

Cognitive aging and modifiable risk factors: preliminary evidence from a pilot study of older adults

Envejecimiento cognitivo y factores de riesgo modificables: evidencia preliminar de un estudio piloto de adultos mayores

Alejandra Korenfeld-Kershenobich¹ and Rigoberto González-Piña^{1,2,3*} 

¹Special Education Department, Universidad de las Américas; ²Postgraduate Section, School of Medicine, Instituto Politécnico Nacional; ³Clínica de Rehabilitación del Daño Cerebral CLIREDAE “Dr. Hugo Iván González Gutiérrez”. Mexico City, Mexico

Abstract

Background: Recently, cognitive decline has become a public health problem, so identifying the factors that facilitate or prevent its development is crucial for prevention. **Objective:** The objective of the study is to investigate the relationship between cognitive function and variables such as educational background, depression, daytime sleepiness, and life satisfaction in older adults. **Material and methods:** Twenty volunteers (10 women and 10 men) between 60 and 84 years old were assessed using the Montreal Cognitive Assessment (MoCA), and the score was correlated to age, years of education, score in Beck's depression inventory, score in Epworth Sleepiness Scale, and Life Satisfaction Index. **Results:** The study found a positive correlation between years of education and MoCA scores. Depression was negatively associated with cognitive performance in women, while life satisfaction showed divergent correlations, being significantly positive in women and negative, but non-significant, in men. **Conclusion:** Cognitive reserve, mood, and overall well-being significantly impact cognitive aging, with notable gender-specific effects, emphasizing the importance of considering sex differences in neuropsychological research and the need for tailored interventions to support cognitive health in aging populations must be encouraged.

Keywords: Aging. Cognitive aging. Cognitive reserve. Depression. Gender differences. Life satisfaction.

Resumen

Antecedentes: Recientemente, el deterioro cognitivo se ha convertido en un problema de salud pública, por lo que identificar los factores que facilitan o impiden su desarrollo es crucial para la prevención. **Objetivo:** Investigar la relación entre la función cognitiva y variables como la escolaridad, la depresión, la somnolencia diurna y la satisfacción con la vida en adultos mayores. **Material y métodos:** Se evaluó a veinte voluntarios (10 mujeres y 10 hombres) de entre 60 y 84 años mediante la prueba Montreal Cognitive Assessment (MoCA). La puntuación obtenida se correlacionó con la edad, los años de escolaridad y los puntajes en el Inventario de Depresión de Beck, la Escala de Somnolencia de Epworth y el Índice de Satisfacción con la Vida. **Resultados:** Se encontró una correlación positiva entre los años de escolaridad y las puntuaciones en el MoCA. La depresión se asoció negativamente con el rendimiento cognitivo en las mujeres, mientras que la satisfacción con la vida mostró correlaciones divergentes: significativamente positiva en mujeres y negativa, aunque no significativa, en hombres. **Conclusión:** La reserva cognitiva, el estado de ánimo y el bienestar general influyen de manera significativa en el envejecimiento cognitivo, con efectos diferenciados según el sexo. Estos hallazgos subrayan la importancia de considerar las diferencias de género en la investigación neuropsicológica y de promover intervenciones personalizadas para favorecer la salud cognitiva en las poblaciones envejecidas.

Palabras clave: Adultos mayores. Envejecimiento cognitivo. Reserva cognitiva. Depresión. Diferencias de género. Satisfacción vital.

*Correspondence:

Rigoberto González-Piña

E-mail: rgonzalez@udlax.mx

Date of reception: 30-09-2025

Date of acceptance: 10-11-2025

DOI: 10.24875/AMH.M25000135

Available online: 24-03-2026

An Med ABC. 2026;71(1):5-11

www.analesmedicosabc.com

0185-3252 / © 2025 Asociación Médica del Centro Médico ABC. Published by Permanyer. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Introduction

Cognitive impairment (CI) in older adults has emerged as a significant public health concern, particularly regarding the increasing global population of individuals over the age of 60¹. This demographic shift has amplified the need for early detection and intervention strategies aimed at mitigating the impact of CI. It not only affects the quality of life of individuals but also places a substantial burden on healthcare systems² and caregivers. As the aging population grows, understanding the underlying factors that contribute to CI and identifying early markers has become a critical area of research.

