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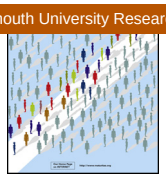

Effect of a non-dieting lifestyle randomised control trial on psychological well-being and weight management in morbidly obese pre-menopausal women

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ABSTRACT

Objective: This study examined the effects of a non-dieting lifestyle intervention approach for morbidly obese women designed in the framework of the self-determination theory (SDT) and Health at Every Size on weight maintenance and psychological functioning.
Participants and design: Predominantly white (97%), morbidly obese (BMI $\geq$ 35 kg m^{-2} with at least one co-morbid condition or a BMI $\geq$ 40 kg m^{-2}) pre-menopausal women (N = 62), aged between 24 and 55 years were initially randomly assigned to 12 weeks of lifestyle intervention (IIG) or delayed start control group (DSCG). The program consisted of 3 months intensive lifestyle intervention followed by 9 month maintenance phase. The DSCG group commenced the program after 3 months.
Results and conclusions: Initially, the IIG showed a significant decrease in body weight (baseline to end of the RCT phase) compared with a significant increase in the DSCG group. However, no significant changes in weight status were evident in either group at 12 months compared with baseline. The 3-month intensive intervention resulted in significantly improved psychological functioning in both groups, which were maintained at 12 months. The study provides additional support for a non-dieting, theory-based, lifestyle approach to weight management and psychological well-being among morbidly obese females.

1. Introduction

Lifestyle interventions and treatment programs for obesity have been problematic and mostly unsuccessful long-term [1,2]. For example, lifestyle interventions are effective for up to 2 years in individuals with a body mass index (BMI) of <35 kg m^{-2} [3] but initial weight loss is followed by relapse and the majority of participants return to their pre-intervention weight within 3–5 years [4,5]. In particular dieting is a consistent predictor of subsequent weight gain [5,6]. In this respect, the National Institute for Health Care Excellence [7] and the American College of Cardiology/ American Heart Association [8] have indicated that bariatric surgery should be the treatment of choice over drug treatment or lifestyle interventions in individuals with a BMI >40 kg m^{-2} or BMI between 35 and 40 kg m^{-2} in the presence of obesity related complications. However, uncertainties remain regarding the efficacy of surgical interventions and there is in particular need for good quality long-term interventions [7]. In addition to this, surprisingly, little research exists on the influence of lifestyle interventions in morbidly obese adults (BMI $\geq$35 kg m^{-2} with at least one co-morbid condition or a BMI $\geq$40 kg m^{-2}) [8]. This despite the notion that surgery is a relatively invasive and expensive intervention whereas lifestyle interventions have the potential to be universal and inclusive, inexpensive and with ancillary benefits [9].

Moderate weight loss (5–10%) can reverse many of the metabolic disorders associated with obesity [10]. Therefore, weight loss has typically been the primary focus of interventions [11] but traditional interventions often ignore evidence that dietary restraint and weight fluctuation may also have profound effects on psychological and physical health [12]. Also, emphasis on weight loss and dietary restraint may promote potentially unhealthy eating behaviors and attitudes, especially among obese females [13].

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It has been shown that disorders associated with obesity can be reduced and health improved by lifestyle changes in the absence of weight loss [14,15], although it is unclear whether this is also the case for morbidly obese individuals. To this end, traditional lifestyle intervention models with their emphasis on weight loss achieved mainly by calorie restriction have more recently been challenged by the Health at Every Size treatment paradigm [16,17]. Health at Every Size programs advocate moving away from weight loss as being the primary focus of interventions and re-emphasise psychological and metabolic outcomes as indicators of wellness.

Although the number of studies adopting the Health at Every Size approach is still limited, in a review Miller and Jacob [12] contend that the Health at Every Size Approach can assist with improved psychological functioning, eating habits, lifestyle behavioral patterns and promote gradual weight reduction over time. A RCT study showed that a Health at Every Size program was more effective than a program based on dietary restriction in terms of long-term behavioral change and effects on selected health risk indicators among Caucasian obese females [18]. Furthermore, by emphasising self- and size acceptance and normalized eating the Health at Every Size approach also focuses on the integration of suitable and sustainable physical activity in people's life [19].

A psychological approach which potentially could facilitate participants' motivation to overcome barriers to behavioral change is self-determination theory (SDT) [20]. Briefly this theory details the motivational bases of regulatory processes and focuses on the concept of autonomy, which is not included in any other empirically derived theory of motivation. SDT distinguishes between *autonomous* and *controlled* motivations—ends of a continuum describing the extent to which regulatory processes are self-determined [20]. Several studies have shown that individuals high on the autonomy orientation report more internalized (i.e., autonomous) reasons and greater perceived competence for health improvement and are also more successful in maintaining behavioral changes [21,22].

