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Research Article

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Diet Intervention in Obese Patients: A Retrospective Study

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ABSTRACT
Background & Aims: Obesity remains a major public health concern in Portugal. Hypocaloric diets with reduced carbohydrate content have shown promise in promoting weight loss and improving metabolic health, but long-term adherence remains a challenge. This study aimed to evaluate the effects of a hypocaloric and low-carbohydrate diet on body composition and adherence over 12 months in overweight and obese adults attending a hospital-based nutrition clinic.

Methods: This retrospective cohort study included adults with a body mass index (BMI) $\geq$ 25 kg/m² followed at the Nutrition Outpatient Clinic of the Algarve Local Health Unit. Anthropometric and body composition data were collected at baseline and at 1, 3, 6, and 12 months. Statistical analysis was performed using IBM SPSS Statistics®, version 27.

Results: Significant reductions were observed in weight (97.0±19.7 to 88.2±21.8 kg), BMI (35.6 ± 5.3 to 32.5 ± 5.4kg/m2) and visceral fat (VF; 13.3±5.5 to 11.3±5.3kg) over time, particularly within the first six months (n = 41; $P < 0.01$). Among those who completed the 12 months follow-up (n = 11), average weight loss was 8.6 %. BMI was strongly associated with VF ($\rho = 0.739$) and inversely associated with FFM ($\rho = -0.616$). Age was positively associated with dropout ($\rho = 0.371$) and VF ($\rho = 0.353$).

Conclusions: This intervention resulted in clinically meaningful reductions in body weight and visceral adiposity. The findings suggest that participants who attended the nutrition consultations for longer periods achieved more significant results. However, the high dropout rate highlighted the importance of tailored strategies to support long-term adherence, particularly in older individuals.

Abbreviations

BMI	:	Body Mass Index
CHUA	:	Centro Hospitalar E Universitário Do Algarve
CI	:	Confidence Interval
DALY	:	Disability-Adjusted Life Years
OR	:	Odds Ratio
RR	:	Relative Risk
SD	:	Standard Deviation
FM	:	Fat Mass
FFM	:	Fat-Free Mass
VF	:	Visceral Fat

Introduction

Obesity is a chronic and relapsing condition characterized by an excessive accumulation of body fat that poses significant risks to physical and mental health[1]. It has a multifactorial aetiology and is influenced by a complex interplay of biological, genetic, epigenetic, psychosocial, behavioural, and environmental factors [2,3].

The Global Burden of Disease 2021 report published in 2024 highlighted the growing impact of obesity and high body mass index (BMI) as significant risk factors contributing to the global disease burden [4]. Since 2000, the disease burden attributable to high BMI has increased by 16 %, with obesity-related conditions, such as high blood sugar, cardiovascular diseases, and metabolic disorders, on the rise. The report forecasts that if key risk factors-especially high BMI, high blood sugar, and poor metabolic health-are effectively addressed, global disease burden could decrease significantly by 2050, leading to improved health outcomes and increased life expectancy. In a 2023 position statement, the European Association for the Study of Obesity reported that obesity affects one in four adults in Europe, increasing their risk of mortality and morbidity

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[3]. In Portugal, according to the most recent national health survey, obesity represents a major public health challenge, with 28.7 % of the adult population classified as obese and 38.9 % as overweight [5,6]. Data from 2023 showed that, in Portugal, the economic impact of overweight and obesity amounted to approximately EUR 1.15 billion, representing 5.8 % of public healthcare expenditures, highlighting the urgent need for effective intervention strategies [7].

The disease burden associated with excess weight in Portugal was estimated at 183,348 disability-adjusted life years (DALYs) in 2018, with most cases linked to cardiovascular diseases, type II diabetes, and depression [7]. In addition, the report on the Global Burden of Disease highlighted that poor dietary habits and obesity are key contributors to the national disease burden in Portugal. Inadequate dietary habits were the fifth leading risk factor contributing to the loss of healthy years and the third leading risk factor contributing to total mortality in the period between 1990 and 2016 [8]. The report highlighted that, although Portugal has seen some improvements in dietary risks over the past decades, the persistence of unhealthy eating patterns, high calorie intake, and low consumption of nutrient-dense foods remains a major public health challenge [8,9]. In this context, it is mandatory to identify effective approaches for treating obesity and its comorbidities while adapting them to the regional context. One of the most studied approaches in the setting of adult obesity is the combination of caloric restriction with low carbohydrate intake [10-12]. Low-carbohydrate and low-calorie diets have been widely studied for their effectiveness in weight loss, obesity management, and metabolic health improvement [12]. Research indicates that these diets can lead to significant reductions in body weight, fat mass (FM), and insulin levels, particularly in the short to medium term, by promoting fat oxidation and reducing insulin spikes [13,14]. However, long-term adherence remains a challenge, and some studies suggest that weight loss outcomes may not differ significantly from other calorie-restricted diets over extended periods [12,15,16]. This study aimed to evaluate the effects of a hypocaloric and low-carbohydrate dietary intervention on body composition, in overweight and obese Portuguese adults, over a 12-month period. The study intended also to focus on the adherence of patients to this dietary intervention, by gender and BMI.

