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Original article

The Effect of Cardio Tennis Exercises on Lipid Metabolism of Sedentary Women

Şeniz Karagöz[1], Alparslan Ünveren[2], Tülay Köken[3]*

[1] Faculty of Sports Sciences, Afyon Kocatepe University, Afyonkarahisar, Turkey; [2] Faculty of Sport Sciences, Kütahya Dumlupınar University, Kütahya, Turkey; [3] Department of Biochemistry, Faculty of Medicine, University of Health Sciences, Afyonkarahisar, Turkey.

Summary. *Background:* It is known that regular exercises have physical, physiological, social and spiritual effects on people. In this currently performed study, it was intended to investigate the effect of regular cardio tennis exercises on lipid metabolism of middle-aged sedentary women. *Methods:* The sample group of this study is consisted of 30 healthy middle-aged sedentary women with a mean age of 44.40 ± 3.89. Body components of exercise group subjects were analyzed by bioelectrical impedance analyzer before the program, during mid-program (in the 5th week) and after the program (in the 10th week) and their blood samples were taken so as to determine the lipid metabolism of exercise group subjects. To fulfill this aim, depending on cardio tennis exercises carried out for 10 weeks, three days a week for one hour; body components, total cholesterol, triglyceride, low-density lipoprotein-cholesterol (LDL-C), high-density lipoprotein-cholesterol (HDL-C), changes in the leptin and ghrelin hormone levels of middle age sedentary women have been examined. *Results:* As a result of the findings obtained in the research, it was identified that high-density lipoprotein-cholesterol (HDL-C) levels of sedentary women who participated in the study have shown a statistically significant increase after 10 weeks ($p < 0.05$). Although total cholesterol (TC), triglyceride (TG) and low-density lipoprotein-cholesterol (LDL-C) parameters were found to have decreased, it was observed that there was no statistically significant difference. Besides, it was identified that there was no statistically significant difference in the blood leptin and ghrelin hormone levels of sedentary women after 10 weeks of exercise ($p > 0.05$). *Conclusion:* Consequently, it was concluded that regularly performed cardio tennis exercises had a positive effect on body components of sedentary women while it only increased HDL-cholesterol lipid, which is included in the metabolism parameters.

Key words: Exercise-Sedentary Women, Lipid Metabolism, Leptin, Ghrelin

Introduction

Nowadays, physical inactivity emerged as a result of industrialization and modern lifestyle negatively affects individuals in all age groups. A sedentary lifestyle brings with it a number of serious health problems. It is noticed in earlier researches that health problems such as high blood pressure, obesity, muscular weakness, postural disorder, diabetes and increased coronary artery risk factors are experienced more commonly especially in middle aged and older women (4, 5). Physical activity and exercise are actions that are considered as a tool of preventive health approach and aim to improve or improve the health of the individual along with maintaining improved physical fitness and increasing resistance to fatigue and diseases (1,2). The importance and main purpose of exercise for health is to prevent or slow down organic and physical disorders caused by a sedentary life, to increase the physiological capacity, which forms the basis of body health, and to maintain physical fitness and health for many years (3). Our body is physically and physiologically adaptable to

regularly done exercises. It is expected that a number of physical and physiological changes occur in people who exercise, both with acute and chronic adaptation. Physical activity and exercise are the movements that increase the resistance to fatigue and some diseases and are considered as an instrument of preventive health approach, aiming to improve or develop the health of the individual and maintaining the state of advanced physical fitness (1,2). The importance and fundamental goal of exercise for health is to prevent or slow down the organic and physical disorders that may be caused by a sedentary life, raising the physiological capacity, which is the basis of body health along with maintaining the physical fitness and health for many years (3). The physical inactivity caused by industrialization and modern lifestyle affects individuals negatively in every age group. A sedentary lifestyle brings along with serious health problems. In the conducted studies it was observed that health problems such as high blood pressure, obesity, muscular weakness, postural disorder, diabetes and increased coronary artery risk factors are more common especially in women and middle age and older (4,5). Due to the fact that women have different physical and physiological changes starting from the pre-adolescent period in their young, middle-age and old-age periods, the exercise prescriptions designed for women should be tackled in a more detailed way considering the general condition of the individuals, their previous and current exercise status and their health problems; and whether they smoke, drink alcohol and take any drug. Furthermore, their genetic factors should be taken into consideration (6-8).

