REVIEW PAPER

Physiotherapy Quarterly (ISSN 2544-4395)
2022, 30(4), 30–40

Which is the most common rest interval for the incremental shuttle walking test in different populations? A systematic review

DOI: https://doi.org/10.5114/pq.2022.121153

Vivian Carla Junglos[1,2,3], Paula Stefânia M.S. Patrício[2,3], Ana Cristina F. de Oliveira[2,3], Viviane M. Caceres[4], Danielle S.R. Vieira[2,3,5]

[1] Cardiology Institute, University Foundation of Cardiology, Porto Alegre, Brazil
[2] Research Laboratory in Cardiovascular and Respiratory Assessment and Rehabilitation, Federal University of Santa Catarina, Araranguá, Brazil
[3] Rehabilitation Science Graduation Program, Federal University of Santa Catarina, Araranguá, Brazil
[4] Adelaide Medical School, Faculty of Health and Medical Sciences, The University of Adelaide, Adelaide, Australia
[5] Department of Health Sciences, Federal University of Santa Catarina, Araranguá, Brazil

Abstract

Introduction. The incremental shuttle walking test (ISWT) has been widely used in different health conditions. Because of the learning effect, the test should be performed at least twice. However, there is no formal recommendation or consensus on the rest interval that should be used between the tests. Therefore, the aim of this study was to systematically review the most common rest intervals applied for ISWT in adult and elderly individuals with different health conditions.

Methods. We performed a systematic review based on the PRISMA protocol, registered in PROSPERO. Searches were conducted in 8 electronic databases (MEDLINE via PubMed and OvidSP, PEDro, LILACS, SciELO, Cochrane, CINAHL, Web of Science, and Scopus) by using specific terms.

Results. We initially found 1538 references, of which 75 met the inclusion criteria. Numerous studies did not report the rest interval between the tests and therefore could not be included in the review. Of the 75 studies, 41 evaluated individuals with respiratory dysfunctions, mainly chronic obstructive pulmonary disease. Most of them (n = 57) used a 30-minute interval, followed by a 20-minute interval (n = 6) and a 15-minute interval (n = 4).

Conclusions. This systematic review demonstrates that many studies did not point out the rest interval for ISWT. Although there was a predominance of a 30-minute interval between the tests, future research is needed to understand the implications of the resting interval on ISWT outcomes.

Key words: exercise test, walk test, respiratory disorders, cardiovascular diseases

Introduction

The cardiopulmonary exercise test (CPET) is considered the gold standard for the evaluation of exercise capacity. However, its use is limited, since it needs time, high-cost equipment, and a trained team [1]. Alternatively, field tests, such as the incremental shuttle walking test (ISWT), have been extensively applied in different populations [2–6].

ISWT is a symptom-limited incremental test used to assess functional capacity. It has the advantage of a gradual increase of the intensity through an external velocity control and the imposition of a progressive effort [7, 8]. The gradual increase in velocity ensures a quantitatively similar cardiorespiratory stress to all individuals [8]. Furthermore, ISWT provides a more significant cardiovascular load in comparison with other walking tests with submaximal characteristics [8–10].

The proper use of measurement instruments in clinical practice depends on the degree to which they produce accurate results of the phenomena under investigation [11]. In this context, standardized assessment methods have been shown to be an important strategy to improve measurement accuracy [12]. Considering the standardization for the application of ISWT, the European Respiratory Society and the American Thoracic Society recommend that at least 2 tests should be performed at first exposure owing to the occurrence of a significant learning effect for the first 2 ISWTs [13].

Despite the recommendation concerning the number of tests, to the best of our knowledge, there are no guidelines regarding the most appropriate rest interval between 2 ISWTs. The American Thoracic Society recommends a 60-minute interval between two 6-minute walking tests (6MWT) [14]. As there are more physiological response similarities between ISWT and CPET [15–17], we would at least expect a rest interval similar to the one recommended for 6MWT.

In this context, the aim of this study was to systematically review the most common rest interval used for ISWT in adult and elderly individuals with different health conditions.

Subjects and methods

Study design

We performed a systematic review in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) protocol [18], which was registered in the International Prospective Register of Systematic Reviews (PROSPERO) (ID: CRD42018109387).

Correspondence address: Danielle Soares Rocha Vieira, Research Laboratory in Cardiovascular and Respiratory Assessment and Rehabilitation, Federal University of Santa Catarina, Pedro João Pereira Street, 150 Mato Alto, Araranguá, SC, zip code: 88.905-120, Brazil, e-mail: danielle.vieira@ufsc.br, https://orcid.org/0000-0001-6222-6142

Received: 18.08.2020
Accepted: 01.12.2020

Citation: Junglos VC, Patrício PSMS, de Oliveira ACF, Caceres VM, Vieira DSR. Which is the most common rest interval for the incremental shuttle walking test in different populations? A systematic review. Physiother Quart. 2022;30(4):30–40; doi: https://doi.org/10.5114/pq.2022.121153.

Eligibility criteria

Randomized clinical trials, experimental and observational studies published in English, Portuguese, or Spanish in which ISWT was conducted at least twice in individuals above 18 years old with different health conditions were included in the review. Studies in which the rest interval between tests was not reported, as well as reviews, short communications, letters, case studies, guidelines, theses, abstracts published in scientific events, and studies with unavailable full texts were not included.

Outcomes

The outcome of this review was the rest interval between ISWTs used in different populations.

Search strategies and information sources

The search was performed in 8 databases (MEDLINE via PubMed and OvidSP, PEDro, LILACS, SciELO, Cochrane, CINAHL, Web of Science, and Scopus) by 2 independent examiners between September and October 2017 with the following descriptors: ISWT, incremental shuttle walking test, and incremental shuttle walk test. The following search strategy was used for MEDLINE via PubMed: ((ISWT [Title/Abstract]) OR "incremental shuttle walking test" [Title/Abstract] OR "incremental shuttle walk test" [Title/Abstract]). The references of the articles included in this study were also revised. Besides, corresponding authors were contacted when we were not able to access their full-text studies.

Study selection and data extraction

Two reviewers independently selected the studies through the assessment of the title and abstract. In cases of disagreement, a third researcher participated in the evaluation. The full text of an article was retrieved when it was considered potentially eligible.

Two reviewers independently extracted the data regarding the participants' characteristics (health condition and severity, sex, and age) and ISWT (number of tests performed and the rest interval) through a standardized form. If any divergences emerged, a third evaluator was consulted.

The results of the systematic review were presented in a narrative form for each health condition (respiratory, cardiovascular, other types of dysfunctions, and without dysfunctions).

Results

The search methodology used to identify relevant studies is summarized in Figure 1. Of 1538 references screened, 938 were duplicates and 253 were excluded after title and

