

TITLE PAGE

(1) **Title:** The efficacy of 12 weeks supervised exercise in obesity management

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(1) What is already known about this subject?

- Research supports a multidisciplinary teamed (MDT) weight management approach for weight-loss, the Royal College of Physicians state that MDTs are needed nationwide to tackle severe and complex obesity.
- Current MDT programmes predominantly adopt an educational approach, focusing on psychological aspects of behaviour change, dietetics by modifying nutritional intake and physical activity (PA) advice.
- Aerobic training has been labelled the most important exercise component in obesity programme prescription.

What this study adds?

- This is the first RCT to report the outcomes for introducing and monitoring a structured and supervised exercise program as an adjunct to a multidisciplinary teamed (MDT) weight-loss lifestyle programme for morbidly obese patients.

- Those patients who receive the MDT weight management education alone displayed further reductions in their functional capacity.
- Supervised and structured exercise interventions regardless of modality in addition to an educational MDT weight management programme significantly improved anthropometric, psychological and cardiovascular function measures compared to MDT education alone (CON).

ABSTRACT

Objective: The objective of this randomised control trial was to investigate the effect of adding either aerobic training (AT) or resistance training (RT) to a multidisciplinary teamed (MDT) educational weight-management programme on the health-related fitness of morbidly obese individuals.

Participants: Males (n=9) and females (n=24) aged between 24 and 68 years with a body mass index (BMI) of $\geq 40\text{kg}\cdot\text{m}^2$ ($\geq 35\text{kg}\cdot\text{m}^2$ with co-morbidities) undertaking a weight management programme were recruited (Completion: M=8, f=19). Participants were randomly allocated to either AT (n=12), RT (n=11) or CON (n=10). AT and RT undertook three structured ~60 minute moderate intensity sessions weekly, two supervised gym-based and one structured home-based session for 12 weeks; CON undertook usual care alone.

Anthropometric, psychological and functional capacity measures were obtained pre and post-intervention.

Results: Both exercise interventions elicited improvements compared to CON in the: shuttle walk test (AT [$\Delta 207.0\pm 123.0$ metres, 68.0%, $P=0.04$], RT [$\Delta 165.0\pm 183.3$ metres, 48.8%, $P=0.06$], CON [$\Delta -14.3\pm 38.7$ metres, -6.2%]), triceps skinfold ($P<0.001$), self-efficacy ($P=0.005$) and interest/enjoyment ($P=0.006$). RT displayed additional improvements compared to CON in BMI (RT [$\Delta -1.02\pm 0.91\text{kg}\cdot\text{m}^2$, -2.5%, $P=0.033$], AT [$\Delta -1.84\pm 2.70\text{kg}\cdot\text{m}^2$, -4.3%, $P=0.142$], CON [$\Delta -0.31\pm 1.47\text{kg}\cdot\text{m}^2$, -0.6%]), waist circumference ($P=0.022$), competence ($P=0.019$), biceps skinfold ($P=0.012$) and medial calf skinfold ($P=0.013$). No significant differences were observed between exercise modalities.

Conclusion: Regardless of exercise mode, the addition of supervised and structured exercise to a MDT weight management programme significantly improved anthropometric, functional and psychological measures in obese participants with a BMI $\geq 35\text{kg}\cdot\text{m}^2$.

INTRODUCTION

Overweight and obesity in England affects 61.3% of the population and is associated with many chronic and debilitating diseases, such as diabetes mellitus and cardiovascular diseases (CVD)^{1,2}. Diet and pharmacotherapy alone has been deemed less effective and 2.5-fold more expensive than a combined diet, exercise and behaviour modification approach³. Previous research supports a multidisciplinary teamed (MDT) weight management approach for weight-loss⁴⁻⁶ with the Royal College of Physicians⁶ stating that MDTs are needed nationwide to tackle severe and complex obesity. Current MDT programmes predominantly adopt an educational approach, focusing on psychological aspects of behaviour change, dietetics by modifying nutritional intake and physical activity (PA) advice⁷. An important factor in weight management is regular PA, which positively effects metabolic and psychological parameters, however, when employed alone weight-loss is often less than expected, usually due to increased energy intake⁸. Therefore by combining structured exercise with dietetics and behaviour change, physiological, psychological and functional health benefits should improve⁹⁻¹¹.

Fat mass reduction is greater when undertaking structured exercise under the supervision of a qualified exercise specialist¹². Exercise adherence in obesity can be dependent on the professional, supportive, encouraging and friendly nature of the instructor, whereas an exercise leader lacking in motivational skills has been attributed to non-adherence to exercise¹³. Instructors help overcome typical barriers associated with exercise in this client group, such as self conciousness, lack of exercise knowledge, boredom, low motivation and the fear of pain and injury⁹. Personalised exercise for obese individuals can affect obesity treatment, however, it is unknown how effective exercise regimes are in class III obesity (BMI $\geq 40\text{kg.m}^2$)^{14,15}.

Combined Aerobic Training (AT) and Resistance Training (RT) has been readily researched in obesity, predominantly investigating weight-loss and fat mass reduction outcomes¹⁶.

