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EVALUATION OF BODY MASS, MUSCLE STRENGTH AND MUSCLE FUNCTION IN MILITARY PEOPLE FROM A BATTALION OF THE BRAZILIAN ARMY

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ABSTRACT

Introdução: envelhecer é um processo natural caracterizado pela perda da função fisiológica, a prática de atividade física caracteriza-se como boa estratégia assegurando o bem-estar, sendo comumente os militares beneficiados por este fator. Objetivo: avaliar a perda de massa muscular, força e função muscular em militares da ativa e da reserva remunerada vinculados a um Batalhão de Infantaria Blindada. **Métodos:** estudo transversal quantitativo que avaliou militares do sexo masculino, com idade acima de 40 anos, estado civil, grau hierárquico, força de preensão palmar bilateral, composição corporal, força de membros inferiores, velocidade de marcha e equilíbrio. A análise foi realizada no SPSS 23.0, através do Teste t de *Student*, Teste U de Mann-Whitney e Teste Qui-Quadrado. **Resultados:** A média de idade foi de 46 e 59 anos, quanto a hierarquia, os militares ativos majoritariamente eram Segundo Sargentos, enquanto os reservistas em sua maioria capitães. Referente ao estado civil, 82,9% eram casados. Comparando-se a prática e a não prática de atividade física, observou-se que no grupo ativo, aqueles que não praticavam, apresentaram médias superiores de IMC. Ao comparar as variáveis de força de preensão palmar bilateral, equilíbrio e velocidade de marcha, teste de sentar e levantar e a classificação dos praticantes e não praticantes em ambos os grupos, não houve diferença significativa. **Conclusões:** a prática de atividade física contínua ao longo da vida colabora na manutenção do bem-estar, esse estudo demonstrou que a perda de massa muscular relacionada ao envelhecimento é menor se comparada à população em geral.

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INTRODUCTION

Life expectancy has increased rapidly in recent decades, due to global economic growth driven by reductions in child mortality, better living standards, better lifestyles and education, and higher quality and availability of health care.[1,2] Growing aging of population is a global phenomenon. Between 1970 and 2025, an increase of about 694 million (223%) of people aged 60 and over is expected. By 2050, the projection is for 2 billion elderly people worldwide, 80% of them living in developing countries, and the fastest growing segment of the elderly population will be those aged 80 and over. The share of the European population aged 80 and over is projected to nearly triple between 2011 and 2060.[1,3] Aging is a natural process characterized by a progressive loss of physiological function leading to an increased risk of disease and mortality rate. Characterized by loss of muscle mass and reduced muscle strength and function, sarcopenia is a generalized age-related skeletal muscle disorder that increases the risk of negative outcomes such as falls, fractures, physical disability, loss of independence, reduced quality of life, hospitalization, institutionalization and mortality.[4,5] This condition often overlaps with physical frailty, representing a reduction in the ability to maintain physical fitness, physical performance and a sense of well-being over time and, especially, after stressors as acute illnesses.[6,7] Indeed, frail elderly patients often experience a decline in muscle strength, gait speed, and endurance capacity.[8] Age-related mechanisms that promote the onset of sarcopenia include inflammation, immunosenescence, anabolic resistance, and increased oxidative stress.[9,10]These mechanisms are enhanced in the case of sedentary lifestyle and protein-energy malnutrition, which may be related or to loss of appetite senescence or increases in energy demand related to diseases.[11,12]Thus, exercise and nutritional supplementation are considered the current pillars for the treatment and prevention of physical frailty and sarcopenia.[13] A sedentary lifestyle is the main factor responsible for muscle weakness which, in turn, results in further reduced levels of physical activity and loss of muscle mass and strength. On the other hand, exercise is highly effective in combating the decline in muscle mass and strength associated with aging. In fact, physical activity represents the most effective strategy currently available in the treatment of sarcopenia. Plus, it's the best way to preserve health, longevity and well-being. However, there is still no conclusive evidence to prescribe a specific exercise program in terms of type, intensity, frequency and duration.[14]

