

## A Study Of Correlation Between Exercise, Body Mass Index And Heart Rate

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**Abstract: Objective:** To study correlation between exercise, body mass index (BMI) and heart rate.

**Material and Method:** A total of 57 individuals of age group 19 to 39 were selected for the study. Out of these, 45 individuals went to gymnasium for exercise, while the other 12 did not go to gymnasium. An informed consent was taken, a questionnaire was administered to the participants and required measurements were made. **Results:** There was a significant effect of exercise on BMI and weight. ( $p$  value is significant by paired  $t$  test for both weight and BMI before and after exercise). There was statistically significant reduction in BMI of females as compared to males. Correlation between reduction in BMI and exercise duration of 45 to 60 minutes per day was significant. There was no correlation found between exercise done for more than 60 minutes and BMI reduction. No significant correlation was found between duration (months and years) and how many days a week exercise done with BMI. Statistically significant correlation was also noted between total duration of exercise (number of months) and heart rate. **Conclusion:** Exercise helps in bringing BMI towards normal as regular exercise helps to increase BMI in underweight persons and to decrease BMI in overweight individuals. Up to 45 minutes to 1 hour exercise for longer duration is beneficial for weight and cardiovascular benefit.

**Key Words:** Body mass index (BMI), exercise, gymnasium, heart rate.

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**Introduction:** There is an increase in prevalence of obesity worldwide<sup>1</sup>. Obesity also means an increase in body mass index (BMI). This increase in body weight and BMI can lead to many complications. These may be metabolic complications like diabetes mellitus or cardiovascular complications like hypercholesterolemia or hypertension<sup>2</sup>. Obesity has been directly linked or indirectly linked to increased morbidity and mortality. Obesity can be controlled or prevented by avoiding weight gain. Increase in weight can be either due to increased calorie consumption or decrease in the expenditure of the consumed calories. This imbalance is more prevalent in persons having a sedentary life style particularly those living in the city areas<sup>3</sup>. One of the suggested methods to control body weight is regular physical activity or exercise<sup>4,5</sup>. Decrease in body weight is also associated with improved insulin sensitivity in diabetics and lowering of blood pressure in hypertensives<sup>6</sup>. Regular physical activity is an important part of a healthy lifestyle. Daily physical activity is one of the suggested methods to control lifestyle diseases. It is also associated with decreased risk of heart disease, obesity, cancer and related to psychological well-being with lower levels of stress and better cognitive functioning<sup>7,8,9</sup>. WHO has recommended classifications of body weight that include degrees of underweight and gradations of excess weight or overweight that are associated with

increased risk of some non-communicable diseases<sup>10,11</sup>. These classifications are based on body-mass index (BMI)<sup>12,13</sup>.

Numerous studies have suggested that higher levels of physical activity are associated cross-sectionally with lower body weight (usually body mass index; BMI) or body fat, and more favourable patterns of body fat distribution. However, the relationships between physical activity and weight are not straightforward<sup>14,15,16</sup>. Correlations of physical activity with BMI or body fat that have been reported in population studies are typically low. There are some contradictory findings, either showing no strong relationships between these factors, or associations only in subsets of the samples. Inconsistent findings of studies examining relationships between physical activity and BMI or body fat may be partly attributable to the types of measures used to both these parameters. Another factor possibly contributing to the inconsistent pattern of associations found between physical activity and BMI is the type of physical activity that has been assessed. In view of the above reasons following study was undertaken to determine a correlation between exercise, body mass index and heart rate.

