

Applicability of the step test for physical fitness assessment of women with chronic venous disease symptoms: a cross-sectional study

Aplicabilidade do teste do degrau na avaliação da aptidão física de mulheres com sintomas de doença venosa crônica: estudo transversal

Ícaro do Carmo Carvalho^{1,2} , Daniela Karina da Silva Ferreira^{1,3} 

Abstract

Background: Chronic Venous Disease (CVD) can seriously impact physical fitness. Certain measures and aptitude tests can be employed to evaluate this condition in people with CVD that are simple, quick, and less expensive alternatives when compared to laboratory methods. **Objectives:** To evaluate the applicability of the 4-minute step test, correlating its results with those of other measures and tests used with people with CVD symptoms. **Methods:** Cross-sectional descriptive study carried out with 47 active women with CVD symptoms who participate in public physical exercise programs and were recruited by spontaneous demand. After clinical evaluation of disease stage, sociodemographic data were collected and calf circumference measurements, ankle goniometry, the tiptoe test, and the 4-minute step test were conducted. The women were already familiar with the apparatus used. **Results:** The step test showed significant correlations ($p < 0.05$) with calf measurements ($r = 0.31$ and 0.32), flexibility ($r = 0.48$ and 0.47), and the tiptoe test ($r = 0.33$ for number of repetitions and 0.42 for speed of execution), in addition to an inverse correlation with disease severity ($r = -0.29$). Significant correlations were also found by age group ($r = 0.60$ and 0.54 , for calf circumference in the elderly) and by classification in tests and measurements ($r = 0.19$ for the tiptoe test, and $r = 0.29$, for ankle flexibility). **Conclusions:** The step test proved applicable and its use in conjunction with other aptitude tests offers a more complete evaluation of active women with CVD symptoms.

Keywords: varicose veins; physical fitness; physical fitness monitors; muscle strength; lower limbs.

Resumo

Contexto: A doença venosa crônica (DVC) pode impactar a aptidão física dos indivíduos. Algumas medidas e testes de aptidão são aplicados para avaliar essa condição em pessoas com DVC, sendo alternativas simples, rápidas e menos dispendiosas de avaliação comparadas a métodos laboratoriais. **Objetivos:** Avaliar a aplicabilidade do teste do degrau de 4 minutos, correlacionando seus resultados com os de outras medidas e testes aplicados a pessoas com sintomas de DVC. **Métodos:** Estudo descritivo transversal realizado com 47 mulheres ativas com sintomas de DVC, participantes de programas públicos de exercícios físicos e recrutadas por demanda espontânea. Foi realizada avaliação clínica da doença, e foram coletados dados sociodemográficos, medidas de perimetria de panturrilha e goniometria de tornozelo, teste ponta do pé e teste do degrau de 4 minutos. As mulheres já eram familiarizadas com o implemento utilizado. **Resultados:** O teste do degrau apresentou correlações significativas ($p < 0,05$) com as medidas de panturrilha ($r = 0,31$ e $0,32$), flexibilidade ($r = 0,48$ e $0,47$) e teste ponta do pé ($r = 0,33$ para n.º de repetições e $0,42$ para velocidade de execução), além de correlação inversa com a gravidade da doença ($r = -0,29$). Correlações significativas também foram encontradas por faixa etária ($r = 0,60$ e $0,54$, para perimetria de panturrilha em idosos) e por classificação nos testes e medidas ($r = 0,19$ para o teste ponta do pé e $r = 0,29$ para flexibilidade de tornozelo). **Conclusões:** O teste do degrau se mostra aplicável, e sua utilização, em conjunto com outros testes de aptidão, permite uma avaliação mais completa de mulheres ativas com sintomas de DVC.

Palavras-chave: varizes; aptidão física; monitores de aptidão física; força muscular; membros inferiores.

