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Reduction in Hypertension and Related Lipid Profile Parameters after Exercise in Females

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Abstract: The effect of exercise on BMI and plasma lipid profile has been investigated in hypertensive females of four ethnic groups of Baloch (B), Pathan (P), Hazara (H) and Punjabi (PU). A total of 32 females, i.e. 8 from each group as control and another batch of 32 females' in similar distribution followed prescribed exercise protocol for ten weeks. After the trial fasting blood samples were collected from controlled group and exercised subjects. Exercise manifested significant decrement in Systolic Blood Pressure (SBP) in P, H and PU groups and of Diastolic Blood Pressure (DBP) in all the ethnic sub-populations. Marked and significant decrease of total cholesterol in all the ethnic groups was observed and the lowering of LDL cholesterol was also found in most except Pathan sub-population. Striking and significant rise of HDL of the exercising females was observed in all ethnic sub-populations. Triglyceride levels were considerably and significantly lowered in B, P, and H subjects. The beneficial effects of exercise on blood pressure and plasma lipids in female hypertensive subjects have been clearly demonstrated.

Key words: Exercise, blood pressure, cholesterol, high density lipoprotein, low density lipoprotein

INTRODUCTION

Hypertension is one of the most frequent chronic conditions in medical consultation (Grundy *et al*., 1998; Moleiro and Perez, 2003) and leading cause of death worldwide (Kearney *et al*., 2005) being major risk factor for stroke and Coronary Heart Disease (CHD) in adults. Blood pressure above optimal (<120 <80 mm Hg) is established as a major cardiovascular disease risk factor (Chiriac *et al*., 2002; Stamler *et al*., 2003).

High blood pressure is associated with overweight tendencies and obesity (Marc *et al*., 2001). According to Guimaraes (2002) elevation of blood pressure is associated with body mass index, life style and family history of hypertension, cardiovascular diseases and diabetes. Saito *et al*. (2003) reported the presence of positive correlation of blood pressure with Body Mass Index (BMI). BMI index has been reported to be the most important predictor of both types of blood pressure independent of life style and family history (Fu *et al*., 2003). Hypertension has been shown to be particularly important in women because of it being modifiable risk factor and is extremely prevalent in older women (August and Oparil, 1999).

Vigorous exercise has been proven the best way to help lower blood pressure (Diya, 2009). An immediate (acute) reduction in BP following exercise has been termed 'post-exercise hypotension' and is agreed to be caused by reductions in vascular resistance (the resistance to flow that must be overcome to push blood through the circulatory system) (Hamer, 2006). The beneficial effect of physical activity has been demonstrated by many trials. Data from more than 40 observational studies showed clear evidence of an inverse relationship between physical activity and all cause mortality (Kahn *et al*., 2002). Regular physical activity of about forty five minutes daily is associated with a significant 20-30% reduction in risk of all cause mortality. Contrarily it is also suggested that exercise has little effect on reducing resting systolic and diastolic blood pressures in children and adolescents (Alpert and Wilmore, 1994).

Regular participation in physical activity as well as a single exercise session can positively alter cholesterol metabolism (Durstine and Haskell, 1994). Exercise is involved in increasing the production and action of several enzymes that function to enhance the reverse cholesterol transport system (Durstine and Haskell 1994). Exercise has been shown to improve blood pressure, lower the risk of cardiovascular heart disease, improve lipid profiles (i.e. raise HDL, lower LDL and total cholesterol) and enhance insulin sensitivity (Diya, 2009). Many studies have shown that regular exercise is beneficial and increases the HDL level and decreases total cholesterol and LDL levels (Khan *et al*., 1987; Thompson *et al*., 1997; Leon and Sanchez, 2001). These responses are, however, affected several interacting factors such as age, sex, ethnicity, and steroid hormones, although the strongest predictors are exercise-induced plasma volume changes, dietary habits and initial fitness levels (Krummel *et al*., 1993; Leon, 1991).

