup for participants aged ≥ 60 years*

Weight, height, blood pressure and fasting blood glucose were measured for older adult participants at community venues, such as the village hall, school or temple. Weight was measured using a frequently calibrated electronic balance with 50 g sensitivity (Seca digital scale, Hamburg, Germany). Height was measured to 0.1-cm precision using a stadiometer. Body mass index (BMI) was calculated using weight divided by height squared (kg/m²). The Omron HEM-FM31 (Omron, Singapore) was used for blood pressure measurement. Capillary blood was taken from a finger for a blood glucose test.

Hypertension was defined as systolic blood pressure > 140 mm Hg or diastolic blood pressure > 90 mm Hg for the average of three measurements or treatment for raised blood pressure in the past 2 weeks. Diabetes mellitus was defined as fasting blood glucose > 126 mg/dL (3.9 mmol/L) or treatment with insulin or another medicine for high blood glucose, or both.

**Data management and statistical analysis**

A data manager was assigned to oversee data management and the production of electronic records. The data manager’s duties included coordinating data entry, reviewing data collection forms and ensuring the accurate and timely capture of data with the Dimagi CommCare programme (Dimagi, Cambridge, MA, USA) for tablet computers.

Electronic records were submitted to a central server. The data were retrieved from the Dimagi CommCare website and downloaded into an Excel spreadsheet, then checked for errors and cleaned. The cleaned data set was then transferred into Stata 16 for analysis (StataCorp, College Station, TX, USA). Continuous variables were expressed as the mean ± the standard deviation (SD), and categorical variables were expressed as numbers and percentages. The 95% confidence interval (CI) was calculated based on a binomial distribution. Cross-tabulations were conducted to assess the associations between two variables. Logistic regression analysis was applied to estimate the crude odds ratio (COR) and adjusted odds ratio (AOR) with their 95% CIs. Statistical significance was established at a P value of < 0.05. Only variables with
Table 1  Sociodemographic characteristics of study participants, Lao PDR

| Characteristics                        | Total (N = 2206) | Men (n = 1110) | Women (n = 1096) |
|----------------------------------------|------------------|----------------|------------------|
|                                        | No.   | %     | No.   | %     | No.   | %     |
| Family characteristics                 |       |       |       |       |       |       |
| Family type                            |       |       |       |       |       |       |
| Living alone                           | 35    | 1.6   | 9     | 0.4   | 26    | 1.2   |
| Nuclear                                | 770   | 34.9  | 386   | 34.7  | 384   | 35.0  |
| Extended                               | 1401  | 63.5  | 715   | 64.4  | 686   | 62.6  |
| Needs support for self-care            |       |       |       |       |       |       |
| Yes                                    | 163   | 7.4   | 73    | 6.9   | 90    | 8.2   |
| No                                     | 2043  | 92.6  | 1037  | 93.4  | 1006  | 91.8  |
| Region                                 |       |       |       |       |       |       |
| North                                  | 700   | 31.7  | 353   | 31.8  | 347   | 31.6  |
| Central                                | 714   | 32.4  | 381   | 34.3  | 333   | 30.4  |
| South                                  | 792   | 35.9  | 376   | 33.9  | 416   | 37.9  |
| Area                                    |       |       |       |       |       |       |
| Rural                                  | 1081  | 49.0  | 564   | 50.8  | 517   | 47.2  |
| Urban                                  | 1125  | 51.0  | 546   | 49.2  | 579   | 52.8  |
| Ethno-linguistic group                 |       |       |       |       |       |       |
| Lao-Tai                                | 1959  | 88.0  | 975   | 87.8  | 984   | 89.8  |
| Mon-Khmer                              | 165   | 7.5   | 88    | 7.9   | 77    | 7.0   |
| Chinese-Tibetan                        | 8     | 0.4   | 3     | 0.3   | 5     | 0.5   |
| Hmong-Mien                             | 74    | 3.3   | 44    | 4.0   | 30    | 2.7   |
| Individual characteristics             |       |       |       |       |       |       |
| Age (years)                            |       |       |       |       |       |       |
| Mean age (SD)                          | 68.4 (6.5) | 67.7 (6.0) | 69.1 (6.8) |
| Age group                              |       |       |       |       |       |       |
| 60–64                                  | 731   | 33.1  | 409   | 56.0  | 322   | 44.0  |
| 65–69                                  | 655   | 29.7  | 339   | 51.8  | 316   | 49.2  |
| 70–74                                  | 387   | 17.5  | 189   | 48.8  | 198   | 83.2  |
| 75–79                                  | 256   | 11.6  | 99    | 38.7  | 157   | 125.8 |
| ≥ 80                                   | 177   | 8     | 74    | 41.8  | 103   | 58.2  |
| Education level                        |       |       |       |       |       |       |
| No formal education                    | 655   | 29.7  | 138   | 12.4  | 517   | 47.2  |
| Primary school                         | 1161  | 52.6  | 661   | 59.5  | 500   | 45.6  |
| Secondary school                       | 258   | 11.7  | 202   | 18.2  | 56    | 5.1   |
| University                             | 132   | 5.9   | 109   | 9.8   | 23    | 2.1   |
| Employment status                      |       |       |       |       |       |       |
| Currently employed or working          | 1454  | 65.9  | 682   | 61.4  | 772   | 70.4  |
| Unemployed, unable to work             | 217   | 9.8   | 129   | 11.6  | 88    | 8.0   |
| Unemployed, able to work               | 309   | 14.0  | 179   | 16.1  | 130   | 11.9  |
| Retired                                | 226   | 10.2  | 120   | 10.8  | 106   | 9.7   |
| Marital status                         |       |       |       |       |       |       |
| Married                                | 1362  | 61.7  | 975   | 87.8  | 387   | 35.3  |
| Single                                 | 19    | 0.9   | 0     | 0     | 19    | 1.7   |
| Separated/divorced/widowed             | 825   | 37.4  | 135   | 12.2  | 690   | 62.9  |

SD standard deviation
a $P$ value $< 0.2$ from the initial bivariate analysis were included in the multivariate analysis.