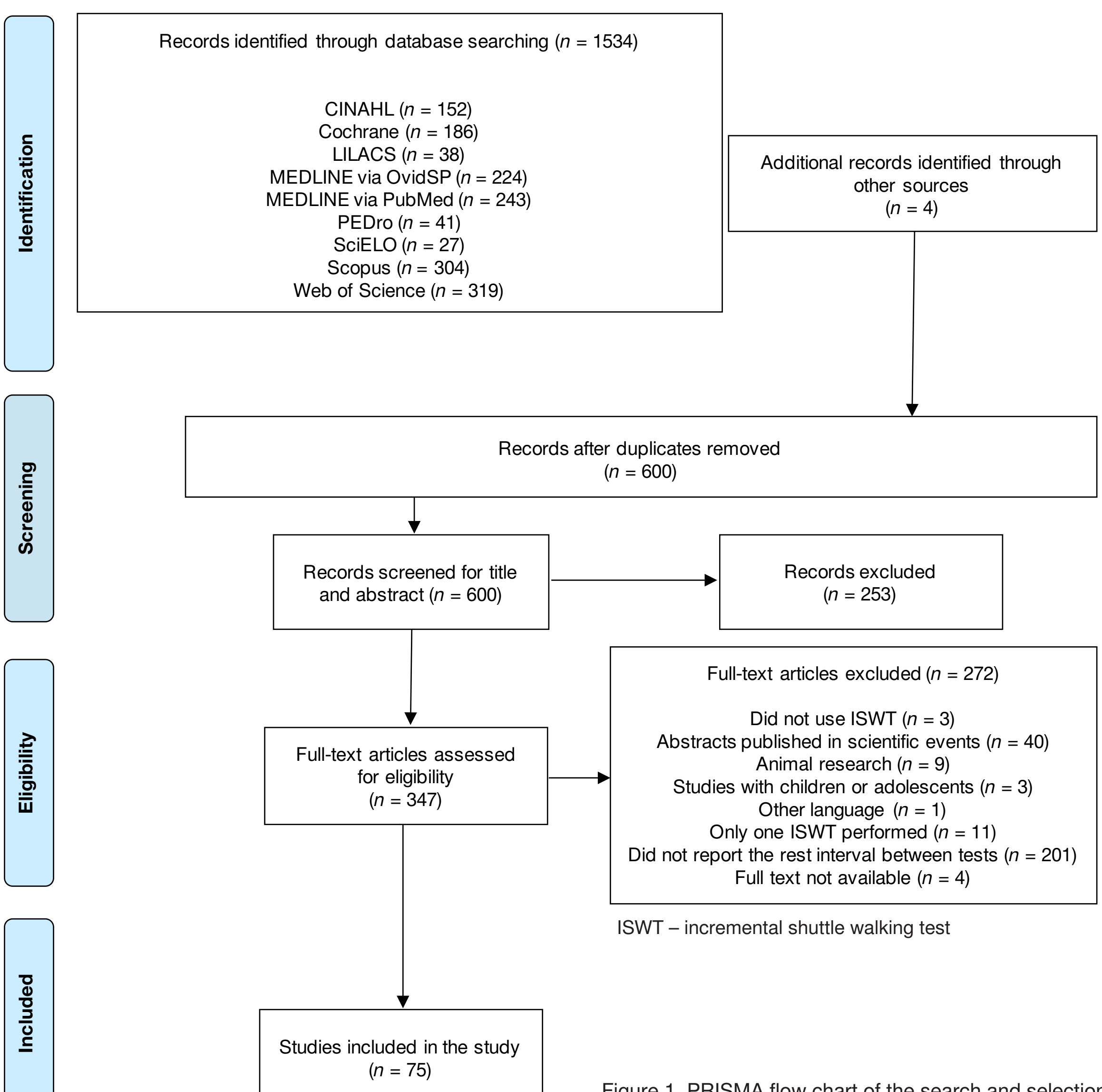

Figure 1. PRISMA flow chart of the search and selection of studies

abstract review. Thus, 347 full-text articles were assessed for eligibility; out of these, 272 were excluded for not meeting the eligibility criteria. Additionally, it was not possible to access the full version of 4 studies, even after contacting the authors. Therefore, 75 studies were deemed eligible for inclusion in this review.

Of the 75 articles included in the review, 41 evaluated individuals with respiratory dysfunctions [4, 10, 19–57], 10 presented patients with cardiovascular dysfunctions [3, 58–66], 9 reported subjects with other health conditions [5, 67–74], such as metabolic and musculoskeletal diseases, and 15 involved healthy participants [2, 75–88].

Regarding the number of ISWTs performed, 70 papers (93.33%) referred to 2 tests and 5 (6.67%) to 3 tests. In most studies (*n* = 57), a 30-minute interval was applied, regardless of the study design. The other resting intervals used were: 15-minute interval (*n* = 4), 20-minute interval (*n* = 6), 20–30-minute interval (*n* = 3), 45-minute interval (*n* = 1), 60-minute interval (*n* = 2), and 240-minute interval (*n* = 1). Moreover, 1 study involved the time needed for the heart rate to return to baseline to determine the interval between the tests [32].

A more detailed description of the main characteristics of the studies included in the review for each of the health conditions can be found in the supplementary material.

ISWT in individuals with respiratory dysfunctions

We identified 41 studies in individuals with respiratory dysfunctions. Most of them (*n* = 32) assessed patients with chronic obstructive pulmonary disease [4, 10, 19, 22, 23, 26, 28–32, 34, 36, 39–57]. Other conditions evaluated were bronchiectasis (*n* = 4) [21, 35, 37, 38], idiopathic pulmonary fibrosis (*n* = 1) [33], obstructive sleep apnoea syndrome (*n* = 1) [20], lung cancer (*n* = 1) [27], alpha-1-antitrypsin deficiency and macroscopic emphysema (*n* = 1) [24], and chronic airflow limitation in an elderly (*n* = 1) [25]. The studies involved subjects of both sexes, with an age range of 18–76 (IQR: 70–89) years.

ISWT was conducted twice in all studies. As presented in Figure 2, most of them (*n* = 30) used a 30-minute rest interval [4, 19, 21, 24, 25, 28–30, 33, 34, 36–45, 47–49, 51–57]. Moreover, 4 studies used a 15-minute interval [20, 22, 23, 27], 2 used a 20-minute interval [26, 46], 3 used an interval of 20–30 minutes [10, 31, 50], 1 used a 60-minute interval [35], and 1 study used the time needed for the heart rate to return to baseline [32].

ISWT in individuals with cardiovascular dysfunctions

We found 10 studies that assessed functional capacity through ISWT in individuals with different cardiovascular dysfunctions, mainly coronary artery disease (*n* = 4) [58, 59, 62, 65]. Other conditions included acute myocardial infarction [64], myocardial revascularization [60], and systemic arterial hypertension [3], among others. Individuals of both sexes aged 54 ± 8 to 68 ± 10 years were investigated.

Of these 10 studies, 8 performed ISWT twice [3, 58, 59, 61–65] and the remaining 2 conducted 3 tests [60, 66]. The most frequent rest interval was 30 minutes (*n* = 8) [3, 58, 59, 61–65]. Moreover, 1 study used a 20-minute interval [66] and 1 applied a 45-minute interval between the tests [60] (Figure 2).

ISWT in individuals with other health conditions

In 9 studies, ISWT was used to evaluate individuals with health conditions other than respiratory and cardiovascular dysfunctions. The investigated conditions included frail elderly [5, 67], obesity [68–70], metabolic syndrome [71, 72], intellectual disability [73], and intra-abdominal surgery [74]. The studies were performed with patients of both sexes, with age varying from 31 ± 7 to 79 (IQR: 53–90) years.

ISWT was conducted twice in all 9 studies. Seven studies used a 30-minute interval [5, 67–72], 1 used a 60-minute interval [73], and another 1 used a 240-minute interval between the tests [74] (Figure 2).

