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Review Article

The Role of Exercise in Weight Loss and Maintenance: A New Paradigm Based on Motor Skills Repertoire

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Abstract

Many weight loss strategies are available in the literature but many of the individuals regain their weight. The relapse to obesity is of major concern because as individuals relapse, the inflammation becomes more severe. Therefore, strategies must be used for weight loss and long-term weight loss maintenance (LTWLM). Literature shows that individuals who are successful at LTWLM include exercise in their routine. When the goal is weight loss and maintenance the main factor is not the type of exercise or even the intensity and volume of training sessions. If an individual intends to use exercise in LTWLM, the main concern is the affective relation to it. Only by developing an affective response to exercise will an individual truly incorporate more SPA in their life and the amount of physical activity energy expenditure will be increased to an extend that helps overriding the energy gap that results from weight loss. Exercise prescription needs to meet every demand in physical fitness for daily and labor and help qualify and create possibilities for leisure time physical activities and sports.

Keywords: *Exercise; Weight Loss; Weight Maintenance; Fundamental Motor Skills*

Abbreviations

DEE: Daily Energy Expenditure; EE: Energy Expenditure; FFM: Fat-Free Mass; FMS: Fundamental Motor Skills; LTWLM: Long-Term Weight Loss Maintenance; PA: Physical Activity; RMR: Resting Metabolic Rate; SPA: Spontaneous Physical Activity; VLED: Very-Low Energy Diet

Introduction

Obesity is a growing epidemic that affects 500 million people worldwide [1]. This is a result of an imbalance between energy intake and energy expenditure (EE). Although obesity has increased especially from the second half of the 20th century, the current energy intake is lower than it was then, but EE has fallen even further due to modern commodities and what is called an obesogenic environment [2].

The main problem of obesity is a state of low-grade inflammation. When adipocytes grow to store more energy, a decrease in adipose tissue PO_2 occurs due to tissue remodeling [3], and the hypoxia alters the production of cytokines to an inflammatory state associated to a number of metabolic disorders such as diabetes, hypertension and coronary artery disease [4]. Therefore, weight loss for overweight/obese individuals has to be viewed as management of the low-grade inflammation and its metabolic consequences.

Many weight loss strategies are available in the literature but the majority only leads to desirable effects for periods of 3 to 6 months [5] and many of the individuals regain their weight. This relapse to obesity is of major concern because as individuals relapse, the inflam-

mation becomes more severe [6]. Therefore, weight loss interventions must also lead to long-term weight loss maintenance (LTWLM), which is defined as intentionally losing over 10% of body weight and keeping this weight off for a period of at least one year [7].

This review is going to approach the biological drive to regain the lost weight, explore the strategies of those who we successful in LTWLM and propose a new perspective for the role of exercise in weight loss and maintenance for adults.

The biological drive to regain the lost weight

Losing weight is already a difficult task itself but maintaining the lost weight seems to be ever harder. Data from the 1999 - 2006 National Health and Nutrition Examination Survey (NHANES) revealed that among those who accomplished LTWLM, less than 5% of people were able to keep it over 20% and about 25% were able to maintain 10% of lost weight for over a year [8]. Data from the same study showed that after one year, among those who lost at least 10% body weight only 7.6% continued to lose weight, while 58.9% had maintained their weight (variation within 5%) and 33.5 regained weight (> 5%) [9]. Moreover, a meta-analysis by Anderson., *et al.* [10] showed that the success rate of LTWLM falls to 21% at 5 years, which means that 4 in every five people who are successful in losing weight will return to the initial body weight after 5 years. Those data combined show that only about 6% who aim at losing weight of people are able to lose more than 10% body weight and keep it for over 5 years.

Weight regain occurs because the body adapts to weight loss in a way that favors compensatory weight gain (Figure 1). The human body has a very complex set of signals that are integrated by the hypothalamus sending a message that reflects energy stores. The problem of weight loss, especially for those who have increased number of fat cells is that this signaling is not affect by total fat mass but by fat cell size. Once an individual loses weight, as the number of fat cells remains constant, their size is reduced and the myriad of signals send to the hypothalamus is that there is a lack of energy in the body. Literature shows that diet-induced weight loss is accompanied by increased ghrelin and reduction in insulin and leptin [11], which also leads to increased appetite and energy intake.

