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30 Minutes of Acute Moderate-Intensity Exercise Prior to a High Fat Meal Does not Attenuate Postprandial Triglycerides in Postmenopausal Women

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Abstract: There is an increased instance of circulating triglycerides among older adults which could lead to atherosclerosis; therefore, we sought to determine if 30 minutes of moderate-intensity exercise, prior to a high fat meal, attenuates postprandial triglycerides (PPT) in postmenopausal women. Five postmenopausal women (59.8 years), participated in an exercise trial consisting of 30 minutes of moderate-intensity exercise 60% heart rate reserve (HRR), heart rate, blood pressure, and blood lipids collected. Following exercise participants ingested a high-fat meal (62 grams CHO, and 57 grams fat) and rested for four hours. Lipid levels were collected at 1, 2, 3, and 4 hours post-feeding. The control trial did not exercise and were given the high fat meal followed by rest. A randomized cross-over design was utilized, in which all subjects participated in the control and exercise trial. There was no difference in PPT between the control and exercise trials. PPT increased from pre-exercise in both trials ($p<0.05$) (pre-feeding 88.4±26.7 con. 93.6±36.8 ex., 1hr 141±51.7 con. 139±65.4 ex., 2hrs 195±32.7 con. 166±82.4 ex., 3hrs 203±52.2 con. 185±78.1 ex., 4hrs 179±22.4 con. 193±50.5 ex). Glucose values were similar between trials; peaking post-feeding followed by a gradual return to baseline in both trials ($p<0.05$) (pre-feeding 86±5.5 con. 84.6±5.8 ex., 1hr 117±11.3 con. 125±23.5 ex., 2hrs 104±4.1 con., 113±16.7 ex., 3hrs 97.4±6.3 con., 88.6±11.6 ex., 4hrs 87.6±6.7 con., 81.2±9 ex). 30 minutes of moderate-intensity exercise does not attenuate PPT in postmenopausal women.

Key Words: Fat Ingestion, lipaemia, fat oxidation, gerontology, geriatrics.

1. Introduction

Most of the population who adhere to a western diet spends a majority of their day in a postprandial state. Elevated postprandial levels of sugar and fat increase blood lipid levels and are cause for atherosclerosis and cardiovascular disease (CVD) [1]. The increased and steady ingestion of fat throughout the day, as is common in the western diet, causes an increase in circulating triglycerides (TG). This increase in triglyceride rich lipoproteins leads to a buildup of low-density lipoproteins (LDL) which can aid in the development or progression of the diseased state of atherosclerosis [2]. Healthy, premenopausal women are at a decreased risk for developing CVD, more so than are aged-matched, healthy, postmenopausal women. The increase in subcutaneous fat storage compared to visceral fat, in conjunction with certain estrogen protective functions, are the determining factors which contribute to a decreased risk of CVD [3]. The decrease in estrogen post-menopause is thought to be the cause for the decrease in ability to protect against TG and atherosclerotic risks. Postmenopausal women, having lost their estrogen protective functions, show a decreased ability to metabolize TG and are at higher risk for developing CVD compared to premenopausal women [3].

Moderate-intensity and high-intensity exercise have been shown to attenuate postprandial triglycerides (PPT) and reduce the risk for CVD. The effects of acute exercise and PPT have been examined primarily utilizing younger populations. It has been observed that young women have a decrease in PPT following exercise intensities as low as 30% VO_{2max} [4]. Trained individuals also have an increased response to TG metabolism, likely due to an increase in total fat oxidation [5]. When utilizing a lower percentage (50%) of VO_{2MAX} it may be necessary to exercise for a longer duration (1-2 hours) to decrease PPT. The longer the exercise duration, the greater an impact on reducing PPT [8,16]. When developing a program in which higher intensity exercise is established, a shorter duration may be utilized. Exercising at 60-70% of VO_{2MAX} for a duration of 0.5-1 hour also decreases PPT in males ages 21-39; it is currently unknown if postmenopausal women will elicit the same response [6].