Combined exercise programmes lead to decreased abdominal subcutaneous and visceral fat compared to AT alone¹⁷. AT and RT both positively affect health-related fitness parameters and previously untrained individuals undertaking RT alone experience early adaptations associated with AT¹⁸ with a 12-week intervention finding that both the AT and RT groups' exercise capacity improved¹⁹. AT improved depression symptoms and cardiovascular fitness (VO_{2max}) versus RT, which improved muscle strength and basal metabolic rate^{19, 20}.

However, the benefits of the individual exercise modes on specific health-related fitness parameters in the obese population are still unclear.

AT has been labelled the most important exercise component in obesity programme prescription, generating the negative energy balance required for weight-loss and reducing related co-morbidities^{21, 22}. Hansen *et al.*¹⁶ also found that RT had no effect on fat mass loss. Others conclude that AT outweighs RT in improving cardiovascular fitness and fat mass loss, therefore should be used in obesity management as a preventative measure of associated lifestyle related diseases¹⁰. Contrary to this, early research indicated RT is equal to AT in facilitating fat mass loss whilst promoting fat free mass gain²³. These inconsistent findings demonstrate the need for further exploration and clarification^{16, 23, 24}.

Therefore, the purpose of this preliminary study was to assess the efficacy of adding supervised AT or RT to a community MDT tier 2 obesity service. It was hypothesized that both AT and RT would significantly improve health-related fitness parameters following 12 weeks of structured exercise compared with CON.

MATERIALS AND METHODS

Participants

Male (n=8) and female (n=19) participants in a community weight-loss service with a BMI of ≥ 40 or ≥ 35 kg·m² with co-morbidities were recruited and written informed consent obtained.

Participants mean baseline characteristics \pm standard deviation (SD) were stretch stature 168.2 \pm 8.8 cm, BMI 44.45 \pm 6.11 kg·m², body mass 126.4 \pm 23.3 kg, systolic blood pressure 129 \pm 11 mmHg, diastolic blood pressure 80 \pm 8 mmHg with ages ranging from 24-68 years.

Volunteers with unstable diabetes, orthopaedic limitations, motor neurone disease, stage II hypertension cardiovascular disease, pulmonary disease, renal disease and chair bound were excluded. A favourable ethical opinion was provided by the South-Central NHS Research Ethics Service (Reference: 11/SC/0353).

Study Design

The study employed a randomised controlled trial (RCT) design with three groups: AT, RT and control (CON). *A priori* power analysis using G*Power (Franz Faul, Universitat Kiel, Germany) suggested that 21 participants were required in total based on waist circumference data from a similar research design²⁵. Therefore, 10-11 participants per group were recruited to account for attrition.

Procedures

Recruitment and Randomisation

Participants were recruited between November 2011 and March 2012 upon commencing the community weight-loss programme's structured 12-week group education sessions.

Participants were randomly allocated to a group in order of appointment, according to non-blocked computer-generated sequences. The principal investigator informed the participants following their pre-measures being taken.

Control group

CON consisted of 12 weekly educational MDT sessions, one weekly session provides PA advice to overcome barriers and advice for aerobic and resistance exercise (usual care). This group were not restricted from performing PA of their own accord and any such activities were recorded.

Exercise Interventions

The interventions consisted of two supervised gym-based sessions and one structured home-based session, totalling 3 ~one hour sessions per week for 12 weeks, in addition to the routine education programme. AT and RT consisted of a 45-60 minute moderate intensity main programme, with a 5-10 minute aerobic warm-up and cool-down. Each intervention was personalised taking into consideration co-morbidities such as hypertension, musculoskeletal restrictions and medication.

AT participants exercised at an intensity relative to their heart rate reserve (%HRR). The warm-up and cool-downs were 30-45% HRR and in the main session was 50-70% (moderate) HRR. The AT group were asked to record any other structured exercise.

RT participants also performed at a moderate intensity expressed as 60% of their estimated 1-repetition maximum (1-RM)¹⁴. Participants were closely monitored initially to ensure the programme was appropriate and that no further adaptations were needed; 30-60 seconds rest between sets was advised. RT predominantly used compound exercises, utilising the main muscles and opposing muscle groups. The RT group record any other structured exercise.

Participants received personalised programmes detailing durations, sets and repetitions and a method for personal progression to ensure a progressive overload. Participants' attendance, activities and heart rate (pre, midway and post-exercise) were recorded in each session.

Outcome measures

Measurements were recorded pre and post-intervention. Post-intervention assessments were performed at least 48 hours following the last exercise session for both exercise groups.

Anthropometric measurements were obtained using the International Society for the Advancement of Kinanthropometry (ISAK) accredited methods, ensuring consistency and were repeated for precision. Body mass and stretch stature were measured and BMI calculated. Waist (~1cm above the iliac crest) and hip circumferences (widest area around the gluteus maximus) were recorded and waist:hip ratio (WHR) calculated. Three skin fold measures were obtained (triceps, biceps, medial calf); landmarks were identified ensuring skin folds were accurately repeated measuring site specific adipose tissue.