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There are reports of no effect of exercise on lipid profile as of Rowland *et al.* (1996) and Welsman *et al.* (1997) did not observe any significant changes in blood lipid levels after aerobic training. Aellen *et al.* (1993) reported that exercise failed to induce beneficial alterations in the lipoprotein profiles, especially in the anti-atherogenics (reduces LDL and increases HDL). The study of Tsekouras *et al.* (2008) has reported the partial beneficial effects. These contrary results expound the need of further investigation in assessing the effect of exercise on lipid profile from different aspects.

Hypertension is becoming an increasing common disease in the developing countries (WHO, 1978) including Pakistan and because of traditional sedentary lifestyle women population is more vulnerable to increase in BMI and hypertension (N.H.S of Pakistan, 1997). The present study is carried out for a trial of evaluating the effect of exercise in the women particularly to promote healthy lifestyle and reduce health risks.

MATERIALS AND METHODS

The work was carried out on hypertensive subjects of different ethnic groups including Baloch (B), Pathan (P), Hazara (H) and Punjabi (PU) inhabitants of Quetta region of Balochistan. Participant volunteers were recruited from the local community, primarily through newspaper advertisements and through pasting posters in all departments of University of Balochistan, Bolan Medical College, hospitals, telephonic messages, emails and by counseling in different communities and also in various medical camps.

The subjects smoking, with history of CAD, renal impairment or proteinuria, hepatic impairment, gout or hyperuricemia, diabetic neuropathy or retinopathy was excluded from the trial. It was ascertained that participating subjects did not participate in an exercise program for at least 6 months prior to study and followed only the exercise protocol of the trial.

Assortment of hypertensive subjects were according to the WHO (1978) standard, where hypertension in adults is arbitrarily defined as systolic blood pressure to or greater than 160 mm Hg or/or diastolic pressure equal to or greater than 95 mm Hg. Resting systolic and diastolic blood pressure was measured indirectly using a standard sphygmomanometer (Wenzhou, China) after the subjects sat for 10 min rest. Measures were taken 3 times at 2 min interval and an average of the last two measures was calculated (Khan *et al.*, 1993).

Body mass and body height were measured in control as well as exercised group and body mass index was calculated following the procedure of Santos *et al.* (2001).

Sixty four sedentary hypertensive women participated in the study. All participants were free living and consumed self selected foods. Following 12 h fasting blood was drawn from 64 participating volunteer women with 16 from each ethnic group. Of these 32 (8 from each ethnic group) were prescribed exercise for 10 weeks. Motorized treadmill (Green master, china) was used for exercise. Exercise consisted of walking on the treadmill 4 times per week. Each session lasted about 50-60 min including a warm up time (5-10 min), fat burning period (10 min), aerobic exercise (15 min) the main performance with treadmill exercise (15 min) and a cool down period (10 min). After completion of 10 week exercise session the exercising along with non exercising participants were again sampled blood with 12 h fast and serum was stored at -20°C.

Body mass index, blood pressure (systolic and diastolic) and lipid profile (total cholesterol, LDL-cholesterol, HDL-cholesterol and triglyceride) were estimated with commercial kits (Human Gesellschaft fur Biochemica und Diagnostica mbH, Germany) under the similar laboratory conditions for all the control and exercise performers.

Statistical analysis was undertaken with statistical program of Sigma Stat 3.5. Student t test was used for comparison between normal and obese subject groups and $p<0.05$ was considered as statistically significant.

RESULTS

The blood pressure comprised Diastolic Blood Pressure (DBP) and Systolic Blood Pressure (SBP), while lipid profile comprised the monitoring of total Cholesterol (CHO), Low Density Lipoprotein Cholesterol (LDL), High Density Lipoprotein Cholesterol (HDL) and Triglycerides (TG) concentrations.

