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SCIENTIFIC ARTICLE - ORIGINAL

EPIDEMIOLOGICAL ANALYSIS OF CANCER MORTALITY IN THE STATE OF GOIÁS BETWEEN 2015 AND 2024

EDUARDO RIBEIRO SENE[1], ANA MARIA RAGAGNIN DALMASO[1], BRUNNA MACHADO MEDEIROS[1], LYANDRA YURI KATSUYAMA NOGUEIRA[1], ADEMAR CAETANO DE ASSIS FILHO[1]

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ABSTRACT

Introduction: Cancer is characterized by uncontrolled cell growth resulting from the transformation of normal cells into malignant ones, constituting a relevant public health problem. **Objective:** To analyze the epidemiological profile of mortality due to neoplasms in the state of Goiás, Brazil, from 2015 to 2024. **Methods:** This is a cross-sectional, descriptive, and quantitative study conducted using secondary data from the Mortality Information System (SIM), made available by DATASUS. All deaths by place of residence in the state of Goiás with the underlying cause classified in Chapter II of the ICD-10 (Neoplasms), occurring between 2015 and 2024 and involving individuals of all age groups, were included. The variables analyzed were year of death, sex, age group, education level, marital status, race/color, place of occurrence, health macroregion, and neoplasm groups. Data were analyzed descriptively using tables and graphs. **Results:** During the analyzed period, 68,385 deaths due to neoplasms were recorded in Goiás, showing an increasing trend over the historical series. There was a predominance of males and a higher concentration of deaths among individuals aged 60 years or older. The main causes of death were neoplasms of the digestive organs and of the respiratory and intrathoracic system, followed by breast neoplasms and neoplasms of the genital organs. Deaths were more concentrated in the most populous macroregions of the state, with a predominance of hospital deaths and individuals with low educational attainment. **Conclusion:** Cancer mortality in Goiás showed progressive growth, associated with population aging, sociodemographic inequalities, and the organization of the health care network.

Keywords: miology, Mortality, Neoplasms, Goiás, Sociodemographic profile.

INTRODUCTION

Cancer is a disease characterized by uncontrolled cellular growth resulting from the transformation of normal cells into malignant ones. These cells acquire the capacity for sustained proliferation, adaptation, and survival, escaping physiological control mechanisms. From a modern biological perspective, cancer represents an evolutionary process in which

transformed cells are subjected to selective pressures similar to those of natural selection. This phenomenon contributes to tumor heterogeneity, treatment resistance, and disease progression, all of which are central factors underlying its high lethality.[1]

Global statistics for 2022 reported approximately 20 million new cancer cases and nearly 10 million cancer-related deaths. Demographic projections indicate that the annual number of new cancer cases will reach 35 million by 2050, representing a 77% increase compared with 2022.[2]

In Brazil, data regarding the most prevalent cancer types reveal a sex-specific pattern. Among men, the most frequent malignancies include prostate cancer, followed by cancers of the trachea, bronchi, and lungs, as well as colorectal cancer, highlighting the importance of neoplasms associated with smoking and aging. Among women, breast cancer is the most common, followed by colorectal and cervical cancers, reflecting both behavioral factors and gaps in early detection and access to healthcare services.[3]

Cancer represents a major public health problem and ranks among the leading causes of mortality in Brazil. The risk factors associated with its development are largely shared with other noncommunicable chronic diseases and include smoking, obesity, alcohol consumption, exposure to ionizing radiation and solar radiation, and dietary habits characterized by high consumption of processed and ultra-processed foods. In addition, intrinsic factors, particularly those of a genetic nature, also exert a significant influence on the occurrence of the disease.[4]

In countries with a high Human Development Index (HDI), reductions in cancer incidence and mortality rates have been observed, mainly due to the implementation of effective prevention, screening, and treatment strategies. In contrast, in countries undergoing socioeconomic transition, these rates remain stable or continue to rise, reflecting structural limitations and restricted access to healthcare services. In this context, the main challenge lies in optimizing the use of available resources and strengthening policies capable of improving cancer control.[5]

Against this background, an epidemiological analysis of cancer mortality in the state of Goiás is essential for understanding the disease profile and for supporting prevention strategies and the development of public health policies.

MATERIALS AND METHODS

This is a descriptive cross-sectional study with a quantitative approach, conducted using data obtained from the Mortality Information System (SIM), accessed through the Brazilian Unified Health System Information Technology Department (DATASUS). The study aimed to describe deaths due to neoplasms among residents of the state of Goiás between 2015 and 2024.

For the analysis, inclusion criteria comprised death records by place of residence registered in the state of Goiás, involving individuals aged from 0 years to 80 years or older, with a diagnosis of neoplasm during the study period.

Data were obtained from DATASUS considering deaths whose underlying cause was classified under Chapter II of the International Classification of Diseases, 10th Revision (ICD-10), entitled Neoplasms. This chapter comprises 14 categories, including malignant neoplasms of the lip, oral cavity and pharynx; digestive organs; respiratory and intrathoracic organs; bone and articular cartilage; and skin (melanoma and other malignant neoplasms). In addition, the following variables were collected for analysis: age group, sex, educational level, marital status, year of death, and place of occurrence (residence).

The data obtained were analyzed and presented descriptively through tables and graphs created using Microsoft Excel. The findings were subsequently discussed based on scientific literature published in Portuguese and English.

As this study used publicly available secondary data with free access, submission to a Research Ethics Committee was not required, in accordance with Resolution No. 466/2012 of the Brazilian National Health Council.

RESULTS

Between 2015 and 2024, a total of 68,385 deaths due to neoplasms (Chapter II of ICD-10) were recorded among residents of the state of Goiás, demonstrating an increasing trend throughout the study period. In 2015, 5,956 deaths were reported, with a progressive increase through 2019 (6,874 deaths). After a slight reduction in 2020 (6,768 deaths), growth resumed in 2021 (6,875 deaths) and intensified in subsequent years, reaching 7,241 deaths in 2022, 7,686 in 2023, and 7,755 in 2024.

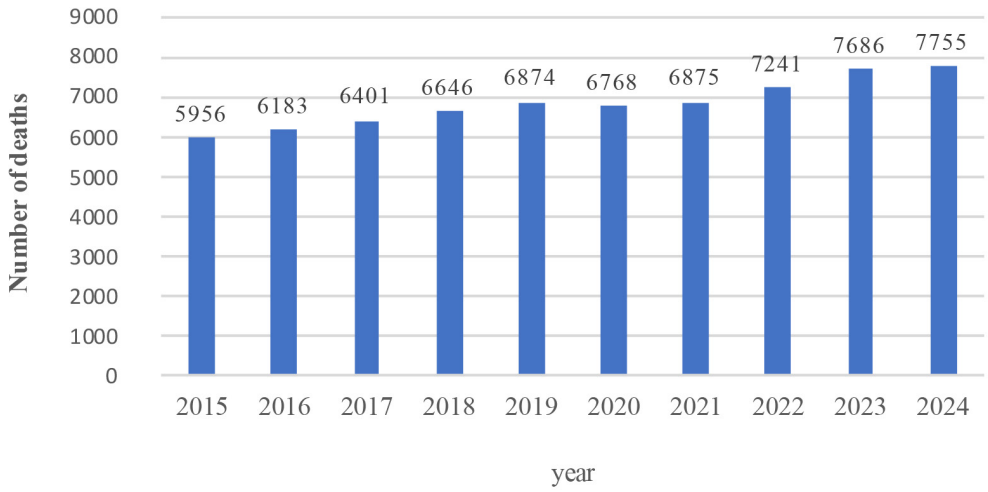

Figure 1: Distribution of deaths due to neoplasms according to year of death, Goiás, 2015–2024.
Fonte: MS/SVS/CGIAE – Mortality Information System (SIM). Prepared by the authors.

