

Effects of Mode and Duration of Exercises on Fat Mass of Obese Population

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ABSTRACT

A meta-analysis was performed to determine impact of resistance and aerobic exercise on body fat of obese population. Database of Google Scholar, BioMed Central, and Medline was reconnoitered for the purpose of research article of interest. Inclusion criteria encompass all those studies in which effects of aerobic and resistance exercise were determined on body fat mass of obese participants. Studies in which combination of aerobic and resistance exercise were used, or outcome measures were other than body fat mass or studies conducted before 2010 were excluded from this review. A total of 805 obese participants were included in 10 randomized controlled trials (RCT) including 401 in resistance training protocol and 404 in aerobic training protocol were part of this meta-analysis. Results revealed that resistance exercise had a mild pool affect in increasing weight of participants with an effect size (SMD) of 0.26 (95% of CI -0.09 to 0.63) calculated at random effect model, I^2 83.80% (95% of CI 71.76 to 90.71) in comparison to aerobic exercises performed during the duration of two to eight weeks of training protocol. The meta-analysis concluded that resistance exercises had a mild pool effect in increasing the weight of the participants in comparison to aerobic exercises.

Key Words: Aerobic exercises, Resistance exercises, Obesity, Fat mass, Body fat index and body fat composition.

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INTRODUCTION

The epidemic of obesity is increasing globally. This increasing trend is showing soaring prevalence since 1980, which is almost double during last decade.^{1,2} According to World Health Organization in 2016, an estimated 600 million population around the globe were obese, projecting the number to reach up to 3 billion people by the year 2030.³ Multiple factors that are making obesity pandemic include body size preference, socio-economic status, regional disparities, food marketing and westernization of lifestyle.⁴ According to a study, body size preference was the main source of rising obesity epidemic during the initial decades of past century when obesity was considered as a symbol of beauty, health and wealth. While obesity is a significant contributor of various comorbidities like diabetes mellitus, dyslipidemia, chronic heart diseases, musculoskeletal disorders, sleep apnea syndromes and certain type of cancers, finding an appropriate management strategy is a serious concern for healthcare providers.^{5,6}

Multiple strategies including pharmaceutical, psychological, nutritional, surgical and complementary therapies are claiming substantial results in the management of obesity.⁷ But the role of exercises as effective interventional strategy has widely been accepted

and known for many years and has proven to be effective both in long and short term.^{8,9} According to the study of Gillen *et al.* in 2018, effectiveness of exercise in management of obesity is dependent on dosage and type of exercise; as receptivity of exercise among general population is poor and required substantial time and commitment for its performance.¹⁰ Therefore, an effective quantification of exercise is required to evaluate prescribed dosage of exercise in terms of its frequency, intensity, time and type (FITT). American College of Sports Medicine (ACSM) FITT protocol is proven to be an effective tool for quantification of exercise.¹¹

According to an Australian-based concept of multimodal management, obesity is classified as a disease threatening the life expectancy of population, thus making it obligatory to be treated within the standard healthcare system. They also recommended tailored exercise program designed for obese population to improve adherence and provide desirable outcome within the possible duration of time.^{12,13} Multiple studies have focused two basic exercise regimes: aerobic exercises including walking, running, cycling, jogging *etc.* and resistance exercises including weight lifting that are primarily be used in the management of obesity. But the impact of these two exercises on body fat percentage; is different as aerobic exercises primarily trigger in reducing body fat percentage whereas, resistance exercises, besides reducing the body fat percentage, triggers the increase in lean mass (muscle mass). Thereby, it often causes increase in body weight. But no meta-analysis evaluating the claim of randomized controlled trial has been conducted till date. Hence, the present study is an attempt to consolidate the results of all those RCTs in which effects of aerobic and resistance exercises are compared in management of body fat mass among obese population depending on exercise protocol ranging from two months to eight months of duration.

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METHODOLOGY

Databases of Google Scholar, BioMed Central, PubMed, Cochrane and Medline were reconnoitered for purpose of research article of interest by using following keywords: Resistance exercises, aerobic exercises, obesity, exercise and obesity, body fat mass, body fat index, and body fat composition. All studies, in which effect of aerobic and resistance exercise in the management of body fat mass was determined, were procedurally scrutinized and those studies fulfilling the inclusion criteria were retrieved and comprehended in the present study.

