

Six Minute Step Test Vs. Six Minute Walk Test to Measure VO₂ Peak in Obese Class 1 Adults: An Observational Study

Dharini P. Vengurlekar¹, Jahnvi Panwar²

¹Intern at P.E.S Modern College of Physiotherapy, ² Associate Professor at P.E.S Modern College of Physiotherapy, Pune, India.

Corresponding Author: Dharini P. Vengurlekar

DOI: <https://doi.org/10.52403/ijhsr.20240508>

ABSTRACT

Introduction: Exercise testing and interpretation is important for determining exercise capacity and identifying factors which might limit the exercise performance. Impaired cardiorespiratory fitness and sedentary lifestyle are hallmarks of obesity and thus assessing the VO₂ peak in such a population is important. While both the SMST and 6MWT are commonly used functional tests, limited research directly compares their effectiveness in Class 1 obese adults. Addressing this gap in the literature can provide valuable insights into the strengths and limitations of each test, guiding researchers and clinicians in selecting the most appropriate assessment tool for this specific population. Identifying the test that poses lower risks and discomfort for obese individuals is essential to ensure their safety during exercise testing. This observational study aimed to compare the Six Minute Step Test (6MST) and the Six Minute Walk Test (6MWT) in measuring VO₂ peak in obese Class 1 adults.

Method: This Observational study, with convenient sampling and sample size 66, included adults between age 18- 25 within the category of Obese Class 1 (BMI 30-34.9 kg/m²). The exclusion criteria were any Cardio-vascular and respiratory conditions, recent fractures or diagnosed case of any neurological condition. The participants performed both the 6 Minute Walk Test and 6 Minute Step Test in random order and the heart rate and SpO₂ were recorded pre and post-test, and VO₂ peak was calculated by the indirect method.

Result: Results were calculated using paired t-test and significant statistical difference was found between the 6 Minute Walk test and 6 Minute Step Test. Specifically, both VO₂ peak and heart rate were significantly different between the tests, with 6MST yielding higher values.

Conclusion: Consequently, this study suggests that 6MST cannot substitute for 6MWT in assessing aerobic capacity in Class 1 obese adults. The implications of these findings underscore the importance of considering specific physiological demands and practical constraints when selecting assessment tools for this population.

Keywords: 6 Minute Walk Test, 6 Minute Step Test, Obesity, VO₂ Peak, Obese Class 1, Cardiorespiratory fitness.

INTRODUCTION

Exercise testing and interpretation is important for determining exercise capacity and identifying factors which might limit

the exercise performance. Although maximal exercise testing is considered the gold standard for assessing aerobic capacity, the role of such testing is limited in people

whose performance may be limited because of several reasons such as any painful condition or due to exertion.⁽¹⁾ Submaximal exercise testing is considered beneficial over maximal exercise testing, as it does not have as many limitations as the maximal exercise testing, and it is the method of choice for the many individuals seen by physical therapists to measure cardiorespiratory capacity.⁽²⁾ Obesity is a medical condition in which excess body fat has adverse effects on the health.⁽³⁾ Obesity is considered a chronic disease and a habitual complaint which is non-communicable, with alarming global rise. It leads to several adverse cardiac, pulmonary, and metabolic effects. In addition to the mechanical disadvantage of excessive body fat, obese individuals have an appreciable functional limitation of performance, affecting daily living activities⁽⁴⁾. In this context, several authors have studied the deleterious effects of obesity on cardiorespiratory fitness (CRF) focusing on physical rehabilitation as one of the strategies for treatment. Cardiopulmonary exercise testing (CPX) is useful to objectively assess the integrated physiological system's response to dynamic exercise and is considered the gold standard method to assess aerobic performance. However, because of its high technical and cost requirements, indirect protocols for peak oxygen consumption (VO_{2peak}) prediction have been developed to lower these walls in clinical setting.⁽⁵⁾ Peak oxygen uptake (VO_{2peak}) is accepted as the criterion measure of CRF. This variable is typically expressed clinically in relative (mL/kg/min), to compare between individuals with differing body weight. VO_{2peak} is considered the highest VO₂ during an inclining workload of physical activity until voluntary termination.⁽⁶⁾ There are various tests to measure the CRF, however, the most appropriate test of use in this population has not been established. Stepping is particularly attractive for the current purpose because it requires a minimum of space and technical expertise,

