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Effect of Regular Physical Activity on Metabolic Parameters and Anthropometric Indices in Obese Military Personnel: A Quasi-Experimental Study

Obez Askerî Personelde Düzenli Fiziksel Aktivitenin Metabolik Parametreler ve Antropometrik İndeksler Üzerine Etkisi: Yarı-Deneysel Bir Çalışma

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Abstract

Objective: In recent decades, the world has witnessed a rapid rise in obesity, which has also become a problem in military health care systems. This study aimed to determine the changes in blood lipid profile, blood glucose levels, and anthropometric indices upon regular physical activity in obese men among military personnel. **Material and Methods:** This study involves quasi-experimental research conducted on 265 military personnel. The subjects underwent physical activities continuously for 2 months under coach supervision. The mean values of blood lipid and blood glucose profiles, as well as the anthropometric indices of these individuals before and after the study period, were compared. To make comparisons, the statistical t-test and standardized mean difference (SMD) with 95% confidence interval were used. **Results:** Results of this study indicate that after regular physical activity, the mean values of triglyceride levels [SMD=-0.390, p<0.001], total cholesterol [SMD=-0.259, p=0.003], high-density lipoprotein [SMD=0.387, p<0.001], low-density lipoprotein [SMD=-0.369, p<0.001], and fasting blood sugar [SMD=-0.338, p<0.001] significantly decreased. Based on the test results, the weight [SMD=-0.218, p=0.013] and body mass index [SMD=-0.587, p<0.001] of the individuals had also decreased. Moreover, the waist circumference [SMD=-0.416, p<0.001], hip circumference [SMD=-0.249, p=0.005] and waist-to-hip ratio [SMD=-0.566, p<0.001] also showed a decrease. **Conclusion:** It is seen in this study that regular physical activity can improve anthropometric indices, blood glucose, and blood lipid profile. It is hence suggested that managers of organizations take adequate measures to encourage employees to exercise and participate in physical sports daily or even make it mandatory, if necessary, for administrative personnel who do not have any physical activity.

Keywords: Obesity; physical activity; metabolic parameters; anthropometric indices; blood sugar; lipid profiles

Özet

Amaç: Son yıllarda dünya, askerî sağlık sistemlerinde de sorun hâline gelen hızlı bir obezite artışına tanık olmuştur. Bu çalışmada, askerî personel arasındaki obez erkeklerde düzenli fiziksel aktivite sonrası kan lipid profili, kan glukoz seviyeleri ve antropometrik indekslerdeki değişiklikleri belirlemek amaçlanmıştır. **Gereç ve Yöntemler:** Bu çalışma, 265 askerî personel üzerinde yürütülen yarı-deneysel bir araştırmayı içermektedir. Katılımcılara, antrenör gözetiminde 2 ay boyunca sürekli fiziksel aktivite yaptırılmıştır. Çalışma periyodundan önce ve sonra bu bireylerde, kan lipid ve kan glukoz profilleri ile antropometrik indekslerin ortalama değerleri karşılaştırılmıştır. Karşılaştırmalarda istatistiksel t-testi ve %95 güven aralığı ile standardize ortalama fark [standardized mean difference (SMD)] kullanılmıştır. **Bulgular:** Bu çalışmanın sonuçları, düzenli fiziksel aktiviteden sonra, trigliserid [SMD=-0,390, p<0,001], total kolesterol [SMD=-0,259, p=0,003], yüksek yoğunluklu lipoprotein [SMD=0,387, p<0,001], düşük yoğunluklu lipoprotein [SMD=-0,369, p<0,001] ve açlık kan şekeri [SMD=-0,338, p<0,001] düzeyleri ortalama değerlerinin anlamlı olarak azaldığını göstermiştir. Test sonuçlarına göre bireylerin ağırlığı [SMD=-0,218, p=0,013] ve beden kitle indeksi [SMD=-0,587, p<0,001] de azalmıştır. Ayrıca bel çevresi [SMD=-0,416, p<0,001], kalça çevresi [SMD=-0,249, p=0,005] ve bel-kalça oranı [SMD=-0,566, p<0,001] da düşüş göstermiştir. **Sonuç:** Bu çalışmada, düzenli fiziksel aktivitenin antropometrik indeksleri, kan şekerini ve kan lipid profilini iyileştirebileceği görülmektedir. Bu nedenle kurum yöneticilerinin, çalışanları günlük olarak egzersiz yapmaya ve fiziksel aktivitelere katılmaya teşvik edecek yeterli önlemleri almaları, hatta herhangi bir fiziksel aktivite yapmayan idari personel için gerekirse bunu zorunlu hâle getirmeleri önerilmektedir.