Obesity is associated with diverse negative psychological consequences [23]. However, studies investigating aspects of psychological functioning associated with obesity have often been limited in their use of assessment tools. To date surprisingly few lifestyle intervention studies have incorporated self-reported psychological measures of general well-being or quality of life despite their increasing use in other health domains and acceptance as important outcome measures in clinical trials [24].

The aim of this study was to examine the effects of a non-dieting lifestyle intervention designed in the frameworks of Health at Every Size [16] and SDT [20] on weight maintenance and psychological well-being among persons recruited to the WHEEL (Weight, Healthy Eating and Exercise in Leeds) study. The selected psychological outcome measures in this study were chosen in relation to the theoretical framework adopted and those more commonly utilised in the context of obesity research. It was expected that the participants in the intervention groups would demonstrate an improvement in their psychosocial profile in comparison to the control group. At 12 month follow-up it was expected that all participants who underwent the intervention would demonstrate an improved psychosocial profile.

2. Methods

2.1. Trial design

The WHEEL project was a delayed-start, RCT comprising of community-based supervised exercise, lifestyle physical activity and psycho-educational classes on healthy eating and weight management (see Fig. 1). Criteria for eligibility to the study have been published [25], however, a medical doctor reviewed the applicants' medical history in relation to the study inclusion criteria.

2.2. Participants

Pre-menopausal, predominantly white (97%), morbidly obese females older than 18 years of age (24–55 years) were recruited to a multi-disciplinary University-based weight management program by local media advertisements and the e-mail servers of local government and Metropolitan University in Leeds, UK. All participants were classified as morbidity obese as determined by a BMI of $>40\,kg\,m^{-2}$ or a BMI $\geq 35\,kg\,m^{-2}$ with at least one co-morbid condition [8] and provided individual written informed consent for study procedures and the written approval from their general practitioner. The study protocol was approved by the Research Ethics Committee of the Leeds Teaching Hospital's NHS Trust. Table 1 provide some of the characteristics of the sample.

2.3. Interventions

Eligible participants were invited to a 2-h orientation session on weight management by the principal investigator (EB) during which the requirements of the study were explained. The study protocol involved three months of intensive non-dieting lifestyle intervention followed by nine months maintenance for all eligible participants. Half of the participants were required to act as a waiting-list control for 3 months in order for the study investigators to meet the ethical approval conditions. Accordingly, at the end of the orientation session, participants were randomly assigned to 12 weeks of lifestyle intervention (initial intervention group) or waiting list control (delayed-start). The 31 participants assigned to the waiting list control group were requested to maintain their current lifestyle habits. The delayed-start group were scheduled to commence the intensive lifestyle intervention phase after 3 months.

The intervention consisted of a 'lifestyle change' program [26] designed within the behavioral change framework of the SDT. This "self-determined" intervention strategy emphasised relatively individual approaches to physical activity and eating behavior, in which health professionals provided a treatment rationale, but offered choice, minimised pressure and acknowledged participants' perspectives within the intervention process. The intervention incorporated elements of both lifestyle physical activity and structured supervised aerobic exercise. Healthy eating and weight management psycho-educational sessions were conducted weekly throughout the intervention period. An outline of the lifestyle management program has been published previously [25].

2.4. Outcomes

Body weight was assessed using a digital scale (Seca α 770 digital low form scale; Birmingham). Participants were measured in their underwear, without shoes to the nearest 100 g. To assess whether the intervention was successful in terms of increasing autonomy and internalised self-determined behavior in participants the General Causality Orientation Scale (GCOS) [27] and the Multidimensional Health Locus of Control Scales (MHLC) [28] were used. The GCOS measures autonomy, controlled and impersonal motivational orientation whereas the MHLC has 3 factors: Internality, change, and powerful others. The General Well Being Schedule (GWB) [29] was used to assess changes in participants' quality-of-life. A total score on the GWB schedule between 0 and 60 reflects 'severe distress', 61–72 'moderate distress', and 73–110 'positive well-being' [30]. In addition, the GWB schedule consists of 6 subscales: emotional control and stability, energy level, relaxed vs. tense or anxious, cheerful vs. depressed mood, satisfying and

