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Long term physical exercises improve cardiometabolic risk factors

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Abstract

Regular physical exercises have shown to improve the biochemical indices of cardiometabolic diseases. This study was carried out to assess the effect of the length of physical exercises on these biochemical parameters in healthy young men. Ninety participants who are undergoing regular physical exercises during military training and thirty controls were recruited in this study. They were categorized into four groups; Non–exercised control group (NE), exercised for 6 months (E6M), exercised for 18 months (E18M) and exercised for 30 months (E30M). Thirty participants were included in each group. Plasma HDL-cholesterol, triglycerides (TG), total cholesterol (TC), glucose and haemoglobin levels were measured using enzymatic techniques and colorimetric methods. LDL-cholesterol level was calculated using the standard equation. A significant reduction in mean TG was observed in all groups that underwent regular exercises ($p<0.05$). LDL-cholesterol and TC levels were also significantly low in groups E18M and E30M. HDL-cholesterol levels were significantly high in groups who exercised for more than 18 months ($p<0.005$ in E18M and $p<0.01$ in E30M). Plasma glucose was significantly reduced after 18 months of exercise ($p<0.05$). Plasma haemoglobin levels showed an increase with exercises but it was significantly reduced in E30M ($p<0.05$). In addition exercised groups showed improved BMI values. Results of this study imply that exercise during military training improves the risk factors of cardiometabolic diseases such as body composition, lipid profiles and glucose levels favorably. Further the improvements become significant when the duration of the exercises ≥18 months.

Keywords: exercise, cholesterol, triglycerides, glucose, haemoglobin, cardiometabolic.

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Introduction

Physical inactivity has been considered as a risk factor for early mortality [1]. Current epidemiological studies have shown a direct relationship between physical inactivity and metabolic syndrome [2]. Metabolic Syndrome increases the risk for non communicable diseases such as Coronary Artery Disease (CAD), stroke and diabetes [3, 4, 5]. The prevalence of cardiometabolic risk factors in young adults is increasing with the sedentary life style due to industrialization and urbanization [6, 7]. Obesity, hypertension, dysglycaemia and dyslipidaemia have been identified as significant regulators of the individual's risk for cardiometabolic diseases [5, 6, 7]. Several studies have shown that cardiometabolic diseases are robustly increasing worldwide in young adults and are more common amongst the South Asian populations [8]. Therefore it is important to focus on early identification of metabolic risk factors of the young population and measures need to be taken to prevent at earliest possible.

Regular physical exercises have shown to improve health parameters of people [9]. However, the amount of physical exercises (light, moderate or more intense) required to gain significant improvements in the biochemical parameters in the absence of diet control remains controversial. Physical exercise is an integral part of military training. Military service requires maintaining of the body composition, fitness and medical standards [10, 11]. The young officer cadets recruited to the General Sir John Kotelawala Defence University (KDU) undergo regular intense physical training in addition to their academic work. This study was carried out to assess the effect of the length of physical exercises on biochemical parameters of these young men.

Materials and Methods

A group of 120 healthy participants were selected (random sampling) from the officer cadets and the non-military civil students recruited to KDU. The study samples consisted of gender matched four groups with 30 participants in each group. The ages ranged from 18 – 22 years. The three exercised groups were consisted of officer cadets who had formal military training with regular exercise for varying durations; six months (E6M), eighteen months (E18M) and thirty months (E30M). A group of 30 students from non-military civil students with no regular exercises was taken as the non-exercised (NE) control group. Ethical approval from the Ethics Review Committee of the General Sir John Kotelawala Defence University was obtained for this study and the study was conducted according to the Declaration of Helsinki. Written informed consent was obtained from all participants.

Exercise protocol

The exercised groups participated in a supervised, progressive, strength training program, with 45 minute to 2 hour sessions five days a week which included running, stretching and muscle strengthening exercises. In addition, a 45 minute swim per week was also conducted.

Anthropometric measurements

Anthropometric measurements of height, weight, waist and hip circumference were performed in all subjects. Height was measured to the closest 0.1 cm using a calibrated stadiometer (Seca, Rumily, France) and weight was measured with a calibrated electronic weighing scale (Seca, Rumily, France) in light clothing to the nearest 100g. Both height and weight were taken without footwear. BMI of each individual was calculated by weight (kg) divided by height (m). Waist circumference was taken at the midpoint between the iliac crest and the last rib in expiration using a flexible measuring tape to the nearest 0.1 cm. The hip circumference was also measured at the widest part of the buttocks at inter-trochantric level to the nearest 0.1 cm using the same tape. Both waist and hip circumferences were measured by one person in the research team to avoid the personnel errors.

