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Impact of Whole Body Vibration Versus Resistive Exercise Training on Lipid Profile in Elderly

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Abstract: Plasma lipoprotein levels are an important determinant of atherosclerosis and play an important role in its development and progression. Atherosclerosis is one of the main causes of cardiovascular disease. The aim of this study was to investigate the effect of vibration exercise versus resistance training on plasma lipoproteins in elderly. Sixty elderly subjects ranged from (60-70) years were randomly assigned into two groups, Group I (n=30) received vibration exercise program and Group II (n=30) received strength training program; experiment was carried out three times a week for 12 weeks. The mean values of total cholesterol (TC), triglycerides (TG) and low density lipoproteins (LDL) were significantly ($p< 0.01$) decreased from 236.27±29.95, 178.93±15.22, 156.07±20.10 to 215.43±30.25, 167.63±15.34, 142.27±19.04, respectively in Group I and from 235.43±33.66, 183.00±21.64, 160.13±16.98 to 189.47±31.58, 147.90±18.08, 129.17±14.82, respectively in Group II, while the mean value of HDL was significantly($p< 0.01$) increased from 32.07±9.30 to 33.87±8.80 in Group I and from 35.13±5.61 to 40.57±5.56 in Group II. Also, there was a significant ($p< 0.01$) difference between both groups after treatment. In conclusion, these findings suggested that vibration exercise may be effective and low time consuming tool to enhance plasma lipoprotein levels in elderly.

Key words: Plasma Lipoproteins · Vibration Exercise · Strength Training · Elderly

INTRODUCTION

Cardiovascular disease (CVD) is one of the most prevalent chronic diseases, with mortality exceeding 3.5 million in the developing countries [1].

It has been documented that serum concentrations of total cholesterol (TC), low density lipoprotein cholesterol (LDL), high density lipoprotein cholesterol (HDL) and fasting serum concentrations of triglyceride (TG), provides information on person's potential to suffer from CVD. Studies have shown that lower TC and LDL, combined with raised HDL concentrations, are associated with a reduced risk of CVD [2].

Cardiovascular disease is not a single illness but a term which describes conditions that affect heart and blood vessels. These include coronary heart disease, stroke and other disease such as deep venous thrombosis, peripheral artery disease and valvular disease [3]. The primary risk factors associated with CVD are hypertension, dyslipidemia and diabetes mellitus [4].

Hypertension and dyslipidemia are considered as more directly causes in their conveyance of risk for CVD. The expansion of arterial walls and the cardiac strain resulting from hypertension are directly implicated in the onset of atherosclerosis. Irregular lipid profiles associated with dyslipidemia are connected to the accumulation of arterial plaques [5].

Metabolic syndrome (MS) is a complex of symptoms including obesity, hyperglycemia, decreased HDL levels, increased TG levels and high blood pressure and comprises risk factors for heart disease and other health problems such as diabetes and stroke. MS have an increasing prevalence worldwide, which is largely associated with the increase in obesity and sedentary lifestyle [6].

Atherosclerosis is the major cause of coronary artery disease. Plasma lipoprotein levels are an important determinant of atherosclerosis. Lipids play an important role in its development and progression. It is well established that increased LDL, total cholesterol and TG

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concentrations, as w-ell as decreased HDL cholesterol concentrations, are strong independent predictors of coronary artery disease [7].

Low HDL levels are associated with a higher risk of coronary heart disease irrespective of the level of LDL cholesterol. Conversely, higher levels of HDL are associated with lower cardiovascular risk at any prevailing level of LDL. The magnitude of the potential risk reductions achieved follows the role of ones: every increase of 1% in HDL or decrease of LDL will decrease coronary risk by 1% [8].

Lipid profile is a term that describes the varying levels of lipids in the blood; the most commonly reported ones being low density lipoprotein (LDL) cholesterol, high density lipoprotein (HDL) cholesterol and triglycerides. High levels of LDL cholesterol indicate surplus lipids in the blood, which increase the risk of cardiovascular complications. HDL cholesterol transports lipids back to the liver for recycling and disposal; consequently, high levels of HDL cholesterol are an indicator of a healthy cardiovascular system [9]. It was reported that reductions in LDL cholesterol decreased the incidence of heart attacks and ischemic strokes. Individuals with elevated total cholesterol levels have twice risk of developing CHD [10].