especially when used in confluence with pulse oximetry. Step testing is an affordable method of testing for predicting cardiorespiratory fitness by measuring the Heart Rate response to stepping at a fixed step height or by measuring postexercise recovery HR. Step tests bear little or no equipment, steps are easily transportable, stepping skill requires little practice, the test usually is of short duration, and is advantageous for mass testing. Six-minute step test (6MST) has been used to assess functional capacity,⁽⁷⁾ with the step height being 20cm as per the guidelines. The six minute walk test (6MWT) was officially introduced in 2002, developed by the American Thoracic Society, coming on with a comprehensive guideline of unobstructed 30m walkway. The 6 Minute Walk Test is of sub-maximal exercise capacity to test aerobic capacity and endurance. The distance covered over a time of 6 minutes and other parameters such as post test heart rate and oxygen consumption are used as outcome by which to compare changes in performance capacity.⁽⁸⁾ Purpose of this study was to know if the 6 Minute Step Test could be used instead of the 6 Minute Walk Test. The aim is to compare Six Minute Step Test Vs Six Minute Walk Test to measure VO₂ Peak in

Obese class 1 Adults, with the objective to compare Six Minute Step test and Six Minute Walk Test by checking if there is a difference between the VO₂ peak of the two tests, in Obese class 1 adults. The objective is to compare Six Minute Step test and Six Minute Walk Test by checking if there is a difference between the VO₂ peak of the two tests, in Obese class 1 adults.

MATERIALS & METHODS

The study design is an Observational study. The sample size is 66 with a convenient sampling method. The population under study is Class 1 Obese Adults, with specific criteria. The inclusion criteria were both males and females aged 18- 25 years and BMI category of 30- 34.9 kg/m². Only the individuals who are sedentary (i.e., no more

than 150 min per week of moderate physical activity) and a low score (less than 8) on the Baecke Questionnaire.⁽¹⁴⁾ were included. Any individual with cardiovascular and respiratory conditions, recent fractures or diagnosed case of any neurological condition were excluded. The materials used were pen, paper, chair, 20 cm height step, timer, pulse oximeter, consent form, data collection sheet. Outcome Measure taken were VO₂ peak and heart rate.

PROCEDURE

Ethical clearance was obtained. Subjects were selected according to the inclusion and exclusion criteria. Purpose was explained and written consent was taken. Procedure of both the test was explained. Pre test the heart rate and SpO₂ were recorded. Subject was asked to perform both the test with a break of 30 min in between. Post the six minute step test the number of steps, heart rate and SpO₂ were recorded. Post the six minute walk test the distance walked, heart rate and SpO₂ were recorded. Data was collected.



Picture 1-Subject performing 6 minute Walk Test



Picture 2-Subject performing 6 Minute Step Test

STATISTICAL ANALYSIS

Descriptive statistics was performed to assess the mean and standard deviation of the respective groups. Given the nature of the data, we have used a paired t-test for comparing the means of related samples (VO₂ Peak during 6MWT vs. 6MST).

p-values less than 0.05 are considered to be convention. Data was analysed using the tool “jupyter notebook” (version 7.1) with “Python” for drawing the conclusion.

RESULT

In all cases, the p-values are significantly below the standard of 0.05. This means there are statistically significant differences between the 6 Minute Walk Test (6MWT) and the 6 Minute Step Test (6MST) in terms of VO₂ peak and heart rate. The VO₂ peak of the obese male adults is 21.63± 4.17 and females is 21.46± 3.93, which is much less as compared to healthy, where for the males it is 40.35± 5.77 and females 34.68 ±6.75. The bar graphs visually represent the comparisons between the 6 Minute Walk Test (6MWT) and the 6 Minute Step Test (6MST) across different metrics:

VO₂ Peak: The figure 1 compares the peak oxygen uptake (VO₂ Peak) during the 6MWT and the 6MST, indicating that the VO₂ Peak values are higher during the 6MST compared to the 6MWT. Heart Rate (bpm): The figure 2 shows the heart rate achieved during the 6MWT vs the 6MST, with the 6MST eliciting a higher heart rate. These graphical representations, combined with the statistical test results, suggest significant differences in the outcomes of the 6MWT and 6MST, supporting the idea that 6MST cannot be used instead of the 6MWT.