Blood pressure measurement

Seated blood pressure was measured by a mercury column sphygmomanometer. All data were entered in a pre-designed data collection booklet.

Blood sampling and biochemical determination

About 5 mL of venous blood samples were drawn into heparinised tubes after 12 hours of overnight fast. The samples were centrifuged immediately at 1500×g for 15 min to separate plasma. Plasma samples were used to measure glucose, HDL-cholesterol, triglycerides (TG), total cholesterol (TC) and haemoglobin concentrations. Glucose concentration was measured by GLUCOSE GOD-PAP (Biolab, France). HDL-cholesterol level was measured using HDL Cholesterol kit (Human, Germany). A TG kit (Biolab, France) was used to measure TG levels and cholesterol liquicolor kit (Human, Germany) was used to measure TC levels. Plasma haemoglobin levels were measured using a haemoglobin assay kit (Biolab, France). All the reactions were carried out according to the manufacturer's protocols and colorimetric determination was done at given wave lengths using a spectrophotometer. LDL-cholesterol was calculated by using the following standard equation; LDL = TC-HDL-TG/5.0 (mg/dL).

An interviewer administrated questionnaire was given to the participants to collect information about the participants' sleeping behavior, alcohol usage, smoking habits and medication usage.

Statistical analysis: Statistical analyses were conducted using SPSS 20.0 statistical software. Analysis of variance followed by post-hoc test was used to evaluate the difference between mean values of exercise groups and NE group. $p \leq 0.05$ was considered as the significance to reject the null hypothesis.

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Results

Effect of exercises during military training on BMI

BMI values obtained for NE group and the exercised groups lied within the normal range (18.50 - 24.99 kg/m^2) according to the WHO's "International Classification of adult underweight, overweight and obesity according to BMI". The mean anthropometric characteristics of the study groups are presented in Table 1. However, in an attempt in developing a population specific BMI for the Asian populations it was found that Asian populations have higher tendency in developing type 2 diabetes and cardiovascular disease at BMIs lower than the WHO cut-off points for overweight and varies from 22 kg/m^2 to 25 kg/m^2 [12]. Additional cut-off points were added to have sub categories within the normal range [12]. According to the obtained results, the mean BMI of NE group is higher than the exercised groups and falls within the second sub category (23.00- 24.99 kg/m^2) of the WHO BMI classification. All the exercised groups showed the mean BMIs in the first sub category of the WHO BMI classification (18.50-22.99 kg/m^2).

Table 1: Mean anthropometric characteristics of the study groups

Group	Mean height (m)	Mean weight (kg)	BMI (kg/m^2)	Waist circumference (cm)	Hip circumference (cm)
NE	1.68±0.10	67.30±13.48	23.84±3.10	89.55±9.72	102.45±7.58
E6M	1.69±0.05	59.1±7.54	20.70±2.42	79.66±6.13	91.56±6.62
E18M	1.72±0.06	58.70±7.29	19.84±4.47	82.07±6.33	94.33±5.35
E30M	1.68±0.07	63.00±9.63	22.32±2.38	83.06±6.70	97.27±5.59

Values are mean± standard deviation. **NE**, Non–exercised control; **E6M**, exercised for 6 months; **E18M**, exercised for 18 months; **E30M**, exercised for 30 months

Table 2: P values of one way ANOVA and means for different types of serum lipids, glucose and hemoglobin of different study groups

Biochemical parameter	NE	E6M	E18M	E30M	P One way ANOVA
Total Cholesterol (mg/dL)	181.3±7.6	178.4±5.3	167.5±7.1*	145±8‡	0.01
HDL-Cholesterol (mg/dL)	40.1±6.5	38.8±1.3	44.3±1.7‡	55.7±5.9*	0.000
LDL- Cholesterol (mg/dL)	129.3±9.9	128.1±5.7	120.2±7**	85.4±9‡	0.000
Triglycerides (mg/dL)	95.7±5.4	55.1±3.1	40.4±3.3‡	60.1±3.3*	0.006
Glucose(mg/dL)	90.2±1.7	80.7±1.7	75±1.8**	85±3.5	0.04
Haemoglobin(g/dL)	16.37±0.52	17.74±0.63	17.76±0.64	13.38±0.47**	0.00

Values are mean± standard error. **NE**, Non–exercised control; **E6M**, exercised for 6 months; **E18M**, exercised for 18 months; **E30M**, exercised for 30 months

†P <0.001 for the comparison with the control group.

‡P <0.005 for the comparison with the control group.

*P <0.01 for the comparison with the control group.

