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Body Composition Changes over a 7-Month Period in Midlife Women Participating in a Multicomponent Exercise Programme: Weight Status and Assessment Methods

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Abstract

Background and Objectives: In women, midlife is associated with changes in body composition, including increased adiposity and central fat distribution. This study examined changes in body composition over the course of a 7-month multicomponent physical activity programme in midlife women, compared changes by baseline weight status, and investigated the relationship between ultrasound-derived subcutaneous adipose tissue thickness and bioelectrical impedance analysis (BIA)-derived fat mass. **Methods**: This prospective pre–post study included 40 women who completed a structured 7-month multicomponent physical activity programme. Anthropometric measurements, ultrasound assessments of subcutaneous adipose tissue thickness at three anatomical sites, and BIA-derived body composition parameters were collected at baseline and after the intervention. **Results**: Significant reductions were observed in body weight, circumferences, subcutaneous adipose tissue thickness, and fat mass (all $p < 0.01$), while fat-free mass did not change significantly. Overweight and obese women showed greater absolute reductions in several anthropometric and body composition variables than normal-weight women ($p < 0.05$), whereas between-group differences in fat mass reductions were not statistically significant. Ultrasound-derived adiposity measures were significantly correlated with BIA-derived fat mass, with correlation coefficients ranging from 0.44 to 0.82 for most measurements ($p < 0.01$). **Conclusions**: Changes in anthropometric and body composition parameters were observed over the 7-month period among women participating in the multicomponent physical activity programme. The findings highlight differences in absolute changes according to baseline weight status and support further investigation of ultrasound-derived adiposity measures as complementary tools for body composition assessment. Controlled studies are needed to establish the specific contribution of multicomponent exercise to these changes.

Keywords: physical activity; body composition; adiposity; ultrasound; bioelectrical impedance analysis

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1. Introduction

The increasing prevalence of overweight and obesity represents a major public health concern worldwide. In 2022, approximately 43% of adults globally were overweight, and 16% were living with obesity [1]. The widespread adoption of obesogenic lifestyles has

contributed to a major public health crisis, with more than one billion individuals affected and obesity prevalence continuing to rise in nearly all countries [1,2]. Excess adiposity is associated with increased morbidity and mortality, including cardiovascular disease, diabetes, and other chronic conditions [3]. These trends highlight the importance of effective strategies for monitoring and improving body composition.

Although body mass index (BMI) is widely used to classify overweight and obesity, it does not provide information on total body fat or its distribution. Furthermore, BMI does not account for variations due to growth, ageing, or population differences [4,5]. Therefore, complementary methods are needed to assess body composition more comprehensively. Bioelectrical impedance analysis (BIA) is widely used because of its low cost, rapid application, and portability, although its estimates depend on predictive equations. Ultrasound assessment of subcutaneous adipose tissue thickness has also emerged as a non-invasive method for evaluating regional adiposity [6]. A recent scoping review highlighted advances in ultrasound-based body composition assessment over the past decade, while identifying the need for further validation, particularly regarding the estimation of whole-body fat mass (FM) and the monitoring of longitudinal changes [7].

Women globally exhibit higher rates of overweight and obesity than men [2], owing to differences in body fat distribution, energy metabolism, and other physiological factors related to obesity [8]. Sex differences have also been reported in physical activity (PA) levels and sedentary behaviour, with women generally engaging more frequently in lower-intensity activities and showing distinct activity patterns across the lifespan [9]. These differences highlight the importance of examining body composition and PA responses specifically in women. Although many studies focus on weight loss among individuals with overweight or obesity, the present study adopts a broader perspective by examining anthropometric and body composition changes in midlife women who voluntarily participated in a 7-month multicomponent PA programme.

In Italy, national data indicate that approximately 40% of adults aged 18–69 years are overweight or obese, with a higher prevalence among men than women (51.5% vs. 34.5%) [10,11]. Excess body weight is also associated with socioeconomic inequalities, while its prevalence increases with age. Despite the established health benefits of regular PA, sedentary behaviour remains widespread in Italy, particularly among women and adults over 45 years of age [12]. These data support the relevance of feasible and sustainable PA programmes targeting women during midlife and ageing, when women experience a physiological tendency toward increased FM and unfavourable changes in body composition [13].

Regular PA is associated with improvements in body composition and cardiometabolic health, while exercise-based weight-management strategies may contribute to reductions in adiposity and cardiovascular risk [14,15]. Recent evidence from a network meta-analysis of randomized controlled trials has further highlighted differences in the effects of exercise modalities on anthropometric and metabolic outcomes in adults with overweight and obesity [16]. Multicomponent programmes combining aerobic and muscle-strengthening exercises, together with balance and mobility activities, may provide a practical and adaptable approach for adults with different levels of physical fitness. However, evidence regarding their effects on body composition in midlife women remains limited, particularly when local adiposity assessed by ultrasound is considered alongside whole-body estimates obtained through BIA. Further investigation is therefore warranted to characterise changes in anthropometric and body composition measures following structured multicomponent PA programmes.

Accordingly, this study aimed to describe changes in anthropometric characteristics and body composition parameters over 7 months among midlife women participating in a

multicomponent PA programme. Secondary aims were to compare absolute and percentage changes between normal-weight and overweight/obese participants and to examine the associations between ultrasound-derived subcutaneous adipose tissue thickness and BIA-derived FM at baseline and after 7 months. By combining longitudinal assessment, weight-status comparisons, and regional ultrasound measurements, this study seeks to contribute to the understanding of body composition changes in midlife women and the complementary information provided by different assessment methods. We hypothesized that participants would show reductions in adiposity-related measures, with relative preservation of fat-free mass, and that ultrasound-derived subcutaneous adipose tissue thickness would be positively associated with BIA-derived FM.

