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ORIGINAL ARTICLE

Effects of BodyPump and resistance training with and without a personal trainer on muscle strength and body composition in overweight and obese women—A randomised controlled trial

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Group training;
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Summary
Objectives: Overweight and obese individuals are recommended to perform regular resistance training, and the health- and fitness industry offer several exercise programs with purpose to improve muscle strength and body composition. This randomised controlled trial aimed to compare 12 weeks (45—60 min, 3 sessions/weeks) of popular exercise programs, available at health- and fitness centers worldwide.
Methods: Previous untrained women with BMI ≥ 25 were allocated to either BodyPump (a high-repetition group session) (n = 25), individual resistance training with a personal trainer (n = 25), non-supervised individual resistance training (n = 21) and non-exercising control group (n = 21). Primary outcome was one repetition maximum (1RM) in squat and bench press, and secondary outcome was body composition (Inbody720).
Results: The BodyPump group did not improve muscle strength, compared to any of the other groups. In 1RM squat, the personal trainer group increased 17% (95% CI 5.1—23.0), 20% (95% CI 7.5—24.8) and 30% (95% CI 15.8—33.0 kg) more than the non-supervised group, BodyPump and controls, respectively. In bench press the personal

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trainer group increased 10% (95% CI 1.5—7.2) and 16% (95% CI 3.5—9.3 kg) more compared to BodyPump and controls. No difference was found compared to the non-supervised group in bench press. There were no between-group differences in body composition.
Conclusion: Twelve weeks of BodyPump did not improve muscle strength in overweight women, but a personal trainer amplified the effects of individual resistance training on maximal strength in squat. None of the intervention groups showed effect in body composition.

Introduction

Increased body mass index (BMI) is associated with several health challenges, both to the individual and to the public [1,2]. In 2010, a high BMI was estimated to cause 3.4 million deaths [1]. The worldwide prevalence of women classified as overweight (BMI $\geq$ 25.0 kg/m^2) increased from 29.8% to 38.0% between 1980 and 2013 [3], and the prevalence classified with obesity (BMI $\geq$ 30.0 kg/m^2) increased from 6.4% to 14.9% between 1975 and 2014 [4]. Today overweight and obese individuals are recommended to perform resistance training 2—3 times a week, in combination with endurance training and dietary restrictions [5—7]. Regular resistance training is found to maintain or increase muscle strength and lean body mass, but may be insufficient in weight loss or decrease in fat mass [6,8]. However, Shiroma et al. [9] followed almost 36,000 healthy women and found that women exercising regular resistance training significantly reduced the risk of diabetes type-2 and cardiovascular diseases, compared to endurance training only. This support the importance of including resistance training in the physical activity recommendations for overweight individuals.

The health- and fitness industry offers a large variation in resistance training programs; in groups and individual. BodyPump, distributed from Les Mills International, is a pre-choreographed group resistance program, with over 5 million participants every week [10]. This is a full-body workout session, with a high number of repetitions (approximately 800 repetitions in total), including low-to-moderate loads. According to Les Mills, regular BodyPump exercise improves muscle strength, increases lean body mass and decrease fat mass [10]. To our knowledge, only two studies have examined the effects of BodyPump over time [11,12]. Greco et al. [11] found positive changes in maximal muscle strength in sedentary young students, but body composition did not change significantly in response to BodyPump. Nicholsson et al. [12] included elderly women and found positive changes in maximal muscle strength, but did not investigate the effect on body composition.

Individual heavy load resistance training with a personal trainer is another popular alternative in the health- and fitness industry. Today more than six million Americans employee a personal trainer (The International Health, Racquet and Sportsclub Association, 2015), however; search on Pubmed and other Sport related journals, did not reveal any studies on the amplitude of a personal trainer on muscle strength and changes in body composition in overweight and obese women.

The purpose of the present study was to evaluate the effects of BodyPump and traditional heavy load resistance training with and without a personal trainer on muscle strength and body composition in overweight and obese women. We hypothesized that BodyPump would improve muscle strength and body composition, compared to an inactive control group and that resistance training with a personal trainer would emphasize the effect on muscle strength and body composition, compared to non-supervised exercise.

Material and methods

Study design

This is a four armed assessor blinded randomised controlled trial (RCT) comparing the effects of 12 weeks of BodyPump, individual heavy load resistance training with a personal trainer, individual non-supervised resistance training and a

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non-exercising control group. All exercise sessions in the study were performed in a health- and fitness club setting. Primary outcome was maximal muscle strength (one repetition maximum [1RM]). Secondary outcomes were strength-endurance (maximal repetitions with 70% of 1RM) and body composition.

