Impact of aerobic and resistance exercise combination on physical self-perceptions and self-esteem in women with obesity with one-year follow-up

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Running Head: OBESITY, EXERCISE, AND SELF-ESTEEM

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Abstract

The effectiveness of an exercise intervention including both aerobics and resistance training components in improving physical self-perceptions and global self-esteem in women with obesity was examined. An experimental design with a 1-year follow-up was used. Women with obesity (*n* = 72) participated in a structured exercise program for 12 weeks after being randomized into a control and an exercise group. Exercise self-efficacy, body attractiveness, physical strength, sport competence, physical condition, physical self-worth, and global self-esteem were measured at pre-intervention, early intervention, mid-intervention, immediately after the intervention, and five times following program termination at 1, 3, 6, 9 and 12 months, respectively. Analyses of covariance revealed exercise effects for all of the dependent variables except for body attractiveness. Generally, exercise effects lasted between six and 12 months. A 12-week physical exercise program including aerobic and resistance training components has the potential to improve physical self-perceptions and self-esteem in women with obesity.

Key words: exercise and self-esteem model, exercise self-efficacy, body image, physical self-concept

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Obese individuals are often subjected to negative stereotyping with the stigma of obesity being associated with low self-esteem and body-esteem, poor quality of life, and depressive symptoms (Friedman et al., 2005). With increase of obesity, weight stigma may be developed with the process of external devaluation leading to negative self-perception and negative self-evaluation (Ratcliffe & Ellison, 2015). This in turn, may lead to an internalized weight stigma. Processing self as a stigmatized individual may include negative self-judgments about the meaning of being an obese person, attentional and mood shifts, and avoidance and safety behaviors possibly accompanied by deregulated eating and weight management behaviors (Ratcliffe & Ellison, 2015). Weight loss, on the other hand, may lead to improvements in the aforementioned psychological outcomes while such improvements may in turn facilitate the maintenance of successful weight loss (Palmeira et al., 2009; Teixeira et al., 2010). Therefore, to better understand the mechanisms through which people may become obese, lose weight, and/or maintain reduced weight, a deeper understanding of the psychological correlates of obesity and weight loss is deemed important (Lasikiewicz et al., 2014).

Of the behavioral and/or dietary weight loss studies reviewed by Lasikiewicz et al. (2014), positive psychological improvements have generally emerged in self-esteem, depressive symptoms, body image, and health-related quality of life (HRQOL). Body image has been operationalized via the constructs of body dissatisfaction, appearance evaluation, body shape concerns, image avoidance, and body esteem (Lasikiewicz, 2014). For some outcomes such as self-esteem and reduced depressive symptoms, weight loss was positively but infrequently correlated with degree of psychological improvement while stronger and more systematic associations emerged with measures of body image and HRQOL

(Lasikiewicz, 2014). Therefore, the role of weight loss in experiencing psychological improvements in weight loss interventions and particularly for self-esteem and depressive symptoms remains inconclusive.

Despite the vital importance of exercise in the prevention of weight gain or maintenance of weight status or weight loss (Wuorinen, 2014), it is not clear yet, whether improvements in psychological outcomes might be attributed to exercise as a component of an intervention (Lasikiewicz et al., 2014). Indeed, Lasikiewicz et al. (2014) reported that only three studies have examined the isolated impact of exercise of which two studies found exercise to be ineffective (Imayama et al., 2011; Messier et al. 2010) while in one study improved psychological outcomes were observed in males only (Kiernan, King, Stefanick, & Killen, 2001). Specifically, exercise efficacy, body esteem, and global self-esteem have been measured by Messier et al. (2010) while esteem-related constructs have not been included in the other two studies by Imayama and Kiernan. Hence, given that the full range of constructs used in the EXSEM has not been examined in these studies, it is deemed important to investigate whether an exercise program that combines both aerobics and resistance training components may influence the full set of variables embedded in the EXSEM. Also, given that Kiernan et al. (2001) have demonstrated positive effects of exercise on a range of psychological outcomes (e.g., cognitive restraint, disinhibition, hunger, body dissatisfaction, symptoms of depression, anxiety, and stress) in men but not women, it is important to also examine whether such effects hold for women. Additionally, in contrast to existing studies where aerobic exercise only (Imayama et al., 2011; Kiernan et al., 2001) or resistance exercise only have been used (Messier et al., 2010), the efficacy of a combination of aerobic and resistance training exercise program in influencing EXSEM constructs has not been examined. Examining such an exercise combination is important as the extant literature as to the best type of exercise in improving body image remains inconclusive (Martin Ginis, Strong, Arent, Bray, & Bassett-Gunter, 2014). Martin Ginis et al. (2014) have demonstrated that either aerobic or strength-training exercise had significant influences on different measures of body image in young women with body image concerns. This might be the case because even a single strength-training session may provide individuals with immediate positive feedback about their capabilities and on progress and level of function (e.g., knowing the amount of weight one can lift). It may also make individuals aware of their bodies' level of functional capabilities leading to reduced emphasis on physical appearance (Martin Ginis et al., 2014). Further, aerobic exercise may also have effects as women perceive aerobic exercise to be more conducive to weight loss compared to other types of exercise. That is, women may become more satisfied with their bodies owing to engaging in a behavior that may alleviate concerns about being overweight (Martin Ginis et al., 2014).

Compelling reasons as to why physical self-perceptions are worthy of study as outcomes of exercise interventions include that physical self-worth as a global outcome of all salient physical self-perceptions has been strongly and consistently correlated at .7 with global self-esteem (Fox, 1997; Harter, 1996), and that aspects of physical self-perceptions have improved as outcomes of exercise interventions (Fox, 2000). Additionally, self-esteem has been considered a powerful indicator of mental well-being or adjustment while aspects of physical self-perceptions have been directly linked to mental well-being both in the general population (Sonstroem & Potts, 1996) and psychiatric populations (Van de Vliet et al., 2002), even after controlling for self-esteem. Furthermore, physical self-perceptions are more likely to be affected by exercise rather than global self-esteem (Elavsky, 2010; Gothe et al., 2011; McAuley, Mihalko, & Bane, 1997) given that it is considered a relatively stable theoretical construct (Robins, Trzesniewski, Tracy, Gosling, & Potter, 2002). Moreover, longitudinal studies of the links between exercise and self-esteem are scarce and particularly investigations including long-term follow-ups of individuals completing structured exercise programs (Elavsky, 2010). Given that levels of self-esteem attained as an outcome of participation in structured exercise programs tend to decrease either during or after program completion (McAuley, Blissmer, Katula, Duncan, & Mihalko, 2000), more longitudinal data are needed to evaluate the extent of such losses, and gain an understanding of how to minimize such reductions (Elavsky, 2010).

Exercise and Self-esteem Model

To trace the pathway via which exercise participation may influence levels of self-esteem, Sonstroem and Morgan (1989) developed the Exercise and Self-esteem Model (EXSEM) based on the proposition that self-concept is best studied as a collection of self-perceptions which are organized on hierarchical levels of specificity/generality (Shavelson, Hubner & Stanton, 1976). In EXSEM it is proposed that, within a vertical competence continuum, self-efficacies (SE) of individuals' abilities to perform specific sport training or exercise activities, generalize to broader perceptions of physical competence (Sonstroem, Harlow, & Josephs, 1994). In turn, perceived physical competence may affect levels of global self-esteem (GSE) which represents the highest, most general level within the model (Sonstroem et al., 1994). Self-efficacy is defined as the conviction that one can successfully execute the behavior which is assumed to lead to particular outcomes (Bandura, 1977). Self-esteem has been defined as the degree people feel positive about themselves (Gergen, 1971, p. 11).

In line with Sonstroem and Morgan (1989), characteristics of the EXSEM include that self-concept is hierarchically organized in terms of generality; that is, at lower levels, self-concept becomes more situation-specific, thus developing a greater correspondence with situational criteria compared to global self-concept. Stability is positively related to hierarchical levels of generality, that is, situation-specific constructs at the lower levels are more susceptible to influence from behavior and the environment compared to global self-concept at the apex of the hierarchy which is relatively stable. Additionally, self-concept is evaluative in nature and therefore provides a link to self-esteem. Finally, self-concept can be differentiated from similar constructs with which is theoretically related (Sonstroem & Morgan, 1989).

