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Case Report

Physiological and body composition adaptations following a 12-week progressive exercise program in women living with obesity: a case report

Short title: Exercise adaptations in obesity

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Abstract

Exercise-induced physiological adaptations are central to obesity management, particularly by improving body composition (BC) and metabolic efficiency. Progressive exercise programs may help reduce adiposity while preserving fat-free mass (FFM) in adults with obesity. However, evidence comparing different delivery formats remains limited. Therefore, this study aimed to evaluate the effects of a 12-week progressive exercise program on BC parameters in women living with obesity and to compare outcomes between in-person and online delivery formats. This comparative case report investigated the effects of a 12-week progressive exercise program in three adult women with class II obesity. Two participants completed the intervention (in-person or online), while one served as a non-exercising control. Anthropometric measures and BC were assessed at baseline and after 12 weeks using standardised procedures and bioelectrical impedance analysis (BIA). Both intervention participants achieved approximately 9% weight loss, reducing body mass index from class II to class I obesity. Body fat percentage decreased by 15–17%, alongside increases in FFM (5–8%). Reductions in waist, hip, and thigh circumferences were also observed, with minimal differences between delivery formats. The control participant showed no meaningful changes. The 12-week progressive exercise program appeared to be associated with improvements in BC parameters in the intervention participants. These findings suggest that progressive exercise may be associated with favourable physiological adaptations regardless of delivery format. Larger studies are needed to confirm these findings.

Keywords: Obesity; Exercise intervention; Body composition; Physiological adaptations; Case report

Introduction

Overweight and obesity are major public health concerns, currently affecting nearly 30% of the global population (GBD 2015 Obesity Collaborators, 2017; Kupila et al., 2023; Su et al., 2017). Since 1980, the number of individuals with obesity has more than doubled in 70 countries and continues to rise worldwide (GBD 2015 Obesity Collaborators, 2017). Prevalence varies across regions and is influenced by socioeconomic determinants such as poverty, education and inequality (Anekwe et al., 2020). In Portugal, significant regional disparities exist, with the highest prevalence of adult obesity observed in the Azores (30.4%) and Alentejo (28.2%), followed by the Lisbon metropolitan area (22.5%), Madeira (22.3%), North (22%), Centre (20.1%) and Algarve (19.2%) (Lopes et al., 2017).

Physical exercise is widely recognised as an effective strategy for controlling body weight (BW) and adiposity, with both moderate and high-intensity protocols showing consistent findings (Ahn et al., 2022; Bellicha et al., 2021; Goodman et al., 2024). Nevertheless, adherence to high-intensity interval training (HIIT) (Andreato et al., 2019) and high-intensity functional training (HIFT) (Feito et al., 2018) may be limited among individuals with obesity, due to barriers such as injury risk, low tolerance, or lack of motivation. These limitations highlight the need for alternative exercise approaches that are adaptable, progressive, and better aligned with individual capabilities and long-term adherence.

From a physiological standpoint, regular exercise promotes a series of metabolic adaptations that enhance energy expenditure, improve substrate utilisation, and regulate endocrine and inflammatory responses associated with obesity (Ahn et al., 2022; Hawley et al., 2014). Increases in mitochondrial density, insulin sensitivity, and skeletal muscle oxidative capacity contribute to improved metabolic efficiency and body composition

(BC) (Ahn et al., 2022; Hawley et al., 2014), supporting the role of structured physical exercise as a key strategy in obesity prevention and treatment.

Several studies have investigated structured exercise programs for adults living with obesity, with evidence showing reductions in BW and fat mass (FM) alongside preservation or gains in fat-free mass (FFM) (Bellicha et al., 2021). However, the magnitude of these adaptations varies widely depending on exercise modality, intensity, program duration, and participant characteristics (Ahn et al., 2022; Bellicha et al., 2021). This variability may limit the identification of optimal intervention strategies and underscores the need for more standardised and adaptable training models, particularly given the recognised challenges in developing effective and individualised exercise prescriptions (Erickson et al., 2023; Noone et al., 2024).

