AMHSR ORIGINAL ARTICLE

Effect of Moderate Swimming Exercise on Weight Gain in High Fat Diet Rats

Fatimah Riahi, Simin Riahi

Department of Epidemiology, Faculty of Medicine, AJA University of Medical Sciences, Tehran, Iran

ABSTRACT

Purpose: Obesity is one of the most common problems in the world. Imbalance between energy consumption and expenditure is a main factor in weight disorder. Exercise helps losing weight by increasing energy expenditure and modulation of the energy intake. The present study examined protective effects of daily moderate aerobic exercise on preventing weight gain in high fat diet rats.

Materials and Methods: Male wistar rats weighing 200 ± 20 grams were randomly divided into 4 groups of five rats as follow: Normal (cont), Normal and exercise (Ex), sedentary and high fat diet (HFD/sed) and exercise and high fat diet (HFD/Ex). High fat diet (HFD) was made by adding 10% animal oil to the standard rodent chow. Exercise protocol consisted of swimming for 1 hr/day, 5 days/week for a period of 8 weeks. Weight gain was calculated according to weight of each rat in the initiation of exercise and food intake was measured in a certain day each week.

Results: Moderate swimming exercise increased the food intake in control group, which was significant in the first ($P = 001$), third, fourth, fifth ($P = .05$) and eighth weeks ($P = .001$). Moderate swimming exercise decreased the food intake in HFD/Ex group, which was significant in the first and third weeks ($P = .001$). HFD decreased the food intake in the first, second, third, ($P = .001$) fourth and fifth weeks ($P = .05$) in comparison with the control group. There was a gradual increment of weight gain in all groups during the experiment without any significant difference.

Conclusion: Findings of this study indicated that moderate swimming exercise without any calorie restrictions was not sufficient to prevent weight gain.

Keywords: exercise; high fat diet; weight gain.

AMHSR 2016;14:46-50
www.journals.ajaums.ac.ir

INTRODUCTION

Obesity is one of the most common problems in the world. It is estimated that 1.6 billion of adult people are overweight and 400 million are obese (body mass index >30 kg/m^2).[1] Obesity is a chronic disease and is accompanied with many disorders such as diabetes, hypertension and cardiovascular disease, sleep apnea, dyspnea, mental illness, osteoarthritis, foot and ankle tendinitis, plantar fasciitis, low back pain and chronic lower extremity pain. The exact mechanisms that lead to weight gain or loss are not well known, while behavioral, environmental, inherited, and physiological factors are also involved.[2] Weight loss is considered as the main part of treating this problem.[3] Diet and energy expenditure directly and heredity indirectly affect this process. Imbalance between energy consumption and its expenditure causes weight disorders. If an individual expends more energy than its consumption (active lifestyle) weight loss happens and if energy consumption is more than its expenditure (like sedentary lifestyle or hyperphagia) weight gain happens.[4] Recent study showed food compositions such as its content of fat and

sugar has a very important role in promoting obesity even in absence of excessive food intake.[4] It is obvious that sedentary life style has an important role in increasing obesity prevalence and exercise is important in fat burn and weigh loss, however, the volume of needed activity to prevent weight gain is not known. In this study, we tested the effect of high fat diet consumptions on weight gain and effects of moderate intensity swimming exercise on the prevention of weight gain in rats feeded high fat diet.

MATERIALS AND METHODS

Animals

Male wistar rats (200 ± 20 g) were purchased from Pasture Institute of Iran (Tehran). During the experiment, all animals were kept in standard polyester cages (two rats in each cage) in a room with standard temperature (22 ± 2ºC) and humidity (55 ± 5%) with a 12-hour light/dark cycle and free access to water and standard rodent chow. All protocols of the study were approved by Institutional Animal Ethics Committee of Aja University of Medical Sciences (Iran), which followed the NIH guidelines for care and use of animals.

Experimental Groups and Design

Following the acclimation phase, rats were randomly divided into four groups (n = 5 per group) as follow: Normal rats (sedentary normal) were healthy animals that remained sedentary (cont), trained normal group were healthy animals that did exercise for eight weeks (Ex), high fat diet and sedentary group animals (HFD/sed), trained and high fat diet group that did exercise for eight weeks (HFD/Ex). High fat diet was prepared by adding 10% animal oil to standard rodent chow.[5] Rat's weight was measured initially, weekly and at the end ofeighth week of the exercise. Weekly weight gain was calculated according to initial weight. Food consumption was measured for all rats in certain day of week by digital scale. Each rat was given a pre-weighed pellet, and after 24 hours; its remnants were weighed to determine the food consumption.

