

Association between physical activity and dynapenia in adults aged 80 years and older at the Peruvian Naval Medical Center Hospital

Asociación entre actividad física y dinapenia en adultos de 80 años a más en el Hospital del Centro Médico Naval del Perú

Ismael Francisco Hurtado-Loira^{1,*}, Adriana Antoinette Giron-Cabrera¹, Christians Elier Yataco-Trelles¹, José Francisco Parodi-García², Fernando Miguel Runzer-Colmenares¹

¹ Universidad Científica del Sur, Facultad de Ciencias de la Salud, Miraflores, Peru.
² Universidad de San Martín de Porres, Facultad de Medicina Humana, Centro de Investigación del Envejecimiento, Lima, Perú.

ABSTRACT

Objective: This study aimed to assess the association between physical activity and dynapenia in adults aged 80 years and older at the Peruvian Naval Medical Center Hospital from 2010 to 2015. **Methods:** An analytical cross-sectional study was conducted in adults aged 80 and older at the Peruvian Naval Medical Center Hospital. The exposure variable was physical activity, assessed using the Physical Activity Scale for the Elderly (PASE), and the outcome variable was dynapenia, defined according to handgrip strength cut-off points (< 27kg in men and < 16 kg in women). Both variables were measured at a single point. Prevalence ratios (PR) and 95% confidence intervals (95% CI) were estimated using Poisson regression with robust variance. **Results:** The analysis revealed a low physical activity prevalence of 54.37% (n=460) and a dynapenia prevalence of 46.81% (n=396). Of the participants, the majority were found in the age group of 80 to 89 years (74.35%, n=629), and 63.83% were male (n=540). Additionally, in an adjusted model, low physical activity was associated with a 1.29-fold higher prevalence of dynapenia (95% CI: 1.11-1.50) compared to participants with adequate physical activity. **Conclusions:** Low physical activity was significantly associated with dynapenia among adults aged 80 years and older in this cross-sectional study. Further longitudinal research is needed to clarify the temporal relationship between low physical activity and muscle strength decline.

Key words: Sedentary behavior; Muscle strength; Elderly; Sarcopenia; Comorbidity (source: MeSH NLM).

RESUMEN

Objetivos: Este estudio tuvo como objetivo evaluar la asociación entre la actividad física y la dinapenia en adultos de 80 años o más atendidos en el Hospital del Centro Médico Naval del Perú durante el periodo 2010-2015. **Materiales y métodos:** Se realizó un estudio transversal analítico en adultos de 80 años o más atendidos en el Hospital del Centro Médico Naval del Perú. La variable de exposición fue la actividad física, evaluada mediante la Physical Activity Scale for the Elderly (PASE), y la variable de resultado fue la dinapenia, definida según puntos de corte de fuerza de presión manual (<27 kg en hombres y <16 kg en mujeres). Ambas variables fueron medidas en un único momento. Se estimaron razones de prevalencia (RP) e intervalos de confianza al 95% (IC95%) utilizando regresión de Poisson con varianza robusta. **Resultados:** El análisis evidenció una prevalencia de baja actividad física de 54,37% (n=460) y una prevalencia de dinapenia de 46,81% (n=396). La mayoría de los participantes se encontraba en el grupo de 80 a 89 años (74,35%, n=629), y el 63,83% eran hombres (n=540). Asimismo, en el modelo ajustado, la baja actividad física se asoció con una prevalencia 1,29 veces mayor de dinapenia (IC95%: 1,11-1,50) en comparación con los participantes con actividad física adecuada. **Conclusiones:** La baja actividad física se asoció significativamente con la dinapenia en adultos de 80 años o más en este estudio transversal. Se requieren estudios longitudinales adicionales para esclarecer la relación temporal entre la baja actividad física y la disminución de la fuerza muscular.

Palabras Clave: Conducta Sedentaria; Fuerza Muscular; Anciano; Sarcopenia; Comorbilidad (fuente: DeCS Bireme).

Article history

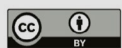
Received: January 16, 2026
Peer reviewed
Accepted: March 18, 2026
Online: March 24, 2026

How to cite this article

Hurtado-Loira IF, Giron-Cabrera AA, Yataco-Trelles CE, Parodi-García JF, Runzer-Colmenares FM. Association between physical activity and dynapenia in adults aged 80 years and older at the Peruvian Naval Medical Center Hospital. Med Educ Clin Pract. 2026;1(1):e010. doi: 10.21142/mecp.2026.1.1.e010.