ISWT in apparently healthy individuals

We identified 15 studies that reported ISWT use in apparently healthy individuals. They were conducted with subjects

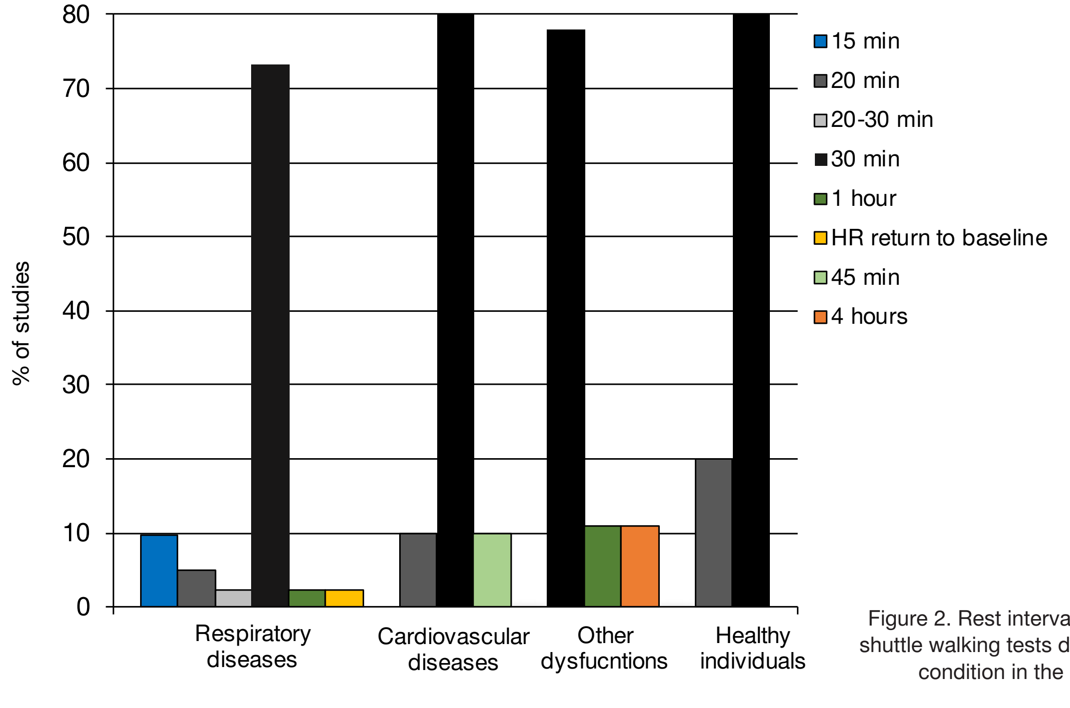

Figure 2. Rest interval between incremental shuttle walking tests depending on the health condition in the reviewed studies

of both sexes, with a considerable variation of age (18–83 years).

In 12 of them, ISWT was performed twice [2, 29, 75, 77–79, 83–88] and in the remaining 3 the test was conducted 3 times [76, 80, 81]. Moreover, most studies (*n* = 12) used a 30-minute interval between the tests [2, 29, 75, 77–79, 83–88] and 3 applied a 20-minute interval [76, 80, 81] (Figure 2).

Discussion

The main finding of this review was that most studies assessing ISWT performed 2 tests with a 30-minute rest interval, independently of the health condition investigated. As highlighted before, there is no official recommendation for this aspect for ISWT. Only 1 study verified whether 30 minutes between 2 ISWTs would be sufficient for the return of cardiovascular variables, as well as would affect test performance [86]. This study was conducted with 334 apparently healthy individuals of both sexes aged 18–53 years. It was demonstrated that, regardless of age, the 30-minute interval was adequate for blood pressure recovery and did not affect the test performance. However, this interval was not enough for the heart rate and the double product to return to their baseline values. Furthermore, it must be considered that this study assessed healthy subjects, and we hypothesize that these variables could demand a longer time to return to baseline among individuals with cardiorespiratory or other dysfunctions.

In this way, a 30-minute rest period between ISWTs must be applied with caution, depending on the outcome variable and population under investigation. Therefore, to avoid ISWT inaccuracy, further studies are needed to support the most appropriate rest interval choice in different populations.

Besides, several studies identified in this review did not report the number of tests performed or the rest interval between ISWTs; therefore, they could not be included. Standardization in the use of a measurement instrument is of considerable importance to ensure its accuracy [12]. That being said, the impact of the rest interval between ISWTs on the outcomes should always be considered and presented in the methodological aspects of studies involving this test.

Limitations

The review has some limitations, such as (1) the impossibility to find full texts for all studies, even after contacting the authors; and (2) lack of the bias risk assessment for the included studies. However, the focus of this review was to establish which rest interval was most commonly applied for ISWT, regardless of the risk of study bias. In addition, we observed that the 30-minute interval was used in most studies, irrespective of the study design, from randomized clinical trials to cross-sectional studies.

Application to practice

CPET is considered the gold standard for functional capacity assessment. However, given its high cost and the need for trained personnel to perform it, field tests have been widely used as an alternative form of evaluation. In this context, ISWT imposes greater cardiovascular stress compared with other walking tests with submaximal characteristics, and its findings are highly correlated with those obtained by using CPET. Achieving accurate results through health outcome measures, including ISWT, depends on the standardization of how they are applied. In this sense, some guidelines recommend performing at least 2 tests owing to the learning effect. However, there are no recommendations regarding the rest interval for ISWT. In the present review, we found that the 30-minute interval was the most frequent, regardless of the health condition assessed. Only 1 study investigated the influence of this interval on the outcomes obtained in ISWT, and it was observed that 30 minutes were not enough for all cardiovascular variables to return to baseline values in healthy individuals. We hypothesized that these variables could require an even longer time to return to baseline among subjects affected by health disorders, especially those with cardiorespiratory dysfunctions. Thus, additional consideration should be given to rest interval selection, and further studies are needed to investigate this aspect so as not to compromise the accuracy of the test.

Conclusions

This systematic review demonstrates that although a large number of studies did not point out an important characteristic for ISWT application, in those papers that reported this information, there was a predominance of using a 30-minute interval between tests.

The absence of formal recommendations concerning the rest interval in ISWT, as well as scarce investigation of the influence of this interval on the outcomes obtained in the test make it important to expand the discussion on the topic and to carry out further research.

Ethical approval

The conducted research is not related to either human or animal use.

Disclosure statement

No author has any financial interest or received any financial benefit from this research.

Conflict of interest

The authors state no conflict of interest.

Funding

The authors received no specific funding for this work.

References

1. Di Thommazo-Luporini L, Jürgensen SP, Castello-Simões V, Catai AM, Arena R, Borghi-Silva A. Metabolic and clinical comparative analysis of treadmill six-minute walking test and cardiopulmonary exercise testing in obese and eutrophic women. Rev Bras Fisioter. 2012;16(6): 469–478; doi: 10.1590/s1413-35552012005000036.
2. Gonçalves CG, Mesquita R, Hayashi D, Merli MF, Vidotto LS, Fernandes KBP, et al. Does the incremental shuttle walking test require maximal effort in healthy subjects of different ages? Physiotherapy. 2015;101(2):141–146; doi: 10.1016/j.physio.2014.11.002.
3. Jurio-Iriarte B, Gorostegi-Anduaga I, Aispuru GR, Pérez-Asenjo J, Brubaker PH, Maldonado-Martín S. Association between modified shuttle walk test and cardiorespiratory fitness in overweight/obese adults with primary hypertension: EXERDIET-HTA study. J Am Soc Hypertens. 2017;11(4):186–195; doi: 10.1016/j.jash.2017.01.008.
4. McKeough Z, Leung R, Neo JH, Jenkins S, Holland A, Hill K, et al. Shuttle walk tests in people with COPD who demonstrate exercise-induced oxygen desaturation: an analysis of test repeatability and cardiorespiratory responses. Chron Respir Dis. 2018;15(2):131–137; doi: 10.1177/1479972317729051.

