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Maximal oxygen consumption percentage in relation to maximal heart rate percentage during cycling in obese males

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ABSTRACT

This study aimed to determine the relationships between Maximal oxygen consumption percentage in relation to maximal heart rate percentage as two exercise intensity indexes in none-trained obese adults' men during cycling and comparing to ACSM guideline. Thirty none-trained obese men (35-50 aged, BMI ≥30). For this purpose, 34 adult obese male completed an incremental maximal exercise test on cycle ergometer. Heart rate and oxygen uptake measured in each stage and maximum out put of protocol. %HRmax, %VO2max calculated by HR and VO2 values of each stage used for measure. Individual linear regressions used for determine relationship between %HRmax and %VO2max in all stage. The data show that %HRmax versus %VO2max relationship in difference with ACSM guideline during exercise test. But, this relation is closer in later stages of protocol. So that, the values of two indexes is equal in last stage of exercise protocol. Based on this data and to support some other studies, our study show that the pattern of %HRmax versus %VO2max relation in obese men is difference with ACSM guideline that prescript for healthy people. It seems that relationship pattern between exercise intensity indexes should be determined in each different population by directly.

Keywords: Obesity, Exercise intensity, Maximal oxygen consumption

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INTRODUCTION

Exercise intensity is the most important constituent of effective sports - rehabilitative exercises in improving cardiorespiratory fitness in healthy individuals or patients suffering some form of deteriorated cardiovascular fitness motor disabilities [1]. Every optimal training program intended to improve cardiovascular fitness depends on such factors as intensity, volume, frequency, duration and manner of exercise training and the prescription of an appropriate training program requires to determine the accurate level of intensity based on each of the indices of exercise intensity (% HRmax, % VO 2Max, % VO 2Reserve, % HRR, Borg scale) with due consideration of the factors affecting them. Research findings suggest that each of these indices, depending on certain effective factors, represent different ranges of exercise pressure during a specific exercise [2, 3]. For example, to prescribe exercise intensity in healthy subjects, American college of Sports Medicine (ACSM) reports 70-85 (%) of maximum heart rate (% 70-85HR max) as being equivalent to 60-80% of maximum oxygen uptake (% 60-80VO2 max), but the findings of David and Swain were inconsistent with ACSM guidelines [4]. The percentage of maximum heart rate (% HRmax) method is widely prevalent in prescribing exercise intensity for the healthy population [5]. Maximum oxygen uptake percentage (% VO2Max) is yet another method of prescribing exercise intensity [6]. However, there is always the question whether prescribing or designing a training program based on

indicators of (% HRmax, % VO2Max) should follow ACSM model in all populations, whether healthy or sick, or such various factors as the physical fitness level, age, sex, type of disease or drugs used, in turn disturb the likeness pattern of these two indicators of exercise intensity. In this regard, some recent studies assert that despite reasonable accuracy in the pattern of relationship between the two exercise intensity indexes (% HRmax, % VO2max), based on ACSM guidelines, this sameness pattern is not applicable in individuals with motor disabilities, and some diseases like chronic obstructive pulmonary disease, spastic patients and the elderly [7,8,9,10].

There is also this question whether the people with low cardiorespiratory fitness due to certain diseases or other similar effective factors should be treated in the same manner when prescribing exercise intensity index as healthy individuals or the should follow a particular pattern.

However, some studies maintain that the level of cardiorespiratory fitness is among the confounding factors in the model of correlation of indices of exercise intensity [11, 12]. Some other studies also suggest that decline of cardiorespiratory fitness would change the correlation pattern of these indices and to determine the appropriate exercise intensity based on any of these indices their correlation pattern should be studied directly [13,14]. Research findings suggest that obese and sedentary individuals possess low cardiorespiratory fitness [1]. Therefore, the aim of this study is to determine the correlation pattern of the two indices (% HRmax, % VO 2Max) in non-athletic obese male adults (BMI $\geq$ 30).

