ORIGINAL ARTICLE

Effect of BMI on maximum oxygen uptake of high risk individuals in a population of eastern Uttar Pradesh

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Abstract

Background: Maximum oxygen uptake (VO_2max) is an important determinant of physical fitness of an individual that reflects the endurance capacity during aerobic physical activities. It has been established as a reliable parameter to assess fitness level of both athletes and non-athletes. However, the effect of body mass index (BMI) on maximum oxygen uptake during a short-term aerobic exercise is relatively underexplored. Herein, we report the effect of BMI on respiratory fitness by measuring maximum oxygen uptake after a short-term aerobic exercise for normal and high risk (overweight and obese) individuals and suggest a correlation between them. **Materials and methods:** Thirty individuals of age within the range of 20-40 years were first medically examined to be certain that they did not have any cardiorespiratory complications and their BMI was calculated. Based on their BMI, they were classified into three—normal, overweight and obese groups and subjected to a treadmill exercise as per Bruce Protocol. Recorded data were analyzed and student t-test was performed to test significance of the data. **Result:** This study establishes a correlation between maximum oxygen uptake and BMI of individuals that suggests that with increased BMI, VO_2max decreases resulting into a decrease in respiratory fitness level. This trend was found to be consistent among all normal, overweight and obese group individuals. **Conclusion:** We report the effect of an aerobic exercise on the maximum oxygen uptake of normal and high risk individuals who were not subjected to a long term respiratory endurance exercise; instead we report the finding of correlation between BMI and VO_2max immediately after a short-term aerobic exercise.

Key Words

Maximum oxygen uptake; respiratory fitness; aerobic exercise; BMI.

Introduction

Obesity has been one of the major health concerns over the past decades. It is a well-known risk factor for several health conditions including diabetes, arthritis, and cardiorespiratory complications (1). Over a span of several decades in the past, considerable advances have been made in this field but a large number of issues still remain unaddressed. There are numerous studies on obesity and its correlation with several physical health parameters and medical hazards of obesity which show that the risks due to obesity include insulin resistance, diabetes mellitus, and associated with many other diseases as well (2,3). Although BMI does not give a measure of percentage of fat present in body, but it provides a an indicator of body fitness and is used to screen for weight categories that may lead to health problems and thus the BMI has been used as a reliable parameter for physical fitness and health (4,5). Correlation of BMI with physical fitness and aerobic performance has been very well studied but mostly all these studies were related to respiratory endurance where the participants were subjected to aerobic exercises consistently over a long period of time.

Aims & Objectives

To study immediate effect of aerobic exercise on the respiratory fitness of normal as well as high risk individuals and establish a correlation between VO_2max and BMI.

Material and Methods

VO_2max, also known as maximal oxygen consumption, maximal oxygen uptake, peak oxygen uptake or maximal aerobic capacity, is the maximum capacity of an individual's body to transport and use oxygen during incremental exercise, which reflects the physical fitness of the individual. VO_2max is widely accepted as the single best measure of cardiovascular fitness and maximal aerobic power (6).

Present study has been conducted on apparently healthy volunteers, 9-10 in each group, preferably groups being constituted by subjects of age between 20-40 years. First, on the basis of their height and weight, BMI of each volunteer individual was calculated as follows: BMI = (Weight in kg)/(Height in meter)^2. Based on their BMI, subjects were divided into three groups specified as follows:(i) Normal: BMI in the range of 18.5 kg/m^2 -24.9 kg/m^2; (ii) Overweight : BMI in the range of 25 kg/m^2 - 29.9 kg/m^2 and (iii) Obese: BMI greater than 30 kg/m^2. Here, based on BMI, the overweight and obese individuals were considered as high risk individuals. We define high risk individuals as those who are prone to develop cardiorespiratory complications because of high BMI. Subjects reported at lab around 11 am after a light breakfast. They were allowed to rest for 5 min in sitting posture before the commencement of the exercise trial. Resting pulse rate was recorded manually to rule out any abnormalities before being subjected to the exercise.

Systolic and diastolic blood pressures were recorded by using mercury type sphygmomanometer before and after the exercise. Immediately after recording the heart rate and blood pressure, 12 lead ECG was done. Subjects performed exercise testing on a treadmill. Bruce Protocol was followed for the treadmill exercise in this study. According to Bruce Protocol, the elevation and speed of treadmill are increased at the interval of every three minutes.

