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Hypocaloric and Moderate-Carbohydrate Diet for Weight Loss in Overweight and Obese Patients: A Retrospective Study

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ABSTRACT

Background/Objectives: *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 moderate-carbohydrate diet on body composition and follow-up retention over 6 months in overweight and obese adults attending a hospital-based nutrition clinic.*

Subjects and Methods: *This retrospective longitudinal observational study included adults with body mass index (BMI) ≥25 kg/m² followed at a hospital-based nutrition outpatient clinic in Portugal. Participants received an individualized hypocaloric diet with moderate carbohydrate content. Anthropometric and body composition data were collected at baseline, 3 months, and 6 months. Longitudinal changes were analysed using non-parametric methods.*

Results: *Body weight, body mass index (BMI), and visceral fat (VF) decreased significantly over 6 months (97.0 ± 19.7 to 93.2 ± 19.9 kg; 35.6 ± 5.3 to 34.2 ± 5.1 kg/m²; and 13.3 ± 5.5 to 12.1 ± 5.0, respectively; all $p < 0.01$), with the largest changes observed within the first 3 months. No significant changes were observed for fat mass (FM), fat-free mass (FFM), or total body water. The 6-month follow-up rate was 46.3%.*

Conclusion: *In conclusion, a hypocaloric diet with moderate carbohydrate content was associated with modest but significant reductions in body weight, BMI, and visceral fat over 6 months in a real-world clinical setting. Early response was more pronounced, highlighting the importance of initial intervention and sustained engagement to optimize outcomes.*

Keywords

Obesity, Low-calorie diet, Low-carbohydrate diet, Weight loss, Nutrition consultation.

List of 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, posing 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].

According to the Global Burden of Disease 2021, high body mass index (BMI) remains a major contributor to global morbidity and mortality [4], with the disease burden attributable to high BMI increasing by 16% since 2000. Obesity-related conditions, such as hyperglycemia, cardiovascular diseases, and metabolic disorders, continue to rise worldwide. In Europe, obesity affects one in four adults and is associated with increased mortality and morbidity [3].

In Portugal, obesity represents a major public health challenge [5]. National data indicate that 28.7% of adults are classified as obese and 38.9% as overweight [6].The economic burden of overweight and obesity was estimated in EUR 1.15 billion in 2023, representing 5.8% of public healthcare expenditures [7].

Furthermore, excess weight was accounted for 183,348 disability-adjusted life years (DALYs) in 2018, largely driven by cardiovascular diseases, type 2 diabetes, and depression [7]. In addition, poor dietary habits are key contributors to national disease burden, ranking among the leading risk factors for mortality and loss of healthy years, in the period between 1990 and 2016 [8,9].

In this context, identifying effective and sustainable dietary approaches for the treatment of obesity and its associated comorbidities remains a public health priority. Among the most extensively studied approaches in the setting of adult obesity are carbohydrate restricted diets (CRDs) with low calory intake [10-12]. A recent dose-response meta-analysis of 110 randomized controlled trials demonstrated that carbohydrate restriction (≤45% of total energy intake) is associated with significant reductions in body weight in adults with overweight and obesity. Specifically, each 10% decrease in carbohydrate intake was associated with an additional reduction of approximately 0.6 kg at 6 months and 1.1 kg at 12 months [11]. The analysis suggested that weight loss increased progressively as carbohydrate intake decreased in the short to medium term, with clinically meaningful reductions particularly evident within the first 6 to 12 months. Complementing these findings, a comprehensive meta-analysis of 174 randomized trials evaluated the effects of CRDs (≤45% energy from carbohydrates) on cardiovascular health and body composition [12]. CRDs were associated with significant reductions in body weight, BMI, fat mass, waist circumference, and visceral adipose tissue, alongside improvements in triglycerides, blood pressure, inflammatory markers, and HDL levels. Importantly, subgroup analyses indicated that moderate-carbohydrate diets (26-45% of energy) provided balanced benefits in body composition and cardiometabolic markers, whereas more restrictive ketogenic patterns were associated with greater short-term weight loss but also modest increases in LDL and total cholesterol. Overall, more pronounced carbohydrate restriction may produce greater short-term weight loss; however, moderate-carbohydrate diets (approximately 30-45% of total energy intake), particularly when combined with caloric restriction and lifestyle modification, may offer a more sustainable and clinically balanced strategy. Nevertheless, adherence remains challenging, and weight-loss effects tend to diminish beyond the first year [13].