Regarding distribution by Health Macroregion, the highest concentration of deaths was observed in the Central-West Macroregion, followed by the Central-Southeast and Central-North Macroregions. The Northeast and Southeast Macroregions presented lower numbers of deaths, while the category "unknown" accounted for only a residual proportion. This pattern reflects the greater population density, higher degree of urbanization, and concentration of specialized healthcare services in the central regions of the state. Among the municipalities, the highest numbers of deaths were recorded in Goiânia (17,790 deaths), Aparecida de Goiânia (4,776), Anápolis (4,451), Rio Verde (1,620), and Luziânia (1,625).

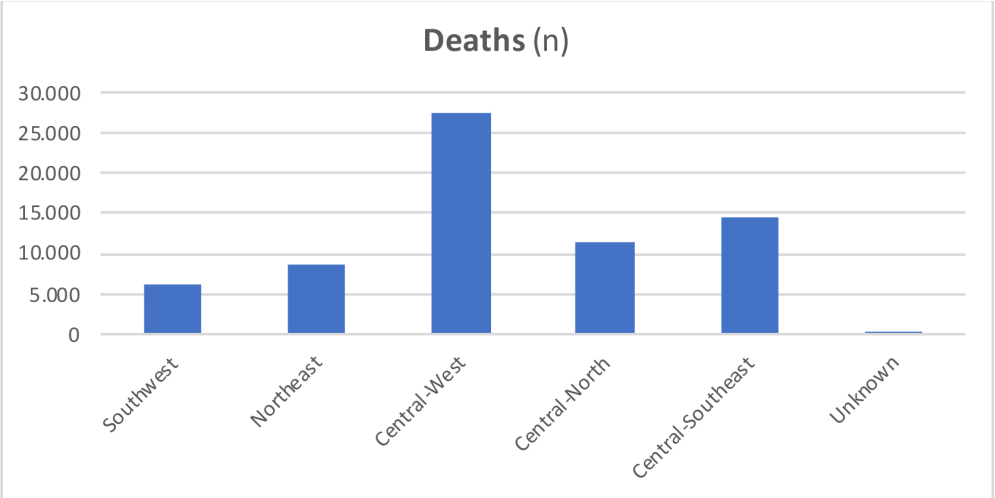

Figure 2: Distribution of cancer-related deaths in the state of Goiás according to Health Macroregion, 2015–2024.
Fonte: Mortality Information System (SIM/DATASUS). Prepared by the authors.

The most frequent neoplasm groups according to Chapter II of the ICD-10 (Neoplasms) were those involving the digestive organs (30.6%), respiratory and intrathoracic organs (16.0%), breast (7.9%), male genital organs (7.8%), female genital organs (7.1%), and the lymphatic and hematopoietic tissues (7.2%). This profile is consistent with the national pattern of cancer mortality, although percentage variations exist among the different anatomical groups.

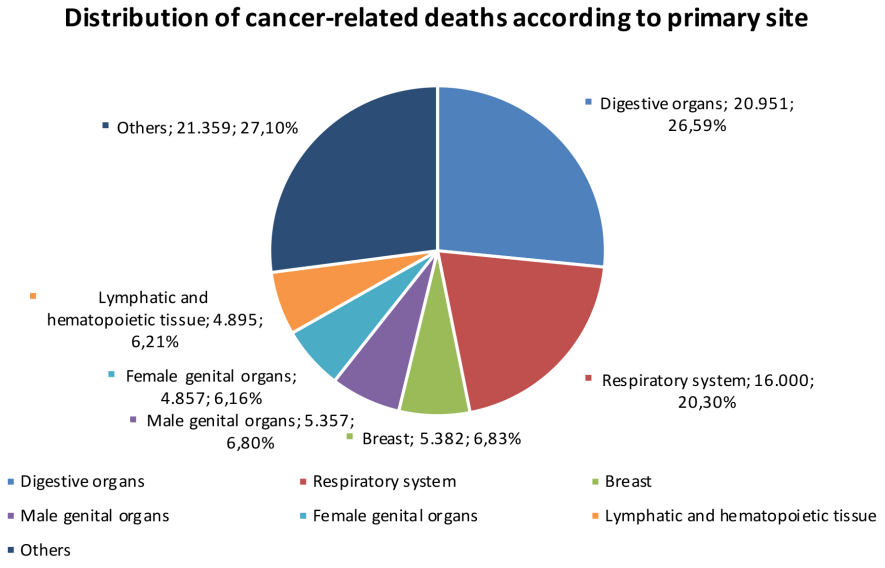

Figure 3: Proportional distribution of cancer-related deaths in the state of Goiás according to Chapter II groups of ICD-10 (Neoplasms), 2015–2024.
Fonte: Mortality Information System (SIM/DATASUS).

Note: Only groups accounting for ≥5% of total deaths were presented individually; the remaining groups were combined into the "Others" category (malignant neoplasms of the lip, oral cavity, and pharynx; respiratory and intrathoracic organs; bone and articular cartilage; skin [melanoma and other malignant neoplasms]; mesothelial and soft tissues; urinary tract; eye, brain, and central nervous system; thyroid and other endocrine glands; and neoplasms of ill-defined sites, multiple primary sites, in situ neoplasms, benign neoplasms, and neoplasms of uncertain or unknown behavior).

The distribution of deaths by age group demonstrated a strong association with aging, with a marked concentration beginning at 50 years of age. The highest proportions were observed among individuals aged 60–69 years (24.69%) and 70–79 years (24.44%), followed by those aged 80 years or older (18.88%), indicating that more than two-thirds of all deaths occurred in individuals aged 60 years and older.