How to cite: Carvalho IC, Ferreira DKS. Applicability of the step test for physical fitness assessment of women with chronic venous disease symptoms: a cross-sectional study. *J Vasc Bras.* 2022;21:e20220092. <https://doi.org/10.1590/1677-5449.20220092>

¹ Universidade Federal de Pernambuco – UFPE, Recife, PE, Brasil.

² Prefeitura da Cidade do Recife, Programa Academia da Cidade, Recife, PE, Brasil.

³ Fundação Oswaldo Cruz – Fiocruz, Centro Pesquisas Aggeu Magalhães, Recife, PE, Brasil.

Financial support: None.

Conflicts of interest: No conflicts of interest declared concerning the publication of this article.

Submitted: July 01, 2022. Accepted: September 03, 2022.

The study was carried out at Laboratório de Cinesiologia e Avaliação Funcional (LACAF), Departamento de Fisioterapia, Universidade Federal de Pernambuco (UFPE) and at four hubs of Programa Academia da Cidade do Recife (Coque, Ilha do Leite, Cavouco, 13 de Maio), Recife, PE, Brazil.



Copyright© 2022 The authors. This is an Open Access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

■ INTRODUCTION

Chronic venous disease (CVD) has high prevalence and most frequently affects adult women and elderly women.^{1,2} Its signs and symptoms impact quality of life and functionality right from the initial phases and the lower limbs are particularly affected.³

Risk factors associated with lifestyle, such as spending long periods standing up or sitting down and in inactivity, contribute to emergence and exacerbation of CVD.² This is why many different studies have investigated the effects of physical exercises in this population as a method for preventing or controlling the disease.⁴⁻⁶ These studies attempt to assess functionality of the calf muscle pump, which is musculature that is directly involved in venous return and which, once debilitated, directly contributes to emergence and exacerbation of CVD.

Measures and tests used to assess the physical fitness of these patients include calf circumference and ankle goniometry,⁷ the 6-minute walk test,⁵ the tiptoe test,⁸ and assessments that utilize complex equipment, such as plethysmography⁹ or dynamometry.⁶

The step test is widely used to conduct cardiorespiratory assessment in healthy individuals and in patients with pulmonary diseases. It is a submaximal test, but one that imposes high metabolic demand, and is used to assess physical capacity and muscle resistance, is easy to administer, is inexpensive, and offers good representativeness of activities of daily living.^{10,11} Using a step as apparatus, the test consists of performing up and down steps for a specific period of time. It can be considered an ergometric test and there are several different protocols, varying the time of execution, which may be constant or incremental.¹²

The step test could therefore be a useful option for testing people with CVD and assessing the muscular resistance of their lower limbs, considering its simple administration and low cost and people's familiarity with the exercise.^{13,14}

The objective of this study was to correlate the results of the 4-minute step test with other tests of physical fitness, with a view to its applicability for assessing women with CVD within a public physical activity program.

■ METHODS

This descriptive, cross-sectional study assessed active women with self-reported signs and symptoms of CVD, such as presence of visible lower limb varicose veins, who had been participating for at least 3 months in either the Academia da Cidade Program of the city of Recife, or the Projeto Vida Ativa, run by the Universidade Federal de Pernambuco (UFPE), in the state of Pernambuco, Brazil. Recruitment was by

spontaneous demand from June to August of 2019, and women were excluded if they had active ulcers (Clinical, Etiological, Anatomic, and Pathological classification [CEAP]: C6); orthopedic, neurological, or systemic diseases that affect the calf muscle pump (CMP) or cause difficulties with performing the tests; or if they had uncontrolled diabetes or hypertension.

Sociodemographic data and health variables related to risk factors for development and exacerbation of CVD (age, marital status, number of gestations, and treatments for the disease) were collected. Clinical CVD classification (CEAP) was appraised by a healthcare professional; the Brazilian version of the Venous Insufficiency Epidemiological and Economic Study – Quality of Life/Symptom (VEINES QoL/Sym) questionnaire was administered for quality of life assessment; calf circumference was measured for both legs, using an inelastic tape measure (recorded in centimeters); and goniometry of the ankle joint was conducted for both feet using a universal goniometer (recorded in degrees), to determine maximum amplitude of ankle joint movement.