**Results**

Table 1 presents the sociodemographic characteristics of the participants. Of the total 2320 participants recruited to this study, 114 participants were removed from the analysis due to poor hearing. Of the 2206 participants, 1110 (50.3%) were men, and 1096 (49.7%) were women, with a mean age of 67.7 years (SD = 6.0) for men and 69.1 years (SD = 6.8) for women. The majority (63.5%; 1401) of participants lived with their extended families; only 1.6% (35) lived alone (0.4% [9] of men and 1.2% [26] of women). Only 7.4% (163) were reported to need help with self-care. One third of the study population came from each of the three provinces, and half of participants lived in rural areas, and the other half in urban areas.

Nearly one third of respondents (33.1%; 731) were in the youngest age group (60–64 years); of these, 56.0% (409) were men and 44.0% (322) were women; 177 participants were aged ≥ 80 years (the oldest age group), accounting for 8.0% of participants, of whom 41.8% (74) were men and 58.2% (103) were women. More than half (52.6%; 1161) of the respondents had completed primary education. Among women, a higher percentage were more likely not to have had any formal education (47.2%; 517/1096), while among men, only 12.4% (138/1110) had not had any formal education. Only 5.9% (132) of all participants had attended university. The majority of participants (65.9%; 1454) reported they were currently working, and 61.7% (1362) were married.

Table 2 shows the substance-use behaviours and health-related characteristics of the respondents. Altogether, 32.0% (706) of respondents were current smokers: 53.0% (589/1110) of men and 10.7% (117/1116) of women. Among the 1110 men, 45.5% (505) were former drinkers, 38.0% (422) were occasional or social drinkers and 16.5% (183) were heavy drinkers. In terms of physical activity, 22.6% (251) of men engaged in vigorous-intensity workouts lasting ≥ 1 hour per day, 34.9% (387) engaged in moderate-intensity workouts lasting for ≥ 1 hour, 29.7% (330) walked or bicycled for > 1 hour, and 35.0% (389) were sedentary for ≥ 90 minutes. Among the 1096 women, 6.3% (69) engaged in vigorous-intensity workouts lasting ≥ 1 hour per day, 24.3% (266) engaged in moderate-intensity workouts lasting for ≥ 1 hour, 78.6% (861) walked or bicycled for at least 10 minutes and up to 1 hour, and 36.5% (400) were sedentary for ≥ 90 minutes.

Among the men, 29.8% (331) had hypertension, and 17.5% (194) had diabetes mellitus. Among the women, 29.0% (318) had hypertension, and 22.6% (248) had diabetes mellitus. In assessing the BMI of the respondents, 14.1% (311) were underweight (12.4% [138] of men and 15.8% [173] of women), 23.1% (509) were overweight (22.1% [245] of men and 24.1% [264] of women) and 7.0% (155) were obese (5.8% [64] of men and 8.3% [91] of women).

The study found that 49.3% (1088/2206) of respondents (39.7% [441/1110] of men and 59.0% [647/1096] of women) had scores associated with some level of cognitive impairment. The mean score for all participants was 18.8 (SD = 5.4). The highest mean score was found in the group aged 60–64 years (mean = 20.4), followed by that in the group aged 65–69 years (mean = 19.6). The lowest mean score was found in the group aged ≥ 80 years (mean = 14.7). The mean scores for temporal orientation, spatial orientation, registration (words), attention/calculation, counting backwards, recall (words), registration (objects) and word fluency were highest among those in the group aged 60–64 years, followed by those in the group aged 65–69 year.

Among the 2206 older adult participants, 163 (7.4%) reported that they needed help with self-care from a family member, and the primary caregiver was their daughter (42.9%; 70 participants), followed by their son (35.6%; 58), spouse (11.6%; 19) and others (9.2%; 16) (Table 4).

Table 5 presents results of the multivariate logistic regression analysis for factors associated with cognitive impairment in both men and women. In the bivariate analysis, the following family characteristics were significantly associated with cognitive impairment: being an adult who needs assistance with self-care (COR = 3.4; 95% CI: 2.4 to 4.9), living in a rural area (COR = 1.8; 95% CI: 1.5 to 2.1) and being from the northern region (COR = 2.2; 95% CI: 1.7 to 2.7) or southern region (COR = 1.9; 95% CI: 1.6 to 2.4). The following individual factors were significantly related to impairment in cognitive function: being female (COR = 2.1; 95% CI: 1.8 to 2.6); being an older adult aged 65–69 years (COR = 1.6; 95% CI: 1.3 to 2.1), aged 70–74 years (COR = 2.7; 95% CI: 2.1 to 3.5), 75–79 years (COR = 3.6; 95% CI: 2.6 to 4.9), ≥ 80 years (COR = 8.7; 95% CI: 5.6 to 13.7); not having formal education (COR = 20.9; 95% CI: 11.4 to 38.2); being separated, divorced or widowed (COR = 2.1; 95% CI: 1.7 to 2.5); and being unemployed and unable to work (COR = 2.2; 95% CI: 1.6 to 3.0). For health-related and substance-use behaviours, the risk factors were being underweight (COR = 2.2; 95% CI: 1.7 to 2.9) and being sedentary (that is, sitting for > 90 minutes per day) (COR = 1.2; 95% CI: 1.0 to 1.3).

