Universidade de Aveiro
Ano 2022

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Impacto das disfunções musculoesqueléticas no estado funcional de pessoas consideradas saudáveis

Impact of musculoskeletal impairments on functional status of considered healthy people

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Dissertação apresentada à Universidade de Aveiro para cumprimento dos requisitos necessários à obtenção do grau de Mestre em Fisioterapia – ramo musculosquelética, realizada sob a orientação científica da Doutora Alda Marques, Professora Coordenadora da Escola Superior de Saúde da Universidade de Aveiro e co-orientação da Doutora Sara Almeida, Epidemiologista Associada do IQVIA

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palavras-chave disfunção musculosquelética, estado funcional, testes funcionais.

resumo

As disfunções musculoesqueléticas representam uma enorme sobrecarga para a saúde das pessoas em todo o mundo, uma vez que afetam a estrutura e função de músculos, ossos e articulações, o que desencadeia alterações nos padrões de movimento. Estas alterações vão originar um declínio no estado funcional, com repercussões consequentes na qualidade de vida.

O objetivo deste estudo foi determinar o impacto que as disfunções musculosqueléticas apresentam no estado funcional através de quatro testes funcionais. Este estudo transversal foi realizado em instituições comunitárias, escolas de terceira idade, centros desportivos e centros de dia, foram incluídos participantes com idade superior ou igual a 40 anos. As características sociodemográficas e antropométricas foram recolhidas, as disfunções musculosqueléticas foram autorreferidas e, em seguida, o estado funcional foi avaliado. O estado funcional dos membros superiores foi avaliado com a força de preensão manual com um dinamómetro e dos membros inferiores foi avaliado com a força muscular isométrica do quadríceps com o dinamómetro de mão, o teste de levantar e sentar 1 minuto (1min.STS) e o teste de sentar e levantar 5 vezes (5STS).

545 participantes foram incluídos no estudo, destes, 56 (10.6%) apresentavam disfunção musculosquelética. Os principais fatores associados ao estado funcional diminuído foram ser mulher, idade superior, alto IMC e o consumo de medicação. Em conclusão, este estudo mostra uma relação entre pessoas que apresentavam disfunção musculoesquelética e um menor desempenho no estado funcional em comparação com aquelas sem comprometimento. Também demonstra que a idade, o IMC, a medicação e diferenças de sexo influenciam o resultado dos testes funcionais que levam a um declínio do estado funcional. A fisioterapia pode ajudar na consciencialização para esta temática e na implementação de programas de saúde, nomeadamente, através do exercício para melhoria da função e qualidade de vida das pessoas ao longo do tempo.

keywords musculoskeletal impairment, functional status, functional tests.

abstract Musculoskeletal impairments represent a huge burden on the health of people around the world, as they affect the structure and function of muscles, bones and joints, which triggers changes in movement patterns. These changes will lead to a decline in functional status, with consequent repercussions on quality of life.

The aim of this study was to determine the impact that musculoskeletal impairments have on functional status through four functional tests. This cross-sectional study was carried out in community institutions, senior schools, sports centers and day care centers, participants aged 40 years or older were included. Sociodemographic and anthropometric characteristics were collected, musculoskeletal disorders were self-reported, and then, functional status was assessed. The functional status of the upper limbs was assessed with handgrip strength with a dynamometer and lower limbs was assessed with isometric quadriceps muscle strength with a handheld dynamometer, the 1-minute stand to stand test (1min.STS) and the 5 times sit to stand test (5STS).

545 participants were included in the study, of which, 56 (10.6%) had musculoskeletal impairment. The main factors associated with decreased functional status were being a woman, older age, high BMI and medication consumption.

In conclusion, this study shows a relationship between people who had musculoskeletal dysfunction and a lower performance in functional status compared to those without impairment. It also demonstrates that age, BMI, medication, and sex differences influence the outcome of functional tests that lead to a decline in functional status. Physiotherapy can help raise awareness of this issue and the implementation of health programs, namely through exercise to improve people's function and quality of life over time.

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Abbreviations

1min.STS – 1 minute sit to stand test

5STS – 5 repetitions sit to stand test

BMI - Body mass index

CCI - Charlson comorbidity index

HHD QMS – Handheld dynamometer quadriceps muscular strength

ICC - Intraclass correlation coefficient

ICF - International Classification of Functioning, Disability and Health

IQR – Interquartile range

MDC - Minimal detectable change

MSK - Musculoskeletal

SEM - Standard error measurement

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Introduction

Musculoskeletal impairments include deficiencies in movement, function or structure of muscles, bones and joints, the origin of which may be congenital, neurological or from trauma or disease (MacTaggart et al., 2019). They are characterized by pain, decreased mobility and an overall decline in functional status, which greatly affects health status related to quality of life (Beaudart et al., 2018; Minetto et al., 2020).

Musculoskeletal impairments represent an enormous burden on people's health worldwide, with the functional status being the most affected system (Antonopoulou et al., 2009; Lewis et al., 2019). Musculoskeletal health is essential to maintain the individual's functional independence, since it contributes to mobility, dexterity, and the most varied functions that allow independence in activities of daily living throughout life (Briggs et al., 2016).

Deficient musculoskeletal health can cause acute pain, or, if persistent, become chronic, with the complications that this entails in other health domains, such as functional limitation (Briggs et al., 2016). Based on the International Classification of Functioning, Disability and Health (ICF), the functional status can be defined as an interaction of several factors, between health status, personal and environmental factors, and their reciprocal influence on the structures and functions of the body, which allow an active participation in the activities of the daily life (World Health Organization, 2001). It is known that people with musculoskeletal impairments have a higher consumption of health care and a lower quality of life, especially with regard to functional status since these people tend to become more inactive (Branco et al., 2016; Briggs et al., 2016). Musculoskeletal conditions are the biggest triggers of dysfunction and functional limitation, and its prevalence is expected to increase with the aging of the population, since these affect the older population in greater numbers (Chen et al., 2003).

Although it is known that musculoskeletal impairments have a huge impact on civilization, few studies have been carried out to understand the causes and prevalence of these injuries (Atijosan et al., 2007). In addition, this impact has been measured through mortality statistics and, therefore, are underestimated results, since people do not die from these conditions (Woolf et al., 2010). However, some of them tend to become chronic and, therefore, recurrent throughout life, contributing to the decline of their health status (Woolf et al., 2010). The permanence of these conditions is accentuated over time, through several factors that cannot be modified, such as advancing age, but by several others that can be identified, modified and even treated, such as comorbidities, obesity and tendency to physical inactivity (Woolf et al., 2010).

