



Research Article

EXERCISE CAPACITY AMONG CONSTRUCTION WORKERS – AN OBSERVATIONAL STUDY

N.Ashok and Bandarupalli Sai Manjusha

SRM College of Physiotherapy, SRM IST

ARTICLE INFO

Article History:

Received 06th March, 2019

Received in revised form 14th

April, 2019

Accepted 23rd May, 2019

Published online 28th June, 2019

Key words:

Construction workers, Exercise capacity, Incremental shuttle walk test, VO2max.

ABSTRACT

Background: A Construction worker is a laborer employed in the physical construction of built environment and its infrastructure. They are exposed to strenuous heavy workloads. A high physical work load increases the risk of the cardiovascular disease. Exercise capacity is the maximum amount of physical exertion a person can sustain. Cardiovascular changes in the body also depends upon the severity of the exercise. There is no study done to assess the exercise capacity. So it is quite important to know the exercise capacity to improve their quality of life. **Objective:** To find out the exercise capacity among construction workers by performing Incremental shuttle walk test. **Methodology:** Non-Experimental study design. 100 Construction workers, Both male and females, Age 25-50 years were included in the study and subjects with any coordination problems, recent cardiovascular problems, plantar fasciitis, smokers were excluded from the study. **Outcome Measure:** Incremental shuttle walk test. **Result:** The mean value of shuttle walk level is about 8.5 level and speed is about 1.78 m/s, Number of shuttle covered is on average about 20, the mean distance covered is 536.65 metre and the mean VO2 max value is 72.76 ml/kg/min. **Conclusion:** The maximum number of participants are having good exercise capacity but exercise training is necessary to improve their functional capacity to a higher level.

Copyright©2019 N.Ashok and Bandarupalli Sai Manjusha. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

INTRODUCTION

A Constructional worker is a laborer employed in a physical construction of built environment and its infrastructure. These workers were exposed to strenuous heavy workloads like lifting heavy weights, sudden impacts of heavy loads. Such work requires good cardiovascular activity which in lack may result less work capacity.

A high physical work load is associated with increased risk of cardiovascular diseases¹, reduced work ability², increased risk of sick leave³. Such work demands good musculoskeletal health and high physical capacity in order to attain a low workload. These workers are at a high risk of occupational disability than workers in less physically demanding jobs with cardiovascular disease being the main cause^{4,5}.

Exercise capacity is the maximal amount of physical exertion that a patient can sustain. These are Aerobic and Anaerobic exercises. Aerobic means with oxygen the energy is obtained by utilizing nutrients in the presence of oxygen. It involves activities with lower intensities that are performed for longer duration.⁶ Muscular exercise brings about a lot of changes on various systems in the body. These changes depend upon the severity of the exercise.

The Cardiovascular changes in the body also depend upon the severity of exercise. The volume of oxygen consumed during the particular activity is observed and the exercise capacity of an individual can be determined. The maximal oxygen uptake (VO2 max) is explained as the maximum integrated capacity of the pulmonary, Cardiovascular and muscular systems to uptake transport and utilise Oxygen⁷. There is an increase in VO2 max by 50% during this exercise. The standard of measuring the maximal oxygen uptake during high intensity whole body exercise^{8,9} is commonly used to know the persons exercise potential.¹⁰

Incremental shuttle walk test was conducted on the basis of the method described by Singh et al.¹¹ This is a maximal exercise test which provide data to correlate with measurements taken during cardiopulmonary exercise testing.¹² It is simple to make the individual understand about the test and it is inexpensive.

The incremental shuttle walk test was originally developed to assess patients with chronic obstructive pulmonary disease¹³, as well as for patients with other conditions such as cardiac disease¹⁴, obesity¹⁵, cancer¹⁶, intermittent claudication¹⁷.

It is a 10metre shuttle walk test consisting of 12-levels in which the subject should walk around the two cones kept at the ending points according to the beep sounds recorded. The walking speed was increased by a small increment of 1minute intervals. The test was terminated by individual if he or she feels too breathless to continue the walk or by the examiner if

*Corresponding author: N.Ashok
SRM College of Physiotherapy, SRM IST

the individual was unable to cover the 10m distance in a given time¹⁸. After the completion of the test, heart rate is checked. When compared to the individuals with low physical work load, the persons like construction workers do have great physical work load. So it is necessary for them to increase their physical capacity in order to avoid or minimise their casualties. This will increase their Cardiovascular endurance which in turn gives high quality and productivity of their work and healthy life.