The incremental shuttle walk test (SWT) comprised of 10 metre shuttles in which the participants followed the beep²⁶. Participants' aimed to walk for as long as possible until attaining test termination criteria^{27, 28}.

Psychological parameters measured included; motives for PA, self-efficacy to regulate PA (SERPA) and the hospital anxiety and depression scale (HADS)²⁹⁻³¹.

Statistical Analyses

The data are presented as mean \pm SD and percentage change. A descriptive exploratory analysis of all data was completed checking parametric assumptions using PASW (version 20, SPSS, USA). The data were normally distributed, apart from two psychological measures.

The alpha level was set at $P \leq 0.05$ to indicate any significant differences between measures.

Differences between the three groups were analysed using a one-way analysis of variance (ANOVA). The one-way ANOVA determined any significant differences between the three groups using pre-post deltas (Δ). A post hoc Scheffe was applied to determine pairwise

comparisons for all measures between groups, due to its highly cautious nature in reducing the risk of type 1 errors³².

For non-normally distributed data the Kruskal-Wallis test was undertaken with a post hoc Mann-Whitney U test³³. Univariate analyses of effect size and observed power were undertaken for each measure using partial eta squared. Paired sample t-tests and Mann Whitney-U were undertaken on pre-post data for the three groups to determine pre-post differences.

RESULTS

Figure 1 outlines participant progression. CON consisted of 3 males and 4 females (n=7); RT 2 males and 8 females (n=10); and AT 3 males and 7 females (n=10).

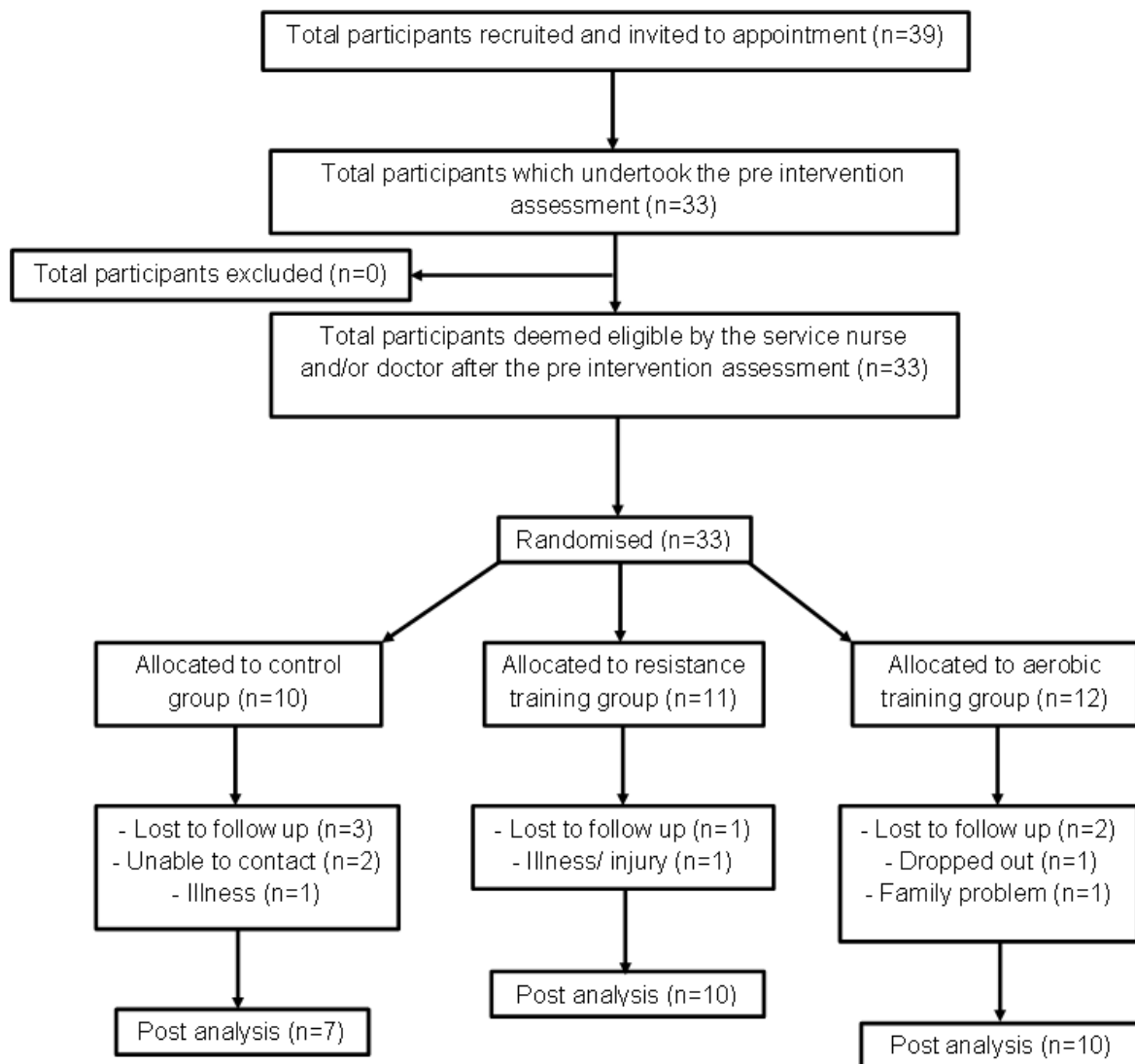


Figure 1: Study flow diagram and dropout rates.