Exercise Protocol

In the present study, we used endurance swimming as a model of exercise intervention. This study shows that in obese individuals the moderate intensity is more acceptable. Daily training of moderate-intensity swimming for eight weeks can induce cardiac hypertrophy.[6] The rats in swimming groups performed swimming in a rubber swimming tank with dimension of 55 × 100 × 60 cm for 30 min in the morning. The water depth was enough to prevent from resting and to eliminate bobbing behavior. The tank was filled with tap water and was sufficient for six rats to swim simultaneously. Water temperature was fixed at 32 ± 2ºC to prevent hypothermia. The exercise program in the first week of the training began with acclimatization to water. In the first day, rats swam for 10 minutes. Then, the duration of training increased 10 minutes daily until each rat could swim continuously for 30 minutes. In subsequent weeks, the rats could swim 60 minutes a day for five times a week (60 min/day; 9:00-11:00 AM on Saturday to Wednesday).[7] The control groups remained sedentary in the swimming tank filled with tap water in 5 cm depth in order for animal's paws to reach to the bottom of tank. After each session, the animals were dried and kept in a warm place to prevent from hypothermia stress.

Statistical Analysis

The results were expressed as Means ± SEM. All statistical comparisons were performed using one-way analysis of variance (ANOVA) and Tukey test as Post hoc. All states of $P = .05$ were considered as significant difference.

RESULTS

Food Intake

Figure 1 demonstrates the weekly food intake for each group during this 8-week experiment. The curve shows that swimming exercise increased the food intake in control group, that is significant in first ($P = .001$), third, fourth, fifth ($P = .05$) and eighth weeks ($P = .001$). High fat diet decreased the food intake in first, second, third ($P = .001$) fourth and fifth weeks ($P = .05$) in comparison with sedentary ones. Swimming exercise decreased the food intake in HFD group which was significant in first and third week ($P = .001$).

Body Weight Gain

Table 1 demonstrates the weekly body weight gain in each experimental group during this 8-week experiment. Weekly body weight gain was calculated according to weight of each rat in the initiation of experiment. At the end of week 8 of the experimental protocol, weight gain in control group was 140 ± 17 grams while the high fat diet increased weigh gain in HF/sed group to 163 ± 19, although it wasn't significant. Swimming exercise reduced weight gain in Ex (143 ± 8) and HFD/Ex groups (158 ± 9) in comparison with their sedentary control peers, however this effect wasn't significant. Results showed an insignificant gradual increment of

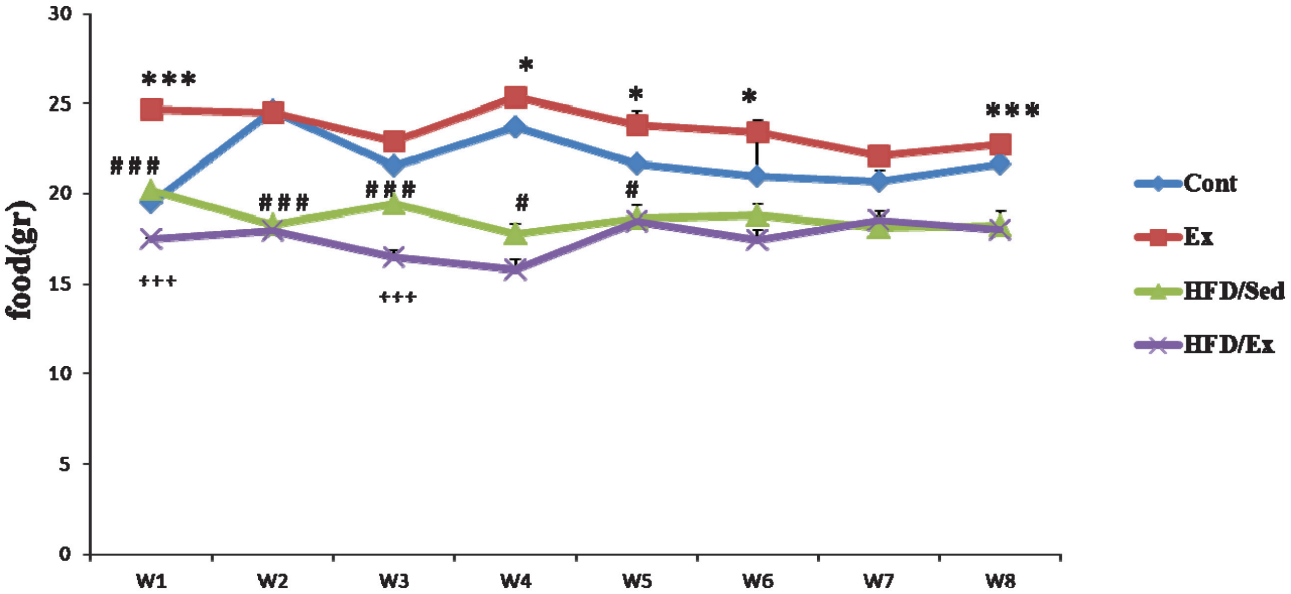

Figure 1. The curve shows the average daily food intake of control (cont.), Exercise (EX), High fat diet (HFD/sed), and high fat diet / exercise (HFD/Ex) groups through the week 8. All values are presented as mean ± SEM.
*(P<.05);***(P<.001): cont. VS Ex.; #(P<.05), ###(P<.001): HFD/Sed. VS Cont.; †††