MATERIALS AND METHODS

The study population consisted of obese male adults in Saveh city. The sample included 30 obese male adults with BMI of (BMI $\geq$ 30) in the age range of 35 to 50 who were randomly selected in order to participate in this study. The subjects are non-athletes, nonsmokers and have no orthopedic abnormalities. To measure heart rate and to determine the correlation pattern of exercise intensity indices, YMCA ergometery test was conducted on ergometer bike (Tunturi, E604) [15]. It was emphasized to all subjects to avoid any physical heavy activity for 48 hours before performing the test. At first, resting heart rate (HR) was recorded after 15 minutes of rest in sitting position. In the warm-up stage, the subjects pedaled for 1 min on a cycle ergometer with no workload. YMCA exercise test is a standardized test that is done without rest in form of successive stages and after completion of each stage the workload is increased against the previous step. In the last 10 seconds of each stage, heart rate is recorded using a Polar Heart Rate Monitor. Oxygen consumption (VO2) in each stage is calculated according to the related formula. The final heart rate of test is also recorded once the subjects have stopped exercise. The data related to heart rate and VO2 is used to calculate the percentage maximum heart rate (% HRmax) and the percentage of maximum oxygen uptake (% VO2max) in each stage. At the end, after collecting the data on HR and VO2 in each stage, % HRmax and % VO2max of those stages are calculated in tests are calculated in all the tests and to determine the correlation model between these two indicators of exercise intensity linear regression analysis is used in SPSS environment to find the regression model of these two indicators.

RESULTS

The main objective of this study was to determine the relationship between two exercise intensity indicators (% HRmax, % VO2max) in obese male adults. Statistical findings showed that the maximum oxygen uptake in obese men participating in this study was 31±3 ml/kg/min. Also the correlation model between the values of the indices of% HRmax and % VO2max at any level or at any stage of the test was linear and significant. The regression equation of these two exercise intensity indicators is (%VO2max = 1.61 ×% HRmax - 58.4).

The present study was aimed at determining the correlation pattern of the two exercise intensity indexes (% HRmax, % VO 2Max) during exercise on an ergometer cycling by obese male adults. The results showed that the correlation pattern of the said indexes for the purpose of prescribing an exercise program in obese adult males was to some extent inconsistent with the ACSM guidelines. The role of regular exercise to achieve health benefits and increased energy expenditure in treatment of obesity and weight loss is well acknowledged in these individuals [14]. Hence in addition to the type of exercise, duration, frequency and the intensity of exercise are of particular importance for designing prescribing an efficient and safe training program appropriate to the intended targets in normal subjects or obese patients [14, 16]. Proportional to the duration and frequency of training, several different ways for prescribing exercise intensity to enhance cardiorespiratory fitness of healthy subjects and patients are proposed by ACSM [17, 18]. In this regard, measurement of oxygen consumption (VO2) is known as the best physiological parameter to

prescribe and monitor exercise intensity [19]. When it is possible to record VO2 during exercise, the ACSM prefers the method of administration and control of training intensity, % VO 2Max as the primary method [16]. VO2 measurement and recording during the training program is, however, difficult and costly [19]. In cases where the recording the values of VO2 is not possible, the two methods of % HRmax and % HRR have been proposed by the ACSM [20]. On the other hand, due to the linear relationship between VO_2 and heart rate (HR) during exercise is also applicable to use target heart rate to control exercise intensity based on oxygen consumption [16, 19]. The findings of Strath et al show that after alignment of age and fitness level, heart rate is an accurate predictor for measuring energy expenditure (VO2) which increases concurrence of exercise intensity indices [21]. But, some sources assert that the body's fitness level, age, gender, type of disease and the mode of drug consumption each cause the linear relationship between HR and VO_2 to change [1,9,12,14], and this in turn manipulates the ACSM guidelines on relationship between the two exercise intensity indicators (% HRmax,% VO_{2Max}) and other indexes of exercise intensity.

