




ORIGINAL RESEARCH

Correlation between appendicular skeletal muscle mass and quality of life and psychological well-being in non-institutionalized older adults in Chile

Correlación entre masa muscular apendicular esquelética y calidad de vida y bienestar psicológico en personas mayores no institucionalizadas en Chile

Mauricio Lorca-Navarro¹  Esperanza Araya-Orellana²  Hernán Valenzuela-Soto³ 

¹ Universidad Austral de Chile - Faculty of Medicine - Institute of Movement and Human Occupation Sciences - Valdivia - Chile.

² Universidad San Sebastián - Faculty of Rehabilitation Sciences and Quality of Life - School of Kinesiology - Valdivia - Chile.

³ Universidad Metropolitana de Ciencias de la Educación - Faculty of Arts and Physical Education - Department of Kinesiology - Santiago - Chile.



Open access

Received: 09/09/2024

Accepted: 08/07/2025

Corresponding author: Esperanza Araya-Orellana. Escuela de Kinesiología, Facultad de Ciencias de la Rehabilitación y Calidad de Vida, Universidad San Sebastián. Valdivia, Chile. E-mail: esperanzaaraya@gmail.com.

Keywords: Aged; Skeletal Muscle; Quality of Life; Psychological Well-being (MeSH).

Palabras clave: Persona Mayor; Músculo Esquelético; Calidad de Vida; Bienestar Psicológico (DeCS).

How to cite: Lorca-Navarro M, Araya-Orellana E, Valenzuela-Soto H. Correlation between skeletal muscle mass and quality of life and psychological well-being in non-institutionalized older adults in Chile. Rev. Fac. Med. 2025;73:e116536. English. doi: <https://doi.org/10.15446/revfacmed.v73.116536>.

Cómo citar: Lorca-Navarro M, Araya-Orellana E, Valenzuela-Soto H. [Correlación entre masa muscular apendicular esquelética y calidad de vida y bienestar psicológico en personas mayores no institucionalizadas en Chile]. Rev. Fac. Med. 2025;73:e116536. English. doi: <https://doi.org/10.15446/revfacmed.v73.116536>.

Copyright: ©2025 The Author(s). This is an open access article distributed under the terms of the [Creative Commons Attribution 4.0 International License](https://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution, and reproduction in any medium, as long as the original author and source are credited.



Abstract

Introduction: In recent years, there has been a considerable increase in the prevalence of muscle atrophy among older adults. It has been reported that muscle loss becomes more frequent after the age of 70, constituting a serious public health problem due to its association with negative health outcomes.

Objective: To evaluate the correlation between appendicular skeletal muscle mass (ASMM), quality of life (QoL), and psychological well-being (PWB) in non-institutionalized older adults in Chile.

Materials and methods: Correlational study conducted in 59 non-institutionalized older adults (≥65 years) in Santiago, Chile. ASMM was calculated using a predictive equation published in the literature, QoL was assessed using the WHOQOL-BREF and the WHOQOL-OLD instruments, while PWB was assessed using the Ryff's Scales of Psychological Wellbeing. Spearman's correlation coefficient was employed to measure the correlation between ASMM and QoL and PWB in the entire sample, as well as in males and females.

Results: The mean age and mean ASMM were 75.68 years and 15.27 kg, and 77.97% of participants were female. The mean scores on the WHOQOL-BREF, WHOQOL-OLD, and Ryff's Scales of Psychological Wellbeing were 58.80, 65.54, and 105.68, respectively. In the case of QoL, ASMM was negatively correlated with the "Quality of Life" domain of the WHOQOL-BREF ($r=-0.37$; $p=0.040$); the other correlations were not significant. Regarding PWB, significant correlations were found with the overall score and the domains "Positive relationships," "Autonomy," "Environmental mastery," and "Personal growth," all of which were negative ($r=-0.37$, $p=0.004$; $r=-0.56$, $p=0.000$; $r=-0.38$, $p=0.003$; $r=-0.33$, $p=0.012$; $r=-0.29$, $p=0.024$). Moreover, in the stratified analysis by sex, different correlations were observed in the three instruments, mainly in the WHOQOL-OLD and the Ryff's Scales of Psychological Wellbeing.

Conclusions: ASMM was negatively correlated with the "Quality of Life" domain of the WHOQOL-BREF, as well as with the overall score on the Ryff's Scales of Psychological Wellbeing and with four of its domains. There were no correlations with the WHOQOL-OLD. Analysis by sex revealed different correlations.

Resumen

Introducción. En los últimos años, se ha observado un aumento considerable en la prevalencia de personas mayores. Se ha reportado que la pérdida de masa muscular es más frecuente desde la séptima década de vida, representando un serio problema de salud pública debido a su asociación con efectos negativos en la salud.

Objetivo. Evaluar la correlación entre masa muscular apendicular esquelética (MMAE), calidad de vida (CV) y bienestar psicológico (BP) en personas mayores (PM) no institucionalizadas en Chile.

Materiales y métodos. Estudio correlacional realizado en 59 PM (≥65 años) no institucionalizadas de Santiago (Chile). La MMAE se calculó mediante una ecuación predictiva publicada en la literatura, y la CV y el BP se evaluaron con los instrumentos WHOQOL-BREF y WHOQOL-OLD, y las Escalas de Bienestar Psicológico de Ryff, respectivamente. Se utilizó el coeficiente de correlación de Spearman para medir la correlación entre MMAE y CV y BP en la muestra total, así como en hombres y en mujeres.

Resultados. La edad promedio y la MMAE promedio fueron 75.68 años y 15.27kg; 77.97% de los participantes eran mujeres. Los puntajes promedio en el WHOQOL-BREF, el WHOQOL-OLD y las Escalas de Bienestar Psicológico de Ryff fueron 58.80, 65.54 y 105.68. En el caso de la CV, la MMAE se correlacionó negativamente con el dominio "Calidad de vida" del WHOQOL-BREF ($r=-0.37$; $p=0.040$); las demás correlaciones no fueron significativas. En cuanto al BP, se encontraron correlaciones significativas con la puntuación global y las dimensiones "Relaciones positivas con los otros", "Autonomía", "Dominio del entorno" y "Crecimiento personal"; todas negativas ($r=-0.37$, $p=0.004$; $r=-0.56$, $p=0.000$; $r=-0.38$, $p=0.003$; $r=-0.33$, $p=0.012$; $r=-0.29$, $p=0.024$). Además, en el análisis estratificado por sexo se observaron correlaciones diferenciadas en los 3 instrumentos, principalmente en el WHOQOL-OLD y las Escalas de Bienestar Psicológico de Ryff.

Conclusiones. La MMAE se correlacionó negativamente con la dimensión "Calidad de vida" del WHOQOL-BREF, con el puntaje global en las Escalas de Bienestar Psicológico de Ryff y con cuatro de sus dimensiones. No hubo correlaciones con el WHOQOL-OLD. El análisis por sexo reveló correlaciones diferenciadas.

