Science & Sports (2012) **27**, 226—232

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ORIGINAL ARTICLE

Effect of two different diets and exercise training on weight gain in rats

Effet de deux régimes alimentaires et de l'entraînement sur la prise de poids chez le rat

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Received 29 March 2011; accepted 20 October 2011
Available online 16 December 2011

KEYWORDS
Weight gain;
Diets;
Protein;
Fat;
Physical training;
Rats

Summary
Objective. — 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 control weight gain. It is not known, however, how physical exercise can prevent overweight when associated with different types of diets. To test this, we compared the combined effect of 30 days of two different diets and exercise training on total weight change in rats.
Material and methods. — The study was carried out on four groups of rats ($n = 12$), 6 weeks old; the standard diet sedentary group (SS), standard diet with exercise (SE), high-protein diet with exercise (PE) and high-fat diet with exercise (FE).
Results. — 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 maintained in trained rats receiving fat diet. Fat diet increased both insulin concentrations ($P < 0.05$), glycaemia ($P < 0.001$) and muscle glycogen ($P < 0.01$).
Conclusion. — Our results demonstrated the positive effect of physical exercise on reducing both food intake and weight gain in the case of standard diet. We showed, as well, that combined effect of exercise training with hypocaloric diet (protein diet) induced the less weight gain. Whereas, in combination with hypercaloric diet (Fat diet), physical exercise prevented overweight. Fat diet disrupts, also, carbohydrate and fat metabolisms.

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doi:10.1016/j.scispo.2011.10.008

MOTS CLÉS
Gain de poids ;
Régime hyperprotidique ;
Régime hyperlipidique ;
Entraînement physique ;
Rats

Résumé
Objectif. — L'obésité est un problème de santé majeure qui ne cesse d'augmenter à travers le monde. Il est bien connu que le régime alimentaire et l'exercice physique sont les deux principales stratégies pour contrôler le poids corporel. Cependant, l'effet préventif de l'exercice physique régulier sur la prise de poids, quand il est associé à plusieurs types de régimes, reste mal évalué. Le but de ce travail était d'étudier l'effet additif de deux types de régimes alimentaires et de l'exercice physique pendant 30 jours sur la variation du poids chez le rat.
Matériels et méthodes. — L'étude a été menée sur quatre groupes de rats mâles ($n = 12$), âgés de six semaines ; un groupe de rats témoins sédentaires qui reçoivent un régime standard (SS), des groupes d'animaux entraînés qui reçoivent un soit régime standard (SE), soit un régime hyperprotidique (PE), ou un régime hyperlipidique (FE).
Résultats. — La prise pondérale et la consommation alimentaire sont significativement diminuées avec l'entraînement ($p < 0{,}001$). Le gain pondéral diminue avec le régime protidique ($p < 0{,}01$) et se maintient pour le groupe FE. Le régime lipidique augmente respectivement l'insulinémie ($p < 0{,}05$), la glycémie ($p < 0{,}001$) et les taux de glycogène musculaire ($p < 0{,}01$).
Conclusion. — Nos résultats montrent l'effet positif de l'exercice physique sur la baisse de la prise alimentaire et pondérale en cas de régime équilibré. On a pu montrer également que l'association de l'entraînement physique avec un régime hypocalorique (régime protidique) induit une meilleure perte de poids alors que son association avec un régime hypercalorique (régime lipidique) prévient la prise pondérale. Le régime lipidique provoque aussi une perturbation des métabolismes glucidique et lipidique.

1. Introduction

Obesity is an important public health problem and given the numerous risk factors associated with overweight, it has become more important to prevent the onset of the condition instead of trying to treat it. Strategies recommended for weight control have generally included healthy diets [1] and regular physical activity [2]. However, the poor role of exercise alone, without any nutritional intervention on the correction of overweight in humans [3], is now well established. Moreover, in the context of prevention, there is intense debate about the effect of regular physical exercise in avoiding weight gain regardless of the type of diets. Thus, the aim of this study was to examine the combined effects of physical exercise and different types of diets on body weight changes in rats.

Physical exercise can, in part, limit weight gain because it lowers the energetic balance in two ways; first, by increasing energy expenditure as it was reported in studies on wheel running rats [4,5] and second by reducing food intake as it was demonstrated in a study conducted in rats [6] 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. Exercise also improves blood lipidic constants, especially HDL cholesterol [7], as lipid oxidation is the major form of energy generation during moderate and prolonged exercises [8].

Besides, appropriate diets play, also, an important role in preventing obesity [9,10]. However, there are still misconceptions about the type of diets that can avoid overweight. The possible advantage of a diet that emphasizes protein or fat is not fully clear.

Atkins diet is the most popular of the high fat diets. It was reported to be effective on promoting weight loss in humans in spite of ''ad-libitum'' consumption of high fat products [9]. However, many studies in humans and rats showed that high-fat diet induces obesity [11,12].

Besides, several trials showed that high-protein diets resulted in more weight loss than the other types of diets [1,13], but other studies did not show this effect [14,15]. A recent study in humans [10] comparing three different diets used in overweight control (high-protein, high-fat and high-carbohydrate diets) concluded that reduced-calorie diets, regardless of which macronutrients they emphasize, result in clinically meaningful weight loss.

Therefore, the aim of this study was to examine whether the diet composition influences the expected effect of physical training on total weight change and on metabolic and hormonal regulation in rats.

2. Methods and materials

2.1. Animals and diet

Male albino Wistar rats weighing 130-150 g 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 ($22 \pm 2\,^{\circ}C$), relative humidity ($70 \pm 4\%$), and a 12 h 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), high-protein diet with exercise (PE) and high-fat diet with exercise (FE). The composition of each diet was detailed in Table 1.

It should be noted that, especially with the high-fat diet, rats were subjected to this type of diet for another month