Cesari et al.[15]ccorroborate that a physically active lifestyle throughout the life cycle is more beneficial than a sedentary lifestyle, both for mental and physical well-being. As demonstrated by Marchewka and Jungiewicz,[16]the level of quality of life and functionality of the elderly depends on the degree of physical activity before the age of 35 and, to a lesser extent, on a conscious approach to physical fitness, treating it as preparation for the phases later in life. In this sense, the military profession provides the practice of physical exercises from the beginning of adult life. Military personnel must be prepared for emergencies inherent in military life, regardless of their role and whether they are in peacetime or wartime.[17]Each soldier's physical fitness is a critical element in military operations. Military historians have repeatedly emphasized the importance of a high level of physical capability to the military's occupational tasks.[18-20]Soldiers who are in good physical shape not only benefit from improved mission performance, but are also more resistant to operational stressors from variable natures faced during combat.[21]In addition, able-bodied soldiers are less susceptible to musculoskeletal injuries due to the protective effects that resistance exercise confers on tendons, ligaments, and bones, and are less susceptible to disease.[22] The improvement and maintenance of physical fitness in the daily life of the barracks is of paramount importance, as the Brazilian Army's (BA) Military Physical Training Manual (PTM) emphasizes, in which: "...physical preparation, in particular the PTM, it applies and is mandatory for all military personnel considered fit for active duty".[23] Given this context, this study aims to evaluate the loss of muscle mass, strength and muscle function, in active and paid reserve soldiers, linked to the 7th Armored Infantry Battalion (7th AIB).

METHODS

This is a cross-sectional and quantitative study that evaluated 75 male individuals aged over 40 years. To analyze the results, the soldiers were initially divided into two distinct groups: 1) 43 soldiers who are currently part of the career military staff of the 7th AIB; and 2) 32 paid reserve soldiers, registered with the Inactive and Pensioners Section (IPS) of the 7th AIB. Afterwards, these groups were further subdivided, into above and below the mean age of the group. For that, the mean age of active soldiers was 46.3 (±8.0) while those in reserve was 58.4 (±6.8). The 7th AIB is located in the city of Santa Cruz do Sul/RS. This is an Brazilian Army Infantry barracks, an army weapon that is characterized by its physical aptitude to fight on foot, under any weather conditions and in all types of terrain.[24]During the data collection period, the Battalion had a contingent of 948 active soldiers, aged between 18 and 56 years, 939 men and nine women. Of these, seventy individuals were 40 years or older, completed in 2018.
The military personnel were evaluated according to the demographic data from which they were highlighted in this study: age, marital status and hierarchical level; bilateral handgrip strength (HGS), body composition, lower limb strength, gait speed and balance. The measurement of the maximum isometric handgrip strength was obtained from the hydraulic Jamar dynamometer (Sammons Preston Rollyan, 4, Sammons Court, Bolingbrook, IL). Three measurements were taken from both hands, with an interval of one minute of recovery between each measurement, using the highest value obtained.[25]The cutoff points adopted for Brazilian men were 40.89 kgf for the left hand and 42.82 kgf for right hand.[26] The analysis of body composition was performed using bioimpedance using the Inbody 720 device (Body Composition Analyzer, Biospace Co. Ltd), which provided the following variables: Body Mass (BM) (in kg); Skeletal Muscle Mass (SMM), automatically calculated by the equation [(height²/BIA resistance x 0.401) + (gender x 3825) + (age x -0.071)] + 5.102, validated by Janssen et al.27 (BIA resistance in Ohms; gender: male = 1 and female = 0; and age in years).[27]Skeletal Muscle Index (SMI): obtained through the formula: SMM / BM x 100. (in %). A BMI equal to or less than 8.50 kg/m² was considered as a cutoff point for low muscle mass, according to the statistical analysis of data from the NHANES III study, with men and women over 60 years old;[28]Body Mass Index (BMI), obtained through the formula BMI = weight/height², (in Kg/m²) and classification according to the parameters of the World Health Organization[29]in: 1) underweight, 2) eutrophic, 3) overweight and 4) obesity. Height was obtained using a stadiometer, with an accuracy of 0.1cm (in cm). Age was reported in full years of life, obtained at the time of the body assessment, being self-reported by the subject. Waist circumference (WC) was assessed using an anthropometric tape, measuring 0.1mm, according to the NHANES protocol.[30] In addition, the Short Physical Performance Battery (SPPB) test was applied to assess balance, gait, strength and endurance, examining the ability to keep the feet together in side-by-side, semi-tandem and tandem positions, time to walk 4 meters, and time to get up from a chair and return to a sitting position 5 consecutive times. The final SPPB score is given by the sum of the three tests, ranging from 0 to 12. Classification: 0 to 3 points: incapacity or poor ability; 4 to 6 points: low capacity; 7 to 9 points: moderate ability and 10 to 12 points: good ability. The performance of the SPPB tests followed as stipulated by Guralnik et al.[31] Descriptive data analysis was performed using the Statistical Package for Social Sciences (SPSS) version 23.0, using Student's t-test for independent samples and Mann-Whitney U-test and Chi-Square Test.