Introduction

Currently, most of the world's population has a life expectancy of 60 years or more, which has resulted in an increase in both the number and proportion of older adults (OA). This demographic shift poses significant challenges for health and social care systems in all countries.¹ According to the World Health Organization (WHO), by 2050 the global population of people aged 60 and over will experience a twofold increase (1 billion in 2020 vs. 2.1 billion in 2050).¹

Although the population aging phenomenon originated in high-income countries, at present middle- and low-income countries, such as countries in Latin America and the Caribbean, are experiencing the most significant changes,¹ mainly due to the aforementioned increase in longevity and decline in fertility rates.² In fact, this demographic trend is expected to continue in the region over the coming decades, with an estimated 80% of older adults living in low- and middle-income countries by 2050.¹ It is therefore important to reduce health inequalities; improve the quality of life of this population through strategies such as providing person-centered integrated care and primary health care services that respond to the needs of older adults; and facilitate access to long-term care for older adults who need it.¹

In this context, it is essential to understand the factors that directly affect the quality of life and psychological well-being of OAs, especially those related to their physical functioning. Among these factors, muscle mass is particularly important because, due to its fundamental role in locomotion, metabolic function, force production, etc., its decrease is associated with diminished functionality, autonomy, and health, resulting in a reduced quality of life,³ especially in OAs, in whom the annual loss of muscle mass is considerably greater.^{3,4}

Multiple studies have pointed out that this situation is a public health issue because of its link to negative outcomes like decreased physical performance, loss of mobility, osteoarthritis, dementia, and death.⁵ The loss of muscle mass and strength is considered one of the main contributors to functionality decline in OAs, so much so that a decrease in both is now the primary diagnostic criterion for sarcopenia.^{6,7}

The appendicular muscle mass index (AMMI) is a measure of muscle mass in the upper and lower limbs relative to height and can be calculated using various indirect prediction models (e.g., dual-energy X-ray absorptiometry (DXA), magnetic resonance imaging (MRI), computed tomography (CT), and bioimpedanciometry) and double indirect prediction models (e.g., anthropometry).⁸ In Chile, where the prevalence of sarcopenia in OAs is 19.1%,⁹ researchers from the Instituto de Nutrición y Tecnología de los Alimentos (Institute of Nutrition and Food Technology) developed a valid, reliable, and low-cost anthropometric model for predicting ASMM in OAs, obtaining values similar to those calculated using DXA (16.8 ± 4.0 vs. 16.9 ± 3.7), making it a useful tool for detecting this condition in the country.¹⁰

Quality of life (QoL) is a broad and multidimensional concept that combines objective and subjective factors. The WHO defines it as “an individual's perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards, and concerns.”¹¹ While this definition hints at the subjective nature of QoL, other definitions acknowledge that other objective factors such as economic, social, and environmental conditions must be considered when evaluating this concept.¹¹

In the context of aging, QoL is related to aspects such as functional status, social inclusion, financial independence, and health policies that affect individual experiences.¹¹ It also integrates individual and macrosocial levels that interact dynamically and are expressed through positive and negative assessments, reflecting the attitude of OAs toward their own aging process.¹¹

The concept of QoL in OAs has been explored mainly regarding biopsychosocial factors, such as psychological well-being, social support, and health. For example, a study that assessed QoL in this population using the World Health Organization Quality of Life (WHOQOL-OLD) instrument reported that people who perceived themselves as ill had lower QoL scores than those who did not, and that self-acceptance, social support, autonomy, and having a purpose in life positively influenced the perception of QoL.¹²

Psychological well-being (PWB) is defined by Carol Ryff as the fulfillment of personal growth and the achievement of valuable goals that give meaning to life.¹³ PWB is conceptualized through a eudaimonic perspective and explained by a multidimensional model that includes six domains: self-acceptance, autonomy, environmental mastery, positive relationships with others, a feeling of purpose and meaning in life, and personal growth and development.

The perception of PWB is influenced by sociodemographic factors such as age, sex, marital status, and educational level.¹³ With aging, the life purpose and personal growth domains may decline due to losses (e.g., of interests and capabilities) and limited contextual opportunities, while autonomy and environmental mastery tend to be more stable.¹³ It has been reported that men tend to excel in the areas of autonomy, personal growth, and self-acceptance, while women show better well-being in social relationships. Married people score higher in several domains, and a higher level of education is associated with better perceived health, more self-acceptance, purpose in life, and personal growth due to access to more resources for coping with challenges and self-regulation.¹³

Ryff's Psychological Well-Being Scales are a useful tool for measuring PWB^{14,15} that has been adapted and validated in different languages, including Spanish.¹⁶

Although the relationship between muscle mass and functionality has been extensively studied, there is little evidence on its association with psychosocial aspects such as QoL and PWB, especially in non-institutionalized OAs in Latin America. This gap warrants local research that integrates physical and subjective dimensions of aging to guide more comprehensive intervention strategies. Therefore, the objective of this study was to evaluate the correlation between ASMM and QoL and PWB in non-institutionalized older adults in Chile.

Materials and methods

Study type

Cross-sectional correlational study.

Study population and sample

The study population consisted of non-institutionalized OAs (≥ 65 years) registered in the social services department of the Estación Central district of Santiago, Chile. Individuals with evident cognitive impairment were not considered eligible due to their inability to follow instructions. Convenience sampling was used to include OAs who, after agreeing

to participate in the study, accepted to have their anthropometric measurements taken and the instruments administered at their homes (n=59).

Procedures and variables

The OAs were contacted by telephone to invite them to participate in the study. After agreeing, a home visit was scheduled to take anthropometric measurements and assess QoL and PWB using the instruments described below. These procedures were performed by three duly trained evaluators after confirming that they did not suffer from any cognitive impairment. The following information was also collected: age, biological sex, marital status, educational level, and living arrangements (with relatives, partner, children, alone, or others). Each assessment lasted approximately 30 to 40 minutes.

Instruments used

In order to estimate the ASMM, the following anthropometric parameters were measured: weight (kg), knee height (cm; measured at the left knee with a height gauge and with the subject seated with the left leg flexed at 90°. The fixed part of the caliper was placed under the heel and the movable part was placed parallel to the fibula on the malleolus and behind the fibula, pressing the two blades to compress the soft tissue), calf circumference (cm), muscle strength (kg; measured using a handgrip strength test), and hip circumference (cm). The ASMM was calculated using the following predictive equation: $ASMM (kg) = 0.107(\text{weight kg}) + 0.251(\text{knee height cm}) + 0.197(\text{calf circumference cm}) + 0.047(\text{dynamometry kg}) - 0.034(\text{hip circumference cm}) + 3.417(\text{sex male}) - 0.020(\text{age years}) - 7.646$ ($R^2=0.89$).¹⁰

QoL was assessed using the validated Chilean versions of the abbreviated WHOQOL (WHOQOL-BREF)¹⁷ and WHOQOL-OLD,¹⁸ which are described below.