Table 1. WEEKLY BODY WEIGGHT GAIN in control, exercise, high fat diet, and high fat diet/exercise groups

Group	Weight gain week1	Weight gain week2	Weight gain week3	Weight gain week4	Weight gain week5	Weight gain week6	Weight gain week7	Weight gain week8
CONT	29 ± 5	40 ± 6	56 ± 8	76 ± 8	99 ± 13	120 ± 14	136 ± 17	140 ± 17
Ex	33 ± 4	45 ± 5	61 ± 7	93 ± 11	103 ± 9	101 ± 15	140 ± 9	143 ± 8
HFD/Sed	35 ± 7	53 ± 12	72 ± 13	88 ± 16	120 ± 20	140 ± 17	162 ± 19	163 ± 19
HFD/Ex	38 ± 4	64 ± 3	75 ± 4	99 ± 9	117 ± 11	128 ± 12	144 ± 10	158 ± 9

weight gain in all groups during the experiment.

Table 1 Shows Weekly body weight gain of control (cont.) and Exercise (EX), High fat diet (HFD/sed) and high fat diet /exercise (HFD/Ex) groups. Weekly body weight gain started at the week 1 of the diet and activity protocol, and continued to the week 8. Values are expressed as weight gained in proportion to the weight at the initiation of exercise. All values are presented as mean ± SEM.

DISCUSSION

The recent study has shown that moderate swimming exercise significantly increases the food intake in comparison with sedentary rays, however, this increase in food intake due to exercise isn't accompanied with similar increase in weight gain. Ingestion of high fat diet significantly decreased the food intake in comparison with the control group. Swimming exercise decreases the food intake in HFD/Ex in comparison with HFD/sed which is significant in the first and third week. In all points of the time, there was no significant difference between the groups.

High-fat diet is one of the main causes of obesity, because it increases the energy intake;[8] and it has an important role in weight gain, however, in this study it couldn't significantly increase the obesity. It may be due to a lesser content of fat (15%) in comparison to other studies. Bravo and colleagues increased the weight gain significantly by adding 35.8% fat to rat's standard diet.[9] Jeong and colleagues added 24% fat to mice food and made them obese in 8 weeks.[10] Chapman and colleagues, in a study, showed that intra duodenal infusions of fat suppressed the appetite and food intake.[11]

Significant decrease in food intake in HFD animal is in agreement with the studies that indicated ingestion of high fat diet decreases food intake by suppression appetite.

It is known that endurance training reduces energy expenditure.[12] There is a brief suppression of hunger and

appetite which delays eating after exercise.[13] According to the result of this study, ingestion of HFD decreased the food intake in comparison to the normal diet group, which is due to its high energy content. In standard diet group, exercise significantly increased the food intake in order to compensate the energy expenditure during the exercise. Exercise has no effect on food intake in high fat diet group except a significant increase in the first and second weeks. Base on this study, exercise increased food intake in normal diet and has no effects on HFD group. Exercise has no effects on weight gain. Ross and colleagues recorded that in obese men, without caloric restriction, the weight loss was about 8% after 12 weeks of aerobic exercise. In another study they showed that the weight loss in premenopausal women was 6.8% after 14 weeks of aerobic exercise.[14] In this study, animals had free access to food, and it was seen that moderate swimming exercise without caloric restriction has no effects on weight gain. This result is in agreement with another study that showed exercise without caloric restriction in obese adults is trivial.[14] Foster-Schubert and colleagues demonstrated that, in postmenopausal women, exercise combined with the restriction of calorie is a useful way to reduce the body weight. Exercise with moderate calorie restriction is the best way to enhance the weight loss.[15] Exercise has directly impacted the energy expenditure and modulation of energy intake, and has negative effects on the energy balance.[13] High fat diet with exercise prevents negative energy balance, thus energy content of diet is one of the most important factors in weight control.[16] Exercise burns calories and its combination with caloric restriction is necessity for weight loss. Exercise without caloric restriction slightly reduces weight. Studies indicated that without caloric restriction substantial weight lose occur when aerobic exercise is done in a large volume.[17] A dose-response relationship between the exercise volume and body weight indicated that sufficient amounts of exercise is necessary to decrease the body weight considerably.[18] Exercise in such effective volumes to lose weight may not be practical for most people, so caloric restriction is recommended in combination with exercise.