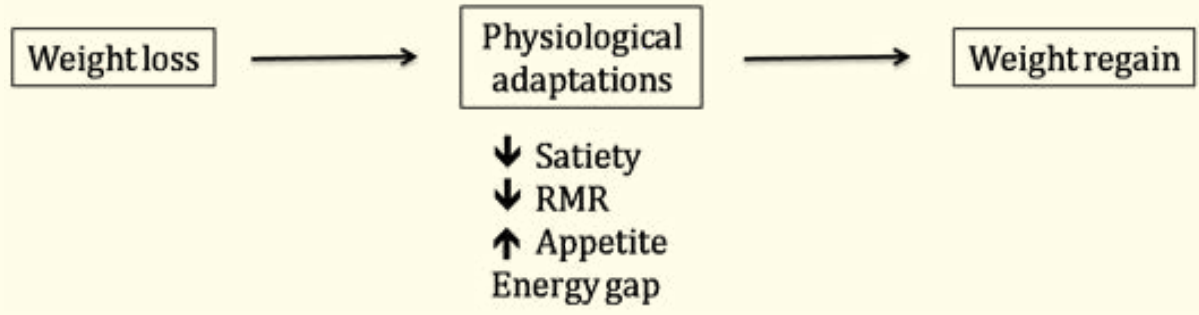

Figure 1: *Weight loss leads to a set of physiological adaptations that include decreased satiety and resting metabolic rate (RMR) and increase in all aspects of appetite. That combination leads to an energy gap that is persistent until the individual regains the lost body weight or even more.*

Another mechanism involved is adaptive thermogenesis. Camps, Verhoef and Westerterp [12] submitted overweight/obese men and women to 8 weeks of a very-low energy diet (VLED) followed by 44 weeks of weight maintenance. During the course of the study, average body mass fell from 92.9 to 83.3 kg after 8 weeks of VLED and was 87.5 kg after 44 weeks of weight maintenance. Resting metabolic rate (RMR) was reduced after 8 weeks of VLED and at the end of the study values were still significantly lower than baseline. Furthermore, individuals had an imbalance between measured and predicted RMR, which would lead to overestimation of RMR using prediction models. Johannsen., *et al*. [13] also found that after 30 weeks of severe weight loss (30% of body weight), where approximately 17% of the loss consisted of fat free mass (FFM), RMR declined to a greater extent than would be expected if only the reduction in body mass and FFM were accounted.

The reduced RMR would not be a problem if energy intake were low enough to maintain energy homeostasis. However, when obese adults lose weight, the body's response is an increase in all aspects of the appetite, including the hedonic reward pathways that increase food palatability [11]. The combination of reduced RMR and the increased appetite create an imbalance that has been termed energy gap [14]. This energy gap is persistent until the moment that the individual recovers the lost weight or comes back to an even greater body weight after regain [11]. Animal models of obesity show that the energy gap is actually increased while the animal is maintaining body weight [15], which would help explain why the success rate of LTWLM falls so drastically over time.

This biological drive to regain weight has to be constantly and continually overridden in order for the lost weight to be maintained. The next session will approach the strategies of those who were successful at LTWLM.

General strategies to maintain the lost weight: what is determinant to maintain body weight?

From the assumption that the relapse to obesity constitutes a factor that further aggravates the obesity-induced inflammation, it seems obvious to postulate that from the individual´s health perspective, the adoption of strategies that ensure the maintenance of the lost weight for periods of at least 5 to 10 years is paramount and even more important than the strategies typically employed for weight loss alone.

In that sense, it is important to emphasize the importance of behavioral changes for the success in maintaining body weight for long periods of time. Literature points to a set of behaviors that decisively contribute for LTWLM once present in someone's life (Kruger, Blanck and Gillespie; Kwasnicka., *et al*.; Kayman, Bruvold and Stern). One key factor in all of the studies conducted to relate behaviors that predict the success of LTWLM is exercise [16].