Studies of middle-aged men participating in moderate-intensity exercise of 30-minutes in duration (continuous or accumulated) has been shown to attenuate PPT; this same effect has yet to be examined among postmenopausal women [7]. There exists an increase in PPT metabolism in postmenopausal women when exercising at a moderate intensity for 90-minutes [8]. It is unclear if the loss of estrogen-protective factors would inhibit the clearance of triglycerides among exercising postmenopausal women after 30-minutes of moderate-intensity exercise. The purpose of the present study is to determine if 30-minutes of moderate-intensity exercise will attenuate PPT levels among postmenopausal women after the ingestion of a high fat meal.

Data presented in the current study could have clinical significance in exercise prescription for postmenopausal women. The full blood lipid panel has been included for observation of any peripheral lipid changes which may have an influence on PPT metabolism.

2. Design and Methods

IRB approval was given from California Baptist University, Riverside, California; and data collection concluded the 12th of August, 2015. *Participants*: All participants completed a written informed consent prior to testing. The subjects included five volunteers, ≥60±1 years of age, all of whom were self-reported postmenopausal; none of the participants had experienced their menstrual cycle in greater than five years (Table 1). The participants' activity level ranged from no planned activity to occasional planned treadmill walking (2-4d/wk) from 30-45min. Each participant completed a health history questionnaire verifying that they were free of any American College of Sports Medicine (ACSM) contraindications that would prohibit them from exercising [9]. The participants were non-smokers and were free of any self-reported metabolic or cardiovascular disease. One individual dropped out after completing the exercise trial but before completing the control trial. Two individuals were excluded due to the aforementioned exclusionary factors.

Table 1 Participant Demographics

	Age	Race	Occupation	BMI	Years Since Last Menstruation	Hormone Theraphy
P1	61	White	Primary Teacher	21.6	12	No
P2	60	White	Primary Teacher	32.4	5	No
P3	59	White	Primary Teacher	26.2	10	No
P4	60	White	Retired	23.7	6	Yes
P5	59	White	Registered Nurse	23.7	10	No

Participants were relatively homogeneous, with the exception of one participant who was on a hormone replacement therapy for osteopenia. *Protocol*: Each subject participated in an exercise trial followed by the control trial with a minimum of seven days between the control and exercise trials. The control group followed the same protocol as the exercising group; however the subjects did not participate in exercise. Prior to beginning the activity, the participants were informed of the protocol for exercise, feeding, and blood collection. Participants completed a ten-hour fast and abstained from caffeine intake prior to any lab work or exercise [7]. The day prior to testing the participants were instructed to not participate in any vigorous-intensity exercise or prolonged moderate-intensity exercise; defined as nothing more than walking at a pace which does not elicit breathlessness. They were also advised to abstain from alcohol and to make a conscience effort to increase their water intake.

Upon arrival, the participants were instructed to lie in a supine position for 15 minutes; after which their resting blood pressure, heart rate, and blood lipid profile (total cholesterol (TC), high-density lipoproteins (HDL), TG, LDL), as well as Glucose were measured. Their blood profiles were collected via a sample of capillary blood and was analyzed using an Alere Cholestech LDX (Alere North America LLC, Orlando FL). The Alere Cholestech LDX has been certified by the Cholesterol Reference Method Laboratory Network (CRMLN) and has met the analytical goals for accuracy and reproducibility set by the National Cholesterol Education Program (NCEP) [10]. Participants walked on a treadmill at 60% of their estimated HRR for 30-minutes (HRR was obtained utilizing the Karvonen formula). This has shown to be a significant length of time to attenuate PPT in various populations, not including postmenopausal women. The time of exercise did not begin until 60% of their estimated HRR was reached [7, 11, 12]. Heart rate was measured throughout the activity and their blood pressure was collected at ten-minute intervals. The participants were limited exclusively to water intake ad libitum during exercise. All participants completed the 30-minute exercise protocol as well as the five-minute cool down. Participants were then given a meal which consisted of a moderately high fat content. The meal included six mini-donuts and four chicken tenders totaling 57g of fat, 62g of carbohydrates, and 14g of protein. This meal was selected due to the fat content similarity used among men in previous studies (40g of fat, and 56.8±6.1g of fat) [2, 13]. Heart rate, blood pressure, and blood lipids were measured at one, two, three, and four-hour intervals post-feeding [14]. *Statistical Analysis*: The data was tested for normality before running a two-way repeated measures ANOVA, analyzing the exercise and control group scores pre-feeding and at one, two, three, and four-hours post-feeding. The data was analyzed using STATISTICA Academic software (Tulsa, Oklahoma).