CONCLUSIONS

The present findings provide further evidence that swimming exercise without calorie restriction is not sufficient to prevent weight gain and also limiting the food intake is an important factor in weight loss.

ACKNOWLEDGMENTS

The authors cordially appreciate the Epidemiology Research Centre (AJA University of Medical Sciences) and the financial support of the Vice Chancellor for Research, AJA University of Medical Sciences, Tehran, Iran.

CONFLICT OF INTEREST

None declared.

REFERENCES

1. Martins C, Morgan L, Truby H. A review of the effects of exercise on appetite regulation: an obesity perspective. Int J Obes (Lond). 2008;32:1337-47.
2. Miller CT, Fraser SF, Levinger I, et al. The effects of exercise training in addition to energy restriction onfunctional capacities and body composition in obese adults during weight loss: a systematic review. PLoS One. 2013;8(:e81692.
3. Kushner RF. Weight loss strategies for treatment of obesity. Prog Cardiovasc Dis. 2014 Jan-Feb;56:465-72.
4. Miller WC, Lindeman AK, Wallace J, Niederpruem M. Diet composition, energyintake, and exercise in relation to body fat in men and women. Am J Clin Nutr. 1990;52:426-30.
5. Heidarian E, Jafari-Dehkordi E, Seidkhani-Nahal A. Effect of garlic on liverphosphatidate phosphohydrolase and plasma lipid levels in hyperlipidemic rats.Food Chem Toxicol. 2011;49:1110-4.
6. Thomas TR, Pellechia J, Rector RS, Sun GY, Sturek MS, Laughlin MH. Exercisetraining does not reduce hyperlipidemia in pigs fed a high-fat diet. Metabolism. 2002;51:1587-95.
7. Teerapornpuntakit J, Dorkkam N, Wongdee K, Krishnamra N, Charoenphandhu N.Endurance swimming stimulates transepithelial calcium transport and alters theexpression of genes related to calcium absorption in the intestine of rats. Am J Physiol Endocrinol Metab. 2009;296:E775-86.
8. El Elj N, Lac G, Tabka Z, Gharbi N, El Fezaa S. Effect of physical exercise on reducing food intake and weight gain. Procedia Soc. Behav. Sci. 2011;30:2027-31.
9. Bravo R, Cubero J, Franco L, et al. Body weight gain in rats by a high-fat diet produces chronodisruption inactivity/inactivity circadian rhythm. Chronobiol Int. 2014;31:363-70.
10. Jeong JH, Park HG, Lee YR, Lee WL. Moderate exercise training is moreeffective than resveratrol supplementation for ameliorating lipid metaboliccomplication in skeletal muscle of high fat diet-induced obese mice. J ExercNutrition Biochem. 2015;19:131-7.
11. Chapman IM, Goble EA, Wittert GA, Horowitz M. Effects of small-intestinal fat and carbohydrate infusions on appetite and food intake in obese and nonobese men. Am J Clin Nutr. 1999;69:6-12.
12. Macko RF, DeSouza CA, Tretter LD, et al. Treadmill aerobic exercise training reduces the energyexpenditure and cardiovascular demands of hemiparetic gait in chronic strokepatients. A preliminary report. Stroke. 1997;28:326-30.
13. King NA, Burley VJ, Blundell JE. Exercise-induced suppression of appetite:effects on food intake and implications for energy balance. Eur J Clin Nutr. 1994;48:715-24.

14. Swift DL, Johannsen NM, Lavie CJ, Earnest CP, Church TS. The role of exercise and physical activity in weight loss and maintenance. Prog Cardiovasc Dis. 2014;56:441-7.

15. Foster-Schubert KE, Alfano CM, Duggan CR, et al. Effect of diet and exercise, alone orcombined, on weight and body composition in overweight-to-obese postmenopausalwomen. Obesity (Silver Spring). 2012;20:1628-38.

16. King NA, Blundell JE. High-fat foods overcome the energy expenditure inducedby high-intensity cycling or running. Eur J Clin Nutr. 1995 Feb;49:114-23.

17. Donnelly JE, Smith B, Jacobsen DJ, et al. The role of exercise for weight loss and maintenance. Best Pract Res Clin Gastroenterol. 2004;18:1009-29.

18. Slentz CA, Houmard JA, Kraus WE. Exercise, abdominal obesity, skeletal muscle,and metabolic risk: evidence for a dose response. Obesity (Silver Spring). 2009;17:S27-33.

Corresponding Author:
Simin Riahi, PhD
Department of Epidemiology, Medical Faculty, AJA University oF Medical Sciences.
Tel: +98 21 88004098
Cell: +98 9124193358
E-mail: Riahy_simin@yahoo.com

Received: February 2016
Accepted: March 2016