2. Materials and Methods

2.1. Research Design and Participants

We initially recruited 45 apparently healthy women by directly inviting women attending a fitness centre in Ferrara, Italy. Participants voluntarily enrolled in the programme to improve their physical fitness. The programme consisted of two supervised sessions per week over a 7-month period. To be included in the final analysis, participants were required to attend at least 80% of the scheduled sessions. Five initially recruited women did not meet this adherence criterion and were therefore excluded from the final analysis. The remaining 40 participants met the eligibility criteria, completed the 7-month structured PA programme, and were included in the final analysis. The analysed sample had a mean age of 46.1 $\pm$ 7.4 years. Menopause was defined as at least 12 consecutive months of amenorrhea. Ten of the 40 women (25%) met this criterion, while the remaining 30 were classified as non-postmenopausal.

Participants were assessed at two time points: baseline (T0) and at the end of the 7-month programme (T1). They were instructed to maintain their habitual dietary patterns throughout the intervention period.

The inclusion criteria were: (1) female sex; (2) age between 35 and 65 years; (3) voluntary participation with written informed consent; (4) availability of repeated anthropometric and body composition measurements at scheduled time points for inclusion in the final analytical database; (5) medical clearance for PA; and (6) not engaging in any other organised exercise or structured physical or sports activities.

An a priori power analysis was performed using G*Power software (version 3.1.9.7; Heinrich-Heine-Universität Düsseldorf, Düsseldorf, Germany). A two-tailed paired-samples *t*-test was specified, assuming a medium effect size (Cohen's d = 0.50), an alpha level of 0.05, and statistical power of 0.80. Under these assumptions, the minimum required sample size was 34 participants. The medium effect size was selected as a conventional planning assumption in the absence of pilot data. To account for potential dropouts, a larger sample (n = 45) was initially recruited. As suggested by Andrade [17], the a priori sample size was determined for analyses related to the primary objectives.

This study was conducted in accordance with the principles set out in the Declaration of Helsinki, and all participants provided written informed consent. The study protocol was approved by the Bioethics Committee of the University of Bologna (protocol code 0157696, 6 June 2024).

2.2. Body Composition Assessment

The same trained operator performed all anthropometric measurements according to standardised procedures [18]. Measured variables included stature, body weight, and waist and hip circumferences, as well as mid-upper arm, thigh, and calf circumferences.

Stature was measured to the nearest 0.1 cm using an anthropometer (Magnimeter, Raven Equipment Ltd., Dunmow, Essex, UK), with the participant standing upright and the head positioned in the Frankfurt plane. Body weight was measured to the nearest 0.1 kg using a calibrated digital scale (SECA, Basel, Switzerland). Waist circumference (WC) was measured at the level of the omphalion, and hip circumference (HC) at the point of greatest gluteal protrusion. Mid-upper arm circumference (MUAC) was measured at the midpoint between the acromion and the olecranon, while the arm was relaxed. Thigh circumference was measured at the hypoischial level, and calf circumference at the sura level. All circumferences were measured with a non-elastic tape (Seca medical tape, SECA, Hamburg, Germany) to the nearest 0.1 cm.

BMI was calculated as weight (kg) divided by squared stature (m^2). WHO cutoffs (2000) were used to classify weight status.

Subcutaneous superficial adipose tissue thickness (SAT) was measured in the standing position using ultrasound adipometry (BodyMetrix Deluxe 2D, Hosand Technologies s.r.l., Viterbo, Italy), in accordance with the manufacturer's guidelines. Two ultrasound readings were taken at each site, and the mean was used in the analyses. Measurements were taken at three sites: the triceps, abdomen, and thigh. The triceps site was located midway between the shoulder and the elbow, on the back of the arm. The abdominal site was located 3 cm lateral to the omphalion. The thigh site was located along the anterior midline, midway between the knee and the hip. The sum of the three thicknesses (ΣSATs) was calculated. SAT thickness (mm) was considered the primary indicator of local adiposity.

Total body composition parameters (fat-free mass, FFM, kg; fat mass, FM, kg; fat percentage, %Fat) were assessed using single-frequency bioimpedance analysis (Akern 101 Sport Edition, Akern Srl, Florence, Italy), operating at a frequency of 50 kHz and with a constant current of 400 μA. Resistance (Rz, ohms) and reactance (Xc, ohms) were measured in the supine position in the morning using a right-sided tetrapolar electrode placement. All assessments were performed under standardised conditions for bioelectrical impedance analysis (BIA) on fasted participants. Measurements were taken under conditions that excluded prior exercise and the presence of metallic objects. In addition, for participants who were not postmenopausal, measurements were performed outside the menstrual bleeding phase, based on participants' self-report at the time of assessment. At T1, the assessment conditions were the same as at T0. FFM was estimated using the regression equation proposed by Kyle et al. [19]. FM was calculated as body weight minus FFM, and %Fat as (FM/weight) × 100.

2.3. Exercise Intervention

The exercise intervention consisted of a 7-month multicomponent PA programme designed according to the FITT-VP principles (frequency, intensity, time, type, volume, and progression). Participants performed two supervised training sessions per week, each lasting approximately 50–60 min (100–120 min per week). Exercise intensity was monitored using the Rating of Perceived Exertion (RPE) scale and was maintained within a target range of 11–14.

The training programme followed a progressive structure over the 7 months, with gradual increases in exercise intensity and complexity to promote physiological adaptations and ensure participant safety.

Each session included a warm-up (10 min; RPE 9–10; light aerobic activity, such as slow walking, combined with dynamic joint mobility exercises for the upper and lower limbs), aerobic training (20–25 min; RPE 11–14; moderate-intensity continuous or interval exercise, such as brisk walking or stationary cycling), strength training (15–20 min; RPE 12–14; functional resistance exercises targeting major muscle groups, e.g., squats,

lunges, step-ups, resistance band exercises, and core stability exercises), balance training (3–5 min; RPE 11–12; static and dynamic exercises, such as single-leg stance, tandem walking, and postural control tasks), and a cool-down with stretching (5–10 min; RPE 9–10; static stretching for major muscle groups and diaphragmatic breathing). The programme was designed to improve overall physical fitness and functional capacity. All exercise sessions were conducted by the same instructor throughout the 7-month intervention, ensuring continuity in programme delivery. Participants were required to attend at least 80% of the scheduled sessions to be included in the final sample. Further details regarding the frequency, intensity, time, type, volume, and progression of the intervention are provided in Supplementary Table S1.