The following protective factors were identified: being retired from work (COR = 0.4; 95% CI: 0.3 to 0.6), engaging in moderate physical activity lasting for 10 minutes and up to 1 hour (COR = 0.5; 95% CI: 0.4 to 0.6) and...
lasting for > 1 hour (COR = 0.4; 95% CI: 0.3 to 0.5), walking or bicycling for > 1 hour (COR = 0.5; 95% CI: 0.4 to 0.6), being a former smoker (COR = 0.6; 95% CI: 0.4 to 0.7) and being an occasional or social drinker (COR = 0.5; 95% CI: 0.4 to 0.6).

In the adjusted analysis, the significant risk factors for cognitive impairment were being an adult who needs assistance with self-care (AOR = 1.8; 95% CI: 1.2 to 2.7); living in a rural area (AOR = 1.5; 95% CI: 1.2 to 1.8); being from the northern region (AOR = 1.4; 95% CI: 1.1 to 1.9); being aged 70–74 years (AOR = 2.2; 95% CI: 1.6 to 3.0), 75–79 years (AOR = 2.1; 95% CI: 1.5 to 3.0) and ≥ 80 years (AOR = 4.7; 95% CI: 2.9 to 7.6); having no formal education (AOR = 9.5; 95% CI: 5.4 to 16.8); and being

### Table 2
Description of substance-use behaviours and health-related characteristics of study participants, Lao PDR

| Characteristics                                      | Total (N = 2206) | Men (n = 1110) | Women (n = 1096) |
|------------------------------------------------------|------------------|----------------|-----------------|
|                                                      | No. | %   | No. | %     | No. | %     |
| Substance-use behaviours                             |     |     |     |       |     |       |
| Cigarette smoking                                    |     |     |     |       |     |       |
| Never smoker                                         | 1121| 50.8| 196 | 17.6  | 925 | 84.4  |
| Former smoker                                        | 379 | 17.2| 325 | 29.3  | 54  | 4.9   |
| Current smoker                                       | 706 | 32.0| 589 | 53.0  | 117 | 10.7  |
| Alcohol drinking                                     |     |     |     |       |     |       |
| Lifetime abstainer/former drinker                    | 1421| 64.4| 505 | 45.5  | 916 | 83.6  |
| Occasional/social drinker                            | 586 | 26.6| 422 | 38.0  | 164 | 15.0  |
| Heavy drinker                                        | 199 | 9.0 | 183 | 16.5  | 16  | 1.4   |
| Physical activity (per day)                          |     |     |     |       |     |       |
| Vigorous-intensity workout                           |     |     |     |       |     |       |
| Never or < 10 minutes                                | 1800| 81.6| 805 | 72.5  | 995 | 90.8  |
| 10 minutes to 1 hour                                 | 86  | 3.9 | 54  | 4.9   | 32  | 2.9   |
| ≥ 1 hour                                             | 320 | 14.5| 251 | 22.6  | 69  | 6.3   |
| Moderate-intensity workout                           |     |     |     |       |     |       |
| Never or < 10 minutes                                | 903 | 40.9| 393 | 35.4  | 510 | 46.5  |
| 10 minutes to 1 hour                                 | 650 | 29.5| 330 | 29.7  | 320 | 29.2  |
| ≥ 1 hour                                             | 653 | 29.6| 387 | 34.9  | 266 | 24.3  |
| Walking or bicycling for at least 10 minutes         |     |     |     |       |     |       |
| 10 minutes to < 1 hour                               | 1641| 74.4| 780 | 70.3  | 861 | 78.6  |
| ≥ 1 hour                                             | 565 | 25.6| 330 | 29.7  | 235 | 21.4  |
| Sedentary behaviour per day                          |     |     |     |       |     |       |
| None or < 90 minutes                                 | 1417| 64.2| 721 | 64.9  | 696 | 63.5  |
| ≥ 90 minutes                                         | 789 | 35.8| 389 | 35.0  | 400 | 36.5  |
| Health-related characteristics                       |     |     |     |       |     |       |
| Hypertension<sup>a</sup>                             |     |     |     |       |     |       |
| No                                                    | 1557| 70.6| 779 | 70.2  | 778 | 71.0  |
| Yes                                                   | 649 | 29.4| 331 | 29.8  | 318 | 29.0  |
| Diabetes mellitus<sup>b</sup>                         |     |     |     |       |     |       |
| No                                                    | 1764| 79.9| 916 | 82.5  | 848 | 77.4  |
| Yes                                                   | 442 | 20.0| 194 | 17.5  | 248 | 22.6  |
| Body mass index                                       |     |     |     |       |     |       |
| Underweight (< 18.5)                                 | 311 | 14.1| 138 | 12.4  | 173 | 15.8  |
| Normal (18.5–24.9)                                   | 1231| 55.8| 663 | 59.7  | 568 | 51.8  |
| Overweight (25.0–29.9)                               | 509 | 23.1| 245 | 22.1  | 264 | 24.1  |
| Obese (≥ 30)                                          | 155 | 7.0 | 64  | 5.8   | 91  | 8.3   |

<sup>a</sup> Hypertension was defined when a participant had systolic blood pressure > 140 mm Hg or diastolic blood pressure > 90 mm Hg for the average of three measurements or had been treated for raised blood pressure in the past 2 weeks

<sup>b</sup> Participants were defined as having diabetes mellitus when their fasting blood glucose was > 126 mg/dL (3.9 mmol/L) or they were taking insulin or other medicines to treat high blood glucose, or both
underweight (AOR = 1.5; 95% CI: 1.1 to 2.2). However, participants were less likely to have cognitive impairment if they engaged in moderate-intensity physical activity lasting for 10 minutes and up to 1 hour (AOR = 0.6; 95% CI: 0.5 to 0.8) and for > 1 hour (AOR = 0.6; 95% CI: 0.4 to 0.8).

