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Effect of Physical Exercise on Reducing Food Intake and Weight Gain

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Abstract

The prevalence of obesity and associated health conditions is increasing, which underscores the importance of developing effective strategies to counteract overweight. It is well known that diet and exercise are the two main ways to loose weight. It is not known, however, how exercise training can induce weight loss.To test this, we compared the combined effect of 30 days of two different diets and exercise training on weight loss enhancement. The study was carried out on four groups of rats (n=12); the standard diet sedentary group (SS), standard diet with exercise (SE), high-protein diet with exercise (PE) and high-fat diet with exercise (FE). Significant reductions in weight gain and in food intake were observed with training ($p<0.001$). Body weight was decreased by protein diet ($p<0.01$) and increased by fat diet ($p<0.001$). Fat-diet increased both insulin concentrations ($p<0.05$), glycaemia ($p<0.001$) and muscle glycogen ($p<0.01$).Our results demonstrated the positive effect of physical exercise on reducing both food intake and weight gain. We showed, as well, that combined effect of protein diet and exercise training induced the greatest weight loss. Fat diet, on the contrary, disrupts carbohydrate and fat metabolism and promotes overweight.

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Keywords: physical exercise, obesity, food intake, weight loss, rats.

1. Introduction

Obesity is the second leading cause of preventable death after smoking. This causes health problems such as insulin resistance, osteoporosis, atherosclerosis, hypertension and heart failure (Berkel et al., 2005; Périard et al. 2010). In addition, disturbances of bones and muscles as well as dementia of the Alzheimer type are associated with sedentarity (Rabaeus, 2005). Obesity results from a complex interaction of genetic, behavioral and environmental factors causing an imbalance between energy intake and energy expenditure.

It is well known that diet and exercise are the two main ways to loose weight. However, physical exercise can enhance weight loss because it lowers the energetic balance by two ways; first, by increasing energy expenditure as it was reported in studies on wheel running rats (Bi et al., 2005) and second by reducing food intake as it was demonstrated in a study conducted in rats (Ebal et al., 2007) where it was noted that a moderate exercise training induced a weight loss that was not related to an increase in energy expenditure but to a reduction of food intake.

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Exercise also improves blood lipidic constants, especially HDL cholesterol (Ben Ounis et al. 2008), as lipid oxidation is the major form of energy generation during moderate and prolonged exercises (Gomes et al. 2004).

Besides, weight loss can be reached, as well, with diets (Sacks et al., 2009). However, there is intense debate about what type of diets are most effective on loosing overweight. The possible advantage for weight loss of a diet that emphasizes protein or fat is not fully clear.

Thus, the aim of this study was to investigate the combined effect of endurance exercise training performed on rats and two different diets (protein and fat diets) in the management of obesity.

2. Methods and materials

2.1. Animals and treatments

Male albino Wistar rats weighing 130-150g obtained from SIPHAT (Tunis, Tunisia) were used in this study. Before any experiment, all animals were kept for 1 week in the same laboratory conditions of temperature (22±2°C), relative humidity (70±4%), and a 12h light/dark cycle. They received a nutritionally standard diet (SICO, Sfax, Tunisia) and tap water. All experiments were carried out with the approval of the local animal use committee.
Animals were randomly divided into four groups of 12 rats: the standard diet sedentary group (SS) (control group), standard diet with exercise (SE) (62% carbohydrate, 17% protein, 4% fat; 352 Kcal), high-protein diet with exercise (PE) (42% carbohydrate, 23% protein, 3% fat; 287 Kcal) and high-fat diet with exercise (FE) (56% carbohydrate, 15% protein, 14% fat; 407 Kcal).

2.2. Experimental protocol:

Food intake and animals weight were measured every day. Animals in the trained groups were subjected to swimming exercise in groups of 6 rats in a swimming tank of 100×50 cm with a depth of 50 cm, filled with tap water. The water temperature was kept at 32±2°C. The trained groups swam 1 h/day 5 times weekly for 4 wks. During 5 days before the experiment, the animals were acclimated to the water and exercise with a gradual increase in swimming period. All animals were sacrificed by decapitation 24 h after the last bout of exercise.
Blood was collected into dry tubes and centrifuged at 3000g for 15 min at 25°C to separate serum. After blood collection, the entire muscle of both paws were dissected out and immediately immersed in 0.9 % NaCl solution. Glucose concentration was immediately measured. All samples were stored frozen at -30°C until the time for analysis.

2.3. Determination of hormonal and biochemical parameters:

Insulin, corticosterone and IGF-1 concentrations were determined using specific radioimmunoassay kits for the determination on the hormones in rat serum (DSL-Texas-USA). Plasma glucose and triglyceride were measured by colorimetric methods using commercial kits obtained from BIOMAGHREB (Tunis, Tunisia).

3. Statistical analysis

Results are expressed as mean ±SE. A two-way ANOVA was performed for effects of diet and physical activity on each variable. Statistical comparisons between groups were done by Student t test. Significance was accepted at the level of $p < 0.05$.

4. Results

At the end of the study, exercised animals with different diets had a lower weight gain than did sedentary group ($p<0.001$, Table 1). Weight gain was decreased with protein diet (PE vs. SE; $p<0.01$, Table 1) and increased with fat diet (FE vs. SE; $p<0.001$, Table 1). Food intake was lower in trained rats ($p<0.001$, Table 1).

