Physical fitness according to the level of physical activity in older people: a cross-sectional analysis

Aptidão física de acordo com o nível de atividade física em pessoas idosas: uma análise transversal

Débora Jesus da Silva [1]
Lucas dos Santos [2*]
Yuri Silva de Souza [1]
Paulo da Fonseca Valença Neto [3]
Pabline dos Santos Santana [1]
Cláudio Bispo de Almeida [4]
Cezar Augusto Casotti [1]

[1] Universidade Estadual do Sudoeste da Bahia (UESB), Jequié, BA, Brazil
[2] Universidade Estadual do Tocantins (UNITINS), Augustinópolis, TO, Brazil
[3] Ministério da Saúde (MS), Brasília, DF, Brazil
[4] Universidade do Estado da Bahia (UNEB), Guanambi, BA, Brazil

Date of first submission: May 29, 2023
Last received: August 31, 2023
Accepted: October 23, 2023

***Correspondence:** lucas.ds@unitns.br

Abstract

Introduction: Aging is marked by physiological changes and a decrease in physical activity. These aspects can have repercussions, namely declining functionality and increasing likelihood of adverse events. **Objective:** To compare performance in physical fitness tests of sufficiently and insufficiently active older people. **Methods:** Epidemiological population study, cross-sectional, carried out with 209 older people (58.4% women) from Aiquara/BA. Sociodemographic information was obtained by means of interviews. Physical fitness was measured by means of the following tests: handgrip strength, chair stand, arm curl, timed up and go, sit and reach and step in place. The level of physical activity was checked by the International Physical Activity Questionnaire (<150 min/week physical activity = insufficiently active). Comparisons were made using the Student t-test or Mann-Whitney U-test, according to the distribution of normality determined by the Kolmogorov-Smirnov test ($p \leq 0.05$). **Results:** We found that 51.70% of the participants were insufficiently active (men: 66.66%; women: 40.98%). In addition, insufficiently active participants of both sexes performed less well in the handgrip strength, chair stand, arm curl, timed up and go and step in place tests ($p < 0.05$). Moreover, insufficiently active men showed lower performance in the sit and reach test than sufficiently active men ($p < 0.05$). **Conclusion:** Insufficiently active older women and men have lower muscle strength/resistance, dynamic balance/agility and cardiorespiratory endurance. Furthermore, insufficiently active men show less flexibility than those sufficiently active.

Keywords: Aging. Epidemiology. Motor activity. Physical functional performance.

Resumo

Introducão: *O envelhecimento é marcado por alterações fisiológicas e diminuição do tempo em atividade física (AF). Tais aspectos podem repercutir no declínio da funcionalidade e propiciar maior probabilidade para eventos adversos.* ***Objetivo:*** *Comparar o desempenho em testes de aptidão física de pessoa idosas suficiente e insuficientemente ativas.* ***Métodos:*** *Estudo epidemiológico populacional, transversal, realizado com 209 pessoas idosas (58,40% mulheres) de Aiquara/BA. As informações sociodemográficas foram obtidas a partir de entrevistas. A aptidão física foi mensurada por meio dos seguintes testes: força de preensão manual; levantar e sentar da cadeira; flexão do antebraço; levantar, caminhar 2,44 m e sentar; sentar e alcançar o pé; e marcha estaci-onária. O nível de atividade física foi averiguado pelo International Physical Activity Questionnaire (< 150 min/sem em AF = insuficientemente ativo). As comparações foram feitas por meio dos testes t de Student ou U de Mann-Whitney, conforme a distribuição de normalidade averiguada pelo teste de Kolmogorov-Smirnov (p ≤ 0,05).* ***Resultados:*** *A prevalência do nível de AF insuficiente foi de 51,70% (homens: 66,66%; mulheres: 40,98%). Verificou-se, em ambos os sexos, que os insuficientemente ativos demonstraram menor desempenho na força de preensão manual; sentar e levantar da cadeira; flexão do antebraço; levantar, caminhar e sentar; e marcha estacionária (p < 0,05). Além do mais, os homens insuficientemente ativos apresentaram menor desempenho no teste sentar e alcançar o pé em relação aos suficientemente ativos (p < 0,05).* ***Conclusão:*** *Identificou-se que os idosos insuficientemente ativos, de ambos os sexos, apresentaram menor força/resistência muscular, equilíbrio dinâmico/agilidade e resistência cardiorrespiratória. Ademais, os homens insuficientemente ativos demonstraram menor flexibilidade do que os suficientemente ativos.*

