The effects of continuous *vs* intermittent exercise on lipid profile in obese children

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Aim: *To investigate the efficacy of 8 weeks of continuous or intermittent exercise on lipid profile in obese children.*

Methods: *A randomised pretest–posttest design was implemented to compare the effects of continuous and intermittent exercise, measuring lipid profiles in obese children before and after the intervention. Thirty obese children (11 male and 19 female; age range: 12–15 years; body mass index ≥25) were randomised into two exercise intervention groups to engage in an 8-week exercise programme consisting of either continuous exercise (Group A) or intermittent exercise (Group B).*

Results: *Data showed that there was a significant decrease in total cholesterol, triglycerides and low-density lipoprotein (LDL) cholesterol and a significant increase in high-density lipoprotein (HDL) cholesterol in both groups following intervention. There was a significant improvement in the lipid profile results of Group B compared with Group A.*

Conclusions: *Intermittent exercise programmes are more effective than continuous exercise programmes in improving lipid profiles in children with obesity. Findings from this research could lead to improved health outcomes in obese patients by increasing aerobic capacity, wellness and metabolic fitness.*

Key words: ■ Obesity ■ Child obesity ■ Intermittent exercise ■ Continuous exercise

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Obesity is an abnormal accumulation of body fat and has been defined as a weight at least 20% above the weight corresponding to the lowest death rate for individuals of a specific height, gender and age (ideal weight). Body mass index (BMI) is the internationally recommended indicator of overweight and obesity in healthy individuals (Heiat et al, 2001). In clinical practice, the 91st and 98th percentiles of national BMI percentile reference charts are used (Rolland et al, 1991).

The early onset of obesity in childhood has been shown to be associated with an increased risk of obesity in adulthood and, as a result, an increase in the prevalence of obesity-related disorders—including coronary disease, insulin resistance, diabetes mellitus, hypertension, sleep apnoea, arthritis, cancer, stroke and heart failure—in later life (Ministry of Health, 2004). A lack of physical activity and sedentary lifestyles are major factors that contribute to the development of paediatric obesity (Reybrouck et al, 1997). Primary prevention should be the unequivocal first strategy to directly address childhood obesity (Schonfeld-Warden and Warden, 1997) as encouraging sustainable physical activity habits in children will help establish desirable healthy lifestyle patterns that continue into adulthood (Riddoch, 1998).

Clinicians require clear exercise guidelines based upon sufficient evidence from which to prescribe the most effective exercise plans (Ogden et al, 2006); however, although the benefits of regular exercise are well documented, the rationale underlying the modes of exercises recommended for specific health benefits remains unclear due in large part to the limited evidence supporting these recommendations (Andersen and Jakicic, 2009). Debusk et al (1990) observed that subjects who exercised with the exercise broken up into intermittent sessions experienced increases in physical fitness and improvements in blood lipid levels. In 2002, Murphy et al (2002) investigated the effects of a continuous training programme consisting of a 30-minute exercise routine at 70–80% of maximum heart rate (HR_{max}), 5 days a week. Participants involved in this continuous exercise programme showed increases in aerobic capacity and improvements in blood lipid profiles.

In a comparison study involving middle-aged adults, Haskell et al (2007) found that intermittent bouts of walking led to significantly

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greater improvements in aerobic fitness, body composition, plasma lipoprotein and blood pressure compared with continuous or long sessions of physical training. Seeking to reproduce these results in adolescents, Koubaa et al (2013) found that continuous exercise resulted in significant improvements in lipid profile and body composition.

Reviewing the available literature, there is a wide contradiction when comparing the effects of intermittent and continuous exercise on lipid profiles, among other physiological measurements. This study aimed to investigate and compare the effects of intermittent and continuous exercise on the lipid profile of obese children. We hypothesised that there would be no significant difference in lipid profile between participants who engaged in either intermittent or continuous exercise programmes.

METHODS

Participants

This study was conducted at the Faculty of Physical Therapy, Cairo University, Egypt. A randomised pretest–posttest design was implemented to investigate the effects of continuous and intermittent exercise on lipid profile in obese children. Thirty obese children (11 male and 19 female; age range: 12–15 years; body mass index ≥25) were randomised into two exercise intervention groups to engage in an 8-week exercise programme consisting of either continuous exercise (Group A; 5 males and 10 females) or intermittent exercise (Group B; 6 males and 9 females). The inclusion criteria were:

- Aged 12–15 years old
- No current or previous neurological or musculoskeletal disorders and in good health
- Able to understand and follow the verbal commands and instructions included in the test.