Inclusion criteria encompass studies in which effects of aerobic and resistance exercises were determined on body fat mass of obese participants. All those studies in which combination of aerobic and resistance exercise were used, or outcome measures were other than body fat mass or studies conducted before 2010 (that were replaced by latest version of evidences) were excluded from this review.

Data abstraction and quality valuation were performed through inclusion and exclusion criteria, guided by developed uniform protocol. A data-mining form was planned to ensure data precision by combining material from studies such as first name of author, year of publication, duration of intervention, and the sample size in aerobic and resistance group (Table I).

Table I: Summary of studies used for quantitative analysis.

Author	Study	Aerobic N	Resistance N	Training duration
Hassannejad A <i>et al.</i> ¹	2017	20	20	3 months
Schroeder EC <i>et al.</i> ¹⁴	2019	17	17	2 months
Villareal DT <i>et al.</i> ¹⁵	2017	40	40	6 months
Beavers KM <i>et al.</i> ¹⁶	2017	86	81	6 months (calories restriction and exercise)
Theodorou AA <i>et al.</i> ¹⁷	2016	15	11	8 months
Sigal RJ <i>et al.</i> ¹⁸	2015	74	75	6 months
Wanderley FA <i>et al.</i> ¹⁹	2015	24	19	8 months
Alberga AS <i>et al.</i> ²⁰	2015	75	78	6 months
Ho SS <i>et al.</i> ²¹	2012	15	16	3 months
Willis LH <i>et al.</i> ²²	2012	38	44	2 months

Data analysis was performed through MedCalc software. A continuous measure tool through standardized mean difference (SMD) was used to determine the pool effect at random effect model (I^2 at 95% of CI). The data was interpreted on the basis of SMD table and forest plot using Hedge g statistics. Cohen rule of thumb was used for interpretation of findings, which states that a value of 0.2 reflects small effect, 0.5 indicates mediums and a value greater than 0.8 reveals a greater effect size. Level of heterogeneity was measured by using Cochrane Q and percentage of heterogeneity. I^2 was determined by subtracting degree of freedom Df by Cochrane Q and dividing the number by Cochrane Q to get the value in percentage ($I^2 = Q - Df / Q$). Having a range of 0% to 100%, 0% indicates no heterogeneity; whereas, higher value reflects higher percentages of heterogeneity among the studies.

RESULTS

Eight hundred and five participants in 10 randomized control trials were included as part of this meta-analysis for the purpose of determining the SMD of interventional strategies. The searches were conducted from Medline, BioMed Central, PubMed, Cochrane and Google Scholar database. A total of 50 studies were identified initially. Articles were austere examined, and all those RCTs (N=33) were incorporated in which effects of aerobic and resistance exercises were determined on body fat mass as a primary outcome. After initial screening, 20 articles were selected, out of which 10 articles were further screened out, based on inclusion and exclusion criteria; and finally a review of 10 RCTs was conducted and incorporated in this study.

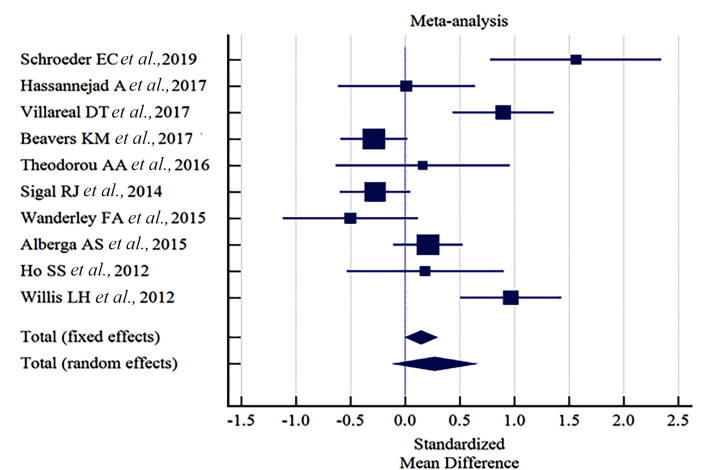


Figure 1: Forest plot illustrating the effects of SMD at 95% of CI.

