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90 Minutes of Moderate-Intensity Exercise does not Attenuate Postprandial Triglycerides in Older Adults

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ABSTRACT

International Journal of Exercise Science 9(5): 677-684, 2016. To determine whether 90 minutes of moderate-intensity exercise, prior to a high fat meal, attenuates postprandial triglycerides (PPT) in older adults. Eight sedentary older adult volunteers (mean ± SD age = 58 ± 8 years, BMI 26.5 ± 4.2); completed two trials consisting of exercise and a no-exercise control. Exercise trials involved 90 minutes of moderate-intensity exercise 60% heart rate reserve (HRR). Following exercise, an overnight fast of 12-16 hours was performed. Participants were given a high fat meal that consisted of 146 grams of CHO, and 92 grams of fat and instructed to rest. Lipid levels were collected at pre-feeding, 1, 2, 3, and 4 hours post feeding. The control trial involved no exercise, performed an overnight fast of 12-16 hours, and was given the high fat meal followed by four hours of rest and data collection. There was no difference in PPT between the control and exercise trials ($p < 0.05$). Triglycerides (TG) increased in both trials over pre-feeding values (pre-feeding 123.13 ± 65.03 con. 111 ± 53.9 ex., 1hr 161.50 ± 83.77 con. 149 ± 71.03 ex., 2hrs 208.25 ± 120.69 con. 177 ± 97.29 ex., 3hrs 228 ± 146.99 con. 147.25 ± 87.64 ex., 4hrs 211.75 ± 140.15 con. 169.5 ± 68.14 ex). No difference in triglycerides over time was observed among older adults between the exercise and control trials.

KEY WORDS: Fat ingestion, lipemia, fat oxidation, acute exercise

INTRODUCTION

There exists sufficient evidence which links the diseased state of atherosclerosis to elevated levels of total cholesterol (TC), low-density lipoproteins cholesterol (LDL-C), very low-density lipoprotein cholesterol (VLDL-C), and triglycerides (TG) (14, 18, 24). A phenomenon of particular interest is increased postprandial lipemia. Current research suggests that atherosclerosis is linked to the frequent and chronic elevation of postprandial lipemia (14, 29). An increase in postprandial triglycerides (PPT) is complicated by the increased daily ingestion of multiple fatty meals; as is commonly seen in first-world populations (14).

Moderate-intensity walking at 60% and 50% VO_{2Max} for 90min has shown to be an effective tool in decreasing PPT (6, 9, 18, 24, 29). This decrease in PPT can be seen among both trained and untrained individuals, supporting the theory that the increase in TG clearance is independent of anthropomorphic changes (14). Acute exercise creates a clearance of existing intramuscular cholesterol via the skeletal muscle which is replenished as skeletal muscle uptakes plasma VLDL in the postprandial state (16). Plasma TG are hydrolyzed into fatty acids via lipoprotein lipase (LPL). The decrease in circulating VLDL allows for less competition of LPL activity and thereby allowing an increase in TG hydrolysis (14, 16). Additionally, there is an increase in skeletal muscle LPL activity with exercise, which aides in the attenuation of plasma TG concentrations (14).

Exercise effects on PPT are short lived and are insignificant 24-48 hours post-exercise (14, 16). Current research has determined the optimal time to measure PPT following an oral fat tolerance tests (OFTT) is 12-16 hours post-exercise (14, 24, 28). Exercise benefits measured directly prior to, or directly after, a high-fat meal show a decrease in effectively reducing PPT when compared to measured exercise benefits at 12 hours prior to the high-fat meal (30).
Research concerning lipid metabolism commonly utilizes a younger population (20-50 years of age), creating a scarcity in data corresponding to older adults. There is a presumed decrease in LPL activity with age, causing an increase in plasma TG (16). The mechanisms and parameters by which TG can be naturally reduced through exercise are of specific concern to an older population. Therefore, the purpose of this study was to discover whether 90 minutes of moderate-intensity exercise attenuates PPT among older adults.