The Montreal Cognitive Assessment (MoCA) is one of the most widely used tools for screening mild CI (MCI) and early stages of dementia. Developed by Nasreddine et al.³, the MoCA assesses various cognitive domains, including memory, attention, language, executive functions, and visuospatial abilities. Its broad applicability and sensitivity make it an essential tool in both clinical and research settings. Notably, several studies have demonstrated the MoCA's robust cross-cultural validity, with successful adaptations and normative data established across Latin America, East Asia, the Middle East, and other regions⁴⁻⁷. A systematic review by Cova et al.⁴ highlighted that cultural adaptations of the MoCA have preserved its psychometric strengths, although caution is advised when interpreting results in populations with low literacy or limited formal education. However, the ability of the MoCA to detect subtle cognitive changes that might be overlooked by other screening tools, such as the mini-mental state examination, has led to its widespread adoption in cognitive research and clinical practice⁸.

A key concept in understanding cognitive aging is cognitive reserve, which refers to the adaptability of cognitive processes that help to explain the differential susceptibility of cognitive abilities to brain aging, pathology, or insult⁹. Cognitive reserve is influenced by various factors, most notably education, intellectual engagement, and social activities throughout life. Stern¹⁰ proposed that individuals with higher cognitive reserve are better able to cope with the neurodegenerative changes associated with aging, thereby delaying the onset of cognitive symptoms. This protective effect of education has been supported by numerous studies, demonstrating that higher levels of education are associated with better performance on cognitive tests and a reduced risk of developing dementia¹¹⁻¹³.

In addition to cognitive reserve, other factors such as mood disorders and sleep disturbances play a critical

role in cognitive health among the elderly. Depression, a common comorbidity in older adults, has been linked to both the onset and progression of CI. Data from the U.S. NHANES 2011-2014 survey revealed a strong association between late-life depression and lower cognitive performance across multiple domains¹⁴. The Beck Depression Inventory (BDI), a tool widely used to assess the severity of depression, has been correlated with cognitive decline in various studies. In example, Geda et al.¹⁵ found that depressive symptoms are a significant risk factor for developing MCI, particularly in individuals with a genetic predisposition to Alzheimer's disease. Thus, the relationship between depression and CI underscores the importance of addressing mood disorders as part of a comprehensive approach to cognitive health.

On the other hand, sleep-related variables such as excessive daytime sleepiness have been found to be significant modulators of cognitive outcomes. In this context, Yaffe et al.¹⁶ reported that sleep-disordered breathing and the resulting intermittent hypoxia might contribute to CI, further exacerbating the risk of dementia in the elderly population. A recent study by Sakal et al.¹⁷ demonstrated that greater variability in sleep efficiency among older adults is associated with poorer performance in executive function and working memory. The interplay between sleep, mood, and cognitive function highlights the complexity of factors influencing cognitive health and the need for multifaceted intervention strategies.

Life satisfaction, while less studied, is another psychosocial variable that may influence cognitive function in older adults. Higher levels of life satisfaction have been associated with better mental health outcomes and may indirectly support cognitive resilience¹⁸. In a large-scale longitudinal study in Korea, life satisfaction was found to be positively associated with cognitive functioning, especially in women, suggesting potential gender-related modulation¹⁹. These findings emphasize the relevance of psychological well-being as a potentially protective factor in cognitive aging. However, the direct relationship between life satisfaction and cognitive function remains underexplored, and further research is needed to clarify this connection.

This pilot study aims to explore the cognitive status of older adults using the MoCA and to correlate the results with educational background, depression levels, sleepiness, and life satisfaction. By examining these relationships, the study seeks to identify potential protective factors from CI and contribute to the growing body of literature on aging and cognitive health. The findings from this study may inform future interventions

aimed at preserving cognitive function in older adults and improving their quality of life.