Construction is a physically demanding occupation, but a vital part of our nation and the Indian economy. This large workforce handled tasks that range from carrying heavy loads to performing repetitive tasks, placing them at risk of serious injury¹⁹. The physically demanding nature of this work helps to explain why injuries, such as strains, sprains and work related musculoskeletal disorders, are so prevalent and are the most common injury resulting in days away from work²⁰.

On some construction jobs they need to work overhead, reaching up with one or both arms raised above the shoulders. Their head may be tilted back, looking up to see what they are doing. Whether they are drilling, finishing dry wall, overhead work puts stress on their shoulders. Eventually it may lead to serious muscles and joint injuries.

The purpose of this study is to evaluate exercise capacity among construction workers.

Aim of the Study: The aim of the study is to assess the exercise capacity among construction workers by doing Incremental shuttle walk test.

Need for the Study

In many countries proper training is imparted among construction workers prior to work for their benefits. In countries like India, the construction workers do not get training before heavy manual work, and No normative data or exercise capacity of the Indian construction workers have been documented so that structured exercise programs can be scheduled for the necessary workers and improve their quality of life and work. Thus this study is designed to find out the exercise capacity among construction workers to prompt awareness and education among Indian workers for betterment of their lives.

Furthermore, there are lot of studies concentrating on the musculoskeletal problems among construction workers where pain is major reason leading to maneuver musculoskeletal problems. But to our knowledge no studies document the exercise capacity of the construction workers, hence there is a need to find out the exercise capacity among construction workers to prevent cardiovascular disease and help in accurate exercise planning and movement strategies in future.

METHODOLOGY

Study Design: Non Experimental

Study Type: Observational type

Sampling Method: Convenient sampling

Sample Size: 100.

Study Duration: 3 weeks.

Study Setting: Construction sites in Chennai.

Inclusion Criteria

Both males and females

Age group: 25-50 years

Subjects willing to participate

Exclusion Criteria

1. Recent heart surgeries
2. Balance and co-ordination related problems
3. Hypertension
4. Foot ulcers
5. Plantar fasciitis
6. Any fracture in lower limb

Materials Used

1. 10 metre shuttle walk test audio
2. Marker cones
3. Metre scale
4. Stop watch

Procedure

Based upon the inclusion and exclusion criteria the subjects were selected and their consent was obtained. The test procedure was clearly explained to participants. The participants were instructed to wear comfortable clothing and foot wear. The participant should not exercise or have a heavy meals prior to the test and after the test.

Incremental Shuttle Walk Test

It is performed according to the original protocol proposed by Singh et al. This test has 12 levels each lasting 1 minute. Before starting the test the patient should be in rest for 15 minutes. The participant is asked to walk between two cones spaced 10 metres apart. The participant should begin the walk at a very slow pace and this pace is set by a beep.

The participant should walk around the 10metre distance aiming to turn around a cone at the first beep and around the second cone at the next beep. This beeps will gradually gets faster, it means the participant should begin to walk at a faster pace, getting even more faster until the participant cannot keep up with the set pace or until they are too breathless or tired to continue the walk.

After the test is completed the participant is asked to walk slowly around the distance as a cool down period and then rest for at least 10minutes before proceeding to their other activities. During the test the examiner notes the Level, No. of shuttles, distance walked and the speed is calculated. Heart rate is checked. VO₂ max is also calculated to observe the amount of oxygen uptake during the walk test according to the below formula

$$VO_2 \text{ max} = (132.853) - (0.0769 \times \text{Weight}) - (0.3877 \times \text{age}) + (6.3150 \times \text{gender}) - (3.2649 \times 1 \text{ mile walk time}) - (0.1565 \times \text{Heart Rate})$$

Outcome Measure

Incremental shuttle walk test

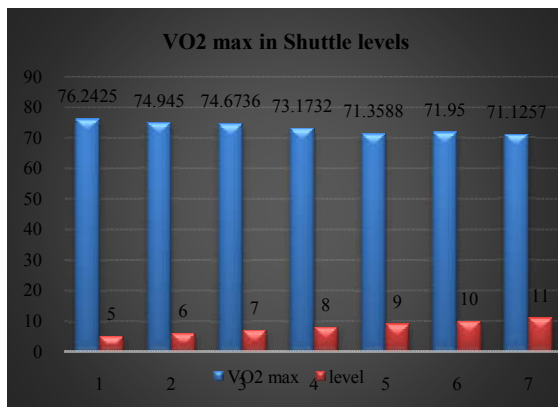
Data Analysis

The IBM SPSS 20.0 version statistics was used for the data analysis. For a description of their assembly and disintegration the descriptive analysis, mean and standard deviation was used.

