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Original

Relationship between 2-minute step test, anthropometric measures and habitual physical activity in sedentary individuals

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ABSTRACT

Objective: To correlate the 2-minute step test (2MST) with anthropometric variables and habitual physical activity.
Methods: This is a cross-sectional study. Sixty young adult participants of both sexes were classified into three groups with 20 participants each according to their body mass index (BMI): eutrophic, with a BMI between 18.5 and 24.9 kg/m^2; overweight, with a BMI between 25 and 29.9 kg/m^2; and obese type I, with a BMI between 30 and 34.9 kg/m^2. In addition to personal and clinical data, we collected height, weight, BMI, waist and neck circumference measurements. The Baecke Questionnaire (BQ) and 2-minute step test (2MST) were used to measure habitual physical activity and functional capacity, respectively.
Results: There was no difference between groups ($p > 0.05$) for the 2MST and BQ. There was no significant correlation between 2MST, anthropometric variables and habitual physical activity ($p > 0.05$, $r = 0.005$ to 0.248). Regarding the accuracy of 2MST in differentiating non-obese from obese subjects, there was insufficient accuracy, with an area under the curve of 0.54.
Conclusion: 2MST does not relate to body mass index, abdominal and neck circumference, or habitual physical activity.
Keywords: Obesity; Physical Functional Performance; Physical Activity.

Relación entre 2-minute step test, medidas antropométricas y actividad física habitual en individuos sedentarios

RESUMEN

Objetivo: Correlacionar el 2-*minute step test* (2MST) con variables antropométricas y actividad física habitual.
Métodos: Este es un estudio transversal. Sesenta adultos jóvenes de ambos sexos, se clasificaron en tres grupos con 20 participantes cada uno según su índice de masa corporal (IMC): eutrófico, con IMC entre 18.5 y 24.9 kg/m^2; sobrepeso, con IMC entre 25 y 29.9 kg/m^2; y obesos tipo I, con IMC entre 30 y 34.9 kg/m^2. Además de los datos personales y clínicos, recopilamos las medidas de altura, peso, IMC, circunferencia de cintura y cuello. El cuestionario Baecke (CB) y la prueba 2MST se utilizaron para medir la actividad física habitual y la capacidad funcional, respectivamente.
Resultados: No hubo diferencia entre los grupos ($p > 0.05$) para 2MST y CB. No hubo correlación significativa entre 2MST, variables antropométricas y actividad física habitual ($p > 0.05$, $r = 0.005$ a 0.248). En cuanto a la precisión de 2MST en la diferenciación entre los sujetos no obesos y los obesos, no hubo precisión suficiente, con un área por debajo de la curva de 0.54.
Conclusión: 2MST no se relaciona con el índice de masa corporal, la circunferencia abdominal y del cuello, o la actividad física habitual.
Palabras clave: Obesidad; Rendimiento físico-funcional; Actividad física.

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Relação entre 2-minute step test, medidas antropométricas e atividade física habitual em indivíduos sedentários

RESUMO

Objetivo: Correlacionar o 2-minute step test (2MST) com variáveis antropométricas e atividade física habitual.
Métodos: Este é um estudo transversal. Sessenta jovens adultos de ambos os sexos foram classificados em três grupos com 20 participantes em cada de acordo com o índice de massa corporal (IMC): eutróficos, com IMC entre 18.5 e 24.9 kg/m^2; sobrepeso, com IMC entre 25 e 29.9 kg/m^2; e obeso tipo I, com IMC entre 30 e 34.9 kg/m^2. Além dos dados pessoais e clínicos, foram coletadas altura, peso, IMC, circunferência da cintura e do pescoço. O questionário Baecke (BQ) e o 2MST foram usados para medir a atividade física habitual e a capacidade funcional, respectivamente.
Resultados: Não houve diferença entre os grupos ($p > 0.05$) para o 2MST e BQ. Não houve correlação significativa entre o 2MST, variáveis antropométricas e atividade física habitual ($p > 0.05$, $r = 0.005$ a 0.248). Em relação à acurácia do 2MST na diferenciação entre obesos e não obesos, houve acurácia insuficiente, com área sob a curva de 0.54.
Conclusão: 2MST não se relaciona com índice de massa corporal, circunferência abdominal e do pescoço, ou atividade física habitual.
Palavras-chave: Obesidade; Desempenho físico-funcional; Atividade física.

Introduction

Individuals with higher body mass index (BMI) need greater effort to perform certain movements, with greater workload, higher energy expenditure and lower mechanical and functional efficiency.[1–3] In this sense, the relationship between tests that evaluate functional capacity in individuals with different body masses has been the focus of several recent studies,[4–6] as a way to deepen the understanding of physical and functional determinants influenced by obesity.