** P <0.05 for the comparison with the control group.

Effect of regular exercises during military training on lipid profile

Mean serum lipid concentrations of different study groups are shown in table 2. The reduction in TC was significant in the exercised groups E18M (p<0.01) and E30M (p<0.005) compared to the NE group. 20% reduction in TC was observed after 30 months of regular exercises (NE=181.3±7.6 vs E30M= 145±8 mg/dl; p<0.005; Fig 1A).

The exercising groups showed a significant decrease in LDL cholesterol with prolong exercises and 33.9% decrease was observed in E30M group compared to the NE group (p<0.05) (Fig 1B). Significantly high levels of HDL-cholesterol were seen in groups who underwent exercises for more than 18 months (p<0.005 in E18M and p<0.01 in E30M) (Fig 1C), E30M showed 38.9% increase in HDL compared to NE. Further, decreased LDL to HDL cholesterol ratios were observed in the exercising groups. 37.2% reduction in TG was seen after 30 months of exercises. Mean TG levels were of exercised groups were significantly different from NE; E6M ($p<0.005$), E18M ($p< 0.05$) and E30M ($p<0.001$) (Fig 1D). An increase in the TG levels in E30M compared to the E18M was observed.

Effect of regular exercises during military training on blood glucose level

Glucose concentration of the NE group is significantly different from the exercised groups and lies near the upper limit of the normal fasting blood glucose range of a healthy adult. Majority of the NE group members (64%) had fasting glucose levels more than 100 mg/dL. In consistent with the pattern showed for TG levels, E30M showed increase in blood glucose level compared to the other two exercising groups (Fig 1 E).

Effect of regular exercises during military training on haemoglobin levels

As shown in figure 1 F, a rise in hemoglobin levels was observed when the duration of the exercise period was increased. A similar trend has been observed by previous studies [13]. However E30M showed marked decrease in their hemoglobin levels.