Table 1 Mean Value of vo2max in Different levels of shuttle walk Test among Construction workers.

Shuttle walk levels	Mean	No. of people in particular level	Standard Deviation
5	76.24	4	4.76
6	74.94	6	4.32
7	74.67	14	5.33
8	73.17	19	5.22
9	71.55	24	5.54
10	71.95	26	2.85
11	71.76	7	2.44
Total	72.76	100	4.68

This table shows that about 4 subjects were at fifth level with mean VO₂ max at 76.2425, 6 subjects were at 6th level with VO₂ max at 74.9450, 14 subjects were at 7th level with VO₂max at 74.6736, 19 subjects were at 8th level with mean VO₂max at 73.1732, 24 subjects were at 9th level with mean VO₂ max at 71.5588, 26 subjects were at 10th level with mean VO₂max at 71.9500 and 7 subjects were found at 11th level with mean VO₂ max at 71.7635.

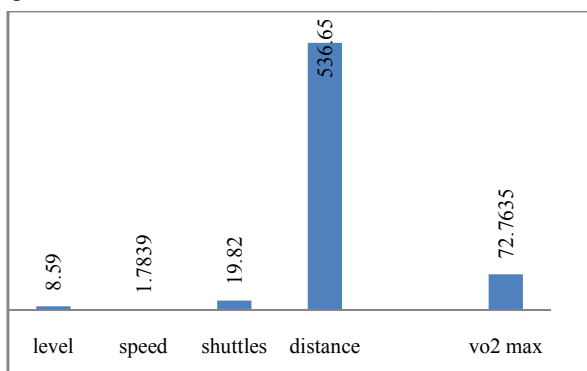


Graph 1 Mean Value of vo2 max in Different levels of Shuttle walk test Among Construction Workers.

Table 2 Mean Value of Different Variables in Incremental Shuttle walk test Among Construction workers

Incremental shuttle walk test variables	No .of people	Minimum	Maximum	Mean	Standard Deviation
Shuttle walk level	100	5.00	11.00	8.59	1.52
Speed (m/s)	100	0.89	3.73	1.78	0.40
No. of shuttles covered	100	10.00	28.00	19.82	4.41
Distance covered (metres)	100	153.00	880.00	536.65	174.61
VO ₂ max (ml/kg/min)	100	53.58	85.62	72.76	4.68

This table shows the mean value of shuttle walk level is about 8.59 level and speed is about 1.78 m/s, Number of shuttle covered is on average about 20, the mean distance covered is 536.65 metres and the mean VO₂ max value is 72.76 ml/kg/min.



Graph 2 Mean value of different variables in incremental shuttle walk among construction workers.

RESULTS

According to Table 1 and Graph 1

4 subjects were at fifth level with mean VO₂ max at 76.24, 6 subjects were at 6th level with VO₂ max at 74.9450, 14 subjects were at 7th level with Vo₂ max at 74.67, 19 subjects were at 8th level with mean VO₂ max at 73.17, 24 subjects were at 9th level with mean VO₂ max at 71.55, 26 subjects were at 10th level with mean VO₂ max at 71.95 and 7 subjects were found at 11th level with mean VO₂ max at 71.76.

Thus among 100 construction workers the Mean of VO₂max was 72.76 and Standard deviation was 4.68. The VO₂ max obtained is different at particular levels of walk test covered by the participants.

According to Table 2 and Graph 2

Mean value of shuttle walk level is about 8.5 level and speed is about 1.78 m/s, Number of shuttle covered is on average about 20, the mean distance covered is 536.65 metre and the mean VO₂ max value is 72.76 ml/kg/min.

By observing the statistic values it is found that most of the participants in this test has good exercise capacity while some participants are below the expected level.

DISCUSSION

This study is done to find the exercise capacity among construction workers. Incremental shuttle walk test is done to assess the exercise capacity among 100 construction workers. The Incremental shuttle walk test is a reliable test to evaluate exercise capacity. In many studies all over the medical field the exercise capacity has been tested for many conditions like chronic heart diseases and transplantations, pulmonary diseases, obesity, pulmonary artery hypertension had documented. But the population who undergoes a strenuous work load like construction workers had not assessed and documented on the exercise capacity testing.

