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Association between obesity and lipid profile

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ABSTRACT

Objective: To analyze the association between obesity and lipid profile in patients followed in a retrospective cohort study. **Methods:** An analytical observational study based on electronic medical records of 216 adults with obesity hospitalized for treatment at a specialized hospital in Bahia, Brazil, between 2016 and 2022. Anthropometric measurements, body composition, and lipid profile parameters (total cholesterol, LDL-c, HDL-c, and triglycerides) were assessed at hospital admission and discharge. Paired statistical tests were applied, with a significance level of 5%. **Results:** Significant reductions were observed in body weight, body mass index, fat mass, body fat percentage, and waist-to-hip ratio ($p < 0.001$). Improvements in lipid profile were also identified, with significant reductions in triglycerides, total cholesterol, and LDL-c levels ($p < 0.001$), while HDL-c levels remained stable. **Conclusion:** Weight loss achieved during hospital-based treatment was associated with significant improvements in anthropometric parameters and lipid profile, highlighting the relevance of structured obesity management strategies for cardiovascular risk reduction.

Keywords: Obesity, Lipid profile, Dyslipidemia, Weight loss, Cohort study.

RESUMO

Objetivo: Analisar a associação entre obesidade e perfil lipídico em pacientes acompanhados em um estudo de coorte retrospectivo. **Métodos:** Estudo observacional analítico, conduzido a partir da análise de prontuários eletrônicos de 216 pacientes adultos com obesidade, internados para tratamento em hospital especializado na Bahia, Brasil, entre 2016 e 2022. Foram avaliados parâmetros antropométricos, composição corporal e perfil lipídico (colesterol total, LDL-c, HDL-c e triglicerídeos) nos momentos de admissão e alta hospitalar. A comparação entre os períodos foi realizada por testes pareados, adotando-se nível de significância de 5%. **Resultados:** Observou-se redução significativa do peso corporal, do índice de massa corporal, da massa e percentual de gordura corporal e da relação cintura-quadril ($p < 0,001$). Houve melhora significativa do perfil lipídico, com redução dos níveis de triglicerídeos, colesterol total e LDL-c ($p < 0,001$), enquanto os níveis de HDL-c permaneceram estáveis. **Conclusão:** A perda ponderal em ambiente hospitalar esteve associada a melhorias relevantes nos parâmetros antropométricos e no perfil lipídico, reforçando a importância de estratégias estruturadas no manejo da obesidade e na redução do risco cardiovascular.

Palavras-chave: Obesidade, Perfil lipídico, Dislipidemia, Perda de peso, Estudo de coorte.

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RESUMEN

Objetivo: Analizar la asociación entre obesidad y perfil lipídico en pacientes evaluados en un estudio de cohorte retrospectivo. **Métodos:** Estudio observacional analítico realizado a partir del análisis de historias clínicas electrónicas de 216 pacientes adultos con obesidad, hospitalizados para tratamiento en un hospital especializado en Bahía, Brasil, entre 2016 y 2022. Se evaluaron parámetros antropométricos, composición corporal y perfil lipídico (colesterol total, LDL-c, HDL-c y triglicéridos) en los momentos de ingreso y alta hospitalaria. Se utilizaron pruebas estadísticas pareadas, con un nivel de significancia del 5%. **Resultados:** Se observaron reducciones significativas en el peso corporal, índice de masa corporal, masa y porcentaje de grasa corporal y relación cintura-cadera ($p < 0,001$). Asimismo, se evidenció una mejora significativa del perfil lipídico, con disminución de los niveles de triglicéridos, colesterol total y LDL-c ($p < 0,001$), mientras que los niveles de HDL-c permanecieron estables. **Conclusión:** La pérdida de peso durante la hospitalización se asoció con mejoras relevantes en los parámetros antropométricos y el perfil lipídico, reforzando la importancia de estrategias estructuradas para el manejo de la obesidad y la reducción del riesgo cardiovascular.

Palabras clave: Obesidad, Perfil lipídico, Dislipidemia, Pérdida de peso, Estudio de cohorte.