Subjects

Recruitment of participations was made via various social media channels and the homepage of the Norwegian School of Sport Sciences (NSSS). In total, 195 overweight or obese women contacted the principal investigator by phone or email. After aims and implications of the study were explained, eligibility criteria checked and a check-off health-profile scheme including health issues contraindicated for participation was fulfilled, a final sample of 143 participants were included. If a participant was uncertain regarding one or more of the check-off points in the health-profile scheme, we asked for a health declaration from their physician, to be able to enter the study. The included participants were allocated to either BodyPump (n = 37), heavy load resistance training with a personal trainer (n = 35), non-supervised heavy load resistance training (n = 35) or a non-exercising control group (n = 36). The statistician performed block randomization, using a computer generated random numbers and an 8-persons block size, meaning that for every eight randomized person each block had two participants with the same intervention. The first 140 included participants were randomized with n = 35 in each group. Then, three more participants were included, randomized from a new 8-person block, giving different n in the four groups.

Inclusion criteria were BMI $\geq$ 25.0, age 18—65 and not regularly exercising defined as ''not performing regular structured exercise $\geq$ twice a week ''the last six months''. Exclusion criteria were diseases or injuries being contraindicated for maximal strength tests and heavy load resistance training (e.g. ischia's, low back pain, osteoarthritis, osteoporosis, secondary hypertension, history of coronary heart disease, stroke, arrhythmias, diabetes type 1 and neurological diseases), vacation or absence from exercise during the intervention period (>2 weeks), pregnancy, obesity surgery or psychiatric diseases (anxiety and depression). The participants were asked not to take part in any other exercise regimens during the intervention period, change any dietary habits or activity of daily living (ADL).

Power calculations were based on the findings from Greco et al. [11], whom detected a difference of 11% (effect size: 0.7) in muscle strength (1RM) compared to inactive controls, after 12 weeks of BodyPump. With a standard deviation of 15, alpha = 5%, and a statistical power of 80%, 30 subjects were needed in each group. With an expected attrition rate of 10-20%, a minimum of 35 women were included in each study group.

The study was approved by the National Committee for Medical Research Ethics Norway, Oslo (REK 2012/783), and all participants gave written consent to participate. The procedures followed the World Medical Association Declaration of Helsinki, and the study is registered in the Clinical Trial.gov Protocol Registration System (NCT01993953).

Procedures and interventions

All intervention groups were prescribed three exercise sessions weekly, for a period of 12 weeks. The duration of each BodyPump session was 60 min. The exercise program in the personal trainer and non-supervised group included linear periodization and varied between 45 and 60 min, due to small variations in the number of repetitions, sets and rest periods. All participants were told not to use less than 45 min or more than 60 min. Participants in the BodyPump group had free access to several local health- and fitness club centers offering BodyPump classes. The personal trainer group exercised with their personal trainer in the health- and fitness club at NSSS. The non-supervised group received instructions about the exercise program, lifting technique, intensity and progression from an instructor at their first exercise session, and a follow-up session after six weeks of the intervention period. All of the other exercise sessions were performed on their own in the health- and fitness club at NSSS. Sixteen personal trainers, educated with a bachelor degree in physical activity and health, including a personal trainer certificate from the NSSS, trained the women. All participants used a training diary to register adherence, training mode, repetitions and sets.

BodyPump is a pre-choreographed full-body workout session including 9—12 free-weight exercises. Table 1 shows an overview of the BodyPump program. The participants exercised with a weight bar (1.25 kg), plates (1, 2.5 or 5 kg) and a step. A typical one-hour BodyPump session includes approximately 800 repetitions, and number of repetitions throughout the session varies between muscle groups, in the range of 50—100. Each music track (4—6 min each) contains exercises for a particular muscle group. Between each music track, there is a short rest period (approximately one minute), primarily used to change weights and pre-

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Table 1 Exercise program BodyPump.

Music nr.	Exercise	Volum (reps)
1 Warming-up	Straight leg deadlift, rowing, shoulder press, squat, lounges and bicepscurl	88
2 Leg	Squat	95
3 Cheast	Bench press	80
4 Back	Rowing, stiff legged deadlift, clean & press and power press	75
5 Triceps	French press, tricepspress, pullover and overhead tricepspress	78
6 Biceps	Bicepscurl	68
7 Leg	Squat, lounges and squat jump	72 + 24 jumps
8 Shoulders	Push up, lateral raise, rowing and shoulderpress	76 + 36 push up
9 Stomach	Sit-ups, sit-ups to the side and side-plank	51 + 30 seconds

pare to the next exercises. Some of the tracks also includes short inter-session rest periods (5—10 s), preferably used to ''shake the legs''. The session starts with a warm up track, containing different resistance exercises for the whole body. This is followed by exercises for the largest muscle groups (legs, chest, back), before smaller groups (arms, shoulders, core), and finally a cool-down including stretching. The participants selected their own training loads, but were encouraged to achieve muscular fatigue in each music track, with proper lifting technique. During a BodyPump session the instructor's gives verbal technique guidance ahead of each exercise. In addition, they repeat the most important technique components throughout each track, and gives individual instructions if necessarily.