* Correspondence

Hurtado-Loira Ismael Francisco
E-mail: Ismaelhurtadolaira@hotmail.com



This work is licensed under a Creative Commons Attribution 4.0 International License

INTRODUCTION

Population aging is a natural and progressive process characterized by the accumulation of molecular and cellular damage, leading to increased vulnerability and functional decline across the life course [1]. According to the World Health Organization (WHO), by 2050 more than 20% of the global population will be aged 60 years or older, highlighting the growing burden of age-related functional impairments [1]. This demographic change underscores the relevance of sarcopenia, a muscle disease, and frailty, a geriatric syndrome that affects between 20% and 50% of individuals aged 80 years and older and highlights the need to address these conditions in order to achieve a better quality of life [2].

Dynapenia is defined as the age-related loss of muscle strength that occurs independently of muscle mass decline. It represents a clinically relevant condition because muscle strength has been shown to be a stronger predictor of disability, falls, loss of independence and mortality than muscle mass alone [3,4]. As a functional impairment, dynapenia directly reflects neuromuscular health and physical capacity in older adults.

Dynapenia is highly prevalent in older populations. Epidemiological studies and large population-based analyses have reported substantial prevalence rates, particularly in individuals aged 75 years and older, where muscle strength decline becomes more pronounced [5,10]. These findings position dynapenia as a major public health concern in advanced age. Although dynapenia is related to other age-associated conditions, it is conceptually distinct from both frailty and sarcopenia. Frailty is characterized by reduced physiological reserve and increased vulnerability to stressors, whereas sarcopenia is defined as a muscle disease involving loss of muscle mass and strength [5,6]. Dynapenia specifically refers to the decline in muscle strength and should not be used interchangeably with these entities. When combined with reduced physical activity and comorbidities, age-related muscle weakness may further exacerbate adverse health outcomes [4,5].

Low physical activity has been increasingly recognized as a contributor to functional decline in older adults. The WHO estimates that approximately one-third of older individuals do not meet recommended physical activity levels [6,7,8]. Epidemiological evidence indicates that prolonged sedentary time is associated with lower muscle strength and poorer functional outcomes, independent of moderate-to-vigorous physical activity [8,9]. Furthermore, interventional studies have demonstrated that muscle strength can improve following resistance training in older adults, highlighting the modifiable nature of age-related muscle decline [9].

In this context, dynapenia manifests as the loss of muscle strength associated with age and affects more than 80% of hospitalized older patients. Hospitalization and reduced physical activity levels are factors associated with this condition, increasing the risk of dynapenia in patients admitted for hospitalization, with a causal relationship that includes the reasons for hospitalization (acute event), chronic conditions, and the immobility inherent to hospitalization. These findings are crucial to investigate the way in which reduced physical activity levels is related to dynapenia, suggesting that insufficient physical activity can aggravate the loss of muscle strength in older people, which would be related to the risk of functional limitations and mortality. Identifying these risk factors is crucial to establish plans that promote exercise and increase the well-being of this group of people [10].

Given that dynapenia reflects functional muscle decline and low physical activity is highly prevalent in advanced age, examining their association is particularly relevant. However, evidence focusing specifically on adults aged 80 years and older remains limited, especially in Latin American populations. Therefore, this study aimed to evaluate the association between low physical activity and dynapenia in adults aged 80 years and older attending a Peruvian naval medical center.

METHODS

Study design

The design of our study was analytical and cross-sectional, based on a secondary analysis of an existing database.

Population and Sample

The information of the participants in this study was extracted from a publicly accessible database belonging to the “CEMENA Frailty Study” [11,12]. The research took place at the Peruvian Naval Medical Center with the purpose of identifying factors linked to frailty in the population attended by the geriatrics service.

Data collection for this database was conducted between 2010 and 2015. The sampling of this study was non-probabilistic by convenience and included information from 1,896 older adults. Individuals aged 60 years and older who were treated on an outpatient basis were included, and patients with a diagnosis of cancer, severe functional dependence, severe dementia, or HIV/AIDS, as well as those hospitalized during recruitment or under home-visit care, were not included [11,12].