Based on an expanded EXSEM, Sonstroem et al. (1994) tested the validity of partitioning the perceived physical competence level into a general physical self-worth level (PSW) and a more specific multidimensional subdomain level as operationalized by the Physical Self-Perception Profile (PSPP: Fox & Corbin, 1989). The subdomain level included the constructs of perceived sport competence (SPORT), perceived physical condition (COND), perceived body attractiveness (BODY), and perceived physical strength (STREN) (Fox, 1990). Perceived sport competence is defined by perceptions of sport and athletic ability, ability to learn sports skills and confidence in the sports environment; perceived physical condition includes perceptions of level of physical condition, stamina, and fitness, ability to maintain exercise and confidence in the exercise and fitness settings; perceived body attractiveness is operationalized as perceptions of attractiveness of figure or physique, ability to maintain an attractive body, and confidence in appearance; and perceived physical strength includes perceptions of strength, muscle development and confidence in situations requiring strength (Fox, 1990). Physical self-worth is defined as general feelings of happiness, satisfaction, pride, respect and confidence in the physical aspect of the self (Fox, 1990).

In the expanded EXSEM (Figure 1), self-efficacy is posited to influence subdomain physical self-perceptions (i.e. SPORT, COND, BODY, and STREN) which in turn are assumed to affect PSW which in turn affects GSE (Sonstroem et al., 1994). In various studies support has emerged of the links between the variables included in the original EXSEM (Baldwin & Courneya, 1997; Levy & Ebbeck, 2005; Sonstroem & Morgan, 1989) and the expanded EXSEM (Elavsky, 2010; McAuley et al., 1997; McAuley et al., 2005; Noack, Kauper, Benbow, & Eckstein, 2013; Sonstroem et al., 1994) with PSW operating as a mediator of the links between subdomain perceptions and GSE.

*****Insert Figure 1 about here*****

Purpose of the Study and Hypotheses

Using the expanded EXSEM (Sonstroem et al., 1994) as a guide (Figure 1), the primary aim of the study was to examine the impact of an exercise intervention including both components of aerobic and resistance training on obese women's exercise self-efficacy, physical self-perceptions (i.e. subdomain perceptions and PSW), and GSE using an experimental design. A secondary aim of the study was to examine whether potential exercise effects would be maintained after completion of the exercise intervention for a period of 12 months. It was hypothesized that the exercise group would report increased levels of the EXSEM constructs compared to the control group participants who would not report increases. Given the need for long term assessment of correlates of weight loss in studies of weight management (Teixeira et al., 2004) and in order to achieve consistency with the 12-month time frames usually employed in studies of weight management (Barte, Veldwijk, Teixeira, Sacks, & Bemelmans, 2014), a 12-month follow-up was used. Hence, it was further explored whether EXSEM construct gains would be maintained for a period of 12 months after exercise program completion and whether they would be associated with changes in weight.

Method

Participants

A sample of 72 Greek Caucasian women with obesity was studied. The study participants were recruited from the Overeaters Anonymous twelve-step program that supports individuals with problems related to food including compulsive overeaters and persons with binge eating disorders. Inclusion criteria were age 18-64 years old, a BMI $\geq$ 30.0 Kg/m^2 and waist circumference (WC) $\geq$ 88 cm. Exclusion criterion was a lack of written permission by a medical doctor to participate in a 3-month aerobics and resistance exercise program. Of the 72 participants in total, 35 participants dropped out (48%) until the end of the 12-month follow-up measurements. Reasons reported for discontinuing participation included sickness, hypertension, discomfort with body appearance, vacation, moving to a different town (see Figure 2).

Procedures

Convenience sampling was used. Contact with the participants was made by the first author in the location where anonymous overeaters had their group meetings after verbal permission had been granted by the director of the program. Individuals with obesity were contacted, were provided with the details of the research study, and were asked to participate in a study where they would attend a 3-month exercise program and also report on questionnaires their perceptions about exercise. University ethics committee approval for the study was secured and willing participants provided written consent for participation while APA research guidelines were adhered to. An initial assessment took place measuring participants' age, height, weight, waist circumference, hip circumference, weekly frequency of strenuous, moderate, and mild exercise, and the variables of exercise self-efficacy, physical self-perceptions, and global self-esteem. After the initial assessment, random allocation to the groups took place (Figure 2) followed by initiation of the intervention. Participants were randomly allocated either to the control (no exercise) or the experimental (exercise) group using simple randomization.

***** Insert Figure 2 about here *****

Participants belonging to the experimental group attended the exercise program in a single group, three times per week, for a total of 12 weeks. In sum, participants attended 36 exercise classes over a period of three months. The dependent variables were measured over nine occasions. Questionnaires were completed before initiation of the exercise program (Time1), before the third exercise class (Time2), in the middle of the exercise program period (Time3) (i.e., before class #19), one day after the end of the exercise program (Time4), and five times additionally at 1, 3, 6, 9, and 12 months after termination of the exercise intervention to assess the extent to which potential exercise effects might be maintained. The exercise program was implemented from April 2011 to June 2011. The maintenance period assessments spanned June 2011 to July 2012. Participants in the control group did not participate in any type of intervention during the study period; however, they were provided the opportunity to participate in a similar exercise program after the end of the maintenance period. Adherence to the program was monitored by the first author who was present in each exercise class and kept records of participants' attendance and participation in the class. Contact information had been gathered from all participants. The dependent variables were measured by the first author during the nine assessments along with exercise possibly undertaken above and beyond exercise participation in the context of the intervention and during the follow-up measurements. Such exercise behavior was included as covariate in the analyses of covariance to control for its possible influence on the findings.

Measurement Tools

Demographic and anthropometric variables were assessed such as participants' age, height, weight, waist circumference, hip circumference, and weekly frequency of mild, moderate, and strenuous exercise. Further, participants' exercise self-efficacy was assessed along with physical self-perceptions and global self-esteem.

Exercise self-efficacy. Women's levels of self-efficacy for completing a group-based exercise program (EXSE) was measured using six items following Bandura's (2006) guidelines for constructing self-efficacy scales; three items measuring the extent to which participants felt confident that they could complete an aerobics program and three items referring to completing a resistance training program "if they wanted to" (Williams, 2010). The three items relative to aerobics exercise corresponded to participation in an aerobics exercise program lasting either for 10 min, 20 min, or 30 min, respectively. The phrase "if you wanted to" was added to the items to control for the effects of outcome expectancy on self-efficacy ratings (Rhodes & Blanchard, 2007; Williams, 2010). Using the stem "How confident are you that you can complete the following exercise program if you wanted to?" participants provided their confidence ratings on items such as "In an aerobics exercise program lasting for 10 min", "In an aerobics exercise program lasting for 20 min" etc. The three resistance training items referred to a 20 min resistance training program using weights of either 1.0 kg, 1.5 kg or 2.0 kg using upper body. Hence, for resistance training, sample items included "In a 20min resistance training exercise program using weights of 1 kg", "In a 20min resistance training exercise program using weights of 1.5. kg" etc. Participants reported their degree of confidence relative to each item on a 0% ("*not at all certain can do*") to 100% ("*completely certain can do*") scale with 50% anchored by "*moderately certain can do*" (Bandura, 2006). The six confidence scores (three scores for aerobics and three scores for resistance training) were summed and divided by the total number of items resulting into a possible score range of 0-100. Cronbach's alpha values for the present sample ranged for total exercise self-efficacy .96-.99.

Physical self-perceptions. The extent to which women held favorable perceptions of their physical self was measured via a short form of the Physical Self-perception Profile (PSPP) (Fox & Corbin, 1989) which was developed based on responses of Greek adults, men and women (PSPP-SF) (Vlachopoulos, Leptokaridou, & Fox, 2014). The PSPP measures the extent to which participants hold favorable perceptions of their sport competence (SPORT) (e.g., "Some people feel that they are among the best when it comes to athletic ability BUT others feel that they are not among the most able when it comes to athletics”); physical condition (COND) (e.g., “Some people make certain they take part in some form of regular vigorous physical exercise BUT others don’t often manage to keep up regular vigorous physical exercise”); body attractiveness (BODY) (e.g., “Some people feel that compared to most, they have attractive bodies BUT others feel that compared to most, their bodies are not quite so attractive”); and physical strength (STREN) (e.g., “Some people feel that they are physically stronger than most people of their sex BUT others feel that they lack physical strength compared to most others of their sex”). Additionally, general perceptions of physical self-worth (PSW) are assessed (e.g., “When it comes to the physical side of themselves, some people do not feel very confident BUT others seem to have a real sense of confidence in the physical side of themselves”). PSW is conceptualized as a global measure deriving from weighted combinations of self-perceptions in the four physical subdomains of SPORT, COND, BODY and STREN. PSW is held to function as a superordinate construct situated between subdomain self-perceptions and global self-esteem, and its’ validity has been established in a number of studies including samples of middle-age adults (Sonstroem, 1998) and individuals with mental illness (Van de Vliet et al., 2002). This particular short form presently used measured each construct via four rather than six items of the original long form PSPP. Responses were provided on a 4-point structured alternative response format on which participants firstly chose between two contrasting descriptions of people and then indicated whether the description they chose was “sort of true” or “really true” for them. Favorable psychometric evidence for this short form has emerged with Greek adults regarding the factor structure tested via confirmatory factor analysis (CFA) (robust Comparative Fit Index = .933; robust Root Mean Squared Error of Approximation = .058) with item loadings ranging .61 - .82 (Vlachopoulos et al., 2014). Cronbach’s alpha values for the present sample ranged across the nine measurements for SPORT .89-.93, COND .77-.89, BODY .80-.87, STREN .90-.93 and PSW .87-.90.