Table1- Shows the mean and standard deviation of age, BMI, 6-minute walk distance and number of step cycles (NSC) during 6 MST, HR and VO₂ peak post 6MWT and 6MST.

Characteristic	N = 36 ¹
AGE	21.64 (±1.87)
BMI	31.86 (±1.61)
6MWD	490.52 (±100)
6MST NSC	155.87 (±15)
6MWT HR	118.49(±16.04)
6MST HR	141.34(±20.13)
6MWT VO ₂ Peak	21.60 (±3.97)
6MST VO ₂ Peak	27.98 (±1.74)
¹ Mean (±SD)	

Table 2- Shows the mean and standard deviation of 6MWT and 6 MST, t-test statistic and p value.

Variable	6 Minute Walk Test Mean (SD)	6 Minute Step Test Mean (SD)	t-Test(P value)
Distance	490.52 (±100)	NA	NA
Step Cycle	NA	155.87 (±15)	NA
Heart rate	118.49 (±16.04)	141.34 (±20.13)	-10.96 (1.65×10 ⁻¹⁶)
VO ₂ Peak	21.60 (±3.97)	27.98 (±1.74)	-13.90 (2.78×10 ⁻²¹)

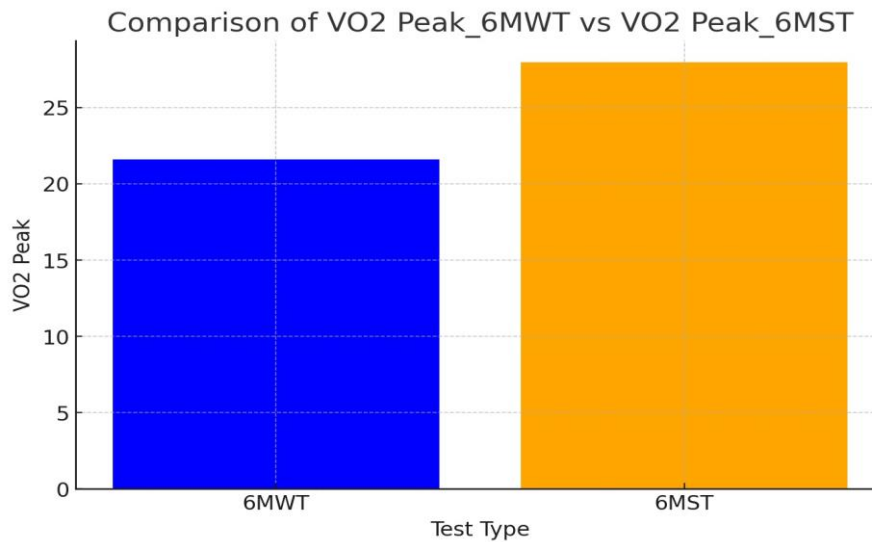


Figure 1- Comparison of VO₂ Peak in 6MWT and 6MST

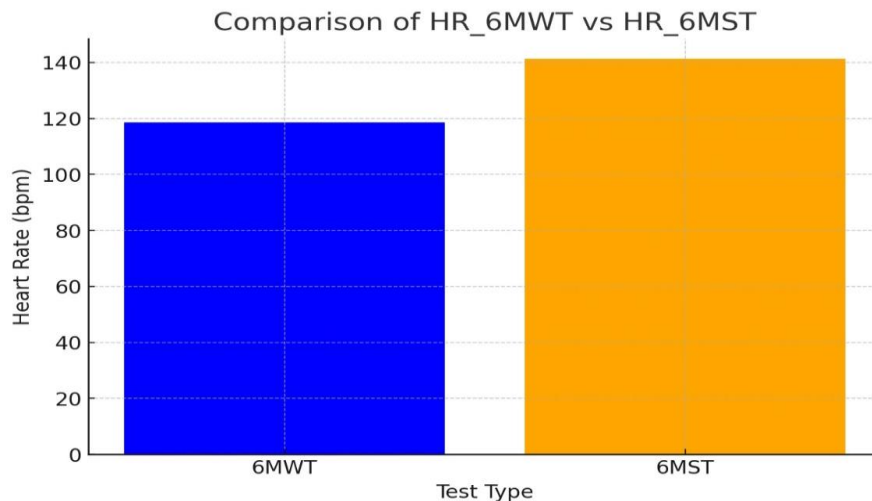


Figure 2- Comparison of HR post 6MWT and 6MST

DISCUSSION

Peak oxygen uptake (VO_{2peak}) is widely referred to as cardiorespiratory fitness (CRF). Low peak oxygen uptake, lack of exercise and overweight are risk factors for cardiovascular, hypertension and diabetes diseases⁽¹⁷⁾ and so there is a strong need to have appropriate assessment tests to design protocols for such a vulnerable population in order to increase their cardiorespiratory capacity and to improve their overall health.

In this study, we aimed to compare two practical, low cost tests to check their difference and in turn to see if they can be used interchangeably. Although the 6 MWT is well established and highly recommended, many clinical settings may lack a corridor that has no obstruction, is of adequate length of 30m as suggested by the ACSM guidelines. We therefore chose to compare the 6 MST to the 6 MWT which requires far less space. We confirmed the sedentary lifestyle of our subjects by the low score on the Baecke questionnaire. The selection of the test to be performed first was determined based on the Research Randomizer. In our study, none of the subjects terminated the test abruptly.

Heart rate and SPO₂ both were measured at the termination of the 6MST and 6MWT, the higher heart rate values show us that 6 MST is more challenging on the body as compared to the 6 MWT. The 6 MWT involves little work against gravity. The 6 MST, on the other hand, involves greater work against gravity and more effort is required and is therefore more affected by body mass, which was seen by Richard Bohannon et al. in his study comparing the 6 Minute Walk Test and 3 Minute Step Test.⁽¹⁸⁾

