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Regular physical activity as a basic component of lifestyle modification reduces major cardiovascular risk factors among male armored force personnel of Shabestar army installation in Iran

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Abstract. *Objectives:* Cardiovascular/Coronary Heart Disease (CVD) is a leading cause of disability and death worldwide. The most important risk factors for CVD are well-established and are strongly influenced by lifestyle changes. Clearly, physical activity has been shown to be extremely important in reducing the burden of this disease. The aim of this case-control study was to examine the association between intensity of activities and CVD risk factors in healthy military personnel.
Participants: Two group of subjects (active [engaging in three session of field exercises/week] = 50, and inactive [with no experience of field exercise] = 50) were classified by a questionnaire containing demographic, health history, type and level of physical activity, and employment information.
Methods: Anthropometric indices, lipid-lipoprotein profile, arterial pressures, and fasting blood glucose were assessed. Independent sample t-tests were used for comparison.
Results: Physically active subjects had significantly ($p \leqslant 0.05$) lower measures of body mass indices (except height), lower levels of total cholesterol (TC), low density lipoprotein (LDL-C), triglycerides (TG), systolic and diastolic blood pressure (S/DBP), risk factor (TC/HDL ratio), atherogenic index (LDL/HDL ratio), and higher levels of high density lipoprotein (HDL-C). Fasting blood sugar (FBS) was normal in both groups.
Conclusions: To reduce the risk factors of developing CVD and preventing its progression significantly, it clearly serves to underscore the beneficial properties of physical activity and to promote its effectiveness as a support for healthier lifestyles in the community and particularly among military personnel.
The findings of this study substantiate the need for physical exercise to reduce signs and symptoms associated with CVD risk, even among a young, healthy, generally active population. Further, that these results would appear to corroborate the concept of increasing physical activity, including aerobic activity, as a preventative measure.

Keywords: Field exercise, activity, inactivity, anthropometry, lipids, military personnel

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1. Introduction

1.1. *Cardiovascular Disease and Associated Risk Factors*

Cardiovascular disease (CVD), particularly coronary heart disease (CHD), remains a major cause of mortality, morbidity, and disability throughout the world [1]. The efficacy and cost effectiveness of various procedures, preventive measures and medical therapies in lowering individual risk factor levels and reducing clinical CVD events are constantly improving. As a result, people are living for longer than ever before. Although progress has been made in the management of CHD for many patients, the risk for CHD remains elevated for most patients. Cardiovascular disease associated with dyslipidemia is a significant cause of morbidity and mortality. Low high density lipoprotein (HDL-C) is a well established independent and predictive risk factors for CVD. Raising HDL-C can be influenced by lifestyle modifications including higher activity levels, thus lowering CHD risk [2]. Furthermore, raising HDL-C reduces coagulation and platelet adhesion, while promoting fibrinolysis and protease expression [3].

Elevated LDL-C is an independent risk factor for CHD and lowering it by 60 mg/dl reduces CHD events by 50% after 2 years [4]. The effects of lowering LDL-C and raising HDL-C have been shown to be independent and additive. Treatments that target both LDL-C and HDL-C can reduce the risk of coronary events by 60% to 80%. Ongoing intervention studies will further define the benefits of combination therapies that reduce LDL-C and elevated HDL-C [4].

1.2. *Benefits of lifestyle modifications*

1.2.1. *Cholesterol and CHD Risk*

Although medications successfully lower LDL-C and decrease CHD risk, therapeutic lifestyle changes remain the initial therapy for most adult patients [5]. Lifestyle modification represents first-line therapy for men and women with low HDL-C. Increases in HDL-C can be achieved through weight loss (HDL-C increases 1 mg/dl per weight loss of 3 Kg), a diet rich in monounsaturated and polyunsaturated fatty acids (up to 5% increase), tobacco cessation (5% to 10% increase), moderate alcohol consumption (5% to 15% increase), and aerobic exercise (5% to 10% increase) [6].

In lifestyle modification, exercise is an important tool in lowering cholesterol and promoting overall health. Although aerobic exercise appears to provide the most cholesterol lowering benefits, it is important to note that any type of physical activity will help lower the cholesterol, help to change body composition and promote heart health [7]. As previously noted, current studies suggest LDL-C can be lowered by 5 to 10%, whereas HDL-C can be raised by between 3 and 6% with regular exercise [8]. Directed exercise can also strengthen the heart, bones, and muscles, in addition to assisting with weight loss.