Although randomized controlled trials provide robust evidence on carbohydrate-restricted diets under controlled conditions, their effectiveness in routine clinical practice remains less well characterized. In Portugal, where obesity represents a substantial health and economic burden, real-world data from hospital-based outpatient settings are limited. Given that the most pronounced weight reductions are typically observed within the first 6 to 12 months, evaluating short-term changes in body composition in a clinical context is particularly relevant for informing practical obesity management strategies.

In this context, this study aimed to describe the evolution of body composition over six months among overweight and obese Portuguese adults receiving a structured hypocaloric diet with moderate carbohydrate content in a hospital-based outpatient setting.

Subjects and Methods

Study design and study population

This retrospective longitudinal observational study was conducted using clinical data collected during routine care at the Nutrition Outpatient Clinic of the *Centro Hospitalar e Universitário do Algarve* (CHUA), Portimão Unit, Portugal. The study aimed to evaluate changes in anthropometric parameters and body composition over the first six months of follow-up in adults with overweight and obesity undergoing a structured dietary intervention in a real-world clinical setting.

Medical records of adult patients (≥18 years) with a baseline BMI ≥25 kg/m² and complete baseline anthropometric and body composition data were reviewed for the period between May 2021 and June 2022.

Exclusion criteria included pregnancy, severe eating disorders, severe psychiatric conditions likely to compromise follow-up, and missing essential baseline data. A total of 41 participants met the eligibility criteria and were included in the study. Participants were followed for up to six months. Three time points were defined for analysis: baseline, 3 months, and 6 months. Participants without data at a given time point were considered to have incomplete follow-up.

All participants received a structured, individualized hypocaloric dietary plan with moderate carbohydrate content (approximately 40% of total energy intake, 30% protein, and 30% fat), based on an estimated energy deficit of approximately 700 kcal/day calculated using the Harris–Benedict equation. Diet plans were adjusted throughout follow-up according to clinical response, tolerance, and individual needs.

Dietary counselling was delivered during routine clinical consultations. Adherence was assessed qualitatively through dietary history and food frequency evaluation; however, due to the retrospective design and lack of standardized measures, adherence was not included in the statistical analyses.

This study was approved by the CHUA Ethics Committee (approval number 253/2024) and conducted in accordance with applicable ethical standards for observational research using anonymized data.

Outcomes

The primary outcome was the change in body weight from baseline to 6 months. Secondary outcomes included changes in BMI, fat mass (FM; percentage and kg), fat-free mass (FFM; percentage and kg), total body water (percentage and kg), and visceral fat (VF). The association between baseline characteristics and incomplete follow-up at 6 months was also explored.

Anthropometry and body composition

Anthropometric measurements were collected using a Tanita® stadiometer and a multifrequency tetrapolar Tanita® bioimpedance analyser (MC-780MA-N). The collected variables included body weight and height, BMI, FM, FFM, VF, and total body water.

Statistical analysis

Data were recorded in Microsoft Excel® and analysed using IBM SPSS Statistics®, version 30.
Continuous variables were described using mean and standard deviation (SD) or median and interquartile range, as appropriate. Categorical variables were presented as absolute and relative frequencies. Normality was assessed using graphical methods and the Shapiro–Wilk test.

Given the small sample size and non-normal distributions, non-parametric methods were used for longitudinal analyses. Changes across baseline, 3 months, and 6 months were assessed using the Friedman test in participants with complete data at all time points. When significant, pairwise comparisons were performed using the Wilcoxon signed-rank test with Bonferroni correction for comparisons between baseline vs. 3 months, baseline vs. 6 months, and 3 vs. 6 months.

Absolute and relative (%) changes between baseline and 6 months were calculated for key outcomes (weight, BMI, and VF).

Differences between participants with and without 6-month follow-up were analysed using independent samples t-test or Mann–Whitney test for continuous variables and Pearson's chi-squared or Fisher's exact test for categorical variables.

Where feasible, univariable logistic regression analyses were performed to explore potential predictors of incomplete follow-up at 6 months (age, sex, baseline BMI, and baseline VF).

Statistical significance was set at $P < 0.05$, with Bonferroni correction applied where appropriate. Confidence intervals were reported at the 95% level.

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 97.0±19.7 kg and the mean BMI was 35.6±5.3 kg/m^2 (classified as class II obesity). 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 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	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.