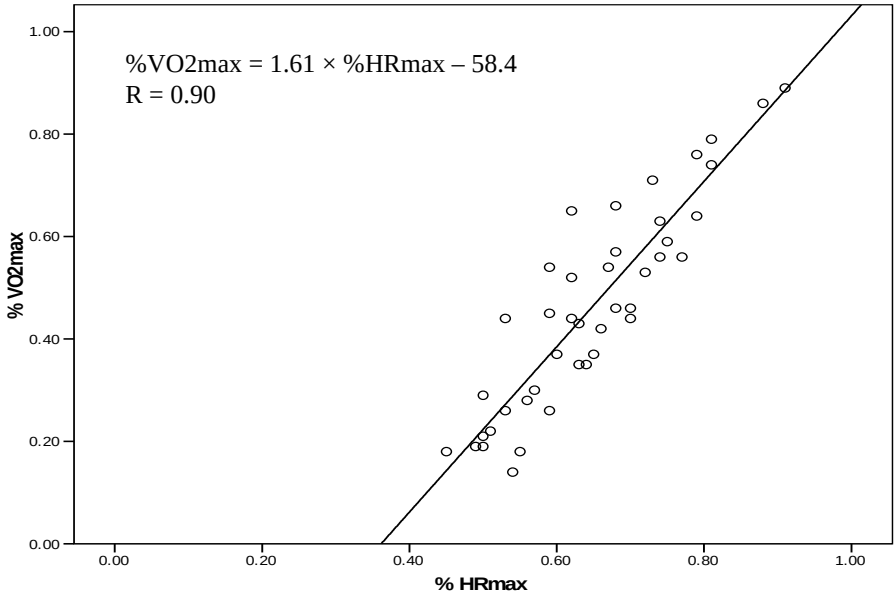

Fig 1; The regression liner pattern between %VO2max and %HRmax during ergometery exercise in adult obese males

In this context, some studies suggest that the lower is a person's cardiovascular or initial fitness; the larger is the difference between these exercise intensity indicators and increased cardiovascular fitness causes the difference between these indices to diminish at any level or intensity of physical activity [14, 13]. Some studies report a closer relationship of these indicators in individuals with high levels of physical fitness. Tolfrey et al report a significant linear relationship (R = 99) between the VO2-HR in elite athletes [22]. Initial laboratory studies show that 6 months of aerobic exercise in the elderly increasing VO 2_{Max} by 18 percent made the relationship between exercise intensity indicators a lot closer [13, 14]. Jakicic's study on obese adults also supports this theory [14].

Recently, some studies have shown that the relationship between % HRmax and % VO2max in healthy subjects designed by the ACSM guidelines is not applicable for certain diseases and patients with movement disabilities [7, 8, 23]. Extensive studies have been conducted on designing and prescribing training programs with appropriate intensity based on any of indicators of exercise intensity (%HRmax and %VO2max) and determining the correlation model between these indicators in patients with a variety of diseases such as chronic heart failure [24], chronic obstructive pulmonary [6,25], heart disease (26], diabetes [27], and motor disabilities [22], and the findings of most of them are inconsistent with the ACSM guidelines on the correlation of these indicators in healthy subjects and they often point out that to provide efficient and effective training program in rehabilitation exercises, the relationship

between exercise intensity indicators in each disease should be investigated directly and separately. For example, the findings of Bernard (2008) showed that the degree of obesity disturbs the pattern of relationship between % HRmax and %VO 2Max in obese individuals, especially during moderate intensity exercise [1] and where it is not possible to measure VO^2, is far more appropriate to use the % HRR method than %HRmax [1].

The findings of this study on obese male adults are also to some extent consistent with the study of Bernard et al. These findings suggest that in low intensities the correlation model between the % HRmax and% VO_{2Max} somewhat varies with the ACSM guidelines. As the findings showed that in lower-intensity exercise, at any level of exercise intensity in terms of $\%VO_{2Max}$, the numerical values of %HRmax in the present study are far higher than the values provided by the ACSM. For example, the ACSM has reported the intensities of %40-60VO2max as being equivalent to %55-70Vo2max while this study observed the intensities of %40-60VO2max as being equivalent to %61-74Vo2max. However as the intensity of exercise gradually increases the numerical valuesof these two indicators become closer to each other and follow the pattern of the ACSM guidelines.

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