In this secondary analysis, all data corresponding to the participants of the aforementioned study were considered, and data from participants younger than 80 years of age and those with missing data in the key variables of our analysis were excluded. Therefore, the final sample size for the present secondary analysis was 846 participant records, after the exclusion of 1,050 participant records based on the age criterion, without the need to eliminate any additional data due to missing information. Some variables presented missing data due to incomplete clinical records or the inability of certain participants. Analyses were conducted using available data for each variable, and denominators were adjusted accordingly.

Variables

Dynapenia was the outcome variable and was assessed through handgrip muscle strength using an electronic dynamometer (Camry, model E108H) [13]. The device has been validated for clinical use in older adults. The assessment protocol followed international recommendations (EWGSOP2) [14] to ensure reproducibility and comparability with existing literature. Each participant performed two trials separated by a 10-minute rest interval, in a seated position with the arm fully extended downward and without external support. Measurements were taken using the dominant hand, and the highest value obtained across the two trials was recorded as the final result. Cut-off values were defined according to the European Working Group on Sarcopenia in Older People (EWGSOP2) consensus: <27 kg for men and <16 kg for women [14].

The exposure variable was low physical activity, assessed using the Physical Activity Scale for the Elderly (PASE). PASE evaluates participation in occupational, household, and leisure-time physical activities. It does not directly quantify sedentary time or posture-based behaviors; therefore, in this study the construct evaluated corresponds to insufficient engagement in physical activity rather than sedentary behavior. Low physical activity was defined using sex-specific cut-off values (<64 for men and <52 for women), thresholds previously applied in gerontological research [14,15]. The instrument has demonstrated moderate concurrent validity ($r=0.68$ compared with objectively measured energy expenditure) and good test-retest reliability ($ICC = 0.75$) [15].

All significant variables in the bivariate analysis in the regression analysis were included in the regression model, but due to multicollinearity issues, the SPPB and functional scope variables were removed from the model as the VIF values exhibited collinearity. Finally, the adjusted regression model included the following covariables: sex, level of education, self-reported health, medical

history (endocrine, cardiovascular, musculoskeletal, neuropsychiatric), balance disorder, and impaired physical performance. For sex, the categories were male and female, and for education level, the categories were higher technical education and complete or incomplete secondary education. Medical history variables were obtained directly from the patients' clinical records and were categorized as follows: endocrine (type 2 diabetes mellitus, hypothyroidism, and obesity), musculoskeletal (osteoarthritis, hip fracture, and other fractures), neuropsychiatric (depression, cerebrovascular disease, and anxiety), and cardiovascular (arterial hypertension, congestive heart failure, and peripheral arterial disease). Each medical history category was classified as zero to one condition or two or more conditions [16,17].

In addition, balance disorder was assessed using the Functional Reach Test, considering a positive result with a cut-off point of less than 20.32 cm, and physical performance was considered impaired with a value of 8 points or below on the Short Physical Performance Battery (SPPB), according to the 2019 sarcopenia consensus [14].

Statistical Analysis

Categorical variables were described using absolute and relative frequencies. Bivariate associations were evaluated using the Chi-square test. Prevalence ratios (PRs) and 95% confidence intervals (95% CI) were estimated using Poisson regression models with robust variance, appropriate for cross-sectional studies with binary outcomes. Two models were constructed: an unadjusted model and an adjusted model. The final adjusted model included sex, education level, endocrine conditions, cardiovascular conditions, musculoskeletal conditions, neuropsychiatric conditions, balance disorder (Functional Reach Test), and impaired physical performance (SPPB). Covariates were selected based on statistical significance in bivariate analyses ($p \leq 0.05$). Multicollinearity was assessed using the variance inflation factor (VIF), and no evidence of collinearity was observed. All analyses were performed using Stata version 18.0.

Ethical Aspects

The database is publicly available at: <https://doi.org/10.6084/m9.figshare.13059011.v2>. The original study was approved by the Ethics Committee of the Centro Médico Naval (CEMENA), Approval Memorandum No. 054-20113005. During the original data collection, participants were recruited through the signing of an informed consent, which was signed by family members in cases of cognitive impairment. Additionally, participants were informed about the objective of the research, the

benefits of their collaboration, the possible risks, and the security in the handling of personal data.