In this study 100 construction workers were taken from the age group of 25-50 years. The test is conducted and the number of levels covered, speed, distance covered and number of shuttles completed at each level are noted. And finally the VO₂ max is calculated with the formula.

The results of this study shows that about 4 subjects were at fifth level with mean VO₂ max at 76.24, 6 subjects were at 6th level with VO₂ max at 74.94, 14 subjects were at 7th level with VO₂max at 74.67, 19 subjects were at 8th level with mean VO₂max at 73.17, 24 subjects were at 9th level with mean VO₂max at 71.55, 26 subjects were at 10th level with mean VO₂ max at 71.95 and 7 subjects were found at 11th level with mean VO₂ max at 71.76.

Onorati.p, 2003 stated that Similar results have been observed with the values of the VO₂ peak on the Shuttle walk test and with the values of the VO₂ peak on the Cardio Pulmonary Exercise Testing performed by patients with COPD.

Singh et al found a significant relation (R = 0.88) between VO₂max determined from the modified Balke treadmill test and Shuttle Walk Test performance in 19 chronic airflow limitation patients. Here on analysing, VO₂ max is found to reduce with increase in levels. 12 level test was taken for the study and no adult was able to complete 12th level among 100 participants. Each test stage has been related to a

particular metabolic equivalent (1 MET: oxygenuptake (VO₂) 3.5 ml/kg/min).

The results of this study shows variables of the shuttle walk level is about 8.5 level and speed is about 1.78 m/s, Number of shuttle covered is on average about 20 ,the mean distance covered is 536.65 metre and the mean Vo 2 max value is 72.7 ml/kg/min.

The average distance covered according to a study is about 572 to 735 in incremental shuttle walk test that varies with age groups and lifestyles of the population²³. The result of this study shows an average distance covered is about 536 metres which shows that they have good speed and functional capacity.

The VO₂ max for an untrained male is about 35–40 mL/(kg·min) and for that of an untrained female is 27–31 mL/(kg·min). The average vo2 max for an elite female runner is 61 to 73 ml /kg/min and for elite male runner is 71 to 84 ml /kg/min. These scores can be affected by training and age. The above results shows that the construction workers have a good vo2 max levels.

On analysis the maximum no of participants were able to attain the normal values and other few participants are near the normal values. This explains that exercise capacity among most of the construction workers is good and can lead a good quality of life in personal and work place. And for persons with less exercise capacity the exercise protocol can be designed.

But level 12 cannot be completed which shows that further training may make them more functionally capable and improve their exercise tolerant and thus may improve their quality of life.

In participants with low exercise capacity the reasons can be myalgia, dyspnea, increased muscle weakness, tachycardia, tachypnoea. Many participants complained of breathlessness and calf muscle pain at the end of the test. Due to this some participants were terminated from the test.

Tissue oxygen availability may not be the only major factor of exercise intolerance, even the slow abnormal oxygen extraction kinetics in the muscle or inability to increase the blood circulation to the muscle to provide the necessary amount of oxygen to meet the muscle requirements. Future studies should be done to find the level of functional impairment and factors limiting exercise capacity.

This study shows that maximum participants had good exercise capacity and only a few were found with low exercise capacity. And these people need to improve their exercise tolerance which in turn makes them physically fit and improve their Quality of life.

CONCLUSION

This study concludes that in construction workers most of the participants show a good exercise capacity with a mean VO₂ max value is 72.76 ml/kg/min but few were found to have low level of exercise capacity and none were able to complete level 12 of incremental shuttle walk test. So this study recommends that exercise capacity should be assessed and exercise training should be imparted to improve their functional capacity and quality of life.

Limitations

- SpO₂ is not documented.
- Years of experience is not taken into account.

Recommendations

- 20 metre Shuttle run test can be done among construction workers.
- Study can be done by comparing the genders among construction workers.
- Exercise protocol and long term follow up can be done to assess the long term benefits.
- Future research can be done by including parameters like Body Mass Index.