Palavras-chave: *Envelhecimento. Epidemiologia. Atividade motora. Desempenho físico funcional.*

Introduction

During aging, morphological and physiological changes occur in the human body[1-3] including an increase in total, abdominal and intramuscular adiposity,[4] rreduction in nerve cells, failure in neuromuscular transmission and a decrease in the number of muscle fibers, which, consequently, generates a progressive decline in the ability to carry out daily activities.[5] Senescence also results in a decrease in the efficiency of the cardiorespiratory system in capturing/transporting oxygen and of the muscular system in using it, resulting in lower cardiorespiratory fitness.[6] Furthermore, there is a deficit in the plastic and elastic capacity of muscles, joints and connective tissues. Such changes tend to negatively influence flexibility indices.[7]

It is suggested that regular physical activity can mitigate the impacts of aging, preserving or even improving physical fitness and quality of life.[8] On the other hand, insufficient physical activity is considered an important factor that increases the probability of impaired physical performance in older people.[9-11] Therefore, the hypothesis that older persons who are insufficiently active exhibit worse performance in physical fitness tests, compared to those who are sufficiently active, is plausible.

To reduce the negative impacts of aging on functionality, the World Health Organization (WHO) recommends a minimum weekly accumulation of 150 minutes of physical activity for older people.[12] However, insufficient levels of physical activity prevail around the world, as observed in a systematic review carried out with 53 studies, which showed that the prevalence of insufficient physical activity levels in older people ranges from 17 to 97.60%.[13]

Given this situation, an adverse epidemiological panorama can be observed in Brazil. Data evidenced by the Ministry of Health, from the research *Vigilância de fatores de risco e proteção para doenças crônicas por inquérito telefônico*, pointed out that 56.50% of Brazilians in the age group of 55 to 64 years and 73% in the group aged ≥65 years are insufficiently active.[14]

It is also clear that there are few health surveys that evaluate the difference, in indicators of physical fitness, between older people who are sufficiently and insufficiently active. In Brazil, only two studies were conducted.[15,16] However, both demonstrated some possible weaknesses, since they were carried out with small samples selected for convenience and presented analyses without stratification by sex, which limits the power of inference and does not consider the specificities of each sex, considering the disparities between men and women in physical fitness indicators.

From this perspective, conducting population surveys that aim to investigate the impact of this important risk behavior on the functionality of older people will make

it possible to track individuals with a greater probability of the outcome and thereby plan strategies that enable active aging with better functionality. Therefore, the aim of this study was to compare the performance in physical fitness tests of sufficiently and insufficiently active older people.

Methods

Epidemiological study, with a cross-sectional design, substantiated by baseline data from the population survey *Condições de saúde e estilo de vida de idosos residentes em um município de pequeno porte: coorte Aiquara*,[17] carried out in Aiquara/BA, Brazil, from February to April 2013, with older people registered in the *Estratégia Saúde da Família* (ESF), which covers the entire country.[18]

This study was approved by the Research Ethics Committee of the State University of Southwest Bahia with Approval No. 171.464/2012 and CAAE No. 10786212.3.0000.0055. All participants were informed about the objectives, procedures and voluntary nature of the research and signed an informed consent form.