Global self-esteem. Levels of global self-esteem were measured using the Rosenberg Self-esteem Scale (RSE) (Rosenberg, 1979). The RSE comprises 10 items five of which are positively worded and five items negatively worded. Higher scores indicate higher self-esteem. All items were rated on a 4-point Likert scale anchored by 1 (“strongly agree”), 2 (“agree”), 3 (“disagree”) and 4 (“strongly disagree”). Sample items include “I feel I do not have much to be proud of” and “I feel that I have a number of good qualities”. Favorable psychometric evidence has emerged in terms of internal consistency, concurrent, predictive, and construct validity using known groups, and test-retest reliability (Rosenberg, 1979). A Cronbach’s alpha value has been reported of .80 in a sample of 609 Greek adults with an alpha of .79 for men and .81 for women (Vlachopoulos et al., 2014). Presently RSE alpha values ranged across the nine measurements .91-.93.

Self-reported exercise behavior. To measure self-reported weekly frequency of exercise outside the context of the exercise intervention, the Godin Leisure Time Exercise Questionnaire (GLTEQ) (Godin & Shephard, 1985) was used. The GLTEQ was used to measure exercise possibly undertaken before initiation of the exercise intervention, and during the study, above and beyond the exercise undertaken in the context of the intervention, by all participants. Appropriate verbal instructions were provided to the participants. Responses were provided to three questions measuring the frequency of strenuous, moderate, and mild exercise performed for a minimum of 15 min in a typical week. The item asking information on the frequency of exercise that takes place at moderate-to-vigorous intensity was not used, as this type of information was obtained analytically by using the first three items. Validity evidence for the scale scores has been obtained via correlations of the GLTEQ scores with objective indicators of exercise and physical fitness (e.g., exercise monitor and maximal aerobic capacity test scores; Jacobs, Ainsworth, Hartman, & Leon, 1993). The measures of physical self-perceptions, global self-esteem, and leisure time exercise behavior were translated into Greek using the back translation procedure (Brislin, 1986).

Description of the Exercise Program

The first part of the exercise program comprised some form of low impact aerobic exercises. Generally, the warming up part of the program (10 min) comprised low impact aerobic exercises without bouncing to ensure protecting participants' joints. This part included exercises such as marching in place, tapping forward-backwards, diagonally-backwards, front heel touches, and side touches. After some active stretching of the leg muscles in a standing position, the main part of the program (20 min) included basic low impact aerobics steps such as step touch, double step touch, knees up, double knee up, repeaters, heels back, double heel back, three steps and knee forward and backward, side lunges, lunges back, double lunges, v-step, mambo step, box step, and front, side, and back kicks. The strengthening program comprised exercises using the body weight and resistance exercises using light weights. This part included different versions of squats using only the body weight or using light weights, and exercises at different positions of the body such as exercises lying down on the back and standing on knees. The cooling down part of the program included static stretching exercises sitting or lying down on the back on the exercise mat. This part began with a few calm breaths and then stretching exercises were performed for the whole body muscles starting from legs and moving toward the upper body muscles.

Data Analysis

There was 46% attrition in the control group (19 participants remained out of 35 at T9 assessment) and 52% attrition in the exercise group (18 participants remained out of 37 at T9 assessment). Analyses were performed using last observation carried forward (LOCF). The intent-to-treat principle was followed by including all randomized participants in the analyses. Cronbach's alpha values were calculated along with descriptive statistics and Pearson's correlations based on Time1 EXSEM scores. Baseline characteristics (i.e., age, frequency of exercise, BMI, and waist-to-hip ratio) and EXSEM constructs were compared across participants who completed or not the study, and between the control and experimental groups using independent samples t-tests. Chi-square tests were also computed to examine the association of membership in the control and experimental group with demographic categorical variables (i.e., study completion, marital status, education). Correlations of EXSE, SPORT, COND, BODY, STREN, PSW, and GSE scores were computed with age, exercise frequency, baseline BMI, and waist-to-hip ratio. Additionally, EXSEM score differences were examined between study completion, marital status, and education level groups using independent samples t-tests. Baseline characteristics that were significantly correlated with dependent variable scores were included as covariates in the subsequent analyses of variance testing the interactions of 2 (control versus exercise) x 9 (time) ANCOVA for each one of the dependent variables. Bonferroni post hoc tests were used to examine mean differences across groups and measurements.

Additionally, regression analyses were used to examine tenets of the EXSEM model regarding (a) the mediating role of Time 3 subdomain perceptions in the prediction of Time 4 PSW by Time 2 exercise self-efficacy, and (b) the mediating role of Time 3 PSW in the prediction of Time 4 GSE by Time 2 subdomain perceptions. Responses were used from the repeated assessments (i.e., T2, T3, and T4 points during the exercise intervention). Mediation analyses were performed on the whole sample including both the control and experimental groups. Preacher and Hayes' (2008) bootstrapping procedure was used to derive estimates of direct and indirect effects for the mediation models. This procedure involved bootstrapping, which is a non-parametric re-sampling procedure, to estimate the size of the indirect effects using adjusted confidence intervals. This approach is particularly important for multiple mediation models in order to examine not only whether an indirect effect exists, but also which mediators contribute to the effect. The analysis was performed using SPSS 22.0 with Preacher and Hayes' INDIRECT.SPS macro. Here, 95% confidence intervals were used and 1000 bootstrapping resamples were run. Further, the confidence intervals were adjusted for bias and the contrasts between the significant indirect effects were examined.

Results

Sample Description

The sample comprised 72 women aged 19 to 53 yr (*M* = 32.47 yr, *SD* = 8.02). Their height ranged 150 to 182 cm (*M* = 166.63 cm, *SD* = 6.88) and their weight ranged 73 to 132 kg (*M* = 101.41 kg, *SD* = 15.20). BMI values ranged 30.10 to 47.25 (*M* = 36.47, *SD* = 4.67), WC ranged 92 to 142 cm (*M* = 110.18 cm, *SD* = 12.88), and hip circumference (HC) ranged 109 to 157 cm (*M* = 126.87cm, *SD* = 12.41). Waist to hip ratio (WHR) ranged 0.70 to 1.05 (*M* = 0.86, *SD* = .07). In terms of frequency of exercise participation, 63 women reported no participation in exercise (87.5%) while nine reported participating in exercise 1-5 times per week (12.5%); regarding education, 34 participants (47.2%) had not obtained a college degree while 38 (52.8%) did so; regarding partnership, 52 women (72.2%) reported not having a partner while 20 (27.8%) reported having a partner; in regard to study completion, 37 participants (51.4%) completed all study measurements while 35 women (48.6%) did not complete all study measurements. Detailed demographic and anthropometric characteristics are reported separately for the control and experimental groups in Table 1.

*****Insert Table 1 about here*****

Cronbach's Alphas and Pearson's Correlations Between EXSEM Constructs

All alpha values for all EXSEM constructs and all nine measurement occasions were greater than .70 (α values ranged .77 to .98). Mean scores were generally average in magnitude for all baseline constructs (Table 2). In terms of Pearson's correlations, between the baseline EXSEM constructs, correlations were positive and substantial in magnitude ranging .43 - .81. That is, EXSE was positively correlated with PSPP subscales and GSE (Table 2). PSPP subscales were positively inter-correlated, and positively correlated with GSE (Table 2).

*****Insert Table 2 about here*****

Group Differences on Baseline Characteristics and EXSEM Constructs

Baseline questionnaire data were available from 72 participants. No significant differences existed on baseline EXSEM variables between those who completed vs. did not complete the study (all p values > .05) using Bonferroni adjustment (p =.007). Further t-tests between the same groups on the demographic and anthropometric variables of age, exercise frequency, BMI, and waist-to-hip ratio using Bonferroni adjustment (p = .01) revealed no significant differences. Independent samples t-tests using Bonferroni adjustment (p = .01) revealed no differences between the control and experimental groups on age, exercise frequency, BMI, and waist-to-hip ratio (all p values > .05). Also, no differences existed for any of the EXSEM constructs (all p values > .05) using a Bonferroni adjustment (p = .007). Chi-square tests using a Bonferroni adjustment (p = .01) examining the association of group membership in control/experimental groups with the categorical variables of study completion (did not complete study/completed study), marital status (no partner/with partner) and education level (no college degree/college degree) revealed no associations between the variables (all p values > .05).