INTRODUCTION

Obesity represents one of the major contemporary public health challenges and is recognized by the World Health Organization (WHO) as a chronic, multifactorial condition of high clinical and epidemiological complexity. According to internationally adopted criteria, individuals with a body mass index (BMI) ≥ 25 kg/m² are classified as overweight, whereas values ≥ 30 kg/m² characterize obesity. This condition results from a persistent energy imbalance mediated by interactions among the central nervous system, endocrine tissues, and peripheral metabolic pathways, involving genetic, environmental, socioeconomic, behavioral, and psychosocial determinants (WHO, 2022; WELSH JA, et al., 2024; NOWICKA P, 2024; KHAN MA, et al., 2022).

Recent global estimates indicate that more than 1 billion people currently live with obesity worldwide, including adults, children, and adolescents, according to consolidated analyses by the NCD Risk Factor Collaboration in partnership with the WHO. When overweight and obesity are considered jointly, this number exceeds 2.3 billion individuals, with projections indicating continued growth in the coming decades in the absence of effective population-level interventions (WHO, 2022; NCD-RISC, 2024; WORLD OBESITY FEDERATION, 2025). In Brazil, population-based surveys and international estimates consistently indicate that approximately 30–32% of the adult population has obesity, reflecting a substantial disease burden and significant impact on the healthcare system (BRAZIL, 2024; WOF, 2025).

The sustained increase in obesity prevalence has occurred despite extensive knowledge regarding its determinants and strategies to address the obesogenic environment. Transformations in global food systems, rapid urbanization, changes in occupational profiles, increased reliance on motorized transportation, and reduced availability of spaces for physical activity have contributed to the consolidation of lifestyles characterized by sedentary behavior and excessive consumption of ultra-processed, energy-dense, nutrient-poor foods. This combination of structural and behavioral factors has been consistently associated with rising obesity rates across diverse social and economic contexts (NOWICKA P, 2024; KHAN MA, et al., 2022; WELSH JA, et al., 2024).

Beyond its well-established association with noncommunicable chronic diseases—such as type 2 diabetes mellitus, systemic arterial hypertension, and certain cancers—obesity exerts a direct influence on lipid metabolism. Evidence demonstrates that individuals with obesity exhibit a higher prevalence of atherogenic dyslipidemia, characterized by elevated triglyceride (TG) and low-density lipoprotein cholesterol (LDL-c) levels, concomitant with reduced high-density lipoprotein cholesterol (HDL-c), a lipid profile closely linked to increased cardiovascular risk (DE ANDRADES CDS, et al., 2023).

Longitudinal studies and clinical interventions consistently show that weight reduction, particularly when mediated by lifestyle modifications, is associated with significant improvements in plasma lipid profile, including reductions in triglycerides and LDL cholesterol and increases in HDL cholesterol (JENSEN MD, et al., 2014; FRANZ MJ, et al., 2007).

Evidence from diverse cohorts and clinical trials indicates that weight losses ranging from 5% to 10% of body weight are associated with clinically meaningful reductions in triglycerides, total cholesterol, and LDL-c, with additional metabolic benefits observed in losses exceeding 10% (WING RR, et al., 2011; POOBALAN A, et al., 2004). Meta-analyses and systematic reviews further support these findings, demonstrating that in interventions combining diet and physical activity, each kilogram of weight lost is associated, on average, with a reduction of approximately 4 mg/dL in triglycerides, 1.0–1.3 mg/dL in LDL-c, and an increase of about 0.4–0.5 mg/dL in HDL-c over follow-up periods of up to 12 months (DATTILO & KRIS-ETHERTON, 1992; POOBALAN A, et al., 2004).

More recently, large-scale observational studies and cohort analyses have deepened the understanding of the relationship between obesity and lipid alterations over time, highlighting metabolic heterogeneity among individuals with obesity and the persistent association between excess adiposity and unfavorable lipid profiles, independent of other traditional risk factors. These findings underscore the relevance of observational investigations—particularly cohort studies—for improving strategies aimed at cardiovascular risk prevention and management. Nonetheless, gaps remain regarding the characterization of this association in different clinical settings, especially in retrospective observational studies based on secondary data, justifying further analyses in this context (BAYS HE, et al., 2024; KIM JH, et al., 2024).