2.4. Statistical Analysis

Continuous variables are presented as means and standard deviations (SDs). Normality was assessed using the Shapiro–Wilk test on paired difference scores for T0–T1 comparisons and on absolute and percentage change scores within each group for between-group comparisons. Changes between T0 and T1 in the overall sample were assessed using paired-samples Student's *t*-tests. Because the paired differences in abdominal SAT showed evidence of non-normality ($W = 0.942$, $p = 0.041$), the Wilcoxon signed-rank test was also performed as a sensitivity analysis. To compare longitudinal changes in anthropometric traits and body composition parameters according to baseline weight status, participants were categorized as normal-weight or overweight/obese based on BMI classification at baseline. Absolute changes ($\Delta = T0 - T1$) and percentage changes were calculated for each outcome and compared between groups using independent-samples Student's *t*-tests. Levene's test was used to assess homogeneity of variances: when Levene's test indicated unequal variances, Welch's *t*-test with separate variance estimates was used. Because the percentage change in thigh circumference showed evidence of non-normality in the overweight/obese group, the Mann–Whitney U test was also performed as a sensitivity analysis. These comparisons were considered exploratory, as weight-status groups were not randomly assigned and may have differed in baseline characteristics. In a separate analysis of body weight, ANCOVA was used to compare T1 weight by baseline weight-status group, adjusting for T0 weight. Homogeneity of regression slopes was assessed by including the group-by-T0-weight interaction; the final model was fitted without this interaction.

Exploratory comparisons of changes by menopausal status were conducted between non-postmenopausal and postmenopausal participants. Between-group differences in changes were assessed using independent-samples *t*-tests, with Welch's test used when variances were unequal.

Ninety-five percent confidence intervals (95% CIs) were calculated for mean paired changes and between-group differences. CIs for Pearson's correlation coefficients were calculated using the refined Fisher z method.

Effect sizes were calculated using Cohen's d_z for dependent samples and Cohen's d for independent-group comparisons, and interpreted as small (0.2), medium (0.5), and large (0.8). Pearson's correlation coefficient (r) was calculated to assess the relationship between ultrasound-derived SAT (local adiposity) and BIA-derived FM parameters (whole-body adiposity) in the overall sample. The strength of Pearson's correlation coefficients |r| was classified as very weak (0.00–0.19), weak (0.20–0.39), moderate (0.40–0.59), strong (0.60–0.79), and very strong (0.80–1.00), following Evans [20]. These thresholds were considered descriptive guidelines rather than absolute criteria, as the interpretation of correlation strength depends on the research context [21]. All *t*-tests, including Welch's *t*-tests, were two-tailed. The level of statistical significance was set at $p < 0.05$. All analyses were performed using STATISTICA software (version 11; StatSoft, Tulsa, OK, USA).

3. Results

3.1. Anthropometric Traits and Body Composition Parameters Before and After a 7-Month PA Intervention

Table 1 presents anthropometric traits and body composition parameters assessed at baseline (T0) and after 7 months of structured PA (T1) in the overall sample, using the paired-samples *t*-test.

Table 1. Anthropometric traits and body composition parameters at baseline (T0) and after the 7-month physical activity intervention (T1) in the overall sample of middle-aged women (n = 40).

	T0		T1				
Variables	**Mean**	**SD**	**Mean**	**SD**	**t (39)**	***p*-Value**	**Cohen's d_z**
Stature (cm)	164.0	5.6	-	-			
Weight (kg)	67.0	10.6	65.5	9.7	3.5870	**0.0009**	0.55
BMI (kg/m^2)	25.0	4.0	24.4	3.6	3.5714	**0.0010**	0.60
WC (cm)	88.9	10.7	85.2	9.1	4.8983	**<0.0001**	0.78
HC (cm)	102.5	6.9	99.7	5.8	6.1894	**<0.0001**	1.00
MUAC (cm)	28.6	2.8	27.7	2.4	4.6473	**<0.0001**	0.67
Thigh C (cm)	56.1	4.3	54.7	3.8	4.2418	**<0.0001**	0.67
Calf C (cm)	36.3	2.5	35.8	2.4	5.1523	**<0.0001**	0.86
Triceps SAT (mm)	15.5	4.1	13.1	3.8	4.0458	**0.0002**	0.66
Abdomen SAT (mm)	26.4	11.7	19.7	7.0	6.2891	**<0.0001**	0.99
Thigh SAT (mm)	19.2	3.8	15.7	3.9	6.1224	**<0.0001**	0.97
ΣSATs (mm)	61.0	15.9	48.5	12.0	7.6613	**<0.0001**	1.21
Fat-Free Mass (kg)	48.2	4.9	48.9	4.6	−1.2298	0.2261	−0.19
Fat Mass (kg)	18.9	8.1	16.7	6.9	3.2151	**0.0026**	0.51
%Fat	27.3	7.8	24.8	6.8	2.8294	**0.0073**	0.45

Note: WC = waist circumference; HC = hip circumference; MUAC = mid-upper-arm circumference; C = circumference; SAT = Subcutaneous Superficial Adipose Tissue. Values in bold indicate statistically significant results.

Significant differences between T0 and T1 were observed for all variables except FFM. Mean values showed a consistent decrease over time for all anthropometric and adiposity-related variables, whereas FFM exhibited a slight, non-significant increase.

With respect to effect size, a small effect size was observed only for FFM, while all other variables showed medium to large effect sizes. The largest effects were observed for SATs and ΣSAT, as well as for WC, HC, MUAC, and thigh and calf circumferences, among anthropometric traits.

