

Resistance training vs. aerobic training and role of other factors on the exercise effects on visceral fat

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Abstract. – In the last 25 years, obesity has reached epidemic levels of prevalence. It has even affected the children such that rates of severe childhood obesity that have almost tripled in numbers. These numbers are alarming because of the known fact that obesity is associated with an increased risk of several comorbidities as well as with an increased risk of premature death. Almost since the beginning, exercise has been known to play a key role in the prevention and treatment of overweight and the non-pharmacological treatment of dyslipidemia. However, the effects of exercise on obesity seems to be dynamic and influenced by several other factors. These factors can be related to exercise or to the associated comorbidities. In this review we will address following factors: (1) The type of exercise which could be either aerobic or resistance training (2) The volume or amount of training (3) Intensity of training and (4) The effect of comorbidity of diabetes mellitus. We will observe that all of these factors modify the effect of exercise on the visceral fat.

Key Words:

Obesity, Resistance training, Aerobic training, Exercise, Diabetes.

Introduction

In the last 25 years, obesity has reached epidemic levels of prevalence. It has even affected the children such that rates of severe childhood obesity that have almost tripled in numbers. These numbers are alarming because of the known fact that obesity is associated with an increased risk of several comorbidities as well as with an increased risk of premature death. Over the last several years, increasing attention has been paid to abdominal adiposity and its association with increased mortality. Visceral adipose tissue (VAT) has been proposed to be the most

pathogenic fat depot and is seriously suspected to be playing a central role in the metabolic syndrome. Additionally, in T2DM a poor cardiovascular outcome is predicted in individuals with an inability to lose VAT which requires further detailed investigation.

Almost since the beginning, exercise has been known to play a key role in the prevention and treatment of overweight and the non-pharmacological treatment of dyslipidemia. A plethora of evidence for the positive effect of exercise on novel risk factors of the metabolic syndrome such as disturbances in adipokine secretion and low-grade inflammation has established the importance of exercise in the treatment of the metabolic syndrome. In addition all overweight or obese individuals who have or are at risk for diabetes are emphasised to undergo weight loss regimes according to the recent guidelines¹ for achieving cardiovascular benefits the most successful weight loss programmes incorporates a combination of dietary changes and exercise. Recently, several studies have explored the effects of exercise on the obesity related variables.

However, the effects of exercise on obesity seems to be dynamic and influenced by several other variables. These factors can be related to exercise or to the associated comorbidities. This hypothesis is reflected in the findings of several studies which suggest that the effects of exercise on visceral fat are modifiable by several factors. These factors include the type of exercise training being received, the duration of exercise, the individual related factors like age, gender, etc. and finally the co morbidities, especially the comorbid diabetes mellitus. In this review, we aim at addressing these variables. We will observe and elaborate the influences of the individual variables on the effects of exercise on visceral abdominal fat. Here we will address following factors: (1) The type of exercise which could be

either aerobic or resistance training (2) The volume or amount of training (3) Intensity of training and (4) The effect of comorbidity of diabetes mellitus. We will observe that all of these factors modify the effect of exercise on the visceral fat.

Aerobic Exercise Vs Strength Training Exercises

The most important variable influencing the effect of exercise on the obesity seems to be the type of exercise. Classically the exercises have been classified into aerobic and anaerobic or strength exercises that have several differences in between them. It is evident from several study findings that aerobic training results in a significant reduction in visceral fat, as well as a consistent improvement in insulin sensitivity²⁻⁷. However, there are very few researches focused specifically on the effects of resistance training (RT) on visceral fat, and even these studies have reported different results. Davidson et al² and Sigal et al⁹, for example, referred that RT produced no effect on visceral fat. On the other hand, a two-year work by Schmitz et al⁸ reported an increase in visceral fat by 7% with RT although this was significantly less than the 21% increase observed in their inactive controls. Also, one needs to note that the study design by Davidson et al² involved only 20 minutes of RT, three times a week and that a more substantial programme could probably yield better results in terms of effect on visceral fat. Likewise, in the research study by Sigal et al⁹, neither RT nor aerobic training (AT) have any significant effects on the visceral fat. These observations only suggest the need for more research in the area of RT

Although aerobic training and strength training could or couldn't have, on their own, reduced VAT significantly, meta-analyses have showed that a combination training of the two types of exercises yields only a modest reduction in VAT. It follows that only two studies involving the combination training fulfilled the inclusion criteria^{10,11}. Slentz et al¹¹ showed that both training types produced similar effects, and the combination training was not superior to the aerobic training.