People included in the study were: 60 or over, non-institutionalized, with permanent residence in the urban area and sleeping four days or more a week at home. Excluded from the study were: those who had cognitive deficit, assessed by the shortened and validated version of the Mini Mental State Examination (MMSE)[19] with a cutoff point of ≤12;[20] those who had neurological disorders or hearing problems, which compromised the understanding of the questions, and those bedridden.[18]

Data collection

Data collection was conducted in two stages: the first consisted of a face-to-face interview, carried out at the interviewee's home, where sociodemographic information (sex and age) was obtained. The second stage was scheduled, according to the availability of the participants, for two to three days after the interview, and carried out in a space provided by the Municipal Health Department. There, anthropometric measurements were collected and physical fitness tests were carried out. More details about the data collection stages and procedures adopted can be found in Santos et al.[21]

Anthropometry

Weight (W) was measured using a portable digital scale (Plenna®). Individuals stood barefoot with their arms relaxed at their sides, looking ahead and wearing light clothing. Height (H) was measured using a portable stadiometer (WiSO®). For this, participants were barefoot, standing with feet together, with heels, buttocks and shoulders touching the wall and with their eyes fixed on a horizontal axis parallel to the floor (Frankfurt Line), during an inspiratory breath-hold.[22] From this information, the body mass index was calculated (BMI = W/H^2).[23]

Physical fitness tests

Physical fitness was verified using handgrip strength (HGS)[24] and the Senior Fitness Test battery.[25] HGS was measured using a Saehan handheld hydraulic dynamometer - SH5002 (Saehan Corporation, 973, Yangdeok -Dong, MasanHoewon-Gu, Changwon 630-728, South Korea), with the dominant arm, with participants sitting, shoulder in neutral position, elbow flexed at 90° and forearm in neutral position.[24] The dynamometer was adjusted according to the participants' hand size. Throughout the measurement, they were prompted to press the dynamometer handle with as much force as possible for five seconds.[24] The test was performed twice, with an interval of one minute. For the analyses, the highest value identified in kilogram-force (kgf) was used.[21]

Using the Senior Fitness Test battery, the strength/endurance of the upper limbs (elbow flexion; arm curl) and lower limbs (getting up and sitting down in a chair; chair stand) was assessed; aerobic endurance (2-minute stationary walk); dynamic balance/agility (getting up, walking 2.44 m and sitting down; timed up and go) and flexibility (sit and reach).[25] More details about the instruments and procedures used to carry out such physical fitness tests can be found in Santos et al.[21]

Before application, the Senior Fitness Test battery was demonstrated individually to each participant by the team of evaluators, made up of a physical education professional, two graduates in this area and a graduate in physiotherapy. Furthermore, to mitigate measurement bias, the older individuals were previously asked to perform a few repetitions in each test to familiarize themselves with the movement patterns.

Next, each test was performed individually, twice with two-minute intervals. For the analyses, the value of the best performance was used.[21]

Physical activity level

The level of physical activity was assessed through the sum of the first four domains (physical activity at work; at leisure; as a means of transport; and in household activities) of the long version of the International Physical Activity Questionnaire (IPAQ),[26] vvalidated for older Brazilians.[27,28] Interviewees who performed physical activities with moderate to vigorous intensity for at least 150 minutes weekly were considered sufficiently active.[12]

Statistical analysis

Descriptive analyses were performed using the absolute and relative frequencies, mean, median, standard deviation and interquartile range (IQR). Furthermore, the percentage of response (missing) for each variable analyzed was calculated. The normality distribution (of quantitative variables) of the general set, and according to sex, was identified using the Kolmogorov-Smirnov test. Thus, for comparisons of variables that showed normal distribution, the Student t-test was used and for variables that showed non-normal distribution, the Mann-Whitney U test. In all analyses a significance level of 5% ($p \leq 0.05$) was adopted. The data were analyzed using the Statistical Package for the Social Sciences (IBM-SPSS® 21.0, 2013, Inc, Chicago, IL).

Results

Initially, a census was carried out for the purpose of identifying all older people living in the seat of Aiquara-BA, with the help of community health agents working in the ESF, which covers 100% of the municipality's population. In this way, all homes in the urban area were visited and 263 older people were identified.[29] Among these, 209 (58.40% women) formed the group evaluated, as illustrated in Figure 1.