On average, body weight decreased by 1.5 ± 2.7 kg [95% CI: 0.7 to 2.4 kg] over the intervention period, with a corresponding reduction in BMI (0.6 ± 1.0 kg/m^2) [95% CI: 0.3 to 0.9 kg/m^2]. WC decreased by 3.8 ± 4.9 cm [95%CI: 2.2 to 5.3 cm], and HC by 2.8 ± 2.8 cm [95% CI: 1.9 to 3.7 cm]. MUAC decreased by 0.8 ± 1.2 cm [95% CI: 0.5 to 1.2 cm]. In the lower limb, thigh circumference decreased by 1.4 ± 2.1 cm [95% CI: 0.7 to 2.1 cm], and calf circumference by 0.6 ± 0.7 cm [95% CI: 0.3 to 0.8 cm].

Regarding body adiposity, triceps SAT decreased by 2.5 ± 3.8 mm [95% CI: 1.2 to 3.7 mm], abdominal SAT showed the largest reduction (6.7 ± 6.7 mm) [95% CI: 4.5 to 8.8 mm], and thigh SAT decreased by 3.5 ± 3.6 mm [95% CI: 2.3 to 4.6 mm]. ΣSATs decreased, on average, by 12.6 ± 10.4 mm [95% CI: 9.3 to 15.9 mm]. The Wilcoxon signed-rank sensitivity analysis also confirmed a significant reduction in abdominal SAT (n = 40, T = 44.00, Z = 4.9195, $p < 0.0001$), consistent with the paired-samples *t*-test reported in Table 1.

FM assessed by BIA decreased significantly from T0 to T1, with a mean reduction of 2.2 ± 4.3 kg [95% CI: 0.8 to 3.5 kg]. Similarly, %Fat decreased by 2.5 ± 5.6 percentage points

[95% CI: 0.7 to 4.3 percentage points], while no significant change was detected for FFM (−0.7 ± 3.8 kg) [95% CI: −1.9 to 0.5 kg].

3.2. Differences in Anthropometric and Body Composition Change According to Weight Status

As expected, at baseline (Table 2), the overweight/obese group had higher mean values for body weight, BMI, circumferences, SAT thickness, FM, and %Fat; FFM was also higher. Given the exploratory nature of this comparison and the BMI-based group classification, these findings are descriptive and should be interpreted cautiously.

Table 2. Sample baseline characteristics by weight status.

Variables	Baseline			
	Normal Weight (n = 23)		OW/Obese (n = 17)	
	Mean	SD	Mean	SD
Stature (cm)	164.9	6.0	162.7	4.9
Weight (kg)	60.6	6.3	75.8	8.8
BMI (kg/m^2)	22.3	1.8	28.6	3.1
WC (cm)	82.4	7.6	97.8	7.5
HC (cm)	98.0	3.7	108.5	5.3
MUAC (cm)	27.1	2.2	30.7	2.3
Thigh C (cm)	53.9	3.3	59.2	3.6
Calf C (cm)	35.2	2.0	37.8	2.3
Triceps SAT (mm)	14.3	3.7	17.2	4.1
Abdomen SAT (mm)	20.1	7.8	34.9	10.8
Thigh SAT (mm)	18.4	3.9	20.2	3.5
ΣSATs (mm)	52.7	12.4	72.3	13.2
Fat-Free Mass (kg)	46.1	4.2	50.9	4.5
Fat Mass (kg)	14.4	4.3	24.9	8.2
%Fat	23.6	5.6	32.3	7.8

Note: WC = waist circumference; HC = hip circumference; MUAC = mid-upper-arm circumference; C = circumference; SAT = Subcutaneous Superficial Adipose Tissue.

Table 3 reports the absolute and percentage changes (Δ) between T0 and T1 in normal-weight women and overweight/obese women. Overweight/obese participants showed significantly greater absolute reductions compared with normal-weight women in body weight, WC, abdominal SAT, and ΣSATs. The same outcomes showed statistically significant between-group differences when changes were expressed as percentages.

Effect size analysis indicated large standardized mean differences for the majority of variables: eight out of fourteen both for absolute and percentage changes. No significant between-group differences were observed for FFM, either in absolute or percentage changes.

The group-by-baseline-weight interaction was not statistically significant ($F(1, 36) = 1.1158$, $p = 0.2979$), providing no evidence that the association between baseline and T1 weight differed between groups. We therefore fitted a standard ANCOVA, with T1 weight as the dependent variable, baseline weight-status group as a factor, and baseline weight as a covariate. The adjusted between-group difference in T1 weight (overweight/obesity minus normal weight) was −2.29 kg (95% CI: −4.45 to −0.14 kg; $F(1, 37) = 4.6466$, $p = 0.0377$).

Table 3. Absolute and percentage changes (Δ) in anthropometric and body composition parameters in normal-weight and overweight/obese women following a 7-month intervention.