This increase in effort post 6MST would also be because of the difference in muscles involved and the degree to which they are used. This test when studied in other populations as in the study by Dal Corso et al.⁽¹⁹⁾ in patients with pulmonary diseases, it suggested that the 6MST causes few alterations to the physiological variables when compared to other functional tests. The study sample included 53% males and

47% females which highlighted differences in VO₂ peak between males and females, with both genders exhibiting significantly lower VO₂ peak values compared to healthy individuals. This finding underscores the impact of obesity on cardiorespiratory fitness, with obese adults, regardless of gender, demonstrating compromised aerobic capacity. There are several reasons which contribute to the reduced VO₂ peak in obese adults as follows

1. Increased Body Mass: Obese individuals have a higher overall body mass, including both fat and muscle tissue. This increased mass requires more energy to move during exercise, which can lead to higher energy expenditure and thus higher oxygen consumption. However, much of the additional mass in obese individuals consists of non-metabolically active adipose tissue, which doesn't contribute significantly to oxygen consumption during exercise.

2. Increased Metabolic Demand: The metabolic demands of carrying excess body weight during exercise are higher for obese individuals. This increased metabolic demand can lead to earlier fatigue and a lower VO₂ peak compared to individuals with a healthier body weight.

3. Mechanical Factors: Obesity can also affect the mechanics of breathing and the function of respiratory muscles. Excessive fat around the chest and abdomen can restrict the movement of the diaphragm and chest wall, making it more difficult to breathe deeply and efficiently. This can limit oxygen uptake during exercise and contribute to a lower VO₂ peak. Previous study by Michael Dreher et al. stated that the resting alterations in lung volumes and gas exchange become attenuated during exercise in the obese, while oxygen cost of breathing and dyspnoea are increased⁽²⁰⁾, which are similar to the findings of this study. A. Singhal et al. concluded in their study that although obese adults usually have a higher absolute muscle mass than lean subjects, they exhibit a lower effort during exercise, with a higher O₂ consumption for any work load, which is