All significant effects were due to differences between CON and the exercise intervention groups. No significant differences occurred between the RT and AT groups following the 12-week intervention. Anthropometric data are displayed in Table 1.

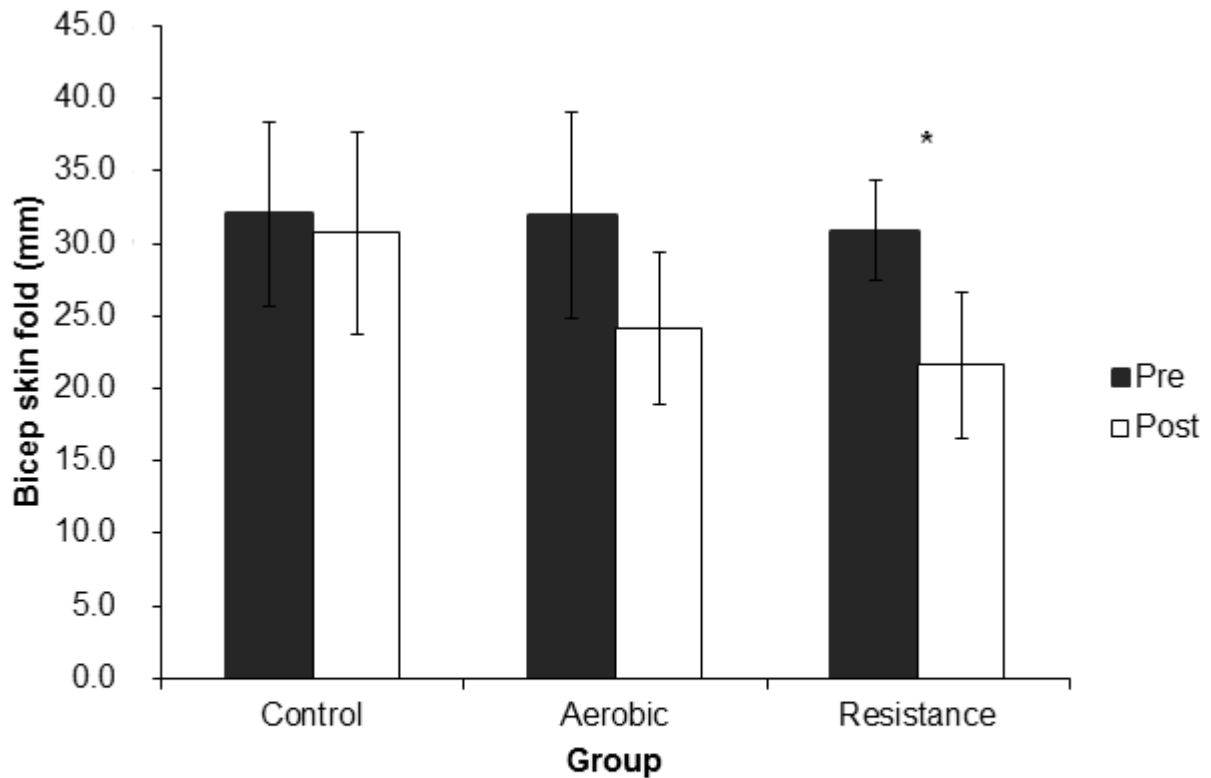
Table 1: Anthropometric measures pre and post means \pm SD for all three intervention groups.