In order to mitigate musculoskeletal impairments and functional impairment, health professionals, namely physical therapists, play an important role in the early identification and assessment of this impact and resulting complications (Burmester et al., 2017; Smith et al., 2016; Woolf et al., 2010). Physiotherapists can prescribe and treat modifiable agents, in addition to educating the patient for health, preventing the decline of functional status and promoting quality of life (Burmester et al., 2017; Smith et al., 2016; Woolf et al., 2010). Musculoskeletal disorders are primarily controllable through the implementation of exercise and physical activity (Smith et al., 2016). Physiotherapists are, therefore, health professionals with a leading role in the management of musculoskeletal conditions, since they have the necessary tools to establish specific interventions to improve functional status and, consequently, quality of life over time (Rand et al., 2007).

In this study, the objective was to determine the impact that musculoskeletal impairments have on the functional status of people considered healthy.

Methods

Study design and Ethics

A cross-sectional study was conducted and reported according to STROBE guidelines. Ethics approval was provided by the Health Sciences Research Unit: Nursing, Coimbra, Portugal - UICISA-E (P517-08 / 2018 AD 6/4/2021). Written informed consent was obtained from all participants prior to any data collection.

Participants

Recruitment of participants was carried out in community institutions, senior schools, sports centers and day care centers, after providing a written authorisation for their participation. A member of staff of each institution was assigned to present the study to eligible participants.

Participants were included if: they were 40 years old or older; showed a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity (World Health Organization, 1995); could follow instructions and accepted to participate voluntarily in the study. Exclusion criteria for the study were the presence of: an acute disease in the previous month, a significant cardiorespiratory (e.g., chronic obstructive pulmonary disease [COPD], asthma, heart failure, myocardial infarction), musculoskeletal (e.g., rheumatoid arthritis, scoliosis, severe osteoarthritis or amputation) and/or neurological (e.g., stroke) disorder, history of neoplasic or immunological disease and signs of substances abuse (e.g., alcohol, drugs) that could interfere or limit participation in the study or data collection. Only interested participants were contacted by researchers to schedule the assessment.

Procedures

First, socio-demographic (sex, age, education level, occupation) and anthropometric (BMI **-** a scale [GIMA, max. 160Kg]) were collected to characterise the sample. Then, musculoskeletal impairments and the frequency of each one was collected to understand their prevalence.

Upper-limb functional status was assessed with the handgrip in kilograms (Baseline Lite Hydraulic Hand Dynamometer, White Plains, NY, U.S.A.) to measure isometric grip force (hand grip strength) (Spruit et al., 2013).

Lower-limb functional status was assessed with the i) handheld dynamometer in kilogram-force (microFET2, Hoggan Health, the best Salt Lake City, Utah) to quantify quadriceps muscle strength; ii) 1 minute sit to stand (1min.STS) which assesses the performance of the lower extremity muscles and iii) five repetition sit-to-stand test (5STS) to evaluate the mobility and balance.

Measures

Body Composition

Body Mass Index (BMI) is a statistical index that estimates the body fat in males and females of all ages (Weir & Jan, 2019). It is normally computed using the following equation [BMI=weight (in kg)/height^2 (in m^2)]. Values are interpreted according to the cut-off points: underweight under 18.5 kg/m^2, normal weight BMI greater than or equal to 18.5 to 24.9 kg/m^2 and overweight BMI greater than or equal to 25 kg/m^2 (Weir & Jan, 2019).

Charlson comorbidity index

The Charlson comorbidity index classifies the number of comorbidities present, which allows a prognosis of mortality (Quan et al., 2011). According to the probability of mortality in one year, each comorbidity was rated. Then, all points are added up and the total score can range from 0 to 24 points, with a higher score predicting earlier mortality (Quan et al., 2011). Charlson et al. (1987) classified comorbidities as mild (CCI scores of 1 – 2), moderate (CCI scores of 3 – 4) or severe (CCI scores ≥5).

Functional status

Upper-limb functional status

Handgrip muscle strength

Upper limp isometric muscle strength was assessed with the handgrip muscle strength (Spruit et al., 2013). The person is asked to hold the handgrip dynamometer in line with the forearm at the level of the thigh, away from the body and to squeeze the handgrip dynamometer as hard as possible (holding 3 seconds) without holding the breath (to avoid the Valsalva maneuver) (Spruit et al., 2013; Williams et al., 2007). Neither the hand nor the handgrip dynamometer should touch the body or any other object (Spruit et al., 2013). The test was repeated twice with dominant hand and the highest of the two performances was registered. The participant rested at least 30 seconds between measurements (P. D. Thompson et al., 2013).

We used reference values of handgrip strength from Spruit et al. (2013) on individuals under the age of 65, however, for people aged 65 and over, we used the reference values of Mendes et al. (2017) that were established for the Portuguese population as in our study (Mendes et al., 2017; Spruit et al., 2013). Afterwards, we used the value obtained in the test, divided it by the 50th percentile (reference values), and multiplied it by 100, to compare this value with the cut off, to verify if they were above or below (presence of impairment) 70% (Koolen et al., 2019). We established this cut-off based on previous studies, where it was considered statistically reasonable in the absence of a value that differentiates the performance capacity (Koolen et al., 2019).

Handgrip muscle strength has been used in several populations, including healthy adults, since it is considered a measure that allows assessing the general well-being of the individual through its ability to assess muscle strength and, thus, predict decline in mobility, functional status and even mortality (Rijk et al., 2016; Spruit et al., 2013).

Handgrip muscle strength assessments with the handgrip dynamometer have shown to be valid and reliable in healthy people, with a very good range of interrater reliability (ICC = 0.86–0.99) but with a very large test-retest reliability (ICC = 0.48–0.99) (Cronin et al., 2017; Massy-Westropp et al., 2004).

Lower-limb functional status

Handheld dynamometer

Quadriceps isometric muscle strength was assessed with the handheld dynamometer (Chamorro et al., 2017). The test consisted of placing the dynamometer perpendicular to the segment, in the distal segment of the leg, and the participant was asked to perform maximum force for 6 seconds, after practice. The test was performed 3 times, for 30 seconds, with 1 minute of rest between measurements to avoid fatigue and record the best value. (Bohannon, 1997; Walsh et al., 1996). We determined the predictive muscular strength of each participant using the predictive equation for knee extension (Andrews et al., 1996). Then, with the observed result, we divided it by the predictive result of the equation, multiplied it by 100 and determined whether it was above or below (presence of impairment) the cut-off of 70% as explained before (Koolen et al., 2019).