Despite this, fewer studies have focused on progressive and adaptable training protocols specifically designed to address the physical and motivational barriers commonly experienced by this population, an important gap given their potential to enhance adherence and optimise individual responses.

Another area with limited evidence is the comparison between in-person and online delivery formats for structured exercise interventions in individuals with obesity (Ahn et al., 2022; Bellicha et al., 2021; Sherrington et al., 2016). Understanding the feasibility and physiological impact of flexible delivery models is increasingly relevant in real-world contexts. Despite the growing use of digital health interventions, direct comparisons between delivery formats within the same structured and progressive program remain limited (Kupila et al., 2023). Previous studies have reported that structured exercise typically reduces body fat percentage (%BF) by approximately 3% to 10%, often accompanied by modest increases or maintenance of FFM (Bellicha et al., 2021; Ramírez-Vélez et al., 2020), adaptations that are closely linked to improved metabolic health (MH). However, the expected magnitude of these changes among women living with obesity remains inconsistent across studies, particularly regarding FFM adaptations.

The Progressive Power Program (PPP) was developed and validated to address these limitations, integrating progressive overload and individualisation within a flexible structure that can be delivered both in-person and online (Bilro et al., 2026). It is a progressively structured and adaptable exercise protocol designed to accommodate different participant profiles and logistical constraints. The PPP combines moderate-to-high-intensity bodyweight exercises with gradual adjustments in volume, intensity, and recovery based on participant performance and tolerance. Therefore, this 12-week case report examined the metabolic effects of the PPP on BC parameters, including BW, body mass index (BMI), basal metabolic rate (BMR), %BF, FFM, and anthropometric measures, in three Portuguese women living with obesity. By implementing the program in both delivery formats, this study provides preliminary insights into the feasibility and potential physiological benefits of this flexible and scalable exercise intervention.

Based on previous evidence demonstrating that structured exercise can reduce BW and %BF while preserving or increasing FFM (Bellicha et al., 2021; Ramírez-Vélez et al., 2020), we hypothesised that participation in the PPP would lead to reductions in BW and %BF and increases in FFM. Specifically, we hypothesised that: (i) participation in the PPP would reduce BW and %BF while increasing FFM; and (ii) these adaptations would occur similarly across delivery formats.

Methods

Study Design

This study was designed as a 12-week longitudinal comparative case report including three participants with class II obesity allocated to different conditions (in-person intervention, online intervention, and non-exercising control). Body composition and anthropometric parameters were assessed at two time points (baseline and post-intervention) to examine within-subject changes. Given the novelty of the PPP and the limited evidence on its physiological effects, particularly across delivery formats, this approach was considered appropriate for providing preliminary, exploratory insights. Due to the small sample size, no inferential statistical analysis was performed, and the results are presented descriptively to support hypothesis generation for future controlled studies.

The study was approved by the Ethics Committee of the University of Évora (approval no. 22175). It was conducted in accordance with the principles of the World Medical Association's Declaration of Helsinki for research involving human participants. All participants were informed about the study objectives, potential risks and benefits, and their right to withdraw at any time without penalty. Written informed consent was obtained from all participants before enrolment. This study is part of a research project that was prospectively registered in the ISRCTN registry (ISRCTN15820243) (Bilro, 2025).

Participants

Participants were recruited through an online advertisement describing the exercise program and study objectives. Interested individuals registered via a Google Forms link shared on social media and were subsequently screened against the predefined inclusion criteria. After that, eligibility was evaluated through a one-to-one interview, during which the following inclusion criteria were applied: (1) reside in the municipality of Évora; (2) be aged 18 to 64 years; and (3) present a BMI ≥25 kg/m² (Abernathy & Black, 1996). Exclusion criteria included lack of access to a computer, tablet or smartphone; absence of regular internet access; diagnosis or medication for cardiovascular, pulmonary, renal, hepatic, or neurological diseases; and any medical or orthopaedic condition that prevented independent exercise or walking.