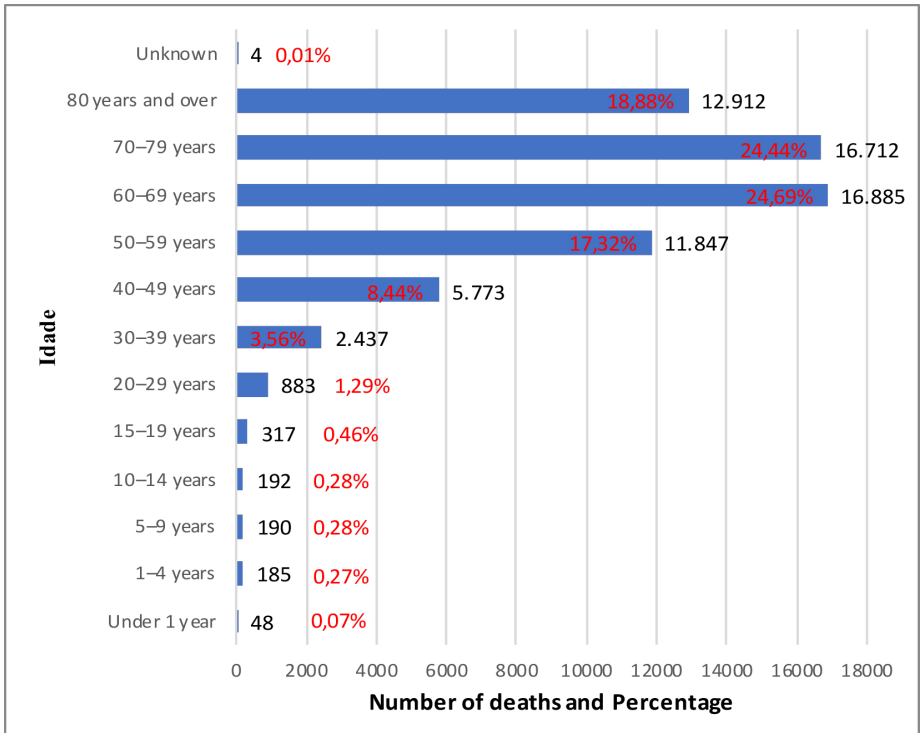

Figure 4: Distribution of cancer-related deaths in the state of Goiás according to age group, 2015–2024.
Fonte: Mortality Information System (SIM/DATASUS). Prepared by the authors.

Variation in the leading causes of death was observed according to age group. Among individuals aged 0 to 14 years, malignant neoplasms predominated, with a smaller contribution from thyroid neoplasms and neoplasms of uncertain behavior. In the 15–39-year age group, malignant neoplasms remained the most frequent cause, followed by cancers of the female genital organs and breast cancer. Among individuals aged 40–59 years, in addition to malignant neoplasms, cancers of the digestive organs and respiratory system were particularly prominent. In those aged 60 years and older, the greatest

burden of mortality was observed, mainly due to malignant neoplasms and cancers of the digestive and respiratory organs, highlighting the increasing complexity and disease burden associated with advancing age.

Table 1: Deaths by place of residence according to Chapter II groups of ICD-10 (Neoplasms) and grouped age categories, Goiás, 2015–2024.

ICD-10 Group	Male, n (%)	Female, n (%)	Unknown, n	Total, n (%)
Total	36,283 (53.1)	32,087 (46.9)	15	68,385 (100.0)
Malignant neoplasms	35,816 (52.3)	31,628 (46.2)	15	67,459 (98.6)
Malignant neoplasms of specified sites	31,457 (46.0)	28,140 (41.1)	14	59,611 (87.2)
Malignant neoplasms of the lip, oral cavity, and pharynx	2,026 (3.0)	522 (0.8)	–	2,548 (3.7)
Malignant neoplasms of the digestive organs	12,029 (17.6)	8,916 (13.0)	6	20,951 (30.6)
Malignant neoplasms of the respiratory and intrathoracic organs	6,507 (9.5)	4,430 (6.5)	4	10,941 (16.0)
Malignant neoplasms of bone and articular cartilage	429 (0.6)	286 (0.4)	–	715 (1.0)

Melanoma and other malignant neoplasms of the skin	810 (1.2)	625 (0.9)	–	1,435 (2.1)
Malignant neoplasms of mesothelial and soft tissues	476 (0.7)	484 (0.7)	2	962 (1.4)
Malignant neoplasms of the breast	62 (0.1)	5,319 (7.8)	–	5,382 (7.9)
Malignant neoplasms of the female genital organs	–	4,857 (7.1)	–	4,857 (7.1)
Malignant neoplasms of the male genital organs	5,357 (7.8)	–	–	5,357 (7.8)
Malignant neoplasms of the urinary tract	1,703 (2.5)	886 (1.3)	–	2,589 (3.8)
Malignant neoplasms of the eye, brain, and other parts of the CNS	1,826 (2.7)	1,520 (2.2)	1	3,347 (4.9)
Malignant neoplasms of the thyroid and other endocrine glands	232 (0.3)	295 (0.4)	–	527 (0.8)
Ill-defined, secondary, and unspecified malignant neoplasms	1,581 (2.3)	1,354 (2.0)	–	2,935 (4.3)

Malignant neoplasms of lymphatic, hematopoietic, and related tissue	2,766 (4.0)	2,128 (3.1)	1	4,895 (7.2)
Multiple independent (primary) malignant neoplasms	12 (0.02)	6 (0.01)	–	18 (0.03)
In situ neoplasms	16 (0.02)	18 (0.03)	–	34 (0.05)
Benign neoplasms	103 (0.15)	153 (0.22)	–	256 (0.37)
Neoplasms of uncertain or unknown behavior	348 (0.5)	288 (0.4)	–	636 (0.9)

Source: Mortality Information System (SIM/DATASUS). Prepared by the authors.

Note: Percentages were calculated in relation to the total number of deaths due to neoplasms during the study period.

In the analysis by sex, a predominance of males was observed, accounting for 36,283 deaths (53.06%), compared with 32,087 deaths among females (46.92%). Among men, the leading causes of death were malignant neoplasms of the digestive organs (17.6%; n = 12,029), respiratory and intrathoracic organs (9.5%; n = 6,507), male genital organs (7.8%; n = 5,357), and lymphatic and hematopoietic tissue (4.0%; n = 2,766). Among women, the most prominent neoplasms were those of the breast (7.8%; n = 5,319), digestive organs (13.0%; n = 8,916), female genital organs (7.1%; n = 4,857), and respiratory and intrathoracic organs (6.5%; n = 4,430). In both sexes, relevant proportions of central nervous system neoplasms (4.9%), urinary tract neoplasms (3.8%), and ill-defined, secondary, or unspecified malignant neoplasms (4.3%) were also observed.

Table 2: Deaths by place of residence in the state of Goiás due to neoplasms, according to Chapter II groups of ICD-10 (Neoplasms) and sex, 2015–2024.

ICD-10 Group	Male, n (%)	Female, n (%)	Unknown, n	Total, n (%)
Total	36,283 (53.1)	32,087 (46.9)	15	68,385 (100.0)
Malignant neoplasms	35,816 (52.3)	31,628 (46.2)	15	67,459 (98.6)
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Multiple independent (primary) malignant neoplasms	12 (0.02)	6 (0.01)	–	18 (0.03)
In situ neoplasms	16 (0.02)	18 (0.03)	–	34 (0.05)
Benign neoplasms	103 (0.15)	153 (0.22)	–	256 (0.37)

Neoplasms of uncertain or unknown behavior	348 (0.5)	288 (0.4)	–	636 (0.9)

Mortality was associated with sociodemographic characteristics and place of occurrence. A higher proportion of deaths was observed among individuals with lower educational attainment, particularly those with 4–7 years of schooling (19.89%) and 1–3 years of schooling (18.92%), in addition to a high frequency of records with unknown educational level (21.62%). Regarding marital status, married individuals (39.32%) predominated, followed by single (19.05%) and widowed individuals (18.23%). Concerning race/ethnicity, White (45.46%) and Brown/Mixed-race individuals (43.15%) accounted for the majority of deaths. Most deaths occurred in hospital settings (77.89%), followed by home deaths (16.61%), highlighting the central role of the healthcare network in oncological care.