The significant differences were recorded at $p \leq 0.05$, and a Tukey Post Hoc test was utilized to isolate where the difference in the data occurred. The alpha levels were set at $\alpha < 0.05$ and the data was reported in mean ± standard deviation (SD).

3. Results

When comparing the mean values between the control and exercise groups, there was no significant difference ($p > 0.05$) in PPT between the exercise and control groups over the four-hour period. There is a significant increase in triglycerides over time at the one, two, three, and four-hour time points from the pre-feeding value. Similarly, there was a significant increase in triglycerides over time at the pre, two, three, and four-hour time points from the one-hour post-feeding value (Figure 1).

We observed a slight decline in LDL among both groups, with the control group trending toward pre-exercise values in the three and four-hours. There was a significant decrease in LDL from baseline at the two, three, and four-hour time points (Figure 2).

No difference were seen among HDL values over time between the control and exercising groups. The decreased mean value pre-exercise among the control group was not substantial enough to effect significant difference among the remaining time points (Figure 3).

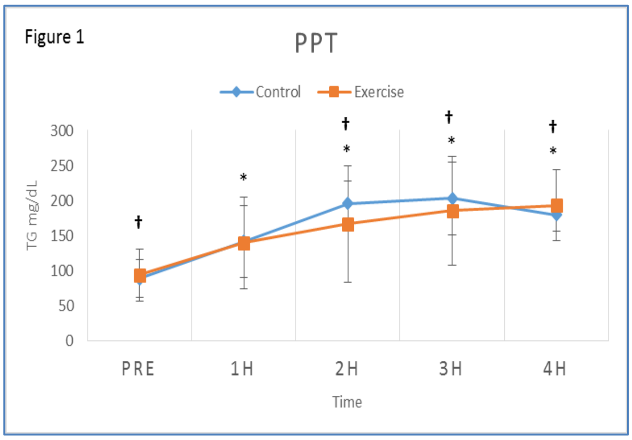

Figure 1. PPT measured in mg/dL over Time, (*) values are significantly different than the pre-feeding value, (†) values are significantly different than the 1-hour values, ($p \leq 0.05$), values represented as mean±SD.

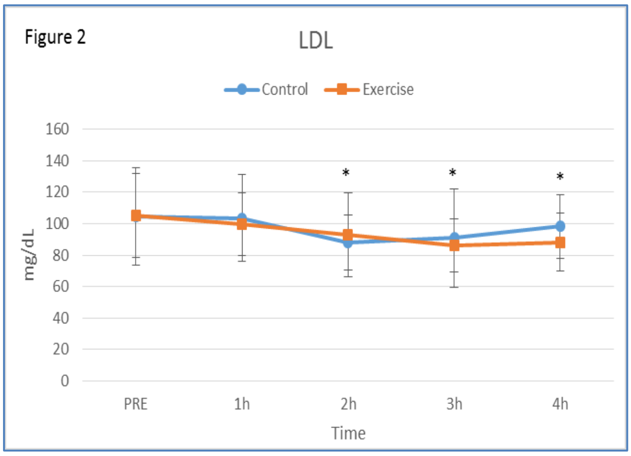

Figure 2. LDL measured in mg/dL over time, (*) values are significantly different than the pre-feeding value, ($p \leq 0.05$), values represented as mean±SD.