To know what type of exercise affects lipid profile parameters and hormones and to investigate what and how the effects of exercise have on the individuals have become an important research topic of recent years and the effects of physical activity on ghrelin hormone, leptin hormone and serum lipids and body components have been investigated by various researchers (9-16). On the other hand, the studies examining the changes in lipid metabolism depending on the chronic exercise were found to be quite limited. Additionally, it was noticed that the studies including the effect of cardio tennis exercises on lipid metabolism did not exist. In this respect this research is an original study since it addresses this gap. It is believed that the effect of tennis branch which is increasingly becoming more popular and prevalent and the cardio tennis exercises, which have been transformed into physical activity and exercise activity for healthy life, may have a significant impact on lipid metabolism and body components.

In this context, it was aimed in this study to investigate the effects of cardio tennis exercises on lipit metabolism and body components of sedentary women

Materials and methods

Selection of subjects

To carry out this study, an ethics committee report numbered 2015-050 was received from the ethics committee of clinical researches of Training and Research Hospital of Antalya.

The sample group of this study consisted of sedentary women aged 40 years and older. Once the medium effect size of the study is accepted as = 0.5; when the level of error is admitted as 0.05 and the power of the study is considered to be 85%, the minimum sample size was determined as 30 as a result of the analysis obtained by using G*Power package program. As for the criteria for the subjects to be excluded from the research were detected as being under 40, having a chronic condition, doing exercise regularly for at least 3 months, not attending the exercises regularly. The sample group of this study is consisted of 30 healthy sedentary women aged 40 years and older with an age mean of 44.40 ± 3.89 years.

Research Technique and Protocol

In order to provide standardization of the study, the volunteering subjects to be included in the study were invited not to use any medication and ergogenic pills within 48 hours before the measurements, and during the program no diet program was implemented. During the study, all subjects were asked to continue their normal lives and were requested that they not perform any additional physical activities during the exercise protocol. The body components of exercise group were analyzed by TANITA BC-418 USA brand

bioelectric impedance analyzer before the program, during mid-program (5th week) and after the program (10th week).

The initial measurements for our study were performed 2 days before the start of cardio tennis exercises (week 0) and the general measurements of the voluntary participants were obtained. At the end of the 5th week, the second measurements and the third measurements were carried out at the end of the 10th week. After starting the exercises, the measurements were performed 2 days (48 hours) after the last cardio tennis exercises in the mornings and following the night hunger.

Venous blood samples from the forearm of the all participants were collected into a 5-cc yellow-lid gel blood collection tube by authorized medical staff in the sitting position. Without losing any time, the taken blood samples were centrifuged at 4000 rpm for 5 minutes with the help of a centrifuge in Afyon Kocatepe University Faculty of Medicine Biochemistry Laboratory and were then divided into serums. The reserved serums were taken into 2 different eppendorf tubes for each individual and kept at -80 °C until the day of measurement.

Analysis of Blood Samples

The taken blood samples were taken into serums obtained pre-program (0 th week), mid-program (5th week) and after program (10th week) so as to determine the lipid metabolism of exercise group subjects. Next, having kept at -80 °C until the day of study serum samples were thawed at room temperature by waiting for an hour. Total cholesterol (TC), triglyceride (TG), LDL-cholesterol and HDL-cholesterol measurements in serum were studied by Roche Cobas C501 autoanalyser by using Roche branded commercial kits (Roche Diagnostics International Ltd., Rotkreuz, Switzerland). The results were demonstrated in mg/dl. Leptin and ghrelin measurements in the serum were carried out by the SunRed brand Human Leptin ELISA kit (Jufengyuan Road, Baoshan District, Shanghai, China). Absorbance reading was performed on a ChemWell 2910 ELISA reader. (Awareness Technology, Inc. Martin Hwy. Palm City, USA). Blood samples were studied twice and their averages were retrieved. Later on, the results were displayed in ng/ml and pg/ml.

Exercise plan

To determine the intensity / heaviness of cardio tennis exercises, the resting heart rate (KAHdin) of the subjects (Polar, Finland) was taken by using the heart rate monitor after resting 20 minutes in the supine position. The karvonen method was employed and the severity of the study was determined as 50-70% for the heart rate reserve. Followingly, it was controlled by Polar M 400 GPRS pulse monitors. Karvonen formula is as follows:

Target Heart Rate of Exercise (KAHrezerv) = (Exercise intensity%) × (KAHmax-KAHdin) + KAHdin

To determine the intensity/severity of cardio tennis exercises, the Carvonen's method was used and the severity of the study was determined as 50-70% for the heart rate reserve. Followingly, it was controlled by Polar M 400 GPRS pulse monitors. The exercise group regularly completed a 10-week cardio tennis exercise, including 3 days a week. Each cardio tennis exercise continued for 60 minutes. Each exercise program consisted of 10 minutes of warm-up, 40 minutes of cardio-tennis exercises and 10 minutes of cool down exercises. Cardio tennis exercises were performed with 120-160 bpm music. To do this, music lists were arranged for warm-up, main phase and cool down phase (17,18).