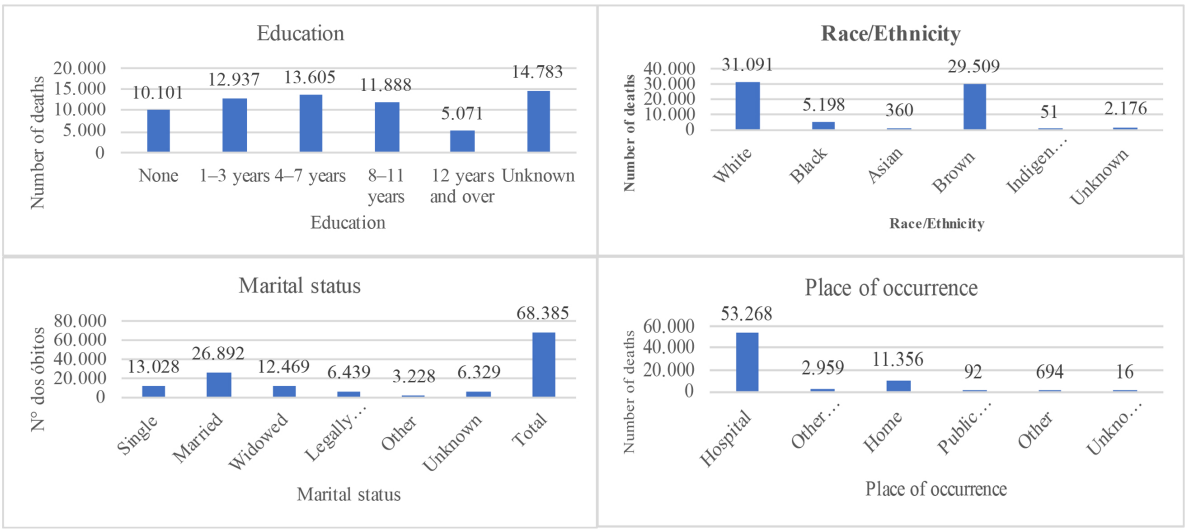

Figure 5: Distribution of cancer-related deaths according to sociodemographic characteristics and place of occurrence in the state of Goiás, 2015–2024.
Source: Mortality Information System (SIM/DATASUS). Prepared by the authors.

Note: Percentages were calculated in relation to the total number of deaths due to neoplasms during the study period.

DISCUSSION

In the present study, a substantial increase in the number of deaths due to neoplasms was observed over the analyzed period, rising from 5,956 records in 2015 to 7,755 in 2024,

corresponding to an approximate increase of 30%. This pattern reflects a sustained upward trend in cancer mortality, consistent with the growing global burden of the disease observed over recent decades. This local increase occurs within a broader context of epidemiological transition, in which, although countries with a high Human Development Index (HDI) account for the greatest absolute increase in cancer cases, low- and middle-HDI countries experience the largest proportional increases in incidence, estimated at 142% and 99%, respectively.[2]

The organization of the state of Goiás into health macroregions follows the principles of regionalization of the Brazilian Unified Health System (SUS), based on population, geographic, healthcare capacity, and patient-flow criteria. The greater concentration of cancer-related deaths in the Central-West, Central-Southeast, and Central-North macroregions, as well as in the most populous municipalities (Goiânia, Aparecida de Goiânia, and Anápolis), is consistent with the demographic distribution of the state, according to data from the Brazilian Institute of Geography and Statistics (IBGE). More populous and urbanized municipalities concentrate medium- and high-complexity healthcare services, which influences diagnosis, mortality reporting, and the centralization of deaths, reflecting both population dynamics and the organization of the healthcare network.[6,7,8,9]

In the Brazilian context, the literature points to regional heterogeneity in cancer mortality indicators. A study evaluating cancer mortality trends in Brazil between 1980 and 2006 identified higher mortality rates in inland regions compared with state capitals and did not observe a significant reduction in overall mortality during the study period.[10]

The distribution of cancer mortality according to the age group observed in this study is consistent with patterns reported in the literature. In the pediatric population, deaths due to malignant neoplasms predominated, in agreement with national studies indicating leukemia and central nervous system tumors as the leading causes of cancer-related death in children. However, due to the grouping structure of the data analyzed in this study, a specific comparative analysis of leukemia and central nervous system neoplasms was not possible.[11]

Among adolescents and young adults, the international literature describes a greater diversity of cancer types, with a progressive increase in incidence beginning in the third decade of life, particularly among women. Thyroid cancer, germ cell tumors, and melanoma are especially prominent, which is consistent with the greater contribution of gynecological and breast cancers observed in this study.[12]

From middle age onward, and particularly among older adults, the greatest burden of cancer mortality is concentrated in neoplasms of the digestive and respiratory systems, which are associated with cumulative exposure to risk factors and population aging. Despite the high incidence of cancer in this age group, mortality is influenced by competing causes of death, highlighting the complexity of the epidemiological profile of cancer throughout the life course.[13]

When comparing the data observed in Goiás with the national cancer mortality profile, a similar pattern was identified between sexes, although differences were noted in the relative frequency of neoplasm types. Among men, neoplasms of the digestive organs (17.6%) and respiratory and intrathoracic organs (9.5%) were important causes of death, consistent with the Brazilian scenario, in which prostate cancer (13.5%) and cancers of the trachea, bronchi, and lungs (13.2%) rank among the most prevalent. Among women, a closer resemblance to the national profile was observed, with breast cancer accounting

for 7.8% of deaths in Goiás, compared with 16.4% nationally, followed by cancers of the trachea, bronchi, and lungs (11.7%) and colorectal cancers (9.6%). The differences observed between state and national percentages may reflect regional disparities related to access to healthcare services, coverage of screening strategies, early diagnosis, and sociodemographic characteristics of the population, all of which are recognized determinants of cancer mortality patterns in Brazil.[14]

The higher proportion of deaths observed among individuals with lower educational attainment reflects a pattern widely described in the Brazilian literature, in which lower educational levels are associated with poorer socioeconomic conditions, greater exposure to risk factors, delayed diagnosis, and reduced timely access to healthcare services. Regarding marital status, the predominance of deaths among married individuals has also been reported in national investigations and is frequently interpreted as a reflection of the higher proportion of married individuals in older age groups, where the burden of cancer mortality is greatest. Concerning race/ethnicity, the predominance of White and Brown individuals mirrors the demographic composition of the state of Goiás. The high proportion of deaths occurring in hospital settings is similar to findings reported in other Brazilian studies and reinforces the central role of hospital-based care in oncology, particularly during advanced stages of disease. Recent investigations emphasize that although hospital deaths are associated with greater availability of specialized services, they may also indicate limitations in the expansion of palliative and home-based care in the country. Therefore, the findings of this study are consistent with the epidemiological profile of cancer mortality described in Brazil and highlight the influence of social determinants and healthcare network organization on oncological outcomes.[9,15,16]

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SCIENTIFIC ARTICLE - ORIGINAL

