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Body mass index and composition in physical preparedness of Iranian military personnel

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ABSTRACT

Purpose: Military personnel are expected to maintain the highest possible level of physical fitness to do their duties. Several factors including body composition and body mass index affect the level of their physical preparedness. The current study was designed to investigate the effect of body composition and body mass index in the level of physical preparedness of Iranian military personnel.

Materials and Methods: In this cross-sectional study, 255 Iranian military personnel were randomly selected. After becoming ensured of the good health of participants, their weight, height and body mass index was determined. The body composition was defined by bioelectrical impedance analysis. Maximum aerobic capacity and metabolic equivalent was estimated using the Bruce treadmill test. Maximum muscle strength in the trunk and lower extremities was measured by the back dynamometer and flexibility was measured by the sit and reach box.

Results: Maximum aerobic capacity, metabolic equivalents, maximum muscle strength adjusted for weight and flexibility had significant negative correlations with percentage of body fat (r = -.172 to -.533) and body mass index (r = -.302 to -.504). Thus the studied factors (excluding flexibility) had more significant association with body fat. There was no significant correlation between pure maximum muscle strength (not adjusted for weight) and body mass index (r = .28, *P* = .658).

Conclusion: The percentage of body fat and body mass index affect several health-related physical fitness factors including aerobic capacity, metabolic equivalents, flexibility and maximum muscle strength adjusted for weight but not pure maximum muscle strength in military personnel.

Keywords: physical fitness; body mass index; body composition; body fat; military personnel.

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INTRODUCTION

Certainly military readiness is a major concern for every country and physical preparedness plays an important role on the battlefield.[1] According to some surveys, physical activity improves resilience, alertness and self-esteem in military operations.[2] Better fitness level enables the military personnel to cope more effectively with stressful situations.[3] So preventive health maintenance and gaining full fitness of the military workforce has been emphasized.[4]

Some studies show that people's physical and psychological health is impressed greatly by good cardiorespiratory fitness as well as long-term ability to exercise.[5] Body mass index (BMI) is used to assess weight relative to height and is calculated by dividing body weight in kilograms by height in meters squared. For most individuals, obesity-related health problems increase beyond a BMI of 25.0 kg/m^2. Still, BMI fails

to distinguish between body fat, muscle mass, and bone. Therefore, because of the relatively large standard error of estimating body fat percentage from BMI (± 5% fat),[6] other methods of body composition assessment should be used to estimate the percentage of body fat during a physical preparedness assessment.

Body composition is mainly divided into two compartments: fat mass and fat free mass. Although there is an accurate technique as the standard method (hydrostatic weighing), some more practical methods such as using skin folds and bioelectrical impedance analysis (BIA) are also accepted for evaluating body composition. They have the advantage of being cheaper, easily obtained and adaptable to field work.

BIA is a noninvasive and easy-to-administer body composition assessment tool. A variety of different BIA analyzers are commercially available that differ in utility and price. The theory underlying this method is that fat-free mass in the body is proportional to the electrical conductivity of the body.[7] While the assessment of body composition and physical fitness level in military personnel has been subject of many studies,[1-4] few surveys have been done regarding the effect of body composition on physical preparedness in military personnel especially in Iran.

Sporis and colleagues[8] have shown that there is a negative correlation between the body fat percentage with sprint tests, anaerobic power tests and maximal aerobic capacity (VO_2max) in military personnel. Mattila and colleagues[9] have reported that increased fat mass and fat percentages are the strong predictor of lower physical preparedness in military personnel. According to Shin and colleagues[10] increased body fat percentage is related to lower level of physical preparedness, while higher level of physical preparedness has correlation with increased muscle mass. In addition, a negative correlation between the body fat percentage of children and adolescents with their level of physical preparedness has been reported in several studies.[11,12]

Currently anthropometric measurements and some fitness tests have been added to the traditional evaluation methods for the better definition of body fat standards used by the American military services since the early 1980s to prevent obesity and motivate good fitness habits.[13] However, lack of enough studies regarding the effect of body composition on the level of physical preparedness in military personnel motivated us to conduct this study on the Iranian military forces. So this study aims to investigate the effect of body composition and BMI on the level of physical preparedness of Iranian military personnel.

MATERIALS AND METHODS

This study was done on the military personnel of the Army of the Islamic Republic of Iran. The sample population included 255 official military employees in different age groups chosen randomly from various units in Tehran from September 2010 to June 2011.

In the first stage of sampling, the participants were chosen randomly from garrisons located in Tehran. In order to cover all military ranks, the personnel who were planned for their rank promotion were chosen as our sampling frame since all personnel usually receive their military rank promotion every four years. Thus, the subjects in this study were randomly selected from a list of approximately one quarter of the personnel of each garrison.