The exercise program in the personal trainer and non-supervised groups were designed to resemble the BodyPump program, and included similar free-weights exercises (squat, lounges, deadlift, bent over rows to chest, bench press, dips or kickback, shoulderpress, modified clean and press, triceps press, bicepscurl and sit-ups). However, all exercises were performed in the free-weight area in the gym, with traditional free-weight equipment. The programs were standardized with nonlinear periodization. Session 1 included 8—10 repetitions, 2 sets and 60 s inter-set breaks. Session 2 included 13—15 repetitions, 2—4 sets and 60 s inter-set breaks, while session 3 included 3—6 repetitions, 2—4 sets and 120 s inter-set breaks. In week 1—4 the participants performed 2 sets in all exercises, while they increased to 3 sets in week 5—8 and 4 sets in week 9—12. The exercise program did not include any form of aerobic endurance training, except of 5—10 min light warm-up on a treadmill or cycle ergometer, and one warm-up set in each exercise. Both groups were instructed to perform repetition maximum in each set, and thereby choose their own appropriate training loads, with proper lifting technique. The participants in the personal trainer group exercised with the same personal trainer during the whole intervention period. The personal trainers were not allowed to interfere with the standardized training program (sets, reps, rest periods etc.) and were restricted to advise the participants to add appropriate loads and conduct the exercises with proper technique. The personal trainers could spot/secure and verbally motivate the participants during the weightlifting exercises, while forced-repetitions were prohibited. Totally, sixteen personal trainers took part in the study, all educated with a bachelor degree in physical activity and health, including a personal trainer certificate from the NSSS (including 33 h theory and 27 h practical teaching). All exercise sessions were performed in the health- and fitness club at NSSS.

The non-supervised group received instructions about the exercise program, lifting technique, intensity and progression from one of the personal trainers at their first exercise session, and a follow-up session with the same personal trainer after six weeks of the intervention period. All of the other exercise sessions were performed on their own in the health- and fitness club at NSSS. All participants used a training diary to register adherence, training mode, repetitions and sets.

Participants in the non-exercising control group were instructed to continue their lifestyle and ADL as usual. If they performed any exercise or activities, this was reported in a training diary. After the intervention period, they were offered BodyPump classes for 12 weeks, and one session of resistance training guided by a personal trainer.

Measurements

All participants included in the study conducted the baseline assessments directly ahead of the intervention. The randomization procedure and allocation to the different intervention groups was done after the baseline assessments, and delivered via opaque sealed envelopes. Immediately

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after the intervention period, the participants who completed the study conducted the same test procedure. All investigators involved in the assessments conducted the same tests at baseline and post-test, and the participants were instructed not to change their diet and activity of daily living during the intervention period.

Primary outcome

Maximal muscle strength was assessed with 1RM in squats and bench press. The participants came in groups of three, and they started with 5—10 min of light warm-up on a treadmill. Firstly, the squat was assessed, followed by the bench press. The participants received an oral instruction and practical demonstration of the exercises and were allowed to practice the technique with light weights (~20 kg), before initiating the test procedure. There was no other familiarization sessions ahead. The test procedure in both exercises included three series with gradually increasing load (40—75—85% of predicted 1RM) and reciprocally reduced numbers of repetitions (12-7-3). The participants conducted the first 1RM with a load about 5% below the expected 1RM. After each approved lift, the load increased with 2—5%, until failure. Resting periods between attempts were 3—5 min. High intraclass-correlation (ICC = 0.91) is found in both squat and bench press 1RM tests, and is considered the gold standard when assessing maximal muscle strength in non-laboratory situations [13].

Secondary outcomes

Strength-endurance tests were completed immediately after the 1RM test, in both squat and bench press. All participants performed the maximal number of repetitions at 70% load of their 1RM, with correct lifting technique. Qualified sport master students conducted all tests, and experienced spotters were present during all lifts.