Informed consent was obtained from the parents of all the children participating in this study via a signed consent form.

Initial preparation

Height and weight measurements were recorded for all participants as part of the initial preparation to calculate BMI. Twelve-hour fasting blood samples were collected by the lab physician on the morning of Day 1 of the intervention and at the end of Week 8 to assess lipid profile. Total cholesterol, triglycerides, high-density lipoprotein (HDL) cholesterol and glucose levels were measured before and after the intervention using standardised techniques described by Wegge et al (2004). Low-density lipoprotein (LDL) cholesterol was calculated using the Friedewald formula (Friedewald et al, 1972).

For the purposes of exercise evaluation, it was determined that the predicted HR_{max} during aerobic training would be the participant's age deducted from the value of 220 beats per minute. Heart rate was measured using a heart rate monitor attached to an EN-Motion (Enraf-Nonius, The Netherlands) treadmill.

Intervention

Group A received continuous training for 8 weeks. This continuous exercise programme consisted of walking for 30 minutes with a training intensity between 50% and 60% of HR_{max}. This was equivalent to 50–60% of the individual's peak aerobic capacity (VO_2 peak), determined during the graduated exercise training. After 4 weeks, the exercise intensity was increased to 70% of the individual's VO_2 peak in order to account for any improvements in aerobic capacity.

Group B received intermittent training for 8 weeks. Participants were instructed to run at a low intensity for 2 minutes with 1 minute rest, repeating this for 30 minutes. The exercise intensity was 75% of HR_{max} and equated to 75% of the VO_2 peak. The exercise intensity was increased by 5% every 4 weeks. During the training period, load increases were carried out by increasing the intensity and number of repetitions.

A t-test was applied to compare the subject characteristics between the two groups and a multivariate analysis of variance (MANOVA) was conducted to compare blood lipid levels at pre- and post-intervention in each group as well as between groups. All statistical analysis was conducted using SPSS version 19.

RESULTS

Participants

Participant characteristics are summarised in *Table 1*. There were no statistically significant differences between the two groups in all categories: mean age, weight, height and BMI (p>0.05).

Table 1. Participant characteristics

	Group A (mean±SD)	Group B (mean±SD)	*t* value	*p* value
Age (years)	13.73±1.03	13.66±1.11	0.17	0.86
Weight (kg)	74.53±6.78	75.13±5.37	–0.26	0.79
Height (cm)	156.8±4.81	157.06±4.38	–0.15	0.87
BMI (kg/m^2)	30.18±1.67	30.42±1.58	–0.40	0.68