The median ages of the women and men were 70 (IQR: 11) and 72 (IQR: 13) years, respectively ($p = 0.390$). In addition, 82.80% of the participants were between 60 and 79 years old, and 51.70% were insufficiently active (men: 66.66%; women: 40.98%). Further information on the characteristics of the population has already been published and can be found in Santos et al.[21]

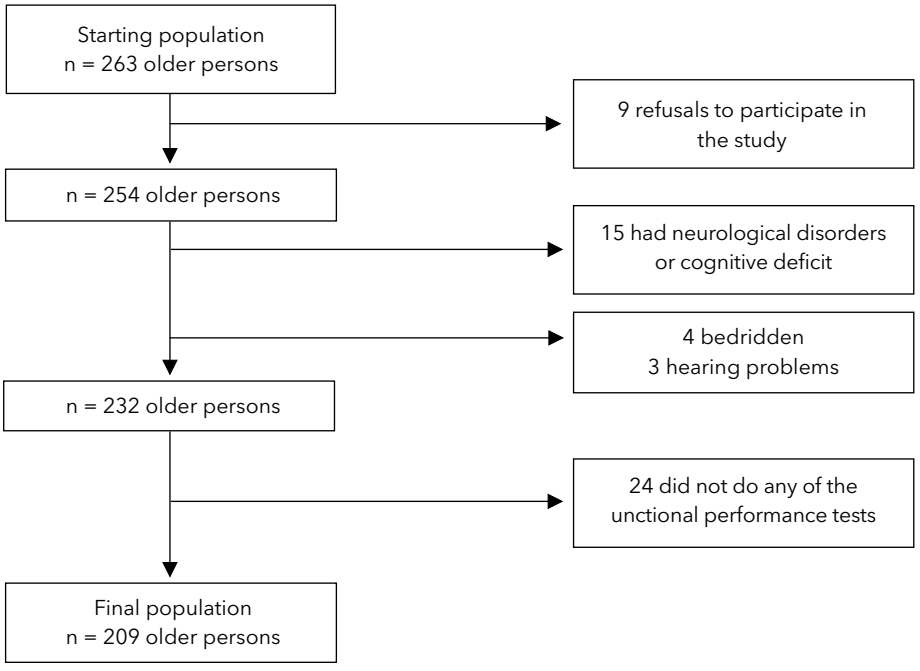

Figure 1 - Flowchart describing the eligibility process of the older persons participating in the study.

As shown in Table 1, there were no differences in anthropometric characteristics between sufficiently and insufficiently active older people (p > 0.05). Table 2 shows comparisons of the functional performance of sufficiently and insufficiently active older persons, according to sex. We found that insufficiently active men demonstrated lower functional performance in all physical fitness tests (p < 0.05). For women, only the sitting and reaching test showed no differences between sufficiently and insufficiently active older women (p = 0.159).

Table 1 - Anthropometric parameters of older individuals, of both sexes, sufficiently (n = 101) and insufficiently (n = 108) active

Variable	%Response	Sufficiently active	Insufficiently active	p-value
Height (m)[@]	99.50	1.56 (0.92)	1.54 (0.83)	0.083[a]
Weight (kg)[@]	100	61.10 (12.37)	63.37 (12.60)	0.191[a]
BMI (kg/m^2)[#]	99.50	25.39 (6.89)	25.22 (6.30)	0.979[b]

Note: IBMI = body mass index. [@]Mean and standard deviation; [#]Median and interquartile interval; [a]p-value obtained by Student t-test; [b]p-value obtained by Mann-Whitney U test.

Table 2 - Performance on physical fitness tests of sufficiently and insufficiently active older individuals stratified by sex