Initially, all participants were examined by the sports medicine specialists and filled a health and physical activity readiness questionnaires. They were not included in the study if they had any past medical or family history of cardiovascular problems, history of sudden cardiac death in their close relatives as well as history of any exercise-related health problems. The participants were asked to sign an informed consent before participating in the physical preparedness assessment tests. There was no disabled or critically injured person among the participants.

In this study, the following examination and tests were used for assessment of body composition and the level of physical preparedness in military personnel: BMI and BIA for assessment of body composition (using Avis 333), cardiovascular endurance test (using exercise stress test/ Bruce protocol), muscular strength test (using back dynamometer) and flexibility test (using sit and reach test).

Statistical Analysis

Both descriptive and analytic methods were used. Means and standard deviations were used for data descriptions. The Pearson statistical test was used to analyze the data. All the statistical analyses were performed using the statistical package for the social sciences (SPSS Inc, Chicago, Illinois, USA) software version 21. The *P* value of 0.05 was considered as the significance level.

RESULTS

255 Iranian military personnel, including 33 women and 222 men (age range 22 to 59 years old) with a mean age of 37 years old and a standard deviation of 7 years old, were randomly included in this study (Table 1).

Table 1. Body composition of the studied military personnel of Iran.

Variable	Minimum	Maximum	Median	Mean	Standard Deviation
Body mass index (kg/m^2)	18.10	41.40	27.54	27.50	3.90
Body fat percentage (%)	9.20	48.00	27.07	28.10	5.46
Lean body mass (%)	35.50	83.60	58.00	57.90	8.50
VO_2max (mL/(kg·min))	12.89	44.67	30.87	31.43	5.33
Metabolic equivalents	3.68	12.76	8.81	8.98	1.52
Maximum muscle strength (kg)	19.50	152.00	77.48	82.50	17.94
Maximum muscle strength (adjusted for body weight)	0.25	1.53	0.97	0.98	0.23
Flexibility (cm)	10	70	42.76	44.00	9.47

The correlations between body fat percentage, fat free mass and BMI with each of variables including VO_2max, metabolic equivalent (Mets), maximum muscle strength, plus maximum muscle strength adjusted for weight and flexibility were separately assessed using Pearson statistical test.

The maximum aerobic capacity, metabolic equivalents, and maximum muscle strength adjusted for weight and flexibility had a significant negative correlation with percentage of body fat and BMI. On the other hand, there was no association between fat free mass and maximum aerobic capacity, metabolic equivalents, and flexibility. However, fat free mass was associated with maximum muscle strength and inversely associated with maximum muscle strength adjusted for weight (Table 2). The negative effect of body fat percentage on maximum muscle strength adjusted for weight, maximum aerobic capacity and flexibility are shown in Figures 1 to 3.

DISCUSSION

Increased body fat percentage and BMI have a negative effect on some health-related physical preparedness factors like maximum aerobic capacity, metabolic equivalents, maximum muscle strength adjusted for

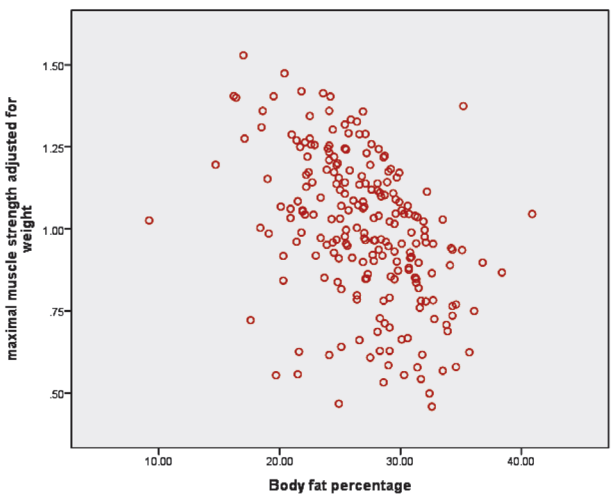

Figure 1. The correlation between body fat percentage and maximal muscle strength adjusted for weight in Iranian military personnel.

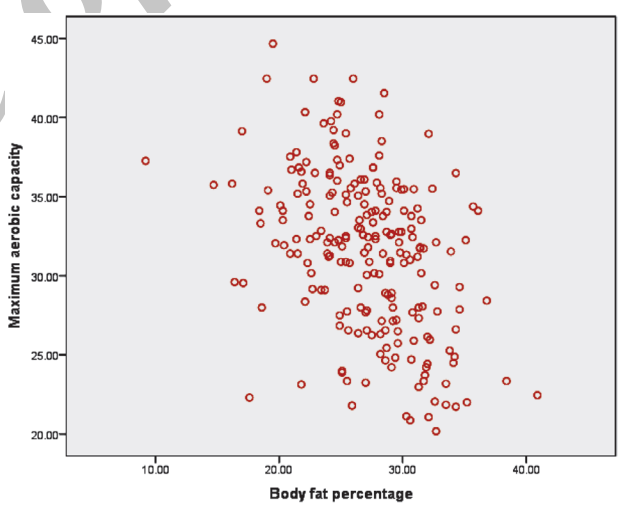

Figure 2. The correlation between body fat percentage and maximum aerobic capacity in Iranian military personnel.