Change in	Absolute Δ							Percentage Δ						
	Normal Weight (n = 23)		OW/Obese (n = 17)					Normal Weight (n = 23)		OW/Obese (n = 17)				
	Mean	SD	Mean	SD	OW/Obese—NW Mean [95%CI]	*p*-Value	Cohen's d	Mean	SD	Mean	SD	OW/Obese—NW Mean [95%CI]	*p*-Value	Cohen's d
Weight (kg)	0.30	1.94	3.18	2.72	2.88 (1.28 to 4.46)	**0.0004**	1.22	0.52	3.35	4.12	3.75	3.60 (1.26 to 5.93)	**0.0028**	1.02
BMI (kg/m^2)	0.13	0.75	1.19	1.04	1.06 (0.45 to 1.67)	**0.0006**	1.16	0.52	3.35	4.12	3.75	3.60 (1.26 to 5.93)	**0.0028**	1.02
WC (cm)	1.30	3.07	7.09	4.91	5.79 (3.01 to 8.58)	**0.0002** [a]	1.43	1.49	3.53	7.24	5.07	5.76 (2.82 to 8.70)	**0.0001**	1.35
HC (cm)	1.44	1.95	4.53	2.86	3.09 (1.44 to 4.74)	**0.0002**	1.28	1.47	2.01	4.13	2.58	2.66 (1.12 to 4.20)	**0.0007**	1.17
MUAC (cm)	0.37	0.95	1.49	1.11	1.12 (0.44 to 1.80)	**0.0014**	1.09	1.29	3.41	4.78	3.48	3.48 (1.24 to 5.72)	**0.0030**	1.01
Thigh C (cm)	0.68	1.57	2.41	2.37	1.73 (0.37 to 3.09)	**0.0085**	0.88	1.24	2.90	3.98	3.92	2.74 (0.43 to 5.05)	**0.0149** [b]	0.81
Calf C (cm)	0.35	0.61	0.85	0.70	0.51 (0.07 to 0.94)	**0.0201**	0.76	1.00	1.76	2.22	1.86	1.23 (0.04 to 2.41)	**0.0399**	0.68
Triceps SAT (mm)	1.95	3.72	3.12	3.99	1.17 (−1.35 to 3.69)	0.3455	0.30	11.04	25.69	16.39	19.60	5.36 (−9.14 to 19.865)	0.4769	0.23
Abdomen SAT (mm)	3.34	4.67	11.19	6.50	7.84 (4.04 to 11.65)	**0.0001**	1.39	12.51	23.51	30.73	12.07	18.23 (6.63 to 29.82)	**0.0059**	0.93
Thigh SAT (mm)	2.83	3.89	4.29	2.97	1.46 (−0.73 to 3.66)	0.2032	0.41	14.26	16.83	20.96	14.45	6.70 (−3.35 to 16.75)	0.1947	0.42
ΣSATs (mm)	8.12	8.72	18.60	8.72	10.48 (4.65 to 16.31)	**0.0002**	1.29	13.91	16.20	25.42	9.79	11.51 (3.14 to 19.88)	**0.0080**	0.83
Fat-Free Mass (kg)	−0.80	2.92	−0.63	4.75	0.18 (−2.51 to 2.86)	0.8936 [a]	0.04	−1.95	6.29	−1.75	9.20	0.20 (−5.11 to 5.51)	0.9392 [a]	0.03
Fat Mass (kg)	0.93	2.83	3.82	5.28	2.89 (−0.03 to 5.81)	0.0519 [a]	0.67	5.14	20.85	12.09	23.61	6.94 (−7.70 to 21.59)	0.3310	0.32
%Fat	1.50	4.41	3.83	6.75	2.33 (−1.53 to 6.19)	0.2261 [a]	0.42	4.89	19.74	8.49	23.72	3.60 (−10.83 to 18.03)	0.6038	0.17

Note: Δ = T0 − T1; OW = overweight; NW = normal weight; WC = waist circumference; HC = hip circumference; MUAC = mid-upper-arm circumference; C = circumference; SAT = Subcutaneous Superficial Adipose Tissue. [a] computed with Welch's test. [b] computed with Mann–Whitney U test. Values in bold indicate statistically significant results.

3.3. Baseline Characteristics and Changes According to Menopausal Status

At baseline (Table 4), postmenopausal women had higher mean values for body weight, BMI, circumferences, SAT thickness, FFM, FM, and body %Fat than non-postmenopausal women. They were also older on average. This comparison was exploratory and descriptive, particularly given the small number of postmenopausal participants (n = 10); the findings should therefore be interpreted cautiously.

Table 4. Sample baseline characteristics by menopausal status.

	Non-Post-Menopausal (n = 30)		Post-Menopausal (n = 10)	
Variables	**Mean**	**SD**	**Mean**	**SD**
Age (years)	42.9	5.4	55.8	1.7
Stature (cm)	163.8	5.9	164.6	4.5
Weight (kg)	65.4	10.5	71.8	9.7
BMI (kg/m^2)	24.4	4.0	26.5	3.8
WC (cm)	87.4	11.0	93.7	8.7
HC (cm)	101.3	6.9	106.0	5.9
MUAC (cm)	28.1	3.0	30.2	1.7
Thigh C (cm)	55.4	4.5	58.3	3.2
Calf C (cm)	35.8	2.3	37.8	2.6
Triceps SAT (mm)	15.0	4.0	17.2	4.0
Abdomen SAT (mm)	25.1	11.3	30.1	12.7
Thigh SAT (mm)	18.7	3.9	20.4	3.0
ΣSATs (mm)	58.8	16.8	67.8	11.3
Fat-Free Mass (kg)	47.9	5.0	49.0	4.6
Fat Mass (kg)	17.6	7.9	22.7	7.8
%Fat	26.0	7.8	31.0	7.0

Note: WC = waist circumference; HC = hip circumference; MUAC = mid-upper-arm circumference; C = circumference; SAT = Subcutaneous Superficial Adipose Tissue.

In exploratory analyses (Table 5), no statistically significant between-group differences in changes from T0 to T1 were detected between non-postmenopausal (n = 30) and postmenopausal women (n = 10) (all $p > 0.05$). The confidence intervals were generally wide, particularly for the postmenopausal group; therefore, these findings should be interpreted cautiously and do not establish that changes were equivalent between groups.

Table 5. Comparison of changes by menopausal status.