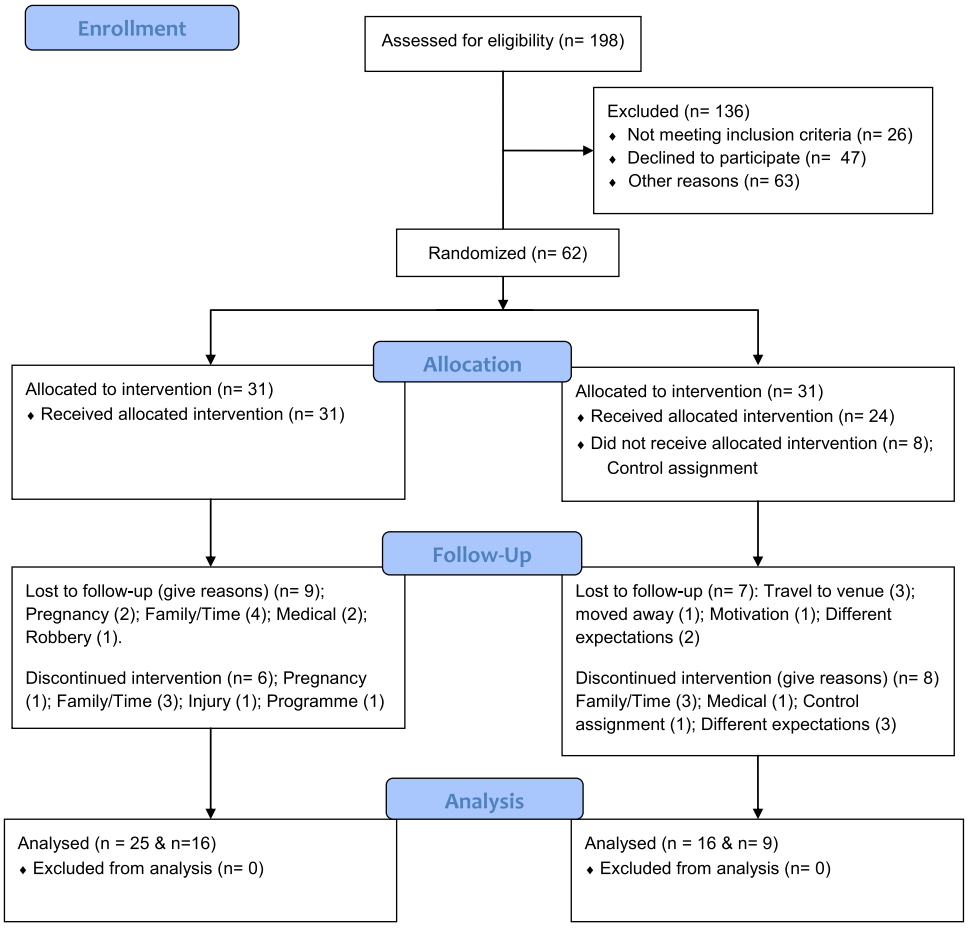

Fig. 1. Trial profile for the WHEEL (Weight, Healthy Eating and Exercise in Leeds) study.

Table 1
Characteristics of the participants enrolled to the initial intervention group or delayed start control group.

Dependent variable	All participants	Initial intervention group ($N = 31$)	Delayed start control group ($N = 31$)
Age, years	40.2 (7.7)	39.3 (7.8)	41.1 (7.6)
Weight, (kg)	104.3 (21.4)	108.4 (21.6)	99.8 (21.0)
BMI, ($kg\,m^{-2}$)	38.6 (7.6)	39.89 (7.44)	37.4 (7.7)
Waist circumference, (cm)	107.9 (16.2)	114.2 (14.0)	107.4 (19.8)
Waist-Hip circumferences ratio	0.86 (0.10)	0.86 (0.10)	0.85 (0.06)
Body Fat content, (%)	33.7 (9.5)	38.2 (9.6)	32.2 (11.7)
VO_2, ($ml\,min^{-1}$)	2258.3 (356.0)	2297.1 (328.0)	2090.0 (329.0)
VO_2, ($ml\,kg^{-1}\,min^{-1}$)	22.1 (3.3)	21.6 (3.5)	22.5 (3.2)
Total cholesterol, ($mmol\,l^{-1}$)	5.33 (0.88)	5.42 (1.1)	5.68 (0.59)
HDL-cholesterol, ($mmol\,l^{-1}$)	1.28 (0.29)	1.15 (0.32)	1.25 (0.30)
Triglycerides, ($mmol\,l^{-1}$)	1.52 (0.65)	1.74 (0.74)	1.90 (0.68)
Fasting glucose, ($mmol\,l^{-1}$)	5.29 (1.1)	5.56 (0.97)	5.72 (1.9)
Systolic BP, (mmHg)	132.9 (17.8)	138.4 (17.8)	137.0 (16.0)
Diastolic BP, (mmHg)	86.8 (10.5)	90.6 (10.6)	87.5 (9.2)

interesting life, and freedom from health concern or worry. The participants also completed the Perceived Stress Scale (PSS) [31]. For the measurement of trait self-esteem participants completed Messer and Harter's [32] Adult Self-Perception Profile (SPP). The SPP has twelve factors: sociability, job competence, nurturance, athletic abilities, physical appearance, adequate provider, morality, household management, intimate relationships, intelligence, sense of humour, and global self-worth.