Furthermore, obesity-related dyslipidemia has become an important clinical target in cardiometabolic prevention strategies. The accumulation of visceral adipose tissue contributes to metabolic disturbances that include increased hepatic production of very-low-density lipoproteins (VLDL), impaired lipoprotein lipase activity, and reduced clearance of triglyceride-rich lipoproteins. These alterations favor the development of an atherogenic lipid profile characterized by elevated triglycerides, increased small dense LDL particles, and reduced HDL cholesterol levels. Such metabolic alterations are strongly associated with the development of atherosclerotic cardiovascular disease, which remains the leading cause of mortality worldwide (BOREN J, et al., 2022; BAYS HE, et al., 2024).

In this context, the present study sought to address the following research question: Is there an association between obesity and lipid profile alterations in patients followed in a retrospective cohort study? Accordingly, the objective was to analyze the association between obesity and lipid profile in adults with obesity using a retrospective cohort design.

METHODS

Study design and setting

This retrospective cohort study was conducted using secondary data extracted from electronic medical records of patients hospitalized in a controlled environment for weight loss between October 2016 and October 2022. The study employed a pre–post analytical approach, comparing clinical, anthropometric, and laboratory variables at admission and after completion of the inpatient program (3 or 6 months). The research took place at a specialized obesity treatment hospital in Brazil that offers an intensive multidisciplinary inpatient program for severe obesity management.

Participants

A convenience sampling strategy was employed. Initially, 1,151 individuals with severe obesity who were hospitalized for 3 and/or 6 months between 2016 and 2022 were screened for eligibility. Participants were included if they were older than 12 years, presented with grade II or III obesity at admission (body mass index ≥ 35 kg/m²), and completed at least three months of inpatient treatment within the multidisciplinary obesity management program. Patients with a recent history of bariatric surgery or gastric bypass were not admitted for obesity treatment at the institution during the study period and therefore were not included in the analysis.

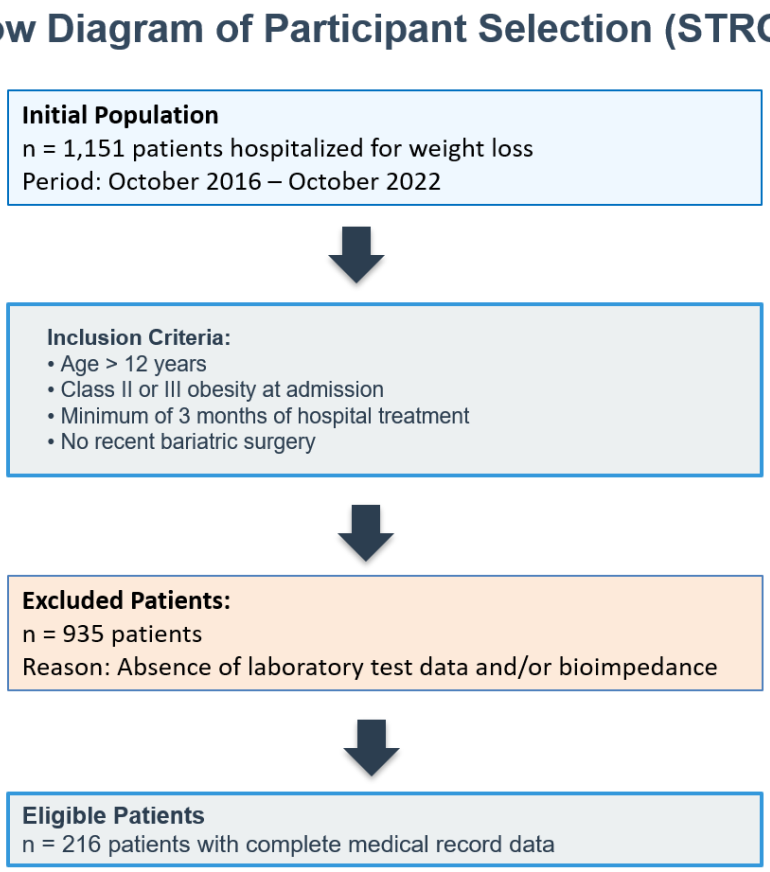
Exclusion criteria

Patients were excluded if they lacked laboratory test results and/or bioelectrical impedance data in their medical records. After exclusions (n = 935), a total of 216 patients were included with complete medical record data.

Data sources and measurement

Data were directly extracted from electronic medical records and transferred to an Excel spreadsheet, then converted to SPSS format for statistical analysis using SPSS software version 29.0.1.0 (IBM Corp., Armonk, NY, USA). Data extraction for research purposes was performed on July 31, 2023. All data were anonymized prior to analysis, and the researchers had no access to identifying information during or after data collection.