Anahtar kelimeler: Obezite; fiziksel aktivite; metabolik parametreler; antropometrik indeksler; kan şekeri; lipid profilleri

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Introduction

Being overweight and obese have become significant health problems, with a high growth rate reaching epidemic proportions worldwide, including Iran (1,2). The prevalence of being overweight and obese has been increasing rapidly worldwide in recent decades, and it has made the regular monitoring and control of obesity and excess weight an essential part of life (3,4). In the United States (US) alone, approximately 55% of people over the age of 20 are either overweight or obese (5).

Obesity is associated with increased body fat, which has detrimental effects on health by increasing the risk of a variety of diseases, including cardiovascular disease, high blood pressure, hyperlipidemia, diabetes (Type 2), respiratory disease, arthritis and different types of cancers (breast, uterus, prostate, etc.). Moreover, obesity is considered to be an independent risk factor for increased mortality (4,6-13).

Obesity is a disorder characterized by the widespread accumulation of fat in the body that threatens health (14). According to the World Health Organization (WHO), more than 60% of the global population is obese and overweight. Obesity is the 5th greatest risk factor for death, meaning that at least 2.8 million adults die each year due to obesity alone (15). As far as the adult population of Iran is concerned, based on recent reports, more than 22.3% of the people are obese or overweight (16,17).

Body mass index (BMI) is one of the most common methods of assessing, screening, and diagnosing obesity in individuals. This indicator represents the total abdominal fat but does not provide information about visceral fat, abdominal or centralized obesity. The BMI depends on the parameters of height and weight (18). In addition, the BMI does not distinguish between weight due to fat accumulation and muscle weight (14,19). To overcome these limitations of BMI, the use of some alternative indicators to express obesity in people is recommended. These alternatives can be waist circumference (WC), hip circumference (HC), and waist-to-hip ratio (WHR). These indicators depend on the fat distribution in specific parts of the body (18-20). The WHR index is used to differentiate the central distribution of adipose tissue from its peripheral distribution in the body, while the WC reflects the abdominal fat accumulation taking into account overall body sizes, such as height and weight. The WC strongly correlates with both weight and BMI (3,18,19). Studies have shown that the WC index is much more useful in diagnosing obesity than the BMI (14,17).

In addition to anthropometric indices, chemical components of the blood can also be used to assess and measure obesity. Examples of such indicators are fasting blood sugar (FBS), high-density lipoprotein (HDL), low-density lipoprotein (LDL), total cholesterol (TC), and triglyceride (TG) (4).

Interestingly, the problems of excess weight and obesity in America's military are not restricted to newly hired soldiers, and according to some reports, about 16% of the existing military personnel are obese, and between 3,000-5,000 soldiers are forced to leave the army each year due to being overweight and obese (21).

Physical activity is any movement in daily life such as work, recreation, sports, and exercise. Physical activity can be a broad range of activities with varying intensity, such as walking, jogging, jumping, sports, and so on (22). According to the definition by WHO, physical activity refers to any kind of motion that involves the skeletal muscles and consumes energy (23).