Variáveis	%Response	Sufficiently active	Insufficiently active	p-value
Men	-	n = 29	n = 58	-
HGS (kgf)[@]	98.85	36.82 (5.57)	31.31 (7.04)	**<0.001**[a]
CS (repetitions)[#]	93.10	14.00 (4.00)	11.50 (4.00)	**<0.001**[b]
AC (repetitions)[#]	87.40	14.00 (3.00)	11.00 (5.00)	**<0.001**[b]
TUG (s)[#]	96.55	5.56 (1.63)	6.50 (2.19)	**<0.001**[b]
SR (cm)[@]	91.95	-1.63 (12.55)	-10.12 (10.62)	**0.002**[a]
SP (steps)[#]	86.20	101.00 (23.00)	83.50 (23.00)	**0.001**[b]
Women	-	n = 72	n = 50	-
HGS (kgf)[@]	100	22.96 (4.75)	19.70 (4.51)	**<0.001**[a]
CS (repetitions)[#]	92.60	11.00 (3.00)	9.00 (3.00)	**0.001**[b]
AC (repetitions)[#]	90.20	12.00 (5.00)	9.00 (5.00)	**0.003**[b]
TUG (s)[#]	95.90	6.75 (2.58)	8.45 (3.32)	**<0.001**[b]
SR (cm)[@]	93.44	2.00 (16.00)	-4.75 (23.00)	0.159[a]
SP (steps)[#]	87.70	73.38 (18.19)	57.44 (23.81)	**0.001**[a]

Note: HGS = handgrip strength; CS = chair stand; AC = arm curl; TUG = timed up and go; SR = sit and reach; SP = step in place; kgf = kilogram-force. [@]Mean and standard deviation; [#]Median and interquartile interval; [a]p-value obtained by Student t-test; [b]p-value obtained by Mann-Whitney U test. Values in bold indicate p < 0.05.

Discussion

The main evidence of this study showed that older persons classified as insufficiently active, male and female, had lower muscle strength/endurance, mobility, agility, dynamic balance and aerobic endurance. Furthermore, insufficiently active men demonstrated less flexibility compared to those who were sufficiently active.

Accordingly, it is noteworthy that our study is the first population health survey, carried out in Brazil, to compare performance in physical fitness tests between sufficiently and insufficiently active older people. Therefore, they

extend the ability to extrapolate evidence related to this perspective, since previous studies conducted in Brazil were carried out with small samples.[15,16]

Among the sample studies mentioned above, Silva et al.[16] observed in 113 older people (86.72% women) from Bauru-SP, Brazil, that those who were insufficiently active had significantly lower performance in the arm curl test (18.78 ± 4.50 repetitions) when compared to sufficiently active ones (23.73 ± 4.20 repetitions). The second sample study evaluated 60 older people of both sexes, involved for at least six months in the activities of the Association of Retirees and Pensioners of Araxá (AAPA) in Minas Gerais, Brazil.[15] The older people were subdivided into three groups: those who practiced physical activity, exclusively at AAPA (G1; 60 minutes, three days a week); those who practiced fun and recreational activities, such as dancing, also at AAPA (G2; 60 minutes; three days a week) and those who did not participate in any type of physical activity (G3). The authors observed that in the chair stand test, the mean values indicated lower performance for G3 (13.50 ± 2.90 repetitions) compared to G1 (17.70 ± 2.30 repetitions) and G2 (16.25 ± 2.20 repetitions) ($p < 0.001$). In the timed up and go test, the mean values in seconds for the groups were: G1 = 6.92 ± 0.91; G2 = 7.31 ± 0.92; and G3 = 8.2 ± 1.30. As described, in the individuals in the insufficiently active group (G3), the time spent performing the test was significantly longer compared to that observed in the sufficiently active groups (G1 and G2).[15]

Corroborating these findings, in the present study, it was found that, in both sexes, sufficiently active older individuals had a greater number of repetitions in the chair stand test and less time in the timed up and go test with walking 2.44 m. Such evidence probably refers to the repercussions that a sufficient level of physical activity tends to provide, such as better performance in basic and everyday activities, such as getting up from a chair and even walking. This gives older people greater mobility, agility, dynamic balance, muscle strength and endurance, especially in the lower limbs.[30]

Another variable analyzed in the present study was HGS, which is identified by the European Working Group on Sarcopenia in Older People as the gold standard test for screening muscle weakness (dynapenia), as it is a direct measure that has a good correlation with total muscle strength.[31] The findings of the present investigation show that, among older persons of both sexes, living in Aiquara/BA, those who were insufficiently active demonstrated lower HGS compared to those who were sufficiently active.