Handheld dynamometer seems to be a good tool for measurement of quadriceps isometric muscle strength and has been widely used in the assessment of functional disability among healthy people and with diverse conditions, including musculoskeletal impairments (Chamorro et al., 2017; Mentiplay et al., 2015).

The measurement properties of the handheld dynamometer have already been reported by other studies and considered this instrument valid and reliable in healthy adults, with moderate to high concurrent validity in relation to the gold standard (isokinetic dynamometer) (Arnold et al., 2010; Mentiplay et al., 2015). In concern to reliability, this test has an intraclass correlation coefficient (ICC) of 0.90 that is excellent, 8.76% SEM (standard error measurement) and minimal detectable change (MDC) of 17.18% expressed as a percentage of the mean and 95% confidence intervals (Mentiplay et al., 2015).

1 minute Sit to stand test (STS)

This test assesses the endurance and strength of the lower extremity muscles (Strassmann et al., 2013). To perform the test, a stopwatch and a chair with 46 cm height are required (Strassmann et al., 2013). Then, the chair must be stabilized against a wall and participants sit with their hands stationary on the hips, without using the hands or arms to assist movement (Ozalevli et al., 2007).

Participants are then instructed to stand up all the way and sit down, as many times as possible, for 1 minute (Strassmann et al., 2013). After 45 seconds, participants were told “you have 15 seconds left until the test is over” (Puhan et al., 2013). Participants were allowed to use rest periods to complete the test (Ozalevli et al., 2007). The number of completed repetitions was recorded and the best performance of 3 trials was considered for analysis (Marques et al., 2016; Podsiadlo,D, Richardson, 1991). With the number of repetitions performed in the test, we divided it by the 50th percentile (reference values) and multiplied it by 100 to see if the performance would be above or below a functional impairment of 70%, since there is no established cut-off point (Koolen et al., 2019; Strassmann et al., 2013).

The 1 minute sit to stand test is an instrument widely used in healthy populations to measure the ability to generate strength and muscular endurance, since it is an exercise easily replicated on a daily basis, and thus, assesses the functional status (Ozalevli et al., 2007; Strassmann et al., 2013). Measurement properties in healthy adult populations are established, since this test is valid, when compared with laboratory tests, and reliable, with an intra correlation coefficient (ICC) of 0.80 (95% CI) which is very good and the responsiveness of the test is 4 repetitions for minimal detectable change (Bohannon & Crouch, 2019; Ritchie et al., 2005). This test also shows a high correlation with other tests that assess functional status such as the 6-min. walk test (Ozalevli et al., 2007).

Five repetitions sit to stand test (5STS)

The sit-to-stand test with five repetitions measures lower limbs muscle strength, mobility and balance (Muñoz-Bermejo et al., 2021). The test is carried out similarly to the previous one, with the same specificities, only the arms are normally crossed on the front of the chest and the timer is stopped when the person sits down for the fifth time (Paul & Canning, 2014).

Five repetitions sit to stand test is widely used in healthy adults and the elderly to assess functional performance through mobility, balance and strength in the lower limbs and agility to perform the test in the shortest possible time (Muñoz-Bermejo et al., 2021).

The test is valid and reliable in healthy population, with high reliability with 0.81 ICC (95% CI), among older adults and has 66% sensitivity and 55% specificity (Bohannon, 2012; Muñoz-Bermejo et al., 2021; Tiedemann et al., 2008). Although no reference values in decades are available, we used the cut-off value of 12s which indicates the limit of normality, timing higher than this shows an abnormal performance (Bohannon, 2006; Klukowska et al., 2021; Mong et al., 2010).

Statistical Analysis

Data were analysed using IBM SPSS Statistics, version 25, and the level of significance was set at $p<0,05$. Descriptive statistics were used to describe the sample, through absolute frequencies, median and interquartile range. The normality of data was checked using the Kolmogorov-Smirnov test. To compare the differences between groups the Chi-square test was used for dichotomous variables, and the Mann-Whitney U-test for ordinal. Since there were no normative values to differentiate the presence of impairment, we used the value of 70% predicted, which was previously established as a statistically acceptable value. Except for the 5STS where the 12s cut off was used. Spearman correlations were performed between the two functional tests (1min.STS and 5STS) that showed differences between the groups, and the sociodemographic variables and clinical characteristics; in the case of dichotomous variables, the point biserial correlation coefficient was used. Multiple linear regressions were performed to understand which variables would explain the variation in the results of the functional tests. All regression assumptions were met, except for normality, with regard to the 5STS test.

Results

In total, 570 participants were recruited, however, 10 were excluded due to unspecified MSK impairment and other 15 for not performing any functional test, thus 545 participants composed the total sample included in the analysis. Figure 1 presents the flowchart of inclusion in the study.

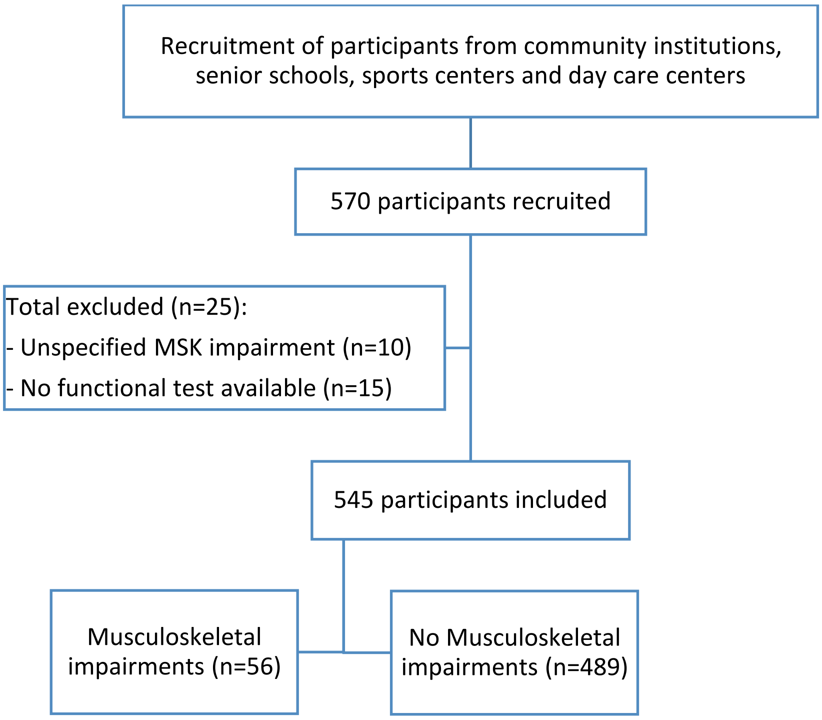

Figure 1 – Flowchart of study participants.

