Chapter

Resistance Training and Weight Management: Rationale and Efficacy

Ina Shaw, Travis Triplett and Brandon S. Shaw

Abstract

In addition to the impact of normal ageing on body composition, increasing levels of sedentariness reduce an individual's ability to mobilise fat, resulting in an altered body composition characterised by increased fat mass, and more specifically an increased total and abdominal fat, and reduced muscle mass. While exercise, and aerobic exercise in general, has been promoted as a means to maintaining an appropriate body weight, aerobic exercise should not be considered as the golden standard to do so. This is because resistance training (RT) has an unsurpassed ability to improve lean mass along with other simultaneous improvements in multiple body composition parameters. An increased muscle mass is essential in that it is the amount of exercising muscle that determines the magnitude of lipolysis (fatty acid release from adipocytes) during exercise. In addition, an increased muscle mass results in an elevated basal metabolic rate (BMR) and resting metabolic rate (RMR), effectively increasing the amount of energy or calories utilised even at rest. RT is especially useful in the general population for weight management in that the ideal form of RT required for improvements in body composition is of moderate intensity, which reduces the risk of injury and improves adherence.

Keywords: body composition, kinanthropometry, obesity, overweight, resistance exercise, strength training, weight training

1. Introduction

Overweight and obesity are global health problems affecting more than 1.1 billion adults [1]. This is problematic in that overweight and obesity are prominent risk factors for the development of numerous conditions and diseases, including cardiovascular, pulmonary and metabolic diseases, such as diabetes mellitus [1, 2]. Consequently, overweight and obesity then result in enormous burdens on the healthcare system and burgeoning healthcare costs [3]. In weight loss regimes, it is important to note that the use of the term "overweight" is a misnomer, since overweight and obesity are situations of an individual being "overfat" and not just having a high weight [4].

Weight loss is a common aim for athletes, obese, overweight and even normal weight individuals. However, an optimal weight loss programme should

concomitantly reduce body fat while maintaining lean mass [5]. As such, the relative effect of various interventions should be assessed on how they impact body composition, rather than weight loss. In this regard, body composition is the amount or percentage of tissues within in the body, primarily including body fluids, bone, fat and muscle tissue an individual has. Typically, body composition is defined as the distribution of the body tissues into extracellular water, fat-free mass/lean mass and fat mass [6]. In this regard, two individuals of the same gender, height and weight can look completely different because of differences in body composition.

Further, in addition to total fatness, fat topography or distribution in the body has been found to be even more important for health promotion and disease prevention [7, 8]. This is so since abdominal visceral fat deposition is especially associated with an increased risk for a variety of health problems and metabolic disturbances such as "syndrome x" [9]. An increased intra-abdominal visceral fat even in the absence of a high body mass index (BMI) or generalised obesity can increase mortality and morbidity from chronic diseases and health conditions such as heart disease, hypertension and diabetes mellitus [7].

2. Exercise as an adjunct weight loss strategy

The most common strategy employed globally for weight loss is the use of dietary intervention or the cutting of calories [10]. This strategy is based on the "calories in versus calories out" model and maintains that you will lose weight if you take in less calories than you use. Problematically, the human body is more complex than that. Human bodies are not static and have a multitude of fluctuations in energy needs, such as stress and activity levels. Further, even the timing and composition of meals will affect nutrient intake, such as the thermic effect of food [11].

Further reasons against the use of caloric restriction strategies for weight loss arise from research findings that treatments relying only on energy restriction commonly cause substantial loss of lean mass [12]. Further, severe caloric restriction is also associated with impairment of muscle dysfunction and aerobic capacity, which is especially detrimental for athletes [13].

Thankfully, the addition of exercise, has frequently been shown to mitigate this loss in lean mass and physiological impairments [12], and potentially offset athletic performance decrements. Exercise is especially useful with weight loss in that it acutely increases energy and lipid utilisation and contributes to increases in lean mass and metabolic rate, which indirectly aids weight loss [14]. It is for this reason that exercise is considered an important component of weight loss and perhaps the best predictor of weight maintenance [15]. Specifically, at least 30 min a day of moderate intensity aerobic exercise per day is recommended for weight loss and maintenance but greater amounts appear to increase the magnitude of weight loss and maintenance [15].

3. Resistance training as an adjunct weight loss strategy

It is critical to note that many weight loss programmes incorporating diet-only and/or even aerobic-only exercise results in weight loss as a result of a deleterious reduction in muscle mass [16], sometimes even without a decrease in fat mass [16]. When it comes to weight loss, it is clear that a combination of interventions is more

effective than a single intervention strategy [17]. Thus, it is critical for clients and health professionals alike to emphasis body recomposition, rather than weight loss, since it focuses on the process of changing the ratio of fat and lean mass, with a focus on losing fat mass while gaining muscle mass. In this regard, research indicates that resistance training (RT) as an exercise modality is most effective at increasing lean mass [8]. RT, also known as strength training or weight training, is any type of exercise in which a muscle or muscle group has to overcome some sort of external resistance. This can be achieved through a variety of techniques, including incremental weight increases, the use of a variety of exercises and types of equipment to target specific muscles or muscle groups. As such, RT can also incorporate a variety of training techniques, such as callisthenics, Pilates, yoga, free weights, weight machines, resistance bands, isometrics, high-intensity interval training (HITT) and plyometrics.