The study of Kwasnicka., *et al*. elucidated some of the main factors in predicting success of LTWLM. According to the authors, regular exercise, satisfaction with the results, self-regulation, motivation to maintain body weight and a favorable (i.e. non-obesogenic) environment were present in individuals who, after one year of weight loss, were able to keep the lost weight off for a period of six months.

A classic study by Kayman, Bruvold and Stern points to factors that are present in individuals that were able to keep the lost weight off for a period superior to two years. The study evidenced highly elucidative differences between those who were successful at LTWLM and those who failed to keep the lost weight off. Regular PA was present among 90% of the successful group and only 34% of those who failed; use of available social support was a strategy adopted by 70% of the successful and 34% of the unsuccessful; and 95% those who were able to keep the lost weight off faced the problem whereas only 10% of the unsuccessful did. As well as in the study of Kwasnicka., *et al*. authors found as a contributive factor the adoption of personally developed strategies.

In a complementary form, some studies report that strategies of monitoring some aspects such as daily ingestion of carbohydrates and fat, the amount of calories in a diet, portion sizes and frequent body weight control have been shown to be effective and present in the myriad of behaviors that lead to successful LTWLM [16]. Again, in these two studies, regular exercise was present in most of the successful strategies.

Many of these behavioral factors seem to depend of personal behavior traits at some level, which would in great part, explain the low level of success in stabilizing body weight found for the general population. It is possible to say that only a minority of the obese population has the psychological profile to adopt the set of behaviors necessary loss and maintenance of the body weight (Kwasnicka., *et al*).

The sum of the aforementioned studies shows that successful LTWLM is not achieved by one isolate strategy but by a set of strategies that leads an individual to healthier habits. Moreover, it is well established that, no matter what the combination of strategies is, exercise is a central aspect. In the next session, we will present a new approach for exercise prescription in weight loss and maintenance.

How exactly should exercise be prescribed?

As it has been described in the previous session, exercise is a very important part of weight loss and LTWLM. The obvious logic on the

incorporation of exercise to weight loss and maintenance is that exercise increases energy expenditure (EE) both during [17] and after training sessions [18] and that helps creating a negative energy balance during the day. In fact, men and women show the same weight loss to a training program if EE is the same [19]. Also, if exercise increases FFM, it leads to increased RMR [20], which accounts for up to 70% of the daily energy expenditure (DEE) of obese adolescents [21]. Another aspect of exercise that may be important in LTWLM is the increased capacity to mobilize and metabolize fat of trained individuals [22] that has been shown to be reduced in obesity [23].

Despite the many benefits that exercise may provide on the daily energy expenditure, both during training sessions and at rest and on the capacity to metabolize fat, one thing seems to be overlooked in many interventions: and individual will only have those benefits if they actually exercise. This may seem and is obvious, however people know that exercise is helpful in the management of obesity but they are still not exercising [24]. So, even before we question ourselves as to what type or intensity of exercise leads to weight loss and maintenance, we should be asking ourselves how to effectively help individuals incorporate exercise and spontaneous physical activity (SPA) in their lives.

The increase in SPA leads to increased DEE but the regulation of motivation for exercise is very complex [25]. Therefore, incorporating exercise and SPA in an individual's life is a task that demands more than just cognition and will power. If the appetite is increased during LTWLM because of hedonic reward pathways, why shouldn't exercise and SPA also be increased by them? Research on children and adolescents reveal that physical activity (PA) and fitness levels are closely related to their fundamental motor skills (FMS) competence [26]. D'Hondt., *et al*. [27] investigated the FMS competence of 954 Flemish primary school children and found that less than 20% of the healthy-weight participants were identified as being motor impaired, while that proportion increased to 43.3% and up to 70.8% in children with overweight and obesity, respectively. A study by Gentier., *et al*. [28] showed that obese children have lower scores not only for gross motor skills, which are affected by how an obese child moves, but also for fine motor skills compared to children of the same age and gender.