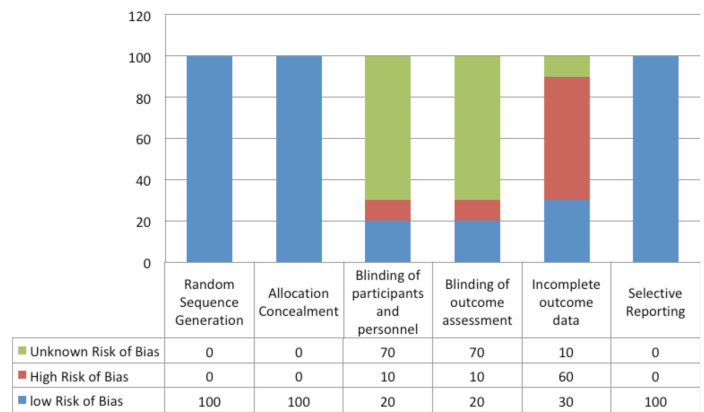


Figure 2: Authors' judgment of risk of bias assessment.

Percentage of heterogeneity was measured using I^2 test that was calculated through Cochrane Q among the SMD of the incorporated studies; as the percent values of level of inconsistency among the studies was 83.80%, random effect model was used for assessing the pool effects.

The effect size was measured by using SMD hedge g statistics that revealed that resistance exercises had a mild pool affect in increasing the weight of the participants with an effect size (SMD) of 0.26 (95% of CI -0.09 to 0.63) calculated at random effect model, I^2 83.80% (95% of CI 71.76 to 90.71). The combine effects of exercises on body weight on SMD as random effects models showed an effect of 0.26 (95% of CI -0.09 to 0.63) of resistance

Table II: Pooled effect of intervention on outcome measure.

Study	N1	N2	Total	SMD	SE	95% CI	T	P	Weight (%)	
									Fixed	Random
Hassannejad A <i>et al.</i> , 2017 ¹	20	20	40	0.0131	0.310	-0.614 to 0.641			5.28	9.39
Schroeder EC <i>et al.</i> , 2019 ¹⁴	17	17	34	1.562	0.385	0.778 to 2.346			3.43	8.24
Villareal DT <i>et al.</i> , 2017 ¹⁵	40	40	80	0.897	0.233	0.434 to 1.360			9.38	10.58
Beavers KM <i>et al.</i> , 2017 ¹⁶	81	86	167	-0.284	0.155	-0.590 to 0.0215			21.14	11.64
Theodorou AA <i>et al.</i> , 2016 ¹⁷	11	15	26	0.160	0.385	-0.635 to 0.955			3.42	8.24
Sigal RJ <i>et al.</i> , 2014 ¹⁸	75	74	149	-0.275	0.164	-0.599 to 0.0486			18.91	11.54
Wanderley FA <i>et al.</i> , 2015 ¹⁹	19	24	43	-0.498	0.306	-1.116 to 0.120			5.41	9.45
Alberga AS <i>et al.</i> , 2015 ²⁰	78	75	153	0.209	0.161	-0.109 to 0.528			19.48	11.57
Ho SS <i>et al.</i> , 2012 ²¹	16	15	31	0.185	0.351	-0.532 to 0.902			4.12	8.76
Willis LH <i>et al.</i> , 2012 ²²	44	38	82	0.966	0.232	0.504 to 1.428			9.43	10.59
Total (Fixed effects)	401	404	805	0.144	0.0712	0.00442 to 0.284	2.025	0.043	100.00	100.00
Total (Random effects)	401	404	805	0.269	0.187	-0.0983 to 0.636	1.437	0.151	100.00	100.00

Table III: Authors' judgment about bias assessment.

Domains	Random Sequence Generation	Distribution Concealment	Blinding of participants and personnel	Blinding of outcome assessment	Incomplete outcome data	Selective Reporting
Hassannejad A <i>et al.</i> , 2017 ¹	✓	✓	?	✓	X	✓
Schroeder EC <i>et al.</i> , 2019 ¹⁴	✓	✓	X	X	✓	✓
Villareal DT <i>et al.</i> , 2017 ¹⁵	✓	✓	?	?	✓	✓
Beavers KM <i>et al.</i> , 2017 ¹⁶	✓	✓	✓	?	✓	✓
Theodorou AA <i>et al.</i> , 2016 ¹⁷	✓	✓	?	?	?	✓
Sigal RJ <i>et al.</i> , 2014 ¹⁸	✓	✓	✓	✓	X	✓
Wanderley FA <i>et al.</i> , 2015 ¹⁹	✓	✓	?	?	X	✓
Alberga AS <i>et al.</i> , 2015 ²⁰	✓	✓	?	?	X	✓
Ho SS <i>et al.</i> , 2012 ²¹	✓	✓	?	?	X	✓
Willis LH <i>et al.</i> , 2012 ²²	✓	✓	?	?	X	✓

exercises in increasing the weight of the participants compared to aerobic exercises, that according to Cohen rule represents mild effect of resistance exercises in soaring the body weight (Table II).