Physical activity reduces the risk of CVD in persons with established disorders such as hypertension, *diabetes mellitus* and hyperlipidemia [11]. Moderate but regular physical activity is associated with a reduction in total mortality among the elderly, a positive effect on primary prevention of coronary heart disease and a significant benefit on lipid profiles [12]. Exercise consistently raises HDL level and reduces plasma triglycerides partially due to increases in lipoprotein lipase synthesis or activity [13].

Elderly individuals who participate in regular weekly non vigorous exercise have a higher HDL than frail individuals who not practice exercise. Lipid oxidation increases in parallel with increased energy demand up to an exercise intensity of about 50 to 60% of maximal oxygen consumption [14].

Increasing attention has been paid to whole body vibration (WBV) training and its use as an alternative form; several studies have recently reported the effect of WBV training on physical fitness in non athletes, including its ability to reduce body weight or arterial stiffness, however there have been no studies focusing on lipid profile response to vibration training [15]. Therefore the purpose of this study was to determine whether 12 weeks of vibration exercise would affect lipid profile (total cholesterol, low density lipoprotein (LDL) cholesterol, high density lipoprotein (HDL) cholesterol and triglycerides) versus resistance exercise in elderly.

MATERIALS AND METHODS

Subjects Characteristics and General Experimental Design

Study Subjects: Sixty elderly men subjects were selected from Physical Therapy Outpatient Clinic in Manshite El Bakry General Hospital in Cairo. All subjects had at least one high lipid profile value [LDL>130mg/dl, HDL<40 mg/dl, TG>150 mg/dl, TC>200 mg/dl], non-smokers, free from respiratory, kidney, liver, metabolic and neurological disorders as well as chronic inflammatory orthopedic disorders, rheumatoid arthritis or chronic cardiac problems as heart failure and ischemic heart disease. Their age ranged from 60-70 years and not involved in any physical activity.

Evaluated Parameters

Blood Samples and Biochemical Markers: Blood sampling: Lipid profile was assessed by way of total cholesterol, LDL-cholesterol, HDL-cholesterol and TG, according to Kwiterovich[12] reference values, determined by the enzymatic colorimetric assay, using LABTEST reagents. LDL-cholesterol values were obtained through Friedewald formula. [16] Blood samples were gathered after 12-14 hours of fasting. 5 ml of blood was drawn via vein puncture from an antecubital vein. The drawn blood was collected into to different tubes, one for cholesterol containing approximately 1 ml of sodium fluoride to prevent clotting of the blood (Anticoagulant), whereas the other tube for triglycerides contained approximately 1ml of serum separator tubes clot activator and gel for serum separation (Clotting agent). The Blood samples were obtained before training and 48 hours after the last session for measurement of fasting serum lipid profile (TC, TG, LDL and HDL).

Subjects were randomly divided into two groups: **Group I**: a vibration exercise group, **Group II**: strength training group. They trained three session/ week. All sessions were supervised and participation assessed. All subjects were free to withdraw from the study at any time. All participants provided their informed consent after receiving a detailed explanation of the study. The Ethics Committee of Research in Faculty of Physical Therapy, Cairo University approved the study. The data of all the participants were available for analysis. The detailed training protocol was as follows:

Vibration Exercise: Exercise session started with an initial 5 minute warming up phase, Then Subjects exercised on a horizontal swinging platform with amplitude of 2 mm (Viberogym professional). Vibration frequency was set to 30 Hz the first six weeks, increased to 35 Hz; one set (4 min) at first, with resting period between sets for 1 minute; increased to four set by the end of training. It took about 20 minutes to fulfill a training session of the last two weeks. During vibration session, the subjects were bare foot to eliminate any damping of the vibration caused by foot wear. They were positioned on platform with knee slightly flexed with feet placed apart on the board. Subjects encouraged working isometrically against the swinging platform [17].

Strength Exercise: Each training session started with five minutes warming up (Bicycling), then resistance training for 35 minutes using five pneumatic resistance training machines (Chest press, leg press, upper back, leg extension, leg flexion) and 5 minutes cool down (Flexibility and stretching exercises). Subjects performed dynamic contractions with intermittent relaxations after each concentric-eccentric phase. After familiarization with the correct movements, the one repetition maximum (1RM) was established prior to the training period using the following equation:

1RM = Weight (kg) X (1 + {0.033x number of repetitions)} [18]

During the first three weeks of training, 1 set with 12 repetitions at 70% at of 1RM was performed then from week 4 to 6, volume was increased by an additional set and from week 7 to 12, 3 sets with 10 repetitions at 80% of 1RM were realized [19].

Statistical Analysis: The mean values of TC, TG, LDL and HDL obtained before and after three month in both groups were compared using the paired ‘‘t’’ test. An independent ‘‘t’’ test was used for the comparison between the two groups ($P < 0.05$).