Therefore, this case study included three women enrolled in an exercise-based intervention program. Participant A was a 42-year-old woman (height: 167 cm; weight: 99.1 kg; BMI: 35.5 kg/m²), Participant B was a 41-year-old woman (height: 159 cm; weight: 93.1 kg; BMI: 36.8 kg/m²), and Participant C was a 55-year-old woman (height: 157 cm; weight: 87.4 kg; BMI: 35.5 kg/m²). All participants were classified as having class II obesity (Pi-Sunyer, 2000), and BMI classification followed World Health Organisation (WHO) criteria (WHO, 2000).

Participants were allocated to the three groups using a simple random allocation procedure to assign Participant A to the in-person group (IPG), Participant B to the online group (OG), and Participant C to the control group (CG), which did not undertake any exercise program.

Measurements

Height was measured with a stadiometer (SECA® 220, Hamburg, Germany), and BC parameters with a multifrequency bioelectrical impedance analyser (TANITA®, MC 780MA, Amsterdam, The Netherlands) (Baran et al., 2022). Waist, hip and thigh circumferences were measured with an accuracy of 0.1 cm, and BW with 0.01 kg precision. BMI was calculated as BW (kg) / height² (m²).

BC parameters assessed via bioelectrical impedance included BW (kg), %BF, BMR (kcal), and FFM (%). Measurements were performed in the morning, in a temperature-controlled room, with participants fasting. Participants were instructed to: (i) abstain from food and drink for six hours before testing; (ii) avoid alcohol consumption and high-intensity exercise for 12 hours prior; (iii) empty their bladder immediately before the test; and (iv) rest for at least five minutes before measurements.

Intervention

The exercise intervention followed the PPP, a structured and progressive training protocol previously described in detail elsewhere (Bilro et al., 2026).

The intervention lasted 12 weeks and consisted of three supervised sessions per week, each lasting approximately 50 minutes. Each session comprised three phases: (i) a general warm-up consisting of five minutes of walking at approximately 65% HRmax; (ii) a specific component involving bodyweight exercise circuits performed at moderate-to-high intensity (75–95% HRmax) until volitional fatigue; and (iii) a high-intensity or interval-based component, depending on the session, followed by active recovery through low-intensity walking.

The training programme was structured into three progressive phases (weeks 1–4, 5–8, and 9–12), with a gradual increase in volume and intensity. Sessions 1 and 2 consisted of multiple sets (ranging from 2–3 to 6–7 sets) of six bodyweight exercises performed for 15–25 repetitions at progressively higher intensities (75–95% HRmax), interspersed with short recovery periods. Session 3 followed an interval-based format, consisting of repeated 20-second bouts of high-intensity exercise alternated with 10-second recovery periods.

All exercises were performed without external load and were selected for their simplicity, adaptability, and suitability for individuals living with obesity (Jönhagen et al., 2009). Examples of exercises included bodyweight squats, lunges, jumping jacks, abdominal exercises, and dynamic functional movements adapted to each participant's tolerance and fitness level. Training intensity was monitored using heart rate, and progression was individually adjusted by modifying exercise duration, number of repetitions, number of sets, and recovery intervals throughout the programme. All sessions were supervised by a sports science graduate.

Given the exploratory case report design and the limited number of participants, no formal sample size calculation was performed.

Results

Results are presented as percentage change (Δ%), calculated as [(FV − IV) / IV] × 100, where FV represents the final value and IV the initial value. Positive values indicate percentage increases, whereas negative values indicate reductions.

Participants A and B demonstrated changes in several BC parameters from pre- to post-intervention (Table 1), including consistent reductions in body weight, BMI, and BMR.

Participant A showed a greater reduction in %BF and a corresponding increase in FFM, whereas Participant B exhibited similar trends.

Differences in the magnitude of these changes were observed between participants.

