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Acute exercise improves postprandial cardiovascular risk factors in overweight and obese individuals

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ABSTRACT

Objectives: The effects of 30 min of exercise on postprandial lipaemia in the overweight and obese are unknown as previous studies have only investigated bouts of at least 60 min in lean, healthy individuals. The aim of this study was to investigate whether a single 30-min bout of resistance, aerobic or combined exercise at moderate-intensity would decrease postprandial lipaemia, glucose and insulin levels as well as increase resting energy expenditure and increase fat oxidation following a high fat meal consumed 14 h after the exercise bout, in overweight and obese individuals compared to no exercise. We also compared the effects of the different exercise modalities.
Methods: This study was a randomized cross-over design which examined the postprandial effects of 30 min of different types of exercise in the evening prior to a breakfast meal in overweight and obese men and women. Participants were randomized on four occasions, each one-week apart, to each condition; either no exercise, aerobic exercise, resistance exercise or a combination of aerobic exercise and resistance exercise.
Results: An acute bout of combination training did not have any significant effect on postprandial measurements compared to no exercise. However, aerobic exercise significantly reduced postprandial triglyceride levels by 8% compared to no exercise ($p = 0.02$) and resistance exercise decreased postprandial insulin levels by 30% compared to aerobic exercise ($p = 0.01$).
Conclusion: These results indicate that a single moderate-intensity 30 min bout of aerobic or resistance exercise improves risk factors associated with cardiovascular disease in overweight and obese individuals.

1. Introduction

Cardiovascular disease (CVD) is a major cause of death in Australia and most industrialized countries [1]. Atherosclerosis is the main cause of coronary heart disease. The initiation of atherosclerosis involves the accumulation of lipids deposited by circulating lipoproteins within the arterial wall. Several lipoprotein types are thought to contribute to the initiation of atherosclerosis, including low density lipoprotein (LDL) and postprandial lipoproteins such as chylomicrons and their remnants [2].

Acute exercise may reduce the risk of atherosclerosis by decreasing concentrations of triglyceride (TG) and circulating atherogenic lipoproteins in the blood [3] while also increasing levels of beneficial high density lipoproteins (HDL) [3]. The effect of a single session of aerobic exercise, such as walking and cycling, on lipid metabolism has been investigated in several studies [3–6]. However, these studies have been restricted to healthy, active, normal-weight participants. In addition, exercise interventions have commonly been of 60–120 min duration at a moderate-intensity ranging from 50% to 75% of VO_2max [3–6]. Postprandial lipaemia has been shown to be greater in the overweight and obese compared to normal-weight individuals after both exercise and no exercise conditions, possibly due to greater fat mass and its negative effect on lipoprotein lipase (LPL) activity [7]. Few studies have investigated the acute effect of exercise in overweight and obese individuals, a group now comprising the majority of the Australian adult population.

In one of the few studies to investigate the effect of resistance exercise on acute postprandial lipaemia [8], participants completed 3 sets of 10 repetitions lasting 88 min compared with the control condition of no exercise and aerobic exercise for the same amount

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Table 1
Participant characteristics and fasting measurements.

Group characteristic	Group mean (range)			
(A)				
Age (years)	58.7 ± 1.1 (50–67)			
Weight (kg)	85.0 ± 2.7 (65–106.4)			
Body mass index (kg/m^2)	31.7 ± 1.2 (25.7–43.2)			
Body fat %	42.0 ± 1.7 (24.5–50.5)			
Waist circumference (cm)	103 ± 2.3 (90–126)			
Waist:hip ratio	0.89 ± 0.01 (0.81–0.97)			
	Control	Aerobic	Resistance	Combination
(B)				
Triglyceride (mmol/L)	1.69 ± 0.19	1.49 ± 0.16	1.48 ± 0.16	1.43 ± 0.18
Total cholesterol (mmol/L)	6.05 ± 0.32	5.98 ± 0.35	5.87 ± 0.29	5.93 ± 0.30
HDL-cholesterol (mmol/L)	1.41 ± 0.10	1.44 ± 0.10	1.37 ± 0.09	1.46 ± 0.09
LDL-cholesterol (mmol/L)	3.88 ± 0.33	3.86 ± 0.36	3.82 ± 0.29	3.81 ± 0.29
NEFA (mmol/L)	0.45 ± 0.04	0.49 ± 0.04	0.47 ± 0.03	0.47 ± 0.04
Insulin (mIU/L)	14.27 ± 2.00	13.4 ± 1.08	14.73 ± 2.07	12.65 ± 1.24
Glucose (mmol/L)	5.93 ± 0.58	5.26 ± 0.21	5.21 ± 0.19	5.32 ± 0.23
HOMA score	3.49 ± 0.47	3.04 ± 0.15	3.27 ± 0.37	3.12 ± 0.42
ApoB48 (μg/ml)	5.02 ± 0.75	4.75 ± 0.64	5.78 ± 0.83	5.32 ± 0.54