Links of Baseline EXSEM Scores with Demographic Variables

Pearson's correlations of EXSEM constructs with age, exercise frequency, BMI, and waist-to-hip ratio revealed significant negative correlations of age with exercise self-efficacy, BODY, COND, and GSE. Exercise frequency was positively correlated with exercise efficacy, SPORT, and GSE. BMI was negatively correlated with all of the EXSEM constructs. Waist-to-hip ratio was negatively correlated with exercise efficacy, COND, and GSE (Table 2). Further, no EXSEM score differences emerged between partner groups and educational level groups (all p values > .007 after Bonferroni adjustment for each one of the categorical variables).

Correlations of Weight Change with Changes in EXSEM Constructs

Reduction in weight between T1 and T9 assessments for the control group was 1.47 Kg (SD = 2.34) while for the exercise group was 7.77 Kg (SD = 10.89). Pearson’s correlations revealed significant associations of weight change (residual scores) with changes in EXSEM constructs (residual scores) between T1 and T9 measurements. The correlations of weight change were $r = -.57$ ($p < .001$) with exercise self-efficacy, $r = -.48$ ($p = .002$) with SPORT, $r = -.52$ ($p = .001$) with BODY, $r = -.69$ ($p < .001$) with COND, $r = -.45$ ($p = .004$) with STREN, $r = -.56$ ($p < .001$) with PSW and $r = -.50$ ($p = .001$) with GSE. That is, reduced weight corresponded to increased EXSEM scores.

Intervention Effects on EXSEM Constructs

Repeated measures 2 (control versus exercise) x 9 (time) ANOVAs with covariates were calculated for each of the EXSEM construct as the dependent variable. The variables of age, BMI, waist-to-hip ratio, weekly frequency of moderate and strenuous exercise above and beyond the exercise intervention possibly undertaken, and weight change between T1 and T9 assessments were used as the covariates in all the analyses. Weight change was calculated as residual scores by regressing T9 weight on T1 weight scores. The statistical power of the study was 0.41. Despite that the interaction ‘group x time’ effects were of interest, main effects for group and time are also presented.

Findings adjusted for covariates. Significant interaction ‘group x time’ terms emerged for the dependent variables of EXSE [$F(8, 224) = 13.54$, $p < .001$, partial eta squared = .32], SPORT [$F(8, 224) = 6.59$, $p < .001$, partial eta squared = .19], COND [F (8,

224) = 13.86, p <.001, partial eta squared = .33], STREN [F (8, 224) = 6.25, p <.001, partial eta squared = .18], PSW [F (8, 224) = 2.61, p = .009, partial eta squared = .08], and GSE [F (8, 224) = 2.30, p = .021, partial eta squared = .07] but not for BODY [F (8, 224) = 1.84, p = .069, partial eta squared = .06].

Main effects for group were for EXSE [F (1, 28) = 6.32, p = .017, partial eta squared = .18], SPORT [F (1, 28) = 1.90, p = .178, partial eta squared = .06], COND [F (1, 28) = 4.00, p = .055, partial eta squared = .12], STREN [F (1, 28) = 0.69, p = .412, partial eta squared = .02], BODY [F (1, 28) = 0.24, p = .623, partial eta squared = .00], PSW [F (1, 28) = 0.24, p = .622, partial eta squared = .00], and GSE [F (1, 28) = 0.40, p = .531, partial eta squared = .01]. Main effects for time were for EXSE [F (8, 224) = 2.50, p = .012, partial eta squared = .00], SPORT [F (8, 224) = 1.44, p = .180, partial eta squared = .04], COND [F (8, 224) = 1.27, p = .256, partial eta squared = .04], STREN [F (8, 224) = 1.38, p = .204, partial eta squared = .04], BODY [F (8, 224) = 0.32, p = .957, partial eta squared = .01], PSW [F (8, 224) = 0.35, p = .941, partial eta squared = .01], and GSE [F (8, 224) = 1.22, p = .286, partial eta squared = .04].

Regarding the interaction terms, and given the values of .01, .06 and .14 representing a small, medium, and large effect size for partial η^2 respectively (Richardson, 2011), large effect sizes emerged for EXSE, SPORT, COND, and STREN. Effect sizes close to medium emerged for PSW and GSE. In relation to main effects for group, a large effect size emerged for EXSE. All effect sizes for time were weak.

Compared with controls, the exercise group reported increased perceptions of EXSE immediately after two exercise classes with a further increase noted at the middle of the program. BMI was a significant covariate. Perceptions of SPORT and COND increased at the middle of the intervention and even further at the end of the intervention (Table 3; Figure 3). For SPORT, significant covariates were BMI and moderate and strenuous exercise. For

COND, BMI was a significant covariate. Perceptions of STREN, PSW, and GSE increased significantly at the end of the exercise intervention (Table 3; Figure 3). For STREN, BMI and moderate exercise were significant covariates. For PSW and GSE, BMI was a significant covariate. No change was observed for BODY in the exercise group. BMI emerged as a significant covariate. A significant increase was noted for BODY in the control group between T1 and T9 assessment, however, corresponding to a small effect size (d = .15).

After termination of the intervention, perceptions of EXSE were found to decrease at the 6-month post-intervention assessment. Perceptions of COND declined 1 month immediately after termination of the intervention, and were further reduced at the 6-month post-intervention assessment. Perceptions of SPORT were found to decrease at the 9-month post-intervention assessment. Perceptions of STREN were found to decline at the 12-month post-intervention assessment. PSW and GSE remained stable after termination of the intervention for 12 months. No change was observed for BODY after termination of the intervention.

*****Insert Table 3 about here*****

*****Insert Figure 3 about here*****

Unadjusted models. Regarding unadjusted models, a significant increase was observed for EXSE after two exercise classes and further at the middle of the program in agreement with the adjusted model. An increase was found for SPORT and COND both in the middle and the end of the intervention similarly to the adjusted models. Unadjusted findings for STREN revealed an increase at mid-intervention and even more at the end of the intervention in contrast to adjusted findings where an end-of-intervention increase was found only. It may be that reduced BMI values over the course of the intervention have facilitated increased perceptions of STREN while such an increase in STREN was not found when effects of BMI were statistically controlled for. For PSW, an increase at the end of the intervention was noted similarly to adjusted findings. For GSE, increases were noted both in the middle and at the end of the intervention compared to adjusted findings showing an increase at the end of the intervention only. Once again, it seems that a lowered BMI in the middle of the intervention may have facilitated an increase of GSE scores that was not evident when BMI effects were controlled for. The potential role of BMI in the present unadjusted models may also be supported by correlational analyses showing systematic inverse associations of weight changes with changes in EXSEM scores.

Testing the EXSEM Using Mediation Analyses

Subdomain perceptions as mediators. Using multiple mediator models, the first mediated effect model tested the four sub-domain self-perceptions at Time 3 as mediators of the associations between self-efficacy at Time 2 and physical self-worth at Time 4. Summaries of the results are presented in Table 4 and Figure 4. The total effect of self-efficacy on physical self-worth (β = .49) was significant, t = 4.76, SE = .10, p < .0001. However, the direct effect of self-efficacy on physical self-worth (β= .13) was not significant, t = 1.38, SE = .10, p > .10. The path coefficients and p values for this multiple mediator model are presented in Figure 4.

Self-efficacy predicted all sub-domain self-perceptions in a positive direction (Figure 4). Of the mediators, only body perceptions directly predicted physical self-worth. In terms of indirect effects, only body perceptions were significant (indirect effect = .21). The pair-wise contrasts associated with this indirect effect were non-significant, suggesting that the magnitude of the effects was comparable. Overall, the model accounted for 64% of the variance in physical self-worth.

*****Insert Table 4 and Figure 4 about here*****

Physical self-worth as mediator. The second model examined the mediating role of physical self-worth at Time 3 between the sub-domain self-perceptions at Time 2 and global self-esteem at Time 4. The results of the bootstrapping procedure are presented in Table 5 and Figure 5. The total effect of sport competence on global self-esteem (controlling for the remaining sub-domain perceptions) was not significant (β= .25, t = 1.78, SE =.14, p>.05). However, the total effect of body perceptions on self-esteem was significant (β=.24, t = 1.97, SE =.12, p =.05). The total effects of perceptions about physical condition and strength on global self-esteem were not significant (physical condition: β=.16, t = 1.01, SE = .15; p> .05; strength: β= .10, t = .83, SE = .12, p> .05). None of the direct effects from sub-domain self-perceptions on global self-esteem were significant (sport competence: β=.21, t = 1.54, SE=.14; p> .05; body perceptions: β=.08, t = .52, SE = .16, p> .05; physical condition: β=.13, t = .87, SE = .15, p> .05; strength: β=.05, t = .40, SE = .12, p> .05). Figure 5 presents the path coefficients, and p values for this model. Perceptions of body attractiveness and strength predicted physical self-worth, both in positive directions (Figure 5). Physical self-worth failed to significantly predict global self-esteem and none of the indirect effects were significant. The model accounted for 37% of the variance in global self-esteem.