Ethical Considerations: In compliance with the ethical requirements of Resolution 466/2012 of the National Health Council, the project was approved by the Research Ethics Committee of the University of Santa Cruz do Sul, under protocol 2.993.722 the participants signed the Informed Consent Form.

RESULTS

The mean age of soldiers was 46.26 (3.86) in the active-dutygroup and 59.53 (7.29) in the paid reserve group. As for the hierarchical rank, active-dutysoldiers were composed mainly of Second Sergeants (38.1%), while the majority of reservists were captains (18.6%). As for marital status, 82.9% of individuals were married. It is worth mentioning the low prevalence of soldiers with a smoking habit (1.3%), while the consumption of alcoholic beverages was frequent in 46.6% of those surveyed, more pronounced among active soldiers. Most of the reserve soldiers were in the habit of practicing physical activities, more than three times a week, for at least an hour. There was no statistical difference in the mean BMI results between the active-duty and reserve groups, classified as overweight. In relation to anthropometric values, it was observed that active-duty soldiers had higher SMM [36.54(4.37)], when compared to reserve soldiers [34.50(4.82)], with a statistical difference. While in %F, fat mass weight and WC there was an increase, but without statistical difference (Table 1). As for the dynamometric values of bilateral handgrip strength, the results were higher among active-duty soldiers. In the other variables, the values were similar, with the exception of SPPB, in which active-duty soldiers obtained a higher result in the "Good capacity" and those in the reserve, a higher value in the classification of "Moderate capacity". The results of this table did not show statistical differences (Table 2). From the intra group division (active-duty and reserve), considering the individuals above and below the mean age of each group, it was observed, both in the active-duty and reserve groups, a reduction in the SMM and lean mass weight in the military above the mean age of the group, more accentuated in the group of reserve soldiers, with a statistical difference. On the other hand, %F, WC and fat mass weight did not follow the same trend (Table 3). Still considering the intragroup division (active-duty and reserve), it was verified in relation to the HGS and the SPPB that the values remained higher in the groups below the mean age, with no statistical difference (Table 4). When comparing the practice of physical activity or not in the active-duty and reserve groups, it was observed that in the active-duty group, those who did not practice physical activity had higher BMI (p=0.011), fat mass (p=0.041) and WC (p=0.041), with no significant difference for %F, lean mass and SMM (p>0.05). In the same comparison in the reserve group, no statistical difference was observed in the analyzed variables (p>0.05). Comparing the variables of right and left HGS, balance, gait speed, sit down and stand up test and the SPPB classification in practitioners and non-practitioners of physical activity in the active and reserve groups, it was not possible to observe a significant difference in the variables (p> 0.05).

DISCUSSION

The assessment of muscle mass, function and muscle strength of the soldiers who are part of this study pointed out that, with aging, the loss of SMM occurs even with the regular practice of physical

Table 1. Bioimpedance data of active service and reserve military personnel

Variables	Active service	Reserve	p
%F	21,38 (6,88)	24,10 (6,78)	0,091[a]
BMI	26,77 (3,41)	26,88 (3,94)	0,902[a]
Lean mass weight	64,15 (7,39)	61,23 (8,10)	0,056[b]
Fat mass weight	18,25 (7,93)	20,16 (8,47)	0,411[b]
MM	36,54 (4,37)	34,50 (4,82)	0,022[b]
WC	90,80 (9,54)	92,24 (9,97)	0,524[a]

%F: Percentage of Fat; BMI: body mass index; MM: musculoskeletal mass;WC: Waist circumference; a: Student's t test for independent samples; b: Mann-Whitney U test; p: level of significance. Source: Research Data (2019).