**Discussion**

This study examined the proportion of adults aged ≥ 60 years with impaired cognitive function living in three different areas of the Lao PDR, using the Revised Hasegawa Dementia Scale Lao version. The study revealed that cognitive impairment was associated with age, particularly in respondents aged ≥ 65 years, and educational levels. Living in rural areas and in the northern region were associated with higher risk of cognitive impairment in comparison with those living in urban areas or the southern and central regions.

The lower Revised Hasegawa Dementia Scale scores in the current study were partly due to low scores on questions 5 and 6, which involve serial subtraction and counting backwards. Almost all respondents (81.3%) reported having had no formal or primary education. The low level of education among study participants might help explain the difficulties with questions 5 and 6. This study also found lower scores related to remembering words and confrontational naming (questions 7 and 8), and the lowest score was related to word fluency (question 9); these scores may reflect limited educational opportunities during adolescence. Many studies have suggested that having a higher level of education is a protective factor against developing cognitive impairment, indicating that attaining only a low education level is associated with poor cognitive function [15, 31]. Continual mental stimulation gained through learning may increase favourable structural or neurochemical alterations in the brain, thus improving cognitive function [32]. However, several cohort studies have not found associations between low education levels and cognitive decline [33, 34]. Adults aged ≥ 60 years in this study spent their adolescence in the middle of a civil war; therefore, the majority of them did not have any formal education.

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**Table 3** Mean (SD) scores on the Revised Hasegawa Dementia Scale, by item and age group, Lao PDR

| Question no. and category (no. of points) | Mean (SD) score | Age group (years) |
|------------------------------------------|----------------|-------------------|
|                                          | All participants (N = 2206) | 60–64 (n = 731) | 65–69 (n = 655) | 70–74 (n = 387) | 75–79 (n = 256) | ≥ 80 (n = 177) |
| 1. Age (1)                               | 0.9 (0.2)          | 1.0 (0.2)         | 1.0 (0.2)      | 1.0 (0.2)      | 0.9 (0.3)      | 0.9 (0.3)     |
| 2. Temporal orientation (4)              | 2.6 (1.4)          | 2.9 (1.3)         | 2.8 (1.3)      | 2.5 (1.4)      | 2.3 (1.4)      | 1.8 (1.4)     |
| 3. Spatial orientation (2)               | 1.9 (0.4)          | 1.9 (0.3)         | 1.9 (0.3)      | 1.8 (0.4)      | 1.8 (0.5)      | 1.7 (0.6)     |
| 4. Registration (words) (3)              | 2.8 (0.7)          | 2.8 (0.6)         | 2.8 (0.6)      | 2.8 (0.8)      | 2.7 (0.8)      | 2.5 (1.0)     |
| 5. Attention/calculation (2)             | 0.9 (0.8)          | 0.8 (0.7)         | 0.8 (0.7)      | 0.8 (1.8)      | 0.6 (0.7)      | 0.5 (0.7)     |
| 6. Counting backwards (2)                | 0.8 (0.8)          | 0.9 (0.7)         | 0.8 (0.7)      | 0.7 (0.7)      | 0.6 (0.7)      | 0.5 (0.7)     |
| 7. Recall (words) (6)                    | 3.9 (2.1)          | 4.2 (2.0)         | 4.1 (2.0)      | 3.7 (2.1)      | 3.5 (2.1)      | 3.1 (2.2)     |
| 8. Registration (objects) (5)            | 3.9 (1.1)          | 4.1 (0.9)         | 4.0 (1.0)      | 3.7 (1.2)      | 3.6 (1.3)      | 3.1 (1.4)     |
| 9. Word fluency (5)                      | 1.1 (1.3)          | 1.5 (1.4)         | 1.2 (1.3)      | 0.9 (1.1)      | 0.8 (1.2)      | 0.5 (1.0)     |
| Total score (30)                         | 18.8 (5.4)         | 20.4 (5.4)        | 19.6 (4.9)     | 17.8 (5.2)     | 16.8 (5.6)     | 14.7 (5.5)    |

The highest possible score is 30 points; a cutoff of ≤ 20 points was used to indicate cognitive impairment

**Table 4** Need for help with self-care among participants aged ≥ 60 years, by gender, Lao PDR

| Characteristics            | Total (N = 2206) | Men (n = 1110) | Women (n = 1069) |
|----------------------------|-----------------|---------------|-----------------|
|                            | No.  | %    | No.  | %    | No.  | %    |
| Needs help with self-care  | 163  | 7.4  | 73   | 6.6  | 90   | 8.2  |
| Primary caregiver          |      |      |      |      |      |      |
| Spouse                     | 19   | 11.6 | 16   | 21.9 | 3    | 3.3  |
| Daughter                   | 70   | 42.9 | 29   | 39.7 | 41   | 45.6 |
| Son                        | 58   | 35.6 | 25   | 34.2 | 33   | 36.7 |
| Other (paid caregiver)     | 16   | 9.2  | 3    | 4.0  | 13   | 14.4 |
Table 5  Odds ratio and 95% confidence interval (95% CI) for risk factors for scoring ≤ 20 on the Revised Hasegawa Dementia Scale among adults aged ≥ 60 years, Lao PDR