Age and BMI: In non exercising control subjects the mean age was 43.125±6.0, 44.3±5.4, 47.6±5.2 and 44.9±4.2 years in Baloch, Pathan, Hazara and Punjabi sub-populations respectively. In exercising volunteers average age was 48.9±6.6, 40.1±5.0, 43.4±4.9 and 38.9±5.2 years in Baloch, Pathan, Hazara and Punjabi sub-populations respectively (Table 1).

The average value of BMI in control female volunteers was 30.7±2.3, 31.0±1.6, 28.3±1.2 and 32.0±1.7 kg/m^2 and in exercising subjects was 28.9±2.3; 29.5±1.1; 29.0±1.2 and 28.0±0.8 kg/m^2 (Table 1).

Table 1: Age (years) and BMI (kg/m^2) of hypertensive control and exercise performing group

	Age (Control)	Age (Exercise)	BMI kg/m^2 (Control)	BMI kg/m^2 (Exercise)
Baloch	43.1±6.0	48.9±6.6	30.7±2.0	28.9±2.3
Pathan	44.3±5.4	40.1±5.0	31.0±1.6	29.5±1.1
Hazara	47.6±5.2	43.4±4.9	28.3±1.2	29.0±1.2
Punjabi	44.9±4.2	38.9±5.2	32±1.7	28±0.8

Blood pressure

Systolic: Exercise showed appreciable fall of systolic blood pressure in all ethnic subjects except in Baloch where slight reduction has been noticed. The statistically significant ($p<0.051$), ($p<0.023$) and ($p<0.040$) decrease levels of 9.7, 9.8 and 11% were noticed in P, H and PU subjects respectively in exercised group (Fig. 1).

Diastolic: Exercise of ten weeks manifested tremendous and significant ($p<0.001$), ($p<0.001$), ($p<0.015$), ($p<0.020$) reduction of 18.1, 12.8, 12.1 and 9.2% in DBP in B, P, H and PU ethnic groups, respectively (Fig. 2).

Cholesterol: Fraction of total cholesterol was significantly ($p<0.002$), ($p<0.007$), ($p<0.001$), ($p<0.018$) reduced in all ethnic groups with noticeable change of **14.3, 9.7, 9.8 and 10%** in B, P, H and PU subjects respectively. However, the level ranged between 261.1±6.6 to 263±6.6 mg/dl and 226±7.3 to 236 mg/dl in control and exercised hypertensive group correspondingly (Fig. 3).

LDL cholesterol: Exercise trained hypertensive subjects manifest marked and significant ($p<0.006$), ($p<0.002$), and ($p>0.001$) reduction in LDL-cholesterol levels in B, H and PU volunteers respectively. Nevertheless the levels ranged 164.5±7.6 to 173±1.8 mg/dl in controlled hypertensive and 47.8±4.4 to 156±3.4 mg/dl in exercised hypertensive subjects respectively.

HDL cholesterol: The HDL cholesterol levels in control hypertensive subjects ranged between 33.5±0.9 to 36±0.8 mg/dl and in exercised volunteers it varied between 43.5±2.5 to 47.8±1.7 mg/dl. Exercise exhibited tremendous and significant ($p<0.01$), ($p<0.001$), ($p<0.001$) and ($p<0.001$) rise with 26, 33, 42 and 25% of HDL-cholesterol levels in B, P, H and PU sub ethnic populations respectively.

Triglyceride: Exercise explicit evident and statistically significant ($p<0.001$), ($p>0.001$) and ($p<0.001$) fall in triglycerides levels with 14.2, 6.9 and 8.9% in B, P and H subjects, respectively. However, the levels ranged between 197±1.8 to 201.5±2.8 mg/dl in controls and 170.1±5.8 to 183.7±3.6 mg/dl in exercise followers.