1.2.2. *Weight Loss*

Many Americans are trying to lose weight as about 97 million Americans are overweight or obese. Being overweight increases ones' risk mortality from many causes.

The National Heart, Lung, and Blood Institute and the National Institute of Diabetes and Digestive and Kidney Disease guidelines recommend initial lifestyle modifications, including increasing physical activity, and behavioral therapy [9].

1.2.3. *Chronic Disease*

Although regular exercise may be important for patients with chronic disease and physical activity may have differential effects depending on the specific disease, more research is needed to identify and validate these benefits. Given the growing numbers of people with diagnosed chronic disease, a collaboration between exercise professionals and health care providers to determine the impact of exercise would seem beneficial [10]. Using cardiac disease as an example of a chronic condition, it has been shown that exercise training reduces risk factors, improves functional capacity and ability, and enhances psychological well being and quality of life in patients suffering from CAD [11]. Recently, the American Heart Association recommended resistance training should be included in cardiac rehabilitation programs 2 times per week, in addition to aerobic exercise [12].

In general, the risk factors for heart attack can be divided into two general groups – those which we have no control over, and those which we can control. The good news is that most of these risk factors are things we have the ability to control and People who exercise regularly have a reduced risk of heart attack. Evidence accumulates that modifying risk factors for CAD works and it is recognized that regular physical activity reduces the risk of many adverse health outcomes and contributes to health by: decreasing the risk for diseases such as coronary heart disease, stroke, some cancers, type 2 diabetes, osteoporosis, and depression. However, other benefits, such as increased cardiorespiratory fitness, increased muscular strength, and decreased depressive symptoms and blood pressure, require only a few weeks or months of participation in physical activity. Although, it is recognized that several confounding or predisposing factors such as genetic factors for hypertension, life style, diet, family habits and the type of jobs engaged might lead to CVD, the purpose of this study was to examine the role of physical activity on CVD risk factors at a military training installation among active and inactive male army personnel. This knowledge is critical to highlight and promote physical activity as a routine part of life and clinical practice, with particular emphasis in military personnel.

2. Methods

The research design was a case-control study of active and inactive (sedentary) male army personnel, located in an army installation in Shabestar, north-west of Iran, who were asked to complete some evaluation procedures, which included demographic and anthropometric data and exercise history questionnaire. A history of a known CVD, diabetes, hypertension, smoking habits was based on participants' self-report on the medical history questionnaire. A total of 100 male volunteers (50 cases of active and 50 controls of inactive personnel) within the age of 20–40 years from a military training installation participated in the study and all subjects signed a written informed consent form. The study was approved by the Ethics Committee on Human Research at Baqiyattalah University of Medical Sciences.

Being physically active was defined as participating in 40 or more minutes of a supervised systematic exercise program of regular vigorous activity and strengthening training for 3 days a week, plus climbing the altitudes on the third session every alternative week; at least in the last three months or more of preceding the entry into the study. Type of activity applied translates to aerobic exercises consisting of running, jogging, stretching exercises and rhythmic activity of body workouts at about 60 to 70% of maximum heart rate. In addition, half of the active subjects participated in an extra program including extra running for 3200 meters run and 30 minutes of martial arts for 45 days within their exercise period. Inactive subjects were randomly recruited from the personnel of the same force engaging mostly in administrative works, static technical works and driving. They were not participating in any regular activity or exercise. All subjects were taking their usual diet (breakfast at the worksite, lunch and dinner at home) and were abstinent from medications or supplements prior to the study. Twenty-four hours before measurement, they were sustained from physical activity. In this study, we have applied the NCEP guideline to obtain an accurate picture of the current coronary heart risk factors.