similar to the findings in this study, where the O₂ consumption was higher post the 6 MST.⁽²¹⁾ The lower VO₂ peak values observed in obese Class 1 adults compared to healthy individuals highlight the importance of individualized assessment and intervention strategies. These individuals may require tailored exercise programs focusing on improving cardiorespiratory fitness to mitigate the associated health risks of obesity. Provided that adequate unobstructed floor space is available, the 6 MWT is more likely to provide performance-based measure for individuals with class 1 obesity. Moreover, the 6 MWT is typically less stressful. These facts may render the 6 MWT a better choice as a brief, portable, low cost field test for use to assess the cardiovascular capacity. Both the 6 MWT and 6 MST are practical methods for measuring VO₂ peak. While the 6 MST requires less space, it tends to be more physically exhausting. Therefore, the 6 MWT would be recommended over the 6 MST for characterizing cardiovascular capacity in class 1 obese adults. The study found that the peak oxygen uptake (VO₂ peak) during the 6MST was higher compared to the 6MWT. This indicates that the 6MST may potentially provide a more rigorous aerobic challenge, leading to a higher VO₂ peak response in obese Class 1 adults. However, it's essential to consider that these higher VO₂ peak values in the 6MST may not necessarily reflect better cardiorespiratory fitness but rather differences in the nature of the tests. The future scope could be as follows- A large sample size could be assessed which includes other classes of obesity as well which could be a more focused evaluation. Here, only one step test was compared (6 min step test), however, in future, other step tests (e.g., Harvard, Queen's college, etc) could be employed. Additionally, investigating the long-term prognostic value of the 6MST compared to the 6MWT in Class 1 obese adults could provide further insights into the practical utility of these tests in predicting health outcomes.

CONCLUSION

A comparison of 6 Minute Walk Test and 6 Minute step Test using the paired students t test showed a significant difference between the two tests.

In conclusion, this study contributes to the ongoing discourse on the assessment of aerobic capacity in Class 1 obese adults by comparing the 6MWT and 6MST. The findings suggest that while the two tests exhibit significant differences, careful consideration of the specific physiological demands and practical constraints associated with each test should be done before deciding on which one to use. Considerations of the specific requirements of the study or clinical setting should also be taken into account.

Declaration by Authors

Ethical Approval: Approved

Acknowledgement: None

Source of Funding: None

Conflict of Interest: The authors declare no conflict of interest.

REFERENCES

1. Vanessa Noonan, Elizabeth Dean, Submaximal Exercise Testing: Clinical Application and Interpretation, *Physical Therapy*, Volume 80, Issue 8, 1 August 2000, Pages 782–807.
2. Christopher B. cooper and Thomas W. Storer. Exercise testing and interpretation – A practical approach
3. Pataky, Z., Armand, S., Müller-Pinget, S., Golay, A., & Allet, L. (2014). Effects of obesity on functional capacity. *Obesity*, 22(1), 56-62.
4. Fagundes, C. F., Thommazo-Luporini, L. D., Goulart, C. L., Braatz, D., Ditomaso, A., & Borghi-Silva, A. (2022). Reference equations of oxygen uptake for the step test in the obese population. *Brazilian journal of medical and biological research*.
5. Carvalho LP, Di Thommazo-Luporini L, Aubertin-Leheudre M, Bonjorno Junior JC, de Oliveira CR, et al. (2015). Prediction of Cardiorespiratory Fitness by the Six-Minute Step Test and Its Association with Muscle Strength and Power in Sedentary Obese and Lean Young Women: A Cross-Sectional Study. *PLOS ONE* 10(12): e0145960.
6. Loftin, M., Sothorn, M., Abe, T., & Bonis, M. (2016). Expression of VO₂peak in Children