Rats fed high-fat diet have higher insulin ($p<0.05$, Fig 1), glycaemia ($p<0.001$, Table 1), and muscle glycogen levels ($p<0.01$, Table 1). Plasma triglycerides were decreased in all groups with training ($p<0.05$, table 1) with a more salient effect with protein diet ($p<0.001$).

Table 1. Values Means ±SE of food intake, weight gain, glycaemia, muscle glycogen and triglyceridemia in rats with different diets

	SS	SE	PE	FE
Food intake (g /day)	15.86±0.2	13.86±0.2 [aaa]	14.73±0.1	14.6±0.1 [aaa]
Food intake (kcal/day)	55,67±1.05	48,47±0.05 [aaa]	54,5±3.65	56,93±0.75 [bbb]
Weight gain/30d (g)	89.96±3.3	67.86±3.4 [aaa]	50.66±5 [aaa bb]	77.56±2.3 [aaa bbb]
Glycaemia (g/l)	1.16±0.03	1.16±0.04	1.14±0.02 [ccc]	1.66±0.05 [aaa bbb]
Muscle glycogen (g/100g)	3.6±0.5	2.46±0.2	3.81±0.63 [b]	4.16±0.2 [a bb]
Plasma triglycérides (mmol/l)	1.76±0.2	1.08±0.17 [a]	0.45±0.06 [aaa ccc]	1.16±0.16 [a]

[a] significantly different from group SS; [b] significantly different from group SE; [c] significantly different from group FE.

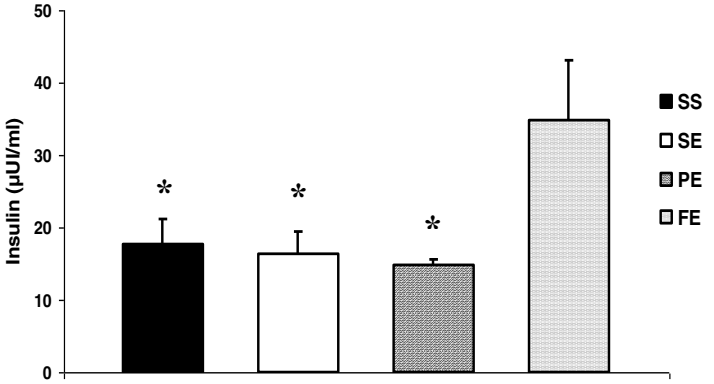

Fig. 1. Effect of physical training and dietary on insulin concentrations.
Values are mean±SE. * $p<0.05$ (SS, SE and PE vs. FE)

5. Discussion

The objective of this study was to investigate the effects of endurance exercise training and two different diets on beating obesity.

As a main result of this research, we showed that five weeks of endurance training induced significant decrease in body mass and in food intake. These findings are in agreement with the study of Mathey et al. (2000) and Ebal et al. (2007) who showed decreased weight gain and food intake during five weeks of moderate strength exercise in rats. This significant lower body weight in trained rats may be explained, on the one hand, by the reduced food intake and

changed body composition by reducing fat mass as result of exercise training (Mathey et al., 2000; Cavalie et al., 2003; Ebal et al. 2007). On the other hand, decreased body weight in trained rats may result from negative energy balance linked with increased energy expenditure during the exercise (Bi Scott et al., 2005). Physical training, generally, results in less weight gain independently of the diet used for weight loss; the negative energy balance alone is responsible for weight reduction (Bi Scott et al., 2005).

In addition, we showed that combined effect of protein diet and physical exercise induced the greatest loss in total weight; they appeared to be additives for lowering body mass. However, we observed significant lower weight gain in rats consuming protein diet with (PE vs. SE; $p<0.01$) and without training (PE vs. SS; $p<0.001$). These findings were in agreement with the study of Layman et al. (2005) who noted that dietary protein and physical exercise have additive effects on body weight loss in humans.

Moreover, many studies have shown that diets with reduced levels of carbohydrates and increased protein result in increased weight loss (Westman et al., 2002; Foster et al., 2003), increased loss of body fat and reduced loss of lean body mass (Westman et al., 2002), and that supplemental exercise tends to increase weight loss through increasing fat loss while preserving lean body mass (Ross et al. 2004).

High-fat diet results showed, however, increased body weight in spite of significant decrease in food intake. In general, high-fat low-carbohydrate diets were used to enhance weight loss (Ebal et al., 2007; Sacks et al., 2009). The greater body mass in the present result, in spite of exercise training and lower food intake can be explained by the overall energy balance which results from equilibrium between energy intake and energy expenditure. It seems that energy from fat diet provides higher calorie storage that exceeds energy spent.

Besides, it has been demonstrated that high-fat diet leads to hypophagia, probably due to an adaptation faculty developed by animals with regard to energy value of the diet and not according to the quantity ingested in mass. This can explain the decreased food intake observed in fat- diet rats (Ebal et al., 2007). In addition, fat diet leads to deleterious metabolic effects with increased glycaemia, insulinemia and muscle glycogen which disrupt overall metabolism.

In conclusion, our findings show that endurance training is the real key in the fight against obesity, not only through an increase in energy expenditure, but mainly through a reduction of food intake. We showed, also, that high-protein diet and endurance training have additive effect leading to a greatest weight loss. Fat diet, on the contrary, disrupts carbohydrate and fat metabolism and promotes overweight.

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