**Objective:** To study the correlation between exercise, body mass index (BMI) and heart rate.

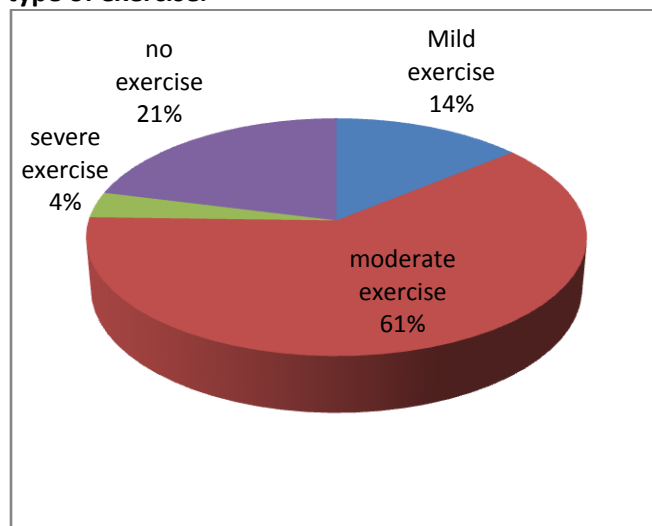
**Material and Methods :** It was a cross-sectional study. A total of 57 subjects were included in the study. Collected data was recorded in a case record form. The case record form contained the details about the subject's name, contact details, age, gender, body weight, past and personal history. Details of exercise were recorded i.e. total duration of exercise, type of exercise, number of hours of exercise per day as well as number of days of exercise per week. Heart rate of all the enrolled patients was also recorded for full minute in sitting posture. Persons not willing to participate and/or not giving consent were excluded from the study. Data was analyzed using appropriate statistical tests. Weight, BMI and heart rate comparisons within and between groups was done using Mann-Whitney U test and student's t test, while correlation was made using Spearman's non-parametric correlation test. Heart rate recorded was resting heart rate before starting any exercise.

**Results :** A total of 57 subjects were enrolled in the study. Out of 57 subjects, 45 subjects were exercising in gymnasium while 12 did not attend gymnasium. Mean age of the study population was 27.17 years (range 19-39). Out of 57 subjects, 26 were males and 31 were females. Out of 26 males, 22 attended gymnasium while out of 31 females 23 performed exercise. Out of 45 subjects attending gymnasium, 8 subjects performed mild exercise, 35 moderate and 2 subjects performed strenuous exercise (figure 1). Out of 45 who attended gymnasium, 34 reported of having exercising regularly, while 11 were irregular.

**Weight:** Mean weight of the study population was  $72.74 \pm 16.9$  kg. However, mean weight of the 45 subjects attending gymnasium before starting exercise at gymnasium was  $75.47 \pm 16.83$  kg and after exercise was  $71.69 \pm 13.75$  kg. Out of 45 subjects attending gymnasium, a decrease in weight was seen in 34 individuals, an increase was seen in 7 individuals and no change was reported by 4. Mean difference in weight before and after exercise was 6.33 kg, which was statistically significant ( $p < 0.05$ ). Those not attending gymnasium were asked about changes in their body weight in preceding months. No significant change in body weight was reported

by them. Average duration of exercise per day was  $88.29 \pm 37.75$  minutes. Average time since starting exercise was  $24 \pm 30.93$  months, while average days of exercise per week was 5. The details of exercise are shown in table 1.

**Figure 1. Distribution of subjects according to type of exercise.**



The reduction in weight of exercising women was statistically significant ( $p < 0.0001$ ), difference of means being 7.14. However, reduction in mean weight in males was not significant ( $p = 0.58$ ). There was a direct correlation between number of minutes of exercise and mean difference in weight ( $p < 0.0001$ ), while no correlation was seen between total duration of exercise, number of days of exercise and mean difference in weight. But on a closer scrutiny, this correlation was statistically significant for those who exercise for 60 minutes or less per day but not in those who exercised for more than 60 minutes.