The bilateral tiptoe test was then performed, recording the maximum number of repetitions, the time taken, and speed of execution, as described in the Monteiro et al.¹⁵ protocol. The step test was also conducted, using a 4-minute protocol. This begins with the subject standing in front of a 20 cm step who, after the initial command, steps up onto and down from the step as many times as possible in 4 minutes, as illustrated in Figure 1. The evaluator offers verbal encouragement while counts how many times she has stepped up onto the step. The subject is permitted to pause and restart when she feels able to do so, although the stopwatch continues running if she does so.¹⁶ Since the participants were already using the step as part of the activities of their programs, they were already familiar with the apparatus.

Measurements were taken and tests administered by a team of academics from the Kinesiology and



Figure 1. Performing the 4-minute step test.

Functional Assessment Laboratory at the UFPE Physiotherapy Department, under supervision by the lead researcher. Tests were administered in rotation, attempting to optimize the time taken to assess the group. All of the participants were given information about the study and the data collection procedures and signed free and informed consent forms. This study is derived from a research project approved by the Research Ethics Committee at the UFPE Health Sciences Center (decision No. 3373609).

Data analysis

Descriptive statistics were employed for presentation of data and variables expressed as mean \pm standard deviation. Normality of the distribution of the sample was demonstrated with the Shapiro-Wilk test and Pearson correlation analysis was used to relate step test results to circumference, goniometry, and tiptoe test variables. For the correlation analyses proposed in this study, adopting a medium effect size (0.3), a 0.05 alpha error, and 80% power, an ideal sample size of 84 individuals was calculated. A significance level of 0.05 was adopted. Data were analyzed using the Statistical Package for the Social Sciences (SPSS) version 25.0.

RESULTS

A total of 47 women with CVD were analyzed, with a mean age of 54 years (± 12 years) and with overweight/obesity (mean body mass index [BMI] of 27.4 ± 3.9 kg/m), 37 of whom were Academia da Cidade Program users and ten of whom were participants of the Projeto Vida Ativa. Table 1 lists the general characteristics of the sample studied. During administration of the tests, one subject had an uncontrolled blood pressure event after the step test, and did not take the other tests, two subjects did not attend for goniometry or the tiptoe test, and four did not attend for the step test (Figure 2).

Table 2 lists the mean values for the volunteers' calf circumference, ankle goniometry, and physical fitness test results.

Participants who stated they preferred the step activity during training sessions ($n = 19$) achieved a mean total of 109 steps in the step test, while those that preferred other activities ($n = 28$) achieved a mean total of 95 steps.

Table 3 shows correlations between step test results and the other measurements and tests conducted.

Table 1. General characteristics of the sample.

		n	%
Age group	Adults (18 to 59 years)	30	63.8
	Elderly women (60 years or over)	17	36.2
Marital status	Single	15	31.9
	Married	20	42.6
	Divorced/separated	4	8.5
	Widowed	8	17
Number of gestations	None	4	8.5
	1	9	19.1
	2	12	25.5
	3 or more	14	29.7
	Information not provided	8	17
CEAP classification	C1	8	17
	C2	16	34
	C3	10	21.3
	C4	11	23.4
	C5	2	4.3
Preferred activity	Circuit training	4	10.5
	Stretching	1	2.6
	LMR	7	18.4
	Step	20	52.6
	Running/walking	5	13.2
	Others	1	2.6
Treatment for CVD	Has been/is being treated	4	8.5
	Has not/is not being treated	43	91.5

CEAP = Clinical, Etiological, Anatomic, and Pathological classification, varying from C0 (lowest severity) to C6 (greatest severity); CVD = chronic venous disease; LMR = localized muscle resistance.