5. De Carvalho Bastone A, de Souza Moreira B, Teixeira CP, Dias JMD, Dias RC. Is the Veterans Specific Activity Questionnaire valid to assess older adults aerobic fitness? J Geriatr Phys Ther. 2016;39(3):117–124; doi: 10.1519/JPT.0000000000000062.
6. Ronan JT, Shafer AB. Concurrent validity of the five-minute pyramid test for VO_2max estimation in healthy young adults. Hum Mov. 2019;20(4):41–45; doi: 10.5114/hm.2019.85092.
7. Da Cunha-Filho IT, Pereira DAG, de Carvalho AMB, Campedeli L, Soares M, de Sousa Freitas J. The reliability of walking tests in people with claudication. Am J Phys Med Rehabil. 2007;86(7):574–582; doi: 10.1097/PHM.0b013e31806de721.
8. Singh SJ, Morgan MD, Scott S, Walters D, Hardman AE. Development of a shuttle walking test of disability in patients with chronic airways obstruction. Thorax. 1992;47(12):1019–1024; doi: 10.1136/thx.47.12.1019.
9. Rosa FW, Camelier A, Mayer A, Jardim JR. Evaluating physical capacity in patients with chronic obstructive pulmonary disease: comparing the shuttle walk test with the encouraged 6-minute walk test. J Bras Pneumol. 2006;32(2):106–113; doi: 10.1590/s1806-37132006000200005.
10. Hill K, Dolmage TE, Woon L, Coutts D, Goldstein R, Brooks D. Comparing peak and submaximal cardiorespiratory responses during field walking tests with incremental cycle ergometry in COPD. Respirology. 2012;17(2):278–284; doi: 10.1111/j.1440-1843.2011.02089.x.
11. Gadotti IC, Vieira ER, Magee DJ. Importance and clarification of measurement properties in rehabilitation. Rev Bras Fisioter. 2006;10(2):137–146; doi: 10.1590/S1413-35552006000200002.
12. Ambagtsheer R, Visvanathan R, Cesari M, Yu S, Archibald M, Schultz T, et al. Feasibility, acceptability and diagnostic test accuracy of frailty screening instruments in community-dwelling older people within the Australian general practice setting: a study protocol for a cross-sectional study. BMJ Open. 2017;7(8):e016663; doi: 10.1136/bmjopen-2017-016663.
13. Holland AE, Spruit MA, Troosters T, Puhan MA, Pepin V, Saey D, et al. An official European Respiratory Society/American Thoracic Society technical standard: field walking tests in chronic respiratory disease. Eur Respir J. 2014;44(6):1428–1446; doi: 10.1183/09031936.00150314.
14. ATS statement: guidelines for the six-minute walk test. Am J Respir Crit Care Med. 2002;166(1):111–117; doi: 10.1164/ajrccm.166.1.at1102.
15. Morales FJ, Martínez A, Méndez M, Agarrado A, Ortega F, Fernández-Guerra J, et al. A shuttle walk test for assessment of functional capacity in chronic heart failure. Am Heart J. 1999;138(2 Pt 1):291–298; doi: 10.1016/s0002-8703(99)70114-6.
16. Lewis ME, Newall C, Townend JN, Hill SL, Bonser RS. Incremental shuttle walk test in the assessment of patients for heart transplantation. Heart. 2001;86(2):183–187; doi: 10.1136/heart.86.2.183.
17. Singh SJ, Morgan MDL, Hardman AE, Rowe C, Bardsley PA. Comparison of oxygen uptake during a conventional treadmill test and the shuttle walking test in chronic airflow limitation. Eur Respir J. 1994;7(11):2016–2020; doi: 10.1183/09031936.94.07112016.
18. Moher D, Shamseer L, Clarke M, Ghersi D, Liberati A, Petticrew M, et al. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. Syst Rev. 2015;4(1):1; doi: 10.1186/2046-4053-4-1.
19. Alison JA, McKeough ZJ, Jenkins SC, Holland AE, Hill K, Morris NR, et al. A randomised controlled trial of supplemental oxygen versus medical air during exercise training in people with chronic obstructive pulmonary disease: supplemental oxygen in pulmonary rehabilitation trial (SuppORT) (protocol). BMC Pulm Med. 2016;16:25; doi: 10.1186/s12890-016-0186-4.
20. Billings CG, Aung T, Renshaw SA, Bianchi SM. Incremental shuttle walk test in the assessment of patients with obstructive sleep apnea-hypopnea syndrome. J Sleep Res. 2013;22(4):471–477; doi: 10.1111/jsr.12037.
21. De Camargo AA, Amaral TS, Rached SZ, Athanazio RA, Lanza FC, Sampaio LM, et al. Incremental shuttle walking test: a reproducible and valid test to evaluate exercise tolerance in adults with noncystic fibrosis bronchiectasis. Arch Phys Med Rehabil. 2014;95(5):892–899; doi: 10.1016/j.apmr.2013.11.019.
22. Dias FD, Sampaio LMM, da Silva GA, Gomes ÉLFD, do Nascimento ESP, Alves VLS, et al. Home-based pulmonary rehabilitation in patients with chronic obstructive pulmonary disease: a randomized clinical trial. Int J Chron Obstruct Pulmon Dis. 2013;8:537–544; doi: 10.2147/COPD.S50213.
23. Dias FD, Gomes ELFD, Stirbulov R, Alves VLS, Costa D. Assessment of body composition, functional capacity and pulmonary function in patients with chronic obstructive pulmonary disease. Fisioter Pesqui. 2014;21(1):10–15; doi: 10.1590/1809-2950/238210114.
24. Dowson LJ, Newall C, Guest PJ, Hill SL, Stockley RA. Exercise capacity predicts health status in α_1-antitrypsin deficiency. Am J Respir Crit Care Med. 2001;163(4):936–941; doi: 10.1164/ajrccm.163.4.2007048.
25. Dyer CAE, Singh SJ, Stockley RA, Sinclair AJ, Hill SL. The incremental shuttle walking test in elderly people with chronic airflow limitation. Thorax. 2002;57(1):34–38; doi: 10.1136/thorax.57.1.34.
26. Garrod R, Ford K, Daly C, Hoareau C, Howard M, Simmonds C. Pulmonary rehabilitation: analysis of a clinical service. Physiother Res Int. 2004;9(3):111–120; doi: 10.1002/pri.311.
27. Granger CL, Denehy L, Parry SM, Martin J, Dimitriadis T, Sorohan M, et al. Which field walking test should be used to assess functional exercise capacity in lung cancer? An observational study. BMC Pulm Med. 2015;15:89; doi: 10.1186/s12890-015-0075-2.
28. Harrison SL, Greening NJ, Williams JEA, Morgan MDL, Steiner MC, Singh SJ. Have we underestimated the efficacy of pulmonary rehabilitation in improving mood? Respir Med. 2012;106(6):838–844; doi: 10.1016/j.rmed.2011.12.003.
29. Harrison SL, Greening NJ, Houchen-Wolloff L, Bankart J, Morgan MDL, Steiner MC, et al. Age-specific normal values for the incremental shuttle walk test in a healthy British population. J Cardiopulm Rehabil Prev. 2013;33(5):309–313; doi: 10.1097/HCR.0b013e3182a0297e.
30. Hill K, Dolmage TE, Woon L, Coutts D, Goldstein R, Brooks D. Defining the relationship between average daily energy expenditure and field-based walking tests and aerobic reserve in COPD. Chest. 2012;141(2):406–412; doi: 10.1378/chest.11-0298.
31. Hill K, Dolmage TE, Woon L, Coutts D, Goldstein R, Brooks D. A simple method to derive speed for the endurance shuttle walk test. Respir Med. 2012;106(12):1665–1670; doi: 10.1016/j.rmed.2012.08.011.