DISCUSSION

It is a sign of modern times that increasing rates of urbanization and associated behavioral changes have led to a higher prevalence of a sedentary lifestyle and less exercise. For example, it is estimated that children today spend 600 kcal/day less on physical activity than their counterparts 50 years ago (Boreham and Riddoch, 2001). Unsurprisingly, we are facing an epidemic of hypertension, obesity, metabolic syndrome and diabetes mellitus-which, unless tackled proactively, will result in

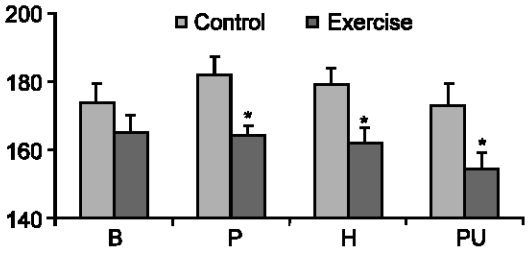

Fig. 1: Systolic blood pressure (mm Hg) in hypertensive female subjects of control and exercise trainers in B (Baloch), P (Pathan), H (Hazara) and PU (Punjabi) ethnic groups. ***p<0.001

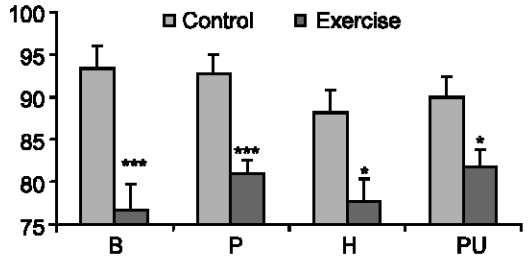

Fig. 2: Diastolic blood pressure (mm Hg) in hypertensive female subjects of control and exercise trainers in B (Baloch), P (Pathan), H (Hazara) and PU (Punjabi) ethnic groups. *p<0.05, ***p<0.001

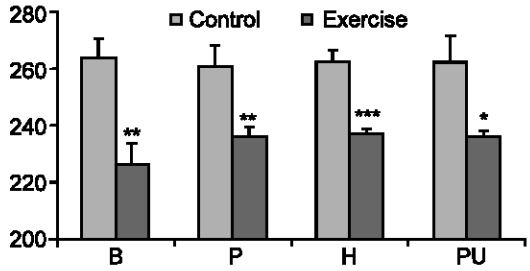

Fig. 3: Serum cholesterol mg/dl in hypertensive female subjects of control and exercise trainees in B (Baloch), P (Pathan), H (Hazara) and PU (Punjabi) ethnic groups. *p<0.05, **p<0.01, ***p<0.001

an increase in cardiovascular diseases, especially in the young and middle aged. Lifestyle changes-especially exercise- and relationships to hypertension may need greater attention, especially at a population level.

The overall results regarding blood pressure of present study suggested that exercise has beneficial and encouraging effect on reducing systolic and diastolic blood pressures in almost all studied pub-populations of hypertensive females. Blood pressure was significantly decreased in all ethnic groups except SBP in Baloch individuals. The SBP was markedly reduced in

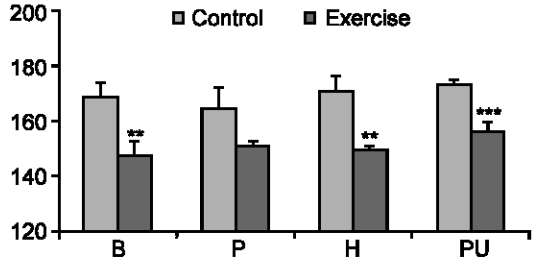

Fig. 4: Serum LDL cholesterol mg/dl in hypertensive female subjects of control and exercise trainers in B (Baloch), P (Pathan), H (Hazara) and PU (Punjabi) ethnic groups. **p<0.01, ***p<0.001