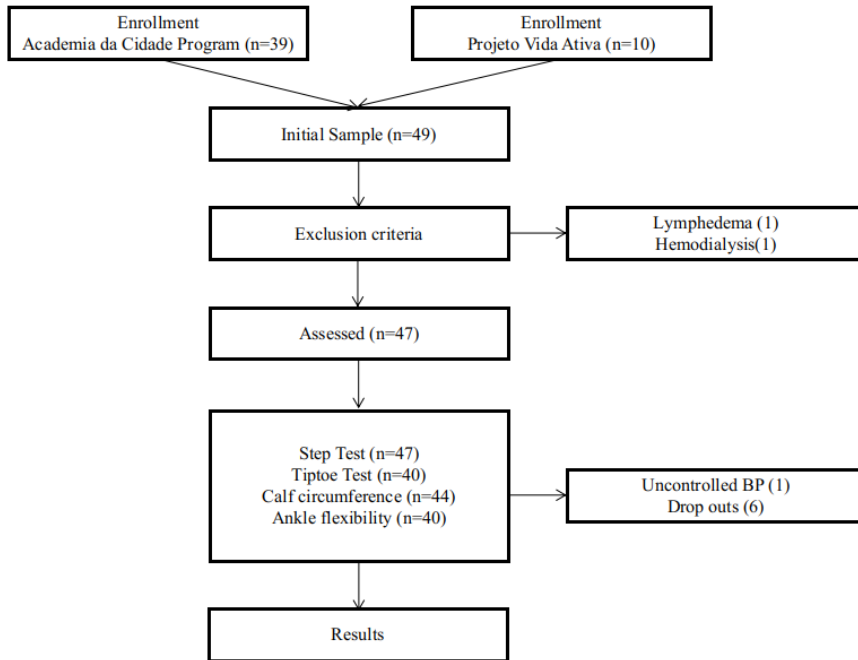


Figure 2. Flow diagram of study phases. BP = blood pressure.

Table 2. Results obtained for circumference and goniometry measurements and physical fitness tests.

	N	Mean	Median	Standard deviation	Min.	Max.	Confidence interval (95%)
Right calf (cm)	44	36.6	36.5	3.2	26.0	44.0	35.6-37.7
Left calf (cm)	44	36.9	37.0	3.2	26.5	44.0	35.9-38.1
Flexibility of right ankle (°)	40	61.3	62.0	13.1	25.0	80.0	57.2-65.9
Flexibility of left ankle (°)	40	59.3	61.0	11.0	27.0	80.0	55.8-63.3
Tiptoe test (repetitions)	40	39.0	33.0	18.0	9.0	83.0	33.0-46.0
Tiptoe test (time in seconds)	40	50.0	44.0	29.0	11.0	145.0	40.0-61.0
Tiptoe test velocity (repetitions/second)	40	0.82	0.83	0.24	0.40	1.48	0.76-0.91
4-minute step test (Number of steps)	47	101.0	104.0	22.0	38.0	146.0	94.0-110.0

Table 3. Correlations between calf circumference, ankle flexibility, and tiptoe test and the 4-minute step test results.

	Correlation	Significance	N
Right calf (cm)	0.312*	0.042	43
Left calf (cm)	0.322*	0.035	43
Flexibility of right ankle (°)	0.480**	0.002	39
Flexibility of left ankle (°)	0.469**	0.003	39
Tiptoe test (repetitions)	0.328*	0.041	39
Tiptoe test (time in seconds)	0.006	0.972	39
Tiptoe test velocity (repetitions/second)	0.418**	0.008	39

*The correlation is significant to 0.05 (both limbs); **The correlation is significant to 0.01 (both limbs).

Since these tests do not have reference tables for classifying performance, the results were stratified into quartiles, revealing significant correlations ($p < 0.05$) with tiptoe test velocity ($r = 0.19$); left ankle movement amplitude ($r = 0.29$); and left calf circumference ($r = 0.10$). Analyzing the group according to their CVD clinical classifications, a significant inverse correlation ($r = -0.297$, $p =$

0.045) was detected, indicating poorer performance on the test in more severe phases of the disease, as illustrated in Figure 3.