Methods

Study Design and Study Population

A retrospective cohort study was conducted on a convenience sample of overweight and obese adults (male and female) with comorbidities, aged >18 years, and with a BMI ≥ 25 Kg/m2. Pregnant women, children, individuals with moderate alcohol consumption, severe eating disorders, and severe mental illnesses were excluded from the study.

Patients were followed for up to 12 months at the Nutrition Outpatient Clinic of the *Centro Hospitalar e Universitário do Algarve (CHUA)—Portimão Unit.* This study was approved by the CHUA Ethics Committee.

Anthropometry and Body Composition

Anthropometric measurements were collected using a Tanita® stadiometer and tetrapolar Tanita® bioimpedance (MC-780MA-N) to assess weight, BMI, FM, fat-free mass (FFM), visceral fat (VF), and water percentage. To calculate energy requirements, the Harris and Benedict equation was used, with a 700-kcal reduction distributed as follows: carbohydrates (40 %), proteins (30 %), and lipids (30 %).

Statistical Analysis

All data were recorded in Microsoft Excel® and analysed using IBM SPSS Statistics®, version 27. Descriptive statistics were calculated for all variables and presented as means, standard deviations, and ranges. Friedman test was used to assess differences in weight, BMI, FM), FFM, and VF across three or more time points. For variables showing statistically significant results, post hoc pairwise comparisons were performed using the Wilcoxon signed-rank test with Bonferroni correction to adjust for multiple comparisons.

Associations between continuous or ordinal variables were examined using Spearman's rank correlation coefficient (ρ). For each correlation, 95 % confidence intervals (CI) and P-values were reported. The association between sex and dropout status (binary variables) was assessed using the Pearson's chi-squared test and confirmed with the Fisher's exact test. Additionally, the odds ratio (OR) and relative risk (RR) were calculated, with 95 % CI, to explore the strength and direction of this association. Statistical significance was set at $P < 0.05$ for all tests, except where Bonferroni-adjusted thresholds were applied.

Results

The study included 41 overweight and obese patients, with a mean age of 52.2 years (SD = 11.6), equally distributed between men and women (50 % female, 50 % male). At baseline, the average weight of the 41 participants was 97±19.7 kg, with a BMI of 35.6±5.3 kg/m2 (classified as grade 2 obesity). The mean FM was 37.3±7.2 kg, while the average FFM was 59.1±6.5 kg; mean total body water was 43.6±5.5 kg and the average VF was 13.3±5.5 kg (Table 1).

Table 1: Anthropometric and Body Composition Variables of the Participants at Baseline (n = 41)

Variable	Mean	Minimum	Maximum	SD
Weight	97.0	63.0	140.0	19.7
BMI	35.6	24.7	47.1	5.3
FM (%)	37.8	20.0	50.9	7.2
FM (kg)	37.3	13.0	60.9	11.7
FFM (%)	59.3	46.6	76.0	6.5
FFM (kg)	57.1	38.0	82.5	11.4
Water (%)	43.6	35.0	55.0	5.5
Water (kg)	42.0	30.0	61.5	9.0
VF (kg)	13.3	4.0	28.0	5.5

BMI: body mass index; FFM: fat-free mass; FM: fat mass; SD: standard deviation; VF: visceral fat.