In a previous study, also conducted with the older population of Aiquara-BA, Brazil, it was shown that insufficiently active participants had a 1.99 times (95%CI: 1.12-3.54) greater likelihood of dynapenia compared to those who were sufficiently activelidade à dinapenia em relação aos suficientemente ativos.[11] Similarly, Pereira et al.,[32] in a survey carried out with 205 older women from Jequié/BA, Brazil, found that insufficiently active participants were 1.34 (95%CI: 1.01-1.80) times more likely to be dynapenic compared to those sufficiently active. Congruently, Cooper et al.,[33] when evaluating 66,582 older English people participating in the UK Biobank epidemiological study, observed that those evaluated in the highest quintile of time spent in moderate physical activity (55.50 minutes/day) had a mean HGS of 1. 28 kgf (95%CI: 1.08-1.48), higher than those in the lowest quintile (42.87 min/day) ($p < 0.001$).

Muscular fitness tends to decrease throughout aging, as a consequence of structural and functional changes in the muscular and nervous system.[5] In older people who are insufficiently active, however, the decline appears to be more pronounced. This is because this group has greater inactivity time in the main muscle groups, which leads to dynapenia.[30]

With regard to the aerobic fitness of older people of both sexes, we found here that lower performance in stationary walking was observed in those who were insufficiently active. However, Castro et al.,[15] when applying this same test in Araxá/MG, Brazil, observed no difference between the sufficiently active groups (G1 = 83.35 ± 13.20 steps; G2 = 75.85 ± 13.10 steps) and the insufficiently active group (G3 = 73.05 ± 15.00 steps) ($p = 0.221$).

This difference in results may have occurred as a result of methodological disparities between the present study and that conducted by Castro et al.,[15] mainly with regard to the representativeness of the population evaluated. Therefore, it must be considered that the present study has a census perspective, which allowed the evaluation of a larger contingent of older people. In contrast, Castro et al.[15] studied a small sample, selected for convenience and without stratification by sex, which may have resulted in a lower power of statistical inference

Regarding flexibility, in the present study, it was observed that insufficiently active males showed lower performance in the sit and reach test compared to

sufficiently active ones. Among women, however, there was no difference between the groups. Given the possible explanations, it is noteworthy that females have higher levels of estrogen since puberty, therefore having a greater capacity for extensibility in muscles, joints, tendons and ligaments. Furthermore, women have a larger lumbosacral region, which provides greater flexibility in this segment.[34] Therefore, despite the insufficient level of physical activity being a risky behavior that may have implications for functional performance, this impact does not appear to be significant for flexibility in older women.

This study had some limitations, including the possibility of memory bias, considering that the time spent in physical activity was quantified by the IPAQ, which despite being a validated instrument for the study population,[27,28] it provides self-reported measurements. However, it is worth highlighting the attempt to minimize this impact by screening older people for cognitive impairment using the MMSE. In addition, it is noteworthy that the results presented refer to the panorama investigated during the collection carried out in 2013, which may not reflect the current reality.

On the other hand, as far as we know, this is the first study that analyzed the functional performance of older people at a population level, by sex and according to the level of physical activity, in a small municipality in the Brazilian Northeast. The evidence obtained, therefore, can support health surveillance measures to identify older people with low functional performance. Aiquara ranks 410th in population of the municipalities in the state of Bahia (out of a total of 417) and has a low Human Development Index (0.583),[17] so this brings up the possibility of using a low-cost, easy to apply and interpret measure (physical activity) within the actions developed in primary health care.

Conclusion

Comparative analyses showed that in Aiquara-BA, older women and men who were insufficiently active demonstrated lower performance in tests of mobility, agility, muscle strength and endurance, dynamic balance and aerobic endurance. Furthermore, we found that insufficiently active men had less flexibility than those who were sufficiently active. Given this situation and the high prevalence of insufficiently active older people in Aiquara, it is necessary to implement public policies that enable, in primary health care, health education measures that highlight the importance of engaging in physical activity to preserve the functional performance of the older population.

Authors' contributions

All authors participated in the project conception, study design, data collection, writing and critical review of the manuscript. Furthermore, LS and DJS carried out the analysis and interpretation of the data. All authors approved the final version of the manuscript and declare that there is no conflict of interest. In addition, they are responsible for all aspects of the work, including ensuring its accuracy and completenes.