The Spanish version of the WHOQOL-BREF questionnaire used has 26 items covering four domains: Physical Health (7 items), Psychological Health (6 items), Social Relationships (3 items), and Environment (8 items). In addition, the first two items refer to the perception of QoL and satisfaction with health status, respectively. Each question is evaluated using a 5-point Likert scale (1-5), which provides a raw score for each item. The average score for each domain is then calculated and these values are converted into a scale between 4-20 (comparable to WHOQOL-100 scores) or between 0-100, thus obtaining scores for the four domains and for two individual items (health status and perception of quality of life), where a higher score indicates a better QoL. The overall score of the instrument is the average of the converted scores. The interpretation of the instrument depends on the scores obtained in each domain and their comparison with reference values, where a high score indicates a better QoL. More information on how to calculate the score on this instrument can be found in the official WHO documents.¹⁹

The WHOQOL-OLD is a specific module for OAs that complements the WHOQOL-100 and WHOQOL-BREF versions by including specific aspects related to the aging experience.¹⁸ The instrument comprises 24 items rated on a 5-point Likert scale, which are divided into the following six domains: Sensory abilities (4 items); Autonomy (4 items); Past, present, and future activities (4 items); Social participation (4 items); Death and dying (4 items); and Intimacy (4 items). Fang *et al.*²⁰ validated three abbreviated versions of this instrument, and the present study employs the version translated into Spanish from version 3 of Fang *et al.*²⁰ and validated in the Chilean population by Urzúa *et al.*,¹⁸

which includes six items from the WHOQOL-OLD (questions 4, 6, 17, 19, 20, and 24), one for each domain. Similar to the WHOQOL-BREF, the score obtained for each question is converted to a 0-100 scale, and the overall score is the average of the converted scores. The interpretation of the instrument depends on the scores obtained in each domain and their comparison with reference values, where a high score indicates a better QoL.

PWB was measured using the version of the Ryff's Model of Psychological Well-being validated in the Spanish population by Díaz *et al.*,¹⁶ which is a Spanish adaptation of the version proposed by Van Dierendock²¹ (6-8 items per scale for a total of 39 items). The version developed by Díaz *et al.*¹⁶ comprises 29 items (4-6 per scale) and, with the exception of the "Personal Growth" scale ($\alpha=0.68$), it has good internal consistency in the remaining scales ($\alpha=0.71-0.83$). The instrument consists of six scales: Self-acceptance (four items), Positive relationships with others (five items), Autonomy (six items), Environmental mastery (five items), Purpose in life (five items), and Personal growth (four items).¹⁶ Each item is answered using a 6-point Likert scale, where 1 means strongly disagree and 6 means strongly agree. The score for each scale is the sum of the scores obtained in the respective items, and the overall score of the instrument (Ryff total) is the sum of the scores obtained in the six scales. The higher the score, the better the PWB.

Both the invitation to participate in the study and data collection took place between October 2019 and March 2020.

Statistical analysis

Data are described using absolute and relative frequencies for qualitative variables and means and standard deviations for quantitative variables depending on the data distribution (Shapiro-Wilk test). The two-sample Wilcoxon rank-sum test was used to compare the means of the variables between different sexes. In addition, Spearman's correlation coefficient was used to measure the relationships between ASMM (dependent variable) and the scores obtained in our instruments (by domain and overall). Data analysis was performed using the STATA® 15.1 program, and a statistical significance level of $p<0.05$ was considered.

Ethical considerations

This study followed the ethical principles for biomedical research involving human subjects established in the Declaration of Helsinki.²² It was also approved by the Scientific Ethics Committee of the Servicio de Salud Metropolitano Oriente (Eastern Metropolitan Health Service) of the Chilean Ministry of Health by means of a resolution issued on August 4, 2020.

Results

Most participants were female (77.97%; $n=46$) and 42.37% ($n=25$) were married. The most common educational levels were incomplete and complete secondary education (each $n=17$; 28.81%), while the most common type of living arrangement was with children ($n=20$; 33.90%) (Table 1).

Table 1. Sociodemographic characteristics of the participants (n=59).

	Variable	n (%)
Sex	Male	13 (22.03)
	Female	46 (77.97)
Marital status	Single	7 (11.87)
	Married	25 (42.37)
	Separated	3 (5.09)
	Divorced	1 (1.69)
	Widowed	23 (38.98)
Educational level	Incomplete primary education	6 (10.17)
	Complete primary education	16 (27.12)
	Incomplete secondary education	17 (28.81)
	Complete secondary education	17 (28.81)
	Incomplete university education	3 (5.08)
Living arrangement	Alone	8 (13.56)
	With partner	16 (27.12)
	With children	20 (33.90)
	With relatives	14 (23.73)
	Other	1 (1.69)

The mean values for age, ASMM, weight, knee height, calf circumference, hip circumference, and grip strength were 75.68 ± 7.49 years, 15.27 ± 3.77 kg, 69.63 ± 11.42 kg, 46.02 ± 5.13 cm, 37.36 ± 3.64 cm, 108.67 ± 15.74 cm, and 19.44 ± 5.51 , respectively. Statistically significant differences between males and females were observed in all these variables, except for age (Figure 1, Table 2).

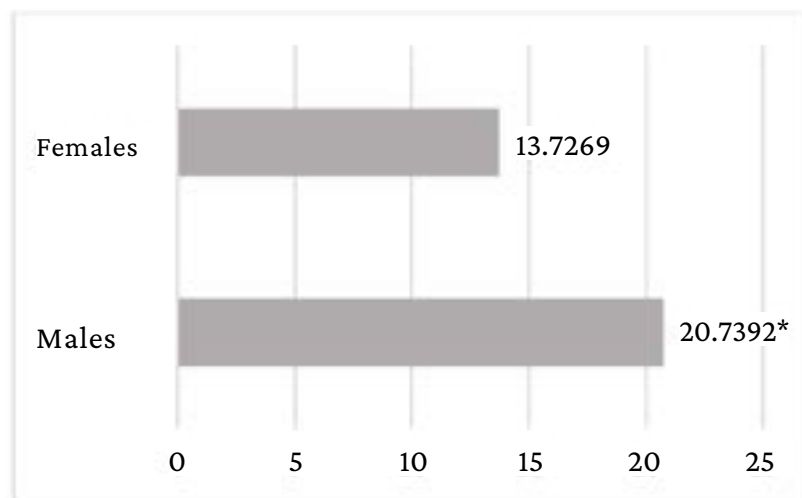


Figure 1. Appendicular skeletal muscle mass by sex.

* $p < 0.05$

Table 2. Anthropometric measurements, grip strength, and age.

Variable	Total (n=59)	Female (n=46)	Male (n=13)	p-value
Weight	69.63±11.42	67.05±10.62	78.31±10.03	0.001
Knee height	46.02±5.13	45.13±5.32	49.15±2.79	0.002
Calf circumference	37.36±3.64	36.42±3.37	40.66±2.50	0.001
Hip circumference	108.67±15.74	106.63±16.14	115.86±12.21	0.003
Grip strength	19.44±5.51	18.00±5.175.17	24.53±3.28	0.000
Age	75.68±7.49	76.26±7.67	73.62±6.62	0.257
Appendicular skeletal muscle mass	15.27±3.77	13.73±2.32	20.74±2.64	0.002

The mean score on the WHOQOL-BREF was 58.80±11.21, and “Psychological health” was the domain with the highest mean score (59.82±10.49). No statistically significant differences were found between males and females in any of the domains or in the overall score (Table 3).

