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Rahul Vashist
Research Scholar, AUUP, Uttar Pradesh, India

Dr. Inder Singh Pal
Asst. Prof., AUUP, Uttar Pradesh, India

Correspondence
Dr. Inder Singh Pal
Asst. Prof., AUUP, Uttar Pradesh, India

Influence of height on cardiovascular efficiency computed using Harvard step test

Rahul Vashist, Dr. Inder Singh Pal

Abstract
The purpose of the study was to ascertain the influence of height on cardiovascular efficiency computed using Harvard step test. This study was conducted with amity students whose height was more than 6 feet & also those whose height was 5 feet 6 inches and less, were classified into two separate groups. 10 subjects from each group were taken. There after the resting heart rate (RHR) of all the subjects were recorded. To know the influence of height on cardiovascular The Harvard Step Test is designed. Means of both the tall height and short height groups, Standard deviation of both the tall height and short height groups and t-ratio was computed and the level of significant chosen was 0.05. It is clearly evident that the performance of the tall group is significantly better than the short group in cardio vascular efficiency index and 3 it can be inferred that the mean angles at knee in respect of the subjects belonging to the tall height group are higher than that of the short height group. The level of significant was fixed at 0.05. Therefore the height of the bench in Harvard Step Test should be according to the height of the subject.

Keywords: height, Harvard step test, angle, mean, t ratio

1. Introduction
The human body performs many movements related to every day activity and also of sports specific activity. But, it is important to perform all these activities in a very effective manner. The movement needs to be economical, which means adequate amount of energy expenditure should be made to perform the given task. In the field of biomechanics, we study how efficiently and economically the body is performing its activities and the specific cause behind these movements. In basic concept, we move our muscles and joints or carry our body to greater distance and lift our body higher; we say that we are doing work. If we want to measure the efficiency of the body, we need to reduce the energy expenditure and increase the work output. Then only we will be able to analyze the economic concept of movement.
In this present study the mechanics of the body is analyzed by taking cardiovascular efficiency as a criterion measure and Harvard Step Test as a tool to measure the physical efficiency index which will help us to analyze and understand the energy expenditure of the body. Through this interdisciplinary approach the scholar wants to analyze the body efficiency and its relation with the mechanical concepts.
It has been already suggested that a scientifically based and systematic program of training is fundamental to pursuit of high level of performance in sport. Of all sports, the endurance events of track and field and swimming are the best documented in these terms. Cardiovascular efficiency improves the efficiency of various organs and systems, this helps in maintenance of working capacity and against the influence of unfriendly environmental conditions, this also improves the ability to recover faster from the load, training brings about improvement in the functions of various organs and systems of the human body. Due to this the person improves the ability to recover quickly from training and competition loads. At same time endurance activities enable the sports men better resist the fatigue i.e. to delay the fatigue and this also helps the sports person to recover faster from fatigue which enables the sports men to tackle higher training volumes with high intensity in a training session, may be for weekly, monthly or yearly.

2. Methodology
The students of Amity school of physical education and sports sciences, whose height was more than 6 feet & also those whose height was 5 feet 6 inches and less, were classified into two separate groups. There after the resting heart rate (RHR) of all the subjects were recorded. From there two height groups, 10 subjects whose height was above 6 feet and 10 subjects whose height was 5 feet 6" and less were selected in a way that the range of the RHR between

the two groups was not more than 5 beats per minute. This procedure was adopted in order to ensure
That the physiological condition of the subjects in both the height groups was more or less identical. The following variables were chosen in the present study. Physical Efficiency Index (PEI), Angles at the hip, knee and ankle and Height of the subject. The Harvard Step Test is designed to give an indication of the overall fitness of one's cardiovascular system. This test measures your pulse recovery rate as a sign of your cardiovascular endurance. Each subject was filmed using Sony Cyber Shot (Digital camera 8.1 megapixels) from the sagittal plane, for the purpose of computation of selected variables. The angles at hip, knee and ankle were measurement using protractor.
The following statistical computations were made by the research scholar:

1. Means of both the tall height and short height groups
2. Standard deviation of both the tall height and short height groups
3. t-ratio was computed and the level of significant chosen was 0.05.