When observed by age group, the step test had a significant correlation with the tiptoe test in adults ($r = 0.48$, $p = 0.018$) and a moderate correlation with calf circumference in elderly participants (right: $r = 0.60$, $p = 0.014$; and left: $r = 0.54$, $p = 0.032$).

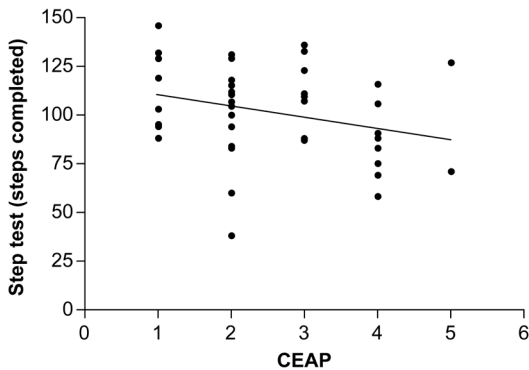


Figure 3. Correlation between clinical classification of chronic venous disease and performance on the step test. CEAP = Clinical, Etiological, Anatomic, and Pathological classification.

DISCUSSION

In physical fitness assessment, properties such as ease of administration and familiarity with the exercise are important to achieving trustworthy results.^{17,18} The step test offers these characteristics since it is similar to the daily living task of climbing stairs, which was confirmed in this study that observed it was easy to administer to active women who identified use of the step as their favorite activity in the physical exercise routines they perform in their exercise programs.

In individuals with CVD, the primary objective of these tests is to verify CMP functionality and its relationship with performance of activities of daily living. Instruments such as dynamometers and ultrasound are frequently employed in laboratories for this purpose when assessing this population.^{6,9,19} However, in addition to not being compatible with activities of daily living, their applicability to large groups may be limited by the high costs of acquisition and maintenance, in addition to the time needed for training and calibrating examiners, although equipment that can be used outside of laboratory settings does exist. Physical tests therefore constitute viable alternatives for obtaining performance data that can be used to identify the impact of CVD on individuals' physical fitness, in addition to yielding parameters to better guide prescription of exercise training and enabling assessment of the effects of training over time.

Walking tests such as the shuttle walk test or the 6-minute walk test, are described in the literature for assessment of cardiorespiratory status and gait velocity in this population,²⁰ while calf circumference measurements, ankle goniometry, and the tiptoe test are used to measure the impact of CVD on calf muscle function and ankle mobility.²¹

The step test can, therefore, be added to this list of assessments, since it employs low-cost apparatus and requires little space and a shorter time for administration, as shown by the results observed in this study, and is correlated with the results of the other tests administered to this population. The step test also proved applicable to the elderly population and demonstrated fidelity, since people with more advanced disease grades exhibit worse performance, corroborating other studies that assess the functional performance of people with CVD.^{8,22}

One limitation of this study is the fact that it only assessed part of the female population already engaged in physical exercise, interfering with generalization of the results observed. The sample did not attain the ideal number of participants, and some missing data, caused by sampling losses, reduced the power of the analyses, and the sequence and order of administration of the physical fitness tests could have had an influence on the results because of the effect of tiredness. It is also important to emphasize that interpretations of the correlation coefficients can vary and the results observed in this study may be interpreted as weak or medium correlations, even those that are significant in some cases. It is thus necessary to conduct additional studies using this instrument to validate it with this population, taking into consideration variables such as age, disease severity, and physical activity level.

CONCLUSIONS

The step test proved to be applicable for assessment of physical fitness and lower limb function in women who attend public physical exercise programs. Its use in conjunction with other tests such as the tiptoe test and goniometry offers a more complete assessment of the functional of the lower limbs, of the resistance of the calf musculature, and of the cardiorespiratory capacity of people affected by CVD, providing the necessary parameters to appropriately prescribe exercise as a coadjutant to treatment. Validation and reproducibility studies reporting reference values will enable its safe administration and replication in other scientific studies of this population.