In this sense, among the tests that investigate the relationship between functional capacity and BMI, the 6-minute walk test (6MWT) is the most used in scientific studies. Hergenroeder et al.[6] observed that adult women with normal weight had greater distances covered in the 6MWT when compared to obese type I, II and III. Gontijo et al.[5] observed a moderate correlation between the distance covered during 6MWT and BMI. Regarding the 6-minute step test (6MST), Arcuri et al.[4] conducted a study with healthy individuals and observed a correlation of 6MST with age, weight and waist circumference. In addition, they observed a consistent correlation between 6MST and 6MWT.

Likewise, another functional test with applicability in several populations is the 2-minute step test (2MST). A systematic review found that it was developed in 1999, with the benefits of being able to be executed in a limited space, with fast execution and low costs, and is usually applied in healthy older adults and adults with several diseases[7]. In addition, Guedes et al.[8] and Pedrosa and Holanda[9] applied the 2MST in elderly hypertensive and hypertensive older women, respectively.

However, despite the scientific initiatives, to the best of our knowledge, the current literature does not present studies investigating the mechanisms involved in the relationship of 2MST with other important variables, such as anthropometric variables and habitual physical activity. For a complete validation of a functional test, it is necessary to understand how the various clinical and personal conditions affect test execution[10–12], such as body mass, age, population characteristics (healthy, elderly, obese), presence or absence of clinical dysfunctions and so on. Thus, the present study is justified by the need to explore the validation of 2MST in sedentary individuals with different BMI.

In view of the above, the objectives of the present study were: 1) to correlate the 2MST with anthropometric variables and habitual physical activity; 2) to compare these variables among eutrophic, overweight and obese type I individuals; and 3) to verify the accuracy of 2MST in differentiating non-obese individuals (eutrophic and overweight) from obese type I. The hypothesis of this study is that 2MST is correlated with BMI, abdominal circumference, neck circumference and habitual physical activity, presenting lower results in its execution in the obese I grade and with acceptable accuracy to differentiate the individuals by BMI.

Methods

This is a cross-sectional study carried out in a university community (São Luís, MA, Brazil), with data collection performed from June to December 2018. This study was approved by the Research Ethics Committee of the institution (opinion number 2.469.206).

Considering the correlation as the main objective of the study, a prior sample calculation was performed based on the detection of a moderate correlation between 2MST and the other anthropometric variables and habitual physical activity. For this, an expected value of $r = 0.50$ was considered for the calculation, as described in previous studies.[5,13] Therefore, using the software Ene, version 3.0 (Autonomous University of Barcelona, Spain), with an alpha value of 5% and a beta value of 20%, a minimum sample number of 30 participants was estimated.

The sampling was intentional non-probability type, composed of sixty participants of both sexes, sedentary, classified into three groups according to BMI: eutrophic group, BMI between 18.5 and 24.9 kg/m^2 ($n = 20$); overweight group, BMI between 25 and 29.9 kg/m^2 ($n = 20$); and obesity type I group, BMI between 30 and 34.9 kg/m^2 ($n = 20$).

The following inclusion criteria were adopted: age between 18 and 45 years, of both sexes. Subjects with a medical diagnosis of cardiovascular, respiratory, metabolic, rheumatologic or neurological disease were excluded from the study. In addition, any other problems that made it impossible to perform 2MST were considered exclusion criteria.

Initially, an evaluation form containing personal data (name, age, gender, ethnicity, date of birth, marital status, profession and schooling), family history, risk factors and medications being used was completed. After this, physical examination was performed, assessing height, weight, BMI, abdominal and neck circumference.

The Baecke Questionnaire (BQ) was applied to measure the habitual physical activity of the study participants and was validated for the Brazilian population by Florindo et al.[14]. This questionnaire measures occupational, leisure, and sports physical activity. Thus, the mean score (ranging from 1 to 5) was used in the present study, which the lowest scores correspond to less active participants.[15]

In addition, 2MST was used to measure participants' functional capacity. It is a simple test to be performed, in which the individual performs a stationary gait next to a wall, as fast as they can for 2 minutes, performing a knee elevation at a minimum height determined by a marking made in the wall with tape. This

marking was performed at the mean distance of an imaginary line extending from the patella to the anterior superior iliac spine.[8] Thus, the examiner counted the amount of elevation of the right knee during the 2 minutes of execution.