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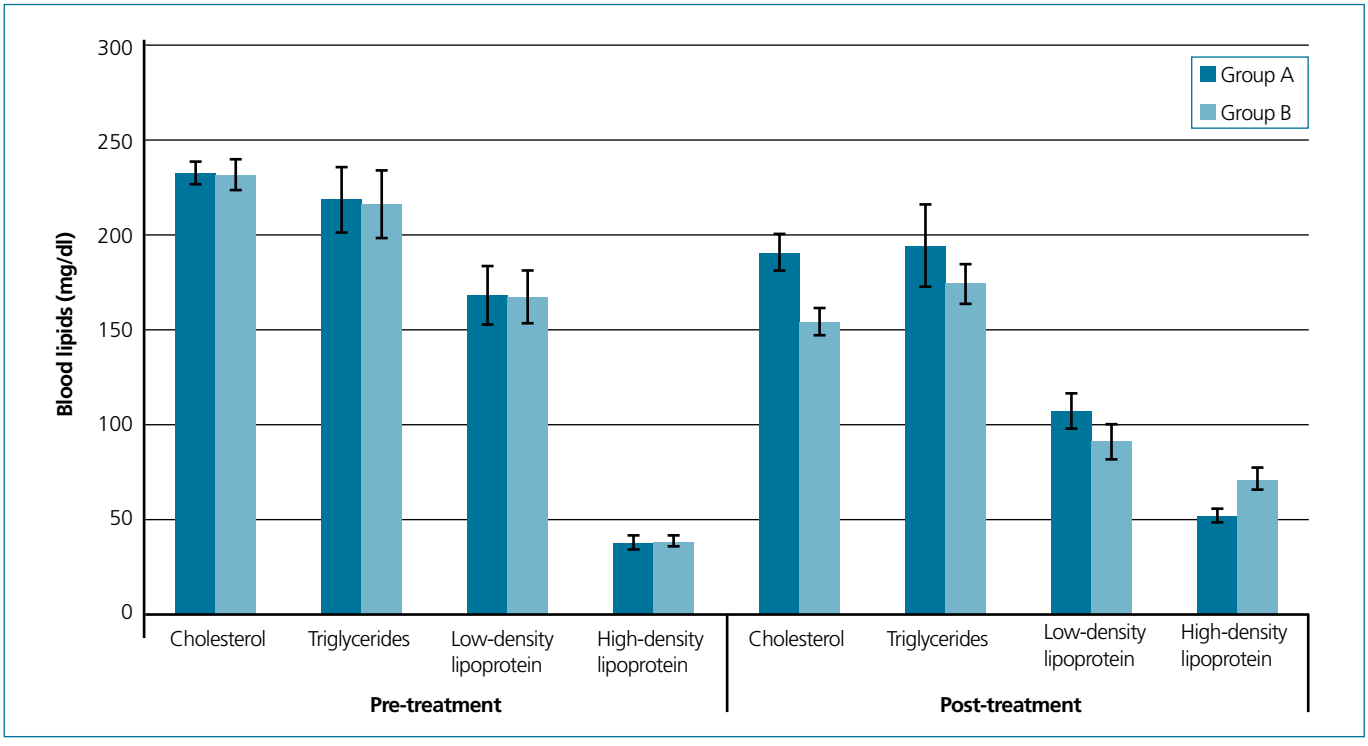

Figure 1. Mean blood lipid levels pre- and post-treatment

Within group comparison

As shown in *Figure 1* and *Table 2*, there was a significant decrease in total cholesterol, triglycerides and LDL levels ($p=0.0001$) and a significant increase in HDL levels in both groups post-treatment ($p=0.0001$).

Between group comparison

There were no statistically significant differences between Group A and Group B in blood lipid levels pre-treatment ($p>0.05$). Post-treatment results showed significant decreases in total cholesterol, triglycerides and LDL in Group B compared with Group A ($p<0.05$) and a significant increase in HDL in Group B compared with Group A ($p=0.0001$).

This study shows that both intermittent and continuous exercise programmes produced significant improvements in lipid profiles in obese children. Participants engaged in the intermittent exercise programme showed significant decreases in total cholesterol (33.42%), triglycerides (19.40%) and LDL (45.36%) and a significant increase in HDL (84.45%). The results of the continuous exercise programme showed significant decreases in total cholesterol (17.99%), triglycerides (11.02%) and LDL (36.21%) and a significant increase in HDL (38.35%). Thus, the intermittent exercise programme produced more significant improvements after 8 weeks compared with the continuous exercise programme.

DISCUSSION

The improvement in lipid profiles may be attributed to the beneficial effects of exercise. Aerobic exercises produce changes in circulating lipoproteins resulting from adaptive changes in the enzymes involved in their metabolism. Specifically, aerobic exercise reduces total cholesterol, triglycerides and LDL and increases HDL (Herzberg, 2004). Eight-week aerobic exercise protocols have been shown to result in favourable changes in lipids and lipoproteins while reducing the negative effects of sedentary behaviour (Varady et al, 2004; Vatansev and Çakmakci, 2010)

The greater improvement in lipid profiles in the intermittent exercise programme compared with the continuous exercise programme is in agreement with Haskell et al (2007), who postulated that intermittent bouts of walking resulted in improvements in aerobic fitness, body composition, plasma lipoprotein and blood pressure compared with continuous or long sessions of physical training. Debusk et al (1990) previously found that subjects who exercised in intermittent sessions experienced improved physical fitness and blood lipid profile.