This collective of research shows that there is a negative correlation between FMS competence and body weight of children and adolescents and that interventions at school age must focus on motor development. Stodden., *et al*. [29] proposed a model that explains the relationship between FMS competence and the levels of PA of children and adolescents. In the early childhood, children who are more physically active will have more opportunities for motor development, so in that phase of life PA is a crucial determinant of FMS competence. As children reach into late childhood and adolescence a greater motor development yields a repertoire that allows for engaging in various types of PA, games and sports and the motor developed children end up being more active and those with poor FMS competence embrace a sedentary life style. That is the moment FMS start to determine one's PA behavior for life.

Tammelin., *et al*. [30] investigated the PA behavior of 7794 males and females who were engaged in sports in adolescence. The results showed that the participation in sports of at least once a week for women and twice a week for men during adolescence led to a physically active life style through adulthood. Lloyd., *et al.* [31] showed that the FMS competence at age 6 influenced the PA behavior at age 26, when females who were proficient at age 6 were also those more engaged in PA 20 years later. Stodden, Langendorfer and Roberton [32] have also shown that FMS competence is positively associated with PA in 18 - 25-year-old adults.

This means that once an individual has developed and affective relation to exercise, it will be maintained for the lifespan. If exercise is an important aspect of LTWLM, the current mechanic proposition of exercise with treadmills, ergometers and weights may just not be enough, because their will hardly lead to an affective response and exercise becomes viewed as an obligation rather than pleasure. We propose that exercise prescription is made with the major goals of creating an affective response to exercise and creating the fundamental basis for engaging in sports and other pleasant activities during leisure time. A middle-aged individual who has been sedentary for most of their life will not be excited about lifting weights with the goal of aesthetics but will find meaning if strength training is made to improve performance and reduce injury risk on his favorite sport.

Considering that physical fitness implies in what an individual is fit for, training prescription for weight loss and LTWLM has to address every aspects of physical fitness. Individuals must be fit for daily, labor and leisure time activities. Given that only daily activities such as

climbing stairs, getting in and out of a car and showering are common to most people and labor and leisure time activities differ, the demands on physical fitness are also very specific to every person. A training program must prepare and individual for their daily and labor tasks and qualify their leisure time, expanding the possibilities of engaging in a set of sports, preferably those who bring affection because those will be made spontaneously. The aspects of prescription are FMS, the abilities required for the chosen modalities and the demands of coordination (i.e. space-time, fine and gross coordination), and conditioning capabilities (maximum oxygen uptake, strength, flexibility and speed) for better performance and injury prevention (Figure 2). That way, exercise is not a punishment for being overweight/obese and loses the aspect of treatment to become rewarding.