Table 2. The correlation between body fat percentage, fat free mass and BMI with physical fitness variables in Iranian military personnel.

Variables	Flexibility	Maximum Muscle Strength (adjusted for weight)	Maximum Muscle Strength	Maximum Aerobic Capacity	Metabolic Equivalent
Body fat percentage	r = -.172* *P* = .007	r = -.533* *P* = .0001	r = -.264 *P* = .0001	r = -.512* *P* = .0001	r = -.512* *P* = .0001
Fat free mass	r = -.121 *P* = .057	r = -.153* *P* = .015	r = -.147* *P* = .020	r = -.113 *P* = .074	r = -.113 *P* = .074
Body mass index	r = -.302* *P* = .0001	r = -.504* *P* = .0001	r = .280 *P* = .658	r = -.390* *P* = .0001	r = -.391* *P* = .0001

*Significant statistics correlation.

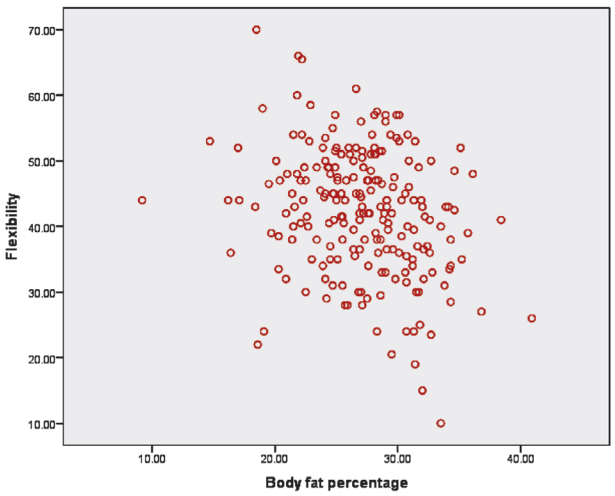

Figure 3. The correlation between body fat percentage and flexibility in Iranian military personnel.

weight and flexibility in military personnel. Additionally, all studied variables except flexibility have had more significant correlations with body fat percentage than BMI.

Same as other previous surveys,[7,9,12,14-17] the negative correlations among body fat percentage and BMI with VO_2max and metabolic equivalents were shown in this study. Since military personnel are expected to be able to carry heavy equipment in long distances in different situations, they require high cardiorespiratory fitness to do their duties. Thus, assessment of body composition in military personnel could be helpful in finding those who may need more cardiorespiratory training.

The effect of BMI and body fat percentage on muscle strength in military personnel has also been the subject of several studies.[9,12,14,17] The majority of these studies have reported that with the increase of BMI and body fat percentage, muscle strength would decrease. This finding is relatively in agreement with the result of our study. However, in the present study this negative effect was observed only in maximum muscle strength adjusted for weight and not pure muscle strength. If one considers the point that heavier people are usually stronger than others, this finding seems reasonable.

To our knowledge, few studies have been done regarding the effect of BMI and body fat percentage on flexibility in military personnel. Some researchers have studied this subject[12,18] and found no correlation between BMI, body fat percentage and flexibility. However, these studies were done mainly on adolescents while this study examined the military personnel who were all adults. Therefore, the negative effect of BMI and body fat percentage on flexibility might be because of the difference between age ranges of participants of this study compared to previous studies.

Based on the result of this study, fat free mass is related to pure maximal muscle strength in military personnel. This finding is in agreement with previous studies.[10,19] On the other hand, the negative correlation between fat free mass and maximum muscle strength adjusted for weight in this study might be because of higher BMI and body fat percentage in those who have high fat free mass.

Similar to several previous surveys,[10,12,14,17] our findings show that the majority of health-related physical preparedness factors such as cardiorespiratory fitness and muscle strength are more related to body fat percentage than BMI.

One of the limitations of this was that a small percentage of military personnel were not willing to participate in our physical preparedness assessment. However, this problem was mainly solved using cash bonuses.

CONCLUSION

A significant correlation was observed between body mass index and body fat percentage and health-related physical preparedness factors in Iranian military personnel. Also, this study showed that body mass index and especially the percentage of body fat could be considered as an indicator of cardiorespiratory fitness in military personnel. Therefore, body composition assessment especially body fat percentage evaluation should be considered as an effective method for evaluation of physical preparedness in military personnel. So, it is suggested that body fat percentage be evaluated instead of BMI for better assessment of physical fitness in military personnel.

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CONFLICT OF INTEREST

None declared.

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