Body composition was assessed with direct segmental multifrequency bioelectrical impedance Inbody720 (Body Composition Analyzer, Biospace Co., Ltd., Seoul, Korea). To obtain reliable measurements the assessment followed a standardized procedure, including overnight fasting [14]. All participants arrived to the laboratory at NSSS between 7 and 9 am on test day. The eight-polar Inbody separates adipose tissue and bone mass from other tissues in the body, leaving ''lean body mass''(LBM) [15]. The ICC for Inbody720 is also found to be high in both fat mass (kg) and fat-free mass (kg) when comparing Inbody720 with Dual-energy X-ray absorptiometry (DXA) with ICC = 0.832 and ICC = 0.899 respectively [16]. The Inbody was calibrated based on the manufacturer specifications. The participant's body weight analyzed with Inbody was registered to the closest 0.1 kg, and height was measured to the closest 0.5 cm. BMI was then calculated as body weight (kg) divided by squared height (m).

Statistical analyzes

Analyzes were done with SPSS statistics program, version 21 (IBM Corporation, Route, Somers, NY, USA). Results are presented for completers only. An attrition rate analysis of baseline characteristics between completers and non-completers was made with an independent t-test. Background data is presented as means with standard deviation (SD) or numbers with percentages (%). The individual training load in squat and bench press was estimated as total load (kg) lifted in each exercise throughout the intervention period, divided by the total number of conducted sessions. The individual relative training load (% of 1RM) was calculated by dividing mean training load throughout the intervention by mean of 1RM at pre- and posttest. A normal distribution of the data was assessed with the Shapiro-Wilk test, and differences between groups at baseline were analyzed with ANOVA. A one-way ANOVA and Bonferroni post-hoc comparisons were used to detect between-group differences in the changes over the training period. Data are presented as means with 95% CI. Level of statistical significance was set at $p < 0.05$.

Results

Fig. 1 shows the flow-chart of the study including reasons for discontinuation. Ninty-four participants completed the study (mean age 39.6, SD 10.1 and BMI 31.1, SD 5.4). Loss to follow-up and discontinued to intervention were 32%, 17%, 40% and 36% in BodyPump, personal trainer, non-supervised and control group, respectively. Of 36 exercise sessions prescribed, mean adherence in the BodyPump group (n = 18) was 21.1 (SD 7.8, 58%), in the personal trainer (n = 27) 32.2 (SD 5.6, 89%) and in the non-supervised group (n = 19) 26.9 (SD 7.6, 74%). The personal trainer group had significantly higher adherence compared to both the BodyPump ($p \leq 0.001$) and the non-supervised group ($p = 0.017$).

Table 2 shows the background characteristics of the participants. There were no significant differences between the groups at baseline, or when analyzing baseline characteristics of the completers and non-completers (data not shown).

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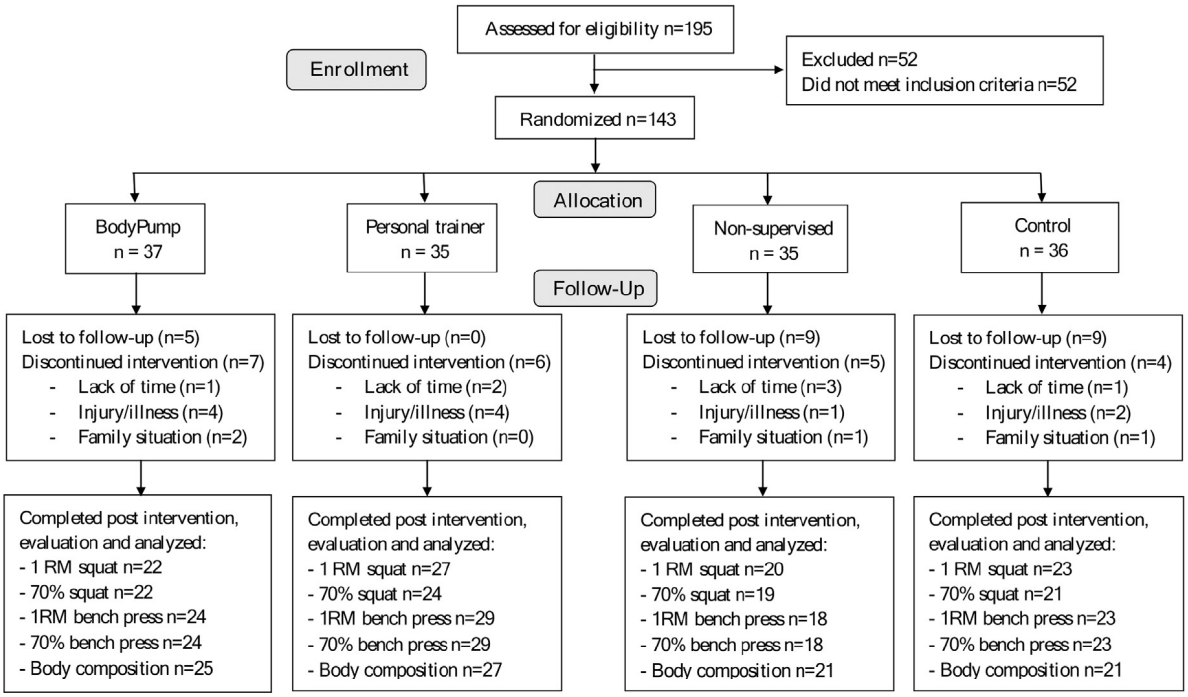