| Characteristics                          | Crude odds ratio (95% CI) with P value | Adjusted odds ratio (95% CI) with P value |
|------------------------------------------|----------------------------------------|-----------------------------------------|
| Family characteristics                   |                                        |                                         |
| Family type                              |                                        |                                         |
| Nuclear                                  | 1                                      |                                         |
| Extended                                 | 1.1 (0.9 to 1.3)                       |                                         |
| Living alone                             | 1.6 (0.8 to 3.2)                       |                                         |
| Needs help with self-care                |                                        |                                         |
| No                                       | 1                                      |                                         |
| Yes                                      | 3.4 (2.4 to 4.9) < 0.001               | 1.8 (1.2 to 2.7) 0.008                  |
| Area                                     |                                        |                                         |
| Urban                                    | 1                                      |                                         |
| Rural                                    | 1.8 (1.5 to 2.1) < 0.001               | 1.5 (1.2 to 1.8) < 0.001                |
| Region                                   |                                        |                                         |
| Central                                  | 1                                      |                                         |
| North                                    | 2.2 (1.7 to 2.7) < 0.001               | 1.4 (1.1 to 1.9) 0.014                  |
| South                                    | 1.9 (1.6 to 2.4) < 0.001               | 1.2 (0.9 to 1.6) 0.121                  |
| Ethno-linguistic group                   |                                        |                                         |
| Lao-Tai                                  | 1                                      |                                         |
| Mon-Khmer                                | 2.4 (1.7 to 3.4) < 0.001               | 1.5 (0.9 to 2.2) 0.093                  |
| Chinese-Tibetan                          | 1.1 (0.3 to 4.5) 0.847                 | 0.7 (0.2 to 3.6) 0.747                  |
| Hmong-Mien                               | 4.5 (2.5 to 8.0) < 0.001               | 2.4 (1.2 to 4.8) 0.011                  |
| Individual characteristics              |                                        |                                         |
| Gender                                   |                                        |                                         |
| Male                                     | 1                                      |                                         |
| Female                                   | 2.1 (1.8 to 2.6) < 0.001               | 1.3 (0.9 to 1.8) 0.072                  |
| Age (years)                              |                                        |                                         |
| 60–64                                    | 1                                      |                                         |
| 65–69                                    | 1.6 (1.3 to 2.1) < 0.001               | 1.5 (1.2 to 1.9) 0.001                  |
| 70–74                                    | 2.7 (2.1 to 3.5) < 0.001               | 2.2 (1.6 to 3.0) < 0.001                |
| 75–79                                    | 3.6 (2.6 to 4.9) < 0.001               | 2.1 (1.5 to 3.0) < 0.001                |
| ≥ 80                                     | 8.7 (5.6 to 13.7) < 0.001              | 4.7 (2.9 to 7.6) < 0.001                |
| Education level                          |                                        |                                         |
| University                               | 1                                      |                                         |
| Secondary school                         | 1.5 (0.8 to 2.6) 0.163                 | 1.3 (0.7 to 2.3) 0.412                  |
| Primary school                           | 4.6 (2.7 to 7.6) < 0.001               | 3.0 (1.8 to 5.1) < 0.001                |
| No formal education                      | 20.9 (11.4 to 38.2) < 0.001            | 9.5 (5.4 to 16.8) < 0.001               |
| Marital status                           |                                        |                                         |
| Married                                  | 1                                      |                                         |
| Single                                   | 1.5 (0.6 to 3.7) 0.375                 | 0.9 (0.3 to 2.7) 0.923                  |
| Separated/divorced/widowed               | 2.1 (1.7 to 2.5) < 0.001               | 1.2 (0.9 to 1.5) 0.111                  |
| Employment                               |                                        |                                         |
| Currently employed or working            | 1                                      |                                         |
| Unemployed, unable to work               | 2.2 (1.6 to 3.0) < 0.001               | 1.6 (1.1 to 2.2) 0.015                  |
| Unemployed, able to work                 | 1.0 (0.8 to 1.3) 0.983                 | 1.2 (0.9 to 1.5) 0.120                  |
| Retired                                  | 0.4 (0.3 to 0.6) < 0.001               | 0.7 (0.5 to 0.9) 0.040                  |
| Physical activity                        |                                        |                                         |
| Vigorous intensity workout (per day)      |                                        |                                         |
| Never or < 10 minutes                    | 1                                      |                                         |
| 10 minutes to 1 hour                     | 0.9 (0.6 to 1.4) 0.658                 |                                         |
Several studies have noted that women are more likely than men to develop cognitive impairment [16, 17]. We found that more women had developed cognitive impairment than men in the bivariate analysis but not in the multivariate analysis. In the Lao PDR, women tend to have a longer life expectancy, and this longer life will be healthier if preventive strategies are undertaken, such as using a multifocal approach to prevent and slow cognitive decline among older adults by encouraging exercise, avoiding high levels of alcohol consumption, socializing and by preventing NCDs [18]. Additionally, the WHO global action plan on dementia recommends increasing public awareness of and developing programmes to encourage positive attitudes towards dementia in the community [35]. Without a strong health systems response and a formal long-term care sector, those who are disabled at older ages become the responsibility of family caregivers, such as daughters and spouses. Other studies have indicated that older adults who are divorced, separated or widowed have a higher risk of cognitive impairment [36], but this was observed only in the bivariate analysis in this study.

In the Lao PDR, the high prevalence of harmful alcohol use in adults aged ≥ 18 years [37] and chronic malnutrition during childhood might affect cognitive function [31, 38]. Risk factors for cognitive impairment include age, family history, education level, brain injury, exposure to pesticides or toxins, and physical inactivity.