2.5. Randomisation

The participants were randomised at the end of the orientations session by means of envelopes which indicated being part of the intervention or delayed start control group. This process was conducted by the lead researcher.

2.6. Analysis strategy

Changes in variables across the intervention study, over time and between groups, were assessed using repeated measures analysis of variance models using intention to treat for missing data. The first analysis evaluated the RCT (Initial Intervention Group, (IIG) vs. Delayed Start Control Group (DSCG)) component of the study by comparing the baseline measures with the data obtained at the end of the 3 months intervention period (end of the planned lifestyle change program sessions for IIG and start of the program

Table 2
Baseline, end RCT phase and 9 months follow-up body mean scores and standard deviations for weight and psychological data.

	Initial Intervention Group			Delayed Start Control Group		
	Baseline ($N=31$)	End RCT ($N=25$)	12 Months ($N=16$)	Baseline ($N=24$)	End RCT ($N=16$)	12 Months ($N=9$)
Body weight	108.4 (21.6)	104.6 (19.2)	106.1 (23.7)	100.1 (20.7)	103.0 (20.8)	102.3 (12.7)
GCOS autonomy	89.58 (17.23)	95.18 (14.85)	101.7 (10.51)	81.00 (18.91)	82.08 (17.89)	97.22 (8.15)
GCOS impersonal	67.24 (23.44)	61.81 (23.16)	55.75 (19.11)	72.35 (24.32)	70.81 (24.24)	63.89 (15.37)
GCOS controlled	64.27 (16.20)	62.14 (13.91)	62.44 (13.38)	59.46 (15.87)	59.69 (15.30)	66.67 (15.89)
Locus of control internal	5.20 (0.87)	5.17 (0.89)	5.38 (0.67)	4.68 (0.93)	4.63 (0.90)	4.71 (0.79)
Locus of control chance	1.81 (0.86)	1.84 (1.01)	1.67 (0.67)	2.35 (0.96)	2.28 (0.90)	2.25 (1.19)
Locus of control powerful others	2.77 (0.77)	2.70 (0.82)	2.70 (0.82)	2.99 (0.81)	2.97 (0.60)	2.97 (0.59)
GWB total	52.90 (21.11)	68.72 (19.91)	78.81 (16.43)	54.46 (17.53)	52.34 (16.16)	66.67 (14.77)
Emotional control and stability	11.48 (3.79)	13.09 (3.10)	14.68 (2.41)	12.07 (2.76)	12.12 (2.78)	13.78 (2.28)
Energy level	10.21 (4.21)	13.04 (4.77)	15.62 (3.87)	9.69 (3.39)	9.65 (3.41)	12.78 (2.59)
Relaxed vs. tense or anxious	15.62 (5.18)	19.00 (4.33)	20.63 (3.32)	16.65 (4.62)	16.07 (3.89)	18.78 (3.70)
Cheerful vs. depressed mood	12.79 (4.59)	16.00 (3.94)	17.69 (2.87)	13.26 (3.51)	12.88 (3.50)	15.44 (2.69)
Satisfying and interesting life	8.93 (3.20)	11.27 (3.02)	12.88 (2.75)	9.15 (2.56)	8.92 (2.73)	11.33 (3.16)
Freedom from health concern	7.86 (4.37)	10.31 (4.31)	11.31 (3.61)	7.61 (4.01)	6.69 (3.16)	8.56 (3.43)
Perceived stress	28.90 (9.64)	24.78 (7.36)	20.81 (7.17)	32.39 (6.39)	29.35 (6.02)	23.33 (4.24)
SPP sociability	2.86 (0.78)	2.75 (0.75)	2.98 (0.76)	2.83 (0.66)	2.79 (0.68)	3.17 (0.45)
SPP job competence	3.12 (0.74)	3.11 (0.62)	3.34 (0.57)	2.91 (0.63)	2.89 (0.69)	3.39 (0.43)
SPP nurturance	3.18 (0.58)	3.13 (0.66)	3.28 (0.67)	3.06 (0.56)	3.02 (0.60)	3.14 (0.66)
SPP athletics	1.76 (0.76)	2.09 (0.82)	2.34 (0.68)	1.64 (0.59)	1.56 (0.57)	2.22 (0.63)
SPP appearance	1.88 (0.58)	1.92 (0.59)	2.39 (0.68)	1.79 (0.56)	1.71 (0.62)	2.22 (0.62)
SPP provider	2.92 (0.76)	2.88 (0.69)	3.04 (0.71)	2.92 (0.61)	2.88 (0.67)	2.94 (0.57)
SPP morality	3.28 (0.60)	3.32 (0.55)	3.61 (0.39)	3.04 (0.60)	3.07 (0.53)	2.89 (0.42)
SPP household	2.74 (0.96)	2.72 (0.95)	2.74 (1.03)	2.67 (0.88)	2.61 (0.94)	2.89 (0.85)
SPP intimate relations	2.64 (0.77)	2.57 (0.79)	2.70 (0.74)	2.64 (0.77)	2.69 (0.82)	2.92 (0.60)
SPP intelligence	2.86 (0.88)	2.98 (0.74)	3.47 (0.58)	2.65 (0.77)	2.63 (0.79)	3.03 (0.44)
SPP humour	3.00 (0.84)	2.94 (0.81)	3.09 (0.76)	3.30 (0.68)	3.26 (0.77)	3.58 (0.43)