Weight and height were assessed in duplicate, using a digital scale and a standard, wall-mounted stadiometer. Body mass index (BMI) was calculated as weight in kilogram divided by height in meters squared. Participants with BMI values corresponding to an adult BMI of < 25 Kg/m^2 were classified as normal weight, participants with BMI values corresponding to an adult BMI of 25 to 29.9 Kg/m^2 were classified as overweight, and participants with BMI values corresponding to an adult BMI of $\geqslant 30$ Kg/m^2 were classified as obese. Waist circumference was measured at the midpoint between the highest point of the iliac crest and lowest point of the costal margin in the maxillary line, using a nonmetallic, constant-tension tape, with the subjects in the light clothing and the hip or gluteal circumference was taken as the largest circumference at the posterior extension of the buttock. Waist to hip ratio was obtained by dividing the waist circumference by the hip circumference. Seated blood pressure was measured; the 2 readings were averaged after a 10- minutes rest, using a mercury sphygmomanometer device. Blood pressure was considered optimal if the systolic pressure was less than 120 mmHg and diastolic pressure was less than 80 mmHg, borderline if the systolic pressure was 120 to 139 mmHg or diastolic pressure was 80 to 89 mmHg, and elevated if the participant had a mean systolic reading $\geqslant 140$ mmHg or a mean diastolic reading $\geqslant 90$ mmHg and were classified as hypertensive [13].

After an overnight fasting period of 12 hours, a blood sample was drawn from an antecubital vein for measurements of total Cholesterol (TC), triglycerides (TG), high-density lipoprotein cholesterol (HDL-C), and low-density lipoprotein cholesterol (LDL-C). They were assayed by enzymatic colorimetric procedures with the use of commercial reagents (Parsazmun – Iran). Dyslipidemia was defined as borderline high at a total cholesterol concentration $\geqslant$ 200–239 mg/dl, and high at $\geqslant 240$ mg/dl, a borderline high LDL-C concentration at $\geqslant$ 130–159 mg/dl and high at $\geqslant 160$ mg/dl, or an HDL-C concentration < 40 mg/dl, and a borderline TG concentration $\geqslant$ 150–199 mg/dl, and high at $\geqslant 200$ mg/dl [14]. Fasting glucose was measured by the glucose oxidase method. Abnormal level was defined as a fasting plasma glucose concentration ⩾ 110 mg/dl [15].

Risk factor (RF) or a predictor of CHD risk was simply obtained as the TC/HDL-C ratio, and atherogenic index (AI) as the LDL/HDL ratio.

An accredited clinical laboratory (Pasteur Medical Laboratory – Shabestar- Iran) using COBAS MIRA PLUS Auto Analyzer Devise- Switzerland completed all analytic measures.

3. Statistical analysis

Statistical Package for the Social Sciences [(SPSS), New York: McGraw-Hill] used to analyze data. Baseline characteristics of the subjects were presented as percent and mean ± SD and independent sample T-tests were used for comparison of the mean of measurements. Statistical significance was determined using a P-value of 0.05. Estimation of coronary heart disease risk factor ratio subjects were calculated from mean of variables measurements divided by their values defined in NCEP Adult Treatment Panel III.

Relationships between anthropometric indices, two lipids and some common CVD risk factors were determined using Pearson correlation. The odds ratios (ORs) and 95% CI were determined to explore the possible confounding effects of the some of the studied factors as independent variables and activity/inactivity as the dependent variables. They were computed using the usual formula [(a*d)/(b*c)], where a, b, c, and d are the observation in a 2*2 table. The ORs were calculated at a chosen reference or cutoff point for each variable as defined by NCEP- ATPIII, as well.

4. Results

The baseline characteristics of the active and inactive participants along with body composition measurements, lipid profile and relevant risk factors are shown in Tables 1 and 2. At the initial assessment, none of the participants smoked, reported complaints or discomforts of cardiovascular disease, or took antihypertensive or lipid lowering medications.

BMI averaged 26.6 ± 2.9 and 22.7 ± 1.9 Kg/m^2 in the inactive and active groups, respectively. Seventy two percent of the inactive group ($n = 36$) had BMI > 25: nine subjects were classified as overweight (BMI 25-<30) and seven subjects as class 1 obesity (BMI 30–35). In the active group only three subjects had BMI in the range of 25.2–25.8, otherwise the whole group were classified in normal BMI category.