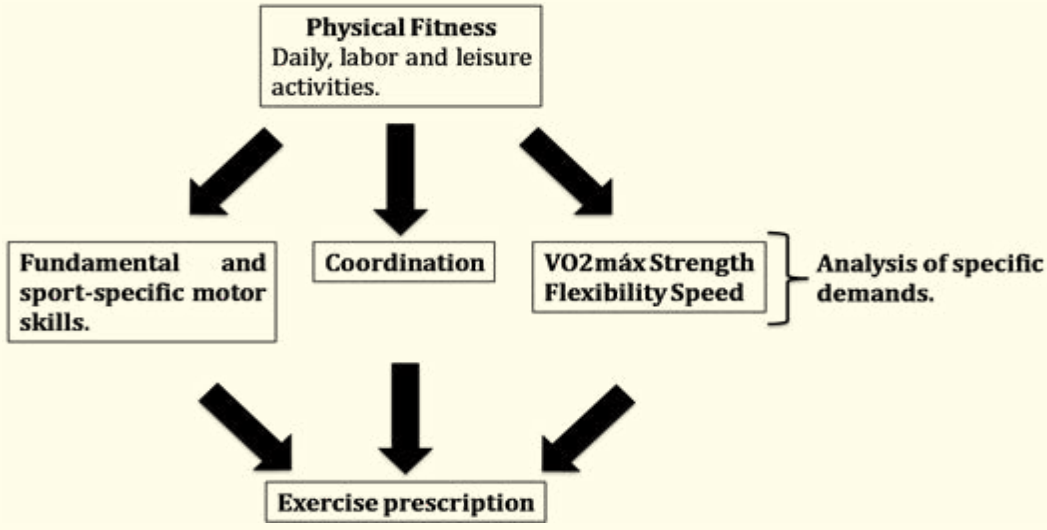

Figure 2: *Physical fitness is determines what an individual is fit to do during daily, labor and leisure time activities. The set of activities is very individual so it is necessary to analyze the specific demands of fundamental and sport-specific motor skills, coordination and conditioning capabilities (VO2máx, strength, flexibility and speed) for exercise prescription that allows the individual to engage in sports for weight loss and maintenance.*

Conclusion

In summary, when the goal is weight loss and maintenance the main factor is not the type of exercise or even the intensity and volume of training sessions. Exercise is paramount in LTWLM, but the main concern has to the affective relation to it. Only by developing an affective response to exercise will an individual truly incorporate more SPA in their life and the amount of physical activity energy expenditure will be increased to an extend that helps overriding the energy gap that results from weight loss. Exercise prescription needs to meet every demand in physical fitness for daily and labor and help qualify and create possibilities for leisure time physical activities and sports.

Conflict of Interest

The authors declare having no conflict of interest.

Bibliography

1. Wietlisbach V., *et al*. "The Relation of Body Mass Index and Abdominal Adiposity with Dyslipidemia in 27 General Populations of the Who Monica Project". *Nutrition, Metabolism and Cardiovascular Diseases* 23.5 (2013): 432-442.

2. Lake A and T Townshend. "Obesogenic Environments: Exploring the Built and Food Environments". *Journal of the Royal Society for the Promotion of Health* 126.6 (2006): 262-267.

3. Trayhurn P. "Hypoxia and Adipose Tissue Function and Dysfunction in Obesity". *Physiological Reviews* 93.1 (2013): 1-21.

4. Virtanen KA., *et al*. "Functional Brown Adipose Tissue in Healthy Adults". *New England Journal of Medicine* 360.15 (2009): 1518-1525.

5. Maclean PS., *et al*. "Biology's Response to Dieting: The Impetus for Weight Regain". *American Journal of Physiology. Regulatory, Integrative and Comparative Physiology* 301.3 (2011): R581-R600.

6. Bacon L and L Aphramor. "Weight Science: Evaluating the Evidence for a Paradigm Shift". *Nutrition Journal* 10 (2011): 9.

7. Wing RR and JO Hill. "Successful Weight Loss Maintenance". *Annual Review of Nutrition* 21 (2001): 323-341.

8. Kraschnewski JL., *et al*. "Long-Term Weight Loss Maintenance in the United States". *International Journal of Obesity (London)* 34.11 (2010): 1644-1654.

9. Weiss EC., *et al*. "Weight Regain in U.S. Adults Who Experienced Substantial Weight Loss, 1999-2002". *American Journal of Preventive Medicine* 33.1 (2007): 34-40.

10. Anderson JW., *et al*. "Long-Term Weight-Loss Maintenance: A Meta-Analysis of Us Studies". *American Journal of Clinical Nutrition* 74.5 (2001): 579-584.

11. Greenway FL. "Physiological Adaptations to Weight Loss and Factors Favouring Weight Regain". International *Journal of Obesity (London)* 39.8 (2015): 1188-1196.

12. Camps SG., *et al*. "Weight Loss, Weight Maintenance, and Adaptive Thermogenesis". *American Journal of Clinical Nutrition* 97.5 (2013): 990-994.

13. Johannsen DL., *et al*. "Metabolic Slowing with Massive Weight Loss Despite Preservation of Fat-Free Mass". *Journal of Clinical Endocrinology and Metabolism* 97.7 (2012): 2489-2396.