References

1. Santos L, Santana PS, Caires SS, Barbosa RS, Rodrigues SC, Almeida CB, et al. Força e massa muscular em idosos do Nordeste brasileiro. Res Soc Dev. 2021;10(14):e570101422270. DOI

2. Santos L, Miranda CGM, Souza TCB, Brito TA, Fernandes MH, Carneiro JAO. Composition of women with and without dynapenia defined by different cut-off points. Rev Nutr. 2021;34: e200084. DOI

3. Santos L, Miranda CGM , Silva IES, Santos PHS, Brito TA, Fernandes MH, et al. Anthropometric indicators as predictors of dynapenia in postmenopausal women. Motriz Rev Educ Fis. 2022;28:e10220001522. DOI

4. JafariNasabian P, Inglis JE, Reilly W, Kelly OJ, Ilich JZ. Aging human body: changes in bone, muscle and body fat with consequent changes in nutrient intake. J Endocrinol. 2017; 234(1):R37-51. DOI

5. Tieland, M, Trouwborst I, Clark BC. Skeletal muscle performance and ageing. J Cachexia Sarcopenia Muscle. 2018; 9(1):3-19. DOI

6. Costa RR, Kanitz AC, Reichert T, Prado AKG, Coconcelli L, Butelli ACK, et al. Water-based aerobic training improves strength parameters and cardiorespiratory outcomes in elderly women. Exp Gerontol. 2018;108:231-9. DOI

7. Monteiro CAC. Treinamento de Flexibilidade de sujeitos idosos envolvendo diferentes metodologias. J Aging Innov. 2019;8(2):77-87. Full text link

8. Clementino MD, Alonso AC, Goulart RMM. A influência da atividade física na percepção da qualidade de vida em idosos. Rev Bras Fisiol Exerc. 2018;17(4):247-54. Full text link

9. Confortin SC, Ono LM, Meneghini V, Pastorio AP, Barbosa AR, D'Orsi E. Factors associated with handgrip strength in older adults residents in Florianópolis, Brazil: EpiFloripa Aging Study. Rev Nutr. 2018;31(4):385-95. DOI

10. Rodrigues WKM, Rocha SV, Vasconcelos LRC, Diniz KO. Atividade física e incapacidade funcional em idosos da zona rural de um município do Nordeste do Brasil. Rev Bras Promoç Saude. 2015;28(1):126-32. DOI

11. Santos L, Silva RR, Santana PS, Valença Neto PF, Almeida CB, Casotti CA. Factors associated with dynapenia in older adults in the Northeast of Brazil. J Phys Educ. 2022;33:e3342. DOI

12. Bull FC, Al-Ansari SS, Biddle S, Borudulin K, Buman MP, Cardon G, et al. World Health Organization 2020 guidelines on physical activity and sedentary behaviour. Br J Sports Med. 2020;54(24):1451-62. DOI

13. Sun F, Norman IJ, While AE. Physical activity in older people: a systematic review. BMC Public Health. 2013;13:449. DOI

14. Brasil. Vigilância de fatores de risco e proteção para doenças crônicas por inquérito telefônico: estimativas sobre frequência e distribuição sociodemográfica de fatores de risco e proteção para doenças crônicas nas capitais dos 26 estados brasileiros e no Distrito Federal em 2021. Brasília: Ministério da Saúde; 2021. 128 p. Full text link

15. Castro LFA, Trindade APNT, Balieiro LC, Saavedra FJF. Avaliação da aptidão física e funcional de idosos com prática de atividade física diferenciada. Rev Kairós Gerontol. 2017;20 (3):57-77. Full text link

16. Silva AB, Silva RF, Jacomini AM, Monteiro HL, Zago AS. Association between insufficient practice of physical exercise, walking, and other modalities in healthy elderly. J Phys Educ. 2018;29:e2956. DOI

17. Casotti CA, Almeida CB, Santos L, Valença Neto PF, Carmo TB. Condições de saúde e estilo de vida de idosos: métodos e desenvolvimento do estudo. Prat Cuid Rev Saúde Colet. 2021; 2:e12643. Full text link