Figure 1 - Flow diagram of participant selection.



Source: Bispo AM, et al., 2026.

Therapeutic interventions and multidisciplinary support

During hospitalization, patients underwent an intensive multidisciplinary treatment program composed of dietary therapy, physical activity, psychological support, educational interventions, and continuous clinical monitoring.

Dietary therapy

Patients received structured dietary therapy during hospitalization, consisting of either a low-calorie diet (LCD), providing 800–1,200 kcal per day, or a very low-calorie diet (VLCD), providing less than 800 kcal per day. Both dietary protocols were characterized by a relatively high protein intake, ranging from 70 to 100 g per day (approximately 0.8–1.5 g/kg of ideal body weight per day), combined with reduced carbohydrate content.

The macronutrient distribution differed between the dietary protocols. The very low-calorie diet consisted of approximately 50% carbohydrates, 20% lipids, and 30% proteins, whereas the low-calorie diet provided approximately 40% carbohydrates, 20% lipids, and 40% proteins. All dietary regimens were supplemented with vitamins, minerals, electrolytes, and essential fatty acids to ensure nutritional adequacy according to Brazilian guidelines for obesity treatment.

Meals were individually prepared and supervised by nutritionists, and dietary adherence was monitored daily in the institutional dining facility. In addition, patients attended weekly 60-minute consultations with nutritionists aimed at providing dietary counseling and addressing barriers to adherence. Body composition assessments using bioelectrical impedance and biochemical laboratory tests were performed monthly throughout the hospitalization period.

Physical activity

Due to frequent musculoskeletal limitations among patients with severe obesity, the physical activity program consisted primarily of low-impact exercises. Participants engaged in water aerobics at least three times per week, horizontal cycling twice weekly with light resistance, and resistance training sessions three times per week. All activities were conducted under professional supervision and were adapted according to individual functional capacity and clinical conditions to ensure safety and adherence throughout the hospitalization period.

Psychological and educational interventions

Participants received individual cognitive behavioral therapy (CBT) sessions lasting one hour twice weekly. Additionally, patients attended daily one-hour group educational sessions using active methodologies aimed at promoting sustainable lifestyle changes.

Clinical monitoring

Patients underwent daily clinical evaluations. Periodic consultations were provided by endocrinologists, cardiologists, orthopedists, and psychiatrists. Physiotherapists, occupational therapists, and nurses continuously monitored patients and delivered interventions as needed.

Anthropometry and body composition

Weight, height, and body composition were measured at admission and after 3 and/or 6 months of hospitalization.

Height was measured using a stadiometer (Tonelli Medical Devices, Brazil). Weight and body composition were assessed using a multifrequency bioelectrical impedance analyzer (InBody 570, Ottoboni, Brazil), which uses a tetrapolar eight-electrode system and three frequencies (5 kHz, 50 kHz, and 500 kHz) to obtain segmental impedance measurements for both arms, trunk, and both legs.

Obesity severity was classified according to body mass index (BMI), following internationally established criteria. Individuals with BMI between 30.0 and 34.9 kg/m² were classified as having grade I obesity, those with BMI between 35.0 and 39.9 kg/m² were classified as having grade II obesity, and individuals with BMI ≥ 40.0 kg/m² were classified as having grade III obesity.

Laboratory measurements

Laboratory parameters were assessed at admission and after 3 and/or 6 months of treatment. The evaluated biomarkers included triglycerides, total cholesterol, high-density lipoprotein cholesterol (HDL-c), and low-density lipoprotein cholesterol (LDL-c). Triglycerides, total cholesterol, and HDL-c were measured using enzymatic colorimetric methods, while LDL-c concentrations were calculated using the Friedewald formula.

Statistical analysis

Statistical analysis initially included descriptive statistics of continuous variables expressed as means and standard deviations. Comparisons between admission and discharge values for anthropometric, body composition, and biochemical parameters were conducted using paired statistical tests, applying the paired Student's t-test for normally distributed variables or the Wilcoxon test for non-normally distributed variables. Statistical significance was set at $p < 0.05$. Analyses were performed using appropriate statistical software SPSS version 29.0.1.0.