The study of the change of anthropometric variables over time showed that weight, BMI, FM, and VF decreased during the first three months. A slight increase was observed between months 3 and 6, followed by a substantial reduction between months 6 and 12 (Table 2). The results of the Friedman test revealed a statistically significant effect of time, up to 12 months, on weight

(χ^2 (2) = 11.5, P = 0.001, W = 0.52) and BMI (χ^2 (2) = 11.5, p=0.003, W = 0.52), indicating a strong effect size. However, no significant differences were observed for FM (χ^2 (2) = 5.4, P = 0.066), FFM (χ^2 (2) = 4.9, P = 0.086), or VF (χ^2 (2) = 5.6, P = 0.061). Post hoc Wilcoxon tests with Bonferroni correction (Table 3) confirmed a statistically significant decrease in weight and BMI between the first month and the 6-month follow-up (P = 0.001) and between baseline and the 12-month follow-up (P = 0.004); no significant differences were found between the 6-month and 12-month follow-up for either variable (P = 0.100 for weight and P = 0.221 for BMI).

The results of the study of the potential effect of time and diet, up to 6 months, on weight, BMI, FM, FFM, and VF are compiled in Table 4. It was observed that time, up to 6 months, had a statistically significant effect on weight (χ^2 (2) = 11.49, P = 0.001, W = 0.52), BMI ($\chi2$ (2) = 11.26, P = 0.004, W = 0.29), and VF (χ^2 (2)=10.89, p=0.004, W=0.54); no significant differences were observed for FM (χ^2 (2) = 2.03, P = 0.369) or FFM ($\chi2$ (2) = 2.82, P =0.244). Post hoc Wilcoxon tests with Bonferroni correction confirmed significant reductions in weight between the first month and the 3-month follow-up (P = 0.012), as well as between the first month and the 6-month follow-up (P = 0.001). A significant difference was also observed between the 3-month and 6-month follow-up (P = 0.011). For BMI, significant differences were found between the first month and 3-month follow-up (P = 0.008) and between the first month and 6-month follow-up (P = 0.016), while the difference between the 3-month and 6-month follow-up was not statistically significant (P = 0.068).

Table 2: Anthropometric and Body Composition Variables Across Follow-up Visits

Variable	1 Month (n = 41)	3 Months (n = 31)	6 Months (n = 19)	12 Months (n = 11)
Weight	97.0±19.7	93.0±19.4	93.2±19.8	88.2±21.8
BMI	35.6±5.3	34.3±5.0	34.2±5.1	32.5±5.4
FM (%)	37.8±7.2	36.0±7.6	36.7±8.9	34.0±8.4
FM (kg)	37.3±11.7	34.2±11.6	35.1±12.2	31.1±12.3
FFM (%)	59.3±6.5	60.7±7.3	59.6±8.8	58.5±9.2
FFM (kg)	57.1±11.4	55.9±10.8	55.4±14.2	51.3±13.7
Water (%)	43.6±5.5	44.3±5.7	45.0±6.0	44.4±4.6
Water (kg)	42.0±9.0	41.0±8.8	41.5±8.6	39.0±9.2
VF (kg)	13.3±5.5	12.0±5.3	12.0±5.0	11.3±5.3

BMI: body mass index; FFM: fat-free mass; FM: fat mass; SD: standard deviation; VF: visceral fat.

Table 3: Results of the Friedman Test Applied to Weight, BMI, FM, and VF at Baseline, 6 Months, and 12 Months

Variable	Friedman χ^2 (df)	P-value (Friedman)	Kendall's W*	P-value (W)	Post Hoc comparison**	
					Z-score***	P -value***
Weight	11.5 (2)	0.001	0.52	0.001	-3.29 -2.85 -1.64	0.001 0.004 0.1
BMI	11.5 (2)	0.003	0.52	0.003	-3.32 -2.85 -1.23	0.001 0.004 0.221
FM	5.4 (2)	0.066	0.25	0.066	n.a.	n.a.
FFM	4.9 (2)	0.086	0.22	0.086	n.a.	n.a.
VF	5.6 (2)	0.061	0.56	0.061	n.a.	n.a.

BMI: body mass index; df: degress of freedom; FFM: fat-free mass; FM: fat mass; n.a.: not applicable; VF: visceral fat.
*Effect size
**Wilcoxon paired test with Bonferroni correction of data obtained at baseline, 6 months, and 12 months.
***Values for the comparison of baseline with 6 months, baseline with 12 months, and 6 months with 12 months.