Problematically, a challenge to body recomposition and RT's unpopularity in weight management is that this loss in fat mass coupled with an increase in fat mass results in a relatively stable weight, that is undesirable by those engaged in "weight loss". In addition, due to this stigma of an increased muscle mass following RT, many individual engaging in a weight management programme fail to engage in RT [18].

RT results in a plethora of physiological changes and adaptions that are well suited to weight loss and body recomposition. In this regard, a unique feature of RT is its ability to maintain or increase muscle mass. It is this increase in muscle mass that not only offsets declines in performance and health, but also increases metabolic rate. In this regard, while aerobic exercise may burn slightly more calories per hour than RT (i.e. running at five miles per hour burns approximately 606 calories per hour for a 73 kg individual versus a general resistance training session for 1 h that burns an average of 448 calories per hour for a 70 kg individual), each kg of muscle burns off around 13 calories per day [19]. As such, even a modest 5 kg increase in muscle mass will result in an additional 65 calories being burnt daily. Further, research has demonstrated that while caloric expenditure of RT is only slightly less than aerobic exercise, excess post-exercise oxygen consumption (EPOC) and post-exercise caloric expenditure are higher following RT (even when matched for oxygen consumption and equal durations) [20] and this may have an additional favourable consequence on weight management programmes.

Physiologists may be interested in the effect of exercise on basal metabolic.

rate, fat size and distribution, and dietary-induced thermogenesis, whereas other scientists, such as nutritionists and psychologists may be concerned about the possible effect of exercise on other factors, such as habitual nutrient intake, and effect on body image and self-concept, feelings of well-being and adherence, respectively. In this regard, the addition (but not sole use) of RT to aerobic training can reduce the amount of total calories, carbohydrates, proteins and fats consumed and as such promotes a favourable improvement in self-reported dietary intake [21].

4. Common myths about resistance training and weight loss

While greater amounts of exercise appear to increase the magnitude of weight loss and maintenance [15], it must be noted that too much exercising actually prevents body fat loss due to increases in cortisol. In fact, research suggests this raised cortisol leads to overeating, weight gain and an increase in abdominal fat [22].

Further, many individuals engaging in a weight loss programme fail to utilise RT for fear of "bulking up", "looking manly", or "becoming muscle-bound". While it is true that RT is the exercise of choice for bodybuilders, many individuals, and females in general, lack the hormonal and genetic profile to develop overly large muscles [23].

A particular problem amongst children and health professionals working with children is the erroneous belief that all RT results in damage to the epiphyseal or growth plates [24]. Despite the need for RT in supporting neural adaptation during normal physiological maturation, RT has proven effective at weight loss and body recomposition in children and adolescents [25, 26]. While literature and research indicate that some risk of injury from RT does exist, this is comparable to that of sports children are already participating in and that risk for injury in children is not dramatically elevated by RT and can be minimised by effective programme design (i.e. appropriate programme development) and education (i.e. on lifting technique) [24, 27].

While the term spot reduction or spot training (the localised loss of fat as a result of exercising a particular part of the body), is commonly practiced using RT, research in this area is still contradictory [28]. In this regard, the present body of knowledge is insufficient about the plastic heterogeneity of regional body tissues when a localised RT programme is applied [28].

A common prevailing myth is the belief that fat can be turned into muscle. However, this is not a physiological probability since skeletal muscle consists of numerous protein muscle fibres, which in turn, are comprised of a number of myofibrils containing multiple myofilaments [29]. On the contrary, body fat, which is known as adipose tissue consists of triglycerides, which consist of glycerol and three fatty acid chains. Fat is exclusively made up of numerous carbon, hydrogen, and oxygen atoms [30]. As such, due to this differentiation in muscle and fat cell chemical composition, neither can be converted into the other [31].

5. Resistance training programme design for body recomposition and weight Loss

The majority of exercise recommendations for weight loss endorse aerobic-type activities with a focus on a significant caloric expenditure during the exercise session [10]. In this regard, the American College of Sports Medicine (ACSM) emphasises diet restriction and aerobic exercise, while not assigning RT a major role in weight maintenance and weight loss, due to insufficient evidence. This is problematic in that RT has a multitude of health benefits and has proven effective in the short-term for modestly decreasing body fat, especially in conjunction with dietary interventions [32]. More importantly, research suggests that RT can also play a vital role in long-term weight management, especially in that it utilises additional mechanisms to that of aerobic exercise [33].

However, for any exercise programme to be effective at weight management, continuous adjustments need to be made to the programme design variables, namely; choice of exercises, order of exercises, frequency, load (weight), volume, rest periods, variation and progression [34].