Ethical considerations

The study followed the ethical principles outlined in the Declaration of Helsinki and complied with Brazilian National Health Council Resolution No. 466/2012. The research protocol was approved by the Research Ethics Committee of the State University of Bahia (UNEB), Brazil Committee opinion number 6,071,858, (CAAE: 65578822.1.0000.0057). Because of the retrospective design and use of secondary anonymized data, informed consent was waived by the ethics committee, as participants were no longer available for contact.

RESULTS

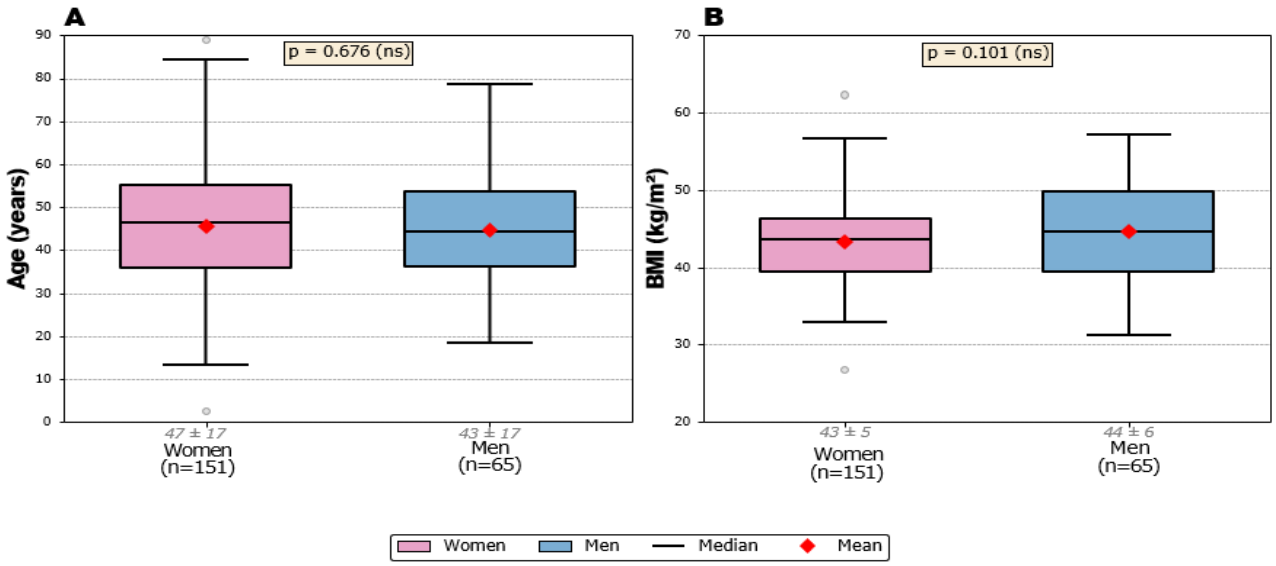
Data from 216 patients with obesity were analyzed using paired comparisons at hospital admission and discharge. The majority were women (n=151, 69.9%), with a mean age of 47 ± 17 years and body mass index (BMI) of 43 ± 5 kg/m². Men (n=65, 30.1%) had a mean age of 43 ± 17 years and BMI of 44 ± 6 kg/m². No statistically significant differences were observed between sexes regarding age (t=0.418, p=0.676) or BMI (t=-1.646, p=0.101) at baseline (**Figure 2**).

Table 1 presents the comparison of anthropometric and body composition parameters between admission and hospital discharge. Statistically significant reductions were observed in all evaluated parameters (p < 0.001).

Mean body weight decreased from 119.35 kg to 94.5 kg, corresponding to a relative reduction of 20.8%. Fat mass showed a marked decrease from 61.1 kg to 39.3 kg (−35.7%), accompanied by a reduction in body fat percentage from 52.4% to 44.1% (−15.8%).

Skeletal muscle mass exhibited a more modest reduction, from 31.9 kg to 29.0 kg, representing a relative change of 9.1%. Body mass index (BMI) decreased from 43.4 kg/m² to 34.1 kg/m², corresponding to a reduction of 21.4%. Basal metabolic rate (BMR) declined from 1,594 kcal to 1,504 kcal (−5.6%). A significant improvement in waist-to-hip ratio (WHR) was also observed, with a relative reduction of 6.5% between the two time points.

Figure 2 -Demographic Characteristics by Sex.