for the DSCG). For this analysis the main results of interest were the interaction effects. The second analysis (follow-up analysis) compared baseline scores of both groups (first measurement for the IIG and the measurements at 3 months for the DSCG) with the 12 month follow-up data. For this analysis time main effects and possible interaction effects were of interest. Post-hoc comparisons were conducted using Fisher LSD in the instance of a significant interaction effect. The level of significance was set at $p \leq 0.05$. All analysis where conducted using SPSS statistical software.

3. Results

The participants' Baseline, EndRCT, and 12 months follow-up scores for body weight and psychological variables are shown in Table 2.

3.1. RCT-Phase

There was an interaction effect for body weight ($p = .04$; $Eta^2 = .13$). Post-hoc comparisons showed that weight in the IIG was significantly higher at the start of the study. In addition, the IIG showed a significant decrease in weight from base line to end of the RCT phase whereas the DSCG showed a significant increase ($p < 05$).

No significant interaction effects were obtained for the GCOS, Locus of Control, or perceived stress. However, significant interactions were found for the total score of the GWB Schedule ($p < .001$; $Eta^2 = .53$; see Fig. 2a) and its subscales (all $p < .001$); Emotional Control and Stability ($Eta^2 = .24$), Energy Level ($Eta^2 = .33$), Relaxed vs. Tense/Anxious ($Eta^2 = .30$), Cheerful vs. Depressed Mood ($Eta^2 = .34$), Satisfying and Interesting Life ($Eta^2 = .41$), and Freedom from Health Concerns Worry ($Eta^2 = .43$). Post-hoc comparisons showed that there were no significant differences at baseline for any of the variables except the 'Emotional Control and Stability' subscale. The IIG showed significant improvements from baseline to end of the RCT phase for the total score of the GWB Schedule and all its subscales and at this point in time scored significantly higher than participants in the DSCG.

Finally, three of the factors of the SPP showed significant interaction effects; Athletics ($p = .001$; $Eta^2 = .19$), Appearance ($p = .04$; $Eta^2 = .08$) and Global Self-Worth ($p < .001$; $Eta^2 = .31$) (see Fig. 2b–d). The IIG showed significant improvements for all 3 scales from baseline to end of the RCT phase and scored significantly higher than the DSCG at this point in time. The latter group showed a significant decrease in 'GSW' from baseline to end of the RCT phase.

3.2. 12 Months Follow-Up

There was no significant time main effect ($p = .15$) or interaction effect ($p = .11$) for body weight suggesting that the participants maintained their body weight over the 12 month period.

The WHEEL intervention significantly increased autonomy ($p < .001$; $Eta^2 = .68$) and lowered the impersonal orientation ($p = .003$; $Eta^2 = .32$). There was also a significant interaction effect for Autonomy ($p = .03$; $Eta^2 = .20$). Post-hoc comparisons indicated that participants in both conditions rated their autonomy significantly higher at 12 months in comparison to baseline. The participants in the DSCG, however, scored significantly lower at baseline than the participants in the IIG.

Significant changes were also evident among the Multidimensional Health Locus of Control Scale. Participants in both groups showed a significant decrease in the Chance Subscale from baseline to 12 month follow-up ($p = 05$; $Eta^2 = 15$). There was also a condition main effect for internal locus of control ($p = .02$; $Eta^2 = .22$) with participants in the IIG scoring significantly higher compared with the participants in the DSCG.