14. MacLean PS., *et al*. "The Role for Adipose Tissue in Weight Regain after Weight Loss". *Obesity Reviews* 16.1 (2015): 45-54.

15. MacLean PS., *et al*. "Enhanced Metabolic Efficiency Contributes to Weight Regain after Weight Loss in Obesity-Prone Rats". *American Journal of Physiology. Regulatory, Integrative and Comparative Physiology* 287.6 (2004): R1306-R1315.

16. Wing RR and S Phelan. "Long-Term Weight Loss Maintenance". *American Journal of Clinical Nutrition* 82.1 (2005): 222S-225S.

17. Ferro Magosso Rodrigo., *et al*. "A Review of Ergogenesis and Effect of Training Variables on Energy Expenditure in Resistance Training Exercises". *Journal of Exercise Physiology Online* 20.2 (2017): 11.

18. Scott CB. "Quantifying the Immediate Recovery Energy Expenditure of Resistance Training". *Journal of Strength and Conditioning Research* 25.4 (2011): 1159-1163.

19. Caudwell P., *et al*. "Exercise and Weight Loss: No Sex Differences in Body Weight Response to Exercise". *Exercise and Sport Sciences Reviews* 42.3 (2014): 92-101.

20. Ballor DL and E T Poehlman. "A Meta-Analysis of the Effects of Exercise and/or Dietary Restriction on Resting Metabolic Rate". *European Journal of Applied Physiology and Occupational Physiology* 71.6 (1995): 535-542.

21. Lazzer S., *et al*. "A Weight Reduction Program Preserves Fat-Free Mass but Not Metabolic Rate in Obese Adolescents". *Obesity Research* 12.2 (2004): 233-240.

22. Stisen AB., *et al*. "Maximal Fat Oxidation Rates in Endurance Trained and Untrained Women". *European Journal of Applied Physiology* 98.5 (2006): 497-506.

23. Ormsbee MJ., *et al*. "Regulation of Fat Metabolism During Resistance Exercise in Sedentary Lean and Obese Men". *Journal of Applied Physiology (1985)* 106.5 (2009): 1529-1537.

24. Dalle Grave R., *et al*. "Major Factors for Facilitating Change in Behavioral Strategies to Reduce Obesity". Psychology Research and Behavior Management 6 (2013): 101-110.

25. Garland T Jr., *et al*. "The Biological Control of Voluntary Exercise, Spontaneous Physical Activity and Daily Energy Expenditure in Relation to Obesity: Human and Rodent Perspectives". *Journal of Experimental Biology* 214. 2 (2011): 206-229.

26. Graf C., *et al*. "Correlation between Bmi, Leisure Habits and Motor Abilities in Childhood (Chilt-Project)". *International Journal of Obesity and Related Metabolic Disorders* 28.1 (2004): 22-26.

27. D'Hondt E., *et al*. "Gross Motor Coordination in Relation to Weight Status and Age in 5- to 12-Year-Old Boys and Girls: A Cross-Sectional Study". *International Journal of Pediatric Obesity* 6.2-2 (2011): e556-e564.

28. Gentier I., *et al*. "Fine and Gross Motor Skills Differ between Healthy-Weight and Obese Children". *Research in Developmental Disabilities* 34.11 (2013): 4043-4051.

29. Stodden David F., *et al*. "A Developmental Perspective on the Role of Motor Skill Competence in Physical Activity: An Emergent Relationship". *Quest* 60.2 (2008): 290-306.

30. Tammelin T., *et al*. "Adolescent Participation in Sports and Adult Physical Activity". *American Journal of Preventive Medicine* 24.1 (2003): 22-28.

31. Lloyd M., *et al*. "Long-Term Importance of Fundamental Motor Skills: A 20-Year Follow-up Study". *Adapted Physical Activity Quarterly* 31.1 (2014): 67-78.

32. Stodden D., *et al*. "The Association between Motor Skill Competence and Physical Fitness in Young Adults". *Research Quarterly for Exercise and Sport* 80.2 (2009): 223-229.

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