Studies on the effects of AT, RT, and AT/RT on metabolic syndrome score and the individual components (HDL-cholesterol, triglycerides, waist circumference, fasting glucose, and blood pressure) showed that RT did not significantly improve metabolic syndrome or any of the

individual components. On the contrary, AT seemed to display an improved metabolic syndrome score ($p < 0.067$), reduce waist circumference and significantly decrease serum triglyceride levels¹². The AT/RT group experienced a beneficial response with significantly improved metabolic syndrome score, waist circumference, triglycerides, and diastolic blood pressure. However, these findings were not statistically different from the AT group with respect to any of the measured variables. Moreover, the study design failed to determine whether this efficient response was due to a synergistic effect of AT/RT or simply the greater total amount of exercise.

Training Volume

Several researches have been conducted to demonstrate the effect of volume of training on reduction in fat percentage. Here we use the word 'volume' instead of intensity to refer to just the amount of the exercise rather than the severity of exercise which will be dealt in the next section. It has been a fact by the 2009 position stand of the American College of Sports Medicine (ACSM) that a weight loss that is clinically significant is demonstrated by a moderate-intensity physical activity of 250 min¹³.

Friedenreich et al¹⁴ opined that a minimum volume of physical exercise has beneficial effects in reducing total body fat and that a higher volume of physical activity would result in a higher reduction of VAT. In contrast to the above findings, McTiernan et al¹⁵ and Irwin et al¹⁶ required the subjects to be trained five to six times per week for 45 to 60 min each. The exercise volume, in this case, was twice as much as in the studies of Friedenreich et al¹⁴ and Kim et al¹⁷. McTiernan et al¹⁵ and Irwin et al¹⁶ clearly showed that a mere increase in the training volume would not lead to a greater decrease in the total fat percentage or VAT. However, this confounded conclusion could be the result of a self-reported overestimation of exercise adherence schedules in the reports of McTiernan et al¹⁵ and Irwin et al¹⁶. To conclude, the volume of exercise seems to have an effect on the consequent effects on visceral fat. However, the exact influence remains controversial.

Training Intensity

The intensity of the exercise training is another factor which influences the exercise related effects on VAT. Several studies results have estab-

lished a positive association between the volume of physical activity and weight reduction¹⁸. The association between exercise intensity and an improvement in lean body mass has been found to be like that of a “dose-response relationship”. In order to assess the impact of training intensity on VAT reduction, only those researches which had an exclusive aerobic exercise oriented protocol have been included in the present review. When the results were tabulated, there was a clear indication of the presence of a threshold for exercise intensity which determined the reduction in VAT. Substrate metabolism, i.e., oxidation of carbohydrates and fats by the working muscles largely governs the accumulation of fat in the body¹⁹. Therefore, factors regulating substrate metabolism such as absolute and relative (i.e. % of VO_2 max) exercise intensities were taken into account to determine the reduction in VAT. Besides, the variation in the individual nutritional status might influence the dissimilarity in maximal rates of fat oxidation during exercise²⁰. It has also been shown that an increase in exercise intensity can increase the rate at which energy expenditure and fat oxidation take place post exercise²¹. Since there are multiple factors which influence a reduction in adipose tissue as shown by this meta-analysis, there cannot be a distinct cut off for exercise intensity to decrease adipose tissue.

Similarly, a reduction in abdominal obesity has been reported to be positively correlating with an improvement in cardiorespiratory fitness²². A substantial evidence also exists to prove that risk for metabolic syndrome is decreased with increase in physical activity²³. On the contrary, Gutin et al²⁴ demonstrated the lack of a significant effect of physical training intensity on decrease in total body fat and visceral fat deposition. Very few studies such as that of Irving et al²⁵ have shown the impact of exercise intensity on abdominal visceral fat in obese adults wherein the abdominal fat was a primary outcome parameter. To summarize, studies demonstrating the effect of physical training intensity on visceral fat deposition as a primary objective have been lacking.

There have been a few mixed-gender studies viz Coker et al²⁶ and Slentz et al¹¹ which fulfilled the a priori set inclusion criteria. However, these studies have not been able to demonstrate a greater drop in VAT for a given physical activity. Moreover, the relative body fat composition that varies among males and females was not taken into consideration. These lacunae make it

difficult to generalize the findings from this subgroup analysis. Hence, gender specific studies have become more valuable in considering the treatment for obesity in general and abdominal adiposity in particular as already stated by Lovejoy et al²⁷. Redman et al²⁸ showed that a restriction of calories and a combination of aerobic exercise and calorie restriction had a greater impact in reducing VAT in men than in women. Therefore, this meta analysis concludes that gender specific researches are of greater value as they consider the obesity phenotype referring to the the tendency of abdominal fat deposition being more in the males than in females²⁹. This could be having an impact on reduction of abdominal fat³⁰.