Significant time main effects were found for the 12-month follow-up analysis for the GWB Schedule total score and all its factors (all $p < .001$). This indicated that the participants in both groups improved significantly on the GWB total and all its subscales from base line to 12 month follow-up. All Effect sizes were high (GWB total $Eta^2 = .69$; Emotional Control and Stability $Eta^2 = 51$; Energy Level $Eta^2 = .61$; Satisfying and Interesting Life $Eta^2 = .65$); Freedom from Health Concern Worry $Eta^2 = .66$; Relaxed vs. Tense/Anxious $Eta^2 = .47$; Cheerful vs. Depressed Mood $Eta^2 = .49$.

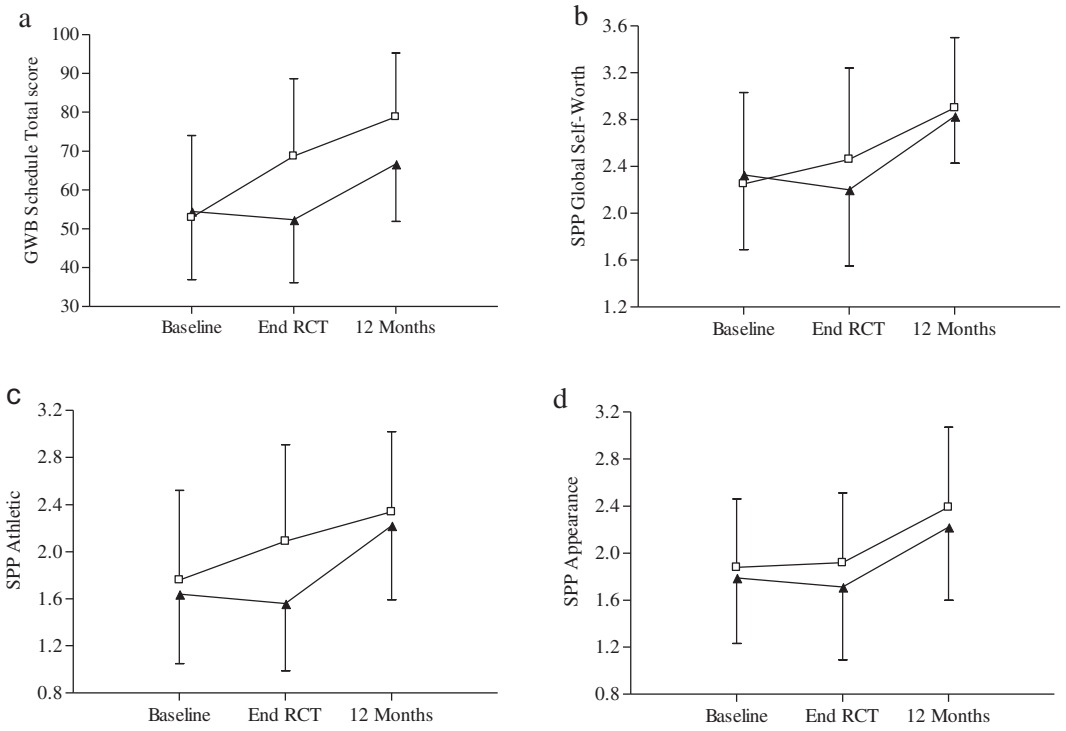

Fig. 2. a–2d: Line graphs for the total score of the General Well Being schedule (1a), Global Self Worth sub-scale of the Self Perception Profile (1b), Athletic sub-scale of the Self Perception Profile (1c) and Appearance subscale of the Self Perception Profile (1d) for the Initial Intervention group (□) and the Delayed Start Control group (▲).

Result for perceived stress showed a significant decrease from baseline to 12 months follow-up indicating that participants in both groups rated their stress levels lower following the maintenance period ($p < .001$; $Eta^2 = .45$).

Significant time main effects were observed for most of the SPP scales except Nurturance ($p = .40$) and Humor ($p = .21$). The effect sizes ranged between high (Athletics $p < .001$; $Eta^2 = .56$; Appearance $p < .001$; $Eta^2 = .54$; Global Self-Worth $p < .001$; $Eta^2 = .68$; Household $p = .004$; $Eta^2 = .31$; Intelligence $p < .001$; $Eta^2 = .48$; Intimate Relations $p = .01$; $Eta^2 = .26$; Provider $p = .01$; $Eta^2 = .25$; Morality $p = .02$; $Eta^2 = .22$; Job Competence $p = .007$; $Eta^2 = .28$;) and low (Sociability $p = .04$; $Eta^2 = .04$). Participants in both groups improved significantly on ten of the 12 self-perception scales from baseline to 12 months.

