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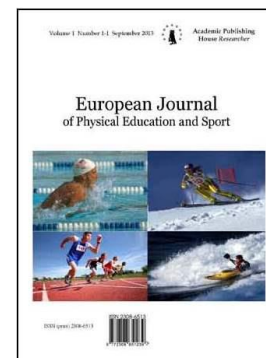
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## Effect of Exercise Machines on Sweat Loss during Exercise

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### Abstract

This study was undertaken to investigate the effect of different cardio machine exercise on the sweat loss. Twelve subjects (6 male and 6 female) in the age range 20 to 35 years were taken as subjects in the study. Subjects were asked to exercise for 30 minutes on each machine while maintaining the exercise intensity in between 65 % to 75 % of maximum heart rate. On each machine before and after exercise, weight of the subjects was measured in kg. During exercise the temperature and humidity of the room were maintained at 26° C and 54.3 % respectively. The data so obtained in the study was analyzed using the randomized block design where gender was the between factor and machine was the within factor. The analysis showed that the effect of exercise machine on sweat loss was significant whereas the effect of gender and interaction (gender × machine) was not significant. Significant sweat loss occurred on treadmill in comparison to bicycle ergometer and stepper. No difference was observed in the amount of sweat loss on bicycle ergometer and stepper. On the basis of the study it is concluded that the reduction of weight due to the sweat loss should not be seen as a reflection of amount of fat reduced from the body during exercise. The study suggested that the cycling and stepper should be preferred over treadmill running as the weight loss due to sweat production was significantly lower than the treadmill.

**Keywords:** treadmill, bicycle ergometer, stepper, mixed design.

### 1. Introduction

Any weight loss or a weight management programme in the fitness centres includes moderate to high volume of endurance workouts in treadmill running, cycling, staircase etc. These workouts lead to burning of fats and breaking down of hydrocarbons into water and carbohydrates along with heat. This heat further enhances the core body temperature which in turns enhance the peripheral body temperature and is finally decimated into the environment through evaporation (sweating) and radiation. Thus, the sweating is a via-medium of heat regulatory system of the body and its magnitude is not much related with the magnitude of reduction of body fat.

The review of literature clearly indicates that the rate of dehydration has a negative impact on the performance and intake of water during exercise has been preferred over pre-exercise intake for avoiding deteriorating performance (Murray, 2007). The effect has been specially found on the cardiovascular efficiency. Further the Vo<sub>2</sub> max and the Exercise intensity has found to be significantly related to sweating. The literature also suggests a gender based effect on sweating (Greenhaff, Clough, 1989).

The literature review indicates a large number of study on the sweat loss and its effect on

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performance of an individual (Murray, 2007) along with different hydration modes and timings on sweat loss and performance. However, the effect of different exercising machines on sweat rate was hard to find. Thus the present study aimed at studying the effect of different cardiovascular training machines on the sweat rate.

**2. Materials and Methods**

**Participants**

Twelve healthy subjects (6 male and 6 female) in the age group 20 to 35 years were randomly selected from the fitness centre.

**Measures**

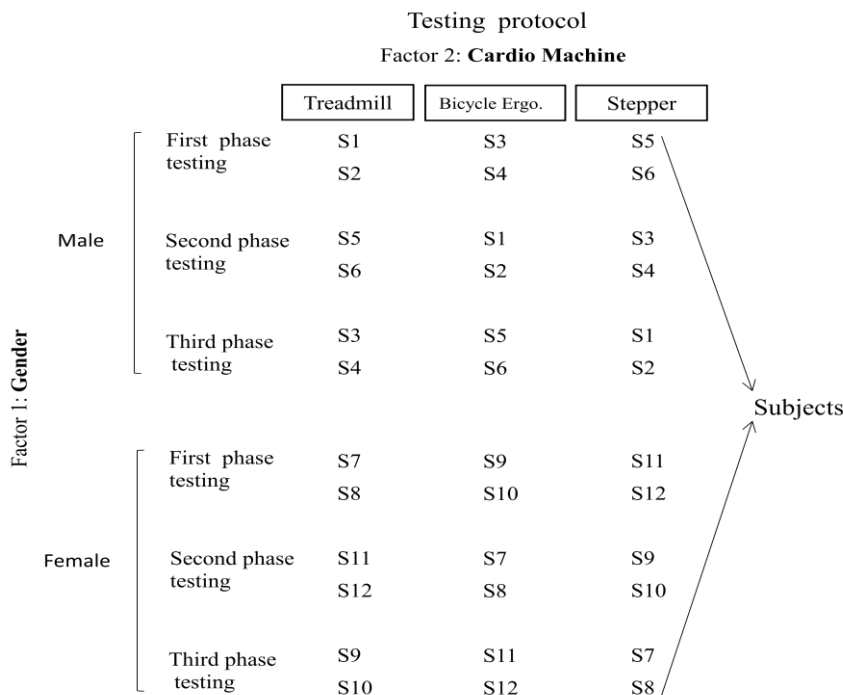
Sweat loss of the subjects were measured in gram by measuring the weight of the subjects before and after the cardio exercise on different machines.

