

# Normative Value for Physiological Cost Index in Young Adults of Gujarat: An Observational Study

Krupa Prabhakar<sup>1</sup>, Dr Anjali Bhise<sup>2</sup>

<sup>1</sup>Ph.D. Scholar, Gujarat University, Tutor/Physiotherapist, Civil Hospital, Asarwa, Ahmedabad, India

<sup>2</sup>Ph.D. Guide, Gujarat University, Principal Chief Physiotherapist, U. N. Mehta Institute of Cardiology and Research Centre, Ahmedabad, India

**Abstract:** ***Introduction:** Physiological cost index (PCI) measures energy expenditure. Whenever person has difficulty in walking, due to any problem in body, energy required for walking increases. Normative value for any measure is necessary to compare changes due to any abnormality in body and so does value of energy expenditure. But the normative value for physiological cost index is not available for the Indian population. So, this study was done to find out the normative value of Physiological cost index in young population of Gujarat. **Methodology:** Study design: An observational study. **Inclusion criteria:** Male and female aged between 18 to 35 years. **Exclusion criteria:** Subject having pain while walking. **Procedure:** Written consent from the participants was taken. The subjects were asked to sit on a chair for 10 minutes before starting the test and the heart rate was measured. The subject was then asked to stand up and start walking when ready. The stop watch was started as soon as the subject started walking and distance covered in 6 minutes was recorded. The walking heart rate was calculated when it reaches to steady state or after 6minute. For the calculation of walking speed distance was recorded.*

$$PCI = \frac{(\text{walking heart rate}) - (\text{resting heart rate})}{(\text{Walking speed})}$$

*Independent sample t test was used to compare the PCI with available normative value. **Result and conclusion:** Normative value of PCI for adult male of Gujarat is 0.34 beats/meter and for female 0.37 beats/meter. No significant difference ( $p=0.324(\text{males}) - p=0.579(\text{female})$ ) was found while comparing these values with available normative values of PCI from other articles.*

**Keywords:** Physiological cost index (PCI), Normative value, Population of Gujarat

## 1. Introduction

Recent articles suggest a worldwide epidemic in terms of obesity and a sedentary lifestyle, which are risk factors for multiple adverse health problems. [1] Studies have shown that physical inactivity doubles health risks and adds a disease burden to society comparable with smoking [2], obesity and hypertension [3], and such inactivity during middle age appears to shorten the life span [4].

Numerous studies have shown that physical activity has far-reaching benefits on health and disease, including reducing mortality rates<sup>5</sup>. Evidence supporting the physical and mental-health benefits of physical activity and exercise continues to accumulate at an accelerated rate. [1] The physical activities are directly related with the well-being, happiness and healthy lifestyle of an individual, mentally as well as physically. [1, 6]

Energy expenditure during physical activities depends upon specific speed of the subject, inclination of the surface, distance elapsed per time. [1, 6] The primary and fundamental physiological parameters for the estimation of energy expenditure during such activities are heart rate, oxygen uptake and respiratory quotient. [7] This parameter can now be accurately measured in digital format during exercise especially in bicycle ergo meter and treadmill test. [7] In advanced labs, we can monitor electrocardiogram, heart rate, blood pressure in beat-by-beat basis, inspired-expired gases in breath-by-breath basis and blood oxygen saturation. [7]

Heart rate is an important measurement of physical exertion. It is more easily measured than oxygen uptake and it has been shown in adults to be an accurate and convenient method of estimating of energy expenditure in any environment.<sup>7</sup>

The physiological cost index (PCI) is a clinical tool thought to indicate the energy expenditure, [8] physiologic cost, [9, 10] or effort of walking. [11] Originally devised by MacGregor, the PCI was designed to assign a physiologic cost to physical performance over a 24-hour period. [12] It assumes a linear relationship between oxygen consumption and heart rate at sub-maximal levels [13] and therefore uses heart rate as an indicator of energy expenditure. The original design was quickly adapted to laboratory based clinical assessments which typically require the subject to walk for less than 10 minutes. Because minimal equipment is used to administer the PCI, it is proposed as a feasible low-cost, low technology alternative to the use of gas and calorimetric analysis equipment during gait analysis, [14] which may be impractical or unavailable in clinical departments.

Normative value for any measure is necessary to compare changes due to any abnormality in body and so does value of energy expenditure. It is also helpful to improve fitness level of the able bodies. But the normative value for physiological cost index is not available for the Indian population. So this study was done to find out the normative value of Physiological cost index in young population of Gujarat.

## 2. Methodology

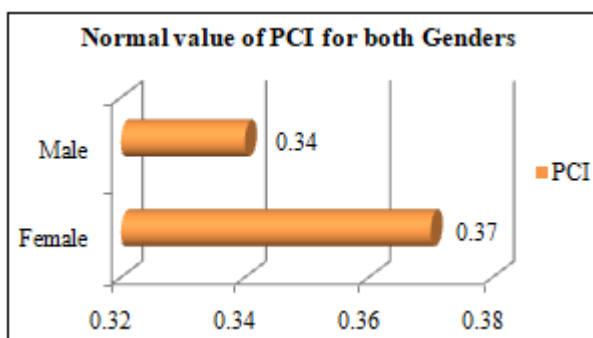
Total 87 participants were enrolled, out of which 62 were females and 25 were males from different cities of Gujarat.