References

1. Krause N, Brand RJ, Kalpan GA, Kauhenen J, Tuomainen TP et al. Occupational physical activity, energy expenditure and 11 year progression of carotid atherosclerosis. *Scand J Work Environ Health* 2007 December;33(6):405-24.
2. Van Den Berg TI, Elders LA, de Zwart BC, Burdorf A. The effects of work related and individual factors on the work ability index: A systematic review. *Occup Environ Med* 2009 April;66(4):211-20.
3. Lund T, Lbriola M, Christensen KB, Bultmann U, Villadsen E. Physical work environment risk factors for long term sickness absence: prospective findings among a cohort of 5357 employees in Denmark. *BMJ* 2006 February 25;332(7539):449-52.
4. Arndt V, Rothenbacher D, Daniel U, Zschenderlein B, Schuberth S, Brenner H. Construction work and risk of occupational disability: a ten year follow up of 14474 male workers. *Occup Environ Med* 2005 August 1;62(8):559-86.
5. Guberan E, Usel M. Permanent work incapacity, mortality and survival without work incapacity among occupations and social classes: a cohort study of ageing men in Geneva. *Int J Epidemiol* 1998 December; 27(6):1026-32.
6. K. Sembulingam, Prema Sembulingam. *Essentials of Physiology, Cardiovascular adjustments during exercise.*
7. Poole D.C., Wilkerson D.P., Jones A.M. (2008). Validity of criteria for establishing maximal O₂ uptake during ramp exercise tests. *Eur J. Applied Physiology.* 102,403-410 10.1007/s00421-007-0596-3.
8. Noakes TD. Implications of exercise testing for prediction of athletic performance: a contemporary perspective. *Med Sci Sports Exerc.* 1988; 20:319-330.
9. Mac Auley D, Mc Crum E, Stott G et al. Levels of physical activity, physical fitness and their relationship in the Northern Ireland Health and Activity Survey. *Int J Sports Med.* 1988; 9:503-511.
10. Davis JA. Direct determination of aerobic power. *M and PJ Foster C Physiological Assessment of human fitness.* Champaign, Human Kinetics 1995; 9-17.
11. Singh SJ, Morgan MD, Scott S, Walters D, Hardman AE. Development of a shuttle walking test of disability in patients with chronic airway obstruction. *Thorax* 1992; 47: 1019-1024, doi: 10.1136/thx.47.12.1019.

12. Dourado VZ, Guerra RL, Tanni SE, Antunes LC, Godoy I. Incremental shuttle walk test in healthy subjects: from the walk distance to physiologic responses. *J. Bras. Pneumol.* 2013;39(2):190-7.
13. Singh SJ, Morgan MD, Hardman AE, *et al.* Comparison of oxygen uptake during a conventional treadmill test and the shuttle walking test in chronic airflow limitation.
14. Quinn A, Doody C, O Shea D. The effect of a physical activity education programme on physical activity, fitness, quality of life and attitudes to exercise in obese females. *J Sci Med Sport.* 2008;11(5):469-472.
15. Andersen AH, Vinther A, Poulsen LL, Mellemegaard A. Do patients with lung cancer benefit from physical exercise? *ActaOncol.* 2011;50(2):307-313.
16. Zwierska I, Nawaz S, Walker RD, Wood RF, Pockley AG, Saxton JM. Treadmill versus shuttle walk test of walking ability in intermittent claudication. *Med Sci Sport* 2004;36(11):1835-1840
17. Walker RD, Nawaz S, Wilkinson CH, Saxton JM, Pockley AG, Wood RF. Influence of upper and lower limb exercise training on cardiovascular functions and walking distances in patients with intermittent claudication. *J Vasc Surg.* 2000;31(4):662-669.
18. Probst VS, Hermandes NA, Teixeria DC, *et al.* Reference values for the incremental shuttle walk test. *Respir Med,* 2012;106(2):243-248.
19. Bjelle A, Eiengberg M, Michaelson G. Occupational and individual factors in acute sholder neck disorders among industrial workers. *Br J Ind Med* 1981;38:356-63
20. James T, Albers Cheryl F. Ergonomics for construction WinkensNational Institiute for occupational safety and health 2007.
21. Firstbeat Technologies (2014-11-11). "Automated Fitness Level (VO2max) Estimation with Heart Rate and Speed Data" (PDF). www.firstbeat.com.
22. Heyward, V (1998). "Advance Fitness Assessment & Exercise Prescription, 3rd Ed". p. 48.
23. Bela Agarwal (2016)"Incremental shuttle walk test: Reference values and predictive equation for healthy Indian adults:p:36-41

How to cite this article:

N.Ashok and Bandarupalli Sai Manjusha (2019) 'Exercise Capacity Among Construction Workers – an Observational Study', *International Journal of Current Advanced Research*, 08(06), pp. 19103-19107.
DOI: <http://dx.doi.org/10.24327/ijcar.2019.19107.3671>