32. Hodonská J, Neumannová K, Svoboda Z, Sedlák V, Zatloukal J, Plutinský M, et al. Incremental shuttle walk test as an indicator of decreased exercise tolerance in patients with chronic obstructive pulmonary disease. Acta Gymnica. 2016;46(3):117–121; doi: 10.5507/ag.2016.012.
33. Johnson-Warrington V, Sewell L, Morgan M, Singh S. Do we need a practice incremental shuttle walk test for patients with interstitial lung disease referred for pulmonary rehabilitation? Respirology. 2015;20(3):434–438; doi: 10.1111/resp.12469.
34. Jones SE, Kon SSC, Canavan JL, Patel MS, Clark AL, Nolan CM, et al. The five-repetition sit-to-stand test as a functional outcome measure in COPD. Thorax. 2013; 68(11):1015–1020; doi: 10.1136/thoraxjnl-2013-203576.
35. José A, Dal Corso S. Inpatient rehabilitation improves functional capacity, peripheral muscle strength and quality of life in patients with community-acquired pneumonia: a randomised trial. J Physiother. 2016;62(2):96–102; doi: 10.1016/j.jphys.2016.02.014.
36. Kaneko H, Maruyama H, Sato H. Relationship between expiratory activity of the lateral abdominal muscle and exercise tolerance in chronic obstructive pulmonary disease. J Phys Ther Sci. 2008;20(2):147–151; doi: 10.1589/jpts.20.147.
37. Lee AL, Cecins N, Hill CJ, Holland AE, Rautela L, Stirling RG, et al. The effects of pulmonary rehabilitation in patients with non-cystic fibrosis bronchiectasis: protocol for a randomised controlled trial. BMC Pulm Med. 2010;10:5; doi: 10.1186/1471-2466-10-5.
38. Lee AL, Cecins N, Holland AE, Hill CJ, McDonald CF, Burge AT, et al. Field walking tests are reliable and responsive to exercise training in people with non-cystic fibrosis bronchiectasis. J Cardiopulm Rehabil Prev. 2015;35(6): 439–445; doi: 10.1097/HCR.0000000000000130.
39. Leung RWM, McKeough ZJ, Peters MJ, Alison JA. Short-form sun-style t'ai chi as an exercise training modality in people with COPD. Eur Respir J. 2013;41(5):1051–1057; doi: 10.1183/09031936.00036912.
40. Lewko A, Marshall J, Garrod R. Ambulatory oxygen therapy assessment: a comparative study of incremental shuttle and 6-minute walking tests. Physiotherapy. 2007; 93(4):261–266; doi: 10.1016/j.physio.2007.03.002.
41. Luxton N, Alison JA, Wu J, Mackey MG. Relationship between field walking tests and incremental cycle ergometry in COPD. Respirology. 2008;13(6):856–862; doi: 10.1111/j.1440-1843.2008.01355.x.
42. Mador MJ, Modi K. Comparing various exercise tests for assessing the response to pulmonary rehabilitation in patients with COPD. J Cardiopulm Rehabil Prev. 2016; 36(2):132–139; doi: 10.1097/HCR.0000000000000154.
43. McNamara RJ, McKeough ZJ, McKenzie DK, Alison JA. Water-based exercise training for chronic obstructive pulmonary disease. Cochrane Database Syst Rev. 2013; 12:CD008290; doi: 10.1002/14651858.CD008290.pub2.
44. Ngai SPC, Spencer LM, Jones AYM, Alison JA. Acu-TENS reduces breathlessness during exercise in people with chronic obstructive pulmonary disease. Evid Based Complement Alternat Med. 2017;2017:3649257; doi: 10.1155/2017/3649257.
45. Ngai SPC, Spencer LM, Jones AYM, Alison JA. Repeatability of the endurance shuttle walk test in people with chronic obstructive pulmonary disease. Clin Respir J. 2017;11(6):875–880; doi: 10.1111/crj.12430.
46. Nikoletou D, Man WD-C, Mustfa N, Moore J, Rafferty G, Grant RL, et al. Evaluation of the effectiveness of a home-based inspiratory muscle training programme in patients with chronic obstructive pulmonary disease using multiple inspiratory muscle tests. Disabil Rehabil. 2016;38(3): 250–259; doi: 10.3109/09638288.2015.1036171.
47. De Oliveira LA, Mesquita R, de Brito IL, de Moraes Laburú V, Pitta F, Probst VS. Relationship between the work developed in maximal and submaximal exercise capacity tests and the degree of airflow obstruction in individuals with chronic obstructive pulmonary disease. Fisioter Pesqui. 2014;21(1):81–86; doi: 10.1590/1809-2950/484210114.
48. Revill SM, Williams J, Sewell L, Collier R, Singh SJ. Within-day repeatability of the endurance shuttle walk test. Physiotherapy. 2009;95(2):140–143; doi: 10.1016/j.physio.2009.02.001.
49. Satake M, Shioya T, Takahashi H, Kawatani M. Ventilatory responses to six-minute walk test, incremental shuttle walking test, and cycle ergometer test in patients with chronic obstructive pulmonary disease. Biomed Res. 2003;24(6):309–316; doi: 10.2220/biomedres.24.309.
50. Singh SJ, Jones PW, Evans R, Morgan MDL. Minimum clinically important improvement for the incremental shuttle walking test. Thorax. 2008;63(9):775–777; doi: 10.1136/thx.2007.081208.
51. Spencer LM, Alison JA, McKeough ZJ. Evaluating the need for two incremental shuttle walk tests during a maintenance exercise program in people with COPD. Physiotherapy. 2014;100(2):123–127; doi: 10.1016/j.physio.2013.12.001.
52. Turner SE, Eastwood PR, Cecins NM, Hillman DR, Jenkins SC. Physiologic responses to incremental and self-paced exercise in COPD: a comparison of three tests. Chest. 2004;126(3):766–773; doi: 10.1378/chest.126.3.766.
53. Vagaggini B, Taccola M, Severino S, Marcello M, Antonelli S, Brogi S, et al. Shuttle walking test and 6-minute walking test induce a similar cardiorespiratory performance in patients recovering from an acute exacerbation of chronic obstructive pulmonary disease. Respiration. 2003;70(6):579–584; doi: 10.1159/000075202.
54. Williams JEA, Green RH, Warrington V, Steiner MC, Morgan MDL, Singh SJ. Development of the i-BODE: validation of the incremental shuttle walking test within the BODE index. Respir Med. 2012;106(3):390–396; doi: 10.1016/j.rmed.2011.09.005.
55. Wootton SL, Ng C, McKeough ZJ, Jenkins S, Hill K, Alison JA. Estimating endurance shuttle walk test speed using the six-minute walk test in people with chronic obstructive pulmonary disease. Chron Respir Dis. 2014; 11(2):89–94; doi: 10.1177/1479972314527470.
56. Yoza Y, Ariyoshi K, Honda S, Taniguchi H, Senjyu H. Development of an activity of daily living scale for patients with COPD: the Activity of Daily Living Dyspnoea scale. Respirology. 2009;14(3):429–435; doi: 10.1111/j.1440-1843.2009.01479.x.
57. Zainuldin R, Mackey MG, Alison JA. Prescription of walking exercise intensity from the incremental shuttle walk test in people with chronic obstructive pulmonary disease. Am J Phys Med Rehabil. 2012;91(7):592–600; doi: 10.1097/PHM.0b013e31824660bd.
58. Buckley JP, Cardoso FMF, Birkett ST, Sandercock GRH. Oxygen costs of the incremental shuttle walk test in cardiac rehabilitation participants: an historical and contemporary analysis. Sports Med. 2016;46(12):1953–1962; doi: 10.1007/s40279-016-0521-1.
59. Bueno FR, Corrêa FR, da Silva Alves MA, Bardin MG, Modesto JA, Dourado VZ. Physical exercise capacity and