	Non-Post-Menopausal (n = 30)		Post-Menopausal (n = 10)		Difference (Non-Post − Post)			
Change in	**Mean**	**SD**	**Mean**	**SD**	**[95% CI]**	**t**	**df**	***p*-Value**
Weight (kg)	1.60	2.82	1.30	2.36	0.30 [−1.60 to 2.20]	0.3020	38	0.7643
BMI (kg/m^2)	0.61	1.08	0.47	0.85	0.14 [−0.55 to 0.84]	0.3881	38	0.7001
WC (cm)	3.97	4.31	3.13	6.47	0.84 [−3.95 to 5.63] [a]	0.3845 [a]	11.77 [a]	0.7074 [a]
HC (cm)	2.80	2.91	2.60	2.64	0.20 [−1.86 to 2.29]	0.1955	38	0.8460
MUAC (cm)	0.84	1.06	0.88	1.46	−0.04 [−1.13 to 1.05]	−0.1016	38	0.9196
Thigh C (cm)	1.36	2.13	1.58	2.13	−0.22 [−1.88 to 1.43]	−0.2870	38	0.7757

Table 5. *Cont.*

	Non-Post-Menopausal (n = 30)		Post-Menopausal (n = 10)		Difference (Non-Post − Post)			
Change in	**Mean**	**SD**	**Mean**	**SD**	**[95% CI]**	**t**	**df**	***p*-Value**
Calf C (cm)	0.58	0.72	0.52	0.63	0.06 [−0.44 to 0.56]	0.2220	38	0.8255
Triceps SAT (mm)	2.25	3.06	3.05	5.73	−0.80 [−4.99 to 3.39] [a]	−0.4217 [a]	10.76 [a]	0.6815 [a]
Abdomen SAT (mm)	6.34	5.84	7.70	9.16	−1.36 [−8.12 to 5.39] [a]	−0.4418 [a]	11.54 [a]	0.6668 [a]
Thigh SAT (mm)	3.63	3.74	2.90	3.07	0.73 [−1.76 to 3.22]	0.5564	38	0.5812
ΣSATs (mm)	12.21	9.65	13.65	12.86	−1.43 [−11.04 to 8.18]	−0.3739	38	0.7105
Fat-Free Mass (kg)	−0.09	3.42	−2.64	4.24	2.55 [−0.13 to 5.23]	1.9227	38	0.0620
Fat Mass (kg)	1.57	3.69	3.93	5.44	−2.36 [−6.39 to 1.67]	−1.5481	38	0.1299
%Fat	1.73	5.03	4.78	6.73	−3.05 [−8.07 to 1.97]	−1.5255	38	0.1354

Note: WC = waist circumference; HC = hip circumference; MUAC = mid-upper-arm circumference; C = circumference; SAT = Subcutaneous Superficial Adipose Tissue; df = degree of freedom. [a] computed with Welch's test.

3.4. Relationship Between Different Body Adiposity Measurements

Table 6 presents Pearson's correlation coefficients between local adiposity measurements assessed by US (absolute values at T0 and T1, as well as changes over time) and total FM assessed by BIA. At both time points, SAT measurements were significantly correlated with total FM (moderate to very strong correlation), with r ranging from 0.44 to 0.82 (all $p < 0.01$), except for thigh SAT, which showed very weak/weak associations. The 95% confidence intervals were consistent with the significance tests: they excluded zero for triceps SAT, abdominal SAT, and ΣSAT at T0 and T1, and for the correlations between changes in abdominal SAT and FM and between changes in ΣSAT and FM.

Table 6. Pearson correlations between local adiposity (SAT) assessed by ultrasound scanning (US) and whole-body adiposity (FM) assessed by bioimpedance analysis (BIA) at baseline (T0), post-intervention (T1), and for the changes over time (Δ = T0 − T1). For change analysis, differences in SAT thickness were correlated with differences in total FM.

Variables	r	95% CI for r	r2	t (38)	*p*-Value
Subcutaneous Superficial Adipose Tissue (T0)					
Triceps SAT	0.441	[0.143 to 0.656]	0.194	3.028	**0.0044**
Abdomen SAT	0.821	[0.680 to 0.899]	0.673	8.850	**<0.0001**
Thigh SAT	0.148	[−0.169 to 0.434]	0.022	0.921	0.3631
Σ SATs	0.752	[0.571 to 0.858]	0.566	7.036	**<0.0001**
Subcutaneous Superficial Adipose Tissue (T1)					
Triceps SAT	0.530	[0.259 to 0.717]	0.281	3.854	**0.0004**
Abdomen SAT	0.754	[0.574 to 0.860]	0.569	7.081	**<0.0001**
Thigh SAT	0.237	[−0.079 to 0.505]	0.056	1.501	0.1417
Σ SATs	0.688	[0.475 to 0.819]	0.474	5.852	**<0.0001**
Changes in local adiposity (T0 − T1)					
Triceps SAT Δ	0.201	[−0.116 to 0.477]	0.040	1.263	0.2142
Abdomen SAT Δ	0.416	[0.119 to 0.639]	0.173	2.820	**0.0076**
Thigh SAT Δ	0.103	[−0.213 to 0.397]	0.011	0.637	0.5281
Σ SATs Δ	0.378	[0.074 to 0.611]	0.143	2.520	**0.0161**

Note: SAT = Subcutaneous Superficial Adipose Tissue. Values in bold indicate statistically significant results.

Furthermore, changes in local adiposity over the 7 months were significantly associated with changes in total FM, particularly for abdominal SAT and for the ΣSAT (weak/moderate associations).

These findings indicate a consistent relationship between local ultrasound-derived adiposity indicators and whole-body FM estimated by BIA.

4. Discussion

Midlife, typically defined as the period between ages 35–40 and 60–65, is characterized in women by significant physiological and hormonal changes [22]. Ageing is often accompanied by weight gain, while the menopausal transition is associated with changes in body fat distribution, particularly an increase in abdominal adiposity. These changes together contribute to a greater risk of overweight and obesity in middle-aged women and increase the likelihood of developing cardiometabolic diseases, including cardiovascular disease, diabetes, and certain cancers [3]. In this context, the present study aimed to examine changes in anthropometric traits and body composition over 7 months among midlife women participating in a multicomponent PA programme, while also examining differences according to baseline weight status and the relationship between local and whole-body adiposity measurements obtained using US and BIA.

