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Physical activity, locomotor capacity and body mass index of persons with lower limb amputation

Atividade física, capacidade locomotora e índice de massa corporal de pessoas com amputação de membro inferior

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ABSTRACT

Objective: To describe physical activity, demographic characteristics, clinical conditions, and body mass index, as well as to compare the scores of physical activity and levels of independence and functionality according to amputation level in persons with lower limb amputations. Method: The study included 70 individuals with lower limb amputation. The following instruments were applied: a) Record to characterize the participants, b) the Physical Activity Scale for Individuals with Physical Disabilities (PASIPD), and c) the Functional Measure for Amputees Questionnaire (FMA). Data were analyzed using descriptive and inferential statistics, and results with p-value less than or equal to 0.05 were considered significant. Results: Study participants had higher scores on Leisure, energy expenditure of 26.93 MET h/d, and had a good score on the Locomotor Capabilities Index. Conclusion: Study participants were physically active, as well as having fewer limitations and restrictions in relation to the ability to move. Evidently, the score of physical activity is associated with better mobility levels. Body mass index was not correlated with physical activity in this study.

Keywords: Physical Activity; Locomotor Capacity; Functionality; Body Mass Index; Amputation.

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RESUMO

Objetivo: Descrever os níveis de atividade física, as características demográficas, as condições clínicas e o índice de massa corporal, e ainda comparar os escores de atividade física e os níveis de independência e funcionalidade de acordo com o grau de lesão de pessoas com amputações de MMII. Método: Participaram do estudo 70 indivíduos com amputações de membro inferior de ambos os sexos, com idade entre 18 e 59 anos. Foram aplicados os seguintes instrumentos: a) Ficha para caracterização dos participantes; b) *Physical Activity Scale for Individual with Physical Disabilities* (PASIPD); c) *Functional Measure for Amputees Questionnaire* (FMA). Os dados foram analisados por meio da estatística descritiva e inferencial sendo considerados significativos os resultados com *p* menor ou igual a 0,05. Resultados: Os participantes do estudo apresentaram maiores pontuações no escore Lazer e obtivem gasto energético de 26,93 MET h/d, por fim apresentaram boa pontuação no Índice de Capacidade Locomotora. Conclusão: A maioria dos participantes do estudo demonstraram ser fisicamente ativos, assim como apresentaram menos limitações e restrições. Evidentemente, o escore de atividade física está associado à melhores níveis de mobilidade.

Palavras-chave: Atividade Física; Capacidade Locomotora; Funcionalidade; Índice de Massa Corporal; Amputação

INTRODUCTION

Lower limb amputation can lead to changes and limitations that affect the lives and performance of individuals. In those with lower limb amputation, abilities inherent to locomotion and balance maintenance are affected (AYTAR *et al.*, 2012). Individuals may also have muscle weakness in the hip, which can contribute to a reduced ability to walk and the inability to run (NOLAN, 2009). In addition, there may also be differences in stability, trunk control, and stride adjustments during gait (LIN *et al.*, 2014). These differences can cause gait asymmetry, which can be caused by the decrease in strength and functionality.

Vieira *et al.* (2017) highlighted that the physical benefits of the practice of regular physical activity by persons with amputations are associated with the improvement of physical abilities that help reestablish skills that depend, for example, on muscle strength or endurance, affecting participation in different activities of daily living. In this sense, it is noteworthy that the practice of regular physical activity should be considered essential for the rehabilitation process of persons following amputation. Physical activity can contribute to the acceptance and overcoming of the difficulties of the new condition, thus facilitating social and family reintegration (GRZEBIEŃ *et al.*, 2017).

Moreover, persons with amputations can develop psychological conditions that increase their chances of being less active, which can lead to a more sedentary lifestyle.

Evidence indicates that the more proximal the amputation level, the greater the gait changes, and the greater the costs involved in energy expenditure (MARTINS *et al.*, 2018), which affects several factors. One of the main factors affected can be body composition, which can be associated with physical inactivity and inadequate dietary patterns, and it has been considered a determinant of health and quality of life both in the general population and in special groups (PANAHI *et al.*, 2018).

Physical inactivity can also increase the chances of loss of lean mass (sarcopenia) and/or fat mass caused by the process called "accelerated aging" (ONO *et al.*, 2010). The increase in body fat directly interferes with the individual's physical performance, thus increasing the risk of comorbidities (WESTERKAMP *et al.*, 2019). In this context, we highlight the relevance of the analysis of factors specific to amputation and their relationship with body mass index, level of physical activity, and functionality. There are gaps in knowledge and lack of studies involving this population segment.