RESULTS

Table 1 summarizes the descriptive characteristics of the study population (n=846). The prevalence of low physical activity was 54.37% (n=460), while frequency of dynapenia was observed in 46.81% of participants (n=396). Most participants were aged 80-89 years (74.35%, n=629), and 63.83% were male (n=540). Regarding educational level, 66.41% of participants with available data had complete or incomplete secondary education (n=526/792). In terms of clinical and functional characteristics it was highlighted that 67.73% of the population had two or more musculoskeletal conditions (n=573). Finally, with respect to geriatric syndromes, we observed that 47.46% had balance disorders according to the functional reach test (n=393/828) and 55.32% had impaired physical performance according to the SPPB (n=468). For further detail, see Table 1.

Table 2 presents the bivariate analysis between muscle strength and the covariables. Among participants with dynapenia, 64.14% (n=254) reported low physical activity, showing a statistically significant association. Regarding age, 61.62% (n=244) of those with dynapenia were between 80-89 years, while 38.38% (n=152) were 90 years or older, also with significant differences. In terms of sex, 76.77% (n=304) of patients with dynapenia were male, and 60.11% (n=217) had completed or incomplete secondary education. For medical history, 35.86% (n=142) of patients with two or more cardiovascular conditions and 74.24% (n=294) of those with musculoskeletal conditions presented dynapenia, both statistically significant. Of the total number of individuals with dynapenia, 63.87% (n=244) had balance disorders, while impaired physical performance was present in 77.27% (n=306), with significant differences in both cases. Variables without statistical significance included self-rated health, endocrine history, and neuropsychiatric history. For further details, see Table 2.

Table 3 presents the Poisson regression analysis evaluating the association between low physical activity and dynapenia. In the adjusted model, the low physical activity was significantly associated with a higher prevalence of dynapenia (adjusted PR = 1.29; 95% CI: 1.11-1.50). Further details are shown in Table 3.

Table 1. Descriptive characteristics of the study population (n = 846)

Variables	n	%
Age		
80-89 years	629	74.35
90 years or older	217	25.65
Sex		
Female	306	36.17
Male	540	63.83
Education level*		
Higher Technical Education	266	33.59
Complete/Incomplete Secondary Education	526	66.41
Self-Reported Health**		
Excellent	85	10.47
Very Good	173	21.31
Good	323	39.78
Fair	182	22.41
Poor	49	6.03
Endocrine History		
0-1 conditions	697	82.39
2 or more conditions	149	17.61
Cardiovascular History		
0-1 conditions	500	59.10
2 or more conditions	346	40.90
Musculoskeletal History		
0-1 conditions	273	32.37
2 or more conditions	573	67.73
Neuropsychiatric History		
0-1 conditions	596	70.45
2 or more conditions	250	29.55
Balance Disorder (Functional Reach Test)***		
No	435	52.54
Yes	393	47.46
Impaired Physical Performance (SPPB)		
No	378	44.68
Yes	468	55.32
Low physical activity		
No	386	45.63
Yes	460	54.37
Dynapenia		
No	450	53.19
Yes	396	46.81

The absolute frequencies of certain covariates may not match the total study sample size (n=846); nevertheless, the proportion of missing data did not exceed 10% in any case.

*Education level (n = 792); **Self-reported health (n = 812); ***Balance disorder (n = 828).

Table 2. Bivariate analysis according to dynapenia status (n = 846)