Ageing is a risk factor for NCDs such as hypertension [25] and type 2 diabetes mellitus [26, 27]. In our study,

| Table 5 (continued) |
|---------------------|
| Characteristics     | Crude odds ratio (95% CI) with P value | Adjusted odds ratio (95% CI) with P value |
| ≥ 1 hour            | 0.8 (0.6 to 1.0) 0.113                  |
| Moderate-intensity workout |
| Never or < 10 minutes | 1                                      |
| 10 minutes to 1 hour | 0.5 (0.4 to 0.6) < 0.001               |
| ≥ 1 hour            | 0.4 (0.3 to 0.5) < 0.001               |
| Walking or bicycling |
| Never or < 1 hour   | 1                                      |
| ≥ 1 hour            | 0.5 (0.4 to 0.6) < 0.001               |
| Sedentary behaviour |
| None or < 90 minutes | 1                                      |
| ≥ 90 minutes        | 1.2 (1.0 to 1.3) 0.112                  |
| Substance-use and health-related behaviours |
| Cigarette smoking   |
| Never smoker        | 1                                      |
| Former smoker       | 0.6 (0.4 to 0.7) < 0.001               |
| Current smoker      | 0.7 (0.6 to 0.8) < 0.001               |
| Alcohol drinking    |
| Lifetime abstainer/former drinker | 1                                      |
| Occasional/social drinker | 0.5 (0.4 to 0.6) < 0.001               |
| Heavy drinker       | 0.4 (0.3 to 0.5) < 0.001               |
| Hypertension        |
| No                  | 1                                      |
| Yes                 | 0.7 (0.6 to 0.9) 0.006                  |
| Diabetes mellitus   |
| No                  | 1                                      |
| Yes                 | 1.1 (0.9 to 1.3) 0.338                  |
| Body mass index     |
| Normal (18.5–24.9)  | 1                                      |
| Underweight (< 18.5)| 2.2 (1.7 to 2.9) < 0.001               |
| Overweight (25.0–29.9)| 0.6 (0.5 to 0.8) < 0.001                |
| Obese (≥ 30)        | 0.5 (0.4 to 0.8) < 0.001               |

CI confidence interval
more than one third of respondents had hypertension, and nearly one fifth had type 2 diabetes mellitus. Hypertension and diabetes mellitus account for both small and large vascular changes that can lead to cerebrovascular accidents, strokes, cerebral haemorrhage and micro-cerebral infarcts [39, 40]. Therefore, effective and timely preventive measures or strategies to address the risks of ill health are required. For instance, Japan has invested in primary, secondary and tertiary prevention strategies, especially those addressing hypertension and diabetes, and therefore has both a high life expectancy and a high healthy life expectancy, even among people in older age groups. Japan’s health investments were initiated in the 1960s when it was a lower-income country and its population was relatively young. Japan continues to have the highest life expectancy globally, partly due to this early investment and also because people can continue to be active and healthy in their older years.

Although respondents who were overweight or obese were observed to have a lower risk of developing cognitive impairment in this study, many other studies have found that maintaining normal body weight throughout the life span is protective against cognitive impairment [25, 26].

Similar to other studies, respondents who engaged in moderate-intensity physical activity had a lower risk of cognitive impairment [14, 18, 21, 41].

One third of respondents were current smokers and current drinkers. Chronic smokers were more likely to drink alcohol, and smoking tobacco is associated with cognitive decline and neurocognitive diseases in later life [19]. However, this study did not find such an association.

In recent decades, the Lao PDR has transitioned from a low-income country to one that is lower-middle-income. When most households lived in poverty and few people had access to health services, many people died young due to poor nutrition and infectious diseases. Impoverished adults who suffered from poor nutrition and a lack of cognitive stimulation during their early life could perhaps be at risk of cognitive impairment. As poverty declined and health services improved in the Lao PDR, there was a rapid reduction in deaths caused by diseases such as malaria, tuberculosis and diarrhoea, with corresponding increases in life expectancy. However, infants may still be malnourished, and children may still not receive an education [38], both of which may impact development at an early stage and place them at risk of cognitive impairment in later life. In addition, unhealthy lifestyles in adult life, such as poor diet, smoking, consumption of alcohol and working in stressful occupations, increase the risks of NCDs such as obesity, diabetes, vascular diseases and hypertension, all of which are associated with cognitive impairment later in life [40, 41].

A limitation of this cross-sectional study is that it provides only a snapshot in time and does not provide information on cause and effect relationships between cognitive impairment and different risk factors. In addition, the cutoff Revised Hasegawa Dementia Scale score of ≤ 20 may not be appropriate for those unfamiliar with subtraction. Screening for cognitive impairment with the Revised Hasegawa Dementia Scale Lao version might be better if the cutoff was ≤ 18 and if question 5 was removed; the appropriateness of making these changes and using a maximum score of 28 (rather than 30) should be confirmed by comparing these scores with clinical diagnoses in future studies. Future research should be performed not only to detect general cognitive impairment but also to differentiate among specific types of cognitive impairment.

However, this study also has strengths: it was conducted in three different parts of the country and had a large sample of respondents representing urban and rural areas and different sociodemographic features. The study provides evidence for future policy planning in the Lao PDR as increasing numbers of older people will place greater demands on the health services, particularly for the management of chronic NCDs, such as hypertension and diabetes, which can contribute to cognitive decline. Older adults are often likely to have one or more of these conditions and require support from various professionals, such as physiotherapists, dietitians and mental health professionals. WHO and other agencies have long advocated for developing a people-centred, multidisciplinary approach to healthcare. Implementing a robust primary care system requires shifting investments in infrastructure and deploying staff to primary care facilities and health networks, and determining the appropriate technology to be used at all levels of the health system, in keeping with clinical and referral pathways. The critical questions are whether the Lao PDR is ready for such profound changes and what the implications of these changes are for health and social services [5, 42]. To address these questions, it is necessary to understand the public policies and disease prevention strategies that enable healthy ageing in order to focus on the opportunity to plan for universal health coverage in recognition that health systems of the future need to respond to older populations [1, 5] as part of the global commitments to the Sustainable Development Goals [9].

