

Effect of Aerobic Versus Anaerobic Exercise on Energy Expenditure in Young Healthy Individuals

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ABSTRACT

Introduction: Energy is expended by individuals engaging in physical activity. It can be calculated after performing aerobic or anaerobic exercise. Energy expenditure index based on heart rate and walking speed has been termed Physiological Cost Index (PCI) by McGregor. The 6 Minute Walk Test is sub-maximal test for assessing energy expenditure. Need of study is to find effect of aerobic and anaerobic exercise on energy expenditure and compare post exercise effect so, that it could be given to any individual for physical fitness in near future according to ones need.

Method: Interventional study, convenient sampling, sample size of 36 subjects. Inclusion criteria: 18-25 years both male and female having BMI (18.5 -24.9 kg/m²). Exclusion criteria: any cardio-respiratory diseases, neurological or orthopedic conditions, not willing to participate. Pre intervention: PCI of subjects assessed by 6mwt and values were put in McGregor's equation. Subjects were randomly divided into aerobic and anaerobic groups. The exercise protocol was of 4 weeks, 5days/week. Post intervention PCI was calculated.

Results: Statistical analysis was done by using SPSS version 16, keeping the level of significance 5%. Paired t-test was applied for within group analysis and unpaired t-test applied for between group comparison. Within group analysis showed statistically significant improvement in PCI values (p<0.05). Between group analysis showed higher improvement in anaerobic exercise group in comparison to aerobic exercise group.

Conclusion: Present study concluded that 4 weeks of aerobic and anaerobic exercise showed improvement on physiological cost index but higher improvement was seen in anaerobic exercise group.

Keywords: aerobic, anaerobic, energy expenditure, healthy individuals

INTRODUCTION

Exercise is a planned and structured physical activity designed to improve or maintain physical fitness¹. Aerobic and anaerobic exercises are two types of exercise that differ based on the intensity, interval and types of muscle fibers incorporated². Aerobic exercise is sub-maximal, rhythmical, repetitive exercise of large muscle groups during which the needed energy is supplied

by inspired oxygen. Anaerobic exercise occurs without the presence of inspired oxygen¹. It is intense, short duration, fueled by the energy sources within the contracting muscles. Any type of exercise recruits the muscle cell. To perform any activity, body needs energy which is taken by the energy system. Energy systems are metabolic systems involving a series of biochemical reactions in the formation of adenosine

triphosphate (ATP), carbon dioxide and water. The cell uses energy produced from the conversion of ATP to ADP (adenosine diphosphate) and phosphate (P). Muscle cells use the energy for the actin-myosin cross-bridge formation while contracting.

Energy is expended by individuals engaging in physical activity¹. The energy expenditure is the amount of energy or calories that a person needs to carry out a physical function such as breathing, circulating blood, digesting food or a physical movement³. Energy expenditure index based on heart rate and walking speed has been termed Physiological Cost Index (PCI) by McGregor.

Physiological cost index: McGregor (1979) proposed a simple and practical method to measure the physiological cost of walking. PCI is a simple tool to measure the energy expenditure during walking. According to McGregor, PCI is defined by dividing the changes in HR (beats/min) by walking speed.

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

The aerobic exercises and anaerobic exercises have their own advantages. The present study was carried out to find the effect of aerobic and anaerobic exercises on energy expenditure in young healthy individuals and compare these exercises so that it could be given to any individual for physical fitness according to the need for best results.

AIMS

- To know the effect of aerobic exercise versus anaerobic exercise on the energy expenditure in young healthy individuals.

OBJECTIVES

Since there is a direct relationship between oxygen consumption (VO₂) and HR, PCI can be used to estimate the oxygen consumption index⁴.

