

Cardio Respiratory Fitness Testing in Spinal Cord Injury Patients Using 6 Minute Push Test
Ravi Solanki¹, Pooja Chaudhari², Anjali Bhise³¹Tutor, Department of Physiotherapy, Government Spine Institute and Physiotherapy College, Civil hospital, Ahmedabad² Post Graduate Student, School of Public Health, University of Texas, USA³ Principal, Government Spine Institute and Physiotherapy College, Civil, Hospital, Ahmedabad.**Correspondence :** Dr. Ravi Solanki, E-Mail: ravibsolanki@gmail.com**Abstract:**

Introduction : 6-minute Push test has been demonstrated as a reliable and valid measure for testing aerobic fitness in patients with spinal cord injury. Purpose of this study was to assess aerobic fitness in patients with spinal cord injury using 6-minute push test and Heart rate recovery. **Method :** Total 47 spinal cord injury patients were randomly selected for the study. 6-minute push test distance and heart rate recovery were assessed. Mean 6-minute push test distance was calculated. Relationship between 6-minute push test distance and heart rate recovery was analyzed by calculating correlation coefficient(r). **Results:** Mean 6-minute push test distances calculated for the paraplegics and the tetraplegics were 280 and 148 meters respectively. 6-minute push test distance was positively correlated(r=0.87) with heart rate recovery. **Conclusions:** Patients with larger 6-minute push test distance are having faster heart rate recovery.

Keywords: 6 Minute Push Test, Aerobic Fitness, Paraplegics**Introduction :**

Spinal cord injury induces motor pareses of substantial parts of the skeletal musculature. In the vast majority of the disabled individuals, physical mobility and regular daily activities are reduced. This leads to a considerable impairment of physical fitness and a loss of peak oxygen uptake and metabolic demands. The concomitant increase of cardiovascular risk factors leads to a higher incidence of diseases of the cardiovascular system. From a public health prospective, identifying persons who could most strongly benefit from exercise interventions, that is, persons with "low" fitness, is more valuable than estimating their precise aerobic capacity. Several field tests have been developed to assess the aerobic capacity of persons with spinal cord injury. 6-minute push test (MPT) is a clinic friendly approach to identify cardiovascular fitness level in persons with spinal cord injury. It measures total distance which can be propelled using wheelchair by the subjects in 6 minutes. It has been validated as a measurement which is sensitive to fitness differences and identifies individuals with low fitness. ^[1] The 6-minute push test demonstrates acceptable reliability with intra-class correlation

coefficient (95% confidence interval) exceeding 0.90 for the whole sample (0.97 (0.94–0.98)) and the tetraplegics (0.93 (0.80–0.98)) and paraplegics (0.97 (0.93–0.99)) subsets. Increased Vagal activity associated with a faster HR recovery has been shown to be associated with a decrease in risk of death.^[2] For this reason, several recent studies have looked at HR recovery after exercise as a prognostic tool.^[1] Previous study has been done in western population to find out average 6-minute push test distance for paraplegics and tetraplegics.^[1] But lack of information exists about average 6-minute push test distance in Indian population and its relationship with heart rate recovery.

Method :

47 (out of 80) individuals with spinal cord injury or spinal cord disease were selected for the study by simple random sampling. All subjects voluntarily provided written informed consent and completed the Institutional Review Board–approved research protocol. All subjects were given identity number and confidentiality was maintained. Inclusion criteria were as follows: age 18 years or older, self-reported Spinal Cord Injury (SCI), self-reported ability to independently self-propel a

Table 1 : Mean 6-minute push test distance in paraplegics and tetraplegics

Injury Category	Age (Mean ± SD) years (Mean ± SD)	Male	Female	6 MPT distance
Paraplegics (n= 35)	42.6 ± 12.34	29	8	280 ± 71.36 m
Tetraplegics (n= 12)	39.5 ± 9.81	9	3	148 ± 34.87 m

manual wheelchair and ability to complete testing in their personal manual wheelchair. Individuals meeting any of the following criteria were excluded: self-reported unstable angina or myocardial infarction within the past month, resting HR >120, systolic blood pressure 180 mm Hg, or diastolic blood pressure >100 mm Hg. Exclusion criteria were consistent with the American Thoracic Society (ATS) relative or absolute contraindications for performing the 6-minute walk test.^[3] Participants self-reported injury level (i.e., tetraplegia (TP) (C5–C8) or paraplegia (PP) (T1–L2). Self-report was confirmed with a brief assessment of active range of motion against gravity (elbow flexion (C5), wrist extension (C6), elbow extension (C7), and gross Opening/closing of the hand (T1)). Participants who could not complete all of these motions were classified as tetraplegic. The study was approved by institutional ethical committee