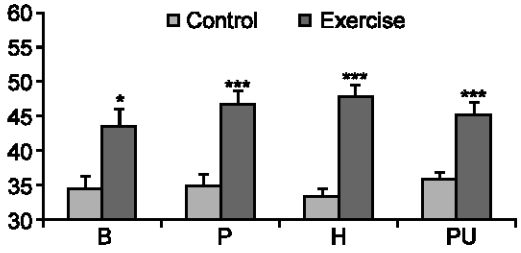

Fig. 5: Serum HDL cholesterol mg/dl in hypertensive female subjects of control and exercise trainers in B (Baloch), P (Pathan), H (Hazara) and PU (Punjabi) ethnic groups. *p<0.05, ***p<0.001

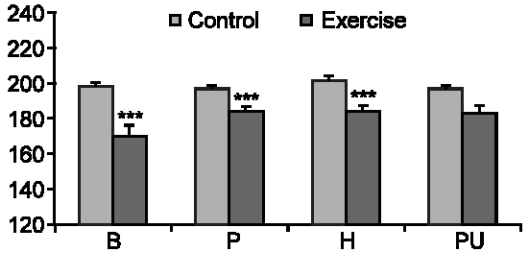

Fig. 6: Serum triglycerides mg/dl in hypertensive female subjects of control and exercise trainers in B (Baloch), P (Pathan), H (Hazara) and PU (Punjabi) ethnic groups. ***p<0.001

P (p<0.05), H (p<0.05) and PU (p<0.05), where as remarkable decrement [B (p<0.001), P (p<0.001), H (p<0.05) and PU (p<0.05)] was noticed in DBP in all ethnic groups.

Similar results have been reported by Kelley *et al.* (2003) and Tsai *et al.* (2002) who in 12 week exercise trials observed that the mean maximal reductions in clinic BP were 11 mm Hg for systolic and 5 mm Hg for diastolic pressure. Hagberg *et al.* (2000) and Chiriac *et al.* (2002) indicated that exercise training decreases Blood Pressure (BP) in approximately 75% of individuals with hypertension, with systolic and diastolic BP reductions averaging approximately 11 and 8mm Hg, respectively. Recently Kovacs *et al.* (2009) demonstrated that blood pressure decreased without any change in BMI or body fat seemed to confirm the independent effect of exercise. Women may reduce BP more with exercise training than men and middle-aged people with hypertension may obtain greater benefits than young or older people.

The study of Alpert and Wilmore, 1994 also supported these results that exercise reduced resting blood pressure in normotensive adolescents, but that aerobic exercise consistently reduced resting blood pressure in hypertensive adolescents. However, the study suggested that exercise has little effect on reducing resting systolic and diastolic blood pressures in children and adolescents.

The mechanisms associated with the chronic adaptations to blood pressure are more complex. A recent meta-analysis supports this chronic role being partially explained by a decreased systemic vascular resistance in which the autonomic nervous system and renin-angiotensin system (a hormone system that helps normalize long-term blood pressure and blood volume in the body) are most likely the underlying regulatory mechanisms (Cornelissen and Fagard, 2005). Another factor contributing to this decrease in vascular resistance is the increase of nitric oxide production (from different sites in the body) causing a vasodilation (increase in the internal diameter of a blood vessel that results from relaxation of smooth muscle within the wall of the vessel) in response to regular aerobic exercise.

Patients with hypertension also improve plasma lipoprotein-lipid profiles and improve insulin sensitivity to the same degree as normotensive individuals with exercise training. These results continue to support the recommendation that exercise training is an important initial or adjunctive step that is highly efficacious in the treatment of individuals with mild to moderate elevations in BP. A large number of studies from American college of sports (1994) indicated that endurance exercise training will elicit a 10 mm Hg average reduction in both systolic and diastolic blood pressures in individuals with mild essential hypertension (blood pressures 140-180/90-105 mm Hg).

The present study explores the beneficial effects of exercise on lipid profile also. In all ethnic groups total cholesterol was markedly decreased with 14.3, 9.7, 9.8 and 10% in B, P, H and PU groups respectively. Exercises manifested pronounce effect on LDL cholesterol with significant reduction in all groups except Pathan. Greater and pronounced outputs of HDL levels were noticed in exercised group with statistically significant elevation. Ten week of exercise training period explicit the positive response on triglycerides, marked and highly significant reduction has been observed in all ethnic groups except PU where non significant lowering was estimated.