Regarding circumferences, both intervention participants showed reductions in waist, hip, and thigh circumferences, whereas the control participant showed no consistent improvements. The waist-to-hip ratio decreased in Participants A and C, while a slight increase was observed in Participant B.

Table 1. Changes in body composition parameters.

Participant		A	B	C
		Groups		
Outcomes	**Moments**	**In-person Group**	**Online Group**	**Control Group**
BW (kg)	Baseline	99.10	93.10	87.40
	After 12 weeks	90.40	85.00	87.60
	Δ%	-8.78%	-8.70%	0.23%
BMI (kg/m^2)	Baseline	35.50	36.80	35.50
	After 12 weeks	32.40	33.60	35.50
	Δ%	-8.73%	-8.70%	0.00%
BMR (kcal·day^{-1})	Baseline	1670	1640	1580
	After 12 weeks	1610	1550	1590
	Δ%	-3.59%	-5.49%	0.63%
BF (%)	Baseline	45.80	40.30	35.50
	After 12 weeks	38.00	34.30	35.10
	Δ%	-17.03%	-14.89%	-1.13%
FFM (%)	Baseline	53.80	56.70	59.40
	After 12 weeks	58.00	59.70	59.90
	Δ%	7.81%	5.29%	0.84%
WC (cm)	Baseline	120.00	111.00	104.00
	After 12 weeks	98.00	98.00	100.00
	Δ%	-18.33%	-11.71%	-3.85%
HC (cm)	Baseline	120.00	125.00	117.00
	After 12 weeks	115.00	109.00	121.00
	Δ%	-4.17%	-12.80%	3.42%
TC (cm)	Baseline	69.00	72.00	58.00
	After 12 weeks	65.00	62.00	61.00
	Δ%	-5.80%	-13.89%	5.17%
WC/HC Ratio	Baseline	1.00	0.89	0.89
	After 12 weeks	0.85	0.90	0.83
	Δ%	-15.00%	+1.12%	-6.74%

Abbreviations: BW, body weight; BMI, body mass index; BF, body fat; BMR, basal metabolic rate; FFM, fat-free mass; kg, kilograms; WC, waist circumference; HC, hip circumference; TC, thigh circumference; Δ%, variation.

Individual changes in body composition and anthropometric measures over the 12-week intervention are presented in Figure 1.