- Study design: An observational study
- Inclusion criteria: Male and female aged between 18 to 35 years
- Exclusion criteria: Subject having any problem in lower limb
  - Pain during walking
  - Any cardiopulmonary/ musculoskeletal/ neurological issue were excluded

## 3. Procedure

- Written consent from the participants was taken.
- The subjects were asked to sit on a chair for 10 minutes before starting the test and the heart rate was measured with pulse oxymeter.
- After that the subject was asked to stand up and start walking when ready.
- The subjects were asked to walk for 6 minutes on a level ground with a distance of 30 meters between two cones.
- The stop watch was started as soon as the subject started walking and distance covered in 6 minutes was recorded.
- The walking heart rate was recorded when it reached to steady state or at the end of walk.<sup>15</sup>
- The heart rate reached to the steady state after 4 minutes of the walking started.
- The walking distance was recorded to calculate the walking speed.
- $PCI = \frac{(\text{walking heart rate}) - (\text{resting heart rate})}{(\text{Walking speed})}$
- Walking speed =  $\frac{\text{distance(meter)}}{\text{Time (minutes)}}$

## 4. Results



Data analysis was done with Microsoft excel version 2007 and SPSS version 20.

Mean value of PCI for the male participants was 0.34 beats/meter and for female participants was 0.37 beats/meter. Comparison of these values was done with the values published in the previous articles. Independent sample t test was applied for the comparison of PCI, and has p value 0.324 for males and 0.579 for females which is statistically insignificant. There is no significant difference in PCI value of Gujarati young population with other published articles.

## 5. Clinical implication

- Can be used to improve physical fitness.
- Pre and post effect of any exercises can also be measured.
- Can be used to compare changes due to any abnormalities in the body.

**Limitation:** Sample size is small as calculation of sample size was not done.

**Conflict of Interest:** Nil

**Funding:** Nil

### Abbreviation

PCI - Physiological Cost Index

SPSS – Statistical Package for the Social Sciences

## References

- Penedo FJ, Dahn JR. Exercise and well-being: a review of mental and physical health benefits associated with physical activity. *Current opinion in psychiatry*. 2005; 18:189-93.
- Pate R, Pratt M, Blair S, et al. Physical activity and public health: a recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. *JAMA* 1995; 273:402–406.
- Paffenbarger R, Lee I, Leung R. Physical activity and personal characteristics associated with depression and suicide among American college men. *Acta Psychiatr Scand Suppl* 1994; 377:16–22.
- Paffenbarger R, Hyde R, Wing A, Hsieh C. Physical activity, all-cause mortality and longevity of college alumni. *New Engl J Med* 1986; 314:605–613.
- Centers for Disease Control. Effects of physical activity on health and disease: a report from the Surgeon General [online] 2001; <http://www.cdc.gov/nccdphp/sgr/prerep.htm>. [Accessed October 2004].
- Fox KR. The influence of physical activity on mental well-being. *Public health nutrition*. 1999; 2:411-8.
- Binaya SJB Rana, Matiram Pun “Estimation of Physiological Cost Index as an Energy Expenditure Index using MacGregor’s Equation” *Journal of the Nepal Medical Association*. Vol- 53, No. 3, Issue 199, JUL-SEP, 2015.
- Tofts LJ, Stanley CS, Barnett TG, Logan JG. Knee joint function and the energy cost of level walking in soccer players. *Br J Sports Med* 1998;32:130-3.
- Sienko Thomas S, Moore C, Kelp-Lenane C, Norris C. Simulated gait patterns: the resulting effects on gait parameters, dynamic electromyography, joint moments and physiological cost index. *Gait Posture* 1996;4:100-7.
- Steven MM, Capell HA, Sturrock RD, MacGregor J. The physiological cost of gait (PCG): a new technique for evaluating nonsteroidal anti-inflammatory drugs in rheumatoid arthritis. *Br J Rheumatol* 1983;22:141-5.

- [11] Taylor P, Burrige J, Dunkerley A, et al. Clinical use of the Odstock dropped foot stimulator: its effect on the speed and effort of walking. *Arch Phys Med Rehabil* 1999;80:1577-83.
- [12] MacGregor J. The objective measurement of physical performance with long-term ambulatory surveillance equipment (LAPSE). In: Stott FD, Reftery EB, Goulding L, editors. *ISAM 1979: Proceedings of the Third International Symposium on Ambulatory Monitoring*. London: Academic Pr; 1979. p 29-39.
- [13] Waters RL, Mulroy S. The energy expenditure of normal and pathological gait. *Gait Posture* 1999;9:207-31.
- [14] Hood VL, Granat MH, Maxwell DJ, Hasler JP. A new method of using heart rate to represent energy expenditure: the Total Heart Beat Index. *Arch Phys Med Rehabil* 2002;83:1266-73.
- [15] Maggie J Bailey, Claire M Ratcliffe. Reliability of physiological cost index measurements in waking normal subjects using steady state, non steady state and post exercise heart rate recording. *Physiotherapy*, October 1995, vol 81, no 10, 618-623.