Our sample was between 43 and 93 years old, mostly composed of male (n=320; 58.7%), overweight (n=395; 72.5%), mainly with primary school (n= 294; 54%), not working (n=417; 76.5%), nonsmokers (n=422; 77.4%), consuming 1 to 4 medications (n=326; 78,4%) and presented mild to moderate comorbidities (n=500; 92,6%). Those with musculoskeletal impairments (n=56; 10.3%) were mainly female and significantly older, with higher educational and level of comorbidities than people without musculoskeletal impairments (n=489; 89,7%). Details of the characterization of the sample can be found in Table 1.

Table 1 - Characterization of the total sample with and without musculoskeletal impairments

Characteristics	**Total (n=545)**	**No Musculoskeletal impairments (n=489)**	**Musculoskeletal impairments (n=56)**	**P-value**
Sex				0.005*
Female, n (%)	225 (41.3)	192 (39.3)	33 (58.9)	
Male, n (%)	320 (58.7)	297 (60.7)	23 (41.1)	
Age (years) median [IQR]	69 [63-76.5]	69 [62-76]	73.5 [69-80]	<0.001*
Education level				<0.001*
Without formal education, n (%)	35 (6.1)	27 (5.5)	6 (10.7)	
Primary, n (%)	294 (54)	252 (51.6)	42 (75)	
Secondary, n (%)	119 (21.9)	112 (23)	7 (12.5)	
Highschool, n (%)	57 (10.5)	56 (11.5)	1 (1.8)	
University, n (%)	41 (7.5)	41 (8.4)	0 (0)	
Occupation				0.005*
Working, n (%)	128 (23.5)	123 (25.2)	5 (8.9)	
Not working, n (%)	417 (76.5)	366 (74.8)	51 (91.1)	
BMI (kg/m^2) median [IQR]	27.1 [24.6-29.9]	27.1 [24.7-29.7]	27.2 [24.4-32.6]	0.263
Underweight, n (%)	3 (0.6)	3 (0.6)	0 (0)	0.736
Normal, n (%)	147 (27)	130 (26.6)	17 (30.4)	
Overweight, n (%)	395 (72.5)	356 (72.8)	39 (69.6)	
Smoking status (pack/years) median [IQR]	0 [0-0]	0 [0-0]	0 [0-0]	0.039*
Never, n (%)	422 (77.4)	373 (76.3)	49 (87.5)	0.141
Current, n (%)	18 (3.3)	17 (3.5)	1 (1.8)	
Former, n (%)	105 (19.3)	99 (20.2)	6 (10.7)	
Use of medication, n (%)	365 (78)	324 (77.3)	41 (83.7)	0.366
0, n (%)	71 (17.1)	69 (19)	2 (3.8)	
1-2, n (%)	144 (34.6)	136 (37.4)	8 (15.4)	
3-4, n (%)	111 (26.7)	89 (24.5)	22 (42.3)	
5-10, n (%)	84 (20.2)	67 (18.4)	17 (32.7)	
11-15, n (%)	3 (0.7)	1 (0.3)	2 (3.8)	
16+, n (%)	3 (0.7)	2 (0.5)	1 (1.9)	
Comorbidities, n (%)	419 (77)	363 (74.4)	56 (100)	<0.001*

CCI median [IQR]	3 [2-4]	3 [2-4]	3.5 [3-4.3]	<0.001*
None, n (%)	9 (1.7)	9 (1.9)	0 (0)	0.001*
Mild (1-2), n (%)	224 (41.5)	213 (44)	11 (19.6)	
Moderate (3-4), n (%)	276 (51.1)	236 (48.8)	40 (71.4)	
Severe (≥5), n (%)	31 (5.7)	26 (5.4)	5 (8.9)	

Data are presented in absolute frequencies and median and interquartile range [IQR] unless otherwise indicated. * p<0.05
Abbreviation: SD – standard deviation; BMI – body mass index; IQR – interquartile range; CCI – Charlson Comorbidity Index.

Figure 2 presents the three main comorbidities presented in the sample. The groups with and without MSK impairments, presented 26.8% (n=15) and 16.6% (n=81) diabetes, 39.3% (n=22) and 38.1% (n=186) dyslipidemia, arterial hypertension 48.2% (n=27) and 47.4% (231), respectively.