Figure 1 Flow chart of participants throughout the study period.

Table 2 Characteristics of the study population at baseline in Body Pump (BP), personal trainer (PT), non-supervised (NS) and control (C) group. Values presented as mean (SD) or numbers (%).

	BP	PT	NS	C	p-Value
Age (years)	39 (10)	38 (9)	42 (11)	40 (10)	0.369
Weight (kg)	84.4 (14.3)	93.3 (21.1)	86.2 (14.1)	86.4 (14.5)	0.229
BMI (kg/m^2)	30.2 (5.4)	32.3 (6.1)	30.8 (4.9)	30.8 (5.0)	0.545
Muscle mass (kg)	28.3 (2.8)	30.0 (4.4)	29.1 (3.3)	27.9 (2.9)	0.168
Fat mass (kg)	33.4 (11.2)	39.3 (14.6)	33.8 (10.8)	36.0 (11.2)	0.286
Fat mass (%)	38.7 (6.3)	41.1 (6.2)	38.4 (6.5)	20.8 (6.1)	0.340
1RM squat (kg)	79.3 (14.2)	80.8 (20.1)	82.6 (18.2)	80.4 (16.4)	0.945
1RM bench press (kg)	37.4 (5.5)	38.6 (6.0)	37.9 (5.8)	38.1 (6.1)	0.909
Daily smoker (yes)	2 (11%) (n = 18)	1 (5%) (n = 22)	0 (0%) (n = 14)	1 (6%) (n = 10)	0.691
Children (yes)	11 (61%) (n = 18)	7 (32%) (n = 22)	10 (71%) (n = 14)	7 (58%) (n = 12)	0.090
Education level (university <4 yr)	9 (50%)	7 (32%)	6 (43%)	6 (50%)	0.329

Maximal muscle strength

Descriptive data is presented in Table 3.The personal trainer group increased significantly in 1RM squat compared to the non-supervised group (Table 4) ($p \leq 0.001$), representing a between group difference of 17%, and the BodyPump group with a difference of 20% ($p \leq 0.001$). Both the personal trainer and non-supervised group increased significantly in 1RM squat compared to control group ($p \leq 0.001$ and $p = 0.020$), with a between group difference of 30% and 12%, respectively. In 1RM bench press, there were significant differences between the personal trainer group and the BodyPump group with 10% ($p \leq 0.001$) and controls with 16% ($p \leq 0.001$). The non-supervised group improved significantly in bench press compared to controls with 16% ($p \leq 0.001$) and to BodyPump with 10% ($p = 0.007$).

Strength-endurance

In strength-endurance, number of repetitions have been multiplied with the load lifted. The personal trainer group increased significantly compared to non-exercising controls in squat with 69% ($p = 0.017$) and bench press (35%) ($p = 0.006$) (Table 4). The non-supervised group increased significantly com-

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Table 3 Within group changes from pre- to posttest, in BodyPump (BP), personal trainer (PT), non-supervised (NS) and control group (C). Presented as n and mean (SD).

Outcome variable	Group	n	Mean (SD)
BMI (kg/m^2)	BP	24	−0.3 (0.6)
	PT	27	−0.2 (0.8)
	NS	20	−0.3 (0.8)
	C	21	−0.4 (0.7)
Muscle mass (kg)	BP	25	0.1 (0.8)
	PT	27	0.9 (0.2)
	NS	21	0.3 (0.8)
	C	21	0.1 (0.8)
Fat mass (kg)	BP	25	−1.0 (1.4)
	PT	27	−1.5 (2.0)
	NS	21	−1.2 (2.4)
	C	21	−1.1 (1.8)
Fat mass (%)	BP	25	−0.8 (1.5)
	PT	27	−1.5 (1.7)
	NS	21	−1.1 (2.2)
	C	21	−0.8 (1.5)
1 RM squat (kg)	BP	22	12.3 (12.0)
	PT	27	28.4 (11.5)
	NS	20	14.4 (10.8)
	C	23	4.0 (10.6)
Strength-endurance 70% squat (kg × reps)	BP	22	149.0 (342.2)
	PT	24	338.2 (609.8)
	NS	19	340.6 (493.3)
	C	21	−71.3 (211.4)
1 RM bench press (kg)	BP	24	3.8 (2.6)
	PT	29	8.1 (4.6)
	NS	18	7.8 (3.3)
	C	23	1.7 (4.2)
Strength-endurance 70% bench press (kg × reps)	BP	24	64.0 (134.3)
	PT	29	93.3 (124.4)
	NS	18	112.8 (139.1)
	C	23	−27.5 (111.4)