Table 2. Dynamometry and Short Physical Performance Battery data for active service and reserve military personnel

Variables	Active service	Reserve	p
Dynamometry*			
HGS-right	47,65 (7,15)	46,19 (5,51)	0,335[a]
HGS-left	45,36 (6,61)	42,48 (7,14)	0,104[b]
Balance*	4,00 (0,00)	4,00 (0,00)	-
Gait Speed	3,98 (0,15)	3,97 (0,17)	0,850[b]
Sit down and stand up	3,19 (1,05)	3,06 (1,22)	0,876[b]
SPPB classification			
Good Capacity	38 (58,5)	27 (41,5)	0,421[c]
Moderate Capacity	5 (45,5)	6 (54,5)	

HGS: hand grip strength. SPPB: Short Physical Performance Battery; *mean (standard deviation); a: Student's t test for independent samples; b: Mann-Whitney U test; c: Chi-Square Test; p: level of significance. Source: Research Data (2019).

Table 3. Bioimpedance data of active soldiers (subdivided into above and below the group's mean age) and reserve (subdivided into above and below the group's mean age)

Variables	Ative Service		p	Reserve		p
	Mean Age			Mean Age		
	Above	Below		Above	Below	
	(n=21)	(n=22)		(n=19)	(n=14)	
	20,4±7,8	22,4±5,8	0,322[a]	25,6±7,4	22,9±6,2	0,282[a]
%F*	26,0±3,7	27,5±3,0	0,144[a]	26,6±4,8	27,0±3,6	0,775[a]
BMI*	62,0±5,7	66,4±8,3	0,084[b]	57,3±5,9	64,1±8,4	0,014[b]
Lean Mass Weight*	16,7±8,3	19,8±7,3	0,207[a]	20,5±8,5	19,9±8,7	0,653[b]
Fat Mass Weight*	35,2±3,44	37,9±4,9	0,068[b]	32,0±3,5	36,3±4,9	0,006[b]
MM*	89,9±10,0	91,7±9,14	0,543[a]	91,1±9,7	93,1±10,3	0,571[b]
WC*						

%F: Percentage of Fat; BMI: body mass index; MM: musculoskeletal mass; WC: Waist circumference; a: Student's t test for independent samples; b: Mann-Whitney U test; p: level of significance; *: mean and standard deviation. Source: Research Data (2019).

Table 4. Dynamometry and Short Physical Performance Battery data of active military personnel (subdivided into above and below the group's mean age) and reserve (subdivided into above and below the group's mean age)

Variables	Ative Service		p	Reserve		p
	Mean Age			Mean Age		
	Above	Below		Above	Below	
	(n=21)	(n=22)		(n=19)	(n=14)	
Dynamometry*						
HGS-right	45,9±6,8	49,4±7,2	0,115[a]	46,1±5,9	46,2±5,3	0,949[a]
HGS-left	43,8±7,1	47,0±5,8	0,106[a]	42,1±4,6	42,7±8,6	0,271[b]
Balance*	4,0±0,0	4,0±0,0	-	4,0±0,0	4,0±0,0	-
Gait speed*	3,9±0,2	4,0±0,0	0,329[b]	3,9±0,3	4,0±0,0	0,733[b]
Sit down and stand up*	3,5±1,1	2,8±1,0	0,008[b]	3,1±1,2	3,0±1,3	1,000[b]
SPPB classification**						
Moderate Capacity	3 (60)	2 (40)	1,000[c]	2 (33)	4 (67)	1,000[c]
Good Capacity	19 (50)	19 (50)		12 (44)	15 (56)	

HGS: hand grip strength; SPPB: Short Physical Performance Battery; *mean (standard deviation); a: Student's t test for independent samples; b: Mann-Whitney U test; c: Fischer's exact test; p: level of significance; *: mean and standard deviation; **: absolute and relative frequency. Source: Research Data (2019).