*****Insert Table 5 and Figure 5 about here*****

Discussion

In the present study, the efficacy of an exercise intervention including both aerobics and resistance training components was examined in improving the constructs embedded in the expanded EXSEM (Sonstroem et al., 1994) in a sample of women with obesity. The extent to which possible exercise effects are maintained in the long term was also examined. The findings generally supported the first hypothesis showing that participation in the three-month aerobics and resistance exercise combination led to increased levels for all of the dependent variables except perceptions of body attractiveness. Increases were noted for exercise self-efficacy, sport competence, physical strength, physical condition, physical self-worth, and global self-esteem. Hence, participation in a 3-month exercise program involving both aerobics and resistance training components has the potential to improve physical self-perceptions, and to a lesser extent physical self-worth and global self-esteem in women with obesity. It has to be noted that while exercise effects for exercise efficacy and subdomain perceptions (i.e. sport competence, physical condition, physical strength) were considerable in magnitude, effects for physical self-worth and global self-esteem were weaker.

Lasikiewicz et al. (2014) have reported three studies examining the isolated impact of exercise on psychological outcomes. In two of these studies, it was concluded that exercise was ineffective in improving psychological outcomes (Imayama et al., 2011; Messier et al. 2010) while in one study improved psychological outcomes were found in males only (Kiernan et al., 2001). However, in these studies the full set of constructs embedded in the EXSEM had not been measured. Rather, exercise efficacy, body esteem, and global self-esteem had been measured by Messier et al. (2010) while esteem-related constructs had not been included in the other two studies. Hence, the present study adds to the extant literature information as to whether an exercise program that combines both aerobics and resistance training components may enhance the full set of variables embedded in the EXSEM. It also contributes to the extant literature by revealing that such effects hold for women with obesity, hence, complementing the study by Kiernan et al. (2001) who demonstrated positive effects of exercise on psychological outcomes (e.g., cognitive restraint, disinhibition, hunger, body dissatisfaction, symptoms of depression, anxiety, and stress) in men. It also contributes to the extant literature by examining the efficacy of a combination of aerobic and resistance training exercise program in contrast to existing studies where aerobic exercise only (Imayama et al., 2011; Kiernan et al., 2001) or resistance exercise only were used (Messier et al., 2010). The present findings support the use of a combined aerobic and resistance exercise program in improving physical self-perceptions embedded in the EXSEM. Overall, the findings are in agreement with findings by Kiernan et al. (2001) where positive psychological effects were observed due to exercise and in contrast to findings of Imayama et al. (2011) and Messier et al. (2001) where no exercise effects were observed.

In terms of maintenance of the exercise effects after termination of the exercise program, perceptions of increased exercise efficacy remained stable for at least six months; perceptions of increased sport competence remained stable for at least nine months; perceptions of physical strength remained stable for at least 12 months; and perceptions of physical condition remained stable for one month after exercise program termination. The medium-sized effects for physical self-worth and global self-esteem remained stable for at least 12 months. Overall, considerable stability has emerged for the increased perceptions of exercise efficacy, sport competence, and physical strength along with the weaker effects for physical self-worth and global self-esteem but not for physical condition. The considerable stability of the present effects adds to the value of using a combined aerobics and resistance training exercise program to improve the EXSEM constructs in women with obesity.

The present lack of strong exercise influence on physical self-worth and global self-esteem may be partly attributed to the insufficiency of the exercise intervention to influence perceptions of body attractiveness. Indeed, strong and consistent correlations of perceived body attractiveness with physical self-worth (Sonstroem et al., 1994) and global self-esteem in children, adolescents, and adults (Harter, 1990) have been reported elsewhere. It seems that participation in a 3-month exercise program involving both aerobics and resistance training components is not enough to cause improvements in perceptions of body attractiveness in women with obesity. Therefore, longer exercise interventions might be tested to examine their efficacy in improving perceptions of body attractiveness in women with obesity.

Exercise, Weight Loss, and EXSEM Constructs

Weight changes have been systematically associated with changes in all of the EXSEM constructs, that is, exercise self-efficacy, sport competence, body attractiveness, physical condition, physical strength, physical self-worth, and global self-esteem. That is, reduced weight was inversely correlated with enhanced perceptions of the EXSEM constructs. Effects of the exercise intervention on EXSEM constructs were also found after controlling for changes in women's weight between the baseline and the end-of-study assessment with body mass index being a significant covariate in all analyses of variance findings. It may be the case that participation in an aerobic and resistance exercise program may lead to improvements in physical self-perceptions and global self-esteem that are independent of weight changes. Indeed, in a number of studies it has been concluded that exercise may influence aspects of physical self-perceptions (Fox, 2000). However, weight change was also associated with changes in all of the EXSEM constructs. Indeed, Jung and Chang (2014) found that adults with obesity experienced more frequently mentally unhealthy days compared to adults with normal weight. This link was stronger in women than men. Additionally, Magallares and Pais-Ribeiro (2014) have concluded in a meta-analysis that women with obesity reported less mental health compared to normal weight women. Further, reduced weight seems to be linked with improved body image and body esteem in women as research has revealed lower self-esteem for obesity samples in comparison to non-clinical populations (Abiles et al., 2010). Self-esteem is considered an important indicator of mental well-being and adjustment while aspects of physical self-perceptions have been directly linked with mental well-being, even after controlling for self-esteem, with these associations holding both in the general (Sonstroem & Potts, 1996) and psychiatric populations (Van de Vliet et al., 2002).

Further, body image has been implicated in the dynamics of weight reduction in weight loss interventions with research showing reciprocal relationships between changes in weight and body image while weight changes have partially explained effects of behavioral obesity treatment on quality of life and self-esteem (Palmeira et al., 2009). Also, data have proved a predictive role of short-term changes in body size dissatisfaction and self-esteem on long-term weight loss (Palmeira et al., 2010). The present associations of weight change with changes in EXSEM constructs are in line with findings by Palmeira et al. (2009) who demonstrated associations of changes in body dissatisfaction, body attractiveness, and mood disturbance with weight change. Additionally, Teixeira et al. (2006) found associations of body shape concerns, physical self-worth, and body attractiveness with weight outcomes. Given these associations, the delineation of the links of body image with EXSEM constructs would be an important avenue for further research leading to a better understanding of the dynamics involved in weight loss. Body image components include assessments of body size dissatisfaction, affective, cognitive and behavioral dimensions of body shape, and dimensions of physical self-concept such as physical self-worth and body attractiveness (Palmeira et al., 2009). For instance, it may be that the weak effects of the present exercise intervention on body attractiveness compared to the other aspects of physical self-perceptions may also be influenced by the construct of body image. That is, it may be required that the intervention positively influences aspects of body image for improvement in perceptions of body attractiveness to occur. That is, one may possibly report greater body attractiveness if body size and body shape dissatisfaction are reduced. Similarly, the role of body esteem (Franzoi & Shields, 1984) should also be investigated in relation to perceptions of body attractiveness and self-esteem.

Validity of the Exercise and Self-Esteem Model

Partial support was obtained based on the present data in favor of the expanded EXSEM (Sonstroem et al., 1994). In regard to the mediating role of subdomain physical self-perceptions in the link between exercise self-efficacy and physical self-worth, it was found that it was perceptions of body attractiveness only that mediated this link. Despite the significant effects of exercise self-efficacy on all four subdomain perceptions, it was only body attractiveness that significantly and substantially predicted subsequent physical self-worth scores. This finding is in agreement with other studies that examined the validity of the EXSEM tenets in middle-aged women (Elavsky, 2010) and older adults (McAuley et al., 2000). In these studies it had been demonstrated that perceptions of physical condition and body attractiveness mediated the relationship of exercise self-efficacy with physical self-worth and global self-esteem. The present finding may be explained by the increased importance attached by women to body attractiveness as a central determinant of physical self-worth and potentially global self-esteem. The present finding may be explained by the strong and systematic associations of perceptions of body attractiveness found with physical self-worth (Sonstroem et al., 1994) and global self-esteem (Harter, 1990).