Table 1
Demographic information reported by the participants in the questionnaire

Variable	Inactive (Control)	Active (Case)
Age (year)	30.0 ± 5.35	27.2 ± 5.1
Martial status (n):		
Single	13	20
Married	37	30
Education:		
High school level (%)	64	42
University level (%)	36	58
Smoking	None	None
History of CVD	"	"
History of CVD in family	"	"
CVD or other medication use	"	"
Chest pain or discomfort	"	"

Waist and hip circumferences and W/H ratios averaged significantly higher, in the inactive group. With the recognition that a W/H ratio of 1.0 or greater in men is indicative of android obesity and increased risk for obesity related disease, 10% of the subjects in the inactive group had a W/H ratio of greater than 1, and the entire active group had a W/H ratio of less than 1.0. Compared with the inactive subjects, the active group showed significantly decreased BMI, waist and hip circumference measurements (Table 1).

The data for systolic and diastolic blood pressure measurements revealed that on average the active group had significantly lower mean of measures. Nevertheless, the analyzed data contained the following categories or prevalence's: 62% of the subjects in the inactive group and 50% in the active group had borderline SBP (< 130 mmHg), 6% of the inactive group and 2% of the active group had high SBP, 36% of the subjects in the inactive group and 40% in the active group had borderline DBP (< 90 mmHg), and finally, 34% and 4% had high DBP, as well.

Both groups had a normal level of fasting blood sugar with no significant difference between their means in both groups, although only one subject showed borderline fasting glucose level of 123 mg/dl.

The effects of physical activity on the lipid profile are presented in Table 2. The active group had significantly reduced total cholesterol, triglycerides and LDL- cholesterol levels. The level of HDL- cholesterol significantly increased in the active group. All the levels in the active group were within normal range for each parameter studied, except only two individuals had slightly higher level of total cholesterol (TC = 204 and 230 mg/dl). Meanwhile, in the inactive group, 18% presented the borderline increased level of TC (>

Table 2
Physical characteristics, lipid profile and other risk factors of the inactive (control) and active (case) participants

variable	Control ($n = 50$) mean ± SD [range]	Case ($n = 50$) mean ± SD [range]	P value	Difference
Weight (kg)	80.26 ± 10.90 [60–110]	69.60 ± 8.01 [50–86]	0.000	10.66
Height (cm)	173.43 ± 6.06 [161.2–190]	174.69 ± 6.24 [164–195]	0.309	−1.2
BMI (kg/ m^2)	26.6 ± 2.98 [20.66–33.95]	22.76 ± 1.94 [18.36–25.82]	0.000	3.9
WC (cm)	94.43 ± 8.63 [76–116]]	80.37 ± 9.19 [50–100]	0.000	14.1
HC (cm)	100.27 ± 5.81 [91–114]	96.06 ± 6.99 [79–113]	0.001	2.4
WHR (%)	0.94 ± 0.054 [0.8–1.06]	0.83 ± 0.065 [0.57–0.93]	0.000	0.11
SBP (mmHg)	126.24 ± 9.25 [102.5–147.5]	120.40 ± 9.35 [97–149]	0.003	5.8
DBP (mmHg)	85.38 ± 6.39 [75–97.5]	79.90 ± 5.96 [60–91.5]	0.000	5.4
FBS (mg/dl)	76.50 ± 11.85 [60–123]	76.66 ± 6.61 [67–102]	0.934	−0.1
TC (mg/dl)	187.24 ± 47.17 [114–319]	160.36 ± 27.30 [112–230]	0.001	26.9
LDL (mg/dl)	106.92 ± 29.28 [57.6–175.4]	86.28 ± 20.39 [48–138.9]	0.000	74.9
HDL (mg/dl)	38.25 ± 7.04 [23.9–58.3]	46.56 ± 8.70 [30.2–65]	0.00	−8.3
TG (mg/dl)	172.4 ± 98.60 [62–575]	97.12 ± 36.75 [50–195]	0.000	20.7
AI	2.80 ± 0.61 [1.55–4.66]	1.92 ± 0.57 [0.81–3.11]	0.000	0.88
RF	4.94 ± 1.13 [3.08–9.31]	3.54 ± 0.82 [2.17–5.28]	0.000	1.4

Values are expressed as the mean ± SD [range].