REFERENCES

1. Junior N, Perez M, Amorim J, Miranda F Jr. Pregnancy and lower limb varicose veins: prevalence and risk factors. *J Vasc Bras.* 2010;2:29-35. <https://doi.org/10.1590/S1677-54492010000200004>.
2. Robertson L, Evans C, Fowkes FGR. Epidemiology of Chronic Venous Disease. *Phlebology.* 2008;23(3):103-11. <http://dx.doi.org/10.1258/phleb.2007.007061>. PMID:18467617.
3. Soydan E, Yılmaz E, Baydur H. Effect of socio-demographic characteristics and clinical findings on the quality of life of patients

- with chronic venous insufficiency. *Vascular*. 2017;25(4):382-9. <http://dx.doi.org/10.1177/1708538116685945>. PMID:28007012.
4. Alberti LR, Petroianu A, Corrêa D, Franco Silva T. Efeito da actividade física na insuficiência venosa crónica dos membros inferiores. *Acta Med Port*. 2008;21(3):215-20. PMID:18674413.
 5. Ozberk S, Karadibak D, Polat M. Predictors of exercise capacity in chronic venous disease patients. *Phlebology*. 2020;35(3):190-8. <http://dx.doi.org/10.1177/0268355519870895>. PMID:31446843.
 6. Padberg FT Jr, Johnston MV, Sisto SA. Structured exercise improves calf muscle pump function in chronic venous insufficiency: a randomized trial. *J Vasc Surg*. 2004;39(1):79-87. <http://dx.doi.org/10.1016/j.jvs.2003.09.036>. PMID:14718821.
 7. Ercan S, Çetin C, Yavuz T, Demir HM, Atalay YB. Effects of isokinetic calf muscle exercise program on muscle strength and venous function in patients with chronic venous insufficiency. *Phlebology*. 2018;33(4):261-6. <http://dx.doi.org/10.1177/0268355517695401>. PMID:28954574.
 8. Pereira DAG, Lages ACR, Basílio ML, Pires MCO, Monteiro DP, Navarro TP. Does the heel-rise test predict explain functional capacity in venous insufficiency? *Fisioter Mov*. 2015;28(1):61-7. <http://dx.doi.org/10.1590/0103-5150.028.001.AO06>.
 9. Lima RCM, Santiago L, Moura RMF, et al. Efeitos do fortalecimento muscular da panturrilha na hemodinâmica venosa e na qualidade de vida em um portador de insuficiência venosa crônica. *J Vasc Bras*. 2002;1(3):219-26.
 10. Andrade CHS, Cianci RG, Malaguti C, Dal Corso S. O uso de testes do degrau para a avaliação da capacidade de exercício em pacientes com doenças pulmonares crônicas. *J Bras Pneumol*. 2012;38(1):116-24. <http://dx.doi.org/10.1590/S1806-37132012000100016>. PMID:22407048.
 11. Pessoa BV, Jamami M, Basso RP, Regueiro EMG, Di Lorenzo VAP, Costa D. Teste do degrau e teste da cadeira: comportamento das respostas metabólicas ventilatórias e cardiovasculares na DPOC. *Fisioter Mov*. 2012;25(1):105-15. <http://dx.doi.org/10.1590/S0103-51502012000100011>.
 12. Andrade CH, Cianci RG, Malaguti C, Corso SD. The use of step tests for the assessment of exercise capacity in healthy subjects and in patients with chronic lung disease. *J Bras Pneumol*. 2012;38(1):116-24. PMID:22407048.
 13. Marrara KT, Marino DM, Jamami M, Oliveira AD Jr, Di Lorenzo VAP. Responsividade do teste do degrau de seis minutos a um programa de treinamento físico em pacientes com DPOC. *J Bras Pneumol*. 2012;38(5):579-87. <http://dx.doi.org/10.1590/S1806-37132012000500007>. PMID:23147050.