Results

Physical parameters such as height, weight, age and recorded VO_2max for normal individuals are detailed in Table 1. The corresponding plot of VO_2max against BMI (Figure 1) shows that the maximum oxygen uptake decreases with increase in BMI of normal individuals. However, it can be seen that the difference in recorded VO_2max is not significantly high because most of the subjects in this study were of comparable BMI values and the BMI values in the group were not uniformly distributed. In this case average VO_2max of normal group individuals was found as (2071.4±317.49) ml/min. similarly, the VO_2max values of high risk individuals (overweight and obese groups) were recorded and analyzed. The recorded parameters of normal, overweight and obese groups are presented in Table 1, Table 2 and Table 3 respectively.

It shows that, similar to normal group individuals, for the high risk individuals VO_2max decreases with increase in BMI. Here, average VO_2max of overweight group individuals was found as (1727.3±326.18) ml/min, which is lower than that of normal group individuals. When VO_2max values of obese individuals were statistically analyzed, it was found that within the obese group, in general, VO_2max decreases as BMI increases. The average VO2max value for obese group was (1427.30 ± 286.11) ml/min which is lower than the VO_2max of both overweight and obese group individuals. It can be seen that the average value of VO_2max decreases across the groups.

In order to investigate significance of these findings we used Student t-test and calculated p-values. When intergroup comparison of VO_2max was done, change in VO2max from normal to overweight BMI was found to be statistically significant (p-value<0.05). If we compare overweight to obese BMI groups, change in VO_2max was again found to be significant (p-value<0.05), whereas the comparison between normal and obese BMI groups, the change was very highly significant (p-value<0.001).

Discussion

It is important to note that *Salvadori A. et. al.* (1998) studied the oxygen uptake and cardiorespiratory performances in the normal and obese individuals and reported that the obese subjects have less VO_2max than the normal individuals (7). There were several similar studies where it has been shown that lean athletes have a many fold higher value of VO_2max as compared to obese individuals and effects of aerobic training and age on respiratory fitness have been studied (8,9,10). Also, in the study of the relationship between maximum aerobic power and heart disease risk factors, it was reported that the maximum aerobic power has a reverse relationship with BMI (11). These studies were conducted for a long term respiratory endurance. Here, in our study we found that the VO_2max decreases with increase in BMI immediately after exercise as well. There are similar studies done in the past as well where it was shown that obese subjects have less VO_2max than the normal individuals (12). It is important to emphasize that most of previous

studies were done on athletes or those who were subjected to a respiratory endurance study.

Conclusion

In the present study the VO_2max vs BMI trend was found to be decreasing within and among the groups. Here our main focus was to study correlation between respiratory fitness and BMI for short term aerobic exercises. It has been well known that respiratory fitness increases when individuals are subjected to aerobic exercise over a long period of time. But the immediate effect of aerobic exercises on normal and high risk individuals without being subjected to respiratory endurance has been underexplored.

Thus, in this paper we address the immediate effect of aerobic exercises on respiratory parameters and its relation with BMI for high risk individuals.

Authors Contribution

All the authors conducted the study and wrote the paper.

Acknowledgement

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Tables

TABLE NO. 1 PHYSICAL PARAMETERS OF NORMAL GROUP INDIVIDUALS

Age (Y)	Height (cm)	Weight (kg)	BMI (kg/m^2)	VO_2max (ml/min)
20	166	52	18.8	1890
24	166	53	19.2	1700
25	178	64	20.2	2568
28	170	60	20.7	2287
23	166	58	21	2234
24	163	59	22.2	2071
18	173	67	22.3	2361
31	160	59	23	2135
24	165	64	23.5	1959

TABLE NO. 2 PHYSICAL PARAMETERS OF OVERWEIGHT INDIVIDUALS

Age (Y)	Height (cm)	Weight (kg)	BMI (kg/m^2)	VO_2max (ml/min)
25	167	70	25.1	2103
20	165	69	25.3	1310
25	163	68	25.5	2023
22	160	67	26.1	1372
20	170	76	26.2	2176
29	178	84	26.5	1792
20	175	82	26.7	1295
27	160	71	27.7	1744
38	174	86	28.4	1595

TABLE NO. 3 PHYSICAL PARAMETERS OF OBESE GROUP INDIVIDUALS

Age (Y)	Height (cm)	Weight (kg)	BMI (kg/m^2)	VO_2max (ml/min)
19	172	90	30.4	1947
22	162	80	30.4	1280
38	172	90	30.4	1392
23	172	90	30.4	1511
32	168	86	30.5	1204
26	166	85	30.8	1225
32	159	80	31.6	1935
19	172	96	32.4	1285
19	172	90	30.4	1947

Figures

FIGURE NO. 1 PLOT BETWEEN VO2 MAX AND BMI FOR NORMAL INDIVIDUALS SUBJECTED TO THE STUDY.