Materials and methods

Twenty older adult volunteers (10 women, 10 men; 60-84 years old) were invited to participate in this study. Participants were community-dwelling older adults, recruited among relatives of undergraduate students of Universidad de las Américas CDMX, with medically controlled morbidities of old age (diabetes, hypertension, arthritis, etc.), and no history of cerebrovascular disease. This pilot study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. The data presented here form part of a broader research initiative originally approved under protocol number 40/16, reviewed, and sanctioned by the Research Committee of the National Rehabilitation Institute LGII (México City). That protocol includes cognitive screening procedures in older adults aimed at detecting early signs of impairment, within which this sub-study on aging and modifiable risk factors was framed. All participants provided written informed consent before their inclusion. Although the study was carried out independently at a different academic site, the procedures adhered strictly to the approved ethical framework regarding human subject research.

One of us was trained to administer the (MoCA, v. 8.1, Spanish version validated by Delgado et al.²⁰), which was conducted on the volunteers by the same researcher. Moreover, ESS for measuring daytime sleepiness²¹, BDI for measuring depression²², and life satisfaction index (LSI)²³ were also assessed. Likewise, all volunteers were asked about their level of education as an index of cognitive reserve.

Statistics

No randomization procedures were applicable in this observational, cross-sectional pilot study. All data were entered and analyzed using Microsoft Excel for Microsoft 365, applying built-in statistical functions. Descriptive statistics were calculated for all variables, including means and standard errors of the mean. Independent sample comparisons between men and women were conducted using the Student's t-test, assuming equal variances. The threshold for statistical significance was set at $p < 0.05$.

Given the small sample size ($n = 10$ per group) and the ordinal nature or non-normal distribution of several variables, Spearman's rank-order correlation coefficient (ρ)

was used to examine the association between MoCA scores and the following independent variables: age, years of education, BDI scores, Epworth Sleepiness Scale (ESS) scores, and LSI scores. Critical t values for the significance of Spearman's ρ were calculated using the formula for small samples (degrees of freedom = $n - 2$), with results considered significant when the absolute t exceeded the critical value at $\alpha = 0.05$.

Results

A total of 20 older adults (10 women and 10 men), aged 60 to 84 years, completed the full assessment battery. No participants were excluded or lost to follow-up. Demographic characteristics and cognitive, mood, sleepiness, and life satisfaction scores by sex are summarized in [table 1](#). There were no statistically significant differences between men and women in any of the analyzed variables, including MoCA total scores ($p = 0.4211$), years of education ($p = 0.3553$), or scores on the BDI ($p = 0.4471$), ESS ($p = 0.1907$), and LSI ($p = 0.4371$), suggesting comparable baseline characteristics across groups.

Spearman's correlation analyses ([Table 2](#)) revealed a significant positive correlation between years of education and MoCA scores in both women ($r = 0.3754$; $t = 1.1455$, $p < 0.001$) and men ($r = 0.7897$; $t = 3.6419$, $p < 0.001$). Among women, life satisfaction was also positively correlated with MoCA scores ($r = 0.3934$; $t = 1.2101$, $p < 0.001$), while depressive symptoms showed a negative correlation ($r = -0.4174$; $t = -1.2992$, $p < 0.001$). In men, these correlations were not statistically significant, and other variables, such as age and daytime sleepiness, showed weak or inconsistent associations with cognitive performance.

Analysis of cognitive domain performance ([Table 3](#)) showed that 5 women and 8 men scored below the MoCA cutoff ($< 26/30$), with the most frequently impaired domain being delayed recall, which affected 8 women and all 10 men. Errors in executive and visuospatial tasks (e.g., cube copying, clock drawing) were also observed, more commonly in women. These domain-specific deficits reflect early signs of cognitive decline and show distinct sex-related patterns.

Discussion

The results of our pilot study suggest that cognitive function, as measured by the MoCA, is influenced by factors such as years of education, depression, daytime sleepiness, and life satisfaction in older adults. These findings align with previous research indicating

Table 1. Ages, years of education, sleepiness, depression, life satisfaction, and cognitive scores in volunteer older adults