Regarding the WHOQOL-OLD, the mean score was 65.54±12.11, and “Intimacy” was the domain with the highest mean score (69.92±21.16). There were no statistically significant differences between males and females in the overall score, but a statistically significant difference was observed in the score for the “Death and dying” domain (82.69±15.76 vs. 65.76±26.01; $p=0.025$) (Table 3).

With regard to PWB, the overall mean score was 105.68±20.91 (females: 106.91±22.43 vs. males: 101.31±14.15). The only domain in which a statistically significant difference in scores between males and females was observed was “Positive relationships with others” (13.00±2.27 vs. 15.93±4.41; $p=0.016$) (Table 3).

Table 3. Perception of quality of life and psychological well-being in non-institutionalized older adults in Chile.

Variable		Total (n=59)	Females (n=46)	Males (n=13)	p-value
WHOQOL-BREF (mean±SD)	Quality of life	56.36±20.55	57.61±22.28	51.92±12.34	0.424
	Satisfaction with health status	55.08±19.02	54.35±19.93	57.69±15.76	0.672
	Physical health	58.84±11.38	58.31±11.88	60.71±9.56	0.672
	Psychological health	59.82±10.49	59.51±10.85	60.90±9.40	0.934
	Social relationships	56.50±16.31	56.70±17.00	55.77±14.18	0.565
	Environment	59.64±14.74	58.70±14.45	62.98±15.88	0.401
	Overall score	58.80±11.21	58.34±11.50	60.43±10.40	0.781
WHOQOL-OLD (mean±SD)	Autonomy	69.49±16.13	68.93±16.38	75.00±14.43	0.162
	Death and dying	69.49±25.03	65.76±26.01	82.69±15.76	0.025
	Social participation	63.46±21.93	60.87±22.14	63.46±21.93	0.801
	Past, present, and future activities	66.10±17.22	65.76±17.376	67.31±15.376	0.894
	Sensory abilities	56.78±16.63	57.61±18.16	53.85±9.39	0.464
	Intimacy	69.92±21.16	69.02±23.09	73.08±12.34	0.648
	Overall score	65.54±12.11	64.50±12.54	69.23±10.00	0.256
Ryff's Model of Psychological Well-being (mean±SD)	Self-acceptance	17.51±4.11	17.28±4.25	18.31±3.59	0.455
	Positive relationships with others	15.29±4.21	15.93±4.41	13.00±2.27	0.016
	Autonomy	17.97±4.38	18.43±4.76	16.31±2.02	0.070
	Environmental mastery	17.39±3.77	17.72±4.15	16.23±1.59	0.761
	Personal growth	16.1±3.45	16.07±3.64	16.23±2.80	0.831
	Purpose in life	21.44±5.39	21.50±5.68	21.23±4.40	0.963
	Ryff total	105.68±20.91	106.91±22.43	101.31±14.15	0.493

Concerning the relationship between ASMM and the perception of QoL assessed with the WHOQOL-BREF (Table 4 and Figure 2), the following was found: i) for the entire sample, there was a negative correlation with the overall score ($r=-0.07$) and with the score for each domain ($r=-0.08$ to -0.37), being the correlation with the score obtained in the “Quality of life” domain statistically significant ($r=-0.37$; $p=0.040$); ii) in females, there was a negative correlation with the overall score ($r=-0.32$) and with the scores for the 5 domains ($r=-0.17$ a -0.42); iii) in females, there was a statistically significant correlation with the scores obtained in the domains “Quality of life” ($r=-0.42$; $p=0.00$), “Social relationships” ($r=0.37$; $p=0.012$), and “Environment” ($r=0.44$; $p=0.020$); iv) in males, there was a positive correlation with overall score ($r=0.57$), which was statistically significant ($p=0.037$); and v) in males, there was a positive correlation with scores in four domains ($r=0.43$ to 0.55), being statistically significant in the “Physical health” domain ($r=0.55$; $p=0.040$).

With respect to the relationship between ASMM and the perception of QoL assessed with the WHOQOL-OLD (Table 4 and Figure 2), the following was evidenced: i) the correlations with the overall WHOQOL-OLD score and with the scores of the 6 domains were not statistically significant for the sample; ii) in females, the correlation with the overall score was negative but not statistically significant ($r=-0.23$; $p=0.130$); iii) in females, the correlation was negative with 5 domains ($r=-0.10$ to -0.36), being statistically significant in the domain “Social participation” ($r=-0.36$; $p=0.015$); iv) in males, a positive and statistically significant correlation was observed with the overall score ($r=0.62$; $p=0.031$); and v) in males, the correlation was positive in 5 domains ($r=0.21$ to 0.65), being statistically significant in the domains “Sensory abilities” ($r=0.63$; $p=0.022$) and “Intimacy” ($r=0.65$; $p=0.017$).

Importantly, a negative correlation between ASMM and QoL means that a higher ASMM is associated with a lower perception of QoL, while a positive correlation means the opposite (a lower ASMM is associated with a higher perception of QoL).

As for the relationship between ASMM and PWB (Table 4 and Figure 3), the following was found: i) the correlation with the overall score was negative and statistically significant in both the sample ($r=-0.37$; $p=0.004$) and in females ($r=-0.46$; $p=0.001$), whereas it was positive ($r=0.08$) but not significant in males; ii) in the sample, the correlation was negative with the score obtained on the 6 scales ($r=-0.20$ to -0.56), being statistically significant in “Positive relationships with others” ($r=-0.56$, $p=0.00$), “Autonomy” ($r=-0.38$, $p=0.003$), “Environmental mastery” ($r=-0.33$, $p=0.012$), and “Personal growth” ($r=-0.29$, $p=0.024$); iii) in females, the correlation was negative and statistically significant on all scales ($r=-0.32$ to -0.51 ; $p<0.005$); and iv) in males, the correlation was positive with the overall score ($r=0.08$) and with the scores of 4 domains ($r=0.05$ to 0.35), but no correlation (positive or negative) was statistically significant.

Similar to QoL, a negative correlation between ASMM and PWB means that a higher ASMM is associated with a lower perception of PWB, while a positive correlation represents the opposite.

Table 4. Correlation between appendicular skeletal muscle mass, quality of life, and psychological well-being by sex and dimensions.

Variable		Total (n=59)		Females (n=46)		Males (n=13)	
		r	p-value	r	p-value	R	p-value
WHOQoL-BREF	Quality of life	-0.37	0.040	-0.42	0.003	-0.44	0.130
	Satisfaction with health status	-0.11	0.403	-0.22	0.150	-0.20	0.510
	Physical health	-0.10	0.474	-0.27	0.072	0.55	0.040
	Psychological health	-0.08	0.554	-0.17	0.250	0.43	0.148
	Social relationships	-0.26	0.050	0.37	0.012	0.48	0.094
	Environment	-0.10	0.436	-0.34	0.020	0.55	0.052
	WHOQOL-BREF total	-0.07	0.611	-0.32	0.280	0.57	0.037
WHOQoL-OLD	Autonomy	0.02	0.907	-0.21	0.163	0.22	0.465
	Death and dying	0.16	0.217	0.04	0.8091	-0.16	0.600
	Social participation	-0.19	0.155	-0.36	0.015	0.21	0.500
	Past, present, and future activities	-0.07	0.582	-0.19	0.218	0.46	0.116
	Sensory abilities	-0.23	0.085	-0.28	0.057	0.63	0.022
	Intimacy	0.00	0.491	-0.10	0.523	0.65	0.017
	WHOQOL-OLD total	0.09	0.500	-0.23	0.130	0.62	0.031
Ryff's Model of Psychological Well-being	Self-acceptance	-0.20	0.127	-0.45	0.002	0.35	0.227
	Positive relationships with others	-0.56	0.000	-0.51	0.000	-0.15	0.516
	Autonomy	-0.38	0.003	-0.32	0.031	-0.19	0.541
	Environmental mastery	-0.33	0.012	-0.47	0.001	0.05	0.741
	Personal growth	-0.29	0.024	-0.49	0.001	0.12	0.5768
	Purpose in life	-0.25	0.062	-0.36	0.014	0.09	0.726
	Ryff total	-0.37	0.004	-0.46	0.001	0.08	0.714

r: Spearman's correlation coefficient.