Participant flow across the study is presented in Figure 1. Follow-up data were available for 31 participants (75.6%) at 3 months and for 19 participants (46.3%) at 6 months. Complete repeated measurements across all three time points were available for 19 participants, who constituted the analytical cohort for longitudinal analyses. The overall attrition rate at 6 months was 53.7%.

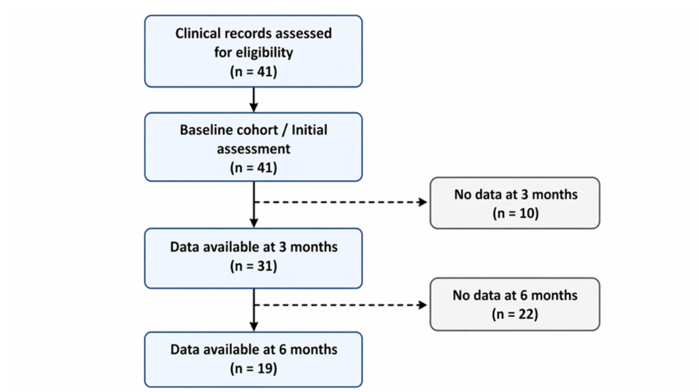

Figure 1: Flow diagram of participant selection and follow-up, including data availability at baseline, 3 months, and 6 months.

To explore potential attrition bias, participants with 6-month data were compared with those without follow-up at that time point. Among participants with complete follow-up, 68.4% were women, compared with 80.0% among those lost to follow-up. No statistically significant association was observed between sex and completion of 6-month follow-up (Fisher's exact test, p = 1.000).

Changes in anthropometric parameters and body composition

Longitudinal analyses in participants with complete data demonstrated statistically significant improvements in body weight, BMI, and VF over the 6-month follow-up period, with the largest changes observed within the first 3 months (Table 2).

Mean body weight decreased from 97.03 ± 19.67 kg at baseline to 93.15 ± 19.45 kg at 3 months and 93.23 ± 19.85 kg at 6 months. The Friedman test indicated a statistically significant overall difference across time points (χ^2 = 12.03, p = 0.002). Post hoc Wilcoxon tests with Bonferroni correction confirmed significant reductions between baseline and 3 months (p = 0.012), baseline and 6 months (p = 0.001), and between 3 and 6 months (p = 0.011), indicating continued weight loss beyond the initial phase of the intervention.

Table 2: Longitudinal changes in anthropometric and body composition parameters over 6 months.

Variable	Baseline Mean± SD	3 Months Mean ± SD	6 Months Mean ± SD	*p* (Friedman)
Weight (kg)	97.03 ± 19.67	93.15 ± 19.45	93.23 ± 19.85	0.002
BMI (kg/m²)	35.66 ± 5.35	34.28 ± 4.97	34.21 ± 5.13	0.004
FM (%)	37.83 ± 7.15	36.00 ± 7.64	36.68 ± 8.94	0.837
FFM (%)	59.29 ± 6.53	60.73 ± 7.26	59.63 ± 8.78	0.206
Total body water (%)	43.58 ± 5.52	44.32 ± 5.73	45.05 ± 6.00	0.144
VF	13.33 ± 5.48	11.95 ± 5.28	12.06 ± 5.03	0.004

BMI: Body mass index; FFM: Fat-free mass; FM: Fat mass; SD: Standard deviation; VF: Visceral fat.

BMI followed a similar trend, decreasing from 35.66 ± 5.35 kg/m² at baseline to 34.28 ± 4.97 kg/m² at 3 months and 34.21 ± 5.13 kg/m² at 6 months, with a significant overall effect of time (χ^2 = 11.27, p = 0.004). Pairwise comparisons showed significant reductions between all time points (baseline vs. 3 months: p = 0.008; baseline vs. 6 months: p < 0.001; 3 vs. 6 months: p = 0.008).

VF also showed a statistically significant reduction over time, decreasing from 13.33 ± 5.48 at baseline to 11.95 ± 5.28 at 3 months and 12.06 ± 5.03 at 6 months (χ^2 = 10.89, p = 0.004). Post hoc analyses indicated significant reductions between baseline and 3 months (p = 0.008) and between baseline and 6 months (p = 0.016), while the change between 3 and 6 months was not statistically significant (p = 0.068), suggesting that most of the reduction occurred during the initial phase.