Applied assessment	Gender	n	Mean $\pm$ S.E.M.	Student's t (p)
Age (years)	Female	10	70 $\pm$ 2.49	0.5000
	Male	10	70 $\pm$ 2.74	
Education (years)	Female	10	15.20 $\pm$ 7.97	0.3553
	Male	10	16.20 $\pm$ 1.78	
ESS (Scale 0-24; 0 = no disorder)	Female	10	6.60 $\pm$ 1.59	0.1907
	Male	10	5.00 $\pm$ 0.76	
BDI (63 = severe depression)	Female	10	9.10 $\pm$ 2.42	0.4471
	Male	10	8.70 $\pm$ 1.70	
LSI (40 = very satisfied)	Female	10	35.20 $\pm$ 2.38	0.4371
	Male	10	31.70 $\pm$ 2.01	
MoCA (normal $\geq$ 26/30)	Female	10	24 $\pm$ 1.70	0.4211
	Male	10	23.60 $\pm$ 1.00	

BDI: Beck's depression inventory; ESS: Epworth sleepiness scale; LSI: Life satisfaction index; MoCA: Montreal cognitive assessment; S.E.M.: Standard error of the mean.

Table 2. Spearman's correlation (r) and absolute t-test values for Spearman's significance obtained for age, education, ESS, Beck, and LSI, versus MoCA score

Assessment	Gender	Spearman (r)	Absolute t value	p
Age	Female	-0.0961	-0.2731	> 0.05
	Male	-0.0270	-0.0765	> 0.05
Education	Female	0.3754*	1.1455	< 0.001
	Male	0.7897*	3.6419	< 0.001
ESS	Female	0.2012	0.5810	> 0.05
	Male	0.2823	0.8322	> 0.05
BDI	Female	-0.4174*	-1.2992	< 0.001
	Male	0.1532	0.4383	> 0.05
LSI	Female	0.3934*	1.2101	< 0.001
	Male	-0.2342	-0.6815	> 0.05

Critical t value (p = 0.05, DF = 8) = 0.9613. Absolute t value > Critical t value = significant correlation.

* Statistically significant correlation.

BDI: Beck's depression inventory; ESS: Epworth sleepiness scale; LSI: Life satisfaction index.

Table 3. Failure frequency throughout the cognitive domains assessed by MoCA

MoCA's sections	Females	Males
MoCA score < 26/30	5	8
Visuospatial/executive		
Partial TMT	2	0
Copy cube	7	4
Draw clock	3	2
Naming	1	2
Memory (no points)		
Memory attempt 1	7	10
Memory attempt 2	2	2
Attention		
Numbers	6	4
Letters	1	0
Subtraction	4	0
Language		
Phrase's repetition	6	6
Fluency	1	1
Abstraction	2	3
Delayed recall	8	10
Orientation	1	6

TMT: Trail making test; MoCA: Montreal Cognitive Assessment.

the complex interplay between cognitive reserve, mental health, and overall well-being in aging populations.

Our findings highlight a positive and significant correlation between years of education and MoCA scores in both men and women. This suggests that higher educational attainment enhances the brain's ability to compensate for age-related CI, consistent with the theory of cognitive reserve¹⁰. A growing body of literature supports the protective role of education, including recent cross-cultural research affirming that MoCA maintains validity across diverse educational backgrounds when appropriately adapted^{4,5}, even in the presence of neuropathological changes²⁴. For instance, a meta-analysis by Meng and D'Arcy¹³ concluded that each additional year of education is associated with a reduced risk of CI, further reinforcing the protective role of cognitive reserve.

These findings reinforce the importance of considering education as both a cognitive and sociodemographic buffer in aging.

The negative correlation observed between BDI scores versus MoCA scores, particularly among women, supports literature indicating that depressive symptoms are a significant risk factor for cognitive

decline in older adults²⁵. Wei et al.¹⁴ found that late-life depression is strongly associated with reduced cognitive performance across various domains, independent of comorbidities or sociodemographic factors. This relationship may be partially explained by neurobiological changes related to depression, such as hippocampal atrophy and reduced synaptic plasticity²⁶, which impair memory and executive functioning domains, particularly sensitive to both aging and mood disorders. Moreover, prolonged depressive episodes may exacerbate cognitive deterioration by inducing neuroinflammation and increasing cortisol levels, which negatively affect brain plasticity²⁷.