He also suggested that PCI was one of the good indicators of energy cost. Therefore, PCI is an effective tool used to measure the energy expenditure during walking. PCI is an easy to use valid and reliable (reliability: 0.84-0.94) measure of energy expenditure and it is recommended as a useful tool for physiotherapist in the assessment and evaluation of functional performance.⁵

The 6-min walk test (6 MWT) is sub-maximal test which is an inexpensive, relatively quick, safe, and well-tolerated method of assessing the functional exercise capacity which can be used to assess PCI⁵. It is calculated by the following formula:⁶

- To study the effect of aerobic exercise on energy expenditure in young healthy individuals.
- To study the effect of anaerobic exercise on energy expenditure in young healthy individuals
- To compare energy expenditure after aerobic exercise and anaerobic exercise in young healthy individuals

LITERATURE REVIEW

Jigar N Mehta, Ashish V Gupta, Nidhi G Raval, Nishu Raval, Nidhi Hasnani (2017) conducted a study on Physiological Cost Index of Different Body Mass Index and Age of an Individual. Aim was to measure and correlate the relationship of energy

expenditure of normal healthy individuals with different BMI and age. 115 participants (59 males and 56 females) were included. Participants were asked to walk on 30m straight floor track for 6 minutes (6MWT) at normal speed. Pre and post walked vitals were taken. PCI was calculated using formula. From this study concluded that as age increases PCI increases and as BMI increases, PCI increases suggestive of more energy expenditure⁷.

Julie S. Pawar, Suraj Shukla, Hiral Jain, Ajay Kumar (2020) conducted a study on the Effect of Aerobic Exercise Training on Energy Expenditure by Physiological Cost Index in Obese Individuals. Aim was to find the effect of aerobic exercise training on energy expenditure by physiological cost index in obese individuals. Experimental study on 30 obese individuals of age group 18-28 years. All 30 individuals were divided in group of 5 each. Training was imparted for 3 days for 4 consecutive weeks. Difference of pre and post PCI was calculated. From this study it is concluded that there is significant reduction in PCI values after 4 weeks of aerobic training in obese individuals⁸.

MATERIALS & METHODS

Study Design: Interventional study

Study Setting: Ahmedabad

Sample size: 36 participants

Sampling technique: Randomized

Sample size estimation: Sample size was estimated using following formula:

$$N = (\sigma / \Delta)^2 * [Z_{\alpha} + Z_{1-\beta}]^2$$

The power of study was kept 80% with 5% level of significance

Based on the calculation, the minimal sample size was 34.

Duration of intervention: 4 weeks, 5 days in a week

Study Duration: 9 to 12 months

Inclusion criteria: Age Group: 18 to 25 years

Young Healthy Individuals

Individuals of Normal BMI (18.5 to 24.9 WHO classification)

Both male and female were included

Exclusion criteria: Any cardio-respiratory diseases

Any neurological or orthopedic conditions

Not willing to participate

Materials:

- Weighing machine
- Stadiometer
- Pulse oxymeter
- Measure tape
- 30-meter track
- chair
- Stop-watch
- 40cm wooden box

Procedure

- Young healthy individuals who fulfill the above inclusion criteria were included.
- Ethical committee approval was taken (SBBIRB PTC/IEC/42/2020-2021)
- Prior informed and written consent of the subject was taken.

FINDING PCI –

Each participant was asked to sit for a while and Resting Heart rate (RHR) was taken. After taking the RHR, the subject performed 6MWT and in between the test (after 2 minutes walking heart rate (WHR) was noted) by using pulse oximeter.

6 MINUTE WALK TEST: 6MWT was performed according to ATS (American thoracic society) guidelines. The 6MWT was performed outdoor along a long, flat, straight, enclosed corridor on a hard even

surface. The walking course was 30 m in length.

Speed was calculated by dividing the distance covered upon the time taken (6 min) (speed = distance /time). PCI was calculated using McGregor's equation.

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

PCI of all the participants by 6 minute walk test was checked and then the subjects were randomly divided into two groups. One for

aerobic exercise and another for anaerobic exercise. There was blinding of all subjects.