In regard to testing the second aspect of the EXSEM, i.e. the mediating role of physical self-worth in the link of subdomain perceptions with global self-esteem, only body attractiveness and perceived strength had a substantial relationship with subsequent physical self-worth. However, physical self-worth did not significantly predict global self-esteem despite its substantial regression coefficient, and hence no mediation could formally be inferred. Despite the lack of a significant impact of physical self-worth on global self-esteem, which may be due to the low power of the regression analyses owing to the small sample size, a path was discerned leading from body attractiveness to physical self-worth and from physical self-worth to global self-esteem. Such a path is in line with the mediating role posited for physical self-worth in the link between subdomain perceptions and global self-esteem (Sonstroem et al., 1994), and highlights the importance of body attractiveness in the present sample of women with obesity. The present findings are important as they expand the validity database of the EXSEM in women with obesity. In sum, the EXSEM seems to be a viable framework to explain the effects of exercise on physical self-perceptions and global self-esteem of women with obesity.

Limitations and Future Directions

The present findings are limited to Greek adult women with obesity and the context of a three-month exercise program including both aerobic and resistance components. The findings should be interpreted in the context of small sample size which may have led to reduced statistical power with implications on the interpretation of the validity of the EXSEM in this population. Further, the levels of attrition might have an impact on internal and external validity of the study; however, attrition is frequent in studies of weight loss (Anderson, Konz, Frederich, & Wood, 2001). Regarding the meaningfulness of scores from measures of exercise self-efficacy that were constructed in line with Bandura's (2006) guidelines, and despite the fact that these measures were not an outcome of translation, the patterns of present findings supported properties of reliability and validity of these measures. Further, regarding the measures of physical self-perceptions, global self-esteem, and leisure time exercise behavior for which good psychometric properties have been obtained with English-speaking populations, the pattern of the present findings and the present psychometric results provide increased confidence for score validity.

In future research a longer exercise intervention may be used given that the exercise program did have effects on particular subdomain perceptions but not all of them such as body attractiveness. Further, the exercise program characteristics might be determined that may be more appropriate to lead not only to effective weight loss but also to enhanced positive psychological outcomes. Also, the present study might be replicated using a larger sample size to enable enhanced statistical power. Overall, it seems that physical exercise has the potential to contribute to increased levels of the expanded EXSEM constructs in women with obesity, and more studies are deemed warranted to better understand positive psychological outcomes in behavioral weight loss interventions.

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Figure Captions

Figure 1. The exercise and self-esteem model tested in the present study.

Figure 2. Participant flowchart.

Figure 3. Graphs depicting mean levels of EXSEM variables for each of the control and experimental groups separately for women with obesity. Black lines represent the control group; grey lines represent the experimental group.

Figure 4. Results of mediation analyses of the EXSEM. Coefficients represent effects of self-efficacy on sub-domain self-perceptions and physical self-worth. SPORT = perceived sport competence; BODY = perceived body attractiveness; COND = perceived physical condition; STREN = perceived physical strength; PSW = physical self-worth. T2 = Time 2; T3 = Time 3; T4 = Time 4. ** $p < .01$.

Figure 5. Results of mediation analyses of the EXSEM. Coefficients represent effects of sub-domain self-perceptions on physical self-worth and global self-esteem. SPORT = perceived sport competence; BODY = perceived body attractiveness; COND = perceived physical condition; STREN = perceived physical strength; PSW = physical self-worth; GSE = global self-esteem. T2 = Time 2; T3 = Time 3; T4 = Time 4. *$p < .05$, **$p < .01$.

Fig. 1

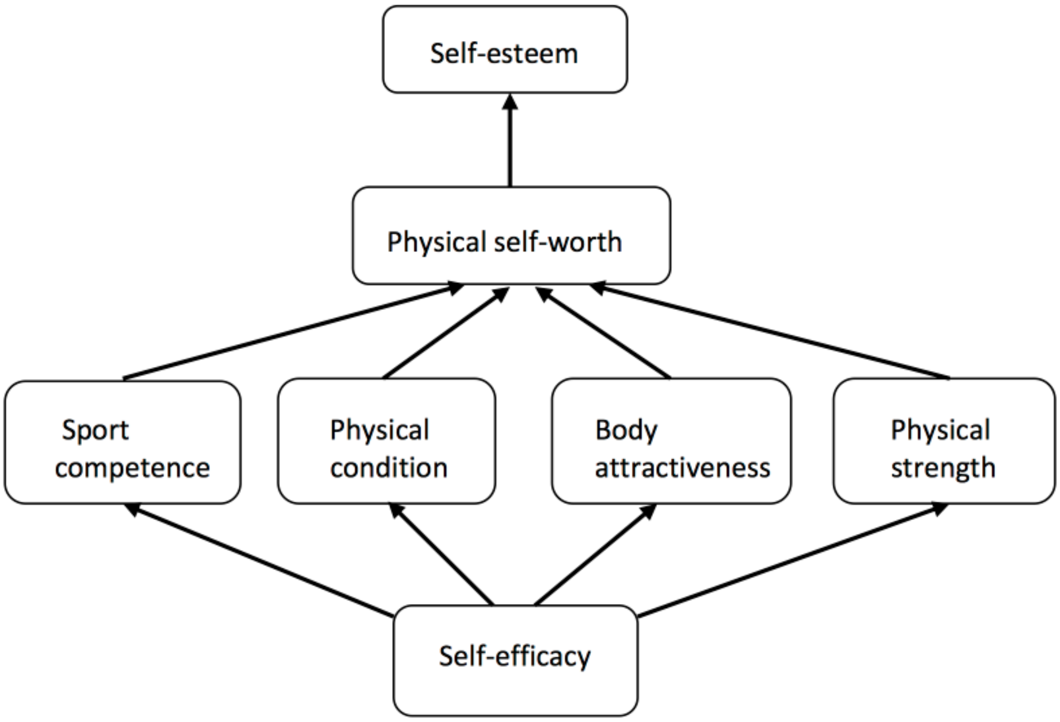
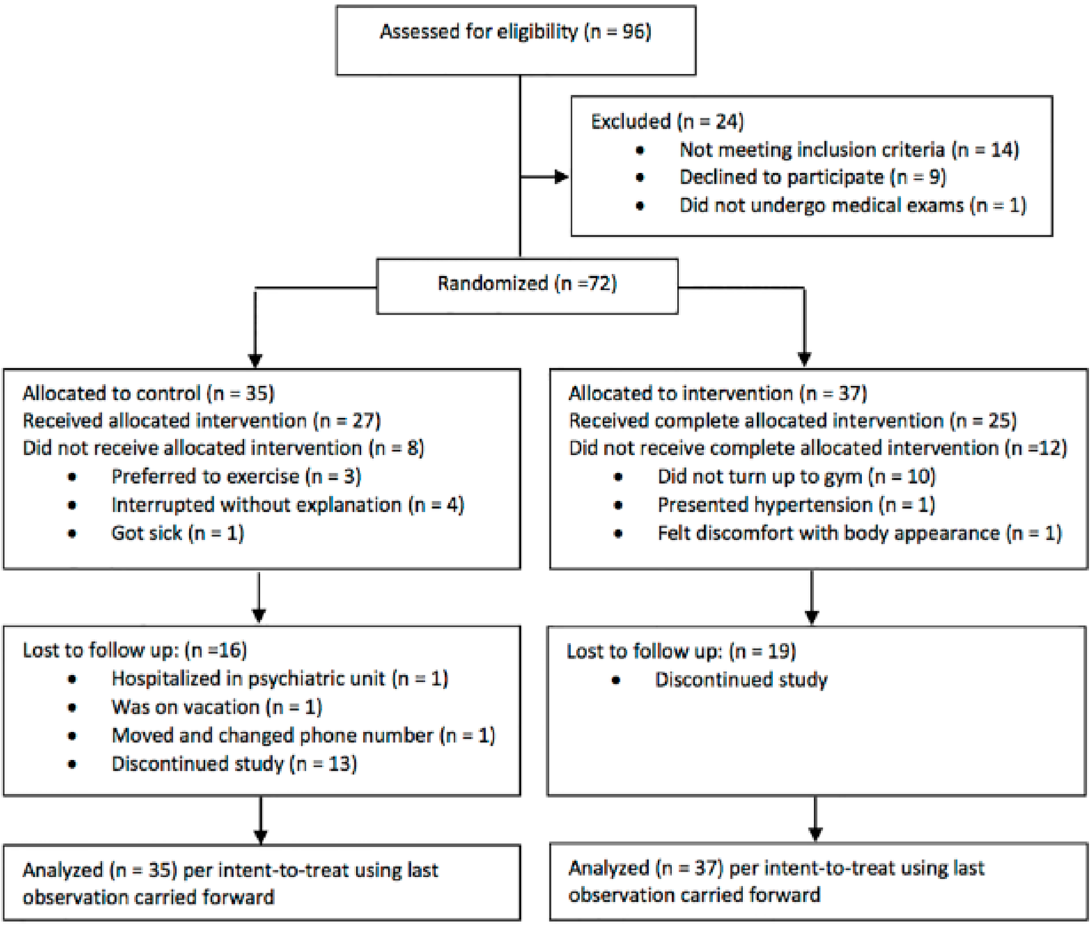