In contrast, the weak positive non-significant correlation observed between daytime sleepiness and cognitive performance may appear counterintuitive, as excessive sleepiness is generally linked to cognitive decline^{16,28}. However, Sakal et al.¹⁷ reported that not only the quantity of sleep but also the variability in sleep efficiency is associated with executive dysfunction, suggesting that more nuanced sleep parameters may explain these seemingly paradoxical findings. It is possible that participants with subtle cognitive complaints become more aware of their sleep patterns and report them more accurately, reflecting early compensatory mechanisms. However, gender differences in sleep patterns and their impact on cognition should be deeper studied, regarding that a variability between men and women is expected²⁹. However, although this correlation was weak and non-significant, it may reflect complex compensatory behaviors or biases in self-reported sleepiness. Further investigation is needed before drawing any conclusions.

Although previous studies have suggested that life satisfaction is not associated with many specific health conditions, such as CI³⁰, we found a significant positive correlation with MoCA scores among women and a non-significant negative correlation among men. These sex-related patterns echo those reported by Lee et al.²⁹, who found that higher life satisfaction was associated with better cognitive functioning, particularly among older women. This may reflect differences in coping strategies, emotional regulation, or social engagement by gender. On the other hand, it has been discussed that lifestyle-based (i.e., dancing and yoga) and cognitive interventions (i.e., memory training) increase cognitive functions or/and life satisfaction in adults³¹. Although the relationship between life satisfaction and cognitive health remains underexplored, accumulating evidence suggests that psychological well-being may buffer against age-related decline and foster resilience.

Although overall MoCA scores did not show statistically significant differences between men and women, a closer examination of performance across cognitive domains revealed distinct patterns of vulnerability. As detailed in [table 3](#), delayed recall emerged as the most frequently impaired domain, affecting 8 out of 10 women and all 10 men. Executive functioning tasks, particularly those involving visuoconstructional skills such as cube copying and clock drawing, also showed a high error rate, with women exhibiting greater difficulty in these tasks, while men demonstrated more consistent deficits in memory recall. These findings align with existing literature indicating that impairments in delayed recall and executive functioning are among the earliest and most sensitive markers of cognitive decline associated with aging³². Furthermore, the predominance of memory-related deficits in men echoes prior studies suggesting sex-related differences in cognitive aging trajectories, especially in memory performance and vulnerability³³.

The correlation analyses and domain-level results suggest that cognitive aging may be modulated by gender-specific factors, despite the absence of significant differences in global cognitive scores. This reinforces the importance of conducting disaggregated analyses in neuropsychological research to detect subtle, yet meaningful, patterns that might otherwise remain obscured in aggregated data. Such findings support the development of tailored strategies aimed at addressing sex-based cognitive vulnerabilities and promoting cognitive health through more individualized interventions³⁴.

From a comprehensive point of view, these preliminary observations highlight the relevance of multidimensional and personalized approaches for early detection and support of cognitive function in older adults. This is especially pertinent in settings where psychosocial and educational factors may serve as protective mechanisms against age-related decline, underscoring the importance of integrating both biological and contextual variables in cognitive aging research and care models.

Limitations

As a pilot study with only 20 participants, we recognize that the results are exploratory in nature. The limited sample size and wide age variability reduce the statistical power and generalizability of our conclusions. Nonetheless, the observed patterns are consistent with emerging evidence from larger populations

and may serve as a foundation for more comprehensive longitudinal investigations.

This study has notable limitations. The small, non-random sample reduces generalizability, and the wide age range introduces variability that may obscure specific patterns. Although the MoCA is widely used, the lack of a version standardized for Mexican populations may limit cultural validity. Finally, the cross-sectional design prevents causal inferences.

Despite these limitations, this pilot study offers relevant preliminary evidence on how education, mood, sleep, and life satisfaction relate to cognitive aging. It highlights gender-specific associations and supports a multidimensional perspective in neuropsychological research. Small-scale, context-sensitive studies like this are essential for advancing geriatric cognitive science globally and guiding future, larger investigations.

Conclusion

Our pilot study reinforces the significance of cognitive reserve, mental health, and life satisfaction in maintaining cognitive function in older adults. The gender-specific differences observed in our results warrant further exploration in larger, more diverse cohorts to better understand the complex relationships between these variables and cognitive health. Future research should also consider longitudinal designs to assess the causality of these relationships over time.