pared to the non-exercising control group in squat with 44% ($p = 0.027$) and bench press with 49% ($p = 0.004$).

Body composition

There were no significant differences between any of the groups in body composition or muscle mass (Table 5). A mean change boxplot of muscle mass showed four outliers (three in control group and one in the non-supervised group), and when excluding these from the analysis, ANOVA and Bonferroni post-hoc test revealed that the personal trainer group increased significantly in muscle mass, compared to controls ($p = 0.047$, 95% CI 0.0—1.2 kg).

Training load

Based on the training diaries and the mean results from the maximal muscle strength tests at baseline and posttest, mean training load in the BodyPump group was calculated to 12% of 1RM in squat and 16% in bench press. In the personal trainer group mean load in squat was 66% of 1RM and bench press 69%, while the non-supervised group trained with 47% of 1RM in squat and 63% in bench press. The personal trainer group exercised with significantly higher load in squat than the non-supervised group (19.8 kg (SD 3.3), $p \geq 0.001$, 95% CI 11.7—27.9). No differences were seen between the two groups in bench press. Both the personal trainer and non-supervised group had significantly higher training load than the BodyPump group.

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Table 4 Differences between BodyPump (BP), personal trainer (PT), non-supervised group (NS) and control group (C) in all variables in muscle strength, analyzed with ANOVA and Bonferroni post-hoc test. Presented with 95% CI and p-value.

Outcome variable	ANOVA (between group mean difference)	Comparison group	Mean difference (SD)	95% CI	Post-hoc p-value
1RM squat (kg)	$p \leq 0.001$	BP vs C	8.3 (3.3)	−0.8 to 17.3	0.092
		PT vs C	24.4 (3.2)	15.8—33.0	≤0.001*
		NS vs C	10.4 (3.4)	1.1—19.6	0.020*
		PT vs NS	14.1 (3.3)	5.1—23.0	≤0.001*
		PT vs BP	16.2 (3.2)	7.5—24.8	≤0.001
		NS vs BP	2.1 (3.5)	−7.4 to 11.4	1.000
Strength endurance 70% squat (kg x reps)	$p = 0.009$	BP vs C	220.4 (136.0)	−147.3 to 588.0	0.654
		PT vs C	409.5 (133.2)	49.4—769.5	0.017*
		NS vs C	411.9 (141.1)	30.3—793.4	0.027*
		PT vs NS	-2.4 (136.9)	−372.5 to 367.6	1.000
		PT vs BP	189.12 (131.6)	−166.6 to 544.8	0.926
		NS vs BP	191.5 (139.6)	−185.9 to 568.9	1.000
1RM bench press (kg)	$p \leq 0.001$	BP vs C	2.1 (1.2)	−0.9 to 5.1	0.370
		PT vs C	6.4 (1.1)	3.5—9.3	≤0.001*
		NS vs C	6.1 (1.2)	2.9—9.4	≤0.001*
		PT vs NS	0.3 (1.2)	−2.8 to 3.4	1.000
		PT vs BP	4.3 (1.1)	1.5—7.2	≤0.001*
		NS vs BP	4.0 (1.2)	0.8—7.2	0.007
Strength endurance 70% bench press (kg x reps)	$p = 0.002$	BP vs C	91.4 (37.0)	−8.5 to 191.3	0.093
		PT vs C	120.7 (35.4)	25.1—216.3	0.006*
		NS vs C	140.2 (40.9)	32.5—248.0	0.004*
		PT vs NS	−19.5 (38.1)	−122.2 to 83.3	1.000
		PT vs BP	29.3 (35.0)	−65.2 to 123.8	1.000
		NS vs BP	48.8 (39.6)	58.0—155.6	1.000

* Indicates a significant mean difference with $p < 0.05$.

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Table 5 Differences between BodyPump (BP), personal trainer (PT), non-supervised group (NS) and control group (C) in all variables in body composition, analyzed with ANOVA and Bonferroni post-hoc test. Presented with 95% CI and p-value.