Self-esteem
Physical self-worth
Sport competence
Physical condition
Body attractiveness
Physical strength
Self-efficacy

Fig. 2



Assessed for eligibility (n = 96)
Excluded (n = 24)
Not meeting inclusion criteria (n = 14)
Declined to participate (n = 9)
Did not undergo medical exams (n = 1)
Randomized (n =72)
Allocated to control (n = 35)
Received allocated intervention (n = 27)
Did not receive allocated intervention (n = 8)
Preferred to exercise (n = 3)
Interrupted without explanation (n = 4)
Got sick (n = 1)
Allocated to intervention (n = 37)
Received complete allocated intervention (n = 25)
Did not receive complete allocated intervention (n =12)
Did not turn up to gym (n = 10)
Presented hypertension (n = 1)
Felt discomfort with body appearance (n = 1)
Lost to follow up: (n =16)
Hospitalized in psychiatric unit (n = 1)
Was on vacation (n = 1)
Moved and changed phone number (n = 1)
Discontinued study (n = 13)
Lost to follow up: (n = 19)
Discontinued study
Analyzed (n = 35) per intent-to-treat using last observation carried forward
Analyzed (n = 37) per intent-to-treat using last observation carried forward

Fig.3

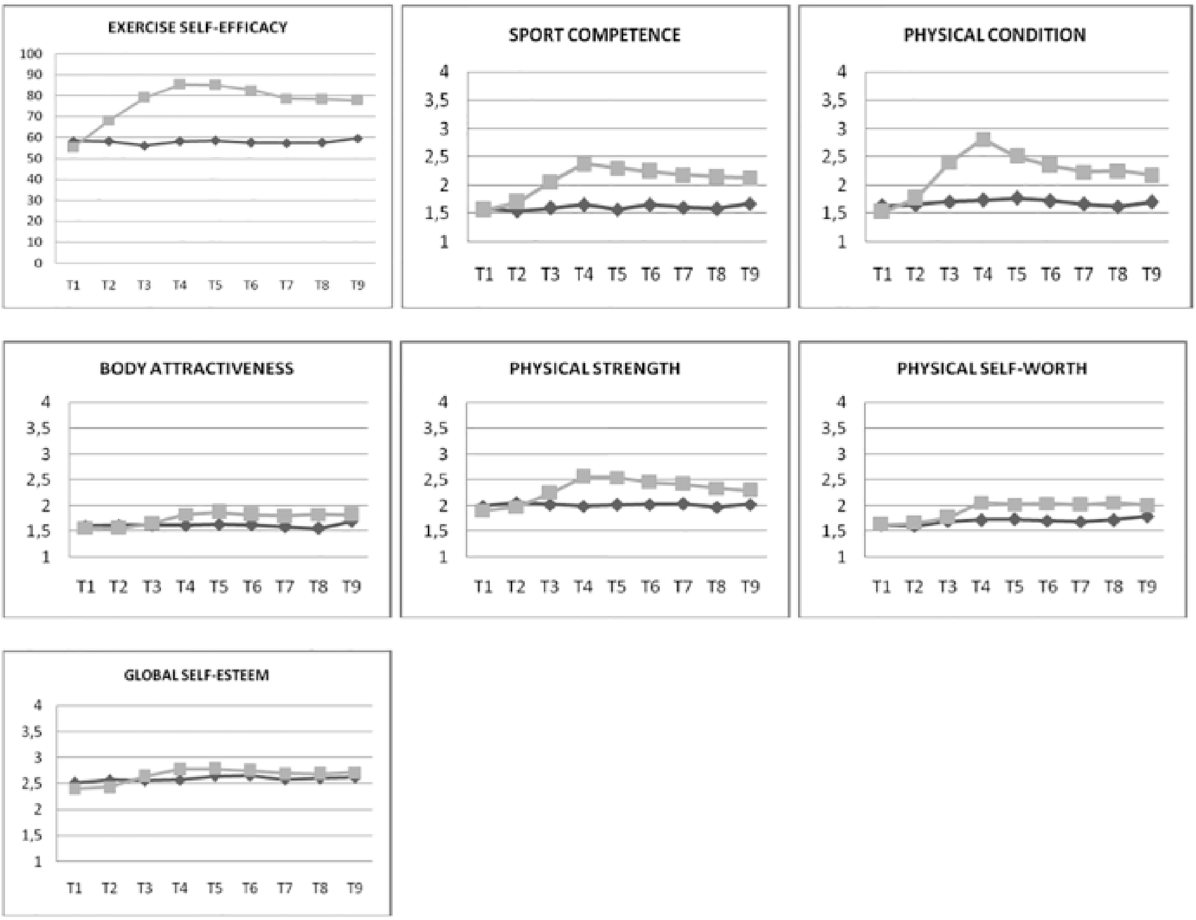

EXERCISE SELF-EFFICACY
SPORT COMPETENCE
PHYSICAL CONDITION
BODY ATTRACTIVENESS
PHYSICAL STRENGTH
PHYSICAL SELF-WORTH
GLOBAL SELF-ESTEEM
T1 T2 T3 T4 T5 T6 T7 T8 T9