The absolute changes in key outcomes between baseline and 6 months are summarised in Table 3. Mean body weight decreased by 4.34 kg (95% CI 1.92 to 6.75; p = 0.001), BMI by 1.68 kg/m² (95% CI 0.81 to 2.55; p < 0.001), and VF by 3.10 units (95% CI -0.05 to 6.25; p = 0.016).

Table 3: Changes in key outcomes between baseline and 6 months.

Variable	n	Mean difference baseline–6 months	IC95%	*p*
Weight (kg)	19	4.34	1.92 to 6.75	0.001
BMI (kg/m²)	19	1.68	0.81 to 2.55	<0.001
VF	19	3.10	-0.05 to 6.25	0.016

BMI: Body mass index; VF: Visceral fat.

In contrast, no statistically significant changes were observed for other body composition parameters. Mean FM (%) was 37.83 ± 7.15% at baseline, 36.00 ± 7.64% at 3 months, and 36.68 ± 8.94% at 6 months (χ^2 = 0.356, p = 0.837). Mean FFM (%) was 59.29 ± 6.53%, 60.73 ± 7.26%, and 59.63 ± 8.78%, respectively (χ^2 = 3.159, p = 0.206). Total body water (%) increased numerically from 43.58 ± 5.52% to 45.05 ± 6.00%, without reaching statistical significance (χ^2 = 3.875, p = 0.144).

Discussion

This study evaluated the effects of a hypocaloric diet with moderate carbohydrate content on body composition over a 6-month period in adults with overweight and obesity in a real-world outpatient setting. The results demonstrated statistically significant reductions in body weight, BMI, and VF, particularly within the first 3 months of follow-up.

These findings are consistent with previous evidence showing that energy-restricted diets with moderate to low carbohydrate intake are effective in promoting short- and medium-term weight loss and reductions in visceral adiposity [10,14-16]. The observed pattern, including more pronounced changes during the initial phase followed by stabilization, is well documented in the literature and reflects the typical trajectory of [15,17,18].

The mean weight reduction observed over 6 months (~4.3 kg; ~4.2%) is below the conventional threshold of 5–10% often considered clinically meaningful [19], but remains relevant given the real-world nature of the intervention and the relatively high attrition rate. In addition, significant reductions in VF may confer metabolic benefits beyond overall weight loss, highlighting the importance of assessing body composition alongside BMI.

Attrition was substantial, with more than half of participants not completing the 6-month follow-up. This finding is consistent with the challenges commonly reported in lifestyle and dietary interventions and underscores the importance of adherence in determining effectiveness [13,20].

Age was positively associated with incomplete follow-up, suggesting that older individuals may face greater barriers to sustained engagement. This is in line with previous evidence indicating that factors such as reduced mobility, comorbidities, and competing health priorities may negatively impact adherence in older populations [21,22]. These findings support the need for tailored strategies, including more flexible follow-up models, simplified dietary approaches, and enhanced behavioural support for this subgroup. No association was observed between sex and follow-up completion, suggesting that retention strategies should not be sex-specific.

Correlation analyses provided additional insights into body composition dynamics. Age was positively associated with VF and negatively associated with baseline weight and FM, reflecting the well-described shift towards central adiposity with ageing [23].

BMI showed strong positive correlations with weight and VF and a negative association with FFM, reinforcing the limitations of BMI as a standalone indicator of body composition. These findings support the inclusion of direct body composition measures in clinical practice [24,25].

This study presents some limitations that should be acknowledged. The relatively small sample size and high attrition rate limit statistical power and generalizability. The retrospective design and reliance on routinely collected clinical data precluded the use of standardized measures of dietary adherence, physical activity, and psychosocial factors. The lack of standardized measures of dietary adherence limits the interpretation of the relationship between the intervention and observed outcomes. In addition, body composition was assessed using bioimpedance analysis, which, although practical in clinical settings, has known limitations in accuracy compared with reference methods.

Despite these limitations, this study provides relevant real-world evidence on the short-term effectiveness of a structured hypocaloric dietary intervention with moderate carbohydrate content in a hospital-based outpatient setting. The findings highlight the importance of early response to intervention and the need to address attrition as a key determinant of effectiveness.

Future research should focus on identifying determinants of adherence, incorporating objective measures of dietary intake, and evaluating strategies to improve retention. Prospective studies with larger samples and longer follow-up would help clarify the sustainability of these effects and their impact on cardiometabolic outcomes.

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