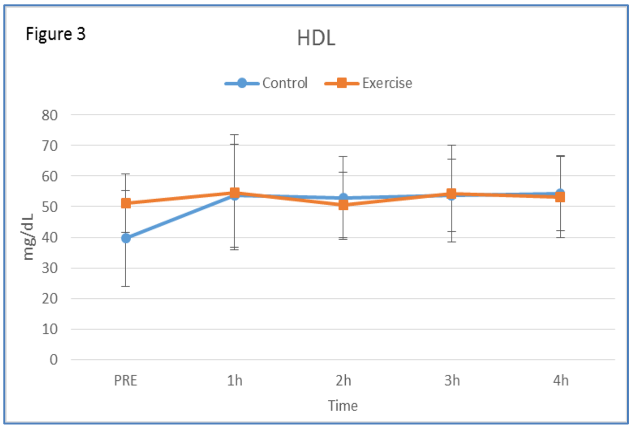

Figure 3. HDL measured in mg/dL over time, no significant difference exists, values represented as mean±SD

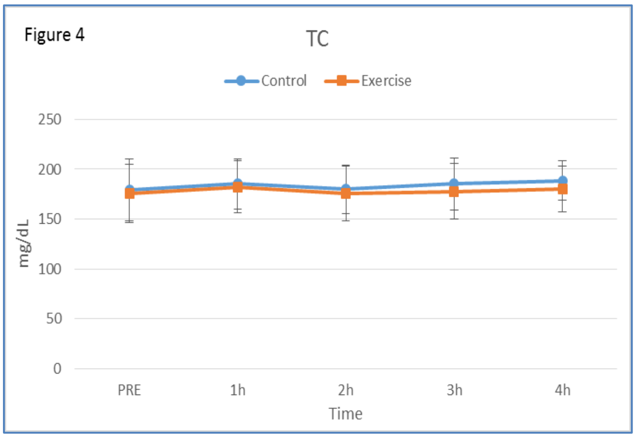

Figure 4. TC measured in mg/dL over time, no significant difference exists, values represented as mean±SD.

There exists a trend towards significance among TC values over time ($p=0.059$), however no significant difference was observed (Figure 4).

Glucose values peaked at one-hour post-feeding and declined steadily over time reaching near pre-feeding values at hour four. Glucose values experienced a significant difference from the pre-feeding values at hours one and two (Figure 5).

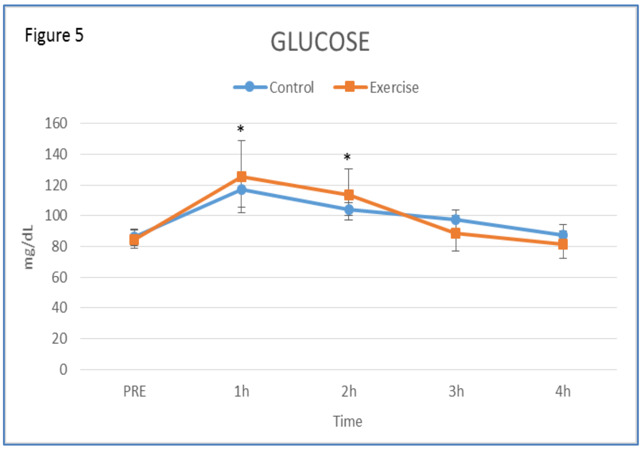

Figure 5. Glucose measured in mg/dL over time, (*) values are significantly different than the pre-feeding value, ($p \leq 0.05$), values represented as mean±SD

4. Discussion

An acute bout of 30 minutes of moderate-intensity exercise did not attenuate PPT levels within four hours following a high fat meal in postmenopausal women. The change in PPT over-time is consistent with the normal curve experienced by researchers (Figure 1) [4-8]. No changes in LDL, HDL, or TC were observed. We experienced a predictable trend among blood glucose values in both groups; consisting of a drastic increase at the one-hour mark, followed by a gradual decrease over the remaining three hours as glucose is countered by the normal insulin response. Glucose reached near pre-feeding values at the three- and four-hour points.