Table 4: Results of the Friedman Test applied to Weight, BMI, FM, and VF at Baseline, 3 months, and 6 Months

Variable	Friedman χ^2 (df)	P-value (Friedman)	Kendall's W*	P-value (W)	Post Hoc comparison**	
					Z-score***	P -value***
Weight	11.5 (2)	0.001	0.52	0.001	-3.29 -2.85 -1.64	0.001 0.004 0.1
BMI	11.5 (2)	0.003	0.52	0.003	-3.32 -2.85 -1.23	0.001 0.004 0.221
FM	5.4 (2)	0.066	0.25	0.066	n.a.	n.a.
FFM	4.9 (2)	0.086	0.22	0.086	n.a.	n.a.
VF	5.6 (2)	0.061	0.56	0.061	n.a.	n.a.

BMI: body mass index; df: degress of freedom; FFM: fat-free mass; FM: fat mass; n.a.: not applicable; VF: visceral fat.
*Effect size
**Wilcoxon paired test with Bonferroni correction of data obtained at baseline, 3 months, and 6 months.
***Values for the comparison of baseline with 3 months, baseline with 6 months, and 3 months with 6 months.

Table 5: Anthropometric and Body Composition Variables of Participants who completed the 12-Month Follow-Up (n=11)

Variable	Mean	Minimum	Maximum	SD
Weight	88.2	61.0	121.0	21.8
BMI	32.5	21.9	37.9	5.4
FM (%)	34.0	19.0	45.0	8.4
FM (kg)	31.1	12.0	45.0	12.9
FFM (%)	58.5	41.0	72.0	9.2
FFM (kg)	51.3	31.0	74.0	13.7
Water (%)	44.4	39.0	53.0	4.6
Water (kg)	39.0	28.0	57.0	9.2
VF (kg)	11.3	4.0	20.0	5.3

BMI: body mass index; FFM: fat-free mass; FM: fat mass; SD: standard deviation; VF: visceral fat

Table 6: Spearman's Rank Correlations Between Age, Anthropometric and Body Composition Variables, and Study Dropout

Variables	Correlation coefficient (ρ)	95% CI	P-value
Age vs. VF	0.353	0.102, 0.589	0.044
Age vs. Weight	-0.397	-0.589, -0.205	0.01
Age vs. FM	-0.39	-0.552, -0.198	0.012
Weight vs. BMI	0.819	0.701, 0.903	0.001
Weight vs. VF	0.739	0.600, 0.819	0.001
BMI vs. FFM (%)	-0.616	-0.765, -0.455	0.001
FM vs. FFM (%)	-0.705	-0.815, -0.612	0.001
Age vs. Drop-put	0.371	0.150, 0.560	0.018
VF (kg)	11.3	4.0	20.0

BMI: body mass index; CI: confidence interval; FFM: fat-free mass; FM: fat mass; VF: visceral fat

A high dropout rate (73.2%) was observed throughout the study. Of the initial 41 participants, only 11 remained in the study after completing one year of nutrition consultations. By the six-month follow-up, 21 participants had dropped out; 14 discontinued within the first two months. These participants had a mean age of 48.3 years, with BMI ranging from 30.5 to 37.6 kg/m2 and VF levels ranging from 9.3 to 10.6 kg; 16 were women. Among the 11 participants who were monitored for 12 months, 8 were women and 3 were men, with a mean age of 55.3 years. The youngest participant was 36 years old, while the oldest was 74 years old, with a standard deviation (SD) of ±12.5 years. Table 5 presents the profile of these participants.

Relationship between Anthropometric Variables, Body Composition and Participant Retention

Spearman's rank correlation analysis showed that age was moderately and positively associated with VF (ρ = 0.353; 95 % CI 0.102, 0.589; P = 0.044), and moderately and negatively associated with baseline weight (ρ = –0.397; 95 % CI –0.589, –0.205; P = 0.010) and FM at month 1 (ρ = –0.390; 95 % CI –0.552, –0.198; P = 0.012) (Table 6). Baseline weight correlated strongly and positively with both BMI (ρ = 0.819; 95 % CI 0.701, 0.903; P < 0.001) and VF (ρ = 0.739; 95 % CI 0.600, 0.819; P < 0.001). A strong inverse association was also observed between BMI and FFM (ρ = –0.616; 95 % CI –0.765, –0.455; P < 0.001). Age was positively associated with study dropout (ρ = 0.371; 95 % CI 0.150, 0.560; P = 0.018).