RESULTS

Table (1) reveals non significance difference between both groups, regarding the demographic features on both groups. In both groups, TC, TG and LDL were significantly ($P< 0.01$) decreased in both groups while, HDL were significantly($P< 0.01$) increased. (Tables 2 and 3). Also, there was a significant ($P< 0.01$) difference

Table 1: Demographic features of the two studied groups:

	Group I (n= 30)	Group II (n= 30)
Age (yrs.)	65.23±3.19	65.70±3.44
Weight (kg)	66.80±4.35	68.13±6.92
BMI (kg/m^2)	24.29±1.78	24.90±1.91
TC	236.27±29.95	235.43±33.66
TG	178.93±15.22	183.00±21.64
HDL	32.07±9.30	35.13±5.61
LDL	156.07±20.10	160.13±16.98

Data are expressed as mean±SD.
x^2= Chi square test.
NS= p> 0.05= not significant.
TC: total cholesterol
TG: triglycerides
HDL: high-density lipoproteins
LDL: low-density lipoproteins

Table 2: Comparison between mean values of group I measured pre and post treatment

	Pre-study	Post-study
TC	236.27±29.95	215.43±30.25**
TG	178.93±15.22	167.63±15.34**
HDL	32.07±9.3	33.87±8.8**
LDL	156.07±20.10	142.27±19.04**

Data are expressed as mean±SD.
**p< 0.01= highly significant.
TC: total cholesterol.
TG: triglycerides.
HDL: high-density lipoproteins.
LDL: low-density lipoproteins.

Table 3: Comparison between mean values of group II measured pre and post treatment

	Pre-study	Post-study
TC	235.43±33.66	189.47±31.58**
TG	183.00±21.64	147.90±18.08**
HDL	35.13±5.61	40.57±5.56**
LDL	160.13±16.98	129.17±14.82**

Data are expressed as mean±SD.
**p< 0.01= highly significant.
TC: total cholesterol.
TG: triglycerides.
HDL: high-density lipoproteins.
LDL: low-density lipoproteins.

Table 4: Mean value and significance of TC, TG, HDL and LDL in group I and group II after treatment

	Group I (n= 30)	Group II (n= 30)
TC	215.43±30.25	189.47±31.58**
TG	167.63±15.34	147.90±18.08**
HDL	33.87±8.80	40.57±5.56**
LDL	142.27±19.04	129.17±14.82**

Data are expressed as mean±SD.
**p< 0.01= highly significant.
TC: total cholesterol.
TG: triglycerides.
HDL: high-density lipoproteins.
LDL: low-density lipoproteins

between the groups after treatment (Table 4). So, it can be concluded that both vibration exercise and resistance exercise have a positive effect on plasma lipoproteins but resistance exercise training was more effective than vibration exercise training.

DISCUSSION

Previous studies have shown that WBVT elicits improvements in lower body strength [20] bone mineral density and peak oxygen uptake [21] which is similar to the results of conventional resistance and aerobic exercise training. Before this study, there was a gap in research regarding the effects on the plasma lipoproteins after WBVT. This study therefore sought to determine the effects of WBVT on Serum Cholesterol, Triglycerides, LDL and HDL in elderly population.

An increase in serum free fatty acids, but not in glycerol, has been reported 150 min after vibration exercise [22]. Mainly because of the considerable time lag, this is more likely to be related to the non significant increase in GH observed than to catecholamine action. WBV reduced 43% of TC level and 39% of free fatty acid level in livers [23].

WBV could significantly reduce the elevated levels of TC and TG in obese mice. The accumulation of TC in liver parenchymal cells is a common liver pathology, a well-established effect of obesity [24].

WBV is a light resistance exercise based on automatic body adaptations to rapid and repeated oscillations of a vibrating platform [25], increasingly being used in rehabilitation and fitness centers as a non invasive and non pharmacological therapy for osteoporosis [26] and can produce continuous eccentric concentric muscular work with increased oxygen consumption [27]. WBV can positively affect body composition by reducing body fat accumulation and serum leptin [28, 29]. It was reported that WBV combined with endurance training could significantly increase resting energy expenditure for the improvement of body composition [30]. Vibration exercise was attracted a lot of attention as an exercise modality, which elevates metabolic rate and activates muscular adaption that could be a potential method for weight reduction [31]. The physical performance regarding to vibration exercise was focused on neuromuscular functions [32] or strength evaluation [33].