The implementation of physical activity programs at workplaces in the US has led to a significant reduction in absenteeism from work by as much as 6-32% and has also reduced the costs of medical care by 20-55% (24).

In different countries, between 60-85% of adults do not have enough mobility to improve their overall health. In a national study conducted in Iran by the WHO, the extent of immobility in urban and rural areas among women and men aged 15-64 years was 76.3 and 58.8 percent, respectively. The total percentage was 67.5% and this is considered as one of the most potent reasons for the prevalence of cardiovascular disease and cancer in the population (25).

According to a report by the Centers for Disease Control and Prevention, about

250,000 deaths of all deaths in the US annually can be attributed to a lack of physical activity (26).

The impact of physical activity on health-related outcomes has been investigated extensively in multiple studies (11,27,28).

Regular exercise is widely recommended for the prevention and management of several metabolic diseases such as obesity, hypertension, coronary artery disease, and diabetes. Physical activities or muscle contractions not only consume intracellular energy (calorie restriction) but also increase the regulation of proteins involved in energy metabolism (29).

The results of various studies indicate that lifestyle interventions such as regular and optimal exercise, are one of the best ways to prevent obesity and metabolic syndromes and have beneficial effects on obesity-related metabolic disorders (30).

Research on how regular physical activity affects anthropometric indices and lipids profiles in the armed forces personnel is unfortunately quite limited, and very few studies have been conducted on this topic. Therefore, this study aimed to determine the changes in various metabolic parameters such as blood lipids profile, blood sugar, FBS, etc., and the anthropometric indices after regular physical activity among obese military personnel.

Material and Methods

Design

This research was a quasi-experimental study with a pre-test and post-test design format. The purpose of this study was to determine the changes in blood lipid profile, anthropometric indices, and blood sugar after continuous physical exercise in military personnel who had a BMI over 30. The participants of this study were 265 military personnel who had majorly administrative tasks only and had no significant physical exercise or workout either at home or in their workplace. All the subjects had volunteered to participate in this study. The samples were divided into 2 groups of overweight (BMI over 30) and obese (BMI over 35). All the participants were males. The study was carried out in adherence to the Helsinki Declaration Principles.

Ethical Considerations

The protocol of this study was approved by the Research Ethics Committee of the Baqiyatallah University of Medical Sciences (ethics code: IR.BMSU.REC.1393.280, approval date: 2017.12.11). The participants were informed of the nature and possible risks of exercise training and experimental procedures before getting their written consent

Measurements

The participants were asked to complete a questionnaire assessing their demographics and other data, including age, marital status, grade, rank, education, work experience, corporate responsibility, and the history of overweight, obesity, or heart disease in their family. To evaluate their lipid and blood sugar profiles, all subjects were made to fast for about 14 h, and 5-7 mL of venous blood was taken between 8-10 am to measure the levels of TC, TG, HDL, LDL, and FBS in the laboratory of a military hospital under standard laboratory conditions. Afterward, all of the subjects had to undergo regular physical activity every other day for 2 hours over a period of 2 months. These activities included warm-up exercises for 10 min, light jogging for 15 min, stretching and exercise for 15 min, and 80 min doing any of one of the sports of volleyball, soccer, or swimming optionally. The training lasted 30 min on the first day, and at the end of the first week, it lasted 2 h. After 2 months of physical training, all of the tests for blood glucose and lipid profiles were repeated, and the results were recorded and analyzed.

Also WC, HC, WHR, and BMI were measured both before and after the intervention. In addition to using the BMI, the use of other indicators such as WC, HC, and WHR are recommended to express obesity and overweight. Anthropometric measurements were taken barefoot with minimal clothing. The individuals' weights were measured using a standard scale. Height was measured in centimeters and in standing position, while the hips, shoulders, and head were in contact with a wall surface. WC was measured after a normal exhalation in the narrowest area of the waist located approximately halfway between the costal border and the iliac crest, and the HC index was measured along the largest HC using a measuring tape. The WHR index was calculated by dividing the WC by HC (17,18).