Procedure for 6-minute Push test

We conducted the 6-MPT in a moderately busy hallway of an academic research center and individuals were tested in their personal wheelchair. The course was a 30-m loop, marked by two cones spaced 15 m apart (30-m loop) with 2.8 m on either end to allow for turning. Two 180 degree turns were required to complete one 30-m loop. Beyond space, the only required equipment was a lap counter and pylons to mark the ends of the loop. ATS guidelines and instructions for the administration of the 6MPT were followed.^[3] A standardized pretest script instructed participants to propel as far as possible on the propulsion course and advised that they could slow or stop at any point during testing. During the test, standard feedback was given at recommended intervals. Participants completed all testing in their

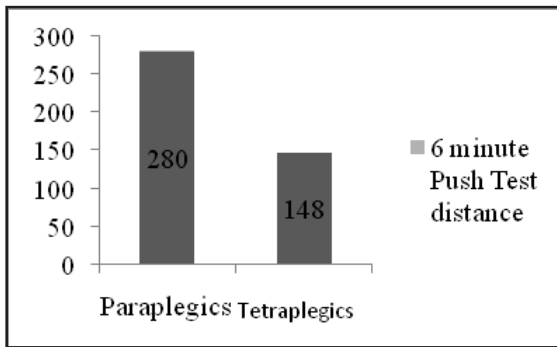
personal wheelchair. At the end of test, peak Heart Rate (HR) was recorded using Polar heart rate monitor. After 1 minute, decline in Peak heart rate was recorded to estimate heart rate recovery. Following testing order was used for each 6-MPT: a 2-min self-selected slow velocity practice test, a 20-min rest, followed by the 6-MPT. The 2-min practice test was completed on a shortened loop (15 m) to allow for more turning practice. For the practice test, participants were instructed to propel at comfortable velocity as if they were pushing around a grocery store, turning in the direction of their choice. Total number of laps completed by the subject was recorded using pen and paper. Distance traveled in 6 min (m) was computed by multiplying the number of completed laps by 15 m and adding the distance traveled in the last lap. Distance traveled in the turns was not measured.

Results:

Forty seven individuals with Spinal cord injury completed the study. 45 individuals reported traumatic event which included road traffic accidents, fall from height etc. One individual reported tuberculosis and one reported transverse myelitis as the cause of their spinal cord injury. More than half had an injury at T1 or lower (75 % PP, n = 35). Among these individuals, 24 reported injuries between T1 and T9 and 11 reported injuries between T10 and L2. (Table 1)

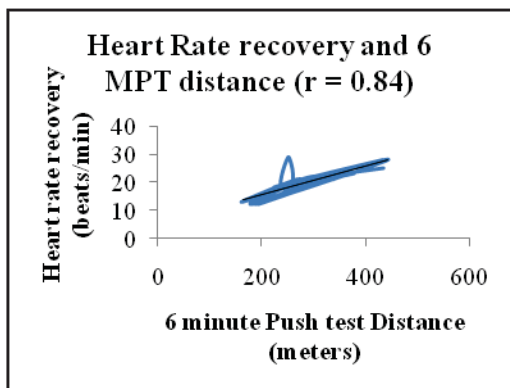
Among individuals with cervical injuries (25%TP, n = 12), nine reported an injury at C5/C6 and three reported injuries at C7/C8. Mean 6 MPT distance for Paraplegics was 280 meters with SD of 71.36 meters. For Tetraplegics it was 148 meters with SD of 34.87 meters. (Figure 1)

Figure 1: Mean 6-minute Push test distance (meters)



Rate of decline in Peak HR at end of 1 minute was recorded and was correlated with 6-minute push test distance. The calculated correlation coefficient was 0.84. (Figure 2)

Figure 2: Heart Rate recovery (after 1 minute) and 6 MPT distance



Discussion:

The 6-MPT has been used across a broad spectrum of populations as a correlate of aerobic capacity and/or functional abilities.^[4-8] We have extended the possible applications of the 6-MPT by configuring it as a manual wheelchair propulsion test. As administered, the 6-MPT is reliable in persons with Tetraplegia (TP) and Paraplegia (PP). It may also serve this disability group as a field-based test to generate peak aerobic capacity.^[1]