18. Santos L, Valença Neto PF, Almeida CB, Souza YS, Silva DJ, Casotti CA. Valores antropométricos normativos em idosos do Nordeste brasileiro: um estudo populacional. Rev Bras Educ Fis Esp. 2022;36:36184395. DOI

19. Icaza MC, Albala C. Proyecto SABE - Mini mental State Examination (MMSE) del estudio de dementiaen Chile: Análisis estatístico. Washington, DC: Organización Panamericana de la Salud; 1999. 18 p. Full text link

20. Bertolucci PH, Brucki SM, Campacci SR, Juliano Y. O mini-exame do estado mental em uma população geral: impacto da escolaridade. Arq Neuropsiquiatr. 1994;52(1):1-7. DOI

21. Santos ES, Santos L, Caires SS, Silva DJ, Souza YS, Valença Neto PF, Casotti CA. Functional performance indicators associated with hypertension in older people. Fisioter Mov. 2023; 36: e36113. DOI

22. Frisancho AR. New standards of weight and body composition by frame size and height for assessment of nutritional status of adults and the elderly. Am J Clin Nutr. 1984;40(4):808-19. DOI

23. Gonçalves TJM, Horie LM, Gonçalves SEAB, Bacchi MK, Bailer MC, Barbosa-Silva TG, et al. Diretriz BRASPEN de terapia nutricional no envelhecimento. Braspen J. 2019;34(Supl 3):2-58. Full text link

24. Figueiredo IM, Sampaio RF, Mancini MC, Silva FCM, Souza MAP. Teste de força de preensão utilizando o dinamômetro Jamar. Acta Fisiatr. 2007;14(2):104-10. DOI

25. Rikli RE, Jones CJ. Development and validation of a functional fitness test for community-residing older adults. J Aging Phys Act. 1999;7(2):129-61. DOI

26. Craig CL, Marshall AL, Sjöström M, Bauman AE, Booth ML, Ainsworth BE, et al. International physical activity questionnaire: 12-country reliability and validity. Med Sci Sports Exerc. 2003;35(8):1381-95. DOI

27. Benedetti TRB, Antunes PC, Añez CRR, Mazo GZ, Petroski EL. Reprodutibilidade e validade do Questionário Internacional de Atividade Física (IPAQ) em homens idosos. Rev Bras Med Esporte. 2007;13(1):11-6. DOI

28. Benedetti TB, Mazo GZ, Barros MVG. Aplicação do questionário internacional de atividades físicas para avaliação do nível de atividades física de mulheres idosas: Validade concorrente e reprodutibilidade teste-reteste. Rev Bras Ci e Mov. 2004;12(1):25-34. Full text link

29. Santos L, Almeida CB, Valença Neto PF, Silva RR, Santos IC, Casotti CA. Habitual physical activity and sedentary behavior as predictors of dynapenia in older adults: a cross-sectional study. Sao Paulo Med J. 2024;142(1):e2023070. DOI

30. Ramsey KA, Rojer AGM, D'Andrea L, Otten RHJ, Heymans MW, Trappenburg MC, et al. The association of objectively measured physical activity and sedentary behavior with skeletal muscle strength and muscle power in older adults: A systematic review and meta-analysis. Ageing Res Rev. 2021;67:101266. DOI

31. 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

32. Pereira AVN, Santos L, Pedreira RBS, Miranda CGM, Fernandes MH, Carneiro JAO. Prevalence and factors associated with dynapenia in older women using different diagnostic criteria. Motriz Rev Educ Fis. 2022;28:e10220005822. DOI

33. Cooper AJM, Lamb MJE, Sharp SJ, Simmons RK, Griffin SJ. Bidirectional association between physical activity and muscular strength in older adults: Results from the UK Biobank study. Int J Epidemiol. 2017;46(1):141-8. DOI

34. Silva CAP. Avaliação do nível de aptidão física funcional em idosos praticantes de Ginástica Para Todos. Estudos Sobre o Envelhecimento. 2017;28(69):74-89. Full text link