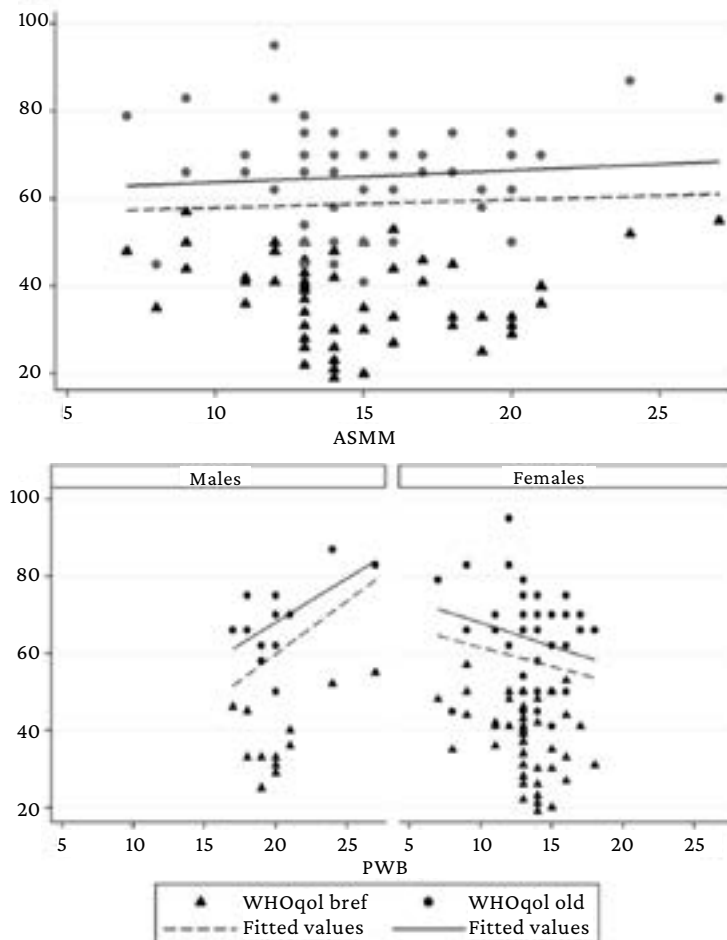


Figure 2. Correlation between appendicular skeletal muscle mass and overall quality of life by sex. ASMM: appendicular skeletal muscle mass; PWB: psychological well-being.

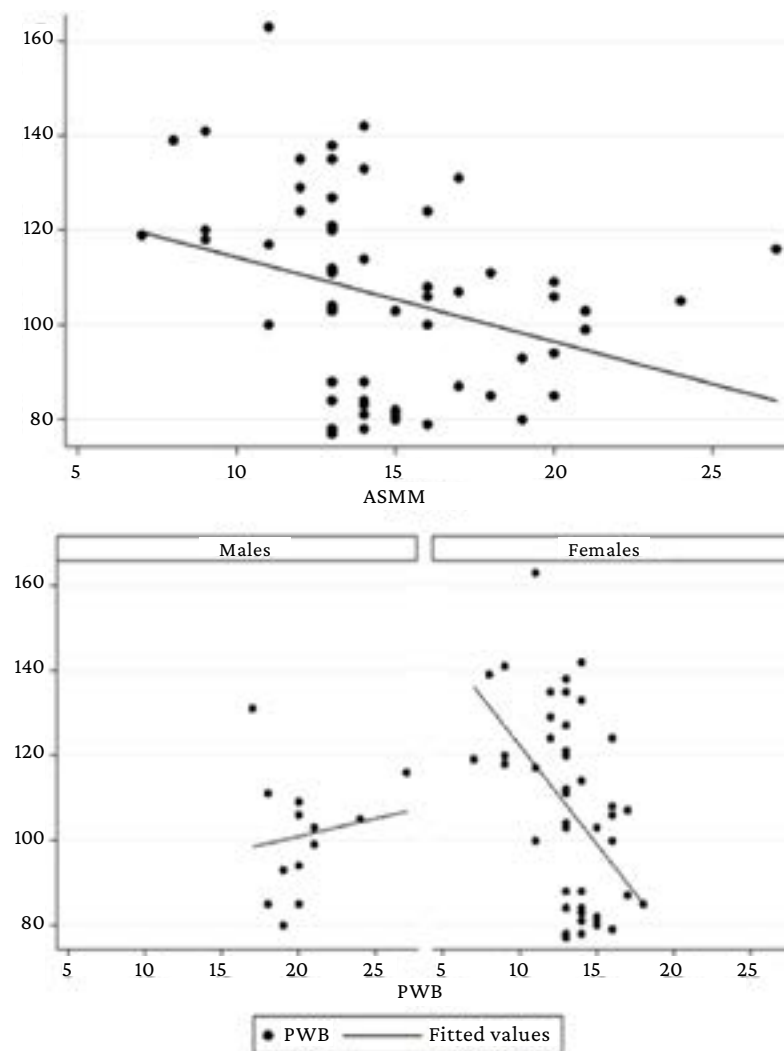


Figure 3. Correlation between appendicular skeletal muscle mass and overall psychological well-being by sex. ASMM: appendicular skeletal muscle mass; PWB: psychological well-being.

Discussion

This study evaluated the correlation between ASMM and QoL and PWB in non-institutionalized OAs in Chile.

One of the noteworthy findings is the predominance of females in the sample ($n=46$; 77.97%), which is consistent with national and international population data.^{23,24} In Chile, for example, the estimated female-to-male ratio in 2020 was 134.4 women for every 100 men in the population aged 60 and over.²³

Regarding QoL perception, the mean scores on the WHOQOL-BREF and WHOQOL-OLD instruments were 58.80 ± 11.21 and 65.54 ± 12.11 , respectively. Furthermore, although no statistically significant differences were observed between sexes in overall scores or in most domains, there was a significant difference in the “Death and dying” domain of the WHOQOL-OLD ($p=0.025$), with higher scores in males (82.69 ± 15.76 vs. 65.76 ± 26.01).

