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Energy Expenditure While Walking on a Flat and Inclined Surface

P. Rajesh[1], T. Mounika[2], Dr K. Madhavi MPT, Ph. D[3], Dr. N. Kavitha[4]

[1, 2]Internees College of Physiotherapy

[3, 4]M.P.T, PhD, College of Physiotherapy, SVIMS

Abstract: ***Energy expenditure refers to the amount of energy an individual uses to maintain essential body functions (respiration, circulation, digestion) and as a result of physicalactivity. Total daily energy expenditure is determined by resting or basal metabolic rate (BMR),food-induced thermogenesis, and energy expended as a result of physical activity. Aim: Energy Expenditure while walking on a Flat surface and inclined surface. Objective: 1) To evaluate VO2 Max of 10 subjects walking in flat surface. 2) To evaluate VO2 Max of 10 subjects walking in inclined surface. 3) To compare VO2 Max of subjects walking on both flat and inclined surface. Method: The study was conducted in COP SVIMS university 10 subjects who met the inclusion criteria were included those who are regularly exercised for the past 3 months, completed a discontinuous incremental exercise test on a treadmill, subjects performed 6-mins intervals walking at their own pace with rest between intervals, and measured their Heart Rate [HR] and calculate VO2 Max in both flat and inclined surface. Eligibility criteriaInclusion criteria 1) Age 20-25 years 2) Gender- only males. Results: VO_2 max is a measure of the maximum amount of oxygen that body can utilize during intense exercise typically measured during an exercise test. When walking on an inclined surface, VO2 max itself did not increase or decrease.***

Keywords: Heart Rate [HR], Energy Expenditure [EE], Physical Activity [PA], Resting Energy Expenditure [REE], Total Daily Energy Expenditure [TDEE]

1. Introduction

Human energy expenditure has been studied for over 100 years, many unanswered questions remainregarding the role that individual components of energy expenditure have in the ethology of obesity.The majority of methods used to measure physical activity, which is the most variable aspect of TDEE, are insufficient, and it is challenging to identify variations in energy metabolism through a static comparison. When energy expenditure is examined in obese and lean subjects at one point in time, there frequently are no differences in energy expenditure when appropriately normalized. However, when subjects are studied longitudinally or when the system is perturbed (such as overfeeding or exercising), differences can be observed. Using a combination of the techniques available today, eachcomponent can be reliably studied, and the role that each has in the development of obesity can be ascertained [2].

The ability to assess energy expenditure [EE] and estimate physical Activity [PA] in free-living individuals is extremely important in the global context of non-communicable diseases including malnutrition, over nutrition (Obesity) and diabetes. It is also important to appreciate that physical Activity and energy expenditure are different constructs with Physical Activity defined as any bodily movement that result in energy Expenditure best assessed using the criterion doubly labelled water (DLW) technique includes components in addition to physical activity Energy expenditure namely resting energy expenditure and the thermic Effect of food.[3]

Physical Activity is defined as any bodily movement that results in Energy Expenditure and accordingly energy is expanded as a result of Physical Activity. Physical Activity is a behavior that results in an elevation of Energy Expenditure above raising levels.

The total daily energy expenditure is typically broken down into three main components

1) **Basal Metabolic Rate [BMR]**: The energy that body requires at rest to maintain essential physiological functions, such as breathing, heart rate, and maintaining body temperature.
   BMR accounts for about 60-75% 0f TDEE
2) **Thermic Effect of Food [TEF]**: The energy required to digest, absorb, and metabolize food.This accounts for about 10% of TDEE
3) **Physical Activity [PA]:** This includes all movement, from exercise to daily life activities like walking, cleaning, or even fidgeting, Physical activity can vary widely and typically accounts for about 15-30% of TDEE The energy expenditure required to move the body is related directly to the body weight to the distance weight is moved, and to the state of physical fitness

The goal of this review is to provide information on the utility and Limitations of range of objective measures of PA and their relationships with EE (Energy Expenditure]

Measuring Energy Expenditure

Heart rate monitoring is used to estimate EE based on the assumption of a linear relationship between HR and oxygen consumption (VO2). Despite considerable inter- individual variability in the slope of the HR-VO2 relationship, the linear relationship is consistent for an individual across arange of sub- maximal tasks. Inter-individual differences are predominantly a reflection of differences in movement efficiency, age, and fitness.

Heartrate can be used to estimate oxygen consumption and Energy expenditure in free living conditions.