Cardio Tennis Exercises were executed at 50-70% intensity of heart rate reserves (HRR) of the exercise group for 10 weeks. The heart rate was managed with the polar M400 GPRS pulse rate every 5-10 minutes and the intensity of the exercise was monitored immediately after the drill work out. Also, the target heart rate of the subjects were kept under control and the intensity of the exercise was lowered to reduce the number of heart beats of subjects whose target heart rates were more than the range. Moreover, the heart rate reserve of the subjects according to the Carvonen's method was determined by the manual method by checking from the carotid artery on the neck of the subjects with the sign and middle fingers of the hand for 15 seconds (8).

Statistical Analysis

The descriptive statistics of all data obtained in this study have been computed. Results are provided as mean ($\bar{\chi}$) ± and standard deviation (SD). Having determined the normality test of the data by the Shapiro Wilks test, repeated measures of variance analysis were applied for data with normal distribution. On the other hand, the data were analyzed with the help of "friedman" test if the data did not show normal distribution. In addition to that, Bonferroni test was used for determine the source of difference between groups. The confidence level selected as 95% and values below $p < 0.05$ were considered statistically significant.

Results

It was found out that there was no significant difference in total cholesterol and LDL-cholesterol in regularly done Cardio tennis exercises ($p > 0.05$). On the other hand, it was determined that HDL-cholesterol did not display a significant difference in the first 5 weeks while there was a statistically significant difference ($p < 0.05$) between 5th and 10th weeks.

Depending on cardio tennis exercises performed regularly for 10 weeks, it was concluded that there was no statistically significant difference ($p > 0.05$) in leptin and ghrelin hormone levels and the triglyceride levels of the exercise group.

Discussion

In addition to the regular exercise habits, balanced and adequate nutrition intake are the most important elements of healthy and fit life. However, the age, gender, current health status, lifestyle and current physical fitness levels of individuals should be considered when preparing regular exercises that are to be carried out for a healthy and fit life, and exercise programs should be prepared accordingly by paying attention to the type of exercise, duration, intensity and frequency. As a result of the research, it was identified that body weight, body mass index and body fat percentage around the waist and hip have shown a statistically and significantly decrease after cardio tennis exercise program ($p < 0.001$). Nonetheless, it was determined that there was no significant difference in Free-Fat Mass and Total Body Water ($p>0,05$). As a result of the analysis, it was achieved that regular exercises, carried out 8 weeks and more, caused reduction in the body weight, body mass index and body fat percentage around the waist and hip (19,20,35). In this current study, similar results

Table 1. Repeated Measures of Variance Analysis Results of Body Components of Exercise Group

Parameters	N	Week 0 $\bar{\chi}$ ± SD	Week 5 $\bar{\chi}$ ± SD	Week 10 $\bar{\chi}$ ± SD	F	p
Body weight (kg)	30	70,1 ± 8,9[a]	69,6 ± 4,9[a]	68,0 ± 8,9[b]	19,030	0,001*
Body mass index (kg/m^2)	30	26,5 ± 3,2[a]	26,4 ± 3,2[a]	26,0 ± 3,2[b]	22,012	0,001*
Basal Metabolic Rate (kcal)	30	1356 ± 111,2	1366 ± 115,4	1361 ± 118,8	0,901	0,181
Body Fat Percentage (%)	30	35,9 ± 4,5[a]	34,9 ± 4,1[b]	34,4 ± 4,3[b]	15,563	0,001*
Body Fat Mass (kg)	30	25,5 ± 6,1[a]	24,6 ± 5,7[b]	24,0 ± 5,8[c]	21,281	0,001*
Fat Free Mass(kg)	30	44,4 ± 3,7	44,9 ± 3,9	44,7 ± 3,9	2,581	1,119
Total Body Water (kg)	30	32,6 ± 2,6	33 ± 2,8	33 ± 2,9	2,930	0,098
Hip Circumference (cm)	30	104,8 ± 5,7[a]	102,3 ± 4,9[b]	100,0 ± 5,1[c]	120,874	0,001*
Waist circumference (cm)	30	91,0 ± 8,3[a]	88,7 ± 7,7[b]	86,4 ± 7,7[c]	75,504	0,001*
Waist / hip (cm)	30	0,87 ± 0,05	0,87 ± 0,05	0,86 ± 0,05	0,790	0,459
Resting Heart Rate (Beats / min)	30	76,4 ± 5,5[a]	72,3 ± 5,3[b]	68,0 ± 4,5[c]	253,154	0,001*

*p < 0,001 is statistically significant.
[a,b,c] The different letters in the same row in a parameter represent the statistical difference between the groups.