IMPACT OF STRUCTURED CARDIOMETABOLIC INTERVENTION IN A HIGH-RISK CARDIOVASCULAR POPULATION: RESULTS OF A PILOT STUDY

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ABSTRACT

Introduction: Cardiometabolic risk is associated with the likelihood of cardiovascular system damage when multiple factors occur concurrently. These include visceral obesity, dyslipidemia, hypertension, insulin resistance, and inflammation—aspects that comprise the pathophysiology of cardiometabolic diseases. Pharmacological and non-pharmacological interventions seek to control these factors and improve clinical outcomes. **Objective:** This study aims to demonstrate the effect of a multidisciplinary care intervention focused on adjusting cardiometabolic risk factors in a population with a high cardiovascular risk profile. **Methods:** This is a pilot cohort study conducted in a specialized outpatient clinic (cardiologist, endocrinologist, and nutritionist). Individuals underwent a systematic approach involving laboratory tests, cardiovascular risk imaging, and bioimpedance for body composition analysis. Dietary patterns, metabolic activity, and preexisting diseases were established. The protocol included a diet (caloric restriction), protein supplementation, resistance training, and gradual pharmacological treatment. Following the cardiometabolic diagnosis, an intervention plan was devised with structured feedback and follow-ups every 90 days via an app and direct contact with the team. Monitoring lasted six months, with constant reevaluations and adjustments. Statistical analysis was performed using Student's t-test $p \leq 0.05$), with data expressed as mean ± standard deviation. **Results:** Twenty-seven individuals were followed (age: 54.2±8.2 years, 59.3% male, weight: 100.0±15.4 kg). The initial prevalence of risk factors was: coronary artery disease: 51.9%, diabetes: 33.3%, hypertension: 14.8%, dyslipidemia: 88.9%. 92.6% of the sample was specific to body weight, with a pre-test BMI of 34.9±4.3 kg/cm^2 vs. post-test 31.1±7.6 kg/cm^2 (p: 0.03). Bioimpedance analysis showed a decrease in fat mass (pre: 39.6±6.7% vs post 35.8±6.4%, p: 0.05) and maintenance of lean mass (pre: 34.0±4.5% vs post 36.1±4.0%, p: 0.10). LDL cholesterol decreased (pre: 96.3±49.4 mg/dL vs post 65.6±39.9 mg/dL, p: 0.03). The same occurred with triglycerides (pre: 199.3±139.0 mg/dL vs post 111.9±69.7 mg/dL, p: 0.01). Fasting glucose, glycated hemoglobin (HbA1c), high-density lipoprotein (HDL), and abdominal diseases did not show significant changes. Statins were used in 77.8% of cases and GLP-1 agonists in 40.7%. **Conclusion:**

Preliminary data suggest that a care program focused on cardiometabolism has high potential to alter risk-associated parameters. Longer follow-up is necessary to determine long-term adherence and the reduction of clinical events.

Keywords: Cholesterol, Cardiometabolic risk factors, Treatment adherence and compliance, Obesity, Weight loss.

INTRODUCTION

Cardiometabolic diseases represent one of the greatest public health challenges in Brazil, ranking among the leading causes of mortality and requiring continuous attention from health authorities.[1] This group of pathologies, which includes systemic arterial hypertension (SAH) and diabetes mellitus (DM), has shown a sustained growth trend in recent decades; epidemiological data indicate that the prevalence of hypertension increased from 53.1% to 66.7% in certain population groups, while diabetes rose from 16.7% to 25% in the same period.[1] Such conditions are often aggravated by modifiable risk factors, such as physical inactivity and smoking, in addition to anthropometric variables, in which individuals with a body mass index (BMI) greater than 27 kg/m² demonstrate a greater probability of developing unfavorable outcomes.[1]

The clinical understanding of these pathologies has evolved into the concept of Cardiometabolic Risk, which recognizes the profound interconnection between obesity, dyslipidemia, and insulin resistance.[2] Recently, Cardiorenal Metabolic Syndrome (CRMS) has emerged as a clinical entity that integrates these factors, highlighting that chronic kidney disease acts as an independent and synergistic cardiovascular risk factor.[2] The redefinition of obesity has also become crucial, shifting the focus beyond body mass index (BMI) and prioritizing the assessment of visceral fat and functional metabolic health, which makes it possible to identify high-risk patients who might previously have been neglected by superficial assessments.[2]

Additionally, cardiometabolic health must be analyzed from the perspective of the life cycle, especially in the female population, which faces specific windows of vulnerability.[3] Hormonal transitions, such as menopause, in addition to conditions such as polycystic ovary syndrome and gestational complications, are early markers that increase the risk of atherosclerosis and hypertension.[3] These biological and sociodemographic particularities require healthcare professionals to adopt a personalized view, recognizing that a woman's risk profile may be shaped by reproductive and hormonal events that occurred decades before the clinical diagnosis.[3]

To address this complexity, current therapeutic management includes promising pharmacological innovations, such as SGLT2 inhibitors and GLP-1 agonists, which offer benefits ranging from glycemic control to direct renal and cardiovascular protection.[2] However, isolated treatment is not sufficient for the sustained reduction of morbidity and mortality; non-pharmacological strategies, centered on lifestyle changes and nutritional interventions, continue to be the foundation for primary prevention and the control of chronic diseases.[1,2] The success of these measures depends directly on the capacity of the healthcare system to offer continuous and educational support to the patient.[1]

In this context, multidisciplinary intervention becomes the strategy of choice, as it allows the patient to be approached in a holistic manner, integrating the knowledge of physicians, nutritionists, physical educators, and other specialists.[2,3] The coordinated action of a

healthcare team is capable of promoting better treatment adherence and more effective management of multiple risk factors.[3] The present study therefore aims to evaluate the impact of a structured multidisciplinary intervention on the clinical and metabolic profile of patients with high cardiovascular risk, supporting the need for integrated and patient-centered care models for the mitigation of cardiometabolic diseases.

CASUISTRY AND METHODS

A pilot cohort study was carried out, conducted in a specialized and multidisciplinary outpatient clinic composed of a cardiologist, endocrinologist, and nutritionist. The protocol was designed to evaluate the impact of a structured intervention on body composition and the metabolic profile of patients over a period of six months.

The casuistry consisted of individuals followed in the aforementioned unit, submitted to a systematized diagnostic approach. The inclusion criteria were based on the need for cardiometabolic follow-up and availability for the proposed follow-up period.

Initial Evaluation Protocol

The diagnostic phase comprised a comprehensive evaluation, divided into three areas:
Laboratory and Cardiovascular Profile: performance of biochemical tests for metabolic evaluation and complementary imaging examinations for risk stratification and cardiovascular function;
Body Composition: patients underwent electrical bioimpedance, aiming at the detailed analysis of fat mass and lean mass;
Multidisciplinary Evaluation: concurrent consultations with the medical and nutrition team for the collection of anthropometric data, history of pre-existing diseases, and dietary pattern.

Intervention and Follow-up

After data collection, a multidisciplinary meeting was held for the consolidation of the cardiometabolic diagnosis. Based on the results, a structured intervention plan was established in four pillars, presented below:
Nutrition: prescription of a diet with mild to moderate caloric restriction associated with protein supplementation;
Physical Exercise: recommendation of resistance training for the preservation of muscle mass;
Pharmacotherapy: use of drug treatment, when indicated, with gradual dose progression;
Monitoring: the patient received a structured feedback report and was followed through a food control application and direct contact with the team.

The in-person follow-up visits for reassessments and therapeutic adjustments were scheduled every 90 days, totaling two follow-up cycles over the six-month period.