METHODS

Participants
Subjects consisted of men (1) and women (7) of various activity levels with a minimum age of 50 years and a mean age of 58±8. Subjects BMI was relatively homogeneous with a 26.5±4.2 average. A health history questionnaire as well as an informed consent advising them of procedures, risks, and benefits of the present study was completed. Subjects with the diseased conditions of known cardiovascular disease, hyperlipidemia, or diabetes were excluded from the present study. Subjects with signs or symptoms of cardiovascular, pulmonary, or metabolic disease, as defined by the American College of Sports Medicine (ACSM), were also not allowed to participate (1). Subjects currently taking medication to monitor lipid metabolism, carbohydrate metabolism, or insulin therapy were also excluded; as were smokers or those partaking in recreational drugs. Subjects with increased resting values prior to the exercise or control trial were also excluded; those values were as follows: blood glucose was over 125mg·dL, blood pressure greater than 160/100mm Hg, or total cholesterol over 240mg·dL. Activity levels ranged from moderately active (walking 3 days per week), to sedentary (non-strenuous work activities). This homogeneously active group has been selected to eliminate the synergistic effects of endurance training on PPT clearance (29). Institutional Review Board approval was given from California Baptist University (14-EF-010).

Protocol
Subjects participated in two, two-day, OFTT trials and underwent the exercise trial first, followed by the control trial, with a minimum of seven days between trials. On day one of the

two-day protocol, the exercise trial participated in 90 minutes moderate-intensity walking. The OFTT took place on day two of the two-day protocol among both control and exercise trial. Both trials underwent the same protocols for data collection; however, exercise was omitted in the control trial and replaced with 90 minutes of rest (seated none activity). Prior to data collection on day one and two subjects rested in a supine position for 15 minutes; at the conclusion of which, resting HR, BP, lipid profile, and blood glucose were collected utilizing the Alere Cholestech LDX (Alere North America LLC, Orlando FL). Subjects were advised to abstain from alcohol for a 24-hour period prior to day one and continue to abstain until the conclusion of day two. Each subject kept a food journal, recording what they ate for the 24 hours prior to day one and concluding with the day two data collection. This food journal was used to replicate the subject's diet prior to each OFTT. Subjects were advised to abstain from exercise for 48 hours prior to day one and concluding with the day two data collection.

On day one, between the hours of 1800-2000, the exercise trial participated in a 90- minute walk of moderate intensity. Walking was performed on a walking track with no noticeable grade. The subjects wore Polar heart rate monitors (model FT7, Polar Electro Inc., Lake Success NY) during the 90 minutes of brisk walking. Subjects were advised to maintain an exercise intensity of 60% HRR ± 5bpm. Water intake was measured and replicated during the 90 minute rest period of the control trial. All subjects completed the exercise without complication.

Subjects returned on day two between the hours of 0730-0800 after participating in a 12-16 hour overnight fast. The exercise trial began the fasting time at the cessation of exercise. After the resting vitals were obtained, subjects were given a 20 minute period in which to consume an OFTT. The OFTT consisted of a standardized Denny's® milkshake containing 490 kcal, 92g fat, 146g CHO, and 24g protein. A dose of 9000PCC lactase units was given in conjunction with the milkshake to ensure that the meal was easily digested. Subjects were then instructed to rest for the duration of data collection. HR, BP, lipid profile, and blood glucose was collected at 0 (pre-OFTT), 1, 2, 3, and 4 hours postprandially.

Statistical Analysis

Two-way repeated measures ANOVA-s were used to analyze the difference in TG, LDL, HDL, and glucose over time for the control and exercise trials. A Tukey post hoc was utilized to examine the differences within the data, when appropriate. An alpha level of $p < 0.05$ was considered statistically significant for all comparisons.

RESULTS

There exists no significant difference in triglycerides when comparing the exercise effect over time, and control effect over time. There does exist a significant difference when examining the effect of time on PPT ($p < 0.05$). This difference lies in the one, two, three, and four hours postprandial over the pre-prandial (baseline) measurement. PPT increases along a predictable curve among both groups with a slight decrease among the exercise trial (Figure 1). Minimal deviation occurs between exercise and control mean values.