Measure	Control		Resistance		Aerobic		F (2,24)	P	Observed power (w^2)	Effect size (n^2)
	Pre	Post	Pre	Post	Pre	Post				
Body mass (kg)	134.0 \pm 28.8	133.3 \pm 30.1	120.4 \pm 22.5	117.5 \pm 22.5	127.0 \pm 21.3	121.5 \pm 17.3	1.014	0.378	0.281	0.252
BMI (kg·m²)	48.6 \pm 7.8	48.3 \pm 7.8	41.5 \pm 5.2	40.5 \pm 5.4 *	44.4 \pm 4.4	42.6 \pm 3.9	4.084	0.030	0.103	0.266
Waist circumference (cm)	133.8 \pm 14.7	132.4 \pm 13.5	123.7 \pm 16.5	120.0 \pm 16.0	124.9 \pm 18.2	120.6 \pm 13.6	1.808	0.186	0.167	0.061
Hip circumference (cm)	145.6 \pm 14.8	143.7 \pm 14.9	131.9 \pm 8.5	127.2 \pm 9.7 *	135.5 \pm 9.4	129.9 \pm 9.4	4.913	0.016	0.588	0.222
WHR	0.92 \pm 0.06	0.92 \pm 0.07	0.94 \pm 0.10	0.94 \pm 0.10	0.92 \pm 0.11	0.93 \pm 0.10	0.096	0.909	0.055	0.003
Relaxed arm circumference (cm)	43.1 \pm 4.7	42.6 \pm 4.9	41.1 \pm 3.7	40.3 \pm 3.6	43.2 \pm 2.3	41.4 \pm 2.2	0.893	0.423	0.523	0.198
Flexed arm circumference (cm)	43.7 \pm 5.9	43.3 \pm 5.1	41.5 \pm 3.6	41.8 \pm 3.7	43.2 \pm 2.8	42.7 \pm 2.4	0.4	0.675	0.151	0.054
Calf circumference (cm)	50.7 \pm 5.9	51.0 \pm 5.9	46.8 \pm 4.4	46.1 \pm 3.6	49.7 \pm 3.8	49.1 \pm 4.0	2.7	0.088	0.340	0.185
Biceps skin fold (mm)	32.0 \pm 6.4	30.7 \pm 7.0	30.9 \pm 3.5	21.6 \pm 5.1*	32.0 \pm 7.1	24.1 \pm 5.3	5.466	0.011	0.945	0.416
Triceps skin fold (mm)	32.9 \pm 10.0	33.4 \pm 10.6	36.3 \pm 6.9	27.3 \pm 6.3 **	36.4 \pm 3.2	27.1 \pm 3.9 **	12.373	<0.001	0.991	0.508
Calf skin fold (mm)	43.6 \pm 13.5	43.3 \pm 12.6	37.4 \pm 10.1	28.9 \pm 8.6 *	40.2 \pm 5.0	32.9 \pm 6.2	5.383	0.012	0.933	0.404

*significantly different to CON ($p \leq 0.05$), ** significantly different to CON ($p \leq 0.01$)

The triceps skin fold significantly decreased in AT ($\Delta -9.29 \pm 3.33$ mm, -25.6%, $P=0.01$) and RT ($\Delta -9.03 \pm 5.80$ mm, -24.8%, $P=0.01$) compared to CON ($\Delta 0.50 \pm 3.34$ mm, 1.5%), displaying a large effect and statistical power $>80\%$. The medial calf skin fold decreased significantly in RT ($\Delta -9.03 \pm 3.71$ mm, -24.9%, $P=0.013$) compared to CON ($\Delta -0.29 \pm 4.83$ mm, -0.7%) the biceps skin fold also improved significantly in RT ($\Delta -9.27 \pm 4.55$ mm, -30.0%, $P=0.012$) compared to CON group ($\Delta -1.31 \pm 2.01$ mm, -4.1%). RT significantly improved BMI ($\Delta -1.02 \pm 0.91$ kg·m², -2.5%, $P=0.033$) compared to CON ($\Delta -0.31 \pm 1.47$ kg·m², -0.6%) and hip circumference ($\Delta -4.71 \pm 2.19$ cm, -3.6%, $P=0.022$) compared to CON ($\Delta -1.93 \pm 2.12$ cm, -1.3%).

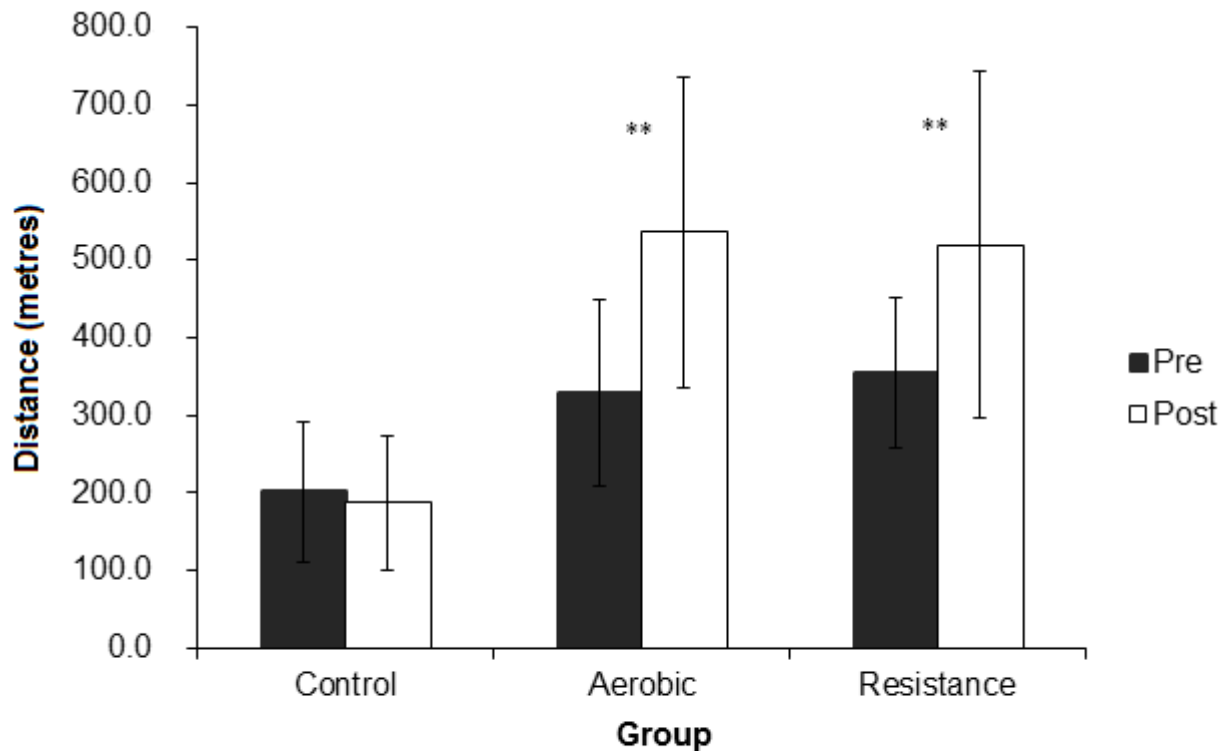
The biceps skin fold measurement significantly improved in AT and RT, as shown in Figure 2. Statistical power was $>80\%$ and there was a medium effect size. A greater mean body mass was highlighted at baseline in the CON group compared RT and AT, however, no statistically significant differences occurred in body mass at baseline between groups.