Fig. 4

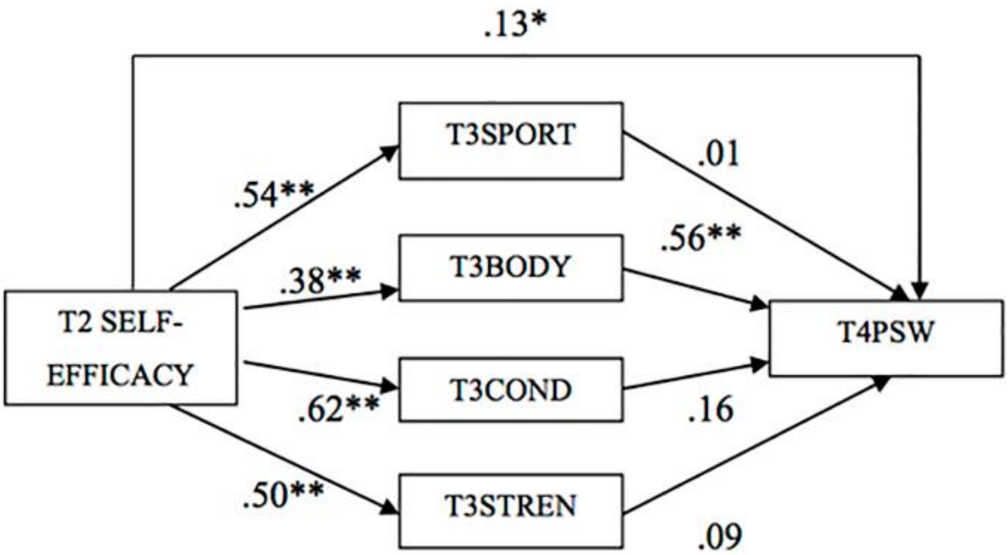

.13*
T3SPORT
T3BODY
T3COND
T3STREN
T2 SELF-EFFICACY
T4PSW
.54**
.38**
.62**
.50**
.01
.56**
.16
.09

Fig. 5

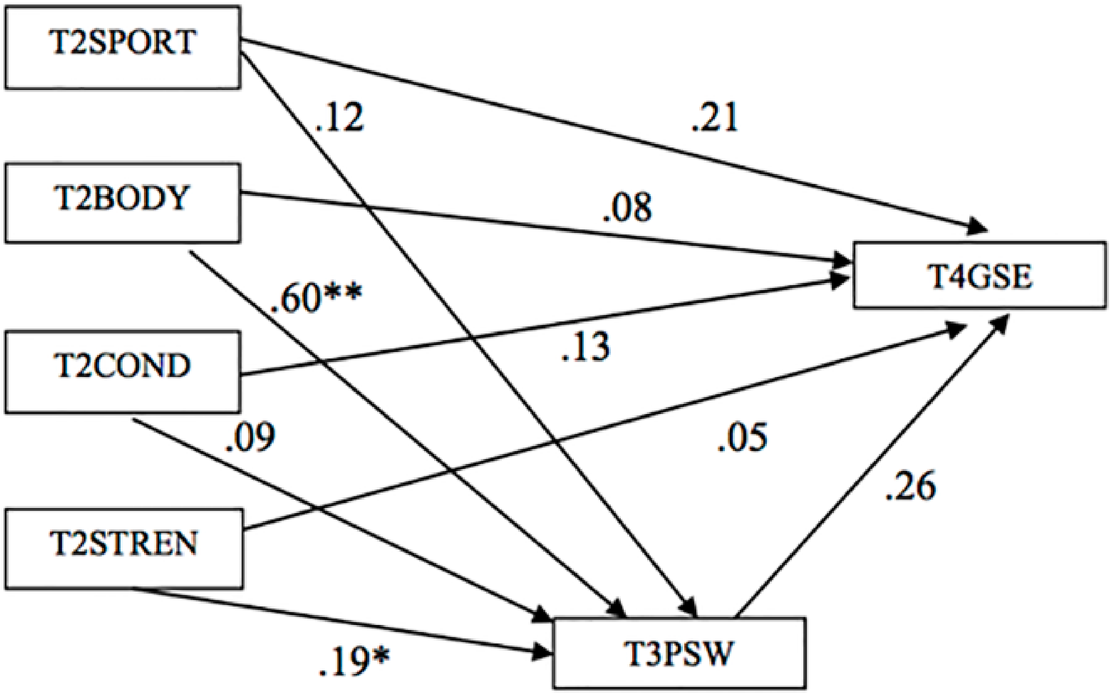

T2SPORT
T2BODY
T2COND
T2STREN
T3PSW
T4GSE
.12
.21
.08
.60**
.13
.09
.05
.26
.19*

Table 1

Baseline characteristics of the study participants by trial arm

Variables	Control group (*n* = 35)		Experimental group (*n* = 37)	
	M	*SD*	*M*	*SD*
Age	32.22	8.84	32.70	7.27
Height (cm)	164.80	6.63	168.37	6.73
Weight (Kg)	101.00	14.87	101.81	15.71
BMI	37.14	4.74	35.84	4.59
Waist circumference	111.25	11.98	109.16	13.77
Hip circumference	127.28	12.20	126.48	12.76
T1 Weekly frequency of strenuous exercise	0.51	1.37	0.24	0.72
T1 Weekly frequency of moderate exercise	0.68	1.45	0.56	1.46
T1 Weekly frequency of mild exercise	1.14	1.78	0.56	1.55

Table 2

Descriptive statistics and Pearson's correlations between the study variables on Time 1 measurement occasion.

Variables	*M*	*SD*	1	2	3	4	5	6	7	8	9	10
1. T1Exercise self-efficacy	56.80	26.34	__									
2. T1Body attractiveness	1.58	0.61	.54**	__								
3. T1Physical strength	1.94	0.80	.56**	.43**	__							
4. T1Sport competence	1.57	0.65	.60**	.45**	.56**	__						
5. T1Physical condition	1.57	0.55	.71**	.54**	.58**	.66**	__					
6. T1Physical self-worth	1.63	0.72	.56**	.81**	.51**	.49**	.62**	__				
7. T1Global self-esteem	2.46	0.59	.75**	.53**	.50**	.51**	.61**	.60**	__			
8. Age	32.47	8.02	-.39**	-.28*	-.04	-.16	-.36*	-.11	-.24*	__		
9. Exercise frequency	3.00	1.58	.74*	.13	-.06	.87*	.51	.02	.69*	-.60	__	
10. BMI	36.47	4.67	-.67*	-.49**	-.48**	-.50**	-.60**	-.46**	-.67**	.36**	-.24	__
11. Waist-to-hip ratio	0.86	0.07	-.32*	-.21	-.11	-.15	-.29*	-.67**	-.27*	.43**	-.56	.21

Note: $*p < .05$; $**p < .01$. Values are based on the data set with completed missing values using the LOCF principle. Responses are provided on a 1-4 Likert scale except for exercise self-efficacy where responses are provided on a 0-100 scale. BMI = Body mass index. Correlations with exercise frequency are based on data from nine participants.

Table 3

Unadjusted means and standard deviations of study variables for each measurement occasion across the control and experimental groups for women with obesity

	EXSE		BODY		STREN		SPORT		COND		PSW		GSE	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
T1 Control	58.23	25.75	1.60	0.63	1.99	0.75	1.58	0.61	1.63	0.54	1.62	0.69	2.52	0.58
T1 Experimental	55.45	27.18	1.57	0.61	1.90	0.85	1.56	0.69	1.52	0.57	1.63	0.76	2.40	0.59
T2 Control	58.09	26.51	1.62	0.64	2.06	0.87	1.54	0.60	1.65	0.52	1.60	0.60	2.57	0.60
T2 Experimental	68.10	24.61	1.56	0.62	1.97	0.84	1.70	0.77	1.77	0.65	1.66	0.72	2.43	0.56
T3 Control	56.09	26.46	1.62	0.62	2.02	0.85	1.59	0.64	1.71	0.60	1.70	0.71	2.56	0.64
T3 Experimental	79.09	21.38	1.65	0.72	2.24	0.80	2.06	0.82	2.41	0.67	1.77	0.77	2.64	0.58
T4 Control	58.09	27.53	1.62	0.69	1.99	0.84	1.65	0.48	1.73	0.51	1.72	0.65	2.57	0.61
T4 Experimental	85.31	20.56	1.83	0.70	2.56	0.88	2.37	0.80	2.81	0.77	2.06	0.77	2.77	0.57
T5 Control	58.42	27.26	1.64	0.62	2.01	0.69	1.57	0.48	1.77	0.58	1.73	0.63	2.64	0.56
T5 Experimental	85.09	20.21	1.87	0.67	2.55	0.83	2.30	0.79	2.50	0.71	2.02	0.76	2.78	0.55
T6 Control	57.52	27.18	1.63	0.64	2.02	0.73	1.65	0.48	1.72	0.56	1.71	0.63	2.65	0.58
T6 Experimental	82.70	20.44	1.82	0.72	2.45	0.87	2.24	0.77	2.35	0.79	2.04	0.75	2.75	0.53
T7 Control	57.33	27.51	1.59	0.60	2.03	0.73	1.60	0.55	1.66	0.55	1.69	0.66	2.58	0.67
T7 Experimental	78.55	22.59	1.79	0.69	2.42	0.83	2.18	0.83	2.23	0.79	2.01	0.74	2.70	0.61
T8 Control	57.57	27.66	1.56	0.60	1.97	0.76	1.58	0.49	1.62	0.55	1.72	0.70	2.60	0.66
T8 Experimental	78.15	22.20	1.83	0.70	2.34	0.91	2.14	0.78	2.25	0.88	2.06	0.78	2.69	0.55
T9 Control	59.57	27.32	1.70	0.64	2.02	0.73	1.67	0.56	1.70	0.58	1.79	0.73	2.62	0.67
T9 Experimental	77.70	23.41	1.82	0.75	2.29	0.91	2.13	0.80	2.18	0.86	2.00	0.81	2.71	0.56

Note: Values are based on the data set with completed missing values using the LOCF principle. Times 2, 3, and 4 represent early intervention, mid-intervention, and end-of-intervention measurements, respectively. Times 5, 6, 7, 8, and 9 represent follow-up measurements at 1 month, 3 months, 6 months, 9 months, and 12 months, respectively. EXSE = exercise self-efficacy; BODY = body attractiveness; STREN = physical strength; SPORT = sport competence; COND = physical condition; PSW = physical self-worth; GSE = global self-esteem.

Table 4

Indirect effects of self-efficacy (IV) on physical self-worth (DV) through four sub-domain self-perceptions (M)

	Bootstrap effect		Bias corrected C.I.'s for unstandardized effects	
	Unstandardized	Standardized	Lower	Upper
M1: SPORT T3	.0002	.01	-.01	.005
M2: BODY T3	.01	.21	.003	.01
M3: COND T3	.003	.10	-.002	.01
M4: STREN T3	.001	.05	-.002	.01

Note: IV = independent variable; DV = dependent variable; M = mediator. CI = confidence interval. SPORT = Sport competence; BODY = Body attractiveness; COND = Physical condition; STREN = Physical strength. T3 = Time 3.

Table 5

Indirect effects of four sub-domain perceptions (IV) on global self-esteem (DV) through physical self-worth (M)

	Bootstrap effect		Bias corrected C.I.'sfor unstandardized effects	
	Unstandardized	Standardized	Lower	Upper
IV1: SPORT T2	.03	.03	-.02	.19
IV2: BODY T2	.15	.15	-.04	.41
IV3: COND T2	.02	.02	-.03	.14
IV4: STREN T2	.03	.05	-.002	.14

Note: IV = independent variable; DV = dependent variable; M = mediator. CI = confidence interval. SPORT = Sport competence; BODY = Body attractiveness; COND = Physical condition; STREN = Physical strength. T2 = Time 2.