Therefore, the aim of this study was to describe physical activity levels, demographic characteristics, clinical conditions, amputation characteristics, and body mass index in those with lower limb amputation. A second aim was to compare the scores of physical activity and levels of independence and functionality according to amputation level.

METHOD

This descriptive, quantitative, and cross-sectional field research was approved by the Ethics and Research Committee on Human Beings of a public university in southern Brazil according to CAEE protocol No. 35925520.4.0000.0118. The research strictly followed the requirements established by Resolution 466/2012/CNS/MS and supplementary legislation. To this end, all measures were taken to minimize the research risks, and all necessary actions were taken to preserve the physical, mental, and emotional integrity of the participants, in addition to ensuring the confidentiality and anonymity of all information.

PARTICIPANTS

This study included 70 males and females aged between 18 and 59 years, with unilateral lower limb amputation of transfemoral (TF), knee disarticulation (KD) and transtibial (TT) levels who were ambulatory with a prosthesis and had completed the prosthetic rehabilitation process. Individuals who presented with the following were excluded from the study: (a) occurrence or self-report of disabling mental conditions, (b) recurrence of amputation surgeries, (c) medical, nutritional, or psychological recommendations about potential negative impacts of the practice of physical activity, d) sensory impairments, such as severe hearing loss associated with muteness and blindness that prevented the filling of the data collection instruments and the consent form.

Individuals were identified in public and private non-profit institutions that provided assistance to those with physical disabilities in southern Brazil. In addition, participants were asked to indicate persons who could potentially meet the eligibility criteria and who could participate in the research in order to obtain the sample size calculated for the study using the Cochran algorithm (MINASSIAN, 1997).

Sample calculation was performed for finite populations of persons with lower limb amputations of the Brazilian population (N=534,225) (CARVALHO, SENA, BARRETO NETO, 2020), which established the need for sixty-seven participants using the estimated prevalence of lower limb amputation of 3%, margin of error less than 5%, and design effect of 1.5 points in order to compensate for potential occurrences of bias from data collection carried out by different strategies.

INSTRUMENTS

For characterization and data collection of the participants, a Characterization Record, prepared by the researchers for exclusive use in this study, was applied with demographic information (gender, marital status, and education level), clinical characteristics (side of amputation, amputation level, cause of amputation, presence of pain), and self-reported anthropometric measurements (height and weight). The following validated instruments were used:

a) *Physical Activity Scale for Individuals with Physical Disabilities* (PASIPD), which assesses the current practice of physical activity based on 13 questions that investigate information about leisure, domestic, and occupational activities. The PASIPD score is calculated by multiplying the mean number of hours per day (h/d) for each item according to the values of metabolic equivalent (MET), associated with activity intensity and sum of the items. The instrument data is provided in MET h/d and has the maximum value of 199.5 MET h/d (WASHBURN *et al.*, 2002).

b) *Functional Measure for Amputees Questionnaire* (FMA), which specifically measures the functionality of individuals with amputation after rehabilitation. It identifies functional limitations that need to be addressed, as it correlates the use of the prosthesis with the performance of daily activities. For this study, a quantitative assessment issue was chosen (*Locomotor Capabilities Index*). The score ranges from 0 to 42 points, with a higher number of points indicates greater functionality (KAGEYAMA *et al.*, 2008).

PROCEDURES

This study was designed during the pandemic caused by the new *SARS-CoV-2* Coronavirus. Therefore, the first contact with the participants was carried out remotely via telephone contact and/or an instant messaging application such as messaging app. All data collection procedures were performed only after acceptance of the consent form. Failure to accept the terms implied automatic termination of participation. All participants were informed about the study objectives, procedures and any potential risks prior to consenting to participate. Data collection was performed by sending the link for completion of the questionnaires made through a form creation program. After the characterization of the participants, the PASIPD was issued. The FMA was issued for completion thereafter.

STATISTICAL ANALYSES

Data were tabulated in *Microsoft Excel®* (2010). Descriptive and inferential statistical analyses were performed using the Statistical Package for Social Sciences (IBM SPSS®) version 20.0. For the descriptive analysis, data were processed using mean standard deviation for quantitative data and absolute and relative frequency for qualitative data. Data normality was tested using the Kolmogorov-Smirnov test, and given the nature of the data, the data were processed using non-parametric tests. The score of post-amputation physical activity and level of independence and functionality according to the amputation sid (right/left) was compared using the Mann-Whitney U test (non-parametric data). The score of post-amputation physical activity and functionality according to the level of amputation (TF, TT) was compared using the Mann-Whitney U test (non-parametric data). In the correlation between the score of physical activity and clinical conditions and level of functionality, the Spearman test (discrete variables, non-parametric data) was used. The significance level adopted was $p \leq 0.05$.