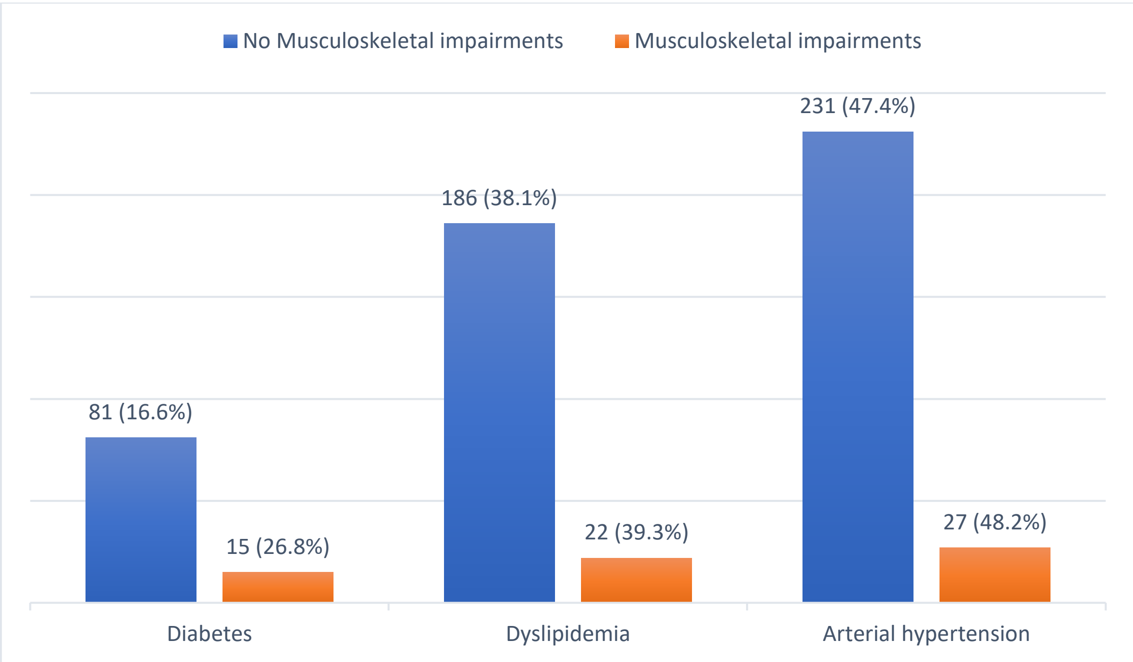

Figure 2 - Characterization of the three main comorbidities in people with (n=56) and without (n=489) musculoskeletal impairments.

Figure 3 exhibits the characterization of comorbidities of the 56 individuals with musculoskeletal impairments. The three most common comorbidities were osteoarthritis (n=29; 43.3%), osteoporosis (n=23; 34.3%) and 22.4% back-spine problems (n=15).

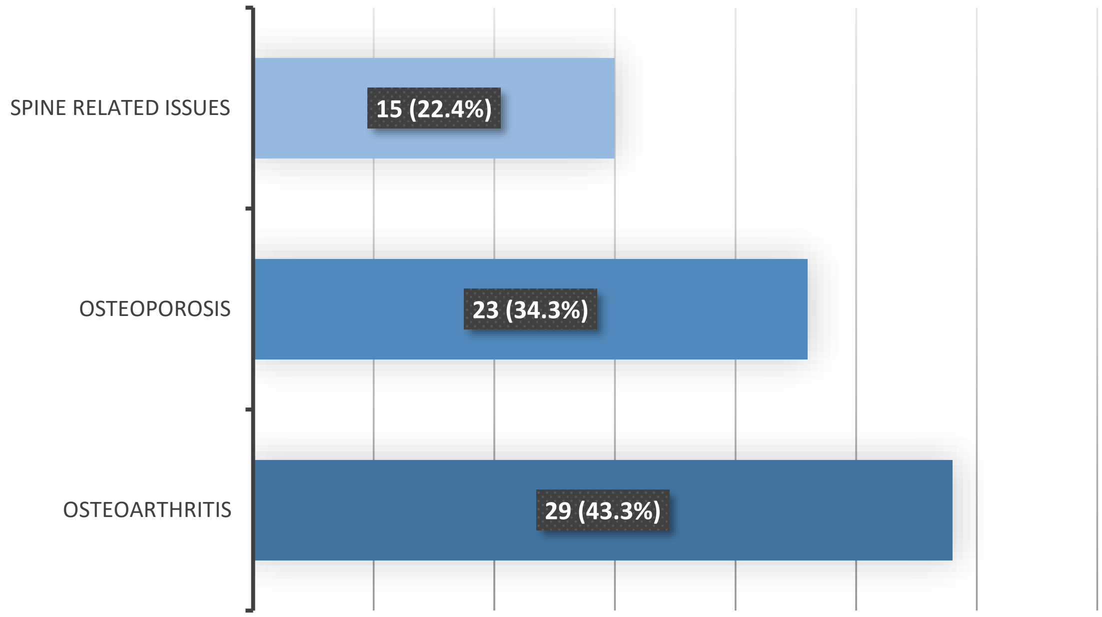

Figure 3 – Characterization of the three main comorbidities among people with musculoskeletal impairments (n=56).

Figure 4 shows the predominant pharmacological groups in the sample and the comparison between groups with and without musculoskeletal impairments. There were five main pharmacological groups. Overall people with musculoskeletal impairments were more medicated across all types of pharmacological groups than those without musculoskeletal impairment, i.e., 31.4% (n=16) vs 12% (n=76) used psychopharmaceuticals; 14 (27.5%) vs 55 (13%) used anxiolytics, sedatives and hypnotics; 61.5% (n=32) vs 48.4% (n=203) used anti-hypertensive; 27 (52.9%) vs 136 (32.2%) anti-dyslipidemics; 23.1% (n=12) vs 14% (n=59) insulins, antidiabetics and glucagon.

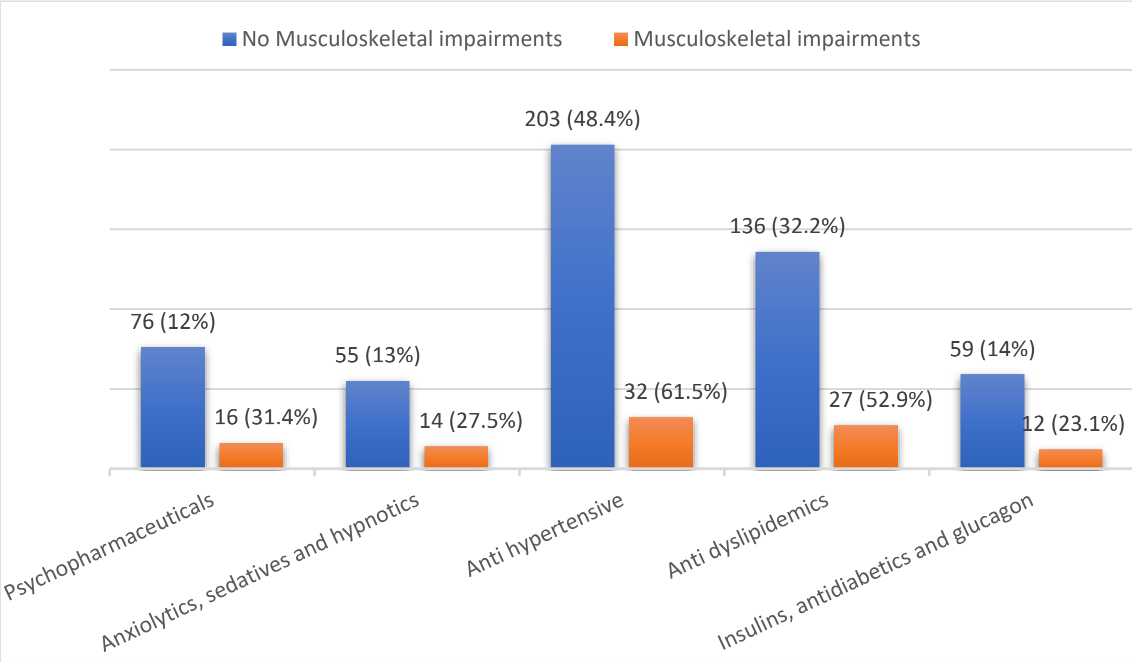

Figure 4 – Characterization of the main pharmacological groups in people with (n=56) and without (n=489) musculoskeletal impairments.