Characteristics	Dynapenia		p*
	No n (%)	Yes n (%)	
Low physical activity			<0.001
No	244 (54.22)	142 (35.86)	
Yes	206 (45.78)	254 (64.14)	
Age			<0.001
80-89 years	385 (85.56)	244 (61.62)	
90 years or older	65 (14.44)	152 (38.38)	
Sex			<0.001
Female	214 (47.56)	92 (23.23)	
Male	236 (52.44)	304 (76.77)	
Education			0.001
Higher Technical Education	122 (28.31)	144 (39.89)	
Complete/Incomplete Secondary Education	309 (71.69)	217 (60.11)	
Self-Reported Health			0.057
Excellent	49 (11.21)	36 (9.60)	
Very Good	78 (17.85)	95 (25.33)	
Good	175 (40.05)	148 (39.47)	
Fair	110 (25.17)	72 (19.20)	
Poor	25 (5.72)	24 (6.40)	
Endocrine History			0.342
0-1 conditions	376 (83.56)	31(81.06)	
2 or more conditions	74 (16.44)	75 (18.94)	
Cardiovascular History			0.005
0-1 conditions	246 (54.67)	254 (64.14)	
2 or more conditions	204 (45.33)	142 (35.86)	
Musculoskeletal History			<0.001
0-1 conditions	171 (38.00)	102 (25.76)	
2 or more conditions	279 (62.00)	294 (74.24)	
Neuropsychiatric History			0.883
0-1 conditions	318 (70.67)	278 (70.20)	
2 or more conditions	132 (29.33)	118 (29.80)	
Balance Disorder (Functional Reach Test)			<0.001
No	297 (66.59)	138 (36.13)	
Yes	149 (33.41)	244 (63.87)	
Impaired Physical Performance (SPPB)			<0.001
No	288 (64.00)	90 (22.73)	
Yes	162 (36.00)	306 (77.27)	

*Analyzed with Chi² test.**Table 3.** Poisson regression analysis of the association between low physical activity and dynapenia

Physical activity	Crude model PR (95% CI)	Adjusted model* PR (95% CI)
Low physical activity		
No	Reference	Reference
Yes	1.50 (1.29-1.75)	1.29 (1.11-1.50)

PR: Prevalence ratio. 95% CI: 95% confidence interval.

Adjusted model includes age, sex, education level, cardiovascular history, and musculoskeletal history

DISCUSSION

The objective of the present study was to evaluate the association between physical activity, as assessed through overall physical activity patterns, and dynapenia in older adults from the Peruvian Naval Medical Center. The results showed that lower levels of physical activity were significantly associated with a higher prevalence of dynapenia, even after adjustment for multiple sociodemographic and clinical variables. These findings are consistent with previous evidence suggesting that reduced movement and low physical activity levels are associated with declines in muscle strength in older adult population [18,19].

The prevalence of dynapenia observed in this study (46.81%) is comparable to that reported in other study conducted in Latin American populations, such as Brazil (45.0%) [20]. These similarities suggest that sedentary lifestyles and aging trajectories in the region share common characteristics that contribute to the burden of dynapenia. Importantly, more than half of the participants (54.37%) exhibited low levels of physical activity, a proportion that underscores the magnitude of sedentary behavior as a public health concern in geriatric populations. Previous studies have consistently linked insufficient physical activity to adverse outcomes such as functional decline, frailty, metabolic disorders, and increased mortality [18,21]. Our findings extend this evidence by demonstrating its specific association with dynapenia, a condition that directly compromises independence and quality of life.

Regarding age, we found an association with dynapenia. This finding aligns with existing literature describing progressive age-related declines in muscle strength due to neuromuscular changes, hormonal alterations, and reduced physical activity [22,23]. Advanced age remains

one of the strongest non-modifiable risk factors for dynapenia. Male sex was also significantly associated with dynapenia. Although women generally present lower absolute muscle strength, several studies have reported a steeper decline in muscle strength among men with advancing age, which may explain the higher prevalence of dynapenia observed in male participants [20,24]. Similar findings have been reported in previous studies evaluating sex related differences in muscle strength decline among older adults.

In addition, a history of multiple musculoskeletal conditions was associated with higher prevalence dynapenia. Chronic musculoskeletal disorders such as osteoarthritis and prior fractures may limit mobility and reduce engagement in physical activity, thereby contributing to muscle disuse and strength loss [25-28]. This highlights the importance of integrated management strategies addressing musculoskeletal health to preserve functional capacity in older adults.

While associations with variables such as age, sex, and musculoskeletal history were observed, these factors were not the primary focus of the study. Their role should be interpreted as contextual rather than central: advanced age and chronic musculoskeletal conditions may exacerbate vulnerability to dynapenia, but the exposure of interest, sedentary behavior, remains the most relevant and actionable determinant identified. By emphasizing sedentary behavior, our results highlight the potential for preventive interventions aimed at reducing inactivity and promoting muscle health in older adults [20].