3. Results

Table 1: Significance of difference in the means of tall and short height groups in Physical Efficiency Index

Group	Mean	Mean difference	Standard deviation	Standard error	t-ratio
Tall group	86.04	5.43	4.69	2.24	2.17*
Short group	80.61		5.31		

*significant at 0.05 level $t_{0.05}$ (18) = 2.10

From the above table it is clearly evident that the performance of the tall group is significantly better than the short group in cardio vascular efficiency index. The t-value of 2.17 was higher than the table value of 2.10 with 18 degrees of freedom

Table 2: Hip, knee and ankle joint angles in case of tall height group

S. No.	Name	Hip	Knee	Ankle
1	Sachin Boora	85	75	98
2	Prashant Nayak	90	70	96
3	Ved	88	72	89
4	E S Narender	86	84	101
5	Farhan	91	86	84
6	Amit kr. Gupta	87	70	82
7	Rishabh Singh Sikarwar	86	74	84
8	Gurunandan	88	73	98
9	Abhishek Singh	81	75	93
10	Mukul Awana	84	82	81

Mean of hip angle- 86.6, Mean of knee angle -76.1 and Mean of ankle angle- 90.6

Table 3: Hip, knee and ankle joint angles in case of short height group

S. No.	Name	Hip	Knee	Ankle
1	Puneet Rajput	60	64	96
2	Arun Panghal	66	71	97
3	Abhishek Bysack	72	80	109
4	Kushank Rustagi	74	54	80
5	Vaibhav S Negi	66	68	95
6	Yatendra	79	60	86
7	Anshu Duhoon	78	72	96
8	Avideep Singh	78	74	98
9	Dikshay Kapur	81	75	89
10	Sujon Sapkota	79	65	89

Mean of hip angle- 73.3, Mean of knee angle- 68.3 and Mean of ankle angle- 93.5

From Tables 2 and 3 it can be inferred that the mean angles at knee in respect of the subjects belonging to the tall height group are higher than that of the short height group. Using the principles of angular kinematics it is clear that after stepping on the bench with one foot and thereafter assuming standing position on the bench with both feet the tall group moves less angular distance as compare to the short height group and therefore performs less work as compared to the short height group. Performing less work automatically consumes less kinetic energy from stepping on the stool with one foot to assuming standing position with both feet on the stool.

4. Discussion

The analysis of data reveals that the tall group has significantly better cardio vascular efficiency index as compared to the short group and that the angles at the hip knee and ankle when one foot is placed on the stool are less than the angles at the same joints in the case of tall group. When the subjects were divided in to tall and short height groups, the two factors were kept in mind Height and Heart rate. Height of the subjects in the tall group were 6 feet and more and those in the short group was 5 feet 6 inches and below. In order to ensure that the physiological condition of both the group was identical, the heart rate of subject belonging to both the groups was also taken as a criterion. The average heart rate of the tall group was 70.5 beat per minute and that of the short group was 69.9 beat per minute. From the pulse rate figures it is clear that the physiological condition of the subjects belonging to the short height group was slightly better than the subjects belonging to the tall height group one

hand it is seen that the physical condition of the tall group as seen from heart rate is slightly inferior yet they have attained a significance better physical efficiency index score as compared to the short height group whose physiological condition as seen from the heart rate is superior to that of the tall group. In the light of the above it can be categorically mentioned that height of the stool should be in commensuration with the height of the subject. Within the delimitations of the present study the following conclusions may be drawn: The tall group whose physiological condition was slightly inferior to that of the short height group recorded significantly higher PEI score as compared to the short height group whose physiological condition was slightly superior.

The angles at the hip, knee and ankle in the case of tall group were higher than that of the short group due to which the subject belonging to the tall group performed less work when they moved from one step position on the stool to the standing position.

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