Table 2 presents the functional status of our sample and comparisons between those with and without musculoskeletal impairments. No significant differences in the performance of the HHD QMS and Handgrip tests were found. Significant differences were, however, found in the number of repetitions of the 1min.STS between groups, with people with musculoskeletal impairments showing lower performance (median of 28.5 vs 35 repetitions) than those without musculoskeletal impairments. Performance time of the 5STS test, was also significantly different with people with musculoskeletal impairment taking longer (median 10.2 [6.8-11.9] seconds) than those without musculoskeletal impairment (median 7.5 [6.2-9.3] seconds) to complete the test.

Table 2 – Functional status of people with (n=56) and without (n=489) musculoskeletal impairments

Functional Status	Total	No Musculoskeletal impairments	Musculoskeletal impairments	P-value
HHD QMS (kgf), n (%)	435 (100)	406 (93.3)	29 (6.7)	
median [IQR], kgf	27.4 [18.6-33.7]	27.4 [18.8-33.8]	27.3 [15.8-33]	0.518
<70% predicted, n (%)	175 (40.2)	160 (39.4)	15 (51.7)	
≥70% predicted, n (%)	260 (59.8)	246 (60.6)	14 (48.3)	

Handgrip (kg), n (%)	392 (100)	363 (92.6)	29 (7.4)	
median [IQR], kg	36 [28-44]	36 [28-44]	30.5 [25-43]	0.079
<70% predicted, n (%)	18 (4.6)	17 (4.7)	1 (3.4)	
≥70% predicted, n (%)	374 (95.4)	346 (95.3)	28 (96.6)	
1min.STS (repetitions), n (%)	396 (100)	365 (92.2)	31 (7.8)	
median [IQR], repetitions	34 [28-41]	35 [28-41.8]	28.5 [23-35.8]	0.002*
<70% predicted, n (%)	40 (10.1)	35 (9.6)	5 (16.1)	
≥70% predicted, n (%)	356 (89.9)	330 (90.4)	26 (83.9)	
5STS (seconds), n (%)	545 (100)	489 (89.7)	56 (10.3)	
median [IQR], seconds	7.6 [6.2-9.5]	7.5 [6.2-9.3]	10.2 [6.8-11.9]	0.002*
≥12seconds, n (%)	108 (19.8)	88 (18)	20 (35.7)	
<12seconds, n (%)	437 (80.2)	401 (82)	36 (64.3)	

Data are presented in absolute frequencies and median and interquartile range [IQR] unless otherwise indicated. * p<0.05
Abbreviation: HHD QMS – handheld dynamometer quadriceps muscular strength; 1min.STS – 1 minute sit to stand; 5STS – 5 repetitions sit to stand; SD - standard deviation; IQR – interquartile range; kg – kilograms; kgf – kilograms strength.

Correlations were only performed with two functional tests, the 1min.STS and the 5STS, as these were the only variables showing significant differences between groups in the previous analysis. In participants without musculoskeletal impairment, there were significant, negative and weak correlations between the 1min.STS (n=396) and age (r_s=-0.432**; p<0.001), occupation (r_s=-0.298**; p<0.001), BMI (r_s=-0.173**; p=0.001), CCI total score (r_s=-0.431**; p<0.001), musculoskeletal impairment (r_s=-0.155**; p=0.002) and positive and weak correlation with the education level (r_s=0.212**; p<0.001). No other significative correlations were found in the other group.

Significant, positive correlations between the 5STS (n=56) with age (r_s = 0.374*; p = 0.005) and CCI total score (r_s = 0.371**; p = 0.006) and negative with pack/years (r_s = -0.285*; p = 0.039), all weak were found in those with musculoskeletal impairment (n=56).

Significant, negative and weak correlations were found between the 5STS of those without musculoskeletal impairment (n=545) and sex (r_s=-0.204**; p<0.001), education level (r_s=-0.360**; p<0.001), smoking status (r_s=-0.130**; p=0.003), pack/years (r_s=-0.171**; p<0.001). Moreover, correlations between the 5STS were also found to be significant, positive and moderate (r_s=0.510**; p<0.001) with age; positive and weak with occupation (r_s=0.329**, p<0.001), BMI (r_s=0.110*; p=0.011), medication (r_s=0.168**; p=0.001), CCI total score (r_s=0.478**; p<0.001) and musculoskeletal impairment (r_s=0.136**; p=0.002). No other significant correlations were found.

Table 3 – Spearman correlations between functional tests (1min.STS and 5STS) and sociodemographic and clinical characteristics of people with (n=31; n=56) and without (n=396; n=545) musculoskeletal impairment

Characteristics	1min.STS (repetitions)		5STS (seconds)	
	Musculoskeletal impairments (n = 31)	No Musculoskeletal impairments (n = 396)	Musculoskeletal impairments (n = 56)	No Musculoskeletal impairments (n = 489)
Sex	r_{pb}=0.205 p=0.305	r_{pb}=-0.011 p=0.830	r_{pb}=-0.169 p=0.221	r_{pb}=-0.204** p<0.001
Age	r_s=-0.019 p=0.926	r_s=-0.432** p<0.001	r_s=0.374* p=0.005	r_s=0.510** p<0.001
Education level	r_s=-0.197 p=0.324	r_s=0.212** p<0.001	r_s=-0.052 p=0.707	r_s=-0.360** p<0.001
Occupation	r_{pb} =-0.163 p=0.415	r_{pb}=-0.283** p<0.001	r_{pb}=0.013 p=0.925	r_{pb}=0.308** p<0.001
Smoking status	r_{pb}=0.233 p=0.241	r_{pb}=-0.041 p=0.433	r_{pb}=-0.224 p=0.103	r_{pb}=-0.120** p=0.008
Pack/years	r_s=0.231 p=0.247	r_s=0.007 p=0.890	r_s=-0.285* p=0.039	r_s=-0.171** p<0.001
BMI	r_s=-0.198 p=0.333	r_s=-0.173** p=0.001	r_s=0.093 p=0.509	r_s=0.110* p=0.011
Medication	r_s=-0.091 p=0.672	r_s=-0.049 p=0.427	r_s=0.053 p=0.711	r_s=0.168** p=0.001
CCI	r_s=-0.224 p=0.261	r_s=-0.431** p<0.001	r_s=0.371** p=0.006	r_s=0.478** p<0.001
MSK impairment	---	r_s=-0.155** p=0.002	---	r_s=0.136** p=0.002