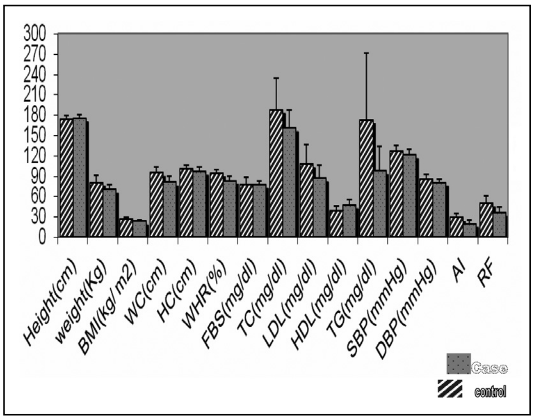

Fig. 1. Comparison of Physical characteristics, lipid profile and other risk factors of the inactive (control) and active (case) participants.

200–239 mg/dl) and 7% with the high level of TC (> 240 mg/dl); 20% with the borderline increased level of TG (150–199 mg/dl) and 28% with the high level of TG (> 200 mg/dl), 16% with the borderline increased level of LDL-C (⩾ 130–159 mg/dl), and 8% with the increased level of LDL-C (⩾ 160 mg/dl), and 60% with the decreased level of HDL-C (< 40 mg/dl). Among active group, 6% presented the borderline high triglyceride, 26% with the decreased HDL-C and two individuals had LDL-C equal to 138 mg/dl. Overall, vigorous physical activity was significant in the magnitude of risk-factor changes. Compared with the active group, the inactive group had a higher atherogenic index and a significant increase (approximately 1.4 fold) in the rate of risk factors for coronary artery disease.

A descriptive comparison of the data of the body composition, lipid profile and blood sugar for both groups is presented in Fig. 1.

The risk factor ratios among the inactive group for BMI, WC, WHR, SBP, DBP, TC, LDL-C, and TG were fairly high, except for HDL-C, which indicates a favorable lower risk for the active group (Table 3).

Simple correlation coefficients between some of the body measurements, two lipid variables (TC, TG) and CVD risk factors were determined. As shown in Table 4, BMI and WHR were significantly associated with SBP in the inactive group, while BMI was also inversely associated with HDL-C in both groups, and WC inversely correlated with HDL-C for the inactive group.

The analysis of the risk factors revealed that the Odds Ratios (ORs) were statistically significant between the two groups, except for SBP and DBP, and subjects without activity had higher risk than active subjects (Table 5).

5. Discussion

Non-communicable diseases currently represent 43% of the global burden of disease and are expected to account for 60% of the disease burden and 73% of all deaths in the world by 2020 [16]. The two leading causes of cardiac failure worldwide are cardiovascular – coronary heart disease (which causes heart attack and heart failure) and cerebrovascular disease (which causes stroke). The direct and indirect costs of CVD are high: enormous health care costs and productivity/income losses [17]. Coronary heart disease (CHD) is a significant cause of morbidity and mortality worldwide. The World Health Organization estimates global mortality associated with CHD to be approximately

Table 3
Estimation(a) of coronary heart disease risk factor ratio among control and case groups

Risk factor	Control	Case
BMI	1.06	0.90
WC	0.92	0.78
WHR	0.94	0.83
SBP	1.05	1.00
DBP	1.06	1.00
TC	0.93	0.80
LDL-C	1.06	0.86
HDL-C	0.95	1.16
TG	1.14	0.64

(a)Calculated from mean of variable measurements divided by their normal values defined in NCEP- ATPIII.

17 million deaths annually, representing about 30% of all deaths globally and will become the greatest cause of morbidity and mortality in the world by the year 2015 [18]. Despite major advances in treatment of ischemic heart disease (IHD), a large number of victims who appear to be healthy, die suddenly without prior symptoms. Available screening and diagnostic methods are insufficient to identify the victims before the event occurs. In developing countries, cardiovascular diseases predominantly affect people of working age (30–64 years). Death and disability in middle age has major social and economic consequences [19].