Considering the statistical analysis, comparisons between groups were performed by means of one-way analysis of variance (ANOVA), followed by the Scheffé post hoc test for identification of specific differences, when overall statistical significance was observed ($p \leq 0.05$), with data expressed as mean ± standard deviation. The present study was approved by the Leide nas

Neves Ferreira Research Ethics Committee under number CAAE: 92909925.3.0000.5082.

RESULTS

For this study, 27 individuals were selected. The baseline characteristics of the sample are presented in table 1.

Table 1: Baseline Characteristics of the Sample.

	Absolute value and percentage
Female sex	11 (40.7%)
Male sex	16 (59.3%)
SAH	4 (14.8%)
CAD	14 (51.9%)
DM	9 (33.3%)
DLP	24 (88.9%)
Sedentary lifestyle	19 (73.1%)
Hypothyroidism	4 (15.4%)
Previous stroke	2 (7.4%)
OSAHS	8 (29.6%)
	Mean ± SD
Age (years)	54.2 ± 8.2
Weight (Kg)	100.9 ± 15.4
BMI (kg/m^2)	34.9 ± 4.3
WC (cm)	111.7 ± 13.4
Height (metres)	1.70 ± 0.1

SAH: systemic arterial hypertension; CAD: coronary artery disease; DM: diabetes mellitus; DLP: dyslipidemia; stroke: cerebrovascular accident; OSAHS: obstructive sleep apnea-hypopnea syndrome; BMI: body mass index; WC: waist circumference; kg: kilograms; cm: centimeters; SD: standard deviation.
Source: The authors.

The evolution of the anthropometric data during follow-up is described in table 2, below. There was a significant decrease in body mass index (BMI).

Table 2: Anthropometric Data During the Follow-up Period.

	Baseline	3 months	6 months	$p^{\dagger}$
	Mean ± SD	**Mean ± SD**	**Mean ± SD**	
Weight (Kg)	100.9 ± 15.4	96.4 ± 15.3	93.8 ± 15.9	0.11
BMI (Kg/m^2)	34.9 ± 4.3	33.4 ± 4.6	31.1 ± 7.6*	**0.03**
WC (cm)	111.7 ± 13.4	106.8 ± 12.2	105.8 ± 12.5	0.12

BMI: body mass index; WC: waist circumference; kg: kilograms; cm: centimeters; SD: standard deviation. * versus baseline. † one-way analysis of variance (ANOVA), followed by the Scheffé post hoc test (p≤0.05).
Source: The authors.

Considering body composition, by means of the bioimpedance technique, loss of fat mass and maintenance of lean mass were found. No changes were observed in the volume of visceral adiposity. The data are presented in Table 3, below.

Table 3: Anthropometric Data During the Follow-up Period.

	Baseline	3 months	6 months	$p^{\dagger}$
	Mean ± SD	Mean ± SD	Mean ± SD	
Bioimpedance				
VAT (index)	18.0 ± 4.6	17,0 ± 4.6	15,9 ± 4.6	0.11
FM %	39.6 ± 6.7	37,7 ± 6.5	35,8 ± 6.4*	**0.05**
LM %	34.0 ± 4.5	35,0 ± 4.2	36,1 ± 4.0	0.10

VAT: total visceral fat; FM: percentage of fat mass; LM: percentage of muscle mass; SD: standard deviation; %: percentage. * versus baseline. † one-way analysis of variance (ANOVA), followed by the Scheffé post hoc test (p≤0.05).
Source: The authors.

Table 4 shows the values obtained in the laboratory evaluations at three and six months. A decrease in the values of low-density lipoprotein (LDL) and triglycerides (TG) is observed after six months of follow-up. The other variables did not show significant changes.

Table 4: Laboratory Test Evaluation.

	Pré	3 months	6 months	$p^{\dagger}$
	Mean ± SD	Mean ± SD	Mean ± SD	
LDL	96.3 ± 49.4	60.9 ± 36.9*	65.6 ± 39.9*	**0.03**
TG	199.3 ± 139.0	123,. ± 83.4	111.9 ± 69.7*	**0.01**
HDL	43.5 ± 11.8	41.2 ± 10.9	42.7 ± 11.1	0.82
Blood glucose	112.7 ± 33.7	108.3 ± 28.2	102.3 ± 30.3	0.27
HbA1c	5.9 ± 1.0	5.8 ± 0.8	5.5 ± 0.7	0.14
CRP	3.1 ± 3.5	2.3 ± 3.2	3.3 ± 10.0	0.93

: LDL: low-density lipoprotein; TG: triglycerides; HDL: high-density lipoprotein; HbA1c: glycated hemoglobin; CRP: C-reactive protein. * versus baseline. † one-way analysis of variance (ANOVA), followed by the Scheffé post hoc test (p≤0.05).
Source: The authors.

Considering drug treatment, statins were used in 77.8% of the individuals and GLP-1 agonists in 40.7% of the sample.

DISCUSSION

The results of this pilot study demonstrate that a structured care intervention focused on cardiometabolism has a significant clinical impact on the reduction of anthropometric

and lipid parameters in a population at high cardiovascular risk. The observed reduction in body mass index (BMI), LDL cholesterol, and triglycerides (TG), accompanied by the preservation of lean mass, reinforces the effectiveness of multidisciplinary approaches in the management of cardiometabolic risk.

The prevalence of cardiometabolic diseases, such as arterial hypertension and diabetes mellitus, has shown a trend of continuous growth, which requires increasingly earlier and more effective intervention strategies.[1,2] In the present study, the use of statins in 77.8% of the sample and GLP-1 receptor agonists in 40.7% reflects alignment with contemporary guidelines, which recommend strict LDL control in the prevention of atherosclerotic events.[4,5] However, real-world data indicate that, even with treatment, a considerable proportion of high-risk patients do not achieve the recommended lipid targets, highlighting the need for more intensive follow-up programs.[4,5]

The effectiveness of GLP-1 analogues in weight reduction and improvement of the metabolic profile is widely recognized, but the therapeutic response is marked by notable interindividual variability.[6,7] Factors such as sex and baseline glycemic index may influence the results. Women tend to show a greater weight-loss response than men with the use of semaglutide and liraglutide.[3,6] Despite this, the phenomenon of the non-responder patient, in which patients do not achieve the expected 5% weight loss, is a clinical reality.[6,7] Some therapeutic failures may be linked to complex biological factors, including GLP-1R receptor genetics and metabolic adaptation.[6] In addition, the management of these patients should consider that an inadequate response to a GLP-1 analogue may require adjustment to higher doses or switching to more potent co-agonists, such as tirzepatide.[7]

A result that deserves discussion is based on the maintenance of lean mass observed in this intervention, during the weight-loss process, which stands out as a positive differential. In scenarios of accelerated weight loss, common in the GLP-1 era, functional sarcopenia becomes a growing concern, which validates the importance of programs that combine pharmacotherapy with lifestyle interventions focused on global metabolic health.[7]

This study has an important limitation that needs to be highlighted. Only 27 individuals were followed, preventing us from verifying whether the proposed intervention could achieve higher levels of effectiveness in the control of the studied risk factors. Our research group is developing a study with a larger number of patients, seeking to overcome this bias.

CONCLUSION

Preliminary data show that a care program focused on cardiometabolism has a high potential to alter risk-associated parameters. A longer follow-up period is necessary to determine definitive adherence and event reduction.

