

# Physiological Cost Index (PCI)

Demonstration

**Number of Participants:** (1-10)

**Audience:** High school (ages 14+)

**Duration:** 10-20 min

**Difficulty:** LEVEL 1



## Material required:

1. Heart rate monitor (Oximeter)
2. Stopwatch and a measured distance (or treadmill that calculates walking speed)
3. Calculator (as needed)

## Setup:

1. Define the variables: Identify the psychological factors that you want to measure and assign them a specific variable name. For example, let's say you want to measure stress levels and anxiety levels, so you can define variables like "stress" and "anxiety".
2. Determine the measurement scale: Decide on the scale or rating system that you will use to quantify each psychological factor. It can be a Likert scale (e.g., 1-5), a visual analog scale, or any other appropriate scale.
3. Select the sample: Choose a representative sample of individuals who will participate in the study. This can be done through random sampling or by selecting a specific population group.

4. Develop the survey or questionnaire: Create a set of questions that will capture the levels of the psychological factors you are interested in. Each question should be related to a specific variable and have response options corresponding to the chosen measurement scale.
5. Administer the survey: Distribute the survey to the selected participants and collect their responses. This can be done through online platforms, in-person interviews, or any other suitable method.
6. Calculate the Psychological Cost Index: Once you have collected the responses, calculate the Psychological Cost Index by averaging the scores obtained for each variable. For example, if you have measured stress and anxiety on a Likert scale of 1-5, you can add up the scores for each participant and divide by the number of participants to obtain the average score for each variable.
7. Interpret the results: Analyze the calculated Psychological Cost Index to understand the overall level of psychological costs experienced by the participants. Compare the averages of different variables to identify any patterns or trends.

**Presenter brief:** PCI is an indirect measure of the energy expenditure of walking. It uses heart rate and walking speed to estimate the oxygen consumption of gait. The measurement relies on the assumption that heart rate is linearly related to oxygen expenditure ( $\text{VO}_2$ ). The PCI can be used to compare the efficiency of different walking patterns or interventions. It has been demonstrated that heart rate and oxygen intake have a linear relationship with submaximal workloads.

## Vocabulary:

1. **Heart rate:** The number of times your heart beats per minute. It is measured in beats per minute (bpm).
2. **Walking speed:** The distance you travel in a given time while walking. It is measured in meters per minute (m/min).
3. **Oxygen uptake:** The amount of oxygen your body uses during physical activity. It is measured in milliliters of oxygen per kilogram of body weight per minute (ml/kg/min).
4. **Energy cost:** The amount of energy your body spends during physical activity. It is measured in kilocalories per hour (kcal/h).
5. **Steady state:** A condition where your heart rate, oxygen uptake, and energy cost are stable and do not change much during physical activity.
6. **Submaximal exercise:** A level of physical activity that is below your maximum capacity and does not cause exhaustion or fatigue.

## Physics & explanation

### High school (ages 14+)

Energy expenditure during physical activity depends on certain patterns of the subject's pace, the incline of the surface, and the distance traveled. Examples of these activities include running, hiking, and walking. These physical pursuits have a direct impact on happiness, well-being, and leading a healthy lifestyle. There are several ways to estimate how much energy is needed for each of the aforementioned tasks. Heart rate, oxygen uptake, and respiratory quotient are the three most important and fundamental physiological markers for the calculation of energy expenditure during such activities. These factors can now be precisely measured in digital form when exercising, particularly in treadmill and bicycle ergometer testing. Of course, they are able-bodied participants who are capable of exercising in this environment. It has been established that the submaximal workloads are linearly related to heart rate and oxygen consumption.

## Learning Objectives

- PCI is calculated by counting the number of heartbeats per meter traveled. The higher the PCI, the more energy is used.
- PCI can be used to compare the efficiency of different walking styles, such as normal walking, using a cane, or using a prosthesis.
- PCI can also be used to assess the impact of various factors on walking, such as age, health, fatigue, or terrain.
- PCI is based on the assumption that heart rate and oxygen consumption are directly related.

## Additional Resources:

1. Estimation of Physiological Cost Index as an Energy Expenditure Index using MacGregor's Equation  
[https://www.researchgate.net/publication/307039274\\_Estimation\\_of\\_Physiological\\_Cost\\_Index\\_as\\_an\\_Energy\\_Expenditure\\_Index\\_using\\_MacGregor's\\_Equation](https://www.researchgate.net/publication/307039274_Estimation_of_Physiological_Cost_Index_as_an_Energy_Expenditure_Index_using_MacGregor's_Equation)
2. <https://medical-dictionary.thefreedictionary.com/physiological+cost+index>
3. (PDF) Estimation of Physiological Cost Index as an Energy Expenditure Index using MacGregor's Equation. Available from:  
[https://www.researchgate.net/publication/307039274\\_Estimation\\_of\\_Physiological\\_Cost\\_Index\\_as\\_an\\_Energy\\_Expenditure\\_Index\\_using\\_MacGregor's\\_Equation](https://www.researchgate.net/publication/307039274_Estimation_of_Physiological_Cost_Index_as_an_Energy_Expenditure_Index_using_MacGregor's_Equation)
4. <https://www.youtube.com/watch?v=1AN67AW6rws>



Physiological Cost Index (PCI) .mp4

5.

## Useful Equations:

$PCI = \frac{Working\ HR - Rest\ HR}{Walking\ Speed}$
$Walking\ Speed = \frac{d}{t}$

### Variables and constants:

PCI is the Physiological Cost Index  
HR is heart rate  
d is the distance traveled  
t is elapsed time