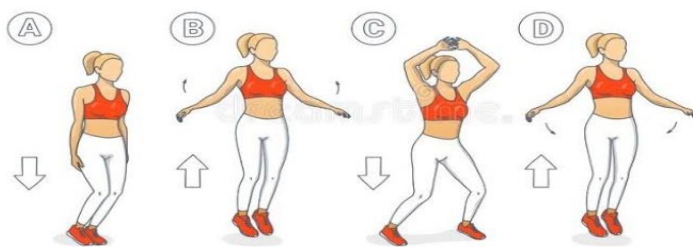
GROUP 1 - AEROBIC EXERCISES

❖ AEROBIC EXERCISES

PROTOCOL (total duration 45min)

- 5 min warm up – head movements, stretching, shoulder rotations
- 35 min exercise programme – Jumping jacks, Butt kicks, Alternate side steps, Prone leg lift
- 5min cool down - cooling down movements in sitting and lying positions⁸.

JUMPING JACKS



JUMPING JACKS

Source: <https://inshape.blog/workout/jumping-jacks-benefits/>



ALTERNATE SIDE STEP

Source: <https://youtu.be/5m3oCKHTwPU>



BUTT KICKS

Source: <https://images.app.goo.gl/SMotCTR1rAPqd5db8>



PRONE LEG LIFT

Source: <https://images.app.goo.gl/t6bwqPHDfx8Uz9AEA>

GROUP 2 – ANAEROBIC EXERCISES

- ❖ **ANAEROBIC EXERCISE PROTOCOL** (total duration 45 min)
 - 5min warm up - head movements, stretching, shoulder rotations
 - 35 min exercise programme – counter movement jump, drop jump, squat jump vertical jump
 - 5 min cool down – cooling down movements in sitting and lying positions⁹.



SQUAT JUMP

Source: <https://images.app.goo.gl/Z45S65Fj77QcstSdA>



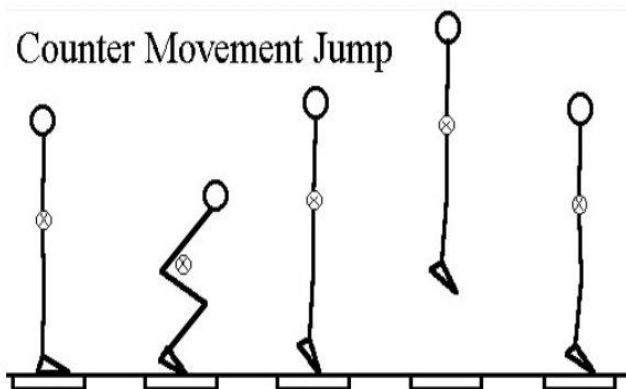
VERTICAL JUMP

Source: <https://www.twinkl.com.br/teaching-wiki/standing-vertical-jump>



DROP JUMP

Source: <https://images.app.goo.gl/tdMZ3cdTXfYoM1Z96>



COUNTER MOVEMENT JUMP

Source: <https://images.app.goo.gl/8Su7krAHHRHamecv2A>

After 4 weeks post intervention PCI was calculated.

significance was kept at <0.05 with 95% confidence interval

Statistical Analysis

The present study was done to know the effect of aerobic versus anaerobic exercise on energy expenditure in young healthy individuals. Total 36 subjects were enrolled in the study according to inclusion criteria. 1 male participant discontinued the anaerobic exercise program hereby considered dropout therefore total 35 participants were in the study.

PCI was calculated by McGregor's equation. Pre and post vitals (WHR, RHR) were recorded and noted.

- Statistical analysis was done using SPSS version 16.0 and Microsoft Excel 2007.
- The distribution of data was evaluated using Shapiro –Wilk test.
- The data followed normal distribution so paired t-test was used for within group analysis and unpaired t test was used for between group analysis. The level of

RESULT

Table no.1 The number of participants and mean age of participants in both groups

| Group | No. of Subjects | Age (Years) MEAN±SD |
|-----------------|-----------------|---------------------|
| AEROBIC GROUP | 18 | 22.11±2.17 |
| ANAEROBIC GROUP | 17 | 22±1.84 |

Table no. 2 Gender distribution of participants in both groups

| Group | No. Of Male | No. Of Female | Total |
|-----------------|-------------|---------------|-------|
| AEROBIC GROUP | 9 (50%) | 9 (50%) | 18 |
| ANAEROBIC GROUP | 8 (47.05%) | 9 (52.94%) | 17 |