*significantly different to CON ($p \leq 0.05$); **significantly different to CON ($p \leq 0.01$)

Figure 2: Pre and post bicep skin fold measurements mean \pm SD for all three intervention groups.

The SWT distance was significantly further in AT ($\Delta 207.0 \pm 123.0$ m, 69.4%, $P=0.04$) and RT ($\Delta 165.0 \pm 183.30$ m, 53.7%, $P=0.06$) compared to CON ($\Delta -14.3 \pm 38.7$ m, -9.7%), with $>80\%$ power ($w^2=0.825$) and a medium effect size, as shown in Figure 3. A significant difference in the SWT was seen between RT and CON at baseline.



*significantly different to CON ($p \leq 0.05$); **significantly different to CON ($p \leq 0.01$)

Figure 3: The pre and post incremental SWT mean distances \pm SD for all 3 intervention groups.

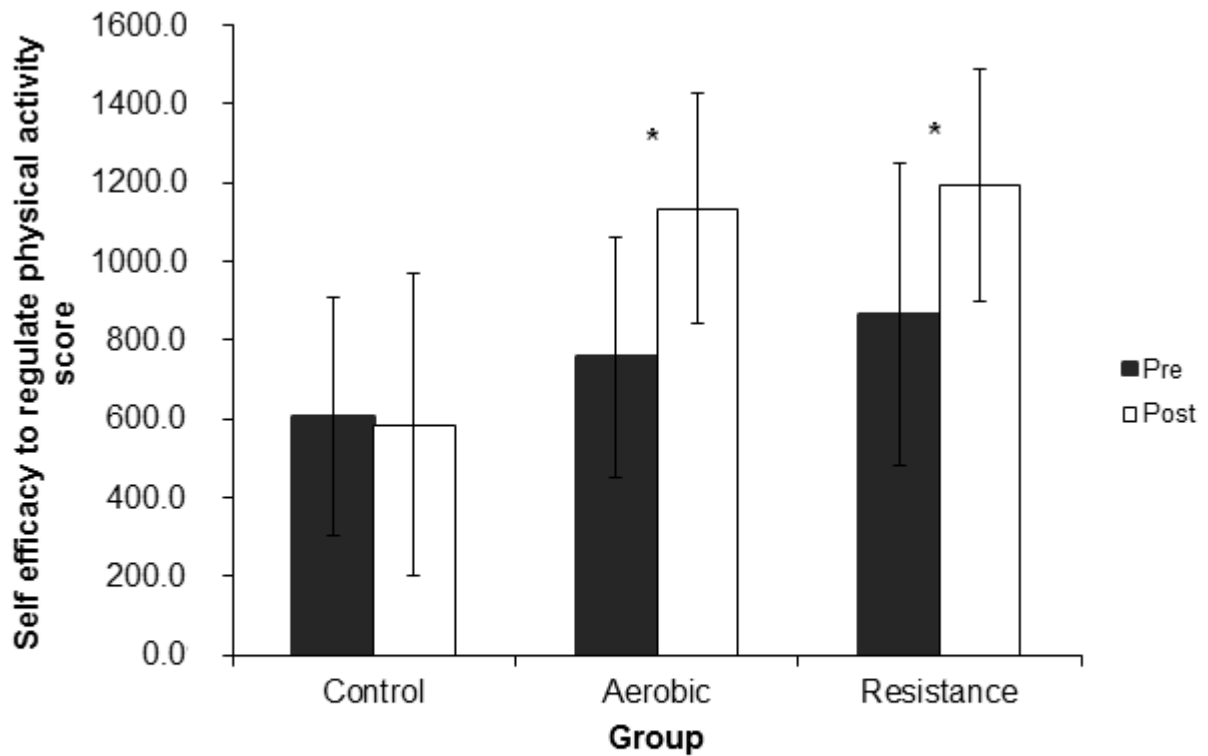
The interest/enjoyment PA motive category was significantly improved in AT ($\Delta -82 \pm 12.52$, 39.9%, $P=0.041$) and RT ($\Delta -50.00 \pm 6.45$, 19.8%, $P=0.006$) compared to CON ($\Delta 5.70 \pm 8.00$, 3.7% decrease). The competence PA motive was significantly higher than CON ($\Delta -0.29 \pm 6.75$, -1.8%) in RT ($\Delta 7.8 \pm 6.23$, 31.7%, $P=0.019$), with no significant difference between AT and CON. Psychological parameters are presented in Table 2.