its prognostic value in postoperative cardiac surgery [in Portuguese]. Fisioter Mov. 2012;25(4):839–847; doi: 10.1590/S0103-51502012000400017.
60. Fowler SJ, Singh SJ, Revill S. Reproducibility and validity of the incremental shuttle walking test in patients following coronary artery bypass surgery. Physiotherapy. 2005;91(1):22–27; doi: 10.1016/j.physio.2004.08.009.
61. Hanson LC, Taylor NF, McBurney H. The 10 m incremental shuttle walk test is a highly reliable field exercise test for patients referred to cardiac rehabilitation: a retest reliability study. Physiotherapy. 2016;102(3):243–248; doi: 10.1016/j.physio.2015.08.004.
62. Hanson LC, McBurney H, Taylor NF. Is the 10 m incremental shuttle walk test a useful test of exercise capacity for patients referred to cardiac rehabilitation? Eur J Cardiovasc Nurs. 2018;17(2):159–169; doi: 10.1177/1474515117721129.
63. Jolly K, Tayor R, Lip GYH, Greenfield S, Raftery J, Mant J, et al. The Birmingham Rehabilitation Uptake Maximisation study (BRUM). Home-based compared with hospital-based cardiac rehabilitation in a multi-ethnic population: cost-effectiveness and patient adherence. Health Technol Assess. 2007;11(35):1–118; doi: 10.3310/hta11350.
64. Jolly K, Taylor RS, Lip GYH, Singh S, BRUM Steering Committee. Reproducibility and safety of the incremental shuttle walking test for cardiac rehabilitation. Int J Cardiol. 2008;125(1):144–145; doi: 10.1016/j.ijcard.2007.01.037.
65. Lee KW, Blann AD, Ingram J, Jolly K, Lip GYH. Incremental shuttle walking is associated with activation of haemostatic and haemorheological markers in patients with coronary artery disease: the Birmingham Rehabilitation Uptake Maximisation Study (BRUM). Heart. 2005;91(11):1413–1417; doi: 10.1136/hrt.2004.050005.
66. Payne GE, Skehan JD. Shuttle walking test: a new approach for evaluating patients with pacemakers. Heart. 1996;75(4):414–418; doi: 10.1136/hrt.75.4.414.
67. De Carvalho Bastone A, Ferriolli E, Teixeira CP, Dias JMD, Dias RC. Aerobic fitness and habitual physical activity in frail and nonfrail community-dwelling elderly. J Phys Act Health. 2015;12(9):1304–1311; doi: 10.1123/jpah.2014-0290.
68. Evans RA, Dolmage TE, Robles PG, Goldstein RS, Brooks D. Do field walking tests produce similar cardiopulmonary demands to an incremental treadmill test in obese individuals with treated OSA? Chest. 2014;146(1):81–87; doi: 10.1378/chest.13-2060.
69. Jürgensen SP, Trimer R, Di Thommazo-Luporini L, Dourado VZ, Bonjorno-Junior JC, Oliveira CR, et al. Does the incremental shuttle walk test require maximal effort in young obese women? Braz J Med Biol Res. 2016;49(8):e5229; doi: 10.1590/1414-431X20165229.
70. Peixoto-Souza FS, Sampaio LMM, de Campos EC, Barbalho-Moulim MC, de Araujo PN, Laurino Neto RM, et al. Reproducibility of the incremental shuttle walk test for women with morbid obesity. Physiother Theory Pract. 2015;31(6):428–432; doi: 10.3109/09593985.2015.1010242.
71. Radhakrishnan J, Swaminathan N, Pereira N, Henderson K, Brodie D. Effect of an IT-supported home-based exercise programme on metabolic syndrome in India. J Telemed Telecare. 2014;20(5):250–258; doi: 10.1177/1357633X14536354.
72. Radhakrishnan J, Swaminathan N, Pereira NM, Henderson K, Brodie DA. Acute changes in arterial stiffness following exercise in people with metabolic syndrome. Diabetes Metab Syndr. 2017;11(4):237–243; doi: 10.1016/j.dsx.2016.08.013.
73. Van Schijndel-Speet M, Evenhuis HM, van Wijck R, van Montfort KCAGM, Echteld MA. A structured physical activity and fitness programme for older adults with intellectual disabilities: results of a cluster-randomised clinical trial. J Intellect Disabil Res. 2017;61(1):16–29; doi: 10.1111/jir.12267.
74. Struthers R, Erasmus P, Holmes K, Warman P, Collingwood A, Sneyd JR. Assessing fitness for surgery: a comparison of questionnaire, incremental shuttle walk, and cardiopulmonary exercise testing in general surgical patients. Br J Anaesth. 2008;101(6):774–780; doi: 10.1093/bja/aen310.
75. Bardin MG, Dourado VZ. Association between the occurrence of falls and the performance on the incremental shuttle walk test in elderly women. Rev Bras Fisioter. 2012;16(4):275–280; doi: 10.1590/S1413-35552012005000033.
76. Braz TV, Ornelas F, Matos NR, Germano MD, Sindorf MAG, Moreno MA, et al. Chronic effect of different load distributions on the autonomic heart rate modulation. J Exerc Physiol Online. 2016;19(2):55–67.
77. Dourado VZ, Banov MC, Marino MC, de Souza VL, de O. Antunes LC, McBurnie MA. A simple approach to assess VT during a field walk test. Int J Sports Med. 2010;31(10):698–703; doi: 10.1055/s-0030-1255110.
78. Dourado VZ, Vidotto MC, Guerra RLF. Reference equations for the performance of healthy adults on field walking tests. J Bras Pneumol. 2011;37(5):607–614; doi: 10.1590/s1806-37132011000500007.
79. Dourado VZ, Pisani LP, Lombardi Junior I, Guerra RLF, Vidotto MC. Incremental shuttle and six-minute walk tests in healthy elderly subjects. Gazz Med Ital Arch Sci Med. 2011;170(1):1–10.
80. Dourado VZ, Guerra RLF, Tanni SE, de Oliveira Antunes LC, Godoy I. Reference values for the incremental shuttle walk test in healthy subjects: from the walk distance to physiological responses. J Bras Pneumol. 2013;39(2):190–197; doi: 10.1590/s1806-37132013000200010.
81. Dourado VZ, Guerra RLF. Reliability and validity of heart rate variability threshold assessment during an incremental shuttle-walk test in middle-aged and older adults. Braz J Med Biol Res. 2013;46(2):194–199; doi: 10.1590/1414-431X20122376.
82. Harrison SL, Horton EJ, Smith R, Sandland CJ, Steiner MC, Morgan MDL, et al. Physical activity monitoring: addressing the difficulties of accurately detecting slow walking speeds. Heart Lung. 2013;42(5):361–364.e1; doi: 10.1016/j.hrtlng.2013.06.004.
83. Hayashi D, Gonçalves CG, Parreira RB, Fernandes KBP, Teixeira DC, Silva RA, et al. Postural balance and physical activity in daily life (PADL) in physically independent older adults with different levels of aerobic exercise capacity. Arch Gerontol Geriatr. 2012;55(2):480–485; doi: 10.1016/j.archger.2012.04.009.
84. Jürgensen SP, de Oliveira Antunes LC, Tanni SE, Banov MC, Lucheta PA, Bucceroni AF, et al. The incremental shuttle walk test in older Brazilian adults. Respiration. 2011;81(3):223–228; doi: 10.1159/000319037.
85. Probst VS, Hernandes NA, Teixeira DC, Felcar JM, Mesquita RB, Gonçalves CG, et al. Reference values for the incremental shuttle walking test. Respir Med. 2012;106(2):243–248; doi: 10.1016/j.rmed.2011.07.023.

86. Ribeiro LRG, Mesquita RB, Vidotto LS, Merli MF, Carvalho DR, de Castro LA, et al. Are 30 minutes of rest between two incremental shuttle walking tests enough for cardiovascular variables and perceived exertion to return to baseline values? Braz J Phys Ther. 2015;19(2):105–113; doi: 10.1590/bjpt-rbf.2014.0078.
87. Spagnuolo DL, Jürgensen SP, Iwama AM, Dourado VZ. Walking for the assessment of balance in healthy subjects older than 40 years. Gerontology. 2010;56(5):467–473; doi: 10.1159/000275686.
88. De Oliveira Vieira W, di Paschoale Ostolin TLV, Ferreira M, Sperandio EF, Dourado VZ. Test timed up and go and its correlation with age and functional exercise capacity in asymptomatic women. Fisioter Mov. 2017;30(3):463–471; doi: 10.1590/1980-5918.030.003.ao04.