4.1. Changes in Body Composition After Intervention

Although the weekly training frequency was relatively low (2 sessions/week), participants showed favorable changes in body composition over the 7-month observation period. These included reductions in body weight, circumferences, subcutaneous adipose tissue thickness, and FM, whereas FFM did not change significantly. The observed reductions in FM and anthropometric indicators, together with the absence of a significant change in FFM, are broadly consistent with previous evidence on exercise and body composition in women. A systematic review and meta-analysis by Khalafi et al. [23], including 101 studies and 5697 postmenopausal women, reported reductions in FM, body %Fat, and waist circumference, alongside improvements in FFM and muscle-related outcomes. Similarly, Martínez-Carbonell et al. [24] found favorable changes in body composition following a 12-week multicomponent exercise programme in postmenopausal women, including reductions in body weight and waist-to-hip ratio and increases in lean body mass. These findings support the consistency of the changes observed in our sample with the broader literature on exercise and body composition in women, although differences in menopausal status, intervention duration, and training protocols should be considered when making comparisons. In the present study, FFM did not change significantly over the 7-month observation period. This finding differs from the increases in FFM or lean mass reported in some previous studies and meta-analyses. Differences in exercise frequency, training intensity, participant characteristics, and body composition assessment methods may partly explain this variability. However, because the present study did not include a control group, it cannot establish whether the observed maintenance of FFM was attributable to the programme itself.

The reduction in abdominal SAT was particularly marked compared with the changes observed at the other measurement sites. Although the underlying physiological mechanisms were not directly assessed, this finding is consistent with previous evidence describing regional differences in adipose tissue responsiveness to PA [25,26]. Nevertheless, the present study did not measure lipolysis or visceral adiposity, and therefore no conclusions can be drawn regarding the specific mechanisms underlying the observed changes.

The observed reduction in FM, together with the absence of a significant change in FFM, is also relevant when considering the potential contribution of multicomponent exercise to

body composition management in midlife women. These results may be related to the characteristics of the multicomponent training programme, which combined aerobic exercise with resistance training performed with relatively high repetitions. Such multicomponent programmes have been associated with improvements in body composition and metabolic health in previous studies [27,28]. Nevertheless, the present study cannot establish whether the maintenance of FFM was specifically attributable to the resistance component of the programme.

4.2. Differences According to Weight Status

The comparison between normal-weight and overweight/obese participants revealed different patterns of change over the 7-month observation period. Overweight/obese women showed greater absolute and percentage reductions than normal-weight participants in body weight, BMI, waist and hip circumferences, mid-upper arm, thigh and calf circumferences, abdominal SAT, and the ΣSATs measurements. Between-group differences in FM changes were not statistically significant for either absolute or percentage changes. This distinction is important when interpreting changes in participants with different baseline body compositions, since larger absolute reductions do not necessarily indicate a greater relative response to an intervention, consistent with Williams et al. [29]. Previous research suggests that changes in body composition following lifestyle interventions may vary according to baseline BMI and the outcome considered. For example, studies of women undergoing lifestyle interventions have reported differences in changes in FM and body %Fat across baseline BMI categories, although the direction and magnitude of these differences may depend on the intervention and population studied [30]. Both absolute and percentage changes should therefore be considered when comparing weight-status groups.

In a separate ANCOVA of T1 body weight adjusted for T0 weight, the adjusted mean difference between weight-status groups was statistically significant. This result describes a between-group difference in T1 weight at a common baseline weight; it does not establish that weight status caused the difference or that the intervention caused weight loss. The weight-status comparisons should be interpreted cautiously because the groups were not randomly assigned.

The relatively small sample size and the study design do not allow these changes to be attributed exclusively to the PA programme. Previous studies suggest that reductions in FM, rather than losses in lean mass, are more strongly associated with improvements in functional capacity during weight loss interventions [31]. In this respect, resistance training plays an important role in preserving FFM during weight loss [32]. As functional capacity was not assessed in the present study, no conclusions can be drawn regarding changes in physical performance. However, the maintenance of FFM observed over time may be relevant to future investigations, which should include direct measures of muscular strength and functional capacity.

4.3. Differences According to Menopausal Status

An exploratory comparison by menopausal status detected no statistically significant between-group differences in changes in anthropometric or body-composition measures. This finding should not be interpreted as evidence that responses were equivalent or that menopausal status was unrelated to change. Only 10 participants were classified as postmenopausal, and this group was older on average than the non-postmenopausal group. The small, age-imbalanced groups and the lack of adjustment for age limit the precision of this comparison and prevent menopausal status from being distinguished from age-related differences. Larger studies with adequate representation of menopausal groups and age-adjusted analyses are needed to investigate this question further.

4.4. Relationship Between Ultrasound and Bioimpedance Measurements

A further objective of the study was to examine the relationship between local adiposity measurements obtained through US and whole-body FM estimated by BIA. Significant correlations were observed between most ultrasound-derived subcutaneous adipose tissue thickness measurements (SATs) and total FM estimated by BIA at both assessment time points, with correlation coefficients ranging from r = 0.44 to 0.82, whereas thigh SAT did not show significant associations. Furthermore, changes in abdominal SAT and ΣSAT measurements were significantly associated with changes in total FM over the 7-month observation period.

These findings are broadly consistent with previous research showing associations between ultrasound-derived adipose tissue measurements and body composition assessed using other methods. Green et al. [33], for example, reported cross-sectional associations between ultrasound-derived subcutaneous tissue thickness and DXA-derived FM, although the associations between changes in these measures over time were weaker. This distinction is relevant to the present study, as correlations observed at individual assessment time points do not necessarily imply that local changes in SAT closely reflect changes in whole-body FM. Similarly, a study comparing ultrasound and BIA in women reported associations between the methods but also identified limitations in their agreement [34], indicating that their estimates should not automatically be considered interchangeable. The present findings therefore support the complementary use of US and BIA to characterize regional and whole-body adiposity, respectively, rather than the use of ultrasound-derived SAT thickness as a direct substitute for whole-body FM estimates. Further studies incorporating a reference method, such as DXA, are needed to clarify the validity of these measurements and their responsiveness to changes in body composition over time.