In the present study, we found that mean 6-minute push test distances for paraplegics and tetraplegics were 280 and 148 meters respectively. Previously study done by Cowan RE et al showed mean 6-minute push test distances of 604 and 445 meters for paraplegics and tetraplegics respectively.^[1] Distances

covered by spinal cord injury patients in 6 minutes in present study were smaller compared to study done by Cowan RE et al.^[1] Several factors like racial variations, exercise habits etc. may be responsible for the same. Previously no baseline data was available to assess cardio respiratory fitness in spinal cord injury patients for Indian population. Hence, it was difficult to categorize aerobic fitness of the patient. Present study has provided average 6-minute push test distance for paraplegics and tetraplegics. Hence while testing cardio respiratory fitness, one can compare 6-minute push test distance with the average one and categorize the aerobic fitness of the spinal cord injury patient in above or below average group.

Recently, consideration has been given to the role of HR in recovery as a predictor of mortality. Heart rate recovery is mediated by vagal reactivation, and the rate at which HR declines appears to be a reflection of a faster recovery from the sympathetic drive necessary during exercise. Increased vagal activity associated with The rate of HR return to baseline after exercise is theorized to be due to high vagal tone associated with fitness and good health.^[9] A drop in HR ≤ 12 beats after 1 minute and ≤ 22 beats after 2 minutes of exercise has been considered as abnormal response. In the present study we found positive correlation (r = 0.84) between 6-minute push test distance and heart rate recovery. Hence patients who covered larger distances in 6 minutes had faster heart rate recovery. These findings implicate usefulness of monitoring 6-minute push test distance during rehabilitation after spinal cord injury to predict prognosis and to design fitness training programs.

Limitations of the present study include small size and mixed injury level for spinal cord injury patients with predominantly male gender.

Conclusion:

In conclusion, the 6-MPT holds potential to be a useful tool for clinicians and researchers. The distance a person with SCI can self-propel in 6 min demonstrated acceptable test-retest reliability. The 6-MPT has been considered a maximal test of aerobic

capacity in persons with injuries above T10. Our initial work suggests that a 6MPT distance less than a threshold value (TP = 148 m, PP = 280 m) correctly identifies most low fitness persons. Further studies are required over larger sample size including equal proportions of male and female gender distributions.

Declarations :

Funding: Nil

Conflict of interest: Nil

References :

1. Cowan RE et al. The 6-min Push Test Is Reliable and Predicts Low Fitness in Spinal Cord Injury. *Medicine & Science in Sports & Exercise* 2012. DOI: 10.1249/MSS.0b013e31825cb3b6
2. Hull SS, Vanoli E, Adamson PB, et al. Do increases in markers of vagal activity imply protection from sudden death? The case of scopolamine. *Circulation*; 91:2516-9. 1995.
3. ATS statement: guidelines for the six-minute walk test. *Am J Respir Crit Care Med*; 166:111-7, 2002.
4. Basaran S, Guler-Uysal F, Ergen N, Seydaoglu G, Bingol-KarakocG, Ufuk AD. Effects of physical exercise on quality of life, exercise capacity and pulmonary function in children with asthma. *J Rehabil Med*; 38:130-5, 2006.
5. Gayda M, Temfemo A, Choquet D, Ahmaidi S. Cardiorespiratory requirements and reproducibility of the six-minute walk test in elderly patients with coronary artery disease. *Arch Phys Med Rehabil*; 85:1538-43. 2004.
6. Kennedy DM, Stratford PW, Wessel J, Gollish JD, Penney D. Assessing stability and change of four performance measures: a longitudinal study evaluating outcome following total hip and knee arthroplasty. *BMC Musculoskeletal Disord*. 6:3 2005.
7. Li AM, Yin J, Yu CC, et al. The six-minute walk test in healthy children: reliability and validity. *Eur Respir J*; 25:1057-60, 2005.
8. Perera S, Mody SH, Woodman RC, Studenski SA. Meaningful change and responsiveness in common physical performance measures in older adults. *J Am Geriatr Soc*. 2006; 54:743-9.
9. Shelter K et al. Heart Rate Recovery: Validation and Methodologic Issues. *JACC*; 38,2001.