*Box plots showing the distribution of (A) age and (B) body mass index (BMI) stratified by sex. Box plots display the median (solid black line), mean (red diamond), interquartile range (box), and whiskers extending to 1.5 times the interquartile range. Outliers are shown as gray circles. Data are presented as mean ± standard deviation below each group. Statistical comparisons between women (n=151) and men (n=65) were performed using independent samples t-tests. ns, not significant.
Source: Bispo AM, et al., 2026.

Table 1 - Comparison of anthropometric and body composition parameters at hospital admission and discharge (n = 216)

Variable	Admission (mean)	Discharge (mean)	Change (%)	p value
Body weight (kg)	119.35	94.5	−20.8	< 0.001
Fat mass (kg)	61.1	39.3	−35.7	< 0.001
Body fat percentage (%)	52.4	44.1	−15.8	< 0.001
Skeletal muscle mass (kg)	31.9	29.0	−9.1	< 0.001
Body mass index (kg/m²)	43.4	34.1	−21.4	< 0.001
Basal metabolic rate (kcal)	1,594	1,504	−5.6	< 0.001

Source: Bispo AM, et al., 2026.

The comparison of lipid profile parameters is presented in **Figure 2**. A significant improvement in major atherogenic lipid markers was observed at the end of hospitalization. Triglyceride levels decreased from 116 mg/dL to 89.5 mg/dL, corresponding to a relative reduction of 22.8% ($p < 0.001$). Total cholesterol levels showed a significant decrease from 184 mg/dL to 161 mg/dL, equivalent to a reduction of 12.5% ($p < 0.001$). LDL cholesterol levels were also significantly reduced, from 113.5 mg/dL to 98.0 mg/dL, representing a decrease of 13.6% ($p < 0.001$). In contrast, HDL cholesterol levels remained stable throughout the hospitalization period, with a slight decrease from 46 mg/dL to 45 mg/dL, which did not reach statistical significance ($p = 0.070$).

DISCUSSION

The findings of this study demonstrate that a clinically supervised, hospital-based weight loss intervention was associated with statistically significant improvements in anthropometric parameters, body composition, and lipid profile among patients with obesity. In a sample of 216 individuals, substantial reductions were observed in body weight, fat mass, body fat percentage, body mass index, and waist-to-hip ratio, accompanied by consistent improvements in major atherogenic lipid markers, including triglycerides, total cholesterol, and LDL cholesterol.

The magnitude of weight loss observed in this cohort (20.8%) substantially exceeds the 5–10% range traditionally considered sufficient to induce clinically meaningful metabolic benefits. Recent evidence suggests that weight reductions of this magnitude are associated with more pronounced improvements in glycemic control, insulin sensitivity, and overall cardiovascular risk. Updated guidelines from the American Diabetes Association emphasize that weight losses greater than 10% may confer additional metabolic advantages, including sustained improvements in lipid profile and cardiometabolic risk reduction, particularly among individuals with obesity and related comorbidities (AMERICAN DIABETES ASSOCIATION, 2024).

The lipid profile findings are consistent with existing literature. Meta-analyses and systematic reviews have demonstrated that weight loss induced by dietary and behavioral interventions is associated with proportional reductions in triglyceride and LDL cholesterol levels, with effects largely dependent on the magnitude of weight reduction. Dattilo AM and Kris-Etherton PM (1992) reported that each kilogram of weight loss is associated, on average, with a reduction of approximately 4 mg/dL in triglycerides and 1.0–1.3 mg/dL in LDL cholesterol, providing a meaningful context for the 22.8% reduction in triglycerides and 13.6% reduction in LDL cholesterol observed in the present study. Recent reviews further support that low-calorie and very-low-calorie diets promote consistent reductions in total cholesterol and atherogenic lipid fractions, particularly among individuals with obesity and metabolic syndrome (FEINGOLD KR, 2023).

In the present study, the observed reductions of 12.5% in total cholesterol and 13.6% in LDL cholesterol align with findings from previous clinical trials evaluating intensive dietary interventions. Theodore RF, et al. (2007) reported substantial decreases in triglycerides, total cholesterol, and LDL cholesterol among individuals undergoing calorie-restricted diets, especially in contexts of obesity associated with metabolic syndrome, reinforcing the biological plausibility of the present results.