The most important risk factors for CVD are well-established. They include high blood pressure, elevated glucose and lipid levels, and exposure to tobacco smoke. These risk factors are usually accompanied by overweight and obesity, which are associated with elevated blood pressure and cholesterol levels, and increased risk of developing diabetes. Overweight and obesity are strongly influenced by an unhealthy diet and physical inactivity. Prevention or treatment of risk factors for CVD is effective and sustainable in the long run. The risk of CVD can be reduced quickly and substantially with successful preventive practices. The most important risk factors for CVD are well-established, and are caused by unhealthy lifestyles, such as hypertension, dyslipidemia, obesity, and diabetes mellitus. These risk factors are often clustered within individual patients, dramatically increasing CVD risk [20,21].

Among the strategies for treatment, drug therapy to prevent or treat CVD has focused on individual risk factors, targeting the small proportion of patients and treating individual risk factors in isolation, but is suboptimal for CVD prevention and treatment. As a consequence, the risk remains substantial, with up to two thirds of patients continuing to experience CV events despite treatment [22]. Lifestyle modifications and interventions seem to be at least as effective as drugs [23] and remain the cornerstone of CVD prevention strategies, particularly for individuals with one or more "borderline" risk factors. Dietary changes and other lifestyle alterations can lower the risk of developing CVD and can delay its progression in patients with established disease [24]. Intensive multifactorial interventions combining lifestyle modifications and drug therapy have the potential to dramatically reduce CVD outcomes. Healthful diets like the Mediterranean diet and more physical activity have been shown to reduce cardiovascular risk significantly.

Physical activity is any form of movement using skeletal muscles. Until very recently in history, it was not necessary to encourage patients with CVD to engage in regular, moderate, and at least occasional vigorous, physical activity because daily life required more activity. However, with urbanization and industrialization, general levels of physical activity have declined. Machines now do most of the work previously done by hand; driving and using public transport have largely replaced walking and cycling. While people in higher income countries, and those in urban settings in other countries may engage in some active forms of recreation, they remain largely inactive, and may spend much time in sedentary recreations, such as watching television and using home computers. Exercise and other forms of physical training include recreational physical activity. These may be aerobic, such as running, cycling, dancing, and other activities that increase oxygen uptake and improve cardiovascular function; or anaerobic, such as resistance training using weights, which increases muscle strength and mass. To promote and maintain health, all adults need moderate-intensity aerobic (endurance) physical activity for a minimum of 30 min on five days each week or vigorous-intensity aerobic physical activity for a minimum of 20 min on three days each week [25]. Higher levels of physical activity are associated with fewer CVD events. Although the precise mechanisms underlying this inverse association are unclear, differences in several CVD risk factors may mediate this effect [26]. Therefore, lifestyle modification, in particular physical activity long considered the cornerstone of interventions, is extremely important in reducing the burden of chronic diseases.

Physical inactivity is known to be associated with development of cardiovascular disease, stroke, and diabetes mellitus, conditions that are even prevalent and disabling for military personnel, as well. It is essential to determine to what extent the beneficial changes

Table 4
Simple correlation between anthropometric indices, two lipids and CVD risk factors for control and case groups

Variable	TC		LDL		HDL		SBP		DBP	
	Cont.	Case	Cont.	Case	Cont.	Case	Cont.	Case	Cont.	Case
BMI	$r = 0.034$	$r = 0.105$	$r = -0.038$	$r = 0.247$	$r = -0.302^*$	$r = -0.282^*$	$r = 0.282^*$	$r = 0.123$	$r = 0.179$	$r = -0.042$
	$p = 0.813$	$p = 0.467$	$p = 0.792$	$p = 0.084$	$p = 0.033$	$p = 0.047$	$p = 0.047$	$p = 0.394$	$p = 0.213$	$p = 0.771$
WC	$r = -0.019$	$r = 0.066$	$r = -0.036$	$r = 0.136$	$r = -0.283^*$	$r = 0.135$	$r = 0.265$	$r = 0.140$	$r = 0.231$	$r = -0.029$
	$p = 0.896$	$p = 0.649$	$p = 0.802$	$p = 0.346$	$p = 0.047$	$p = 0.349$	$p = 0.063$	$p = 0.331$	$p = 0.107$	$p = 0.842$
WHR	$r = -0.036$	$r = -0.049$	$r = -0.063$	$r = -0.029$	$r = -0.220$	$r = 0.068$	$r = 0.293^*$	$r = -0.014$	$r = 0.086$	$r = -0.034$
	$p = 0.802$	$p = 0.749$	$p = 0.664$	$p = 0.842$	$p = 0.125$	$p = 0.641$	$p = 0.039$	$p = 0.921$	$p = 0.553$	$p = 0.814$
TG	–	–	–	–	$r = -0.257$	$r = 0.78$	–	–	–	–
					$p = 0.072$	$p = 0.593$				
TC	–	–	–	–	–	–	$r = 0.045$	$r = -0.020$	$r = 0.124$	$r = -0.193$
							$p = 0.756$	$p = 0.891$	$p = 0.392$	$p = 0.179$