Although dual-energy X-ray absorptiometry (DXA) is widely used as a reference method for body composition assessment, alternative techniques such as BIA have demonstrated good reliability and reproducibility while being considerably less expensive and easier to apply in field settings [35]. Ultrasound (US) has also been shown to provide highly reproducible measurements compared with BIA [6] and represents a promising non-invasive technique for assessing subcutaneous adipose tissue thickness, with high reproducibility and the advantage of avoiding tissue compression, which can affect skinfold measurements. Furthermore, its wide range of measurable thicknesses makes it easier to use than skinfold calipers, even on obese subjects.

In the present study, US was used to directly measure adipose tissue thickness at selected anatomical sites, while whole-body composition parameters were derived from BIA. The use of these complementary methods enabled evaluation of both local and global aspects of adiposity without relying on proprietary prediction equations embedded in certain ultrasound devices.

4.5. Implications of Physical Activity in Midlife Women

The findings of the present study should be interpreted cautiously, given the single-group pre–post design. Nevertheless, the observed changes in anthropometric and body composition parameters suggest that structured multicomponent PA programmes may represent a feasible approach for supporting body composition management and are consistent with the beneficial role of PA in midlife women [26]. The combination of aerobic, resistance, and balance exercises may be particularly suitable for addressing different aspects of physical fitness within an adaptable programme [15,36].

However, dietary intake and PA performed outside the supervised sessions were not objectively monitored. Therefore, the relative contribution of the intervention and other lifestyle factors to the observed changes cannot be established. Future controlled studies should include longer follow-up periods, detailed monitoring of adherence and lifestyle behaviours, and outcome measures addressing both body composition and physical function. This is particularly important given that specific recommendations for middle-aged women remain relatively limited. Guidelines such as those proposed by the Women's Preventive Services Initiative recommend maintaining body weight or limiting weight gain to prevent obesity and related health complications, given the increased risk of weight gain during midlife [13,37].

4.6. Strengths and Limitations

The present study has several strengths. First, it employed a longitudinal design, enabling the evaluation of changes in body composition over a relatively extended intervention period. Second, all anthropometric and body composition measurements were collected directly from participants by trained personnel using standardised procedures, thereby increasing the reliability of the data. In addition, the training programme implemented in the study provided a structured and feasible exercise protocol that may be of practical relevance to coaches, physiotherapists, and health professionals working with middle-aged women seeking to improve physical fitness and body composition.

Several limitations should be acknowledged. First, the single-group pre–post design prevents causal attribution of the observed changes to the PA programme. The convenience sample was recruited from a single fitness centre and consisted of women who voluntarily enrolled to improve their physical fitness, which may limit the generalisability of the findings and introduce selection bias. In addition, the sample size was relatively small. Nevertheless, the number of participants exceeded the minimum sample size estimated through a priori power analysis. Baseline PA levels, previous training experience, and menopausal status were self-reported, and menopause-related symptoms were not systematically collected. Dietary intake and PA outside the supervised sessions were not objectively monitored. Consequently, the contribution of other lifestyle factors to the observed changes cannot be established. Furthermore, body composition was assessed using indirect methods, and functional capacity was not measured. However, it should be noted that the techniques used in this study (anthropometry, US, and BIA) are widely used and non-invasive. Two ultrasound readings were taken at each site and averaged, but the individual readings were not retained. Therefore, an intra-rater intraclass correlation coefficient could not be calculated, and measurement repeatability was not quantified in this sample. Finally, the Kyle et al. equation used to estimate FFM includes body weight as a predictor, while FM is calculated by subtracting estimated FFM from body weight. Thus, BIA-derived FM—and %Fat, which is calculated using body weight—is mathematically linked to body weight. Therefore, the parallel reductions in body weight and FM should be interpreted cautiously and not as fully independent findings.

5. Conclusions

Over the 7-month observation period, participants showed reductions in body weight, anthropometric measures, subcutaneous adipose tissue thickness, and FM, while FFM did not change significantly. Overweight/obese women showed greater absolute and percentage reductions in several body composition measures than normal-weight women; between-group differences in FM changes were not statistically significant. The exploratory comparison by menopausal status detected no statistically significant differences in changes,

but the small postmenopausal subgroup and age imbalance prevent firm conclusions about menopausal-status-related differences.

Ultrasound-derived subcutaneous adipose tissue measurements were associated with BIA-derived FM for most measured sites and time points, suggesting that these methods may provide complementary information on regional and whole-body adiposity.

Overall, the findings document favourable changes in body composition among women participating in a structured multicomponent physical activity programme. However, the uncontrolled pre–post design does not allow these changes to be attributed specifically to the exercise programme or to establish a causal relationship. Further large-scale randomised controlled studies, incorporating objective monitoring of programme adherence, dietary intake and habitual physical activity, adequate characterisation of menopausal status, and reference methods such as dual-energy X-ray absorptiometry (DXA), are needed to confirm these findings and further investigate the validity of the body composition measurements.

Supplementary Materials: The following supporting information can be downloaded at https://www.mdpi.com/article/10.3390/jfmk11040481/s1, Table S1: FITT-VP framework describing the structure and progression of the 7-month multicomponent physical activity program, including frequency, intensity, time, exercise type, training volume, and progression.

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Abbreviations

The following abbreviations are used in this manuscript:

PA	Physical activity
BIA	Bioelectrical impedance analysis
US	Ultrasound scanning
WC	Waist circumference
HC	Hip circumference
MUAC	Mid-upper arm circumference
BMI	Body mass index
SAT	Subcutaneous superficial adipose tissue thickness
FM	Fat mass
%Fat	Fat percentage
FFM	Fat-free mass

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