activity. However, no significant differences were observed regarding muscle function and muscle strength. We sought to analyze the presence of sarcopenia, defined as the loss of muscle mass, muscle strength and function, in military personnel.[32]It is known that the prevalence of sarcopenia is strongly influenced by the age of the population and that it has been associated with the aging process and older people. However, its development has already been recognized as an earlier process in life, which justified the assessment of middle-aged adults.[33-35] Research carried out by Coin et al.[36],in Italy, with 1535 volunteers, 327 of whom were men, aged between 20 and 80 years, demonstrated a gradual and linear loss of muscle mass with advancing age. On the other hand, a study carried out by Kyle et al.[37],with a sample between 18 and 94 years of age, found a more accentuated loss of SMM from 60 years of age onwards. These two studies cited are in line with the data obtained in this research, as the loss of SMM was evident from the age of 40 onwards and became even clearer when we analyzed the group of reserve soldiers, divided into two subgroups by mean age [58.4 (±6.8)]. The work carried out by Coin et al.[36], formulated parameters and cutoff points for the diagnosis of sarcopenia. However, according to the same author, the characteristic of the reference population and the method used to calculate the corresponding cut-off point for SMM loss must be taken into account when using these cut-off points.

Since 2018, the European Working Group on Sarcopenia in Older People 2 (EWGSOP2) uses in its definition low muscle strength as the main parameter of sarcopenia, this being the most reliable measure of muscle function, clearly indicating that low muscle mass alone it is not sufficient for the diagnosis of sarcopenia.[4]The loss of muscle strength, called dynapenia[38], is a powerful predictor of poor patient outcomes, such as longer hospital stays, increased functional limitations, poor quality of life and health-related death. Handgrip strength is moderately correlated with strength in other body compartments; therefore, it serves as a reliable substitute for more complicated measures of arm and leg strength.[39] When evaluating the results obtained in the HGS, we verified that the two groups (Table 2) and the four subgroups (Table 4) are between the 40th and 60th percentiles, according to the graph for Hispanic men, formulated by McGrath et al.[40]When comparing these data with results obtained in studies carried out with a Brazilian and a South Korean population, with the same age group, the military groups remained with higher HGS values in all parameters.[41,42]A study suggested that every increase of 1 hour in the participation in physical activity was associated with a 6 kg increase in HGS in men. This statement may be related to the maintenance of the HGS of military personnel who practice physical exercises.[43] In accordance with the HGS, the data obtained from the SPPB also remained above average. The assessment through the SPPB was established as an assessment of functionality for healthy elderly people and to identify some conditions of disability.[44]Research carried out by Savikanga et al.[45],showed a strong relationship between physical activity and good performance in the SPPB, which corroborates with the results of this study.

A systematic review carried out by Mijnarend et al.[46],concluded that HGS and SPPB provide a valid and reliable measure of muscle strength and physical performance, respectively. However, it ends by stating that the combination of selected instruments and their use in the screening and identification of sarcopenia in elderly people in the community need additional evaluation. In the early stages of the development of sarcopenia, an individual may be above the low physical performance threshold and will likely be above the disability threshold. Although genetic and lifestyle factors can accelerate the loss of muscle strength and progression to functional impairment and disability, interventions such as nutrition and exercise training appear to delay or reverse these processes. Therefore, to prevent or delay sarcopenia, the objective is to maximize muscle mass gain in youth and adulthood, maintain muscle in middle age and minimize loss in old age.[47]Whereas, the population evaluated practiced physical activity throughout life and most still maintain this habit, the loss of SMM may have been delayed or attenuated. In addition, the sarcopenia phenotype has many contributing causes in addition to aging.[48,49]Among these causes, lack of physical activity and exercise throughout life is considered the main cause of sarcopenia.[50]Whereas, the Brazilian Army's Manual of Military Physical Training determines that the practice of physical exercise is mandatory for all active-duty soldiers, we evaluated a homogeneous group that practiced physical exercise throughout their adult life.[23] This study had limitations in the scarce literature related to the body assessments and health of military personnel. Also, a small sample of a contingent of hundreds of thousands of Brazilian Army soldiers was approached. This work covers a population that has been little studied and that, due to the military system, represents a homogeneous sample in several factors. This research can serve to promote improvements in the daily life and health of the military, as well as to encourage further research. This study showed that age-related loss of muscle mass is lower in military personnel when compared to the general population. This is due to the continuous practice of physical activities throughout life. Continuous physical activity helps maintain muscle strength, the main parameter in the diagnosis of sarcopenia. In addition, there was a better performance in SPPB by practitioners of physical activity. This set of findings, in practice, reflects a better quality of life and autonomy in old age. Finally, new studies need to be carried out to monitor the process of loss of SMM in this population, as this was a cross-sectional study.

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