Table 2. Repeated Measures of Variance Analysis Results of Biochemical Data of Exercise Group

Parameters	N	Week 0 $\bar{\chi} \pm SD$	Week 5 $\bar{\chi} \pm SD$	Week 10 $\bar{\chi} \pm SD$	F	p
Total Cholesterol (mg/dl)	30	217,96 ± 36,9	210,46 ± 35,1	215,92 ± 33,6	2,325	0,138
LDL Cholesterol (mg/dl)	30	140,12 ± 30,3	132,40 ± 28,7	137,13 ± 29,0	2,684	0,112
HDL Cholesterol (mg/dl)	30	57,54 ± 12,1^{ab}	56,40 ± 12,7^{b}	59,24 ± 11,5^{a}	3,322	0,024*

*p < 0,001 is statistically significant.
^{a,b,c} The different letters in the same row in a parameter represent the statistical difference between the groups.

Table 3. Friedman Test Analysis Results of Biochemical Data of Exercise Group

Parameters	N	Week 0 Median (min-max)	Week 5 Median (min-max)	Week 10 Median (min-max)	χ^2	p
Triglycerides (mg/dl)	30	112,80 (56,8-302,5)	104,35 (62,3-290,4)	109,20 (57,7-302,4)	0,467	0,792
Leptin (ng/ml)	30	10,49 (6,21-44,4)	10,80 (6,21-46,35)	10,66 (6,61-37,51)	2,336	0,311
Ghrelin (pg/ml)	30	946,00 (482,0-4653,0)	784,00 (355,0-3986,09)	753,50 (482,0-4175,0)	3,983	0,136

*p < 0,001 is statistically significant.
^{a,b,c} The different letters in the same row in a parameter represent the statistical difference between the groups.

with the results of the study in the literature have been attained and it was detected that a 10-week regularly performed cardio tennis exercises resulted in a decrease in body weight, body fat percentage and body fat mass around the waist and hip. Furthermore, it was noticed that although there was no diet restriction, there was a decrease in body fat percentage and body weight because of the cardio tennis exercises and there was no decrease in the amount of muscle mass and body water. It is believed that these mentioned findings are important results in terms of protection from risks such as obesity and maintaining a healthy life. In addition, total cholesterol, showing lipid metabolism in the blood, HDL cholesterol, LDL cholesterol and triglyceride levels were also examined in this study. It was determined that there was a significant difference in HDL-cholesterol levels just after the exercise whereas there was no significant difference in total cholesterol, LDL-cholesterol and triglyceride values. It can be stated that the regular exercise in long term increases HDL cholesterol (21). It is seen that regularly done cardio tennis exercise increased the HDL cholesterol level and reduced the negative effects of cholesterol on blood vessels (such as atherosclerosis). Looking at the Total cholesterol, LDL-cholesterol and Tiriglesirid values by weeks in this current study, it can be noticed that there was a reduction between the week 0 and the 5th week while an increase may be spotted between the 5th and the 10th weeks. It is assumed that this state may stem from the adaptation of the subjects to cardio tennis exercises and their nutritional intake status. In the literature, it was observed that there are different results in studies investigating the effects of regular and different types of exercise on lipid metabolism (22,23). It is believed that this state is caused by the type, the intensity, duration and frequency of the exercise, as well as the lifestyle of the participant, gender, age, initial levels of blood lipid profiles, and daily nutrition intake status.