*Correlation is significant at the 0.05 level; ** Correlation is significant at the 0.01 level

Abbreviation: 1min.STS – 1 minute sit to stand; 5STS – 5 repetitions sit to stand; 1minSTS_pp – 1 minute sit to stand predicted percentage; 5STS_pp – 5 repetitions sit to stand predicted percentage; BMI – body mass index; CCI – Charlson Comorbidity Index; MSK impairment – musculoskeletal impairment.

Table 4 shows that the regression model was statistically significant [F(5,379)=23.41, p<0.001] explaining 24% of the variance of the 1min.STS test. Age and BMI were the only significant predictors of the 1min.STS outcome, and the increase of 3,401 years (age) and 6,173 kg/m^2 (BMI) of the variables was associated with a decrease of 1 repetition in the performance of the 1min.STS test.

Table 4 – Multiple linear regression - impact of age, current occupation, body mass index, Charlson Comorbidity Index, musculoskeletal impairment on 1 minute sit to stand test in people without musculoskeletal impairment (n=396)

	Variables	B	SE	β	t	p
1min.STS	Constant	79.165	6.646	-	-	-
	Age	-0.359	0.111	-0.294	-3.219	0.001*
	Occupation	-0.745	1.490	-0.028	-0.500	0.617
	BMI	-0.442	0.124	-0.162	-3.566	<0.001*
	CCI	-1.508	0.878	-0.149	-1.718	0.087
	MSK impairment	-1.985	2.148	-0.043	-0.924	0.356

Abbreviations: 1min.STS – 1 minute sit to stand; BMI – body mass index; CCI – Charlson Comorbidity Index; MSK impairment – musculoskeletal impairment; B: non standardized coefficient; SE: standard error; β: Beta standardized coefficient.

Table 5 shows that the regression model was not statistically significant [F(3.49)=2.57, p=0.065] explaining 8% of the variance of the 5STS test in the population with musculoskeletal impairment.

Table 5 – Multiple linear regression - impact of age, smoking (pack/years) and Charlson Comorbidity Index on 5 repetitions sit to stand test of people with musculoskeletal impairment (n=56)

	Variables	B	SE	β	t	p
5STS	Constant	2.471	5.330	-	-	-
	Age	0.089	0.095	0.189	0.942	0.351
	Smoking (pack/years)	-0.077	0.069	-0.158	-1.122	0.267
	CCI	0.531	0.910	0.116	0.583	0.562

Abbreviations: 5STS – 5 repetitions sit to stand; CCI – Charlson Comorbidity Index; B: non standardized coefficient; SE: standard error; β: Beta standardized coefficient.

Table 6 shows that the regression model was statistically significant [F(10,436)=24.14, p<0.001] explaining 34% of the variance of the 5STS test in people with MSK impairment. The significant predictors that explain the model are sex, age, smoking (pack/years), BMI and medication. In this case, being women was associated with a worst outcome in the functional test, which means that they take longer to perform the test. People who smoke 9,615 additional packs of tobacco per year [smoking (pack/years)] tend to have a decrease of 1 second on the performance in the 5STS test. The other variables showed a similar pattern, that is, if an individual is 2,632 years younger, their BMI decreases by 6,536 kg/m2 and consumes 12,346 fewer medications, there will be a reduction of 1 second in the test performance.

Table 6 – Multiple linear regression - impact of multiple variables on 5 repetitions sit to stand test on total sample (n=545)

	Variables	B	SE	β	t	p
5STS	Constant	-5.976	2.036	-	-	-
	Sex	0.985	0.300	0.139	3.278	0.001*
	Age	0.133	0.029	0.380	4.592	<0.001*
	Education level	-0.108	0.161	-0.031	-0.673	0.501
	Occupation	0.143	0.389	0.018	0.368	0.713
	Smoking status	0.018	0.237	0.004	0.075	0.940
	Smoking (pack/years)	-0.020	0.009	-0.104	-2.090	0.037*
	BMI	0.127	0.032	0.153	3.946	<0.001*
	Medication	0.680	0.326	0.081	2.088	0.037*
	CCI	0.404	0.230	0.135	1.755	0.080
	MSK impairment	-0.047	0.464	-0.004	-0.102	0.919

Abbreviations: 5STS – 5 repetitions sit to stand; BMI – body mass index; CCI – Charlson Comorbidity Index; MSK impairment – musculoskeletal impairment; B: non standardized coefficient; SE: standard error; β: Beta standardized coefficient.

Discussion

In this study, we aimed to determine the impact of musculoskeletal impairments on functional status of considered healthy people. Of the population under study, 10.3% presented musculoskeletal conditions, being the most prevalent, osteoarthritis, osteoporosis and spine related issues. Participants with MSK conditions had, in general, a lower performance in functional tests, with a significant difference in the 1min.STS and 5STS, which represents impaired functional status compared with participants without MSK conditions.

In people without MSK conditions, sex differences, age, medication, and BMI appear to be triggers for lower performance on functional tests. This is because the MSK condition is only one of the factors influencing the outcome, because factors such as aging bring biological repercussions such as cellular and tissue defects, loss of muscle mass, which lead to disability and decreased force production, which is visible in the results of the functional tests (Kemp et al., 2018; Klukowska et al., 2021). In table 2, it can be seen that, in the assessment of quadriceps muscular strength with the handheld dynamometer, about 40.2% of the sample had functional impairment (<70% predicted). However, 39.4% of the people did not have musculoskeletal impairment, but they had functional impairment, demonstrating exactly which other factors are associated, in this case, with decreased muscle strength of the lower limb (Chamorro et al., 2017).