In the statistical analysis, the distribution of the data was initially verified by histograms analysis. After that, for the comparisons between groups of continuous variables, Bonferroni post hoc analysis of variance (ANOVA) was used. For the gender variable, the comparison between groups was performed using the chi-square test. In order to verify the correlation between 2MST and the other variables, the Pearson correlation coefficient was used. The magnitude of the correlations was based on the study of Zou et al.[13]: 0 = no correlation, 0.20 = weak correlation, 0.50 = moderate correlation, 0.80 = strong correlation, and 1.00 = perfect correlation.

The ROC curve was used to identify the accuracy of 2MST in differentiating the non-obese participants (eutrophic + overweight) from obese (obesity grade I). This grouping of eutrophic + overweight in a single group was based on the study of Hergenroeder et al.[6], whose conclusion points to the similarity in the functional capacity of these two categories of BMI.

Thus, the values of the area under the curve (AUC), the best cutoff point, sensitivity, specificity, positive and negative predictive value, and positive and negative likelihood ratio were identified. The AUC interpretation was based on the classification of Greiner et al.[16] and Akobeng[17]: 0.5 (due to chance); 0.5 to 0.7 (low degree of accuracy), >0.7 to 0.9 (moderate degree of accuracy); >0.9 and <1.0 (high degree of accuracy); and 1.0 (perfect test). The best cutoff point was determined based on the lowest value obtained in equation $(1 - \text{sensitivity})^2 + (1 - \text{specificity})^2$.

All data analysis was performed using SPSS software (version 17.0, Chicago, IL, USA), with a significance level of 5% being adopted.

Results

Sixty participants were included in the study, equally divided into eutrophic (n = 20), overweight (n = 20) and obese type I (n = 20). As shown in Table 1, in the comparisons between groups, a significant difference ($p < 0.05$) was observed in the variables weight, BMI, and abdominal circumference (AC), as expected, with higher values in the obese type I group. Regarding 2MST and BQ, no difference was found between groups ($p > 0.05$).

In the correlations performed using the Pearson correlation coefficient, as shown in Table 2, there was no correlation between the 2MST variable and the other variables ($p > 0.05$, $r = 0.005$ to 0.248). Regarding the accuracy of 2MST in differentiating non-obese (n = 40) from obese (n = 20) participants, there was insufficient accuracy, with an AUC value of 0.54. Other measures related to accuracy are shown in Table 2 and Figure 1.

Discussion

According to the results found, the hypothesis of the present study was rejected. In other words, in summary, we observe the following results: 1) there is no correlation between 2MST and the other variables tested here, 2) no significant difference was found in the execution of the test according to the grouping performed according to BMI, and 3) the test is not accurate to differentiate obese type I from non-obese participants. The correlation between BMI and functional capacity has been identified in several previous studies, especially those that used 6MWT and 6MST.[4–6] We used a test with less clinical and scientific use to measure functional capacity than 6MST and 6MWT, and observed that 2MST did not correlate with BMI. Therefore, we advise against using this test for the obese type I population.

In addition, an important study[18] conducted on this topic investigated physical activity and cardiorespiratory fitness (VO_2max) in twins with different BMI, and observed that higher VO_2max and increased physical activity (objectively measured by accelerometers) are associated with lower BMI, fat percentage and better metabolic health. However, physical activity measured by means of BQ was not related to BMI. Similarly, in our study, we did not observe a significant correlation between 2MST and BQ. Thus, to elucidate this issue, future studies are needed to correlate physical activity measured by means of accelerometers with 2MST, thus excluding possible doubts about self-reported physical activity measures (for example, BQ).

Table 1. Comparison of study participants according to body mass index (BMI).

Variable	Eutrophic (n = 20)	Overweight (n = 20)	Obese type I (n = 20)
Age (years)	21.95 (1.82)	25.05 (8.10)	26.50 (9.76)
Sex (female)	8 (40%)	10 (50%)	10 (50%)
Height (m)	1.66 (0.08)	1.62 (0.09)	1.64 (0.08)
Weight (kg)	59.90 (5.02)	70.48 (8.68)[a, b]	85.23 (10.42)[a]
BMI (kg/m^2)	21.59 (1.75)	26.51 (1.06)[a, b]	31.34 (1.39)[a]
NC (cm)	34.49 (2.72)	36.38 (3.93)	39.02 (3.51)[a]
AC (cm)	75.54 (5.23)	86.19 (8.44)[a, b]	99.24 (7.32)[a]
BQ (score)	2.14 (0.22)	2.29 (0.36)	2.32 (0.45)
2MST (score)	78.70 (16.37)	83.65 (10.77)	79.15 (13.92)

NC: neck circumference; AC: abdominal circumference; BQ: Baecke Questionnaire; 2MST: 2-minute step test; a: Differs from the eutrophic group ($p < 0.05$, Anova one-way post hoc Bonferroni); b: Differs from the obese type I ($p < 0.05$, Anova one-way post hoc Bonferroni).