**Procedure**

The subjects were requested to avoid any alcoholic product from 24 hours prior to the data collection to the completion phase. They were also requested to avoid any stimulant one hour prior to the exercise. With prior consent, the subjects were asked to exercise for 30 minutes on three different machines (Treadmill, Bicycle ergometer and Stepper) on different days as per the protocol of the study. The cardio intensity was kept in between 65 % to 75 % of the maximum heart rate. Sufficient time gap was kept between the two testing. The temperature and the humidity of the training hall were maintained at 26° C and 54.3 % respectively. Sufficient time period was given for recovering into normal condition. The pre and post weight of the subjects was recorded in kg with same minimal clothing.

**Statistical Analysis**

A randomised Block Design (RBD) was used with repeated measures in which gender was used as a blocking factor and Cardio Machine as within subject factor to study the sweat loss. In this study, gender was between-subjects factor whereas cardio machine was within-subjects. In order to remove the order effect counterbalancing was done in the design. Subjects in male and female categories were divided into three groups. As per the protocol in the first phase of testing the male subjects S1 and S2 were tested on treadmill, the subjects S3 and S4 were tested on bicycle ergometer whereas the subjects S5 and S6 were tested on the stepper. Similarly, the testing protocol for the subjects during second and third phase of testing was followed as shown in Figure 1. Similar protocol was followed for female subjects.



**Fig. 1.** Layout of Repeated measures design organized with randomized block

### 3. Results

Assumptions for the repeated measures design used in this study were tested before analyzing the results of the study. The assumption of normality was tested by using the Shapiro-Wilk test. The Shapiro statistic was not significant in any of the group hence assumption of normality was not violated.

Homogeneity of variance was tested by using the Levene's test. This test was not significant for all the between subject group hence the assumption of homogeneity of variance was not violated. Box's M test was used for testing the equality of variance covariance matrix in male and female groups. Since this statistic was not significant hence this assumption was also not violated.

The assumption of Sphericity was not violated as the Mauchly's W test statistic in Table 1 is not significant ( $p > 0.05$ ). Hence no correction was made in the degrees of freedom of different sums of squares.

**Table 1.** Mauchly's test for assumption of sphericity

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Machine	Sphericity Assumed 0.845	0.174	2	0.087	54.617	0.000
Machine * Gender	Sphericity Assumed 3.017	0.072	0.232	0.010	2	0.005
Error(Machine)	Sphericity Assumed			0.032	20	0.002

**Table 2** F-table for testing significance of within subject effect of machine

Mauchly's W	Approx. Lower	df Chi-Square	Sig.	<i>Epsilon</i> Greenhouse Geisser	Huynh-Feldt bound
Machine	0.951	0.451	2	0.798	0.953 1 0.5

Table 2 shows that the effect of Machine is significant ( $p < .001$ ) whereas interaction effect is not significant ( $p > 0.05$ ) hence only the main effect of within subject (Machine) was investigated further. Since partial eta square was 0.845 hence meaningful difference existed among the effect of different machines on sweat loss. Since Gender effect in Table 3 is not significant hence it may be concluded that the Gender is not an extraneous factor in the experiment.