Our findings are therefore in agreement with previous research, showing that people with musculoskeletal disorders, especially those with osteoarthritis, osteoporosis and spine related issues, which are also the most disabling ones, tend to have pain and a functional status decline (Antonopoulou et al., 2009; Marengoni et al., 2009; Picavet & Hoeymans, 2004; Roux et al., 2005). Since Physiotherapy might contribute to prevent or minimize functional status impairment, the early identification of this impairment will help to reduce the burden disability of MSK conditions as can help to reduce pain, maintain or improve mobility, muscle strength, and activities of daily living, improving all functional status and quality of life over time (Atalay et al., 2021; Nigam et al., 2021; Sebbag et al., 2019).

Similarly, to our study, age and BMI have been found to influence negatively the functional performance among participants (Antonopoulou et al., 2009; Burgess et al., 2020). Specifically, the number of repetitions in the 1min.STS test has been found to decrease as age of participants increases (Strassmann et al., 2013). In fact, the population is aging, becoming more inactive and presenting obesity problems, thus, it is necessary to intervene early to stop the burden of the disease on people, society and the economy (Sebbag et al., 2019; Woolf et al., 2010). Age is not a controllable factor, however, other factors such as BMI and inactivity can and should be taken into account to avoid this impact over time (Woolf et al., 2010). Exercise programs conducted by physical therapists can be implemented, promoting the improvement of physical functioning and controlling obesity and pain (Celik & Yildiz, 2021; Hayden et al., 2005; Ulger et al., 2017).

Furthermore, differences were found in functional status, namely through the 5STS, in different sexes, with women taking longer to perform the 5STS test (Klukowska et al., 2021; Roux et al., 2005).

It is known that the female sex is associated with disability since it is influenced by social and environmental risk factors and by inherent physiological and biomechanical mechanisms (Ghimire et al., 2021; Wray & Blaum, 2001).

In addition, the greater the age, the greater the difficulty in performing the test in a shorter time, this is evidenced in other studies, and can be justified by the loss of muscle mass over time, which implies a decrease in muscle strength and function for performing tasks (Klukowska et al., 2021; Volpi et al., 2004). Higher BMI was also associated with worse performance on the test, which is in line with what was mentioned above, since a decrease in muscle mass is usually accompanied by an increase in fat mass, which decreases functional abilities (Klukowska et al., 2021; Volpi et al., 2004).

Our study also showed an association between medication and the worse performance in the 5STS. Although no studies were found that explored this association, we believe that the explanation may be polypharmacy, since 78% (n=365) of the sample is medicated, and of these, about 20% (n=84) is polymedicated, and polypharmacy is associated with disability and functional impairment (Pazan & Wehling, 2021).

Smoking (pack/years) also had a significant correlation with performance on the 5STS, contrasting other studies that did not show this association, or the association was in the opposite direction to ours (Heydari et al., 2015; Klukowska et al., 2021). That is, in our study, the fact of smoking more packs of tobacco per year does not negatively influence the outcome of the functional test. A possible explanation for this event is the fact that our sample consisted of healthy patients and the influence of smoking is closely associated with chronic respiratory diseases that affect functional status, which is an exclusion criterion for our study.

Therefore, our results are in agreement with the literature, since both groups (with and without MSK impairment) have functional status impairment. Functional status impairment is a multidimensional concept, since it can be influenced by several variables as individual characteristics, biopsychosocial, socioeconomic and environmental factors (Orfila et al., 2006). In which MSK impairment is only one of the variables that affects functional status, and in this study, the group without MSK impairment was influenced by independent variables such as advanced age, high BMI, high consumption of medication, and the fact of being a woman.

Although there are uncontrollable factors, there is an emerging concept that allows its management. The concept of precision medicine, which focuses on individual variables to focus on prevention and treatment strategies (Collins & Varmus, 2015). It is necessary to understand the individuality of people and treat them specifically (Jameson & Longo, 2015). That is, each patient has different needs, based on genetic factors, as well as the resulting influence of their social and economic context and environmental risk factors (Collins & Varmus, 2015; Jameson & Longo, 2015). It is in this aspect that health professionals, namely physiotherapists, can act based on this individualized concept, in order to identify needs and determine a specific diagnosis in order to intervene effectively in prevention and treatment (Jameson & Longo, 2015).

Nevertheless, it is known that the best way to prevent, mitigate and treat functional impairment and mitigate MSK impairment is to improve life habits, mainly through physical activity (W. R. Thompson et al., 2020). Thus, it is necessary to intervene in the population to improve and implement healthier lifestyles, since it is proven that the practice of physical activity prolongs more independent years of life, improves the functional status and quality of life of people, minimizing burden on health care system (Sun et al., 2013). The physical therapist is therefore the health professional with a leading role in the prevention, improvement and recovery of functionality (Richards & Cristian, 2006).

The results of our study may provide relevant information for the clinical practice of physical therapy, as they provide information on the impact of functional status in healthy people and show some of the variables that influence this outcome. Showing what the physical therapist must pay attention to in order to intervene in society, giving tools, educating and raising awareness of the population for this issue and its long-term repercussions. In addition to intervening in the maintenance and improvement of healthy lifestyles that benefit the population in all terms.

Strengths and limitations

Some strengths of our study were the sample size, which is quite large and comprehensive allowing exploration of factors associated with functional status. Another advantage of our study was that functional status being assessed with objective physical performance tests, rather than self-report measures, which might limit possible biases and social desirability (Ghimire et al., 2021).

Nevertheless, limitations of our study include the fact of having a cross-sectional design, including a convenience sample of adult participants and therefore casual effects cannot be determined (Ghimire et al., 2021). In addition, the sample is not balanced distributed across decades or in comparison of male and female, and the results may not be representative of the general population. Therefore, a longitudinal study would be necessary to establish the association between musculoskeletal impairments and functional status, thus reducing this bias.

Conclusion

This study shows a relationship between the presence of musculoskeletal impairment and a decreased performance on functional status. It also demonstrates that age, BMI, high consumption of medication and female gender negatively influence the results of functional tests, especially the 1min.STS and 5STS, showing lack of strength, mobility, agility and functional deficit.

Therefore, measures are needed to change this scenario. It is up to the physical therapist to identify the problem, modify lifestyles and implement health programs to provide an active aging population with quality of life through functional status, which is a clinically relevant domain for people's daily lives.

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