Supplementary material

Table 1. Characteristics of the study, population, and ISWT in papers concerning respiratory dysfunctions

Characteristics of the study		Characteristics of the population			ISWT characteristics	
Author (year)	Design	Health condition, severity	*n* (total and by sex and/or group)	Age	Number of tests	Interval
Alison et al. (2016) [19]	RCT protocol	COPD Moderate to severe	110	–	2	30 min
Billings et al. (2013) [20]	Cross-sectional study	Obstructive sleep apnoea syndrome: excessive sleepiness during the day and ODI ≥ 10 hours or AHI ≥ 15 hours	37 M: 29; F: 8	52.4 ± 4.5 years	2	15 min
De Camargo et al. (2014) [21]	Cross-sectional study	Non-cystic fibrosis bronchiectasis FEV_1: 53 (49, 58)% of predicted	75 M: 26; F: 49	45 (19–81) years	2	30 min
Dias et al. (2013) [22]	RCT	COPD FEV_1: 55.14 ± 24.8% to 60 ± 20.1% of predicted	23 M: 8; F: 15	64 ± 5.8 to 66.5 ± 5.8 years	2	15 min
Dias et al. (2014) [23]	Cross-sectional study	COPD FEV_1: 57.1 ± 20.9% of predicted	20 M: 13; F: 7	65.9 ± 5.4 years	2	15 min
Dowson et al. (2001) [24]	Cross-sectional study	Alpha-1-antitrypsin deficiency and macroscopic emphysema	29 M: 19; F: 10	52 (46, 60) years	2	30 min
Dyer et al. (2002) [25]	Cross-sectional study	Elderly with chronic airflow limitation	82 IG: 50; CG: 32 M: 36; F: 46	IG: 76.1 (70, 89) years CG: 75.8 (70, 85) years	2	30 min
Garrod et al. (2004) [26]	Retrospective observational study	COPD FEV_1: 42.2 ± 13.2% to 51.3 ± 21.2% of predicted	91	72 (46–89) years	2	20 min
Granger et al. (2015) [27]	Methodological study	Lung cancer Stage I–IV	20 M: 8; F: 12	66.1 ± 6.5 years	2	15 min
Harrison et al. (2012) [28]	Non-randomized clinical trial	COPD GOLD II	518 M: 298; F: 220	Not reported	2	30 min
Harrison et al. (2013) [29]	Methodological study	COPD FEV_1: 60.9 ± 19.3% of predicted	57 M: 30; F: 27	70.5 ± 9.3 years	2	30 min
Hill et al. (2012) [30]	Cross-sectional study	COPD FEV_1: 48.5 ± 13% of predicted	22 M: 14; F: 8	66 ± 8 years	2	30 min
Hill et al. (2012) [31]	Cross-sectional study	COPD FEV_1: 50 ± 14 of predicted	24 M: 15; F: 9	66.5 ± 7.7 years	2	20–30 min
Hill et al. (2012) [10]	Cross-sectional study	COPD FEV_1: 50 ± 16% of predicted	26 M: 16; F: 10	66 ± 7 years	2	20–30 min
Hodonská et al. (2016) [32]	Cross-sectional study	COPD FEV_1: 46.5 ± 14.3% of predicted	34 IG: 17; CG: 17 M: 11; F: 23	IG: 65.5 ± 7.3 years CG: 62.6 ± 2 years	2	HR return to baseline
Johnson-Warrington et al. (2015) [33]	Cross-sectional study	Idiopathic pulmonary fibrosis	43 M: 24; F: 19	72.17 ± 10.54 years	2	30 min
Jones et al. (2013) [34]	Cross-sectional study	COPD	475 M: 262; F: 213	69 ± 10 years	2	30 min

José and Dal Corso (2016) [35]	RCT protocol	Bronchiectasis	48	> 18 years	2	1 hour
Kaneko et al. (2008) [36]	Cross-sectional study	COPD FEV_1: 42.5 ± 15.9% of predicted	30 COPD: 15; CG: 15 M: 30; F: 0	COPD: 71.9 ± 7.3 years CG: 71.9 ± 5.2 years	2	30 min
Lee et al. (2010) [37]	RCT protocol	Non-cystic fibrosis bronchiectasis	64	> 18 years	2	30 min
Lee et al. (2015) [38]	Cross-sectional study	Bronchiectasis GOLD I–II	85 M: 24; F: 61	63 ± 13 to 65 ± 12 years	2	30 min
Leung et al. (2013) [39]	RCT	COPD	57 M: 34; F: 23	73 ± 8 to 75 ± 8 years	2	30 min
Lewko et al. (2007) [40]	Cross-sectional study	COPD FEV_1: 48.6% of predicted	50 M: 31; F: 19	67 ± 10.5 years	2	30 min
Luxton et al. (2008) [41]	Cross-sectional study	COPD FEV_1: 52 ± 20% of predicted	22 M: 11; F: 11	65 ± 9 years	2	30 min
Mador and Modi (2016) [42]	Cross-sectional study	COPD FEV_1: 44.5 ± 20.2% of predicted	15 M: 15; F: 0	69.6 ± 8.9 years	2	30 min
McKeough et al. (2018) [4]	RCT	COPD FEV_1: 47 ± 17% of predicted	87 M: 50; F: 37	70 ± 7 years	2	30 min
McNamara et al. (2013) [43]	RCT	COPD FEV_1: 55 ± 20% to 62 ± 15% of predicted	53 M: 22; F: 31	70 ± 9 to 73 ± 7 years	2	30 min
Ngai et al. (2017) [44]	RCT	COPD FEV_1: 50 ± 21% of predicted	21 M: 11; F: 10	70 ± 6 years	2	30 min
Ngai et al. (2017) [45]	Cross-sectional study	COPD FEV_1: 54 ± 24% of predicted	22 M: 11; F: 11	71 ± 6 years	2	30 min
Nikoletou et al. (2016) [46]	RCT	COPD FEV_1: 36.9 ± 15.8% to 37.6 ± 12.8% of predicted	41 M: 24; F: 17	70.1 ± 8.4 to 71.1 ± 9.6 years	2	20 min
De Oliveira et al. (2014) [47]	Cross-sectional study	COPD FEV_1: 38 (31, 54)% of predicted	56 M: 29; F: 27	70 ± 9 years	2	30 min
Revill et al. (2009) [48]	Retrospective observational study	COPD FEV_1: 37% of predicted	44 M: 33; F: 11	67.6 ± 9 years	2	30 min
Satake et al. (2003) [49]	Cross-sectional study	COPD FEV_1: 53.6 ± 22.1% of predicted	12 M: 11; F: 1	72 ± 2 years	2	30 min
Singh et al. (2008) [50]	Cross-sectional study	COPD FEV_1: 42.1 ± 24.3% to 45.6 ± 22.6% of predicted	354 M: 198; F: 156	67.9 ± 8.3 to 70.4 ± 7.7 years	2	20–30 min
Spencer et al. (2014) [51]	Non-randomized clinical trial	COPD FEV_1: 59 ± 19% of predicted	48 M: 22; F: 26	65 ± 8 years	2	30 min
Turner et al. (2004) [52]	Cross-sectional study	COPD FEV_1: 28.9 ± 7.9% of predicted	20 M: 15; F: 5	64 ± 7.5 years	2	30 min
Vagaggini et al. (2003) [53]	RCT	COPD FEV_1: 48 ± 14% of predicted	18 M: 15; F: 3	67 ± 8.2 years	2	30 min
Williams et al. (2012) [54]	RCT	COPD FEV_1: 44.6 ± 19.8% of predicted	1615 M: 1014; F: 601	68.4 ± 9 years	2	30 min
Wootton et al. (2014) [55]	Cross-sectional study	COPD FEV_1: 43 ± 15% of predicted	136 M: 82; F: 54	69 ± 9 to 70 ± 7 years	2	30 min
Yoza et al. (2009) [56]	Methodological study	COPD FEV_1: 33.9 ± 14.3% of predicted	83 M: 83; F: 0	71.8 ± 5.7 years	2	30 min
Zainuldin et al. (2012) [57]	Cross-sectional study	COPD FEV_1: 62 ± 17% of predicted	34 M: 19; F: 15	70 ± 9 years	2	30 min

AHI – apnoea-hypopnoea index, CG – control group, COPD – chronic obstructive pulmonary disease, F – female, FEV_1 – forced expiratory volume in the first second, GOLD – Global Initiative for Chronic Obstructive Lung Disease, HR – heart rate, IG – intervention group, ISWT – incremental shuttle walking test, M – male, ODI – oxygen desaturation index, RCT – randomized clinical trial
Data presented as mean ± standard deviation or mean (minimum–maximum) or median (P25, P75).