**Table 3.** Tests of between-subjects effects

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept		3.993	1	3.993	2906.593	.000
Gender	.003	1	.003	2.202	.169	.180
Error	.014	10	.001			

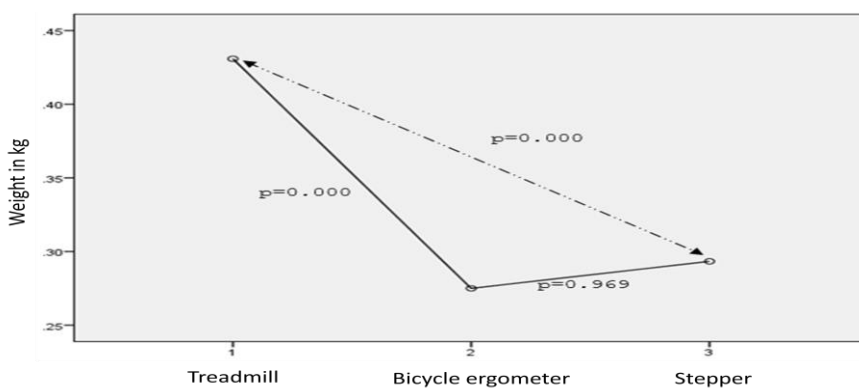
The effect of Machine on sweat loss was further investigated by using the pair wise comparison of means. Such comparisons have been shown in Table 4. The means plot is shown in Figure 2.

**Table 4.** Pair wise comparison of marginal means for the data on weight loss

(I) Machine	Mean (J) Machine	Std. (I-J)	Sig. Difference	95% Confidence Error	95% Confidence Interval for
Interval for				Difference Lower Bound	Difference Upper Bound
Treadmill	Bicy Ergo.	.156*	0.015	0.000*	0.114
.197*	Stepper	.138*	0.017	0.000*	0.09 .185*
Treadmill	Stepper	-0.018	0.018	0.969	-0.069
Bicy Ergo.					
0.03					

\*Significant at 0.05 level of significance

Means plot in Figure 2 shows that the weight loss is maximum during exercise on treadmill in comparison to that of bicycle ergometer and stepper. However, there was no difference in the sweat loss observed during exercise on bicycle ergometer and stepper.



**Fig. 2.** Means plot of sweat loss on three cardio machines (male and female combined)

The findings pertaining to the study clearly revealed that the sweat loss during exercise on treadmill was significantly higher than that of stepper and bicycle ergometer. However, sweat loss during cycling and stepper did not differ significantly. As the workload was kept constant on all the machines the less sweat rate propagates the usage of these machines i.e. stepper and bicycle ergometer for the cardio programme. The earlier study clearly indicates the negative impact of

dehydration on performance and unsafe weight management can compromise other performances and negatively affect health (Turocy et al., 2011). Further the production of sweat is controlled by the body's thermo-regulatory mechanism and trained personnel have shown more sweat production than the untrained person as aerobic training results in enhanced heat dissipation by lowering the core temperature threshold for skin vasodilation and sweating (Ricardo, 2012). Evidence could not be traced out for the relation between sweat loss and fat burning. Some of the earlier studies have shown a high sweat production among males but many of recent studies have rejected this absolute phenomenon and established the effect of fitness and training level as the main causal factor (Mehnert et al., 2002). Further the rate of sweat production has also been attributed to body surface area, height and weight of the subjects (Pandolf et al., 1986). The present study considered gender as a blocking variable but the effect of block was found to be insignificant. Since the subjects consisted of sedentary population and were under the practise of trainers for a subsequent duration, the fitness level of the subjects could be held responsible for this.

#### 4. Conclusion

The present study lead to the conclusion that the reduction of weight due to sweat loss should not be seen as a reflection of amount of fat reduced from the body during exercise. Foreseeing the negative effect of dehydration on other performance the weight management programme should be carefully designed. As of the findings of the present study the cycling and stepper should be preferred over treadmill running as the weight loss due to sweat production was significantly lower than the treadmill.

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