Conclusions
In the current study, more than half of the respondents who were aged ≥ 60 years had some cognitive impairment, and being older than 65 years, having a low educational level and needing assistance with self-care were all associated with being at a higher risk of
developing cognitive impairment. The limitations of this study may include possible overdetection due to the cutoff point for the assessment of cognitive decline used in the Revised Hasegawa Dementia Scale, given that the study participants were not familiar with the subtraction. However, the study results can be used to help inform health policy in the Lao PDR regarding the urgent need for a routine data collection system and for providing an environment that addresses and reduces the identified risk factors for cognitive decline to mitigate their impact. Primary healthcare workers could screen patients for cognitive impairment using the Revised Hasegawa Dementia Scale Lao version even in resource-constrained settings.

Along with the rise in obesity and increase in NCDs associated with recent economic growth and subsequent changes in socioeconomic status, the prevalence of cognitive impairment and subsequent dementia may well increase in the future. Instead of focusing only on medical services and healthcare at an individual level, policy planning needs to address the substantial determinants of poor health outcomes across the life course and work to create a healthy environment for every community, including ageing populations, now and in the future.

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Author contributions
SK, RK, EM, BP, BB and NH conceptualized the study; MV, SS and SK administered the project and oversaw the data collection; MV, SS, SK and VS analysed the data; SK, NH and RK wrote the paper. All authors contributed to revisions and approved the final manuscript. The views and opinions expressed in the document are solely the responsibility of the authors and do not necessarily represent the official views or positions of WHO. All authors read and approved the final manuscript.

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Availability of data and materials
The data sets used and analysed for this study are available from the corresponding author on reasonable request.

Declarations
Ethics approval and consent to participate
This study was approved by the National Ethics Committee for Health Research of the Ministry of Health (approval no. 012/NECHR 07/02/2020), Lao PDR, and the WHO Research Ethics Review Committee (protocol no. 0003062). Written informed consent was obtained from all study participants.

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests.

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References
1. World Health Organization. Global status report on the public health response to dementia. Geneva: World Health Organization; 2021. https://www.who.int/publications/i/item/9789240033245. Accessed 20 Sep 2021.
2. Shah H, Albanese E, Duggan C, Rudan I, Langa KM, Carrillo MC, et al. Research priorities to reduce the global burden of dementia by 2025. Lancet Neurol. 2016;15:1285–94.
3. Kelley AS, McGarry K, Gorges R, Skinner JS. The burden of health care costs for patients with dementia in the last 5 years of life. Ann Intern Med. 2015;163:729–36.
4. Ton TGN, DeLeire T, May SG, Hou N, Tebeka MG, Chen E, et al. The financial burden and health care utilization patterns associated with amnestic mild cognitive impairment. Alzheimers Dement. 2017;13:217–24.
5. The World Health Organization. The World Report on ageing and health, 29 September 2015. https://www.who.int/publications/i/item/9789241565042. Accessed 20 Sep 2021.
6. Lao Statistics Bureau [Internet]. [Population and demography: 2019]. Vientiane: LAOSIS, 2019. https://laosis.lsb.gov.la/. Accessed 20 Sep 2021.
7. Ministry of Health. Annual report 2017 [Internet]. Vientiane: Ministry of Health, Lao People's Democratic Republic, National Health Insurance Bureau; 2017. https://hmsis.gov.la/laov/#/1_7_3=a76e. Accessed 20 Sep 2021.
8. National Health Insurance Bureau. Law on health insurance 2019 [Internet]. Vientiane: National Health Insurance Bureau; 2019. https://www.na.gov.la/. Accessed 20 Sep 2021.
9. United Nations: Resolution adopted by the general assembly on 6 July 2017. 71/313/ Work of the statistical commission pertaining to the 2030 agenda for sustainable development. New York: United Nations; 2017.
10. Kounnavong S, Soundavong K, Xayavong S, Vongpraserth N, Bounsavan P, Houaithongkham S, et al. Lao language version of the revised Hasegawa's Dementia Scale. Nagoya J Med Sci. 2017;79:241–9.
11. Kounnavong S, Ratsasong K, Soundavong K, Kyavang S, Kariya T, Saw YM, et al. Cognitive function measured with the Revised Hasegawa’s Dementia Scale among elderly individuals in Lao PDR. Nagoya J Med Sci. 2019;81:281–90.
12. Li G, Shen YC, Chen CH, Zhao YW, Li SR, Lu M. An epidemiological survey of age-related dementia in an urban area of Beijing. Acta Psychiatr Scand. 1989;79:557–63.

13. Fichter MM, Meller I, Schnoppe11l, Steinkirchner R. Dementia and cognitive impairment in the oldest old in the community: Prevalence and comorbidity. Br J Psychiatry. 1995;166:621–9.

14. Ren L, Zheng Y, Wu L, Gu Y, He Y, Jiang B, et al. Investigation of the prevalence of cognitive impairment and its risk factors within the elderly population in Shanghai. China Sci Rep. 2018;8:3575.

15. Scaczaufca M, Almeida OP, Meneses PR. The role of literacy, occupation and income in dementia prevention: the São Paulo Ageing & Health Study (SPAH). Int Psychogeriatr. 2010;22:1299–105.