Statistical Analysis

Descriptive statistics included the measures of average, minimum, maximum, and standard deviation for each dependent variable both before and after the intervention. For the quantitative nature of dependent variables, the Kolmogorov-Smirnov statistical test was performed to determine the normal distribution. Considering the normal distribution of the results, a Paired t-test and standardized mean difference (SMD) with 95% confidence interval were used to compare the anthropometric indices, blood lipid profiles, and FBS glucose profiles before and after the intervention. All analyses were conducted using the SPSS Version 16 Statistical Software.

Results

General Characteristics of the Study Participants

A total of 265 individuals agreed to participate in the current study. Table 1 shows the demographic characteristics of all the participants. Based on the BMI alone, 64% of participants were overweight (BMI over 30), and 36% were obese (BMI over 35).

Table 1. Demographic characteristics of the study participants (n=265).

	Variable	Frequency (Percent)
Age	≤40 years	153 (57.8)
	>40 years	112 (42.2)
Marital status	Married	260 (98.1)
	Single	5 (1.9)
Education level	≤12 years	26 (9.8)
	12-16 years	228 (86.0)
	>12 years	11 (4.2)
Work experience	≤10 years	28 (10.5)
	10-20 years	115 (43.5)
	>20 years	122 (46.0)

The results for FBS, anthropometric indices, and blood lipid profiles, including the levels of TG, TC, HDL, and LDL, of the total samples pre-test and post-test, are presented in Table 2.

The Effects of the Intervention on Participants' Lipid Profiles and Fasting Blood Sugar

The results of this study indicate that after regular physical activity, the mean values of TG [SMD=-0.390, p<0.001], TC [SMD=-0.259, p=0.003], HDL [SMD=0.387, p<0.001, and LDL [SMD=-0.369, p<0.001] decreased and this decrease was statistically significant.

Table 2. Comparison between the mean values and standard values of lipid profiles, fasting blood sugar levels, and anthropometric indices before and after the intervention (n=265).

Variable	Before the intervention		After the intervention		p value**
	Mean	SD	Mean	SD	
FBS (Mg/dL)	98.68	34.95	89.38	17.02	<0.001
TG (Mg/dL)	178.38	88.34	148.68	61.39	<0.001
TC (Mg/dL)	190.44	38.44	180.74	36.07	0.003
LDL (Mg/dL)	101.44	34.2	89.42	30.82	<0.001
HDL (Mg/dL)	56.05	18.43	62.46	14.5	<0.001
WC (cm)	96.98	7.86	93.82	7.34	<0.001
HC (cm)	101.47	6.49	99.87	6.34	0.005
WHR (Ratio)	0.95	0.04	0.93	0.03	<0.001
Weight (kg)	86.19	13.34	83.43	12.87	0.013
BMI (kg/m^2)	28.58	3.51	26.52	3.67	<0.001

**p value <0.005 is significant; SD: Standard deviation; FBS: Fasting blood sugar; TG: Triglyceride; TC: Total cholesterol; LDL: Low-density lipoprotein; HDL: High-density lipoprotein; WC: Waist circumference; HC: Hip circumference; WHR: Waist-to-hip ratio; BMI: Body mass index.

Our finding shows that after the intervention involving regular physical activity, FBS levels decreased significantly (SMD= -0.338, p<0.001).

The Effects of the Intervention on Various Anthropometric Indices

Based on our results, after the intervention of increased physical activity, the weight [SMD=-0.218, p=0.013] and BMI [SMD= -0.587, p<0.001] decreased, and this decrease was statistically significant. The WC [SMD=-0.416, p<0.001], HC [SMD=-0.249, p=0.005] and WHR [SMD=-0.566, p<0.001] decreased significantly too (p<0.001).