This study has several methodological limitations that should be considered when interpreting the findings. The cross-sectional design precludes establishing causal relationships between sedentary behavior and dynapenia, and the reliance on self-reported questionnaires may have introduced recall bias, potentially affecting the accuracy of the reported levels of physical activity and sedentary behavior. The study population consisted of older adults receiving care at a single medical center, and the use of a non-probabilistic sampling strategy may have introduced selection bias, thereby limiting the generalizability of the findings. Additionally, the data analyzed were collected between 2010 and 2015; the time elapsed since data collection may reduce the applicability of the results to current geriatric populations, as changes in lifestyle patterns, healthcare practices, and demographic characteristics over the past decade could have influenced both the prevalence and determinants of dynapenia. The possibility of residual confounding cannot be excluded, since relevant factors such as dietary intake, body composition, medication use, and other determinants of muscle strength were not incorporated into the adjusted models. Furthermore, the variable selection

strategy for the regression analyses relied exclusively on statistical significance in bivariate analyses, which may compromise the adequacy of confounding control and the stability of the estimates. This decision was intended to favor statistically parsimonious models, given the limited prior evidence addressing the research question in the analyzed population (veterans and their families); however, this approach may have restricted the inclusion of clinically relevant confounders. Despite these limitations, the study provides valuable insights by highlighting the association between physical activity patterns and muscle strength among very old adults. The identification of low levels of physical activity as a factor associated with dynapenia supports the need for future longitudinal research and the development of targeted strategies aimed at preserving functional capacity in aging populations. The relatively large sample size and the use of standardized and validated instruments to assess muscle strength, sedentary behavior, and physical performance strengthen the internal consistency and reliability of the findings.

This study found a significant association between physical activity and dynapenia in adults aged 80 years and older. Specifically, low physical activity was associated with a greater prevalence of dynapenia, even after adjustment for relevant sociodemographic and clinical factors. These findings highlight the relevance of low physical activity as a factor associated with muscle strength decline in very old adults and underscore the need for further longitudinal studies to clarify the temporal relationship between them.

Author contributions

IFHL: Conceptualization, Methodology, Investigation, Resources, Writing – original draft, Writing – review & editing, Visualization, Project administration, Supervision, Funding acquisition.

AAGC: Conceptualization, Methodology, Investigation, Resources, Writing – original draft, Writing – review & editing, Visualization, Project administration, Supervision, Funding acquisition.

CEYT: Conceptualization, Methodology, Investigation, Resources, Writing – original draft, Writing – review & editing, Visualization, Project administration, Supervision, Funding acquisition.

JFPG: Conceptualization, Methodology, Investigation, Resources, Writing – original draft, Writing – review & editing, Visualization, Project administration, Supervision, Funding acquisition.

FMRC: Conceptualization, Methodology, Formal analysis, Investigation, Resources, Data curation, Writing – original draft, Writing – review & editing, Visualization,

Project administration, Supervision, Funding acquisition, Validation.

Conflicts of interest statement

The authors declare no conflicts of interest.

Funding

This research did not receive specific funding from governmental agencies, commercial companies, or non-profit institutions.

Data availability statement

The data supporting the findings of this study are available in the Figshare repository at <https://doi.org/10.6084/m9.figshare.13059011>