RESULTS

The 70 participants in this study with lower limb amputation had a mean age of 38.78 ± 10.71 years with variants between 18 and 59 years. Mean time since amputation was 104.48 ± 110.89 months. Regarding the practice of physical activity, 78% of the participants practiced some type of activity, 48% performed light exercise, 35% moderate exercise, 42% vigorous exercise. Furthermore, 95% of the participants performed activities of daily living. The other socio-demographic and clinical characteristics analyzed are shown in Table 1. The data show that, in the participants, amputation prevailed on the left side, at the transfemoral level, and resulted from traumatic causes. Regarding pain, 57.15% of participants reported that they did not feel residual pain, and 51.43% did not feel phantom pain.

Table 1 - Sample distribution according to demographic, clinical, and nutritional status characteristics (n=70)

Gender	Frequency	Percentage
Male	44	62.9
Female	26	37.1
Marital Status		
Without a partner	26	37.1
With a partner	44	62.9
Education Level		
Illiterate/Incomplete elementary school	1	1.4
Complete middle school/Incomplete high school	17	24.3
Complete high school/Incomplete higher education	33	47.1
Complete higher education	14	20.0
Graduate education - stricto sensu	5	7.1
Clinical Characteristics		
Side of amputation		
Right	28	40.0
Left	42	60.0

Amputation Level		
Transfemoral	35	50.0
Knee disarticulation	9	12.9
Transtibial	26	37.1
Cause of amputation		
Vascular disease	6	8.6
Traumatic	51	72.9
Other	13	18.6
Residual Limb Pain		
Yes	30	42.85
No	40	57.15
Phantom Pain		
Yes	34	48.57
No	36	51.43
Dominant side		
Right	62	88.6
Left	8	11.4
Nutritional Status		(±)
Underweight	2	2.9
Normal Weight	24	34.3
Class 1 Obesity	15	21.4
Class 2 Obesity	7	10.0
Class 3 Obesity	3	4.3

Source: Prepared by the author, 2021

Study participants had higher scores in Leisure (12.50 MET h/d) and had an energy expenditure of 26.93 MET h/d as shown in Table 2. Furthermore, they demonstrated good scores in the Locomotor Capabilities Index (36.72 points).

Table 2 - Score of physical activity and level of independence and functionality of participants

Physical Activity	$\bar{x}$	(±)
Leisure	12.50	13.3
Domestic	8.87	9.1
Occupational	5.56	7.8
Total	26.93	7.8
Level of Independence and Functionality		
Locomotor Capabilities Index	36.72	8.45

Caption: $\bar{x}$: Mean, (±): Standard Deviation/ Source: Prepared by the author, 2021

The comparison between the score of Physical Activity and the Locomotor Capabilities Index in relation to the level of amputation (TF, TT) indicated considerable differences ($p<0.01$) and are presented in Table 3.

Table 3 - Score of physical activity and functionality according to amputation level

	Transfemoral	Transtibial	U	P
	x̄ (SD)	x̄ (SD)		
Physical Activity				
Leisure	11.04 (1.79)	14.98 (3.00)	477.00	0.24
Domestic	8.51 (1.14)	9.46 (2.22)	550.00	0.78
Occupational	5.75 (1.23)	5.23 (1.42)	570.50	0.98
Total	25.31 (2.55)	29.68 (4.65)	534.00	0.64
Independence and Functionality				
Locomotor Capabilities Index	34.50 (1.46)	40.50 (0.65)	335.50	0.01*

Caption: x̄: Mean, SD: Standard Deviation, U: Mann-Whitney U Test, $p<0.05$/ Source: Prepared by the author, 2021

In the analysis of the correlation between physical activity and the locomotor capabilities index, there was a significant correlation (Spearman, p=0.013) between the variables, which shows a positive interaction between physical activity and locomotor capacity.

DISCUSSION

The aim of this study was to describe the physical activity score, demographic characteristics, clinical conditions, amputation characteristics and body mass index, as well as to compare physical activity scores and levels of independence and functionality according to the level of amputation. It is clear that the study participants had an energy expenditure of 26.93 MET h/d. This result is similar to the findings of Washburn *et al.* (2002), who aimed to assess the construct validity of the PASIPD in individuals with physical disabilities, who classified their participants as extremely active (30.7 MET h/d), moderately active (19.8 MET h/d) and non-active (13.2 MET h/d). The findings by Jalayondeja *et al.* (2016) also corroborate this. The aim of their study was to determine the relationships between physical activity, activity of daily living (ADL) and quality of life in people with physical disabilities. They found a range in energy expenditure from 11.87 to 25.48 MET h/d depending on the type of physical disability.