4. Discussion

The present study found a modest (albeit significant) decrease in body weight at 3 months in those participants initially randomised to the intervention (IIG). However, after 3-months intensive intervention and subsequent maintenance no differences compared with baseline were found in body weight between groups. Despite the fact that there were no significant changes in weight status at 12 months in either condition, the lifestyle approach adopted by the WHEEL program resulted in significantly improved psychological functioning within previously sedentary and morbidly obese women. Overall, these results are in partial support with other relatively recent Health at Every Size treatment based study findings.

There is a growing body of evidence which suggest that psychological well-being and psychopathology related to obesity can be improved in the absence of significant decreases in body weight [14,33]. In a study by Tanco et al. [34] only participants within a non-dieting condition showed a significant decrease in depression, anxiety, eating-related psychopathology and an increase in perceptions of self-control as compared to behavioral therapy and waiting list control groups. Similarly, Rapoport et al. [35] concluded that modified CBT for weight management, without a focus on weight loss, was efficacious in inducing modest weight reduction, as well as improving emotional well-being, lessening psychological distress, and improving dietary and exercise behaviors. Subsequently, Bacon et al. [36] reported comparable body weight changes between obese female participants randomised to a restrictive diet and those to a non-dieting intervention. In addition, the non-dieting approach produced improvements in psychological well-being and eating behavior, while at the same time effectively minimized treatment attrition. These studies, however, mainly dealt with overweight and obese individuals. Our study is one of the first studies, which also suggest that psychological functioning and well-being can be improved in morbidly obese women without significant weight loss.

The benefits of either preventing weight gain or promoting and supporting small amounts of weight loss induced by lifestyle changes appear to be crucial in the treatment of obesity associated disorders and improved psychological functioning [37]. The intervention approach selected in the presented study was effective in inducing significant behavioral change in those participants who completed the program. This was indicated by significantly improved general well-being, lower perceived stress, and improved self-perceptions. In addition, in line with the prediction of the self-determination theory's framework, participants felt significantly more autonomous, less reliant on others and felt more in control of their conditions. Similarly results have been reported in a systematic review on the efficacy of non-diet, weight-neutral interventions. This showed that most of these interventions did not result in significant weight gain or worsening physiological or biochemical profiles but improved psychological functioning [33]. Longitudinal studies needed to investigate whether the psychological improvements observed could over time lead to better self-regulation and weight management practices.

In the initial intervention group participants not only showed a significant improvement from baseline to end of the RCT phase in the total score of the GWB Schedule and its subscales with large

to moderate effect sizes. In addition, participants in both conditions showed significant improvements from baseline to 12 months follow-up on the total and all subscales of the GWB schedule with most effects being large. In the Reno Diet-Heart trial [38] increases in self-reported physical activity over four years were associated with improvements in eating self-efficacy and well-being in obese women. Cramer et al. [39] and Nieman et al. [40] have reported similarly improved psychological well-being among mildly obese women within controlled lifestyle intervention trials. In the former study, the exercise group showed improvements for the total scores of the GWB and the subscales 'Energy Level' and 'Freedom from Health Concern or Worry' compared with control. In the latter study, general well-being was reported to improve in the combined lifestyle intervention group (but not exercise training or moderate dietary restriction alone) relative to control participants. In that study, four of the six general well-being subscales were more responsive to the combined intervention. The improvements in general psychological well being noted in the present study occurred despite only small changes in body weight [12].

The Health at Every Size treatment model assumes that if psychological dysfunction is helped, participants are more likely to be able to sustain and initiate health behaviors conducive to good long-term health including weight management. Not unexpectedly a high proportion of the morbidly obese women in this study reported poor levels of psychological well-being and high perceived stress at baseline compared with other data among overweight and obese females [38,39]. The morbidly obese women classified as in 'severe distress' (68%) or 'moderate distress' (18%) in terms of general psychological well-being was much higher than that reported previously for overweight/obese women [30]. Thus, the efficacy of the lifestyle intervention approach adopted in the present study may be particularly effective among participants with psychological distress.

The present study findings may also be contrasted with several longer term RCTs that have examined the psychological effects of adding exercise to dietary restricted weight-loss programs. In the Stanford Weight Control Project II, no significant reduction in symptoms of depression and other measures of psychological distress were reported in overweight, sedentary women for lifestyle interventions compared with control [41]. In contrast, a 12-week weight loss strategy involving increased physical activity, self-selected hypocaloric diet improved various quality of life indices in intervention participants compared to controls in moderately overweight females [42].