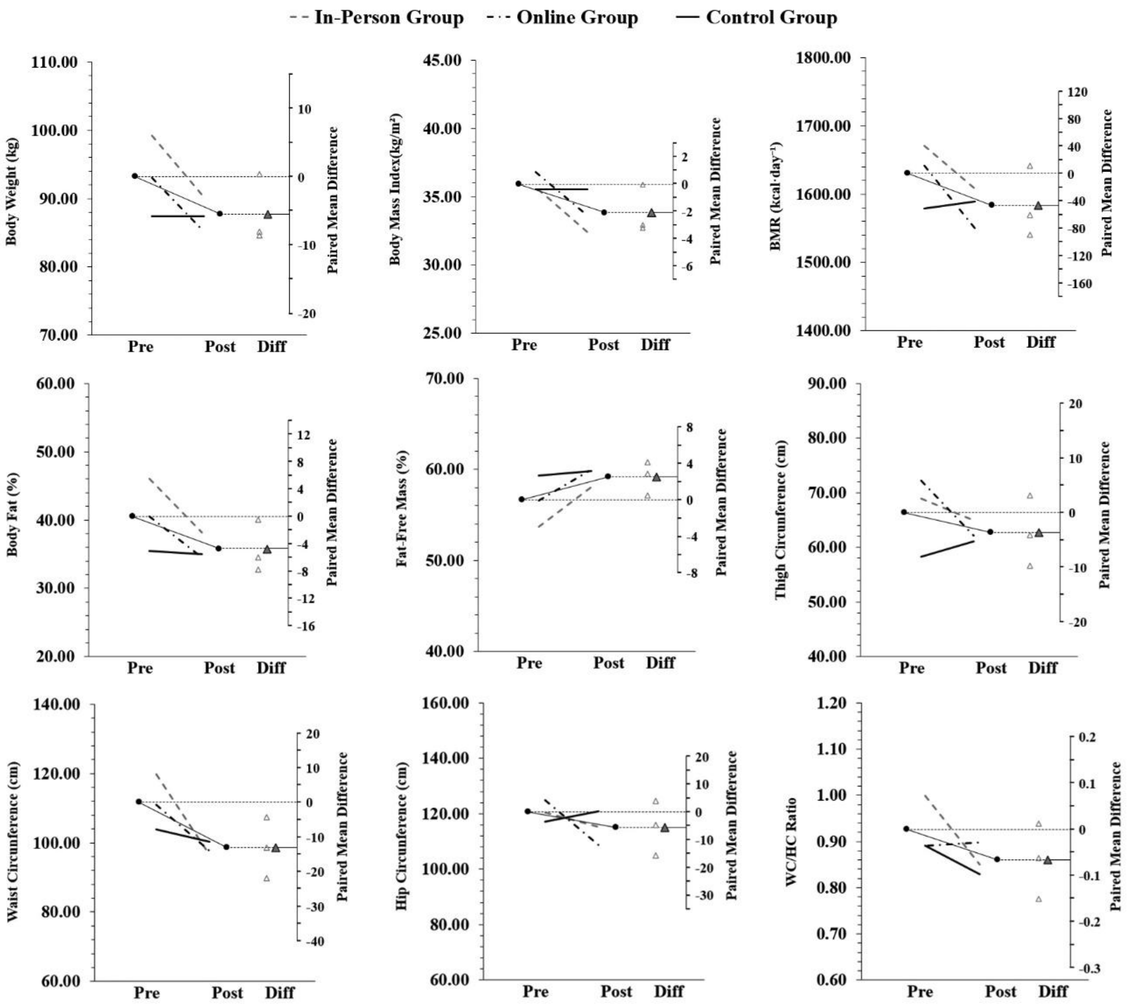

Figure 1: Individual changes in body composition and anthropometric parameters across the 12-week intervention in the in-person, online, and control groups. Abbreviations: kg, kilograms; m, meter; BMR, basal metabolic rate; %, percent; cm, centimetres; WC, waist circumference; HC, hip circumference. Measurements are presented at baseline (Pre), post-intervention (Post), and as paired mean differences (Diff).

Discussion

The primary aim of this case report was to examine the effects of the PPP on BC parameters in adult women living with obesity, and secondarily, to explore potential differences between in-person and online delivery formats. Although the study design is a case report, the findings are consistent with the proposed hypotheses. Participation in the PPP appeared to be associated with reductions in BW and %BF, along with increases in FFM. Furthermore, similar improvements were observed in both the in-person and online delivery formats, suggesting that the program may be associated with comparable physiological adaptations regardless of the mode of implementation (Figure 1).

Both participants who completed the PPP in person and those who completed it online achieved a 9% reduction in BW, whereas the control participant experienced a slight increase. The 9% reduction in BW was accompanied by a 7–8% increase in FFM, which may reflect favourable adaptations in metabolic efficiency and skeletal muscle function. Although Participant A showed a greater reduction in %BF than Participant B, this difference may reflect individual variability in fat distribution and metabolic responsiveness. From a physiological standpoint, these adaptations are consistent with the expected outcomes of structured exercise programs aimed at reducing FM while preserving or increasing FFM, as consistently reported in systematic reviews and experimental studies in adults living with obesity (Ahn et al., 2022; Bellicha et al., 2021; Ramírez-Vélez et al., 2020).