Changes in Overweight and Obese People

Table 3 shows the changes in blood lipid profiles, blood sugar levels, and other anthropometric indices among overweight and obese men after the introduction of regular physical activity. The results show that the most significant change was observed in WC [SMD=-0.636, p<0.001) for overweight individuals and in WHR [SMD=-1.0, p<0.001) for obese people.
According to Table 3, the weight index value for the overweight group is closer to the significant level than for the obese group, which indicates that weight loss after the inter-vention was greater in the overweight group.

Discussion

The results showed that increased physical activity for 2-months for the overweight and obese personnel led to a significant reduction in the values of anthropometric indices, the FBS, and blood lipid profiles.
The results of this study also show a significant reduction in weight and BMI of individuals after doing daily physical exercises. However, weight loss after exercise was noted to be higher in overweight people than in obese people, which is an indication of the weight loss difficulties in obese individuals as compared to overweight individuals. Therefore, people should enter a weight loss before reaching the stage of obesity.
The findings showed that the mean values of FBS after the intervention, declined and this decrease was statistically significant. The results of research by Lee et al., which was performed with the aim of monitoring and controlling obesity in people using certain obesity management services through a smartphone for 24 weeks, showed that after the intervention, the amount of FBS levels decreased significantly in the study group as compared to the control group (4). Also, another study had found similar results (31). On the other hand, it is known that physical activity causes the loss of fats by reducing hepatic glucose production, in-

Table 3. Changes in the blood lipid profiles, fasting blood sugar levels, and anthropometric indices in overweight and obese men.

Indices	Overweight men				Obese men			
	Standard diff in means	Lower-upper limit		p value	Standard diff in means	Lower-upper limit		p value**
FBS (Mg/dL)	-0.339	-0.557	-0.120	0.002	-0.461	-0.760	-0.162	0.003
TG (Mg/dL)	-0.321	-0.539	-0.103	0.004	-0.537	-0.842	-0.233	0.001
TC (Mg/dL)	-0.262	-0.478	-0.046	0.018	-0.296	-0.586	-0.005	0.046
LDL (Mg/dL)	-0.337	-0.555	-0.118	0.003	-0.450	-0.748	-0.152	0.003
HDL (Mg/dL)	-0.525	0.298	0.752	0.000	-0.292	0.002	0.583	0.049
WC (cm)	-0.636	-0.869	-0.403	0.000	-0.510	-0.812	-0.207	0.001
HC (cm)	-0.369	-0.589	-0.150	0.001	-0.275	0.564	0.015	0.063
WHR (Ratio)	-0.283	-0.500	-0.066	0.011	-1.000	-1.348	-0.652	0.000
Weight (kg)	-0.298	-0.515	0.081-	0.007	-0.240	-0.528	0.048	0.103
BMI (kg/m²)	-0.509	-0.735	-0.283	0.000	-0.343	-0.635	-0.050	0.022

**p value <0.005 is significant; FBS: Fasting blood sugar; TG: Triglyceride; TC: Total cholesterol; LDL: Low-density lipoprotein; HDL: High-density lipoprotein; WC: Waist circumference; HC: Hip circumference; WHR: Waist-to-hip ratio; BMI: Body mass index.

creasing insulin secretion from the pancreas, and increasing insulin sensitivity to control blood sugar (32). The results of the current study are in alignment with other previous studies because muscular contractions help in the release of a large amount of glucose inside the cells to be used for producing energy. Muscle contractions probably increase the plasma membrane permeability by increasing the amount of glucose transporter type 4 (Glut4) in plasma. Upon exercise, the level of Glut4 in the muscles of the subject increases, and this improves insulin performance on glucose metabolism and helps in decreasing blood glucose levels (33,34).

In most studies done in this area, the effects of physical exercise on blood glucose levels in diabetic patients have been investigated, and the results of such studies have always indicated a significant reduction in blood glucose levels after physical activity, which can be associated with the increased breaking and consumption of the extra muscle and liver glycogen, increased number of sites for receiving insulin in the cell walls of fat and muscle tissues, and increased absorption of glucose by the working muscles (24).