• WITHIN GROUP ANALYSIS:

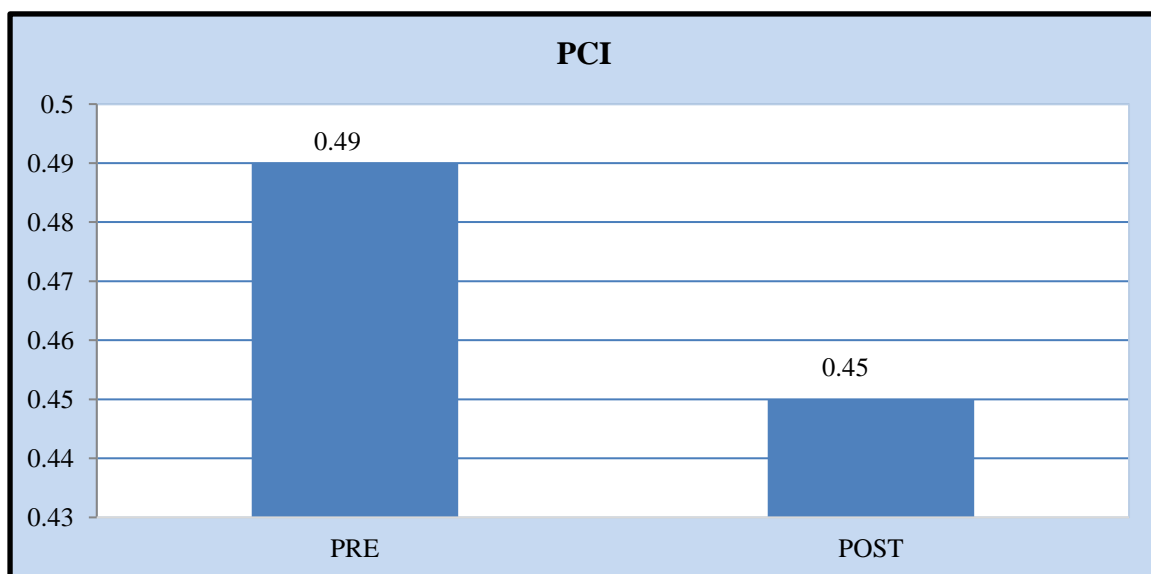
Aerobic group:

• PCI

To analyze the difference in the PCI after 4 weeks of intervention in Aerobic group, paired t-test was used. Analysis showed significant difference in PCI values within group (p<0.05).

Table no: 3 Aerobic group PCI pre-post difference

| Group | Pre intervention (Mean±SD) | Post intervention (Mean±SD) | t-value | p value |
|---------------|----------------------------|-----------------------------|---------|---------|
| Aerobic group | 0.49±0.09 | 0.45±0.09 | 14.51 | <0.05 |



GRAPH 1: Aerobic group PCI pre-post difference

Anaerobic group:

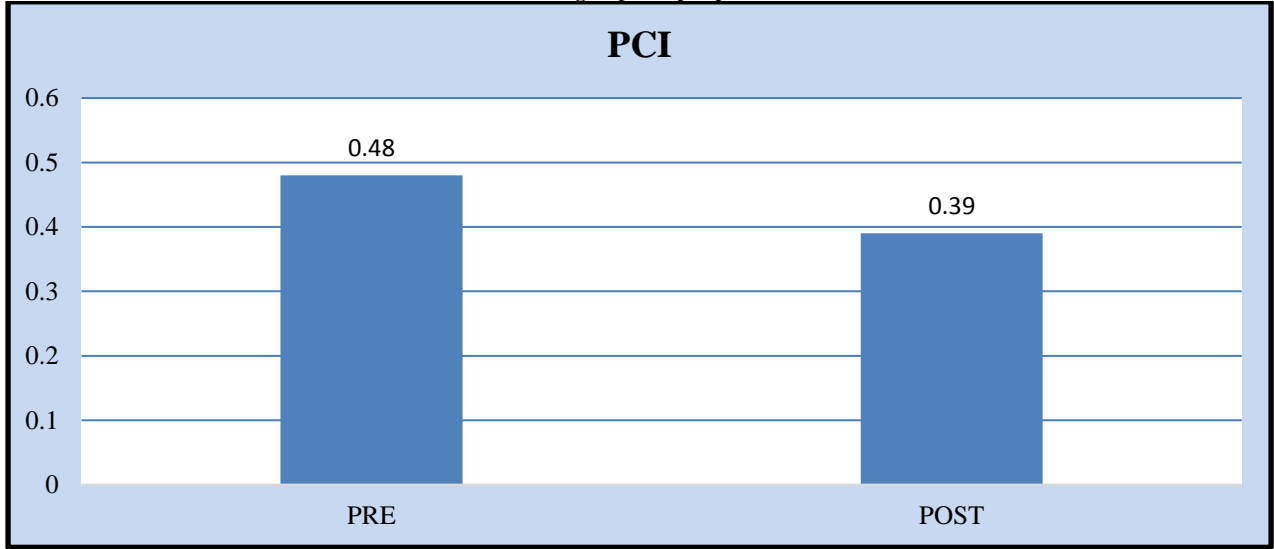
- PCI

To analyze the difference in the PCI after 4 weeks of intervention in Anaerobic group, paired test was used. Analysis showed significant difference in PCI values within group ($p < 0.05$).

Table no 4: Anaerobic group PCI pre-post difference

| Group | Pre intervention (Mean±SD) | Post intervention (Mean±SD) | t-value | p value |
|-----------------|----------------------------|-----------------------------|---------|---------|
| Anaerobic group | 0.48±0.089 | 0.39±0.08 | 19.46 | <0.05 |

GRAPH 2: Anaerobic group PCI pre-post difference



BETWEEN GROUP ANALYSIS

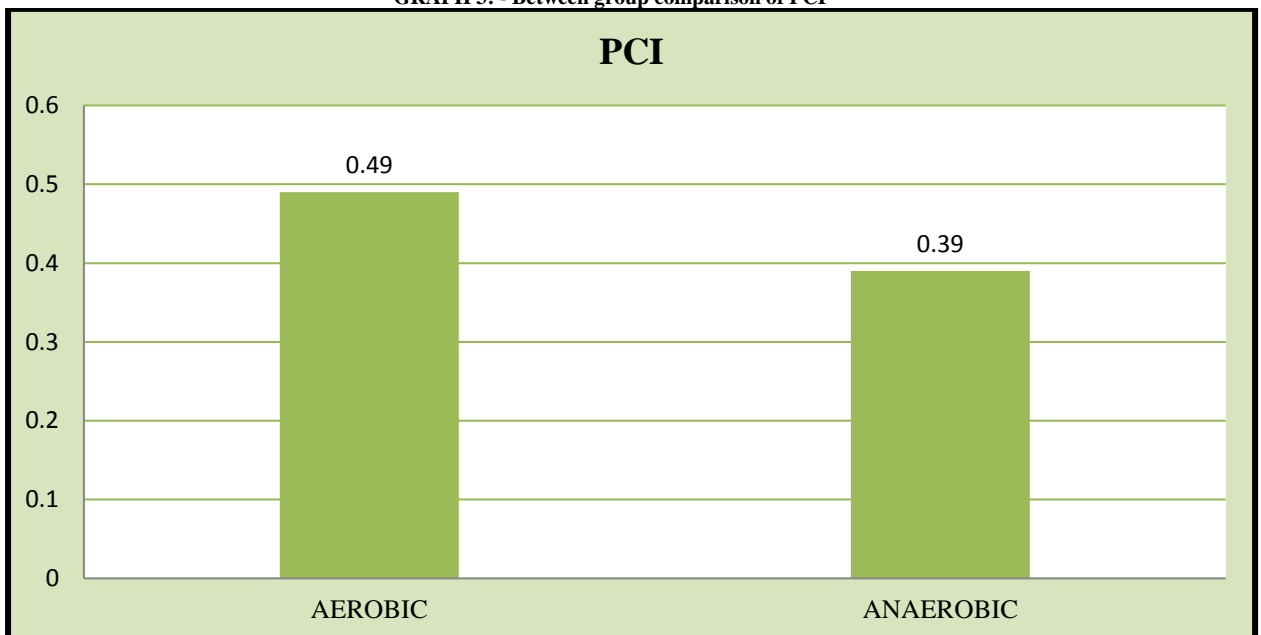
For between group analysis unpaired t-test was used.