The scores obtained in this study differ from those reported by other studies. For example, in Peru, Hernandez-Huayta *et al.*,²⁵ in a study conducted on 447 older adults

(207 from rural areas and 240 from urban areas), lower scores were reported in all domains on both instruments, for both urban and rural populations (57.42 and 52.65 on the WHOQOL-BREF and 61.3 and 59.3 on the WHOQOL-OLD). In contrast, in Germany, Hussenöder *et al.*,²⁶ in a study of 805 individuals over the age of 60, reported higher mean values on both instruments (69.65 on the WHOQOL-BREF and 68.41 on the WHOQOL-OLD). It should be noted that, although the WHOQOL-BREF version used by Hussenöder *et al.*²⁶ also has 26 items, unlike the instrument used in our study, QoL is assessed in 5 domains and not 4: physical health, psychology, social relationships, environment, and overall quality of life. The heterogeneity in QoL levels observed across studies could be explained by social and economic differences between countries, as Germany is a high-income country and, although Chile and Peru are considered middle-income countries, the former has better social and economic indicators.²⁷

With regard to differences between sexes, our results are in line with the findings reported by Santos *et al.*,²⁸ who, in a study conducted in Brazil with 100 OAs, also found no significant differences between males and females in the WHOQOL-BREF and WHOQOL-OLD scores (11.21 vs. 11.32 and 11.63 vs. 11.63, respectively). In turn, Pacheco *et al.*,²⁹ evaluated QoL in 450 OAs from Mexico (n=238) and Ecuador (n=212) using the WHOQOL-OLD, finding no statistically significant differences between sexes (3.79 vs. 3.90).

Concerning PWB, the overall score on the Ryff's Psychological Well-Being Scales was 105.68 ± 20.91 , being slightly higher in females (106.91 ± 20.91 vs. 101.31 ± 14.15 ; $p=0.493$). A statistically significant difference between females and males was only observed in the domain "Positive relationships with others" (15.93 ± 4.41 vs. 13.00 ± 2.27 ; $p=0.016$). These results differ from what was reported by Palma-Candia *et al.*³⁰ in a study that evaluated PWB using the Ryff scale adapted by Van Dierendonck²¹ in 101 OAs (aged 60-88) in Magallanes (Chile), in which the overall score was slightly higher in males (194.33 ± 19.09 vs. 193.24 ± 20.79 ; $p=0.86$), with no statistically significant differences between sexes in any domain.

It is worth noting that, since Palma-Candia *et al.*³⁰ use a longer version of the scale (39 items), it is expected to have a higher overall score (193.70 ± 19.96); however, when converting this figure to a 29-item scale, such as the one used in our study, the score is still much higher (144.50). Furthermore, the finding regarding higher scores in females also differs from the findings reported by Vivaldi&Barra³¹ and Slavinski³² in studies conducted in OAs (≥ 60 years) in Chile and Israel, respectively, which reported higher overall scores on the Ryff scale in males.

In the present study, ASMM was not significantly correlated with overall scores on the WHOQOL-BREF or WHOQOL-OLD instruments, but it was correlated with the "Quality of Life" domain of the WHOQOL-BREF ($r=-0.37$; $p=0.040$). The analysis stratified by sex revealed the following: in females, ASMM was significantly correlated ($p<0.00$) with scores in the domains "Quality of life" ($r=-0.42$), "Social relationships" ($r=0.37$) and "Environment" ($r=-0.34$) from the WHOQOL-BREF and "Social participation" ($r=-0.36$) from the WHOQOL-OLD, but the correlation with the overall scores on both instruments was not significant. In males, correlations were significant with overall scores on both instruments ($r=0.57$ and $r=0.62$) and with the domains "Physical health" ($r=0.55$) from the WHOQOL-BREF and "Sensory abilities" ($r=0.63$) and "Intimacy" ($r=0.65$) from the WHOQOL-OLD.

Even though no studies evaluating the correlation between ASMM and QoL with these instruments were found in our literature review, studies on the impact of muscle mass on QoL in OAs do exist. For example, Trombetti *et al.*,³³ in a study conducted on 48 OAs (26 with mobility limitations and 22 without limitations) in the United States, reported that muscle mass loss contributes independently to the deterioration of QoL as measured

using the Short Form-36 questionnaire ($p=0.024$), while Sayer *et al.*,³⁴ in a study of 2 987 non-institutionalized OAs (aged 59-73) in the United Kingdom, stated that lower grip strength is associated with poor health-related QoL (assessed using the Short Form-36), as the probability of reporting poor general health, compared to excellent health, was significantly higher in individuals with lower grip strength (odds ratio [OR] for each kilogram reduction in grip strength = 1.13, 95%CI: 1.06-1.19; $p<0.001$ in males, and OR for each kilogram reduction in grip strength=1.13, 95%CI: 1.07-1.20; $p<0.001$ in females). However, in a study conducted on 83 OAs (29 pre-frail and 54 frail) in Austria by Haider *et al.*,³⁵ ASMM was not significantly associated with overall QoL (overall score on the WHO-QOL-BREF; $p=0.352$) or with any of the domains assessed in the WHOQOL-BREF and WHOQOL-OLD.

Furthermore, ASMM had a negative and statistically significant correlation with the overall PWB score ($r=-0.37$; $p=0.00$) and the score obtained on the domains “Positive relationships with others” ($r=-0.56$; $p=0.000$), “Autonomy” ($r=-0.38$; $p=0.003$), “Environmental mastery” ($r=-0.33$; $p=0.012$), and “Personal growth” ($r=-0.29$; $p=0.024$); likewise, it showed a statistically significant correlation with all domains in females ($r=-0.32$ to -0.45 ; $p<0.05$). Similar to the association between ASMM and QoL, we found no studies evaluating the correlation between ASMM and PWB measured with the Ryff’s Psychological Well-being Scales.

However, some studies have addressed the association between muscle loss and mental health deterioration. For example, Wang *et al.*,³⁶ in a study of 865 non-institutionalized Chinese OAs, reported that sarcopenia was significantly associated with the presence of depressive symptoms (OR=2.23. 95%CI: 1.06-4.92), while Gariballa & Alessa,³⁷ in a study of 432 critically ill OAs in England, found that low muscle strength was significantly associated with a greater presence of depressive symptoms during acute illness and recovery ($p=0.087$). Nevertheless a Korean study of 7 364 adults (2 124 ≥ 60 years) participating in a national health and nutrition survey found no association between sarcopenia and depression or depressive symptoms in any age group.³⁵

The strong negative association between ASMM and PWB observed in females suggests that psychosocial and cultural factors such as body perception and social roles may be modulating this relationship. In males, the lack of significant correlations could be caused by sample limitations or differences in the subjective perception of well-being.

This study has several strengths, including its multidimensional approach, the use of internationally validated instruments, and the stratified analysis of QoL and PWB by sex, which allowed us to identify key differences between males and females. Still, it has several limitations.