The results found in this study are justified by the characteristics of the population, since most participants practice some type of physical activity, with mean age of 38 years, and by the etiology of amputations that are traumatic in the vast majority (72.9%). Burger *et al.* (1997) reported that younger individuals with traumatic amputations are physically more active than individuals with vascular amputations. Adherence to the practice of some type of physical activity improves the level of physical fitness, in addition to contributing to the reduction of musculoskeletal pain and increasing pulmonary and cardiovascular resistance (CHIN *et al.*, 2001; LEITÃO *et al.*, 2006). Furthermore, we can mention the improvements in motor skills, coordination, and balance (SPORNER *et al.*, 2009). Regarding mobility, the participants in this study had a score of 36.72 points, which is similar to the findings of Rau *et al.* (2007). Here participants obtained a mean score of 39.5 points, which represents a good level of locomotor capacity (KAGEYAMA *et al.*, 2008). In addition, there actually seems to be a positive correlation between the level of mobility in individuals with amputations and the levels of physical activity found, which is supported by the specialized literature. It can be said that individuals who practice physical activity can have better mobility and functional capacity, thus favoring their independence and autonomy (FORTINGTON *et al.*, 2012; ABDALLA *et al.*, 2013; LIN *et al.*, 2014).

When performing the mobility analysis regarding the level of amputation, the participants were classified into two categories: TF and TT. As a result, we observed that individuals with transfemoral amputation had worse locomotor capacity. Possibly, these differences in the results may be related to the different alterations caused by the amputation levels, it is known that the more proximal the amputation, the greater the biomechanical and functional alterations of the individual (BARAÚNA *et al.*, 2006). Many factors may be associated with reduced locomotor capacity, since amputation causes loss of proprioceptive information from areas such as skin, muscles, subcutaneous tissue, tendons, ligaments, and joint capsule (BARAÚNA *et al.*, 2006). In this study, there was a difference in locomotor capacity in relation to the individual's amputation levels. Some studies state that people with amputations, when adopting the static position, tend to present imbalances towards the side with greater mass, that is, the side of the non-amputated limb (ISAKOV *et al.*, 1992; GEURTS, MULDER, 1994).

Regarding body mass index, most participants were among the following classifications: normal weight (35%), overweight (27%), and class I obesity (21%). There was no relationship between Body Mass Index (BMI) and the score of physical activity. There may be limitations in determining body mass index, as this measure does not differentiate between fat and lean mass (GALLAGHER *et al.*, 1996; PRENTICE *et al.*, 2001; ODE *et al.*, 2007). Frost *et al.* (2017) compared BMI with dual-energy X-ray absorptiometry in 38 individuals with lower limb amputation. They concluded that the use of BMI may overestimate individuals with lower limb amputations who are thin and/or muscular or obese, which could explain the non-correlation in our study.

The use of direct measures to assess the level of physical activity of individuals with lower limb amputations is important for the knowledge of a more reliable measure of physiological factors involved in the amputation process. It is noteworthy that this study was developed during the *SARS-CoV-2* Coronavirus pandemic, when study participants reported that they were participating in regular physical activities. This demonstrates the importance of raising awareness about physical activity and/or the adequate guidance for the maintenance and promotion of health in this population.

This study had a number of limitations. A longitudinal study that takes into account the history of physical activity prior to amputation may be a factor to be studied for a more detailed understanding of the individual's life pre- and post-amputation surgery. Studies that take into account pain and the use of prostheses are also important for understanding relationships between these and the intensity of physical activity. The use of BMI as a classification of the body mass index of these individuals, mainly because they are mostly physically active, does not seem to be a good option in this type of study.

CONCLUSION

Most study participants demonstrated to be physically active, as well as having fewer limitations and restrictions in relation to the ability to move. Evidently, the score of physical activity is associated with better mobility levels. BMI does not seem to be a good variable to study as this measure does not take into account some factors such as fat-free body mass. We recommend that investigations should be carried out exploring the causality of more variables that are related to physical activity and the health of these individuals. The understanding of these parameters demonstrates the need for awareness and the contribution of health professionals to the scientific community and, above all, the promotion of health and the reintegration of those with amputations into society.

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