PCI:

Table no: 5 Between group comparison of PCI

| Variable | Aerobic group (Mean±SD) | Anaerobic group (Mean±SD) | t-value | p value |
|----------|-------------------------|---------------------------|---------|---------|
| PCI | 0.49±0.09 | 0.39±0.08 | 2.19 | <0.05 |

GRAPH 3: - Between group comparison of PCI



DISCUSSION

The present study was conducted with the aim to find the effect of aerobic versus anaerobic exercise on energy expenditure in young healthy individuals. Results of the study showed statistically significant ($p < 0.05$) effect of aerobic exercise on PCI.

Also, the results of the study showed statistically significant ($p < 0.05$) effect of anaerobic exercise on PCI, So both the groups showed improvement on energy expenditure.

Further, on discussion about Anaerobic exercise group the subjects showed a higher improvement in PCI in comparison to the subjects who performed aerobic exercise. This is because of the adaptation to this anaerobic type of training. Lactate threshold is improved which means that after performing the regimen for 4 weeks the lactate concentration is lower for the same rate of work. More-over due to anaerobic exercise muscle fibre are hypertrophied which optimizes fibre recruitment to allow more efficient movement which requires minimal energy.

Anaerobic group post PCI values showed more improvement in the energy expenditure (PCI) because there is an increase in aerobic capacity due to anaerobic training. With the increase in the aerobic capacity endurance of the muscle increases as a result of enhanced aerobic metabolism thus increasing time to fatigue.

- This statement is supported by a study done by Hasan Sözen, Can Akyıldız (2018) which concludes that anaerobic training caused a high level of difference in terms of aerobic capacity values, and thus increased aerobic capacity¹⁰.
- Another study conducted by Kerimhan Kaynak, Selcen Korkmaz Eryilmaz et al concluded that sprint interval training

program can improve aerobic capacity of the volleyball players¹¹.

Anaerobic training improves the muscles capacity to tolerate acid that accumulates within them during anaerobic glycolysis. Buffering capacity is enhanced with anaerobic exercise due to which muscles can generate energy for longer periods and thus fatigue is delayed and energy is less expended⁹

- A study conducted by R.L Sharp, D.L Costill et al (1986) concluded that an enhanced buffer capacity the muscle could continue accumulating lactic acid to sustain the exercise for a longer duration¹².

CONCLUSION

From this study it is concluded that both aerobic and anaerobic exercises are effective in improving physiological cost index and decreasing the energy expenditure. But when both of these exercises are compared the anaerobic exercise has more significant improvement in physiological cost index.

Limitations: 1) Study was not carried out on large sample size.

2) People of different BMI (overweight and obese) were not taken.

Clinical implications: Aerobic and Anaerobic exercises have their own advantages. These exercises could be prescribed to any individual according to the need. Aerobic exercise can be prescribed to the normal, old aged as well diseased individuals. Anaerobic exercise generally being high intensity can be prescribed to the athletes or to individuals with specific target of fitness because it will improve their strength, efficiency of movement and results in less energy expenditure. Overall, a combination of both the exercises will show beneficial effect and can be added as exercise

regimen for healthy, athletic and diseased population.

Future recommendations: 1) Study could be conducted on larger sample size.

2) Long term effect of aerobic and anaerobic exercises can be studied.

3) Energy expenditure on different BMI and gender can be studied.

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Conflict of Interest: None

Source of Funding: None

Ethical Approval: Approved

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