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OBESITY IN PREGNANT WOMEN: EPIDEMIOLOGICAL ANALYSIS AND MATERNAL-FETAL IMPLICATIONS IN BRAZIL, 2010 TO APRIL 2026

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ABSTRACT

Introduction: Excess weight during pregnancy, including overweight and obesity, is associated with maternal-fetal complications and requires nutritional surveillance during prenatal care. **Objectives:** To analyze the evolution of the nutritional status of pregnant women monitored by the Brazilian Food and Nutrition Surveillance System (SISVAN) from 2010 to April 2026, with emphasis on the increase in overweight and obesity. **Methods:** This was an epidemiological, observational, descriptive, retrospective, ecological study with a quantitative approach, based on publicly available secondary SISVAN data. Annual records of pregnant women classified according to gestational-week-specific body mass index as underweight, adequate/eutrophic, overweight, or obese were evaluated, including complete data from 2010 to 2025 and partial data from 2026 available through April. Data were analyzed using descriptive statistics, including absolute numbers, relative frequencies, and the combined proportion of excess weight. **Results:** A total of 11,235,560 records were analyzed. From 2010 to April 2026, the proportion of underweight decreased from 21.06% to 11.31%, and adequate/eutrophic nutritional status decreased from 42.58% to 30.13%. In contrast, overweight increased from 23.23% to 29.49%, and obesity increased from 13.13% to 29.08%, representing the greatest increase observed. From 2020 onward, overweight and obesity together accounted for more than half of the monitored pregnant women, reaching 58.57% in April 2026. **Conclusions:** A marked change was observed in the nutritional profile of pregnant women monitored by SISVAN, with a progressive shift from eutrophic status to excess weight. This scenario reinforces gestational obesity as a relevant public health issue and highlights the need for nutritional surveillance, pregestational prevention, dietary counseling, safe physical activity, and multidisciplinary prenatal care.

Keywords: Pregnant women, Obesity, Overweight, Nutritional status, SISVAN, Maternal health.

INTRODUCTION

Obesity is defined as a body mass index (BMI) equal to or greater than 30 kg/m², whereas overweight corresponds to a BMI between 25 and 29.9 kg/m². In the gestational context,

excess weight deserves special attention because of its association with obstetric and neonatal complications, including gestational diabetes mellitus, hypertensive disorders, macrosomia, cesarean delivery, and greater postpartum weight retention.[1]

Pregnancy represents an important window of care, as women maintain frequent contact with healthcare services and may receive targeted guidance regarding nutrition, physical activity, weight gain, and clinical follow-up. International studies indicate that excessive gestational weight gain in women with overweight or obesity increases maternal and fetal risks, reinforcing the need for surveillance and early intervention during prenatal care.[2]

In Brazil, monitoring nutritional status and gestational weight gain is part of prenatal care practices. Recent national recommendations reinforce the need to assess BMI, monitor weight progression at all prenatal visits, and use tools adapted to the Brazilian context in order to guide nutritional care for adult pregnant women.[3]

Considering the epidemiological and clinical relevance of excess weight during pregnancy, the present study aimed to analyze the evolution of the nutritional status of pregnant women monitored by SISVAN in Brazil from 2010 to April 2026, with emphasis on the categories of overweight and obesity.

METHODS

This is an epidemiological, observational, descriptive, retrospective, ecological study with a quantitative approach, conducted using secondary public-domain data obtained from the Food and Nutrition Surveillance System (SISVAN).[4]

The analyzed population consisted of pregnant women monitored by SISVAN in Brazil, with records classified according to BMI by gestational week. Annual data from 2010 to 2025 and partial data from 2026 available up to April were included, considering the parameters “all months,” life stage “pregnant woman,” sex “all,” age “all,” and nationwide coverage.

Data collection was performed through consultation of public SISVAN reports on a year-by-year basis. The categories evaluated included underweight, adequate/eutrophic, overweight, and obesity. For each year, absolute numbers and corresponding percentages for each classification were recorded, in addition to the total annual number of pregnant women monitored. The data were organized into a dedicated spreadsheet and analyzed using descriptive statistics, with presentation of absolute numbers and relative frequencies. The combined proportion of overweight and obesity, referred to in this study as excess weight, was also calculated.

Relative frequencies were calculated as the ratio between the number of pregnant women in each nutritional category and the total annual number of records, multiplied by 100. No inferential statistical tests were applied, considering the descriptive and ecological nature of the study.

Because this study used secondary, public, aggregated, and non-identifiable data, submission to a Research Ethics Committee and individual informed consent were not required. The year 2026 was maintained in the analysis because it was available in the consulted database; however, it should be interpreted with caution, as the records remain subject to updates.

RESULTS

From 2010 to April 2026, a total of 11,235,560 records of pregnant women monitored by SISVAN were analyzed, classified according to nutritional status based on BMI by

gestational week. The annual number of records ranged from 252,620 in 2010 to 1,047,711 in 2021, the year with the highest number of follow-up records.

Throughout the historical series, a progressive reduction was observed in the proportion of pregnant women classified as underweight and as adequate/eutrophic, accompanied by an increase in the categories of overweight and obesity. In 2010, the adequate/eutrophic category accounted for 42.58% of records, followed by overweight (23.23%), underweight (21.06%), and obesity (13.13%). In the partial data for 2026, the distribution was more balanced between adequate/eutrophic (30.13%), overweight (29.49%), and obesity (29.08%), while underweight decreased to 11.31% (Table 1).

The underweight category showed a reduction of 9.75 percentage points between 2010 and April 2026. The proportion of adequate/eutrophic women decreased by 12.45 percentage points during the same period. Conversely, overweight increased by 6.26 percentage points, while obesity showed the greatest increase, with a rise of 15.95 percentage points.

When analyzed together, the categories of overweight and obesity increased from 36.36% in 2010 to 58.57% in April 2026. From 2020 onward, excess weight accounted for more than half of the pregnant women monitored. Furthermore, obesity surpassed underweight beginning in 2017, when it reached 18.19%, compared with 17.32% for underweight (Figure 1).

Table 1:Nutritional status of pregnant women monitored by SISVAN in Brazil, 2010 to 2026 (partial data).