Table 2: Pre and post PA motive scores in all three intervention groups mean \pm SD.

Measure	Control		Resistance		Aerobic		F/ H (2,24)	P	Observed power (w^2)	Effect size (n^2)
	Pre	Post	Pre	Post	Pre	Post				
Interest/ enjoyment	20.9 \pm 7.4	20.3 \pm 10.0	32.0 \pm 8.8	37.0 \pm 6.4**	24.7 \pm 13.0	32.9 \pm 11.5*	8.456	0.002	0.331	0.128
Competence	21.7 \pm 8.1	21.4 \pm 11.9	30.2 \pm 8.7	38.0 \pm 7.4*	24.6 \pm 12.8	35.4 \pm 13.2	6.673	0.005	0.515	0.195
Appearance	28.9 \pm 9.5	32.1 \pm 8.9	32.2 \pm 6.4	33.8 \pm 6.4	29.9 \pm 8.5	32.2 \pm 5.7	0.177	0.839	0.074	0.014
Social	15.3 \pm 6.5	15.4 \pm 7.1	17.6 \pm 6.1	20.5 \pm 8.3	14.2 \pm 10.4	15.3 \pm 7.6	1.901	0.171	0.096	0.026
Anxiety	11.9 \pm 1.9	8.6 \pm 4.5	10.2 \pm 3.4	8.4 \pm 4.4	9.1 \pm 3.7	5.7 \pm 3.5	1.446	0.255	0.173	0.064
Depression	7.9 \pm 2.3	5.4 \pm 2.2	9.5 \pm 3.7	5.5 \pm 4.9	7.6 \pm 4.3	3.5 \pm 3.1	0.893	0.422	0.171	0.063
Fitness	26.9 \pm 7.7	28.6 \pm 4.5	32.3 \pm 3.5	33.1 \pm 1.8	27.0 \pm 5.0	29.7 \pm 7.3	4.778	0.092	0.080	0.018

*significantly different to CON ($p \leq 0.05$), ** significantly different to CON ($p \leq 0.01$)

A significant improvement in the SERPA scores were reported ($H_{(2)}=9.843$; $P=0.007$, $Z=-2.689$; $P=0.005$) with a large effect size. AT ($\Delta 376.00 \pm 375.68$, 56.8%) and RT ($\Delta 329.5 \pm 283.1$, 45.1%) scored significantly higher than CON ($\Delta -22.14 \pm 391.8$, -4.9%), as shown in figure 4.



*significantly different to CON ($p \leq 0.05$); **significantly different to CON ($p \leq 0.01$)

Figure 4: The pre and post interventions (SERPA) scores mean \pm SD for all three intervention groups.

DISCUSSION

The main findings were that the addition of a structured moderate intensity AT or RT programme to a 12 week MDT weight-loss and lifestyle programme significantly improves anthropometric, psychological and functional measures in obese patients with a BMI ≥ 35 kg·m². Due to the nature of the weight-loss programme an improvement was expected in all groups, since the three component educational approach of diet, exercise and behaviour modification is specifically designed to aid weight-loss. However, analyses revealed numerous significant differences between CON and exercise groups. AT and RT

demonstrated significant improvements in the incremental SWT, triceps skinfold, self-efficacy and interest/enjoyment compared to the CON. RT displayed additional improvements in BMI, waist circumference, competence, biceps skinfold and medial calf skinfold.

Previous literature has shown improved VO_{2max} in a MDT weight-loss programme when an additional aerobic exercise component is added³⁴. In the current study both exercise groups significantly improved incremental SWT distance compared to CON, indicating that an individualised, supervised and structured exercise programme, regardless of exercise type, can increase functional capacity in the early stages of obesity management. Improved mobility in the RT group may be a contributing factor for this increased speed and distance walked, supporting previous research³⁵. The reduction in the SWT distance in CON suggests that the educational PA element of the MDT programme is insufficient in enhancing physical activity participation³⁴. These data extend the findings of Pavolou *et al.*³⁴ who found an improved VO_{2max} in their AT group compared to CON when combined with a MDT weight-loss programme, but they did not have a RT group to compare with.