Pearson's chi-squared test did not reveal a statistically significant association between sex and dropout status (χ2 (1) = 0.302; P = 0.583). Fisher's exact test (P = 0.727) confirmed this lack of association. The OR was 1.477 (95 % CI 0.366, 5.955; P > 0.05) and the RR was 1.114 (95 % CI 0.756, 1.641).

Discussion

This study aimed to assess the effects of a hypocaloric and low-carbohydrate diet on body composition over a 12-month period in overweight and obese adults attending a nutrition outpatient clinic in Portugal. The results demonstrated statistically significant reductions in weight, BMI, and VF among participants who remained in the programme for 12 months. These findings are consistent with previous evidence supporting energy-restricted diets with moderate to low carbohydrate intake as effective strategies for short- and medium-term weight loss and VF reduction [11,12,17,18].

In line with published guidelines, the observed average weight loss of 8.6 % over 12 months among adherent participants exceeds the clinically meaningful threshold of 5 % to 10 % body weight reduction, which is associated with significant improvements in cardiometabolic health [19]. The most pronounced changes occurred within the first six months, reflecting the typical pattern of early weight loss followed by stabilisation, as reported in previous studies [13,14,17].

However, the study faced a high dropout rate (73.2 %), with only 11 of 41 participants completing the full 12-month follow-up. This attrition rate is higher than the average reported in dietary intervention studies (typically 20 % to 50 % over 6 to 12 months) and may reflect external factors such as the impact of the COVID-19 pandemic on healthcare access and motivation, as well as internal factors related to adherence, perceived results, or psychosocial challenges [15,16].

The analysis of dropout patterns revealed that age was positively associated with programme discontinuation (ρ = 0.371; 95% CI 0.150, 0.560; P = 0.018). This finding is consistent with studies showing that older adults may face greater barriers to adherence, including lower mobility, cognitive or motivational constraints, and competing health concerns [20,21]. Tailored interventions, such as increased counselling support or simplified meal planning, may help address these challenges and improve retention in this subgroup. In contrast, no statistically significant association was observed between sex and dropout status. While a non-significant trend toward higher dropout among women was observed, the results suggest that retention strategies should not be based on sex alone.

Beyond adherence, the correlation analysis provided further insight into body composition dynamics. Age was positively associated with VF (ρ = 0.353; P = 0.044) and negatively associated with both baseline weight and FM at first month. These findings reflect the age-related shift in fat distribution towards central adiposity, as described in the literature, and suggest that older individuals may benefit from specific strategies targeting VF reduction [22].

BMI was strongly correlated with weight and visceral fat but showed a negative association with FFM (ρ = –0.616; P < 0.001), indicating that higher BMI may reflect greater FM rather than lean mass. This highlights the limitations of BMI as a sole indicator of body composition, supporting recommendations to include direct measures of body fat and lean mass in clinical evaluations[23,24]. The inverse correlation between FM and FFM (ρ = –0.705) further supports this complexity in interpreting anthropometric indicators.

This study presents some limitations that should be acknowledged. The small sample size and high dropout rate substantially reduced the statistical power and limit the generalization of the findings. In addition, the lack of data on dietary intake, physical activity, and psychosocial factors may have obscured relevant influences on both weight loss outcomes and adherence. Finally, the use of bioimpedance analysis, although practical and widely used in clinical settings, may have affected the reliability of the measurements due to its inherent limitations (including sensitivity to hydration status and lower precision compared to gold-standard techniques)

Taken together, these results underscore the potential of hypocaloric and low-carbohydrate dietary interventions to promote weight and fat loss in individuals with overweight or obesity. However, long-term success remains dependent on adherence, which in turn may be influenced by age and other individual factors. Improving retention should be a central focus of future interventions and could include personalised follow-up, behavioural support, and technological tools for monitoring progress.

Future studies should aim to assess dietary intake in more detail, explore psychosocial determinants of adherence, and validate the effectiveness of specific retention strategies. Randomised controlled trials with larger and more diverse samples would help strengthen the evidence base and allow stratification by age, sex, and baseline metabolic profile.

Conclusion

In conclusion, this study found significant reductions in weight, BMI, and visceral fat among participants who adhered to a hypocaloric and low-carbohydrate diet, with an average weight loss of 8.6 % over 12 months. BMI was strongly associated with VF and inversely with FFM. Age correlated with both dropout and visceral adiposity, suggesting its relevance for adherence and metabolic risk. These findings emphasise the importance of early intervention and age-tailored retention strategies.

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