Methods to calculate VO2 max: [4]

Vo2 max is a measure of the maximum amount of oxygen that use during intense physical activity. This measurement is

the best indicator of aerobic endurance and cardiovascular fitness as it calculates how efficiently cells use oxygen for energy.VO2 max, or maximum oxygen uptake, is a measure of how much oxygen that body can consume and use to generate energy. A higher VO2 max means body can better handle aerobic activities like running and swimming (4).

Very well Fit formula

VO2 max is equal to 132.853 - (0.0769 x weight in pounds) - (0.3877 x age) + (6.315 if male or 0 if female) - (3.2649 x walking time) - (0.1565 x heart rate at the end of the test).

Wearables can also estimate VO2 max, but they don't usually account for environmental factors like temperature, humidity, and barometric

There are several methods that can use to measure **VO2max**, but many require equipment such astreadmill or a specially calibrated cycle.

Determine resting heart rate: [4]

Many fitness trackers and watches come with heart rate monitor these, records heart rate while atrest (sitting down, doing little-to-no physical activity). The best time to measure is resting. Heart rate is in the morning before get out of bed.

To determine heart rate without a monitor, place two fingers against the artery on the side of neck,just under jaw. One should be able to feel heartbeat on fingers.

Set a timer for 60 seconds and count, the number of beats, feel. This is resting heart rate in beats per minute (bpm).

Calculate maximum Heart rate [4]:
The most common way to calculate maximum heart rate is to subtract age from 220.Also estimate maximum heart rate with the formula.

HR max= 205.8 – (0.685 X Age)
Example: Age =25
: 220-25

HR max= 195
VO2max =15 X (HR max\HR rest)If **HR max** = 195 and HR min =80 **VO2 max** = 15 X (195\80)

Solve**: VO2 max = 15X 2.43**

=36.45Ml\kg\min.DATA ANALYSIS:

Descriptive statistics

Group	Age	Weight	BMI
Mean	22.36	64.5	22.4
Standard Deviation	1.36	9.8	2.95

Paired *t* test results of Flat Surface

P value and statistical significance:

The two-tailed **P value equals 0.0001** by conventional criteria, this difference is considered tobe extremely statistically significant.

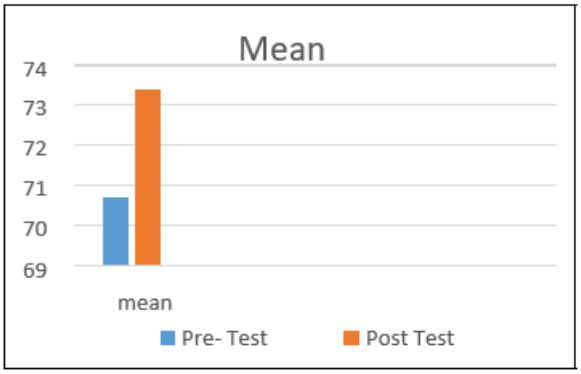
Confidence interval:

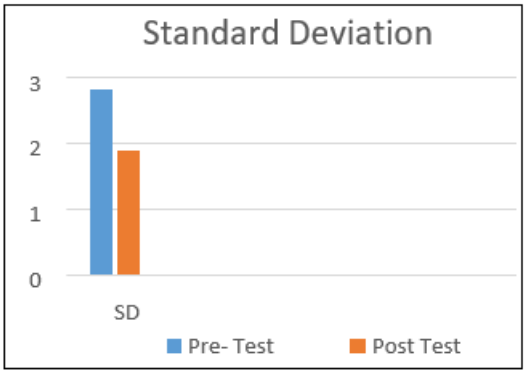
The mean of Pre-test VO2 Max minus Post-test VO2Max equals **-2.70**. 95%confidence interval of this difference: From **-3.66 to -1.74**.

Intermediate values used in calculations:

t = 6.3837 do
= 9
standard error of difference = 0.423

S.no	GROUP	Mean	SEM	SD
1	Pre-test VO2Max[flat surface]	70.70	0.90	2.83
2	Post-test VO2 Max[flat surface]	73.40	0.60	1.90





Paired *t* test results of Inclined Surface

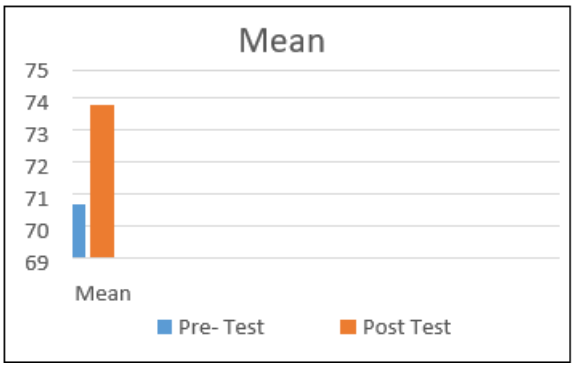
P value and statistical significance:

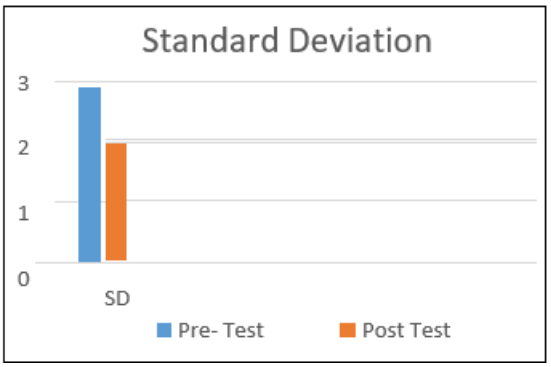
The two-tailed **P value is less than 0.0001** by conventional criteria, this difference isconsidered to be extremely statistically significant.

Confidence interval:
The mean of Pre Est VO2 Max minus Post-test **VO2 Max equals -3.10** 95%confidence interval of this difference: From **-4.14 to -2.06.**

Intermediate values used in calculations:
t = 6.7648 do
= 9
standard error of difference = 0.458

S.no	Group	Mean	SD	SEM
1	Pre Test VO2 Max [inclined surface]	70.7	2.83	0.9
2	Post Test VO2 Max [inclined surface]	73.8	1.99	0.63





Unpaired *t* test results of post VO2 Max

P value and statistical significance:

The two-tailed **P value equals 0.3434** by conventional criteria, this difference isconsidered to be not statistically significant.

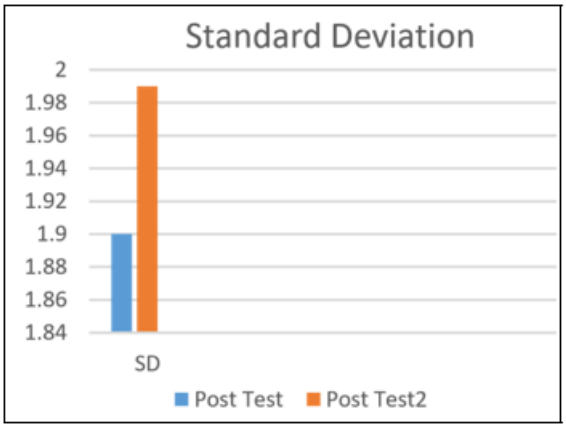
Confidence interval:

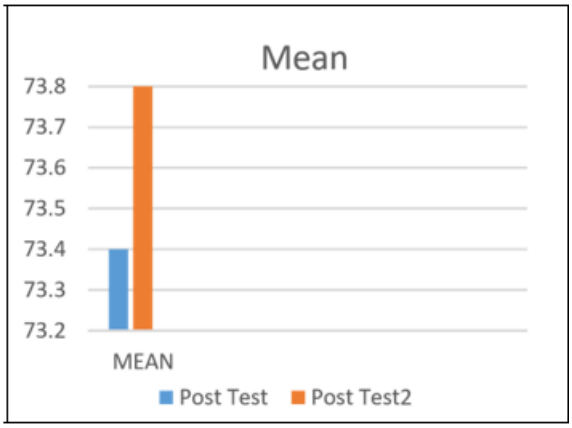
The mean of Post-test VO2 Max minus Post-test **VO2 Max equals -0.40**
95% confidence interval of this difference: From **-1.30 to 0.50**

Intermediate values used in calculations:

t = 1.0000 do
= 9
standard error of difference = 0.400

S. No	Group	Mean	SD	SEM
1	Post- Test VO2 Max (Flat Surface)	73.40	1.90	0.60
2	Post- Test VO2 Max (Inclined Surface)	73.80	1.99	0.63





2. Conclusion

This study focused on comparing the oxygen composition on walking in the flat surface and inclined surface. The oxygen consumption (VO_2) during the activity does increase when walk on an incline compared to walking on a flat surface. This is because body needs more oxygen to produce the energy required for the additional effort. So while the exercise intensity increases and one can use more oxygen (a higher percentage of VO2 max) actual VO2 max remains constant unless it's improved over time through consistent, intensive training.

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