Table 2. Characteristics of the study, population, and ISWT in papers concerning cardiovascular dysfunctions

Characteristics of the study		Characteristics of the population			ISWT characteristics	
Author (year)	Design	Health condition, severity	*n* (total and by sex and/or group)	Age	Number of tests	Interval
Buckley et al. (2016) [58]	Cross-sectional study	CAD	62 IG: 32; CG: 30 M: 29; F: 33	IG: 64.5 ± 7.8 years CG: 63.4 ± 8.6 years	2	30 min
Bueno et al. (2012) [59]	Prospective observational study	Stable CAD with surgical indication	50 IG: 21; CG: 29	IG: 65 ± 9.7 years CG: 63.5 ± 8.2 years	2	30 min
Fowler et al. (2005) [60]	Cross-sectional study	MRS after 6 months	39 M: 34; F: 5	61.2 ± 8.5 years	3	45 min
Hanson et al. (2016) [61]	Methodological study	Cardiac rehabilitation independent of severity or duration of the condition	62 M: 45; F: 17	68 ± 10 years	2	30 min
Hanson et al. (2018) [62]	Methodological study	CAD	15 M: 12; F: 3	65 ± 8 years	2	30 min
Jolly et al. (2007) [63]	RCT	Cardiac rehabilitation after AMI and after MRS	525 M: 402; F: 123	61 ± 10.8 years	2	30 min
Jolly et al. (2008) [64]	RCT	After AMI and after MRS	353 After AMI: 165; after MRS: 188 M: 282; F: 71	61.6 ± 10.2 years	2	30 min
Jurio-Iriarte et al. (2017) [3]	Cross-sectional study	Hypertension and overweight (BMI ≥ 25 kg/m^2) or obesity (BMI ≥ 30 kg/m^2)	256 M: 181; F: 75	53.9 ± 8.1 years	2	30 min
Lee et al. (2005) [65]	Cross-sectional study	CAD	72 IG: 53; CG: 19 M: 64; F: 8	IG: 59 ± 10 years CG: 61 ± 10 years	2	30 min
Payne and Skehan (1996) [66]	Cross-sectional study	Patients with pacemaker	30 ISWT: 10	Not reported	3	20 min

AMI – acute myocardial infarction, BMI – body mass index, CAD – coronary artery disease, CG – control group, F – female, IG – intervention group, ISWT – incremental shuttle walking test, M – male, MRS – myocardial revascularization surgery, RCT – randomized clinical trial
Data presented as mean ± standard deviation or mean (minimum–maximum) or median (P25, P75).

Table 3. Characteristics of the study, population, and ISWT in papers concerning other health conditions

Characteristics of the study		Characteristics of the population			ISWT characteristics	
Author (year)	Design	Health condition, severity	*n* (total and by sex and/or group)	Age	Number of tests	Interval
De Carvalho Bastone et al. (2015) [67]	Cross-sectional study	Fragile and non-fragile elders	26 M: 12; F: 14	75.1 ± 6.6 years	2	30 min
De Carvalho Bastone et al. (2016) [5]	Methodological study	Fragile and non-fragile elders	28 M: 13; F: 15	75.5 ± 6.2 years	2	30 min
Evans et al. (2014) [68]	Cross-sectional study	Obesity (BMI > 30 kg/m^2)	16 M: 9; F: 7	58 ± 12 years	2	30 min
Jürgensen et al. (2016) [69]	Cross-sectional study	Obesity (BMI > 30 kg/m^2)	40 M: 0; F: 40	33 ± 7 years	2	30 min
Peixoto-Souza et al. (2015) [70]	Cross-sectional study	Severe obesity	23 M: 0; F: 23	39.1 ± 7.7 years	2	30 min
Radhakrishnan et al. (2014) [71]	RCT	Metabolic syndrome	61 M: 32; F: 29	G1: mean age of 53 years G2: mean age of 46 years	2	30 min
Radhakrishnan et al. (2017) [72]	Cross-sectional study	Metabolic syndrome	57 M: 37; F: 20	31.1 ± 7.1 to 65.4 ± 4.9 years	2	30 min
Van Schijndel-Speet et al. (2017) [73]	RCT	Elderly people with intellectual disability	131 IG: 66; CG: 65 M: 59; F: 72	IG: 58.2 (44–83) years CG: 57.9 (42–78) years	2	1 hour
Struthers et al. (2008) [74]	Cross-sectional study	Intra-abdominal surgery	50 M: 40; F: 10	79 (53–90) years	2	4 hours

BMI – body mass index, CG – control group, F – female, G – group, IG – intervention group, ISWT – incremental shuttle walking test, M – male, RCT – randomized clinical trial
Data presented as mean ± standard deviation or mean (minimum–maximum) or median (P25, P75).

Table 4. Characteristics of the study, population, and ISWT in papers concerning apparently healthy individuals

Characteristics of the study		Characteristics of the population		ISWT characteristics	
Author (year)	Design	*n* (total and by sex and/or group)	Age	Number of tests	Interval
Bardin and Dourado (2012) [75]	Cross-sectional study	33 IG: 17; CG: 16 M: 0; F: 33	68 ± 7 years	2	30 min
Braz et al. (2016) [76]	Cross-sectional study	21 M: 0; F: 21	48.9 ± 12.2 years	3	20 min
Dourado et al. (2010) [77]	Cross-sectional study	10 M: 7; F: 3	56 ± 16 years	2	30 min
Dourado et al. (2011) [78]	Cross-sectional study	90 M: 40; F: 50	60 ± 9 years	2	30 min
Dourado et al. (2011) [79]	Methodological study	30 M: 4; F: 26	54 ± 9 years	2	30 min
Dourado et al. (2013) [80]	Cross-sectional study	103 M: 54; F: 49	60 ± 10 years	3	20 min
Dourado and Guerra (2013) [81]	Cross-sectional study	31 M: 14; F: 17	57 ± 9 years	3	20 min
Gonçalves et al. (2015) [2]	Cross-sectional study	331 M: 158; F: 173	18–83 years	2	30 min
Harrison et al. (2013) [82]	Methodological study	140 M: 56; F: 84	59.4 ± 11 years	2	30 min
Hayashi et al. (2012) [83]	Cross-sectional study	157 M: 49; F: 108	67.3 (63, 74) years	2	30 min
Jürgensen et al. (2011) [84]	Cross-sectional study	131 M: 61; F: 70	59 ± 10 years	2	30 min
Probst et al. (2012) [85]	Cross-sectional study	242 M: 102; F: 140	50 (31, 66) years	2	30 min
Ribeiro et al. (2015) [86]	Cross-sectional study	334 M: 152; F: 182	61 (39, 70) years	2	30 min
Spagnuolo et al. (2010) [87]	Cross-sectional study	64 M: 53; F: 11	57 ± 10 years	2	30 min
De Oliveira Vieira et al. (2017) [88]	Cross-sectional study	98 M: 0; F: 98	57 ± 10 years	2	30 min

CG – control group, F – female, IG – intervention group, ISWT – incremental shuttle walking test, M – male
Data presented as mean ± standard deviation or mean (minimum–maximum) or median (P25, P75).