Outcome variable	ANOVA (between group mean difference)	Comparison group	Mean difference (SD)	95% CI	Post-hoc p-value
BMI (kg/m^2)	p = 0.848	BP vs C	1.0 (0.2)	−0.6 to 0.7	1.000
		PT vs C	0.2 (0.2)	−0.4 to 0.8	1.000
		NS vs C	0.1 (0.2)	−0.6 to 0.7	1.000
		PT vs NS	0.1 (0.2)	−0.5 to 0.7	1.000
		PT vs BP	0.1 (0.2)	−0.4 to 0.7	1.000
		NS vs BP	0.0 (0.2)	−0.6 to 0.6	1.000
Muscle mass (kg)	p = 0.102	BP vs C	0.1 (0.2)	−0.6 to 0.7	1.000
		PT vs C	0.5 (0.2)	−0.1 to 1.2	0.180
		NS vs C	0.2 (0.3)	−0.5 to 0.9	1.000
		PT vs NS	0.3 (0.2)	−0.3 to 1.0	1.000
		PT vs BP	0.5 (0.2)	−0.1 to 1.0	0.229
		NS vs BP	0.2 (0.2)	−0.3 to 1.0	1.000
Fat mass (kg)	p = 0.769	BP vs C	0.0 (0.6)	−1.5 to 1.6	1.000
		PT vs C	-0.5 (0.6)	−2.0 to 1.0	1.000
		NS vs C	-0.2 (0.6)	−1.8 to 1.4	1.000
		PT vs NS	-0.3 (0.6)	−1.8 to 1.2	1.000
		PT vs BP	-0.5 (0.5)	−1.9 to 0.9	1.000
		NS vs BP	-0.2 (0.6)	−1.7 to 1.3	1.000
Fat mass (%)	p = 0.486	PT vs NS	-0.1 (0.5)	−1.5 to 1.3	1.000
		PT vs BP	-0.7 (0.5)	−2.1 to 0.7	1.000
		NS vs BP	-0.3 (0.5)	−1.8 to 1.1	1.000
		BP vs C	-0.3 (0.6)	−1.8 to 1.2	1.000
		PT vs C	-0.5 (0.5)	−1.9 to 0.9	1.000
		NS vs C	-0.2 (0.6)	−1.7 to 1.3	1.000

Discussion

To our knowledge, this is the first study to investigate the effect of popular resistance training programs available in the health- and fitness industry, on muscle strength and body composition in overweight and obese women. The main findings were that twelve weeks of BodyPump neither changed maximal muscle strength, strength-endurance nor body composition, compared to non-exercising controls. Resistance training with a personal trainer was more effective to improve maximal strength in the lower body, compared to non-supervised resistance exercise, but no differences were found in strength-endurance nor body composition.

BodyPump failed to enhance both maximal muscle strength and strength-endurance, which indicates that the participants selected too low loads and/or did not reach muscular fatigue during the workouts (estimated training intensity was 12% of 1RM in squat and 16% in bench press). Since our participants trained under real-life settings, the workload was self-selected, and, thus, not influenced by the investigators. The participants followed general instructions from licensed BodyPump instructors, not involved or informed about the study. Both the personal trainer and non-supervised group had significantly higher training intensity than the BodyPump group. However, the BodyPump program is based on the ''rep-effect'' [10]. The idea is to exhaust the muscles while using light weights by performing a high number of repetitions and thereby provoke a strong motoneuron recruitement—as during heavy load resistance training [17]. A meta-analysis from 2014 [18] summarizes the evidence when comparing muscular adaptations between low- and high-load resistance training programs in untrained individuals. They conclude that a load $\leq$60% of 1RM increased muscle strength and hypertrophy, although less than heavier load. In addition, neither significant improvement in lean body mass nor decrease in fat mass was found in BodyPump, compared to non-exercising controls. This may also be due to the low training intensity, but also an unfortunate low adherence in the BodyPump group.

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Corresponding with the present study, Arikawa et al. [19] found highest adherence to resistance training (95.4%) in overweight individuals with one to one supervision. This suggests that supervised exercise may be especially beneficial and necessarily for adherence to exercise in overweight women [19]. Nevertheless, participation in a RCT is time-consuming, and three exercise sessions per week, may have been overwhelming for some of the participants. However, ACSM recommends traditional resistance training (60—80% of 1RM) 2—3 times a week [20], and Les Mills encourage members to practice BodyPump 2—3 times a week [10]. Orsatti et al. [21] have reported that one session weekly can increase muscle strength and muscle mass in overweight women, similar with two or three times a week. In the present study, 17 participants in the BodyPump group exercised at least one session a week, compared to 28 in the personal trainer group and 18 in the non-supervised group. Low adherence, as found in the BodyPump and non-supervised group, may still have limited the potential for successful outcomes.