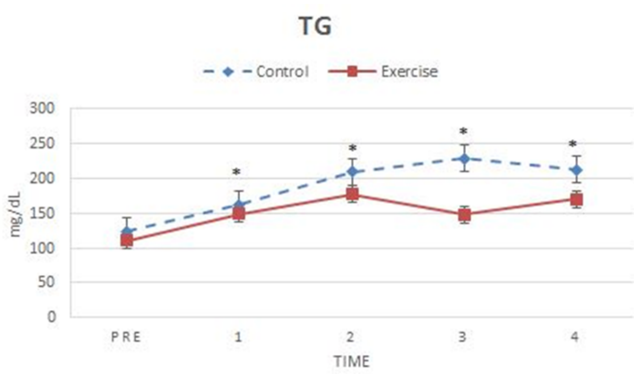

Figure 1. TG over the four hour period. TG measured in mg/dL over time, (*) values are significantly different than the pre-feeding value, (p < 0.05), values represented as mean±SD.

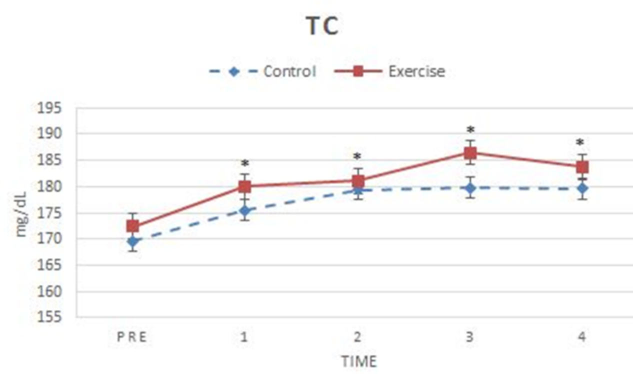

Figure 2. TC over the four hour period. TC measured in mg/dL over time, (*) values are significantly different than the pre-feeding value, (p < 0.05), values represented as

There exists no significant difference interaction of TC between the control and exercise groups. There is a significant difference ($p < 0.05$) of time at all points when compared against pre-feeding values (Figure 2).

Low density lipoprotein (LDL) values remained relatively unchanged throughout the testing period. There was no significant interactions of LDL among control and exercise groups over time. There exists a significant difference of time at the two and three hour points over the pre-feeding value (Figure 3). No significant interactions were found among high density lipoprotein (HDL) values.

No significant difference among glucose values were found between the exercise and control groups over time. There was a significant difference ($p < 0.05$) of time at the one, two, and three hour postprandial values over the pre-feeding time point (Figure 4).

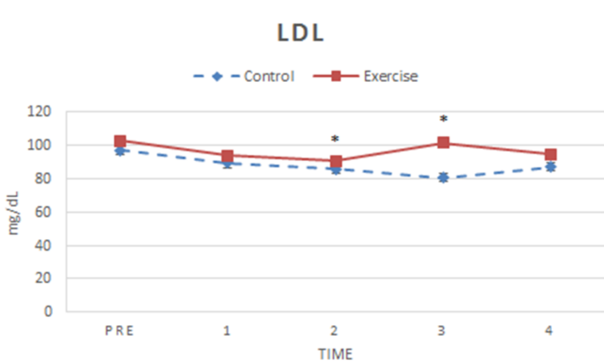

Figure 3. LDL over the four hour period. LDL measured in mg/dL over time, (*) values are significantly different than the pre-feeding value, (p < 0.05), values represented as mean±SD.

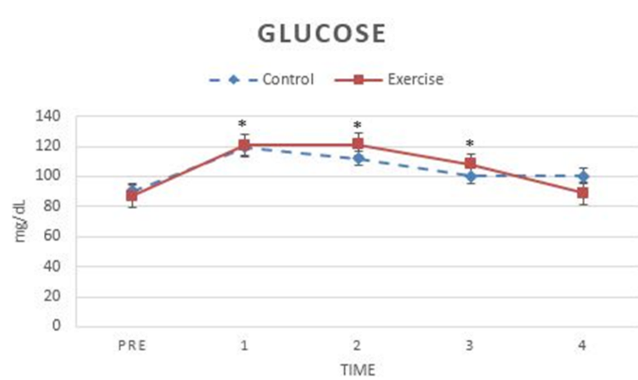

Figure 4. Glucose over the four hour period. Glucose measured in mg/dL over time, (*) values are significantly different than the pre-feeding value, (p < 0.05), values represented as mean±SD.