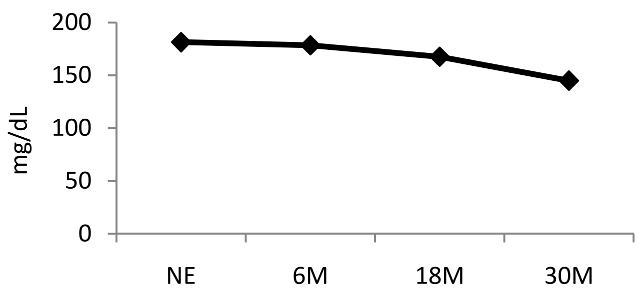

Figure 1.A: The pattern of total cholesterol level with the duration of exercise

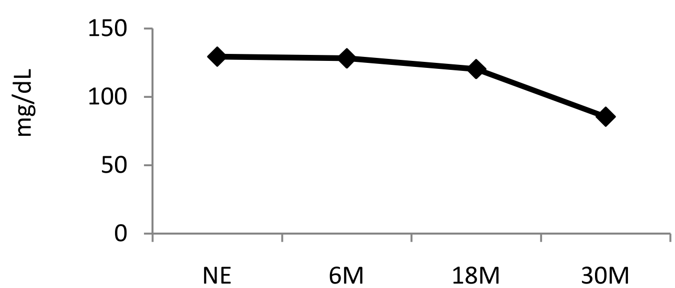

Figure 1 B: The pattern of LDL- cholesterol level with the duration of exercise

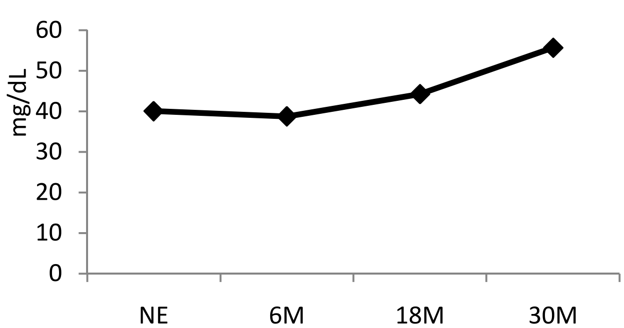

Figure 1C: The pattern of HDL- cholesterol level with the duration of exercise

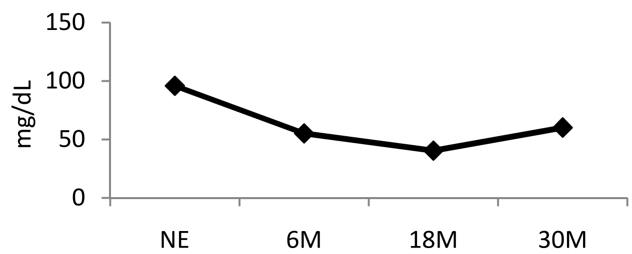

Figure 1 D: The pattern of triglycerides level with the duration of exercise

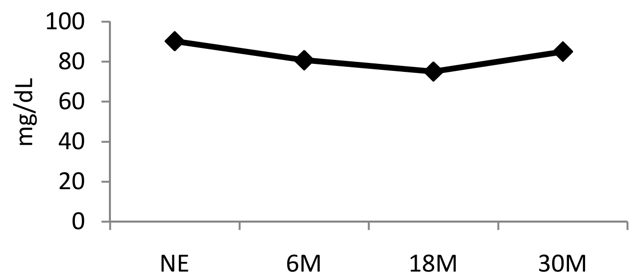

Figure 1 E: The pattern of glucose level with the duration of exercise

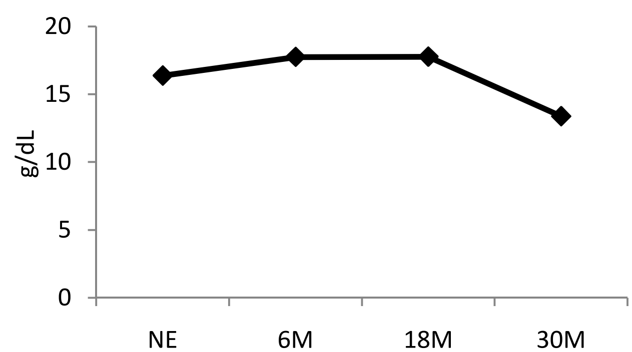

Figure 1 F: The pattern of hemoglobin level with the duration of exercise

Discussion

In this study it was found that the regular physical exercises conducted as a component of cadet training significantly improves the BMI, lipid profiles, fasting glucose and hemoglobin levels and the effect is clearly seen in groups underwent prolong exercises. Further, the study emphasizes the importance of having same amount of exercises in order to maintain the desirable effects.

Blood samples were drawn from 30 subjects from each group; however two subjects from E6M and E30M were excluded from the study as their blood was clotted at the time of experiment being conducted. Analysis of the questionnaire revealed that the recruited subjects had not smoked or consumed alcohol or any alcohol containing beverages during 48 hours prior to the time of the withdrawal of blood and other physiological data collection. Further all the included subjects have had at least 5 hours sleep in the previous night. No study subject was on any kind of medication or vitamin supplement.

In this study the significant improvements in lipid levels were observed after 18 months of regular exercise. This trend was particularly seen in total cholesterol, LDL and HDL cholesterol levels. These findings are consistent with the data published in previous studies [14]. Diet is an important factor of lipid profile [15]. However, our study was conducted in a military setting and the dietary intervention was not included. The beneficial changes observed in the physiological parameters were attributable to controlled regular exercise program without dietary intervention.

High TG levels and glucose levels in blood are indicators of low insulin resistance that leads to type 2 diabetes [16]. Our results show improvements in blood glucose levels and TG after a significant period of regular exercises. Obesity is also related to the lipid profile particularly with the increase of TG, LDL and decrease in HDL levels [17]. Our data is in agreement with these findings and show that regular exercises during military training reduced unhealthy lipid levels while increasing HDL levels and maintaining the BMIs within the most favorable range. It is important to note that all the biochemical parameters tested showed unfavorable increase in the E30M group in general. This is attributed to the fact that the cadets of the E30M group were in their final year of the degree program, hence the time allocated for exercises per day was less than the exercises given to E6M and E18M as they are given more time to concentrate on their academic work. It implies that the same amount of regular exercises is required for maintaining the above parameters in the favorable range.

However, the present study has limitations. Changes in the diet, exclusion of the most obese due to their exception from the military recruitment during the medical examination and the environment associated changes may have had influence on the parameters we measured.

Numbers of people developing cardiometabolic diseases in mid and late adulthood (above 40 years) are increasing rapidly [18, 19, 20]. Therefore in order to prevent cardiometabolic diseases, it is important to identify and manage the risk factors associated with these diseases in young adults.

Conclusion

We believe that this is the first scientific evaluation of physical and biochemical indicators of the young cadets recruited to the armed forces in Sri Lanka which reveals the beneficial effects of the long term regular exercise during military training. Results of this study implies that the standard regular exercises improves the indicators of cardiometabolic diseases such as body composition, lipid profiles and glucose levels favorably and emphasizes the effectiveness of intense exercises as a strategy of improving the common cardiometabolic risk factors. Further the improvements become significant when the duration of the exercises increases to 18 months or more. Hence conducting physical exercises at a constant intensity for long periods maintains the cardiometabolic risk factors at a favorable range.

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