Values are participant characteristics at baseline (A), mean ± SEM and (range) and fasting measurements for each intervention (B), mean ± SEM. HOMA: homeostasis model assessment.

of time. Participants were lean and apparently healthy males and females aged 21–40 years who were recreationally weight trained. Baseline TG levels were lower after resistance exercise compared to control (21%) and aerobic exercise (23%). Furthermore, the area under the curve (AUC) for TG was significantly lower after resistance exercise than after control (14%) and aerobic exercise (18%). Zafeiridis et al. [9] also compared the effect of low- (39 min) and high-volume (79 min) resistance exercise on postprandial lipaemia in healthy young men with normal body weight. Investigators observed a significant decrease in TG AUC for both conditions compared to control. However, the effect of resistance exercise in overweight and obese adults is unknown.

Current Australian physical activity recommendations suggest that adults should undertake 30 min of moderate-intensity physical activity on most days of the week to enhance health [10]. However, it is not known how 30 min of exercise affects postprandial lipaemia in the overweight and obese as previous studies only investigated bouts of at least 60 min in lean, healthy individuals [3–6,8]. In addition, reduction in postprandial lipaemia as a result of different modes of exercise has not been examined and there are no definitive recommendations regarding the exercise modality the overweight and obese should undertake for the best health outcomes. We hypothesized that compared to being inactive, a 30-min bout of moderate-intensity exercise would have positive effects on postprandial lipaemia, glucose and insulin levels of a meal consumed the next day, improve endothelial function, increase resting energy expenditure and increase fat oxidation in those who are overweight and obese. There is a need to examine whether the 30 min dose of exercise, as suggested in current physical activity guidelines, have a beneficial effect on metabolic factors in the overweight and obese. This information should provide the evidence to either support the guidelines or will help to advocate whether different and more specific recommendations should be made for this group.

The aim of this study was to investigate whether a single 30-min bout of resistance, aerobic or combined exercise at moderate-intensity would decrease postprandial lipaemia, glucose and insulin levels as well as increase resting energy expenditure and increase fat oxidation following a high fat meal consumed 14 h after the exercise bout, in overweight and obese individuals compared to no exercise. We also compared the between-group effects of the different exercise modalities in the same measurements.

2. Experimental methods

2.1. Participants

Twenty overweight or obese postmenopausal women and two men, between the ages of 50 and 67 years were recruited from the general population. Both men and women were used as the majority of previous studies have not reported a difference between genders [8,11]. Participants were required to be sedentary or relatively inactive, having undertaken less than 1 h of moderate physical activity each week over the last 3 months. Exclusion criteria included diabetes mellitus, pre-existing heart conditions, smokers, gastrointestinal tract surgery, any other major illness including any that limit the ability to perform the necessary exercises. Study procedures were approved by the Curtin University Ethics Committee (HR 75/2004) and participants gave written informed consent. Participants' physical characteristics are shown in Table 1A.

2.2. Study design

The study was a randomized cross-over design examining the postprandial effects of different types of exercise in the evening prior to a breakfast meal. Participants completed in random order, one-week apart, no exercise (control), 30 min of aerobic exercise on a treadmill, 30 min of resistance exercise (leg press, leg curl, leg extension, bench press, rear deltoid row) or a combination of 15 min of aerobic exercise and 15 min of resistance exercise. A postprandial response was measured following the breakfast meal.

Postprandial day: Participants were instructed to abstain from exercise for three days before each condition and to complete a three-day food diary and activity log before each condition and postprandial session to monitor and identify significant variations in nutrient intake or activity within and between participants. On the intervention day participants completed the required exercise for 30 min at 5 pm. The exercise session was undertaken at an intensity of 60% of each participant's age-predicted maximal heart rate reserve, measured by a polar heart rate monitor (Pursuit Performance Pty Ltd, Australia), for the aerobic component and 8–12 repetitions at 10-repetition maximum (RM) for the various resistance exercises. The 10-RM level was determined during an initial briefing session. Participants performed each exercise at a selected weight and if they completed less than 8 or more than 12