*Correlation is significant at the $P = 0/05$ level (2-tailed).

Table 5
Odds ratio (95% CI) for CVD risk factors in control and case groups

	OR	95% CI	P value
BMI > 25	0.025	(0.007–0.093)	0.000
WC > 120	0.820	(0.72–0.93)	0.003
WHR > 0.9	0.90	(0.82–0.98)	0.056
SBP > 120	0.55	(0.22–1.33)	0.260
DBP > 80	0.53	(0.21–1.32)	0.250
TC > 200	0.163	(0.037–0.50)	0.002
LDL-C > 130	0.132	(0.028–0.62)	0.008
HDL-C < 40	0.23	(0.10–0.54)	0.001
TG > 150	0.064	(0.018–0.230)	0.003

documented in the intervention studies is influenced by physical activity. In this study, cross- sectional analysis showed significant differences between active and inactive groups with respect to anthropometric indices (except height, which is natural and complicated due to the age), lipid profile, and systolic and diastolic blood pressures. Relationships between lower levels of physical activity and higher levels of BMI, WC, and WHR and lipid biomarkers and significant lower HDL were observed. These conditions have reported significant associations, predominantly with the development of atherosclerosis and cardiovascular disease. It is well known that increased body weight is associated with inflammatory and lipid biomarkers. Adipose tissue, particularly visceral adipose, is metabolically active, promoting a thrombotic and inflammatory state [27], as well as an atherogenic lipoprotein state with predominance of high triglycerides and low HDL cholesterol [28]. As our results demonstrate, it is clear that significant differences seen on the above factors are the results of engaging in physical activity programs versus inactivity.

According to the findings shown in Table 2, almost all blood lipids were inversely associated with physical activity status, and favorably HDL-C was significantly higher and positively affected by exercise in active group. Systolic and diastolic blood pressures had also the same trend and were significantly lower in active group.

The association of physical activity and inactivity with some of the risk factors was examined. A significant negative association was observed between BMI, WC and HDL, while a positive association was observed between BMI, WHR and SBP in the inactive group. The magnitude of inverse association between BMI and HDL in the active group was weaker than in the inactive group (correlation coefficient: -0.28 vs. -0.30). Increased BMI or adiposity is reported to be associated with the diagnosis of hypertension [29]. The relationship between different risk factors and CVD is reported among different military recruits or forces [30–34], mainly the association between anthropometric measures, lipid profiles, and components of metabolic syndromes.

In our study, the effect of physical activity on blood lipid levels is evaluated in a random sample of cardiovascular disease-free individuals from army personnel. Our study shows that higher levels of physical activity clearly and substantially lower the measures of risk factors of CVD, accounting for a substantial portion of the benefit of physical activity on CVD risk reduction. Previous studies have demonstrated favorable effects of physical activity on traditional risk factors. Some individuals experience large changes in risk factors with exercise, while most individuals experience modest short-term changes [35,37,37–41]. Cardiovascular and metabolic health benefits occurred within 40 days of vigorous physical activity. Physical activities should be encouraged, even for people with risk factors, and can be prescribed in a gradually increased manner [42]. Even moderate level of physical activity (at least 600 kcal/wk, or the equivalent of just over 2 h/wk of brisk walking) was identified as a potential underlying mechanism to lower risk of clinically important CVD events [26].