Acknowledgments

The authors would like to thank Professors M.C. Rodríguez-Ochoa and M.F. Domínguez-Sánchez for their valuable review and insightful comments on the manuscript draft, as well as all the volunteers for their generous participation and commitment to the study.

Funding

The authors declare that they have not received funding.

Conflicts of interest

The authors declare no conflicts of interest.

Ethical considerations

Protection of human subjects and animals. The authors declare that the procedures followed were

in accordance with the ethical standards of the responsible committee on human experimentation and with the World Medical Association and the Declaration of Helsinki. The procedures were authorized by the Institutional Ethics Committee.

Confidentiality, informed consent, and ethical approval. This research was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. The protocol was reviewed and sanctioned by the Research Committee of the National Rehabilitation Institute LGII (40/16).

Declaration on the use of artificial intelligence. The authors declare that no generative artificial intelligence was used in the writing or creation of the content of this manuscript.

References

1. Bloom DE, Luca DL. The global demography of aging: facts, explanations, future. *Handb Econ Popul Aging*. 2016;1:3-56.
2. Loprete M, Misuraca M, Puliga M. An analysis of the thematic evolution of ageing and healthcare expenditure using word embedding: a scoping review of policy implications. *Socio Econ Plann Sci*. 2023;87:101600.
3. Nasreddine ZS, Phillips NA, Bédrian V, Charbonneau S, Whitehead V, Collin I, et al. The Montreal cognitive assessment, MoCA: a brief screening tool for mild cognitive impairment. *J Am Geriatr Soc*. 2005;53:695-9.
4. Cova I, Nicotra A, Maestri G, Canevelli M, Pantoni L, Pomati S. Translations and cultural adaptations of the Montreal Cognitive Assessment: a systematic and qualitative review. *Neurol Sci*. 2022;43:113-24.
5. Loureiro C, García C, Adana L, Yacelga T, Rodríguez-Lorenzana A, Maruta C. Use of the montreal cognitive assessment (MoCA) in Latin America: a systematic review. *Rev Neurol*. 2018;66:397-408.
6. Yu J, Li J, Huang X. The Beijing version of the Montreal Cognitive Assessment as a brief screening tool for mild cognitive impairment: a community-based study. *BMC Psychiatry*. 2012;12:156.
7. Fujiwara Y, Suzuki H, Kawai H, Hirano H, Yoshida H, Kojima M, et al. Physical and sociopsychological characteristics of older community residents with mild cognitive impairment as assessed by the Japanese version of the Montreal Cognitive Assessment. *J Geriatr Psychiatry Neurol*. 2013;26:209-20.
8. Freitas S, Simões MR, Alves L, Santana I. Montreal cognitive assessment: validation study for mild cognitive impairment and Alzheimer disease. *Alzheimer Dis Assoc Disord*. 2013;27:37-43.
9. Coors A, Lee S, Gazes Y, Gacheru M, Habeck C, Stern Y. Brain reserve affects the expression of cognitive reserve networks. *Hum Brain Mapp*. 2024;45:e26658.
10. Stern Y. Cognitive reserve in ageing and Alzheimer's disease. *Lancet Neurol*. 2012;11:1006-12.
11. Scarmeas N, Stern Y. Cognitive reserve and lifestyle. *J Clin Exp Neuropsychol*. 2003;25:625-33.
12. Ngandu T, von Strauss E, Helkala EL, Winblad B, Nissinen A, Tuomilehto J, et al. Education and dementia: what lies behind the association? *Neurology*. 2007;69:1442-50.
13. Meng X, D'Arcy C. Education and dementia in the context of the cognitive reserve hypothesis: a systematic review with meta-analyses and qualitative analyses. *PLoS One*. 2012;7:e38268.
14. Wei J, Ying M, Xie L, Chandrasekar EK, Lu H, Wang T, et al. Late-life depression and cognitive function among older adults in the U.S.: the National Health and Nutrition Examination Survey, 2011-2014. *J Psychiatr Res*. 2019;111:30-5.
15. Geda YE, Knopman DS, Mrazek DA, Jicha GA, Smith GE, Negash S, et al. Depression, apolipoprotein E genotype, and the incidence of mild cognitive impairment: a prospective cohort study. *Arch Neurol*. 2006;63:435-40.
16. Yaffe K, Laffan AM, Harrison SL, Redline S, Spira AP, Ensrud KE, et al. Sleep-disordered breathing, hypoxia, and risk of mild cognitive impairment and dementia in older women. *JAMA*. 2011;306:613-9.
17. Sakal C, Li T, Li J, Yang C, Li X. Association between sleep efficiency variability and cognition among older adults: cross-sectional accelerometer study. *JMIR Aging*. 2024;7:e54353.
18. Puvill T, Lindenberg J, de Craen AJ, Slaets JP, Westendorp RG. Impact of physical and mental health on life satisfaction in old age: a population-based observational study. *BMC Geriatr*. 2016;16:194.