The other two important findings investigated in this study are the leptin and ghrelin hormones. Leptin hormone is mostly secreted by fat cells in the body and a small amount is secreted by organs such as stomach and heart (24) and this hormone is effective in the hypothalamus region of the brain and gives informa-

tion to our brain about the fat stores in our body. If there is no hunger and sufficient fat is present in the body, leptin reduces our appetite and protects the body fat reservoir (weight). On the other hand, if there is a decrease in body fat reservoirs, the amount of leptin in the blood decreases and our brain perceives it as an increase in appetite. Leptin is effective in long-term weight control owing to the changes in body fat mass. Another factor influencing the leptin hormone is the exercise. The amount of secreted leptin hormone decreases as the body fat rate does not decrease since the exercise is performed (25,26). Compared to the research results in the literature (14,16,27), it was identified in this study that leptin hormone was not affected despite the decrease in body fat ratio. It is believed that it is an important finding in terms of health, appetite level, physical activity and obesity. In this study, it was displayed that cardio tennis exercises had no statistically significant effect on serum leptin levels, and this result is supported by some studies in the literature (9-16) while it demonstrates differences with some studies (28-31). This state shows that the effect of acute and chronic exercise on serum leptin concentration cannot be fully clarified. In fact, in some of the actualized studies, it was highlighted that the balance of energy changes, fat mass decreases, hormonal concentrations and metabolites are changed with regularly performed exercise. In some cases, it was stated that it does not affect the concentration of leptin. In different studies of acute and chronic exercise, different effects have come out. This effect is believed to stem from the methodological difference depending on the exercise type, exercise intensity, exercise duration, frequency of exercise, nutritional intake status of the participants, and circadian rhythm of leptin, time and frequency of sampling. Serum with leptin level and exercise-related change of the hormone ghrelin, which is expected to work according to the ying-yang law, constituted another important aspect of this research. In this study, there were no statistically significant differences in ghrelin hormone levels of sedentary women participating in cardio tennis exercises during the weeks.

Benso et al.(2007) have reported that although there was a significant decrease in body weight of 9 elite mountaineers after a seven-week Everest climbing, the concentrations of leptin and ghrelin did not change. Showing parallel results with the results in the literature, it was detected in this study that regularly carried out cardio tennis exercises did not affect serum ghrelin concentration. On the other hand, there are some other studies in the literature indicating that acute and chronic exercise affect serum ghrelin concentration (32). Mizia et al.(2008) have reported that found a significant decrease in weight loss and an increase in serum ghrelin levels once they applied a 1000 kcal of food restriction and physical activity program for three months to 37 obese women who had a mean age of 40.7 ± 11.0 and in their premenopausal period (33). Moreover, Martins et al. led a group of sedentary overweight males and females with a mean age of 36.9 ± 8.3 with a body mass index of 31.3 ± 3.3 kg/m2 with a maximal loading density of 75% of the heart rate for 5 days during 12 weeks so as to train them 500 calorie treadmill running and walking exercises, and no change in nutrient intake during the study period has been actualized. As a result of the 12-week exercise program, it was reported that body weights decreased, and that the blood acyl ghrelin levels and their appetite increased (34). These results show that regularly implemented exercise has different effects on ghrelin levels due to methodological reasons and indicate that the effect of exercise on the level of ghrelin cannot be fully cleared up. In the previous studies it was found that ghrelin levels were higher in dietary applications, especially with exercise. In this study, it was observed that cardio tennis exercise did not show a significant difference in ghrelin hormone level without diet application. Nonetheless, it was believed that although it was not statistically significant, that blood ghrelin level was in a downward trend may come out with the exercise repressed by the blood ghrelin level. In this context, it can be commented that the diet affected blood ghrelin levels more than chronic exercise.

Conclusion and Suggestions

Consequently, it was identified that regularly carried out 10-week cardio tennis exercises decreased the body weight due to the decrease in the percentage of body fat that is one of the body components of middle aged sedentary women. However, it was found out

that it increased HDL-cholesterol, which is among the lipid metabolism parameters. On the other hand, it was seen that it had no significant effect of serum leptin hormone and serum ghrelin hormone in blood. Regular cardio tennis exercises were able to reduce body weight and body fat percentage, which is judged to be a vital finding. Thus, it is assumed that regular cardio tennis exercise can be benefited as a different kind of physical activity and exercise in the long run in order to improve physical fitness and maintain general health. In addition to the pervious finding that the 10-week regular cardio tennis exercises has made positive effects on lipid profile and has not affected the hormone leptin and ghrelin in the blood without having a food restriction, this study may as well constitute an important reference for original studies in which the effects of cardio tennis exercises on lipid metabolism can be examined.

Conflicts of interest: The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript

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Correspondence:
Şeniz Karagöz
Faculty of Sports Sciences, Afyon Kocatepe University.
Afyonkarahisar, 03200, Turkey.
E-mail: skaragoz@aku.edu.tr