High cholesterol levels are responsible for 20% of the global burden of cerebrovascular disease, and 60% of coronary heart disease. Important determinants of cholesterol levels, which can be modified, include intake of saturated and trans-fatty acids, and physical activity. Consistent with our findings, current studies suggest that LDL-C can be lowered by 5 to 10%, whereas HDL-C can be raised by between 3 and 6% with regular exercise. Exercise an important weapon in the fight against obesity, overweight, high cholesterol and heart disease, and can also strengthen the heart, bones, and other muscles of the body [43]. A growing body of evidence from human and animal data confirms an important beneficial role for exercise in the prevention and treatment of CVD [44,45]. The results of meta-analysis reports the strongest correlation is between duration of exercise sessions and elevation in HDL-C levels [46]. In addition, HDL-C $<$ 35 mg/dl was found in 16% to 18% of men and 3% to 6% of women [47]. Furthermore, clinical data have shown that interventions that raise HDL-C reduce residual CHD risk by 30% to 40% [48]; each 1-mg increase in HDL-C has been associated with a 2% to 4% reduction in residual CHD risk [48,49].

The association of triglycerides with incident cardiovascular disease remains controversial; however, the evidence that elevated serum TG levels are associated with increased risk for atherosclerotic events is increasing. In most studies, TG levels are typically obtained in the fasting state; however, postprandial hypertriglyceridemia plays an important role in atherosclerosis [50]. Elevated LDL-C, low HDL-C, and high TG levels have all been clearly demonstrated to be independently associated with increased CHD risk [51]. In our study, physical activity reduced the serum TG levels. This provides further evidence that physical activity should be encouraged as part of lifestyle therapies to reduce risk for CHD. Similarly, physical activity as a major lifestyle modification has been shown to lower blood pressure via weight reduction in those individuals who are overweight or obese [52,53]. In our study, subjects engaging in regular aerobic physical activity were shown to have lower SBP and DBP and improved cardiovascular risk.

From the ORs in Table 5, it is clear that inactivity is strongly associated with elevated anthropometric indices and dyslipidemia, as is often reported.

Currently, there are one billion overweight or obese people globally. Overweight and obesity are associated with elevated blood pressure and cholesterol levels, and an increased risk of developing diabetes. Excess body fat (generalized or abdominal) accounts for about 60% and 20% of the global burden of diabetes and coronary heart disease, respectively. Major modifiable determinants of overweight and obesity are unhealthy diet and physical inactivity. The latter is essential to account for about one-fifth of the global burden of coronary heart disease [54]. Physical inactivity reduces caloric expenditure and probably contributes to obesity and to its associated lipid and nonlipid risk factors. In middle-aged British men, major CVD risk increased by 6% for each 1 kg/m^2 increase in usual BMI [55]. The obesity epidemic that is affecting the general U.S. population is also posing problems for the U.S. military. Among new military recruits the percentage of overweight and obesity among 18- year old civilian applicants increased from 25.6% in 1993 to 33.9% in 2006 [56]. At present, according to a U.S. military spokeswoman, 16% of active duty personnel are obese [57]. To promote fitness and health, programs have been developed that utilize nutrition and fitness counseling to move military personnel and their families toward healthier food choices, exercise habits, and lifestyles. Those who wish to improve their personal fitness, reduce their risk for chronic diseases and disabilities or prevent unhealthy weight gain may benefit by increasing the amounts of physical activity [25, 58,59]. Data from the Behavioral Risk Factor Surveillance System indicated that from 2001 to 2005, the prevalence of regular physical activity increased 8.6% among women and 3.5% among men [60]. Improved anthropometric measures observed among active duty personnel in our study serve as an important model for this approach.

In summary, our findings indicate that major CVD risk factors in our study were favorably affected by regular exercise and physical activity. Additionally, there were significantly different results between active and inactive military personnel. These results serve to underscore the beneficial properties of physical activity and suggest that behavioral interventions for sedentary individual servicemen may be required to promote the effectiveness of physical activity as a support for healthier lifestyles. It was shown that those who were physically active generally had lower levels of risk factors. Programs that promote physical activity would reduce unhealthy risk behaviors in the community and especially among military servicemen, which would in turn decrease chronic morbidity and mortality.

Implementation of proper programs to reach these goals requires the exercise professionals to reach out and work closely with health care providers to determine the most effective and practical way to include exercise research and/or interventions into routine care or the therapeutic lifestyle changes.

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