Artificial Intelligence use statement

Generative AI was not used in any part of the manuscript

ORCID

Ismael Francisco Hurtado-Loira: <https://orcid.org/0009-0009-0257-8512>

Adriana Antoinette Giron-Cabrera: <https://orcid.org/0009-0005-1912-602X>

Christians Elier Yataco-Trelles: <https://orcid.org/0009-0002-8688-1162>

José Francisco Parodi-García: <https://orcid.org/0000-0002-0336-0584>

Fernando Miguel Runzer-Colmenares: <https://orcid.org/0000-0003-4045-0260>

REFERENCES

- World Health Organization. Ageing and health. <https://www.who.int/es/news-room/fact-sheets/detail/ageing-and-health>; 2024 [accessed October 3, 2024].
- Sharma PK, Reddy BM, Ganguly E. Frailty syndrome among oldest old individuals, aged ≥ 80 years: prevalence & correlates. *J Frailty Sarcopenia Falls*. 2020;5(4):92-101. doi: [10.22540/JFSF-05-092](https://doi.org/10.22540/JFSF-05-092).
- Martins LCG, Lopes MVO, Diniz CM, Guedes NG. The factors related to a sedentary lifestyle: a meta-analysis review. *J Adv Nurs*. 2021;77(3):1188-1205. doi: [10.1111/jan.14669](https://doi.org/10.1111/jan.14669).
- Carrillo Esper R, Muciño Bermejo J, Peña Pérez C, Carrillo Cortés UG. Frailty and sarcopenia. *Rev Fac Med UNAM*. 2011;54(5):12-21. Available at: https://www.scielo.org.mx/scielo.php?script=sci_arttext&pid=S0026-17422011000500003
- Sáez-Moreno MA, Jiménez-Lorenzo R, Lueso-Moreno M, López-Torres J. Prevalence of dynapenia in patients over 65 years. *Aten Primaria*. 2018;50(9):567-568. doi: [10.1016/j.aprim.2018.01.004](https://doi.org/10.1016/j.aprim.2018.01.004).
- Ozols-Rosales MA. Physical activity and disability. *MHSalud*. 2007;4(2):1-5. doi: [10.15359/mhs.4-2.1](https://doi.org/10.15359/mhs.4-2.1)
- World Health Organization. Physical activity. <https://www.who.int/es/news-room/fact-sheets/detail/physical-activity>; 2024 [accessed November 7, 2024].
- Strain T, Flaxman S, Guthold R, Semenova E, Cowan M, Riley LM, et al. National, regional, and global trends in insufficient physical activity among adults from 2000 to 2022: a pooled analysis of 507 population-based surveys with 5.7 million participants. *Lancet Glob Health*. 2024;12(8):e1232-e1243. doi: [10.1016/S2214-109X\(24\)00150-5](https://doi.org/10.1016/S2214-109X(24)00150-5).
- Frontera W, Meredith C, O'Reilly K, Knuttgen H, Evans W. Strength conditioning in older men: skeletal muscle hypertrophy and improved function. *J Appl Physiol* (1985). 1988;64(3):1038-1044. doi: [10.1152/jappl.1988.64.3.1038](https://doi.org/10.1152/jappl.1988.64.3.1038).
- Olaya-Sánchez R, García-Galgo JL, Martínez-Aparicio M, Millán-Mena G, Torralba M, Hernández-Alfaro R. Dynapenia in admitted and non-admitted patients older than 65 years. *PDF*. 2020;49(2):99-109. Available at: <https://cuestionesdefisioterapia.es/index.php/cf/article/view/139>.
- Vargas-Torres-Young DA, Salazar-Talla L, Cuba-Ruiz S, Urrunaga-Pastor D, Runzer-Colmenares FM, Parodi JF. Cognitive frailty as a predictor of mortality in older adults: a longitudinal study in Peru. *Front Med (Lausanne)*. 2022;9:910005. doi: [10.3389/fmed.2022.910005](https://doi.org/10.3389/fmed.2022.910005).
- Vasquez-Goñi GAJ, Papuico-Romero BM, Urrunaga-Pastor D, Runzer-Colmenares FM, Parodi JF. The depressed frail phenotype as a risk factor for mortality in older adults: a prospective cohort in Peru. *Heliyon*. 2022;8(1):e08640. doi: [10.1016/j.heliyon.2021.e08640](https://doi.org/10.1016/j.heliyon.2021.e08640).
- Panhale V, Kini R, Kothale S. Reliability and validity of Camry dynamometer for isometric hand grip strength measurement in healthy Indian adults. *J Hand Microsurg*. 2025;17(4):100291. doi: [10.1016/j.jham.2025.100291](https://doi.org/10.1016/j.jham.2025.100291)
- Cruz-Jentoft AJ, Bahat G, Bauer J, Boirie Y, Bruyère O, Cederholm T, et al. Sarcopenia: revised European consensus on definition and diagnosis. *Age Ageing*. 2019;48(1):16-31. doi: [10.1093/ageing/afy169](https://doi.org/10.1093/ageing/afy169).
- Washburn RA, Smith KW, Jette AM, Janney CA. The Physical Activity Scale for the Elderly (PASE): development and evaluation. *J Clin Epidemiol*. 1993;46(2):153-162. doi: [10.1016/0895-4356\(93\)90053-4](https://doi.org/10.1016/0895-4356(93)90053-4).
- Sánchez-García S, Sánchez-Arenas R, García-Peña C, Rosas-Carrasco O, Ávila-Funes JA, Ruiz-Arregui L, et al. Frailty in elderly Mexican people. *Geriatr Gerontol Int*. 2014;14:395-402. doi: [10.1111/ggi.12114](https://doi.org/10.1111/ggi.12114).
- Urrunaga-Pastor D, Moncada-Mapelli E, Runzer-Colmenares FM, Bailon-Valdez Z, Samper-Ternent R, Rodríguez-Mañas L, et al. Factors associated with poor balance ability in older adults of nine high-altitude communities. *Arch Gerontol Geriatr*. 2018;77:108-114. doi: [10.1016/j.archger.2018.04.013](https://doi.org/10.1016/j.archger.2018.04.013).
- Park JH, Nam HS, Park M, Kim YH. Differential association between physical activity behaviours and dynapenia by comorbid diseases in community-dwelling Korean older adults. *Eur Rev Aging Phys Act*. 2024;21(1):6. doi: [10.1186/s11556-024-00340-z](https://doi.org/10.1186/s11556-024-00340-z).
- Sáez Moreno MA, Jiménez Lorenzo R, Lueso Moreno M, García Atienza E, Castaño M, López Torres Hidalgo, J. Dynapenia and musculoskeletal function in patients over 65