Mean body mass index (BMI) of the enrolled subjects was  $26.9 \pm 6.9$   $\text{kg/m}^2$ . Mean BMI of the exercising group before starting exercise was  $27.42 \pm 5.8$   $\text{kg/m}^2$  and after exercise was  $26.48 \pm 6.1$   $\text{kg/m}^2$ . The reduction in BMI is statistically significant ( $p = 0.01$ ). As mentioned above increase in BMI was seen in 7 patients while, a decrease was reported by 34 patients. Mean increase in BMI was  $1.70 \pm 1.10$   $\text{kg/m}^2$  while mean decrease in BMI was  $2.60 \pm 2.61$   $\text{kg/m}^2$ . Overall mean difference in BMI was  $2.46$   $\text{kg/m}^2$ .

**Table 1. Exercise details of enrolled patients.**

Parameter	Observation made
Total no. of enrolled subjects	57 Exercising: 45
Type of exercise (n=45)	Mild: 8 Moderate: 35 Severe: 2
Average duration of exercise (minutes/day) (n=45)	88.29 ± 37.75 (range 30-180) < 1 hour: 15 1-2 hours: 25 >2 hours: 5
Average duration since starting exercise (months) (n=45)	24 ± 30.93 (range 0.3-150) <6 months: 17 6-24 months: 19 >24 months: 9
Average no. of days/week (n=45)	5.14

As noted in the case of weight loss, there was a direct correlation between number of minutes of exercise and mean difference in BMI ( $p < 0.0001$ ), while no correlation was seen between total duration of exercise, number of days of exercise and mean difference in BMI. On a closer scrutiny, this correlation was statistically significant for those who exercise for 60 minutes or less per day but not in those who exercised for more than 60 minutes. This means that there was statistically significant correlation between those who exercised for 60 minutes or less and mean difference in BMI i.e. the more one exercises up to 60 minutes the higher the decrease in BMI. The details of the body mass index are shown in table 2.

Heart rate: Heart rate was recorded in all subjects. Mean heart rate of all the subjects was  $82.29 \pm 11.57$  beats / minute. Mean heart rate in people exercising was  $81.78 \pm 11.79$  beats / minute, while in those not exercising was  $84.33 \pm 10.98$  beats / minute. The difference in heart rate between the two groups was not statistically significant (Mann-Whitney U test).

Parameter	Observation made
Mean BMI ( $\text{kg}/\text{m}^2$ ) (n=57)	$26.9 \pm 6.9$
Mean BMI (exercising group)	Before: $27.42 \pm 5.8$ After: $26.48 \pm 6.1^*$

(n=45)	
Mean difference in BMI ( $\text{kg}/\text{m}^2$ ) (n=45)	Overall: 2.46 Increase: 1.70 Decrease: 2.60

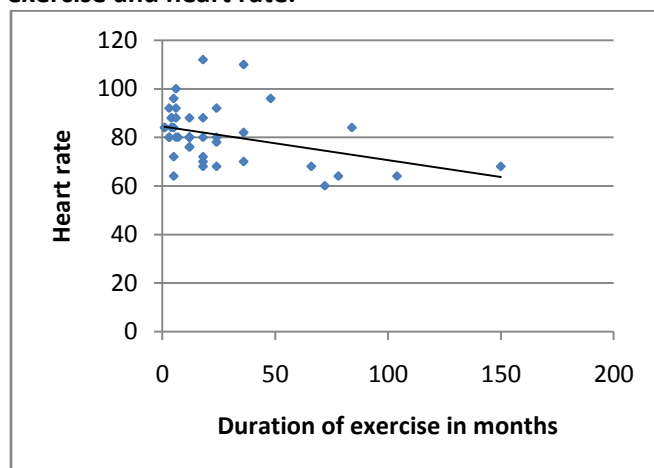
\* $p < 0.01$ , the reduction in BMI is statistically significant (paired t test).