The findings of this study showed that the mean values of TC levels after the intervention significantly decreased. The results of studies by Mousavian et al. (35) and Lee et al. (4) show a reduction in the TC value after the intervention. The results of these studies are consistent with the present study.

The findings of this study show that the mean values of LDL after the intervention reduced, and this reduction was statistically significant. The study by Fathi et al. also showed a reduction in LDL levels. In their study, they examined the effects of endurance exercise for 8 weeks (3 times a week) on the lipid profiles of 40 non-athletic middle-aged men (36).

Various studies have emphasized the beneficial effects of aerobic exercise in reducing LDL-C levels. Doing exercise increases lipoprotein levels as well as the enzyme lipoprotein lipase (LPL) levels as well. The LPL enzyme helps in catabolizing the lipid part of LDL. Therefore, it is expected that LDL level decreases in the blood as a result of exercise (37).

The findings of the present study show that the mean values of HDL levels after the intervention reduced significantly. Hagnäs et al., in northern Finland, studied the changes in anthropometric indices and blood lipids among overweight and obese men during the military training period (8 weeks of military training), and the results of their study showed a significant increase in HDL mean values and standard deviation after eight weeks of military training (38). Also, the study by Lee et al. showed a reduction in HDL after exercise intervention (4).

Various factors affect the fluctuation of blood HDL-C levels, among which are gender, diet, genetic characteristics, and duration of physical activity. The mechanism of how HDL-C levels change after physical activity is complicated, but the LPL enzyme plays a key role in the changes of HDL-C concentrations through plasma TG hydrolysis (37). In addition, Danielsen et al. (39) studied the effects of changing lifestyles (changing feeding behavior and physical activity with moderate intensity) on the anthropometric indices and blood lipid levels of 71 obese participants over a period of 14-10 weeks. Their results showed a significant increase in HDL mean and standard deviation values. These results are consistent with the results of the present study (39). Ho et al. in Australia also similarly studied the effects of physical activity on anthropometric indices of overweight and obese subjects, and the results of their study showed a statistically significant reduction in body weight, BMI, and WC of the subjects after physical activity. Several studies have also reported fat weight loss after aerobic exercise. Aerobic exercise increases the oxidative capacity of skeletal muscles through the utilization of plasma fatty acids and by increasing fatty acids protein carriers (40).

Conclusion

The results of our study show conclusively that regular physical activity in obese people who had no previous regular physical activity significantly improved their anthropometric indices and other metabolic parameters such as FBS and blood lipid profiles. This improvement is more significant in those who fall in the category of "overweight" as compared to those who fall in the "obese" category. Improvement of blood sugar and blood fat via physical activity is more difficult to achieve in people who have entered the stage of obesity. Therefore, it can be concluded that people who are at risk of being overweight or obese should add a regular program of physical activity in their daily life as early as possible. It is also recommended to consider making physical activity mandatory for the administrative personnel of military bases to prevent obesity in these individuals.

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Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

Idea/Concept: Mohammed Samadi, Hamideh Bidel, Mehdi Akhondikalour; Design: Mohammed Samadi, Hamideh Bidel, Rohollah Fallah Madvari; Control/Supervision: Mohammed Samadi, Hamideh Bidel, Gholomhossein Pourtaghi; Data Collection and/or Processing: Mohammed Samadi, Hamideh Bidel, Mehdi Akhondikalour; Analysis and/or Interpretation: Mohammed Samadi, Hamideh Bidel, Mehdi Akhondikalour; Literature Review: Hamideh Bidel; Writing the Article: Hamideh Bidel, Mohammed Samadi; Critical Review: Rohollah Fallah Madravi; Materials: Mohammed Samadi, Gholomhossein Pourtaghi, Mehdi Akhondikalour.

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