The findings of this study are also in agreement with the 24-month study conducted by Vasilescu et al (2010), which set out to compare the effect of continuous aerobic exercise with intermittent aerobic programmes, with particular focus on the

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Table 2. Mean blood lipid levels pre- and post-treatment								
	Pre-treatment			Post-treatment			Within Group A *p* value	Within Group B *p* value
	Group A (mean±SD)	Group B (mean±SD)	*p* value	Group A (mean±SD)	Group B (mean±SD)	*p* value		
Total cholesterol (mg/dl)	231.2 ± 5.68	230.8 ± 8.37	0.87	189.6 ± 9.57	153.66 ± 7.61	0.0001	0.0001	0.0001
Triglycerides (mg/dl)	217.66 ±17.51	215.4 ±18.17	0.73	193.66 ± 21.75	173.6 ±10.42	0.003	0.0001	0.0001
LDL (mg/dl)	167.33 ±15.45	166.66 ±14.09	0.9	106.73 ± 9.46	91.06 ± 9.58	0.0001	0.0001	0.0001
HDL (mg/dl)	37.73 ± 3.34	38.6 ± 2.74	0.44	52.2 ± 3.48	71.2 ± 5.94	0.0001	0.0001	0.0001

HDL: high-density lipoprotein; LDL: low-density lipoprotein

serum lipid and anthropometric characteristics of young subjects diagnosed with metabolic syndrome. Both groups of subjects showed improvements in anthropometric characteristics and serum lipid parameters, relative to the parameters recorded before starting the physical activity. Differences between the initial and final recorded parameters were consistently greater in the intermittent exercise group, which saw improvements in: weight; BMI; body fat percentage; abdominal circumference; total serum cholesterol; HDL; LDL; and triglycerides. The findings from this present study have confirmed previous research and may have important implications for the implementation of submaximal exercise in the treatment and prevention of metabolic syndrome.

The results of this study are further supported by Hernández-Torres et al (2009), who observed that the acute effects of continuous exercise and intermittent exercise on blood lipids are not well known, with few studies comparing different kinds of exercise in the same population. The study measured the concentration of blood lipids at the end of, and 24 hours after, a 14-kilometre, 90-minute single exercise session in subjects with high levels of aerobic training. The first group carried out continuous exercise at 44.5 ± 5.6% of their VO_2 peak, while the second group carried out intermittent exercise at 39–72% of their VO_2 peak. Fourteen male athletes (endurance runners) took part in this study and each completed a 24-hour dietary record. Oxygen uptake and carbon dioxide production were recorded, and blood lactate and lipid levels measured. The results showed that triglycerides were not modified by any kind of exercise, while total cholesterol increased at the end of both exercises: 7.04% after continuous exercise ($p < 0.001$) and 4.23% after intermittent exercise ($p = 0.001$). HDL levels increased after intermittent exercise (11.38%, $p = 0.03$) and LDL levels increased after continuous exercise 7.45% ($p = 0.006$). The increased levels of lipids following continuous exercise were negatively correlated with aerobic fitness indicators (heart rate and percentage of HR_{max} at lactate threshold) and positively associated with energy expenditure. For intermittent exercise, percentage of HR_{max} at lactate threshold was negatively correlated with lipid increase, with a positive correlation between the respiratory exchange ratio and the results.

Limitations

The present study has several limitations. First, the intervention programme was of short duration. Second, the relatively small number of participants may have underpowered the study. Finally, the effect of external factors, such as dietary intake and energy expenditure, may have affected the lipid profile. These factors should be controlled for in future studies. Overall, our findings suggest that 8 weeks of intermittent exercise induces significant changes in the lipid profile that would have favourable effects on aerobic capacity and overall health and wellbeing.

CONCLUSIONS

Both continuous and intermittent exercise programmes significantly improved lipid profiles following 8 weeks of training. An intermittent exercise programme was found to be more effective than continuous exercise at improving lipid profiles in children with obesity. IJTR

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KEY POINTS

- Paediatric obesity is increasing in incidence globally, particularly in more economically developed countries
- Obesity in childhood has been shown to lead to obesity in adulthood with increased health risks for disorders such as coronary disease and diabetes
- Evidence is currently lacking regarding best practices and prescribed exercise for children with obesity
- Intermittent exercise programmes were found to be more effective than continuous exercise programmes in improving lipid profiles of children with obesity.

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