Increases in FFM reflect skeletal muscle hypertrophy and mitochondrial biogenesis, which in turn enhance substrate oxidation and insulin sensitivity (Ahn et al., 2022; Hawley et al., 2014). The observed decrease in BMR, despite improved BC, may reflect metabolic compensation due to reduced BW, rather than a negative adaptation. Such responses are commonly reported following energy expenditure-driven interventions and are thought to reflect improved metabolic economy at rest (Ahn et al., 2022; Hawley et al., 2014).

For instance, Ramírez-Vélez et al. (2020) observed a 6% reduction in BW after 12 weeks of HIIT or resistance training (RT), while Reljic et al. (2021) found 2–3% reductions with HIIT or moderate-intensity continuous training (MICT). In a longer 16-week trial, Gorostegi-Anduaga et al. (2018) reported 7–10% reductions across various aerobic programs, although participants also received dietary and pharmacological interventions. Although the magnitude of the observed changes appears broadly consistent with previous structured exercise programs in adults living with obesity, direct comparisons should be interpreted with caution due to differences in study design, participant characteristics, intervention duration, and exercise modalities.

Importantly, the comparable improvements observed in both in-person and online delivery formats suggest that structured exercise programs can be effectively delivered online. Previous research has demonstrated that digital and internet-delivered lifestyle interventions can produce meaningful reductions in BW and improvements in health-related behaviours, supporting their potential as scalable and accessible strategies for obesity management (Kupila et al., 2023; Sherrington et al., 2016). These findings are also consistent with studies comparing in-person and online exercise programs, which have reported similar physiological and behavioural outcomes across delivery formats (Kupila et al., 2023; Sherrington et al., 2016).

The BC parameters were assessed using BIA, a method that may be less accurate in individuals living with obesity, particularly for estimating FFM and BMR. This limitation is partly related to assumptions of constant FFM hydration and body fluid distribution, which may vary in individuals with higher adiposity (Achamrah et al., 2018; Kyle et al., 2004). Studies comparing BIA with reference methods such as dual-energy X-ray absorptiometry (DXA) have reported systematic differences in the estimation of BC parameters, with BIA sometimes overestimating FFM and underestimating FM in certain BMI ranges (Achamrah et al., 2018). Moreover, the relationship between anthropometric indicators and %BF may vary according to factors such as age and sex, which can influence BC estimation (Deurenberg et al., 1996).

Nevertheless, BIA remains widely used in clinical and exercise research, including studies involving individuals living with obesity and exercise-based interventions (Ahn et al., 2022; Ramírez-Vélez et al., 2020), due to its non-invasive, rapid, and relatively low-cost nature. When standardised measurement procedures are followed, this approach can provide reasonably reliable estimates and is particularly useful for monitoring longitudinal changes in body composition during lifestyle and exercise interventions (Marra et al., 2019).

Several methodological limitations must be acknowledged. The small sample size and case report design limit the generalizability of the findings and preclude causal inference. In addition, dietary intake was neither controlled nor monitored throughout the intervention, representing a potential confounding factor that may have influenced the observed changes in body composition. Future studies should incorporate dietary standardisation or detailed nutritional monitoring to better isolate the independent effects of the exercise intervention.

Despite these methodological considerations, the observed physiological responses, particularly the concomitant reduction in FM and increase in FFM, provide preliminary evidence suggesting that participation in the PPP may be associated with meaningful metabolic and muscular adaptations. Furthermore, offering the program both in-person and online may enhance accessibility and reduce barriers to participation, highlighting the potential of flexible, scalable exercise programs to support long-term obesity management and improve MH and functional capacity in women living with obesity, whether delivered in-person or online.

Conclusion

The 12-week PPP may lead to reductions in BW and improvements in BC parameters in women living with obesity, regardless of the delivery format.

These outcomes suggest that the PPP may be a promising non-pharmacological approach to obesity management, with the potential to accommodate participants' personal, social, and logistical circumstances.

Future randomised controlled trials with larger sample sizes are warranted to confirm these findings and explore the potential synergistic benefits of combining the PPP with dietary and behavioural strategies.

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