Table 2. Correlation between the variables and accuracy of 2-minute step test to differentiate the participants grouped according to body mass index.

Correccional (n = 60)	
Variables	*2-minute step test*
Age (years)	r = 0.129, p = 0.326
Height (m)	r = 0.248, p = 0.060
Weight (kg)	r = 0.137, p = 0.295
BMI (kg/m^2)	r = 0.005, p = 0.972
Neck circumference (cm)	r = 0.226, p = 0.082
Abdominal circumference (cm)	r = 0.114, p = 0.387
Baecke Questionnaire (score)	r = 0.036, p = 0.787
Accuracy	
Parameters	*Values*
Area (95% confidence interval)	0.54 (0.37, 0.71)
Best cutoff point (score)	81.5
Sensitivity (%)	60
Specificity (%)	50
Positive predictive value	70.5
Negative predictive value	38.4
Positive likelihood ratio	1.2
Negative likelihood ratio	0.8

No significant correlation (Pearson correlation coefficient, $p > 0.05$).

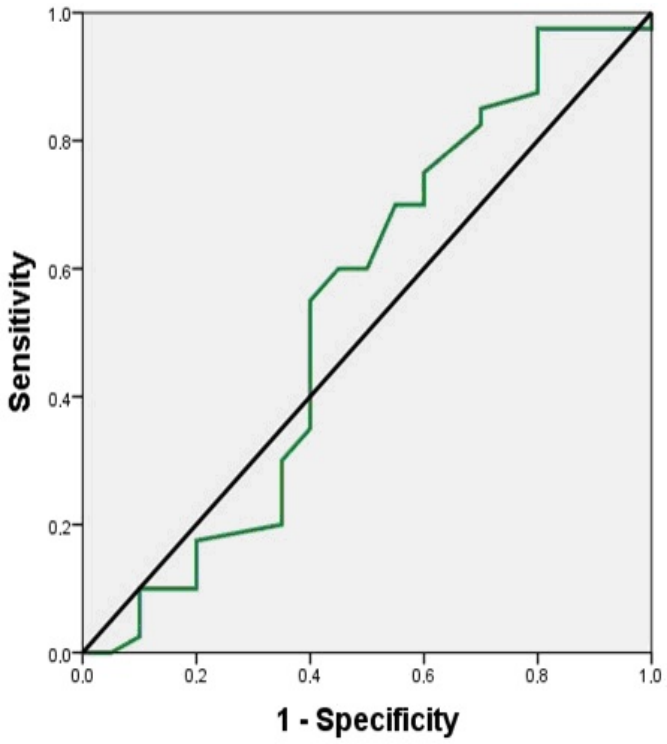

Figure 1. Area Under the Curve for determining the accuracy of the 2-minute step test.

Although our results did not support the use of 2MST in different BMI ranges, this test was used in research with different populations, as follows. In patients under cardiopulmonary rehabilitation, Haas et al.[19] found a high correlation between 2MST and 6MWT and concluded that 2MST is valid, reproducible, sensitive, safe, well-tolerated, capable of replacing 6MWT because it is simpler to implement. In hypertensive elderly women, Pedrosa and Holanda[9] observed a moderate correlation between 2MST, 6MWT and Timed Up and Go Test. In a similar way to the previous study,[9] Guedes et al.[8] investigated the ability of 2MST to differentiate hypertensive elderly from normotensive individuals and observed good sensitivity and specificity.

Confronting published literature with our results, 2MST presents better applications in the elderly and patients with some installed disability. In healthy individuals (eutrophic, overweight and obese type I), 2MST does not have good applicability. Our hypothesis for this result is that 2MST is a softer test than 6MWT and 6MST, so small changes in functional capacity are not identified by 2MST (as in the case of healthy adults).

The study presents some limitations that should be considered. Despite the adequate sample size, the present study was performed with eutrophic, overweight and obese type I participants. Therefore, the results cannot be extrapolated to obese type II and III individuals. The eligibility criteria used were carefully considered to exclude the presence of cardiovascular, respiratory, metabolic, rheumatological or neurological disease, and recruitment was carried out in a university community. Therefore, for greater clinical repercussions, it is necessary to perform studies in patients with some degree of disability or physical limitation and with different BMI ranges.

2MST does not correlate with body mass index, abdominal and neck circumference, or habitual physical activity, and is not an accurate functional capacity test to distinguish non-obese individuals (eutrophic and overweight) from obese type I individuals.

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