Obesity-associated dyslipidemia is driven by interdependent pathophysiological mechanisms, including increased flux of free fatty acids from adipose tissue to the liver, enhanced hepatic synthesis and secretion of

triglyceride-rich lipoproteins (VLDL/TRL), and reduced peripheral clearance of triglycerides and remnant particles—processes that are amplified by insulin resistance and chronic low-grade inflammation. In this context, reductions in adiposity may mitigate hepatic lipid overload and improve TRL/remnant production and clearance dynamics, thereby contributing to decreases in triglycerides, total cholesterol, and LDL-C (BJORNSTAD & ECKEL, 2018; VEKIĆ J, et al., 2019; BOREN J, et al., 2022; BAYS HE, et al., 2024).

Regarding HDL cholesterol, the absence of a significant increase—along with a slight, non-significant reduction—is consistent with evidence indicating heterogeneous responses of this lipid fraction during weight loss, particularly in short- to medium-term interventions. Several studies suggest that serum HDL cholesterol concentration does not fully capture qualitative or functional changes in HDL particles. Emerging evidence indicates that improvements in HDL functionality, such as enhanced cholesterol efflux capacity and antioxidant properties, may occur independently of increases in circulating HDL cholesterol levels (SARIN S, et al., 2019). Moreover, contemporary literature recognizes that isolated increases in HDL cholesterol do not necessarily translate into reduced cardiovascular risk, underscoring the importance of interpreting HDL cholesterol within the broader metabolic and lipid context.

Another important aspect to consider is the potential clinical relevance of the lipid changes observed in this cohort. Reductions in triglycerides and LDL cholesterol are consistently associated with decreased risk of atherosclerotic cardiovascular disease in both observational studies and interventional trials. Epidemiological evidence indicates that each 1 mmol/L reduction in LDL cholesterol is associated with a relative reduction of approximately 20–25% in major cardiovascular events, highlighting the clinical significance of improvements in this lipid fraction (FERENCE BA, et al., 2017).

Moreover, the magnitude of weight loss observed in this study suggests that intensive multidisciplinary treatment programs conducted in controlled clinical environments may produce metabolic improvements that exceed those typically reported in outpatient lifestyle interventions. Such findings reinforce the importance of structured obesity treatment strategies that combine dietary therapy, physical activity, psychological support, and continuous clinical monitoring. These integrated approaches may enhance adherence and promote sustained metabolic benefits, particularly among individuals with severe obesity who often present complex clinical profiles and multiple cardiometabolic risk factors.

Several limitations should be considered when interpreting these results. The retrospective cohort design, based on secondary data extracted from electronic medical records, limits causal inference between the intervention and the observed outcomes. The absence of a control group precludes direct comparison with individuals not exposed to the intervention. Additionally, behavioral variables such as physical activity levels, dietary adherence after discharge, and the use of lipid-lowering medications were not assessed and may have influenced metabolic outcomes. Finally, lipid profile assessment was limited to quantitative measures, precluding evaluation of qualitative or functional aspects of lipoproteins, such as HDL functionality.

Despite these limitations, the relatively large sample size, paired study design, and consistency of the findings with existing literature strengthen the relevance and credibility of the results presented. From a clinical and public health perspective, the findings of this study underscore the relevance of structured, multidisciplinary weight loss interventions in the management of obesity and reduction of cardiovascular risk. The concurrent improvement in anthropometric and lipid parameters observed in this cohort suggests a favorable metabolic impact, particularly among individuals with moderate to severe obesity receiving care in a specialized clinical setting.

Standardized lipid profile assessment at admission and discharge can be used as an objective marker of metabolic response during hospitalization in patients with obesity. In practice, reductions in triglycerides and LDL cholesterol may support discharge planning and help define the intensity of post-discharge follow-up, although maintaining these effects requires structured continuity-of-care strategies.

CONCLUSION

In this retrospective cohort study, an association was observed between obesity and favorable changes in anthropometric parameters and lipid profile among adult patients treated in a specialized hospital setting. Weight loss during the hospitalization period was associated with significant reductions in triglycerides, total

cholesterol, and LDL cholesterol levels, while HDL cholesterol levels remained stable. These findings address the research question and fulfill the proposed objective, reinforcing the relevance of structured obesity management strategies in clinical practice, particularly among individuals with moderate to severe obesity. The results contribute to a better understanding of the relationship between weight loss and lipid profile in real-world healthcare settings.

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