First, its cross-sectional design prevents us from establishing causal relationships and limits our ability to infer temporal directionality between the variables analyzed. Second, although convenience sampling was appropriate given the logistical conditions of the study, it reduces the representativeness of the sample and may introduce selection biases. Third, the small sample size restricts the generalizability of the findings. An additional significant limitation is the high sex disproportion of the sample, with a female predominance; however, this can be explained both by the higher proportion of females aged 60 years or older in Chile²¹ and by a probable reduced disposition of males to participate in studies of this nature.^{27,28,32}

Despite the fact that our findings partially agree with the findings of studies conducted in developed countries such as the United Kingdom, the United States, and Austria, it is

worth noting that differences in sociocultural contexts, healthcare systems, and living conditions may influence perceptions of QoL and well-being, since factors such as access to services, support networks, and functional expectations at older ages vary considerably between countries, thus limiting the direct comparison of results. In this regard, further studies are needed to address the relationship between ASMM, QoL, and PWB in OAs of the region to better understand this phenomenon in Latin America.

Finally, although some of the correlations found were statistically significant ($p < 0.05$), their magnitude was low ($r \approx \pm 0.3$), indicating a weak association. Therefore, the results should be interpreted with caution, bearing in mind that statistical significance does not necessarily imply clinical relevance. This remark is key to avoiding overinterpretation of the findings and highlights the need for studies with larger samples and multivariate analyses to assess the robustness and true relevance of the identified associations.

Conclusions

ASMM was not correlated with WHOQOL-OLD or any of its domains in non-institutionalized OAs in Santiago. In the case of WHOQOL-BREF, only a statistically significant correlation was observed with the “Quality of life” domain, which was negative. As for PWB, negative and significant correlations were found with the overall score and in four domains of the Ryff’s Psychological Well-Being Scales.

When analyzing the data by sex, significant differences were observed: in females, ASMM was negatively correlated with the “Quality of life” and ‘Environment’ domains of the WHOQOL-BREF and “Social participation” of the WHOQOL-OLD and positively correlated with the “Social relationships” domain of the WHOQOL-BREF, but the correlations with the overall scores were not significant. In males, the correlation was statistically significant and positive with the overall score on both instruments and with the domains “Physical Health” on the WHOQOL-BREF and “Sensory abilities” and “Intimacy” on the WHOQOL-OLD. In the case of the PWB, none of the correlations (Ryff total and individual scales) were statistically significant in males, while all correlations in females were negative and statistically significant.

Finally, it should be noted that these results are preliminary and do not provide sufficient basis for proposing specific intervention strategies, as the limitations of the study, including a small sample size, sex imbalance, and lack of adjustment for confounding variables, restrict the possibility of drawing applied conclusions. However, the patterns observed can serve as a guide for future research that explores sex differences in OAs in Chile and other countries of the region in terms of functionality and subjective well-being in greater depth and with more methodological rigor.

Conflicts of interest

None stated by the authors.

Funding

None stated by the authors.

Acknowledgments

None stated by the authors.

References

1. Organización Mundial de la Salud (OMS). Envejecimiento y salud. Geneva: OMS; 2024 [cited 2025 Aug 1]. Available from: <https://www.who.int/es/news-room/fact-sheets/detail/ageing-and-health>.
2. Spijker J. El futuro del envejecimiento en América Latina y el Caribe: nuevas perspectivas metodológicas. *Pap. Poblac.* 2022;28(114):15-38. doi: 10.22185/24487147.2022.114.27.
3. Marques SGdS, Villar R, Marcon LdF, João GA, Rica RL, Bocalini DS, *et al.* Determination of somatotype and physical activity level in frailty older adults. *Motriz: Revista de Educação Física.* 2022;28(Spe 2):e10220002921. doi: 10.1590/S1980-657420220002921.
4. Chen YP, Kuo YJ, Hung SW, Wen TW, Chien PC, Chiang MH, *et al.* Loss of skeletal muscle mass can be predicted by sarcopenia and reflects poor functional recovery at one year after surgery for geriatric hip fractures. *Injury.* 2021;52(11):3446-52. doi: 10.1016/j.injury.2021.08.007.
5. Coelho-Júnior HJ, Marques FL, Sousa CV, Marzetti E, Aguiar SDS. Age- and sex-specific normative values for muscle mass parameters in 18,625 Brazilian adults. *Front Public Health.* 2024;11:1287994. doi: 10.3389/fpubh.2023.1287994.
6. Lee SH, Choi H, Kim KY, Lee HS, Jung JM. Appendicular skeletal muscle mass associated with sarcopenia as a predictor of poor functional outcomes in ischemic stroke. *Clin Interv Aging.* 2023;18:1009-20. doi: 10.2147/CIA.S402548. PMID: 37427011; PMCID: PMC10329446.
7. Yang D, Zhao H, Lei R, Li Y, Zhou X, Yuan F, *et al.* Appendicular skeletal muscle mass index level (ASMI) and its influencing factors in healthy adult males. *Iran J Public Health.* 2023;52(8):1665-72. doi: 10.18502/ijph.v52i8.13404. PMID: 37744543; PMCID: PMC10512139.
8. Alarcón-Rivera M, Cornejo-Mella C, Cáceres-Aravena C, Concha-Cisternas Y, Fernández-Valero P, Guzmán-Muñoz E. Relationship between appendicular muscular mass index and physical function in older people. *AIMS Public Health.* 2024;11(1):130-40. doi: 10.3934/publichealth.2024006. PMID: 38617413; PMCID: PMC11007416.
9. Lera L, Albala C, Sánchez H, Angel B, Hormazabal MJ, Márquez C, *et al.* Prevalence of sarcopenia in community-dwelling Chilean elders according to an adapted version of the European Working Group on sarcopenia in Older People (EWGSOP) criteria. *J Frailty Aging.* 2017;6(1):12-7. doi: 10.14283/jfa.2016.117. PMID: 28244552.
10. Lera L, Albala C, Ángel B, Sánchez H, Picrin Y, Hormazabal MJ, *et al.* Predicción de la masa muscular apendicular esquelética basado en mediciones antropométricas en Adultos Mayores Chilenos [Anthropometric model for the prediction of appendicular skeletal muscle mass in Chilean older adults]. *Nutr Hosp.* 2014;29(3):611-7. Spanish. doi: 10.3305/NH.2014.29.3.7062. PMID: 24559006.
11. Robledo-Marín CA, Duque-Sierra CP, Hernández-Calle JA, Ruiz-Vélez MA, Zapata-Monsalve RB. Envejecimiento, calidad de vida y políticas públicas en torno al envejecimiento y la vejez. *Rev. CES Derecho.* 2022;13(2):132-60. doi: 10.21615/cesder.6453.
12. Urzúa A, Bravo M, Ogalde M, Vargas C. Factores vinculados a la calidad de vida en la adultez mayor. *Rev. Med. Chile.* 2011;139(8):1006-14. doi: 10.4067/S0034-98872011000800005.
13. Mesa-Fernández M, Pérez-Padilla J, Nunes C, Menéndez S. Bienestar psicológico en las personas mayores no dependientes y su relación con la autoestima y la autoeficacia. *Ciênc. Saúde Colet.* 2019;24(1):115-24. doi: 10.1590/1413-81232018241.35302016.
14. Manchiraju S. Psychometric evaluation of the Ryff's Scale of psychological wellbeing in self-identified American entrepreneurs. *Journal of Business Venturing Insights.* 2020;14: e00204. doi: 10.1016/j.jbvi.2020.e00204.
15. Ryff CD. Psychological well-being revisited: advances in the science and practice of eudaimonia. *Psychother Psychosom.* 2014;83(1):10-28. doi: 10.1159/000353263. PMID: 24281296; PMCID: PMC4241300.
16. Díaz D, Rodríguez-Carvajal R, Blanco A, Moreno-Jiménez B, Gallardo I, Valle C, *et al.* Adaptación española de las escalas de bienestar psicológico de Ryff. *Psicothema.* 2006;18(3):572-7.
17. Espinoza I, Osorio P, Torrejón MJ, Lucas-Carrasco R, Bunout D. Validación del cuestionario de calidad de vida (WHOQOL-BREF) en adultos mayores chilenos. *Rev. Med. Chile.* 2011;139(5):579-86. doi: 10.4067/S0034-98872011000500003.
18. Urzúa A, Navarrete M. Calidad de vida en adultos mayores: análisis factoriales de las versiones abreviadas del WHOQoL-Old en población chilena. *Rev. Med. Chile.* 2013;141(1):28-33. doi: 10.4067/S0034-98872013000100004.
19. World Health Organization (WHO). WHOQOL-BREF : introduction, administration, scoring and generic version of the assessment: field trial version, December 1996. Geneva: WHO; 1996 [cited 2025 Aug 1]. Available from: <http://bit.ly/4lWffHV>.
20. Fang J, Power M, Lin Y, Zhang J, Hao Y, Chatterji S. Development of short versions for the WHOQOL-OLD module. *Gerontologist.* 2012;52(1):66-78. doi: 10.1093/geront/gnr085. PMID: 22021402.