- years. *Rev Clin Med Fam*. 2018;11(1):8-14. Available at: http://scielo.isciii.es/scielo.php?script=sci_arttext&pid=S1699-695X2018000100008&lng=es.
20. Borges VS, Lima-Costa MFF, Andrade FB. A nationwide study on prevalence and factors associated with dynapenia in older adults: ELSI-Brazil. *Cad Saúde Pública*. 2020;36:e00107319. doi: [10.1590/0102-311X00107319](https://doi.org/10.1590/0102-311X00107319).
 21. Mahecha SM. Poder del músculo esquelético en la salud y enfermedad. *Rev Nutr Clini Metab*. 2021;4:e288. doi: [10.35454/rncm.v4n4.288](https://doi.org/10.35454/rncm.v4n4.288)
 22. Jung H, Tanaka S, Tanaka T. Body composition characteristics of community-dwelling older adults with dynapenia. *Front Nutr*. 2022;9:827114. doi: [10.3389/fnut.2022.827114](https://doi.org/10.3389/fnut.2022.827114).
 23. McArdle WD, Katch VL. Exercise physiology: energy, nutrition, and human performance. 8th ed. Philadelphia: Lippincott Williams & Wilkins; 2014.
 24. Mitchell WK, Williams J, Atherton P, Larvin M, Lund J, Narici M. Sarcopenia, dynapenia, and the impact of advancing age on human skeletal muscle size and strength: a quantitative review. *Front Physiol*. 2012;3:260. doi: [10.3389/fphys.2012.00260](https://doi.org/10.3389/fphys.2012.00260).
 25. Lu CH, Su SC, Kuo FC. Osteoporosis as the female-specific risk factor for dynapenia in elderly patients with type 2 diabetes. *J Clin Med*. 2024;13:4590. doi: [10.3390/jcm13164590](https://doi.org/10.3390/jcm13164590).
 26. Delinocente MLB, Luiz MM, de Oliveira DC, de Souza AF, Ramírez PC, de Oliveira Máximo R, et al. Are serum 25-hydroxyvitamin D deficiency and insufficiency risk factors for the incidence of dynapenia? *Calcif Tissue Int*. 2022;111:571-579. doi: [10.1007/s00223-022-01021-8](https://doi.org/10.1007/s00223-022-01021-8).
 27. Kishimoto T, Onishi H, Tsubouchi H, Mizukami Y, Kubota M, Ikeda R, et al. Association between upper limb muscle quality and knee osteoarthritis in dynapenia: an observational cross-sectional study. *J Clin Biochem Nutr*. 2024;75(2):145-149. doi: [10.3164/jcfn.24-58](https://doi.org/10.3164/jcfn.24-58).
 28. Haugen IK, Aaserud J, Kvien TK. Get a grip on factors related to grip strength in persons with hand osteoarthritis: results from an observational cohort study. *Arthritis Care Res*. 2021;73(6):794-800. doi: [10.1002/acr.24385](https://doi.org/10.1002/acr.24385)