Surprisingly, most studies use a narrow assessment of the self-concept this despite the notion that the self-concept is multidimensional and hierarchical in nature [43]. The values reported at baseline for each subscale of the SPP were substantially lower than those reported by Messer and Harter [32] for a sample of female homemakers. The present study partly supported the assumption that trait like self-perceptions have a certain enduring quality, which takes considerable time to adjust. Participants in the IIG showed significant improvements on 'Appearance', 'Athletic' and 'Global Self-Worth' subscales at the end of the RCT phase, however, 10 of the 12 subscales showed significant improvements at 12 months follow-up with high effect sizes for the Athletic, Appearance and Global Self-Worth sub-scales and moderate effects for Household and Intelligence. The 'Appearance' and 'Global Self-Worth' subscales had mean scores still well below the norms reported [32] whereas the mean 'Athletic' scale was above these norms at 12 months follow-up. These results suggest that the intervention was successful in improving the morbidly obese women's self-perceptions in different domains of their lives.

The adopted theoretical SDT framework was successful in that all participants completing the study perceived themselves to be more autonomy oriented rather than control oriented at 12 months. The General Causality Orientation Scale looked at participants' general tendency to be self-initiating and their orientation toward programs that promote choice as in WHEEL. It appears that WHEEL enabled participants to use their experience as a source of information about what to do with regards to their lifestyles. Autonomy oriented individuals tend to take responsibility for the choices they make in their lives. The increased self-awareness of one's needs and feelings and the experience of having a choice in the regulation of their behavior are important to behavior change based health initiatives [21]. The participants also considered themselves to be less reliant on medical practitioners and viewed their condition being less fortuitous. This was indexed by a significant decrease in the impersonal orientation scale of the GCOS and chance subscale of the MHLC. Improving autonomy orientation in morbidly obese women appears to be an important pre-requisite for long-term behavioral change [21]. More research is required to explore the tenets of SDT in the context of lifestyle interventions in the morbidly obese.

Research designs in relation to weight loss are theoretically complex and practically problematic [1]. The control arm of any obesity-related intervention presents a set of conceptual issues not seen in many areas of therapeutic development [1,44]. A parallel delayed-start control arm was an ethical requirement of the present investigation. In behavioral interventions the control condition is particularly important and is usually far from 'inactive' [1,45]. Accordingly, control conditions can evoke and meet either positive or negative expectancies [46] including the 'resentful demoralization of those excluded by randomisation' in addition to other subjective effects of the control condition [47]. Consistent with these observations, although all randomised participants showed some reduction in perceived stress during the RCT phase of the present study, less favorable effects on autonomy, internal health locus of control and global self-worth were evident among participants initially randomized to the DSCG. Historically, such effects have been reported to lead to high dropout rates in obesity studies [44]. The present study also showed higher levels of intervention non-compliance and study drop-out in the DSCG.

Although the participants in the present study achieved moderate improvements in psychological well-being they did not lose weight. It has been suggested that weight loss is important to reduce health risks [48]. Hence, a recent review on lifestyle interventions with a physical activity component in class II (BMI >35 and <40 kg/m^{-2}) and class III (BMI >40 and < 0 kg/m^{-2}) individuals showed that significant weight (8.9 kg) was associated with positive effects on blood pressure, cholesterol, triglycerides and fasting insulin [49]. However, it has been proposed that physical fitness is more important for health than weight loss [50]. The participants in the present study become more physically fit [increased VO_2max; data published elsewhere, 25]. This provide some tentative evidence that improved health can be achieved in the absence of weight loss [33].

The findings from the WHEEL study may be limited specifically to the context of obesity management of women. Women-only exercise interventions appear to target some of the potential exercise barriers for obese women and may improve motivation and self-efficacy [43]. Another limitation of our study could be that all but one of our participants where Caucasian, the approach may also be more appropriate for Caucasian women than those from other ethnic backgrounds [9]. Additional studies are needed to verify our lifestyle intervention findings in other ethnic groups and older women. Our study did not examine a number of variables which could provide further insight into the mechanisms of improved psychological well-being. For example, we did not objectively examine physical activity behavior of the participants. In addition, we did not include a measure of eating behavior. Although exit interviews were conducted with those who completed the study in which question were asked about their physical activity

and eating behaviors. Finally, the study was underpowered for the number of comparisons made.

5. Conclusion

The current study is one of the first to provide support for a non-dieting, healthy lifestyle approach to weight management among morbidly obese women. Such an approach can establish health and psychological well-being independently of weight loss in this population. Also, this study complements the focus on the role of a non-dieting weight management approach by including several important psychological dimensions such as general well-being and a multidimensional measure of self-esteem.

Competing interests

The authors have no financial or other competing interest.

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Authors' contributions

E.B.: Study design, data collection, data interpretation, and manuscript preparation.

S.C.: Data interpretation and manuscript preparation.

P.C.: Manuscript preparation.

R.C.J.P.: Data analysis, data interpretation and manuscript preparation.

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