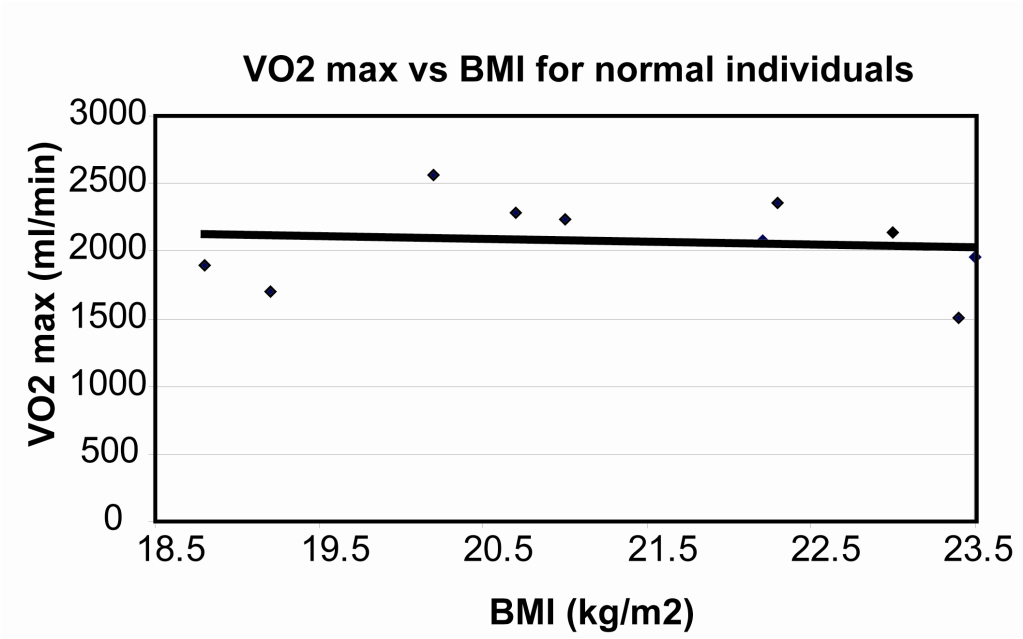

FIGURE NO. 2 PLOT BETWEEN VO2 MAX AND BMI FOR OVERWEIGHT INDIVIDUALS SUBJECTED TO THE STUDY.

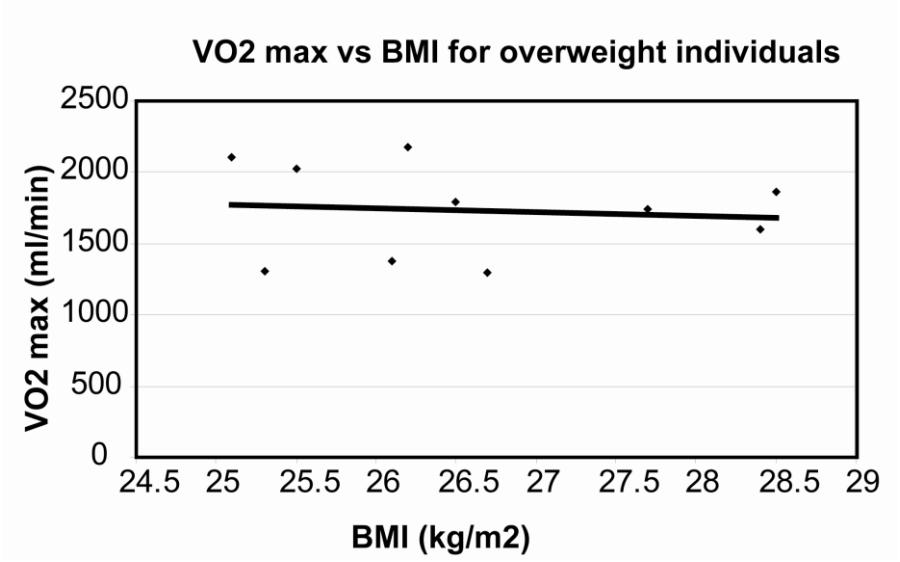

FIGURE NO. 3 PLOT BETWEEN VO2 MAX AND BMI FOR OBES INDIVIDUALS SUBJECTED TO THE STUDY.