Our findings in the BodyPump group is in contrast to Greco et al. in muscle strength, but confers with their findings in body composition [11]. Greco et al. investigated the effect of 12 weeks of BodyPump in 19 untrained female university students and found significant improvements (33%) in maximal strength in squat, compared to a non-exercising control group. However, in Greco et al. all exercise sessions were performed in a laboratory, which might have increased the adherence and training quality. Our findings are also in contrast to Nicholson et al. [12] who found significant improvements in 1RM leg press (13%) and bench press (14%), compared to controls, after 26 weeks of BodyPump in middle-aged and older adults. However, adherence in Nicholson et al. was 89%, compared to 58% in the present study, which may explain some of the differences in results. Nicholson et al. did not assess body composition. None of these studies included endurance training or had compared BodyPump in combination with endurance training, which might be necessarily to change body composition. Previous studies investigating the effect of 3 month of endurance training separately (cycle ergometer), compared to endurance training in combination with endurance strength training in obese women, found that the combination group significantly improved both body composition, physical capacity, as well as liver function [22,23].

Only a few studies have previously investigated the effects of resistance training with a personal trainer, but our result correspond with those reports: direct one to one supervision is beneficial for improving muscle strength [24—26]. Mazzetti et al. [24] compared linear periodized resistance training with and without a personal trainer for 12 weeks in recreationally trained men. They found that the personal trainer group had greater progression in the load lifted during training and improvements in 1RM. Storer et al. [25] investigated 12 weeks of non-linear resistance training on middle-aged men, and found that resistance with a personal trainer was beneficial to improve lean body mass and maximal muscle strength in the upper body. In a cross-sectional study, a group of women with personal trainer experience selected significantly higher training loads, compared to controls [26]. Greater progression of loads and better control over the lifting techniques might be important factors [24], and explain the benefits of supervised resistance training. Our findings support that higher training-loads results in larger improvements in 1RM, since the personal trainer group exercised with significantly higher loads in squat, compared to the non-supervised group (19.8 kg (SD 3.3), $p \geq 0.001$, 95% CI 11.7—27.9). No differences in training load or 1RM were seen between the groups in bench press. Based on our findings, we suggest that the personal trainer effects was a consequence of applying higher training loads during training.

In our study, the personal trainer group did not increase significantly in muscle mass compared to controls. Three outliers in the control group may explain this somewhat unexpected finding, as the majority in the personal trainer group (21 of 27 participants) increased total muscle mass assessed by Inbody. On the other hand, our results is in line with other studies, confirming that resistance training may give moderate to large effects on muscle strength in overweight and obese individuals, while changes in body composition seem more difficult to achieve [8,27,28].

There are strength and limitations of the present study that needs to be highlighted: use of a randomized controlled design, blinded assessments and strictly controlled inclusion and exclusion criteria's can be considered strengths. In addition, ecological validity was maintained because the interventions were performed in the context of a health- and fitness club, which represent the real world of the concepts of interest. All possible variables were standardized, and all participants in the personal trainer and non-supervised group followed the same standardized exercise program, based on the exercises in the BodyPump program. All personal trainers had the same background, and followed the same instructions regarding progression strategy, motivation and instructions. In addition, the partic-

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ipants were encouraged to continue their usual ADL and energy intake, and the study was conducted outside holiday periods.

A limitation in the present study is that we did not include familiarization session ahead of the 1RM test. To increase the validity and capture physiological changes in muscle strength over time, untrained individuals are recommended to perform 2—3 familiarization sessions before pretest [29,30]. However, all participants in the present study were given an oral instruction, demonstration and a test before pretest. Also, the study may have reduced power and increased risk of type 2 error [31] because of an unfortunate high loss to follow-up, which may have reduced our ability to detect statistically significant improvements in the BodyPump group. On the other hand, positive effects were found in the two other intervention groups on muscle strength and the attrition analysis showed no differences in any of the variables between completers and non-completers. Moreover, there were no differences between the groups at baseline. Finally, the study did not control for diet and activities of daily living, although participants were told not to change any lifestyle habits.

Conclusion

After 12 weeks of exercise in a health- and fitness setting, overweight and obese women exercising BodyPump did not improve muscle strength. Individual heavy load resistance training with and without a personal trainer effectively improved muscle strength, and a personal trainer amplified the effects on maximal muscle strength in squat. None of the groups changed body composition.

Disclosure

The study declare no conflict of interest, and no competing financial interests exist.

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