- and Youth, with Special Reference to Allometric Scaling. *Sports medicine (Auckland, N.Z.)*, 46(10), 1451–1460.
7. María José Oliveros, Pamela Seron, Claudia Román, Manuel Gálvez, Rocío Navarro, Gonzalo Latin, Tania Marileo, Juan Pablo Molina, Pablo Sepúlveda, Gabriel Nasri Marzuca-Nassr, and Sergio Muñoz. Two-Minute Step Test as a Complement to Six-Minute Walk Test in Subjects With Treated Coronary Artery Disease. *Front Cardiovasc Med.* 2022; 9: 848589. 2022 May 9.
 8. ATS Committee on Proficiency standards for Clinical Pulmonary function Laboratories (2002). ATS statement: guidelines for the six minute walk test. *American journal of respiratory and critical care medicine*, 166(1), 111-117.
 9. Kinga Węgrzynowska-Teodorczyk, Dagmara Mozdzanowska, Krystian Josiak, Agnieszka Siennicka, Katarzyna Nowakowska, Waldemar Banasiak, Ewa A Jankowska, Piotr Ponikowski, Marek Woźniewski *Eur J Prev Cardiol* 2016 Aug;23(12):1307-13. Epub 2016 Jan 7. Could the two-minute step test be an alternative to the six-minute walk test for patients with systolic heart failure? *Eur J Prev Cardiol.* PMID: 26743588.
 10. C.H. da Costa, K.M. da Silva, A. Maiworm, Y. Raphael, J. Parnayba, M. Da Cal, B. Figueira, D. Condesso, R. Rufino, Can we use the 6-minute step test instead of the 6-minute walking test? An observational study, *Physiotherapy*, Volume 103, Issue 1, 2017, ISSN 0031-9406.
 11. Cabillic, M., Rass-Roumequere, D., Peron, T., Gouilly, P., Beaumont, M., & Chambellan, A. (2011). Enquête sur la réalisation du test de marche de six minutes [A survey on the performance of the six-minute walk test]. *Revue des maladies respiratoires*, 28(9), 1111–1123.
 12. Joyce Nf da Costa 1, Juliano F Arcuri, Ivana L Gonçalves, Simone F Davi, Bruna V Pessoa, Mauricio Jamami, Valéria Ap Di Lorenzo. Reproducibility of cadence-free 6-minute step test in subjects with COPD. 2013 Sep 17.
 13. JOURNAL ATS Statement 2002/07/01. *American Journal of Respiratory and Critical Care Medicine.* American Thoracic Society – AJRCCM
 14. Tebar WR, Ritti-Dias RM, Fernandes RA, Damato TMM, Barros MVGD, et al. (2022) Validity and reliability of the Baecke questionnaire against accelerometer-measured physical activity in community dwelling adults according to educational level. *PLOS ONE* 17(8): e0270265.
 15. ACSM's Guidelines for Exercise Testing And Prescription- 9th edition.
 16. Luporini, I. D. T., Carvalho, I. P., Luís, R., Luporini, R. T., Pantoni, C. B. F., Maria, A., ... & Borghi-Silva, A. (2015). The six-minute step test as a predictor of cardiorespiratory fitness in obese women. *Eur J Phys Rehabil Med.*
 17. Ritt, L. E. F., Darzé, E. S., Feitosa, G. F., Porto, J. S., Bastos, G., Albuquerque, R. B. L., Feitosa, C. M., Claro, T. C., Prado, E. F., Oliveira, Q. B., & Stein, R. (2021). The Six-Minute Step Test as a Predictor of Functional Capacity according to Peak VO₂ in Cardiac Patients. *116(5)*, 889–895.
 18. Bohannon, R. W., Bubela, D. J., Wang, Y. C., Magasi, S. S., & Gershon, R. C. (2015). Six-Minute Walk Test Vs. Three-Minute Step Test for Measuring Functional Endurance. *Journal of strength and conditioning research*, 29(11), 3240–3244. <https://doi.org/10.1519/JSC.0000000000000053>
 19. Dal Corso S, Duarte SR, Neder JA, Malaguti C, de Fuccio MB, de Castro Pereira CA, Nery LE: A step test to assess exercise-related oxygen desaturation in interstitial lung disease. *Eur Respir J* 2007, 29:330–336.
 20. Dreher M, Kabitz HJ: Impact of obesity on exercise performance and pulmonary rehabilitation. *Respirology* 2012; 17: 899–907.
 21. Trilk JL, Singhal A, Bigelman KA, Cureton KJ. Effect of sprint interval training on circulatory function during exercise in sedentary, overweight/obese women. *Eur J Appl Physiol.* 2011 Aug;111(8):1591-7. doi: 10.1007/s00421-010-1777-z.

How to cite this article: Dharini P. Vengurlekar, Jahnvi Panwar. Six Minute step test vs. six minute walk test to measure VO₂ peak in obese class 1 adults: an observational study. *Int J Health Sci Res.* 2024; 14(5):70-76. DOI: <https://doi.org/10.52403/ijhsr.20240508>