Correlation between heart rate and body weight  
A comparison was made between heart rate and body weight. Correlation coefficient was 0.017, 95% confidence interval was -0.24 to 0.27. The correlation was not statistically significant ( $p = 0.89$ ). Correlation between heart rate and body mass index

A comparison was made between heart rate and body mass index (BMI). Correlation coefficient was 0.21, 95% confidence interval was -0.05 to 0.44. The correlation was not statistically significant ( $p = 0.11$ ). Correlation between duration of exercise and heart rate

A comparison between duration of exercise and heart rate was made. Correlation between average number of days of exercise per week and heart rate was not significant (0.29). But, correlation between number of months since starting exercise and heart rate was statistically significant ( $p = 0.012$ ) (figure 2). Correlation number of minutes of exercise per day and heart rate was not found to be significant ( $p = 0.28$ ). However, on considering only those subjects who exercised for less 60 minutes (15 subjects), this correlation was highly significant ( $p < 0.05$ ).

**Figure 2. Correlation between duration of exercise and heart rate.**



**Discussion:** A total of 57 subjects were enrolled in the study consisting of 31 females and 26 males. Out of 57, 45 subjects performed exercise (23 females, 22 males). A reduction in mean weight and body mass index was seen in those attending gymnasium, while no significant change in body weight was reported by those not attending gymnasium. There was an overall reduction in mean weight in those attending gymnasium. On a closer inspection, it was noted that this reduction in mean weight was statistically significant in females, but not in males. Statistically significant reduction was also noted BMI of those attending gymnasium. There was no correlation between heart rate and body weight as well as heart rate and BMI. Statistically significant correlation was seen between mean difference in weight and duration (number of minutes) of exercise per day (<60 minutes/day). Similarly, correlation between heart rate and number of months since exercise started was statistically significant while there was no correlation between number of days of exercise per week and heart rate. Correlation was seen between number of minutes of exercise per day and heart rate (<60 minutes/day).

In our study, mean reduction in body weight was 3.78 kg (5%) in those attending gymnasium. Observed mean reduction may be less, as some subjects who were of poor body build, reported a gain in weight (7 subjects) because they were involved in body mass building exercises. Taking mean difference (6.33 kg) into account, a difference of about 8.5% was noted. Similar weight loss has been reported by a study in Mexico<sup>17</sup>. The mean weight loss was statistically significant in females but not in males. Gender difference in weight loss is a common observation in weight loss programmes, and motivational and biological factors have been suggested as explanations<sup>18</sup>.

An inverse correlation was seen between heart rate and total duration of exercise, which may mean that longer the total duration of exercise, lesser the heart rate. This reflects cumulative benefits of exercise on cardiovascular fitness. An inverse correlation was also seen in those who exercised for up to 60 minutes per day and heart rate but not in those who exercised for more

than 60 minutes. A potential implication of the following observation is that maximum impact of exercise on heart rate is seen till 60 minutes. Beyond this limit, the decrease in heart rate is not straight forward. This may mean that beyond 60 minutes the heart rate may not decrease in proportion to the exercise duration per day.

A potential limitation to this study is that physical activity and weight loss were assessed using self-reported measures. They were assessed by questionnaires and not objectively measured. Since previous research has found that individuals tend to overestimate physical activity levels<sup>19</sup>, future studies should be conducted using objective measures of physical activity to confirm the findings from this study. Small sample size is also one of the limitations. Our study was a cross-sectional study. To confirm a causal relation between exercise, weight loss and heart rate, prospective studies have to be performed on larger scale. A longitudinal study is better suited for such an analysis<sup>19</sup>.

**Conclusion:** A significant effect of exercise is seen on BMI and weight loss. There is a significant effect of exercise on BMI in females as compared to males. Correlation between BMI change and exercise duration of 45 to 60 minutes per day is significant. No significant correlation was found between total exercise duration (months and years) and number of days a week of exercise with BMI. For that a study needed to be conducted on a larger scale for detailed evaluation. Heart rate has a significant correlation with total exercise duration (months) and number of minutes of exercise per day (<60 minutes/day). This work can prove to be a baseline work for further studies on exercise, BMI and heart rate.

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**Disclosure:** No conflicts of interest, financial or otherwise are declared by the authors.