21. Van Dierendonck D. The construct validity of Ryff's Scale of Psychological well-being and its extension with spiritual well-being. *Personality and Individual Differences*. 2004;36(3):629-44. doi: 10.1016/S0191-8869(03)00122-3.
22. World Medical Association (WMA). WMA Declaration of Helsinki - Ethical principles for medical research involving human participants [Internet]. Helsinki: 75th WMA General Assembly; 2024 [cited 2025 Jul 3]. Available from: <https://bit.ly/40k4BRS>.
23. Observatorio del Envejecimiento para un Chile con futuro. Mujeres y envejecimiento: brechas y desafíos [Internet]. Santiago: Pontificia Universidad Católica de Chile; 2020 [cited 2025 Aug 1]. Available from: <http://bit.ly/3U9p2OQ>.
24. Hollingshaus M, Utz R, Schacht R, Smith KR. Sex ratios and life tables: Historical demography of the age at which women outnumber men in seven countries, 1850-2016. *Historical Methods: A Journal of Quantitative and Interdisciplinary History*. 2019;52(3):244-53. doi: 10.1080/01615440.2019.1605863.
25. Hernandez-Huayta J, Chavez-Meneses S, Carreazo NY. Salud y calidad de vida en adultos mayores de un área rural y urbana del Perú. *Rev Peru Med Exp Salud Publica*. 2016;33(4):680-8. doi: 10.17843/rpmesp.2016.334.2551.
26. Hussenöeder FS, Jentzsch D, Matschinger H, Hinz A, Kilian R, Riedel-Heller SG, *et al*. Depression and quality of life in old age: a closer look. *Eur J Ageing*. 2020;18(1):75-83. doi: 10.1007/s10433-020-00573-8. PMID: 33746683; PMCID: PMC7925788.
27. Los datos relativos a Chile, Argentina, Brasil, Perú, Colombia [Internet]. Washington D.C.: Grupo Banco Mundial; 2025 [cited 2025 Aug 20]. Available from: <https://datos.bancomundial.org/?locations=CL-AR-BR-PE-CO>.
28. Santos GDS, Cianciarullo TI. Qualidade de vida de idosos na estratégia saúde da família. *Rev. Fam. Ciclos Vida Saúde Contexto Soc*. 2016;4(3):218-26. doi: 10.18554/refacs.v4i3.1774.
29. Pacheco PO, Pérez RC, Coello-Montecel D, Castro-Zazueta NP. Quality of life in older adults: Evidence from Mexico and Ecuador. *Geriatrics (Basel)*. 2021;6(3):92. doi: 10.3390/geriatrics6030092. PMID: 34562993; PMCID: PMC8482232.
30. Palma-Candia O, Hueso-Montoro C, Ortega-Valdivieso A, Montoya-Juárez R, Cruz-Quintana F. Factores sociodemográficos y de participación social relacionados con el bienestar psicológico en adultos mayores en la región de Magallanes, Chile [Wellbeing of Chilean older adults is associated with group participation]. *Rev Med Chil*. 2016;144(10):1287-96. Spanish. doi: 10.4067/S0034-98872016001000008. PMID: 28074984.
31. Vivaldi F, Barra E. Bienestar Psicológico, Apoyo Social Percibido y Percepción de Salud en Adultos Mayores. *Ter Psicol*. 2012;30(2):23-19. doi: 10.4067/S0718-48082012000200002.
32. Slavinski M. Psychological well-being of the elderly: results of an empirical study. *Studia Universitatis Moldaviae*. 2024;9(169):319-27. doi: 10.59295/sum9(169)2024_46.
33. Trombetti A, Reid KF, Hars M, Herrmann FR, Pasha E, Phillips EM, *et al*. Age-associated declines in muscle mass, strength, power, and physical performance: impact on fear of falling and quality of life. *Osteoporos Int*. 2016;27(2):463-71. doi: 10.1007/s00198-015-3236-5. PMID: 26194491; PMCID: PMC4960453.
34. Sayer AA, Syddall HE, Martin HJ, Dennison EM, Roberts HC, Cooper C. Is grip strength associated with health-related quality of life? Findings from the Hertfordshire Cohort Study. *Age Ageing*. 2006;35(4):409-15. doi: 10.1093/ageing/af1024. PMID: 16690636.
35. Haider S, Luger E, Kapan A, Titze S, Lackinger C, Schindler KE, *et al*. Associations between daily physical activity, handgrip strength, muscle mass, physical performance and quality of life in prefrail and frail community-dwelling older adults. *Qual Life Res*. 2016;25(12):3129-38. doi: 10.1007/s11136-016-1349-8. PMID: 27363692; PMCID: PMC5102974.
36. Wang H, Hai S, Liu Y, Cao L, Liu Y, Liu P, *et al*. Association between depressive symptoms and sarcopenia in older Chinese community-dwelling individuals. *Clin Interv Aging*. 2018;13:1605-11. doi: 10.2147/CIA.S173146. PMID: 30233157; PMCID: PMC6130547.
37. Gariballa S, Alessa A. Association between muscle function, cognitive state, depression symptoms and quality of life of older people: evidence from clinical practice. *Aging Clin Exp Res*. 2018;30(4):351-7. doi: 10.1007/s40520-017-0775-y. PMID: 28527135.
38. Byeon CH, Kang KY, Kang SH, Kim HK, Bae EJ. Sarcopenia is not associated with depression in Korean adults: Results from the 2010-2011 Korean National Health and Nutrition Examination Survey. *Korean J Fam Med*. 2016;37(1):37-43. doi: 10.4082/kjfm.2016.37.1.37. PMID: 26885321; PMCID: PMC4754285.