5.1 Resistance training choice and order exercises for weight management

While almost any RT exercise will have a positive impact on health promotion and weight management, RT exercises for weight management should focus on large muscle groups and those exercises utilising compound movements, such Olympic

lifts, deadlifts and squats. Since these compound exercises require an elevated oxygen use and hormonal response and result in high-calorie-expenditure. These compound exercises should be prioritised in an effective RT programme for weight management. In addition, training the larger muscle groups will also result in an enhanced hypertrophy and increased basal metabolic rate (BMR) (i.e. minimum number of calories required for basic functions at rest) and resting metabolic rate (RMR) (i.e. the number of calories the body burns while at rest) in the long-term [35].

Further, although many programme designs exist or RT sessions, recommendations for weight loss suggest progressing from multi-joint to single-joint exercises in RT sessions. This may be especially important from a safety standpoint to prevent any undue consequences of muscle fatigue at the end of a workout [35].

5.2 Resistance training load (weight) and volume for weight management

Since the principal determinant of BMR is body mass, and more specifically lean mass [36], RT has important long-term implications for successful weight management. This is because RT is the primary exercise intervention for increasing muscle mass [37]. When it comes to hypertrophy, recent research indicates a dose-response relationship between the total number of weekly sets and increases in muscle growth [38]. In this regard, health professionals should consider all aspects related to increasing training volume, such as the total number of sets, reps or time under tension, and resistance (weight) utilised during a training day, month or other block of training time. Thankfully, this increased volume of training serves a dual purpose as it is also deemed high-caloric expenditure in nature. Specifically, moderate loads for hypertrophy correspond to approximately 8–15 of one-repetition maximum (1-RM) [39] and should be performed for three to five sets per exercise to increase volume [37, 40].

5.3 Resistance training frequency for weight management

As the outcome of RT is the same as for that of aerobic exercise interventions for weight loss, it important to note that research indicates a graded dose-response relationship whereby increases in RT volume (i.e. increased number of weekly sets) produce greater gains in muscle hypertrophy [37]. This increase in RT dose also results in an increased caloric expenditure and improves the prognosis not only for hypertrophy but also for weight loss. As for any exercise intervention (whether RT or aerobic), cognisance should be taken of the training status of the individual, with beginners training less frequently and well-trained individuals training more frequently. RT is especially useful in this area of programme design in that it allows for split routines, whereby upper-body and lower-body can be trained on alternate days to facilitate and enhance recovery.

5.4 Resistance training rest periods for weight management

While 3–5 min rest periods are advocated between RT sets for multiple sets per exercise [40], well-trained individuals can consider exercise sets with minimal rest periods for optimising weight loss [41]. This is because decreasing rest periods or making use of super sets has been demonstrated to increase training intensity [40]. Problematically, while RT with minimal rest periods is considered as most effective for weight and fat loss, it can cause significant central nervous system fatigue and eventual overtraining [42].

Frequency	Intensity	Repetitions	Sets	Type
3 or more days/week; aim to increase volume and caloric expenditure; split routines can be utilised to enhance recovery; beginners: train less frequently; well-trained: train more frequently	Moderate loads for hypertrophy	8–15 of 1-RM; emphasis is on volume	3–5 per exercise; with minimal duration rest intervals; emphasis is on volume	Multi-joint/compound exercise utilising more than one muscle or muscle group

Table 1.
Guidelines for resistance training programme design for body recomposition and weight loss.

5.5 Resistance training progression for weight management

While it is important to keep the exercises used in a programme fairly consistent for weeks or months in a particular training period to prevent overuse, health professionals must allow for new ways to stimulate muscle growth and fat utilisation. For example; this could be accomplished by manipulating the number of sets, the number or repetitions, the weight utilised during exercises or additional training days could be added as well to increase overall volume. In turn, when training at a specific repetition maximum (RM) load, it is recommended that a 2–10% increase in load be applied when the individual can perform the current workload for one to two repetitions over the desired number [40]. Progressive increases in volume should be observed for a particular training block of weeks or months, followed by a period of decreased volume. This aids in preventing training plateaus, injury and boredom [40]. **Table 1** provides guidelines on the approaches for the implementation of resistance training in weight management.

6. Conclusions

Despite the credible evidence that exists to suggest that RT can play an important role in a comprehensive weight loss programme, RT is not promoted as widely as aerobic interventions. Problematically, while the inclusion of RT may not optimally enhance short-term weight loss in all populations, the integration of RT with dietary interventions could facilitate long-term fat loss, while preserving lean mass while increasing RMR and BMR. This is in addition to the significant and unique health and functional benefits that RT provides. However, in order to stimulate adaptation toward weight loss and body recomposition, specific progressive RT protocols are necessary that focus on caloric expenditure through high volume training (s with other modes of exercise) and hypertrophy.

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Conflict of interest

The authors declare no conflict of interest.

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