There were no difference in TG values between the exercise and control groups. TG values increased steadily among both the control and exercise groups over time. These findings are valuable due to the lack of research examining the PPT response among postmenopausal women, and what effect exercise may contribute to those values. Our data are not consistent with similar investigations in which 30 minutes of moderate-intensity exercise did attenuate PPT in young and middle-aged men [7, 11]. A significant difference in PPT has been observed among middle aged men (46±2) in a previous study at four- and six-hours post-feeding; their conclusions may indicate that the four hours of time monitored in the present study was an insignificant duration to record a change in PPT values [7].

The participants in this study exercised at an intensity of 60% HRR for 30 minutes. Significant differences in PPT among exercise and control groups have been found using: 30% HRR for 100 minutes, 60% HRR for 60 minutes, 60% HRR for 90 minutes, 70% HRR for 30 minutes, and brisk walking for 90 minutes [4-6, 8, 15]. Researchers have had success when exercising participants at an increased intensity or duration; this is may not applicable to the average postmenopausal woman. Exercise consisting of brisk walking for 90 minutes has decreased PPT in postmenopausal women significantly [8].

The fat content which was ingested by the participants in this study totaled 57g. This fat content is similar to that of previous studies which have shown a successful decrease in PPT with exercise by having their participants ingest 40g, 56.8 ± 6.1g, and 100g [1, 6, 13]. There has also been success using a ratio of fat-ingested to body mass to determine how much fat should be ingested by each individual [5, 7, 8]. It is unclear if the decreased estrogen levels of the postmenopausal women were a factor in hindering their TG clearance.

The acute exercise utilized in the present study was not sufficient to elicit a significant change in LDL values over time. The LDL level decreased at the two-hour mark, showing a trend towards significance (p=0.0176), which could be an indication of a positive change occurring among blood lipid levels. Elevated levels of LDL cholesterol have been linked to arthrosclerosis and CVD; a decrease in LDL cholesterol will improve the cardiovascular health of the exercising individual [16]. It is commonly accepted that chronic exercise is the best effector of decreasing LDL, therefore, the acute bout of 30 minutes moderate-intensity exercise used in this study was insufficient to influence change in LDL. Chronic exercise has yielded a change in LDL in as few as three weeks of moderate (brisk walking) exercise [16].

The lack of change in HDL is consistent with research that has shown that chronic, high-intensity exercise (≥7 days) is required to elicit a positive change in HDL [17]. The moderate volume of exercise used in the present study was not sufficient to effect change in HDL. There was a trend towards exercise decreasing total blood lipid levels which may indicate that some change occurring among the cholesterol values. This change in TC is likely due to the initial sudden increase in blood lipids following feeding. The primary limitation of the present study is the small sample size of five individuals. In addition to drop-out and health screening, the exercise intensity employed in the present study was a limiting factor. Another limitation was the limited control of foods consumed prior to data collection. Future investigation should seek to employ more strict dietary controls. The one participant undergoing hormone replacement therapy may have also been a limiting factor; as the effect of the medication on PPT was not investigated.

5. Conclusion

The impact of these findings is significant for public health, specifically an older population. Research with a focus on an older adult population is invaluable, as this population is often overlooked in the literature. Consequences of this investigation yield an apparent necessity for further investigation into this population and their inability to clear PPT as effectively as a younger population. In conclusion, 30 minutes of moderate-intensity exercise prior to a high fat meal does not significantly decrease PPT over a four-hour period. It has been observed that active individuals have a lower risk of having unfavorable cholesterol values, thus chronic exercise is likely the best action to prompt the exercise benefits of an improved lipid profile. Future investigations should seek to determine if the aforementioned results of the present study are due to the exercise intensity utilized or if there exists a metabolic process among postmenopausal women which limits PPT clearance.

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