Numerous studies and reviews have concluded that moderate exercise training has vital role on blood lipid

profile. Daniels (1999) reported that physical activity appears to have beneficial impact on lipid profile and lipoproteins. While significant improvements had been detected by different authors (Chang *et al*., 2008; Ferguson *et al*., 1999; Huang *et al*., 2007) and this could also explain our results. Studies of Gandapur *et al*. (2001) find out that prolonged aerobic exercise is capable of decreasing total cholesterol, LDL levels and particularly Apoprotein B levels and increasing HDL levels. A greater effect on HDL cholesterol has been indicated by Ferguson *et al*. (1998). Park and Ransone (2003) reported the existence of the threshold intensity of acute aerobic exercise necessary to promote a significant increase in HDL cholesterol (HDL-C).

Our finding are in confirmation of the most of the studies as it demonstrates that after exercise on treadmill for ten weeks, HDL cholesterol levels were statistically significant higher in all hypertensive female volunteers. The subject of the study are middle aged and almost on the final phases of the reproductive life. The earlier studies have reported of marked increase in HDL-C in women of this age. Lindheim *et al*. (1994) reported increased HDL-C levels in postmenopausal women that exercised. Generally, physically active women exhibit higher levels of HDL-C when compared to their sedentary counterparts (Kikkinos and Fernhall, 1999).

However reviewing the literature of Rowland *et al*. (1996) and Welsman *et al*. (1997), they could not observe any significant changes in blood lipid levels after aerobic training. Aellen *et al*. (1993) reported that exercise intensity acts as an important modulator of the beneficial effects of exercise on lipoprotein profile, since high intensity training (above the anaerobic threshold in cycling) failed to induce beneficial alterations in the lipoprotein profiles, especially in the anti-atherogenics (reduces LDL and increases HDL).Thus the results of the present study are unlike these reports. Tsekouras *et al*. (2008) examined the effect of high intensity intervals of aerobic training on VLDL-TG secretion in men. They observed that subjects trained on treadmill for 8 weeks had reduced VLDL-TG, our findings are consistent with these results whereby LDL significantly reduced in all hypertensive female ethnic groups except in Pathan sub-population.

Cauza *et al*. (2006) assessed that a 4 month training period, proved highly beneficial with reductions in fasting blood glucose, HbA1C, total cholesterol, LDL-cholesterol, triglyceride and an elevation in HDL-cholesterol concentrations in diabetes mellitus type 2 patients, thus resulting in a reduced atherogenic lipid profile. While in our findings cholesterol was significantly decreased in all female ethnic participants and triglycerides levels also shows marked reduction in all pub-populations, however in Punjabi hypertensive female's exhibit fall at low levels. Tsai *et al*. (2002) elaborated in his study that significant reductions were found in plasma total cholesterol (-6.1%), Low-Density Lipoprotein Cholesterol (LDL-C) (-14.1%) and triglyceride (-11.4%). Elevation of High-Density Lipoprotein Cholesterol (HDL-C) (+11.2%) was also noted.

On the reports of beneficial effect of exercise many national guidelines for the prevention and treatment of hypertension recommend lifestyle modifications in the form of 'regular aerobic exercise', as well as a reduction of dietary sodium intake, weight loss and moderation of alcohol intake (Appel *et al*., 2006).

It is also apprehended, although regular exercise training has beneficial effects on blood lipid profiles, a period of detraining as little as three months can offset all the advantages gained during training and reverse the beneficial effects of regular exercise training, thus underscoring the need for uninterrupted regular exercise throughout life.

Thus further studies from different aspects to determine precise effects of exercise on blood pressure and associated lipid profile remain in demand. Nevertheless exercise has evident beneficial effects on blood pressure and lipid profile of middle age female populations of different ethnic groups in study.

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