19. Song I, Kim DS. Cognitive impairment and domain-specific life satisfaction among older adults: findings from the Korean Longitudinal Study of Aging. *Geriatr Gerontol Int.* 2025;25:182-9.
20. Delgado C, Araneda A, Behrens MI. Validation of the Spanish-language version of the Montreal Cognitive Assessment test in adults older than 60 years. *Neurología.* 2019;34:376-85.
21. Johns MW. A new method for measuring daytime sleepiness: the Epworth sleepiness scale. *Sleep.* 1991;14:540-5.
22. Beck AT, Ward CH, Mendelson M, Mock JE, Erbaugh JK. An inventory for measuring depression. *Arch Gen Psychiatry.* 1961;4:561-71.
23. Newton T, Butler NM, Dawson I. Engagement levels of a unit of people with a physical disability. *Clin Rehabil.* 1989;3:299-304.
24. Valenzuela MJ, Sachdev P. Brain reserve and cognitive decline: a non-parametric systematic review. *Psychol Med.* 2006;36:1065-73.
25. Ownby RL, Crocco E, Acevedo A, John V, Loewenstein D. Depression and risk for Alzheimer's disease: systematic review, meta-analysis, and meta-regression analysis. *Arch Gen Psychiatry.* 2006;63:530-8.
26. Sexton CE, Mackay CE, Ebmeier KP. A systematic review and meta-analysis of magnetic resonance imaging studies in late-life depression. *Am J Geriatr Psychiatry.* 2013;21:184-95.
27. Butters MA, Young JB, Lopez O, Aizenstein HJ, Mulsant BH, Reynolds CF 3rd, et al. Pathways linking late-life depression to persistent cognitive impairment and dementia. *Dialogues Clin Neurosci.* 2008;10:345-57.
28. Yaffe K, Blackwell T, Barnes DE, Ancoli-Israel S, Stone KL. Preclinical cognitive decline and subsequent sleep disturbance in older women. *Neurology.* 2007;69:237-42.
29. Lee S, Nelson ME, Hamada F, Wallace ML, Andel R, Buxton OM, et al. Sleep disorders and cognitive aging among cognitively impaired versus unimpaired older adults. *Gerontologist.* 2024;64:gnad152.
30. Kim ES, Delaney SW, Tay L, Chen Y, Diener ED, Vanderweele TJ. Life satisfaction and subsequent physical, behavioral, and psychosocial health in older adults. *Milbank Q.* 2021;99:209-39.
31. Zainal NH, Newman MG. Life satisfaction prevents decline in working memory, spatial cognition, and processing speed: latent change score analyses across 23 years. *Eur Psychiatry.* 2022;65:e-27.
32. Weintraub S, Wicklund AH, Salmon DP. The neuropsychological profile of Alzheimer disease. *Cold Spring Harb Perspect Med.* 2012;2:a006171.
33. Jack CR Jr., Wiste HJ, Weigand SD, Knopman DS, Vemuri P, Mielke MM, et al. Age, sex, and APOE ε4 effects on memory, brain structure, and β-amyloid across the adult life span. *JAMA Neurol.* 2015;72:511-9.
34. Gur RE, Gur RC. Gender differences in aging: cognition, emotions, and neuroimaging studies. *Dialogues Clin Neurosci.* 2002;4:197-210.