Cochrane risk of bias assessments of included studies is presented in Table III. The authors' judgment of risk of bias assessment is illustrated in Figure 2.

DISCUSSION

Results of meta-analysis revealed that resistance exercises had a mild pool affect in increasing the weight of participants with an effect size (SMD) of 0.26 (95% CI = 0.09 - 0.63) calculated at random effect model, I² 83.80% (95% CI = 71.76 - 90.71) in comparison to aerobic exercises performed during the duration of two to eight months of training protocol. Similarly, in the study conducted by Alberga *et al.* in 2015 in which it was concluded that six months' training, based on resistance exercises, increased the body weight of the participants by 0.3 kg; whereas, the same study has also revealed that participants given intervention, based on aerobic exercises, protocol,

reduced the weight by 0.1 kg. The individual SMD of all the studies included in this meta-analysis revealed that three studies favored resistance exercises in reducing the body weight mass of the participants with an effect size of mild to moderate (-0.28 to -0.49) after six to eight months of training protocol; whereas, the remaining seven studies favored aerobic over resistance training with an effect size of moderate to high performed during two to six months of training protocol.

It was observed from literatures that the causal effects of resistance exercise on obesity were found to be limited when compared to aerobic. According to Mohammadi HR *et al.* the impact of six months of training, based on aerobic exercises, increased the body fat mass of the participants with the mean difference of 5.45; but the study was not included in measuring SMD due to its quasi experimental design.²³ Further it was also revealed during the analysis of the studies that although the impact of both training protocol were found to be effective for weight loss, but the response of aerobic training exclusively impact the body fat mass, whereas resistance training directly impact the lean mass. Therefore resistant

training was found to be mild to moderately effective in reducing the body fat mass as the composition of fat mass that was reduced after the training was compensated by the increase in the lean mass that was developed during the training in the form of hypertrophy of the muscle mass. The homeostasis between the calories intake and calories burned are normally regulated by two sets of neurons located in the hypothalamus.²⁴ Any activity that causes reduction in food intake and increase in physical activity creates a negative energy balance and cascade the central and peripheral adaptive mechanism to preserve vital function.²⁵ This initial response of food restriction and physical activity invoke a physiological mechanism inside body to relatively reduce the resting energy expenditure, preoccupation of food and other metabolic and psychological processes.²⁶ This may often cause an increase in orexigenic signal from the brain that increases appetite and food intake that subsequently reduces the degree of weight loss that is associated with interventional strategies such as exercises programme.²⁷ Similarly, during a weight reduce state the same mechanism of orexigenic signal may cause a weight gain²⁷. Although the underlying principle of these responses is still unclear, but the implication is that persons who are no longer obese may not be physiologically and metabolically identical to their counterparts who were never obese.²⁴ Hence, the relapse rate and transitional weight gain after an episode of weight loss is consistent with the concept that obesity is a chronic disease that requires persistent vigilance and maintenance.

This meta-analysis, as per the knowledge of researcher, is first of its kind that had compared the effects of two widely used exercises protocol on body fat mass of patients and tried to identify SMD at larger effects size of 805 obese patients included in 10 studies. However, the limitation includes that authors had only incorporated the effect of body fat mass in this analysis and no account had been taken to identify the impact of exercises on other parameters of obesity like body mass index (BMI) and waist hip ratio. Hence, authors recommend performing further meta-analysis in future that provides the effects of exercises on BMI and waist hip ratio on larger scale.

CONCLUSION

The study concluded that resistance exercises had a mild pool effect in increasing the weight of the participants as compared to aerobic exercises that were performed during a duration ranging from two months to eight months of conditioning.

CONFLICT OF INTEREST:

Authors declared no conflict of interest.

AUTHORS' CONTRIBUTION:

BH: Concept writing and interpretation of data.

SIF, UK: Critical revision and intellectual content.

AF, QA: Revision of the manuscript and questions related to integrity and accuracy are resolved.

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