DISCUSSION

The main findings of this investigation is an acute bout of moderate-intensity exercise preformed 12-16 hours prior to ingesting a high-fat meal does not attenuate PPT in older adults. There was no difference in PPT when comparing the exercise group over time with the non-exercise group over time. There exists a significant difference over time at all time points beyond the pre-feeding value. This difference is to be expected among any population and originates from the natural process by which the body metabolizes food and experiences a rapid increase in TG.

Previous examinations have discovered that a chronic exercise intervention is required to effect change in LDL and HDL, or exercise vigorous enough to elicit a deficit of ≥1100 kcal in one bout. The decreased exercise influence in the present study is likely not sufficient to influence LDL and HDL values (14, 23). Conversely, a change in TG has been observed when eliciting a deficit of between 350-700 kcal based on fitness (lower fitness requiring lower kcal expenditure) (14). TC experienced an increase upon feeding, and glucose followed the normal metabolic pattern of feeding, having an initial peak, followed by a decline to near pre-feeding values.

The findings of the present study are not consistent with similar investigations which have found a significant difference following a 90-minute moderate-intensity exercise bout and 12-16 hour fast. A decrease in PPT has been found when walking for 90 minutes at 50% VO_{2Max}, and 60% VO_{2Max} followed by a 12-16 hour overnight fast in non-smoking males and females, trained and untrained, ages 21-43 (3, 6, 10, 29). Exercise intensity as low as 30% VO_{2Peak} for 100 minutes has been shown to reduce PPT among eight young women, age 27 ± 1 (18). The mean age in this present study was 58 ± 8; therefore, age may be an indicator of a decrease in LPL activity with age, leading to an impaired ability to metabolize TG in older adults. Minimal research has been performed examining the effects of LPL activity on older adults; however, reduced LPL activity in rodent models has shown defective fatty acid utilization and TG lipolysis leading to cardiac complications in older mice, including cardiac fibrosis (2). Increased LPL activity has been linked to reduced all-cause mortality; likely attributed to a decrease in circulating cholesterol over time (27). Increased circulating VLDL and chylomicrons can penetrate the intima and perpetuate the diseased state of atherosclerosis; therefore, it can be speculated that mutations in LPL production with age can decrease the exercise effect on TG.

An estimate of HR max was used in the present study, as it is more likely to appeal to an older population who may be unwilling (or unable) to perform a VO_{2Max} test. The utilization of maximal heart rate by way of measuring exercise intensity has yielded successful investigations and is friendlier to sedentary populations (as examined in the present investigation) having not met the exercise guidelines as defined by ACSM (1, 19). The exercise intensity employed in the present study was 60% of estimated heart rate max which is similar to other investigations that have found a significant changes in PPT utilizing younger populations and exercise bouts of 90 minutes (6, 9, 10, 29). The OFTT used in the present study contained 92g of fat and is similar to that of other investigations which have found a significant difference among exercise trials utilizing a fat content of 40g, 80g, 87g, 98g, and 140g (4, 6, 11, 26). Researchers have had success catering the fat content to the lean mass or body mass of the participant; this may be a more effective measure by which the fatty meal is delivered (5, 7, 10, 17, 19, 20, 29). The present study used a standardized Denny's® in an effort to simulate a meal that is ingested daily by restaurant patrons. The wide range of fat content and quality among researchers suggests the necessity for a standardized OFTT (24). Future researchers should consider incorporating a young population, as well as the older population, in an attempt to determine whether age is the divergent factor in TG metabolism. Additional limitations include the scheduled exercise trial prior to the control trial; future studies should consider utilizing a randomized cross-over design, thus decreasing the risk of participants being conscience of their activity and eating habits leading up to the trial. The subjects in the present study self-monitored their HR throughout the exercise trial and reported their heart rate verbally at 15 minute intervals; future studies should consider constant researcher monitoring of HR.

In conclusion, the results of the present study demonstrate that 90 minutes of moderate-intensity exercise 12-16 hours prior to a fatty meal does not influence the rate of PPT clearance in subjects' ≥50 years of age. The present study has sought to determine whether the exercise response on TG among older adults is similar to that of younger populations; whom have experienced an attenuation of TG under similar parameters (6, 9, 10, 29). Further research is needed on LPL activity among older adults and its influence on TG clearance.

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