Anthropometric measurements in both of the exercise groups significantly improved. In RT all three skin fold measurements, hip circumference and BMI significantly decreased whilst only the triceps skin fold significantly decreased in the AT group. The combined reduction in BMI and all skin fold measures suggest a greater fat mass reduction in the RT group compared to CON. In combination with this, circumferences indicated a positive trend, with mean relaxed arm circumferences decreasing in all three groups with greater improvements in the exercise groups. Flexed arm circumference increased in the RT group, but decreased in the AT and CON groups, indicating an improvement in body composition through fat mass loss and fat free mass gain when resistance training^{16, 23}. One could assume the additional

benefits in the RT group could be due to an increase in muscle mass and basal metabolic rate, this would however need to be assessed objectively to confirm this assumption^{19, 20}.

Although the AT and RT exercise programmes were both performed at a moderate intensity to ensure both groups were working at an equivalent work rate¹. It cannot be confirmed that caloric expenditure was identical between or within modalities. Caloric expenditure can differ depending on the patients ability, the type of exercise performed, the duration of aerobic exercise, the sets and repetitions of resistance exercise³⁶. Due to the nature of the research breath by breath analysis to measure energy expenditure was not possible.

Anxiety and depression scores improved in all groups, with no significant difference between groups. Both exercise regimes showed significantly higher SERPA scores compared to CON. Participants in the exercise groups displayed improved self-belief in their ability to regulate PA in different situations even when feeling tired or depressed, whereas those in the MDT-only CON group demonstrated a reduction in self-belief and appeared less confident. This suggests that a prescriptive approach to exercise in MDT weight management programmes improves self-belief (SERPA), confidence and being able to overcome barriers. This supervised prescriptive approach provided regular professional and peer support, ongoing counselling and an increased knowledge and understanding of exercise which all contribute to increased self-belief and confidence^{9, 13}. When Nicolai *et al.*¹² compared supervised and non-supervised exercise, exercising under the supervision of a qualified exercise specialist elicited significant reductions in body weight and fat mass compared to non-supervised. The findings of the present study combined with the literature highlights the importance of supervised and prescriptive exercise on psychological and physiological outcomes in an obese population^{9, 12, 13}.

Supervised and prescriptive exercise such as that reported in the present study is imperative to a MDT approach to weight loss. Exercise education alone is insufficient in halting declines in health related fitness parameters, such as psychological parameters and SWT distance, where reductions were seen in CON compared to the significant improvement in the exercise groups. This measure reflects cardiovascular function which can indicate the ease of undertaking daily tasks (e.g. walking) and premature mortality³⁷.

Research has previously focused on strategies to increase exercise adherence in obesity management⁹. The exercise adherence and drop-out pattern seen in the study are similar to previous research for this population, with a higher attrition rate for CON (30%) compared to 9% and 17% for RT and AT, respectively (Figure 1). The rate of attrition is superior to previous research; a systematic review revealed completion rates of only 12%-42% for 10-12 week programmes¹³, the current study revealed completion rates of 70% for CON, 83% for AT and 91% for RT. This reduced drop-out rate in the exercise intervention groups reflects previous research, since adherence to exercise is more likely if combined with multidisciplinary interventions which have a focus on PA maintenance¹³. The addition of structured exercise regardless of exercise mode to the educational approach adopted might aid in the retainment of individuals in the MDT weight loss programme, however this requires further examination. The exercise group self reported the intrinsic factors that contributed to their adherence included noticeable changes in body composition, fitness and self-efficacy through personal achievement, visible progression and maintenance^{13 38}. Extrinsic motivational factors should be further explored because the motivational skills of the exercise instructor and the supervised structured and individualised exercise programmes could have provided additional peer support and motivation. Previous research supports this, with strong associations between exercise professionals and adherence/ non-adherence combined with personal social, physical and psychological parameters^{12, 13}. Williams *et al.*¹³

recognised that satisfaction was prominently linked to the staff providing such exercise programmes.

All motives for undertaking PA increased in the exercise groups, whereas interest/enjoyment and competence motives decreased in CON. AT and RT's interest/enjoyment motive significantly improved while competence only significantly improved in RT compared to CON. In the pre-intervention assessment the predominant PA motive was appearance, reflecting the Allied Dunbar National Fitness Survey (ADNFS) results, which associated weight control and appearance as predominantly female exercise motives³⁹. The high number of female participants may indicate why appearance was the predominant PA motive. Future research should recruit a larger sample in a multi-centre trial to corroborate these preliminary findings. Furthermore, a study employing a 12 month follow-up design should be incorporated to determine whether these short term improvements can be maintained on completion of the supervised exercise phases.

This preliminary study suggests that supervised structured exercise should be further explored as an addition to MDT weight-loss programmes. The study highlights significant improvements in health-related fitness outcomes compared to routine treatment alone and with lower attrition rates in the exercise groups (RT & AT combined 14%) compared to CON (30%). RT and AT exercise interventions significantly improved anthropometric, psychological and functional capacity measures compared to routine care. Further research is required to confirm whether the addition of supervised and structured exercise to MDT weight-loss programmes is cost-effective and has longer term efficacy in improving health-related fitness parameters in class II/III obesity.

Conflict of interest: None declared

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