Effects of Comorbid Diabetes

Regardless of whether weight loss is observed or not, exercise has been well documented in the literature to reduce VAT in obesity^{31,17,32,33}. It has been observed that aerobic exercise alone³²⁻³⁴ or in combination with resistance exercise³⁵ facilitates abdominal fat loss in T2DM, with the reduction in VAT among these individuals ranging from 8% to 48%³²⁻³⁴. Therefore, exercise has been recommended in the management strategies of DM in most of the cases. However, some limitations worth noting here are that only one of these studies³² compared the exercise-induced abdominal fat loss in T2DM individuals to that in non-T2DM individuals, the study design had a small sample size and only one gender was involved. However, these limitations were overcome by Dobrosielski et al³⁶ who combined the data from two 6-month long clinical trials involving both genders. Improvement in fitness and reduction in total body fat as well as weight among individuals with mild forms of hypertension with and without T2DM were the key findings in this study. A novel finding was that the loss of VAT was less in T2DM as against non-T2DM individuals.

However, it is almost clear that the presence of T2DM affects the exercise induced weight loss in obesity. A striking disparity is seen between T2DM and non-T2DM groups with regard to VAT loss. An important influence of this disorder seems to be the impairment observed in their ability to improve body fat distribution (i.e., lose VAT) with exercise which is independent of change in weight. Ormsbee et al³⁷ reported a dull lipolytic response in obese men to an acute bout of resistance training when compared to lean men. The authors found

that in lean participants of the study there was an increase in growth hormone levels following the exercise regime which was not seen in obese subjects. A moderate-to-vigorous intensity (60-90% HR max) aerobic training exercise was employed in line with the American College of Sports Medicine (ACSM) guidelines, three times a week³⁶, but a more rigorous aerobic training lasting 60 minutes was employed by Lee et al³² for 5 days/weeks in T2DM. Following aerobic exercise training a decrease in α -adrenergic receptor antilipolytic activity occurs which improves subcutaneous adipose tissue (SAT) lipolysis. Authors in the study hypothesized that in people suffering from T2DM a reduced sensitivity of visceral adipocytes to catecholamines or a stronger α -adrenergic-mediated response may be related to the impaired ability to lose VAT. Hence, a sustained catecholamine level is required for greater lipolysis in visceral adipocytes which can be achieved by a vigorous and frequent exercise regime and/or of longer duration. Thirdly there was impairment in the exercised induced decrease in VAT as age advances. This was supported by Mourier et al³⁴, and Lee et al³², in younger T2DM participants, who attained a significant loss of VAT and achieved greater fitness than participants enrolled earlier in the study. Hence, in older subjects with T2DM a greater impairment³⁸ in β -adrenoceptor sensitivity to catecholamines is observed³⁹. It was also observed that T2DM group, was younger and obese per inclusion criteria, resulting in greater abdominal fat reduction than the non-T2DM group.

Early onset T2DM is the fourth category which showed improvement in body weight, fitness, blood pressure, glycemic control and lipids following intensive lifestyle intervention⁴⁰. In this study, all individuals who were on insulin were excluded, but no specific data was maintained on the duration of diabetes, but care was taken to include participants with short duration of diabetes. Further studies are required to analyze if age or the stage of diabetes, is a factor in the amount of fat lost with exercise. Extreme weight loss can cure and improve T2DM as it seen in the bariatric surgery⁴¹. Hence, the weight loss is highly beneficial. Weight loss independently predicts the amount of VAT lost which reinforces the current guidelines. Physical functions can be reduced in obese older adults⁴² and physical function can be improved by promoting exercise in such individuals, which is seen as a significant loss of abdominal fat among non-T2DM older men.

Conclusions

Exercise has become an integral part of the management strategies of obesity. However, the effect of exercise is very dynamic and depends on several factors like the volume of exercise, intensity of exercise, the type of exercise (resistance vs aerobic exercise) and the associated comorbidity, especially the diabetes type 2. All these factors modify the effects of exercise on the visceral abdominal fat and, therefore, should be kept into account while prescribing exercise in obesity patients.

Conflict of Interest

The Authors declare that they have no conflict of interests.

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