In recent years, vibration training, has been used to replace traditional resistance movement because it can increase muscle function, muscle strength and bone density and reduce excess body fat storage [28]. Previous studies have reported the benefit of WBV for patients with cystic fibrosis, multiple sclerosis and stroke [34-36]. WBV led to approximately 10% less body weight, decreased proportion of body fat and lower level of serum leptin than in controls [28].

Low intensity vibration reduced the differentiation of precursor cells to adipocytes, which suggests a possible mechanism of vibration training preventing fat accumulation [23]. Previous studies also showed that vibration training could reduce fat mass but not lean mass, WBV may positively affect body composition by decreasing the rate of fat accumulation while preserving lean mass [28, 29].

WBV may positively affect body weight, exercise performance, fatigue, fat accumulation and obesity-associated biochemical assessments in diet-induced obesity. It may be a potential sport for health promotion and have an anti-fatigue effect in preventing diet-induced obesity. For the future application with current results, the weight control, an important issue in modern society, could be intervened by diet management combined with vibration exercise, especially for obese population which couldn't tolerate the intensive aerobic exercise in the beginning [37].

Vibration training can replace traditional resistance exercise to increase muscle function with similar resistance training effect [28]. TG, TC, LDL and HDL decreased significantly during 12 week of progressive resistance exercise in old adults. Some of these changes were related to changes in body composition, whereas gain in fat mass worsens and gain in lean body mass improves the blood lipid profile. Use of blood lipid lowering drugs is associated with greater reductions in TC and LDL after the training [38].

Aging is associated with an impairment of blood lipids [39]. In addition to changes in dietary intake and the use of lipid lowering drugs [40, 41] physical activity has been associated with improved blood lipids as indicated by data from cross sectional and cohort studies [42-45].

Several side effects of the commonly used blood lipid drugs, statins has been reported including muscle pain and muscle damage, as such, it might have been difficult for subjects using statins to engage in resistance exercise. However, compliance to the study protocol was not significantly different between blood lipid drug users and non-users [46, 47].

Studies investigated the response of blood lipids to 12-week progressive resistance exercise in old adults. The main finding was that TG, TC, LDL and HDL decreased significantly during the training period [38]. Although there was inter-individual variability, we observed a reduction in blood lipids in the majority of participants. The reduction in TG levels was in line with results from a meta-analysis and the mean decreases in TC, LDL and HDL were greater [48]. It is possible that small or non-significant lipoprotein changes with resistance training may be due to the fact that total cholesterol values were below 200 mg/dl at study entry [49]. In our population, the mean TC concentration at baseline was 218 mg/dl.

In general, other studies on resistance exercise have provided rather equivocal results, with some reporting a decrease in the levels of HDL [50] while others reported an increase or no significant change [51-53]. Taken together, the net effect of resistance exercise on HDL seems to be not significant [48]. Different results on HDL and resistance exercise might be associated with length of training periods. According to a study by Sallinen *et al.* [54] the response pattern for circulating HDL is biphasic. Levels of HDL decreased during the first half of a 21-week resistance training program in middle aged men, but rose back to baseline levels during the second half of the training period. It has also been suggested that failure of HDL to increase following a period of training might be because of higher initial levels of HDL, with less capacity for improvement. There is an inverse association between change in HDL and initial levels of HDL, after 40 weeks of brisk walking in women, supporting this hypothesis. In the present study, initial levels of HDL were also significantly correlated with change in HDL [55].

Arnarson *et al.* [38] found that, changes in TG and TC/HDL ratio were related to changes in body composition, where gain in fat mass worsened and gain in lean body mass improved these values, which seem intuitively plausible. Changes in TG have been previously reported to be associated with changes in body fat in women [56]. An association of LBM with improvement in blood lipids have also been indicated previously and might be related to changed muscle physiology or simply reflect strict adherence to training regimen. In our study, compliance was very good and 91% of all prescribed strength training sessions were completed [57].

The application of a 12 wk WBV based intervention in a primary care context is feasible, safe and effective to clinically reduce HbA1c and fasting blood glucose and to improve most of the lipid related cardiovascular risk factors [58].

CONCLUSION

It was concluded that both vibration exercise and strength training have positive effect on plasma lipoprotein levels in elderly. But vibration exercise needs about half of time of the strength training and vibration exercise needs small effort, so patient who are unable to participate on sports activities may prefer vibration exercise training. Strength training has become an established treatment for metabolic diseases. But, it is not suitable for most elderly. Vibration training is a new treatment method that needs less time and less effort, so it is suitable for previously inactive patients' especially elderly subjects.

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