 14. Pessoa BV, Arcuri JF, Labadessa IG, Costa JN, Sentanin AC, Di Lorenzo VA. Validity of the six-minute step test of free cadence in patients with chronic obstructive pulmonary disease. *Braz J Phys Ther*. 2014;18(3):228-36. <http://dx.doi.org/10.1590/bjpt-rbf.2014.0041>. PMID:25003275.
 15. Monteiro DP, Britto RR, Fregonezi GAF, Dias FAL, Silva MGD, Pereira DAG. Reference values for the bilateral heel-rise test. *Braz J Phys Ther*. 2017;21(5):344-9. <http://dx.doi.org/10.1016/j.bjpt.2017.06.002>. PMID:28709587.
 16. Murayama R, Carraro LD, Galvanin T, Izukawa NM, Umeda I, Oliveira MF. Insuficiência vascular periférica compromete a capacidade funcional no paciente com insuficiência cardíaca. *J Vasc Bras*. 2014;13(2):101-7. <http://dx.doi.org/10.1590/jvb.2014.053>.
 17. Dias RMR, Cyrino ES, Salvador EP, et al. Influência do processo de familiarização para avaliação da força muscular em testes de 1-RM. *Rev Bras Med Esporte*. 2005;11(1):34-8. <http://dx.doi.org/10.1590/S1517-86922005000100004>.
 18. Zazá DC, Menzel H-JK, Chagas MH. Effect of a step-training program on muscle strength in older women. *Rev Bras Cineantropom Desempenho Hum*. 2010;12(3):164-70.
 19. Klonizakis M, Tew G, Michaels J, Saxton J. Exercise training improves cutaneous microvascular endothelial function in post-surgical varicose vein patients. *Microvasc Res*. 2009;78(1):67-70. <http://dx.doi.org/10.1016/j.mvr.2009.03.002>. PMID:19289135.
 20. Monteiro DP, Britto RR, Carvalho MLV, Montemezzo D, Parreira VF, Pereira DAG. Shuttle walking test como instrumento de avaliação da capacidade funcional: uma revisão da literatura. *Ciênc Saúde (Porto Alegre)*. 2014;7(2):92. <http://dx.doi.org/10.15448/1983-652X.2014.2.16580>.
 21. Carvalho ÍC, Ferreira DKS. Exercícios físicos para mulheres com varizes: treinar condicionamento geral ou membros inferiores? *Educ Fis Ciênc*. 2021;23(3):e190. <http://dx.doi.org/10.24215/23142561e190>.
 22. Özberk S, Karadibak D, Karabay DÖ, Polat M. The relationship between quality of life, functional capacity, physical activity and performance levels in chronic venous disease. *E - J Cardiovasc Med (Hagerstown)*. 2018;6(3):97-102. <http://dx.doi.org/10.32596/ejcm.18.00397>.

Correspondence

Ícaro do Carmo Carvalho
Rua Casa Forte (Reserva São Lourenço), Condomínio Carvalho, Bloco 2, Ap. 301, Bairro Muribara
CEP 54720-806 - São Lourenço da Mata (PE), Brasil
Tel.: +55 (81) 98563-0385
E-mail: icaroicc@hotmail.com

Author information

ICC - MSc in Educação Física, Universidade Federal de Pernambuco (UFPE); Programa Academia da Cidade, Prefeitura da Cidade do Recife Professional.
DKSF - PhD in Saúde Pública, Centro Pesquisas Aggeu Magalhães (Fundação Oswaldo Cruz); Adjunct professor, Universidade Federal de Pernambuco (UFPE).

Author contributions

Conception and design: ICC, DKSF
Analysis and interpretation: ICC
Data collection: ICC
Writing the article: ICC
Critical revision of the article: DKSF
Final approval of the article*: ICC, DKSF
Statistical analysis: ICC
Overall responsibility: ICC

*All authors have read and approved of the final version of the article submitted to *J Vasc Bras*.