16. Laws KR, Irvine K, Gale TM. Sex differences in cognitive impairment in Alzheimer’s disease. World J Psychiatry. 2016;6:54–65.

17. Lyu J, Kim HY. Gender-specific incidence and predictors of cognitive impairment among older Koreans: findings from a 6-year prospective cohort study. Psychiatry Investig. 2016;13:473–9.

18. Huang C-Q, Dong B-R, Zhang Y-L, Wu H-M, Liu Q-X. Association of cognitive impairment with smoking, alcohol consumption, tea consumption, and exercise among Chinese nonagenarians/centenarians. Cogn Behav Neurol. 2009;22:190–6.

19. Conti AA, McLean L, Toleomeo S, Steele JD, Baldacchino A. Chronic tobacco smoking and neuropsychological impairments: a systematic review and meta-analysis. Neuropsychobehav Rev. 2019;16:143–54.

20. Koch M, Fitzpatrick AL, Rapp SR, Nahn RL, Williamson JD, Lopez OL, et al. Alcohol consumption and risk of dementia and cognitive decline among older adults with or without mild cognitive impairment. JAMA Netw Open. 2019;2:e1910319.

21. Lautin D, Verreault R, Lindsay J, MacPherson K, Rockwood K. Physical activity and risk of cognitive impairment and dementia in elderly persons. Arch Neurol. 2001;58:498–504.

22. Liu J, Fu W, Liu Y. Physical activity and cognitive function among older adults in China: a systematic review. J Sport Health Sci. 2016;5:287–96.

23. Favier F, Forte G, Casagrande M. The executive functions in overweight and obesity: a systematic review of neuropsychological cross-sectional and longitudinal studies. Front Psychol. 2019;10:2126.

24. Dye L, Boyle NB, Champ C, Lawton C. The relationship between obesity and cognitive health and decline. Proc Nutr Soc. 2017;76:443–54.

25. Reitz C, Tang M-X, Manly J, Mayeux R, Luchsinger JA. Hypertension and the risk of mild cognitive impairment. Arch Neurol. 2007;64:1734–40.

26. Luchsinger JA, Reitz C, Patel B, Tang M-X, Manly JI, Mayeux R. Relation of diabetes to mild cognitive impairment. Arch Neurol. 2007;64:570–5.

27. Cueva CH. Type 2 diabetes and cognitive dysfunction in minorities: a review of the literature. Ethn Health. 2019;24:512–26.

28. World Health Organization. STEPS instruments for NCD risk factors (core and expanded, version 1.4): the WHO STEPwise approach to surveillance of noncommunicable diseases (STEPS). Geneva: World Health Organization; 2001. www.who.int/nmh/cd/steps. Accessed 20 Sep 2021.

29. Imai Y, Hasegawa K. The revised Hasegawa’s Dementia Scale (HDS-R)—evaluation of its usefulness as a screening test for dementia. J Hong Kong Coll Psychiatry. 1994;4:20–4.

30. Jeong JW, Kim KW, Lee DY, Lee SB, Park JH, Choi EA, et al. A normative study of the Revised Hasegawa Dementia Scale: comparison of demographic influences between the Revised Hasegawa Dementia Scale and the Mini-Mental Status Examination. Dement Geriatr Cogn Disord. 2007;24:286–93.

31. Forte G, de Pascalis V, Favieri F, Casagrande M. Effects of blood pressure on cognitive performance: a systematic review. J Clin Med. 2019;8:34.

32. Albert MS. How does education affect cognitive function? Ann Epidemiol. 1995;5:76–8.

33. Zahodne LB, Glynour MM, Sparks C, Bontempo D, Dixon RA, MacDonald SWS, et al. Education does not slow cognitive decline with aging: 12-year evidence from the Victoria longitudinal study. J Int Neuropsychol Soc. 2011;17:1039–46.

34. Christensen H, Batterham PJ, Mackinnon AJ, Anstey KJ, Wen W, Sachdev S. Education, atrophy, and cognitive change in an epidemiological sample in early old age. Am J Geriatr Psychiatry. 2009;17:218–26.

35. Ministry of Health, National Institute of Public health. WHO STEPwise approach to non-communicable disease risk factor surveillance (STEPS) survey report, 2013. Vientiane: The National Institute of Public Health, 2013.

36. Saw YM, Saw TN, Than TM, Khaing M, Soe PP, Do S, et al. Cognitive impairment and its risk factors among Myanmar elderly using the Revised Hasegawa’s Dementia Scale: a cross-sectional study in Nay Pyi Taw. Myanmar PLOS ONE. 2020;15: e0236656.

37. World Health Organization. The WHO Global action plan on education, atrophy, and cognitive change in an epidemiological sample in early old age. Acta Psychiatr Scand. 1989;79:557–63.

38. Albert MS. How does education affect cognitive function? Ann Epidemiol. 1995;5:76–8.

39. World Health Organization. The WHO Global action plan on education, atrophy, and cognitive change in an epidemiological sample in early old age. Acta Psychiatr Scand. 1989;79:557–63.

40. Laws KR, Irvine K, Gale TM. Sex differences in cognitive impairment in Alzheimer’s disease. World J Psychiatry. 2016;6:54–65.

41. Lyu J, Kim HY. Gender-specific incidence and predictors of cognitive impairment among older Koreans: findings from a 6-year prospective cohort study. Psychiatry Investig. 2016;13:473–9.

42. World Health Organization. The WHO Global action plan on education, atrophy, and cognitive change in an epidemiological sample in early old age. Acta Psychiatr Scand. 1989;79:557–63.

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