Year	Underweight	Adequate or eutrophic	Overweight	Obesity	Total
2010	53.198 (21,06%)	107.567 (42,58%)	58.686 (23,23%)	33.169 (13,13%)	252.620
2011	63.428 (19,94%)	131.512 (41,34%)	77.459 (24,35%)	45.751 (14,38%)	318.150
2012	79.272 (19,55%)	165.231 (40,74%)	99.511 (24,54%)	61.519 (15,17%)	405.533
2013	96.050 (19,85%)	193.168 (39,91%)	119.849 (24,76%)	74.898 (15,48%)	483.965
2014	97.294 (19,40%)	196.055 (39,08%)	126.381 (25,19%)	81.908 (16,33%)	501.638
2015	126.205 (18,21%)	269.562 (38,90%)	179.897 (25,96%)	117.311 (16,93%)	692.975
2016	154.373 (18,19%)	327.277 (38,57%)	221.150 (26,06%)	145.733 (17,17%)	848.533
2017	126.987 (17,32%)	277.750 (37,89%)	195.002 (26,60%)	133.350 (18,19%)	733.089
2018	119.074 (16,34%)	267.236 (36,67%)	199.734 (27,41%)	142.651 (19,58%)	728.695
2019	101.625 (16,14%)	224.215 (35,62%)	175.187 (27,83%)	128.479 (20,41%)	629.506
2020	146.373 (14,19%)	350.729 (34,01%)	295.811 (28,68%)	238.467 (23,12%)	1.031.380
2021	144.209 (13,76%)	351.096 (33,51%)	302.257 (28,85%)	250.149 (23,88%)	1.047.711
2022	118.560 (13,57%)	290.600 (33,27%)	251.736 (28,82%)	212.690 (24,35%)	873.586
2023	98.326 (13,24%)	241.787 (32,55%)	214.470 (28,87%)	188.295 (25,35%)	742.878
2024	108.704 (12,34%)	275.358 (31,25%)	256.380 (29,10%)	240.676 (27,31%)	881.118
2025	92.851 (11,43%)	244.601 (30,12%)	239.785 (29,52%)	234.935 (28,93%)	812.172
2026 (partial)	28.500 (11,31%)	75.930 (30,13%)	74.306 (29,49%)	73.275 (29,08%)	252.011

Source: prepared by the authors based on SISVAN data.

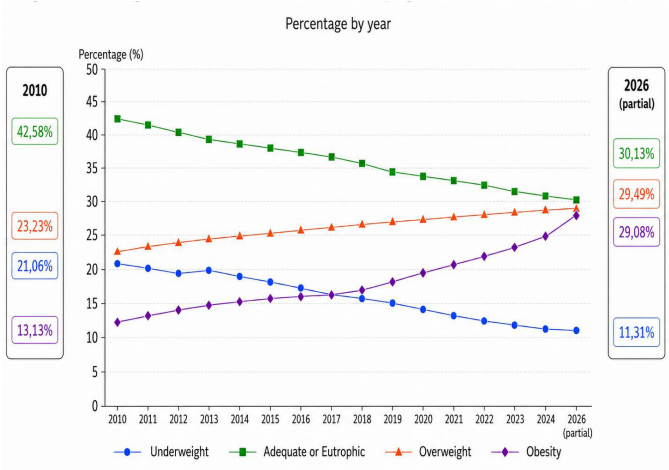

Figure 1: Percentage evolution of the nutritional status of pregnant women monitored by SISVAN in Brazil, 2010 to 2026 (partial data).
Source: prepared by the authors based on SISVAN data.

DISCUSSION

The results demonstrate an important shift in the nutritional profile of pregnant women monitored by the Food and Nutrition Surveillance System (SISVAN) in Brazil, based on public nutritional status reports consulted annually from 2010 to April 2026.[4] During this period, there was a proportional reduction in underweight and adequate/eutrophic categories, accompanied by a continuous increase in overweight and, more markedly, obesity. This pattern suggests that excess weight has become a central condition in the nutritional monitoring of Brazilian pregnant women. From 2020 onward, the combined prevalence of overweight and obesity accounted for more than half of the pregnant women monitored, indicating a progressive shift in the nutritional profile from eutrophy toward excess weight.

This pattern follows the national trend of increasing excess weight in the Brazilian adult population. Data from Vigitel Brazil 2006–2023 demonstrated an increase in the frequency of excess weight among adults living in Brazilian state capitals, rising from 42.6% in 2006 to 61.4% in 2023; among women, the proportion increased from 38.5% to 59.6% during the same period.[5] The 2019 National Health Survey also highlighted the magnitude of the problem, estimating excess weight in 60.3% of Brazilian adults and in 62.6% of adult women, in addition to an obesity prevalence of 29.5% among females.[6] Thus, the findings of the present study should be interpreted as part of a broader nutritional transition that significantly affects women of adult and reproductive age.

In the maternal and child health field, the Brazilian National Survey on Child Nutrition (ENANI-2019) identified excess weight in 58.2% of biological mothers of children under five years of age in Brazil, as well as an increase in excess weight within the mother–child dyad between 2006 and 2019.[7] This finding reinforces that maternal excess weight is not restricted to the gestational period, but may be part of an intergenerational cycle of nutritional risk. Brazilian studies involving women of reproductive age also support this interpretation. In a low-income urban community in Recife, excess weight was observed in 66.3% of women aged 15 to 49 years, associated with socioeconomic, demographic,

and reproductive characteristics.[8] Among adult women monitored in areas covered by the Family Health Strategy, the prevalence of excess weight was 61.0%, associated with factors such as age, early menarche, having children, and systemic arterial hypertension.[9]

From a maternal–fetal perspective, the increase in excess weight is relevant because pregnant women with overweight or obesity are at higher risk of obstetric and neonatal complications. A recent systematic review and meta-analysis described an association between gestational excess weight and outcomes such as gestational diabetes mellitus, hypertensive disorders, macrosomia, and other adverse outcomes, while also highlighting the role of physical exercise interventions in improving pregnancy outcomes.[1] Evidence from a randomized clinical trial involving a telehealth lifestyle intervention in pregnant women with overweight or obesity also reinforces pregnancy as a strategic window for preventing excessive weight gain and promoting healthy behaviors.[2]

In Brazil, current recommendations emphasize that gestational weight gain should be monitored at every prenatal visit, considering the pregnant woman's initial nutritional status and using appropriate tools to guide nutritional care.[3] The availability of Brazilian gestational weight gain charts, developed from the Brazilian Maternal and Child Nutrition Consortium, represents an important advance, as it enables follow-up that is more closely aligned with the national context and reduces exclusive dependence on international references.[10] The incorporation of these tools may favor early identification of inadequate weight gain trajectories and guide timely interventions during prenatal care.

In Primary Health Care practice, the results reinforce the need to use SISVAN not only as a recording system, but also as a tool for surveillance, screening, and care planning. The Ministry of Health recommends that nutritional assessment in Primary Health Care should consider different life stages and events, and provides SISVAN protocols and guidance for the collection and analysis of anthropometric data in healthcare services.[11] In addition to anthropometric classification, SISVAN food consumption markers may support the identification of inadequate dietary patterns, including consumption of ultra-processed foods and low intake of fresh or minimally processed foods. The Protocol for the Use of the Dietary Guidelines for the Brazilian Population in Dietary Counseling for Pregnant Women recommends the use of these markers to support individualized dietary counseling during prenatal care.[12]

The Care Pathway for Overweight and Obesity in Adults also reinforces the clinical applicability of these findings for pregnant women. The document highlights that excessive gestational weight gain and failure to lose weight after childbirth are important predictors of long-term obesity. It also recommends nutritional status assessment at every prenatal visit using BMI by gestational week, documentation in the Pregnant Woman's Health Record, and reduction of the interval between consultations when overweight or obesity is diagnosed.[13] Therefore, the increase in obesity observed in this study points to the need for coordinated actions involving physicians, nurses, nutritionists, and other members of the multidisciplinary team, with continuity of care during the postpartum period.

Lifestyle-based interventions may contribute to reducing excessive gestational weight gain and associated outcomes. A systematic review on mobile health interventions identified benefits in pregnant women with overweight or obesity, including reductions in the incidence of gestational diabetes, preterm birth, macrosomia, and gestational weight

gain.[14] A network meta-analysis also indicated that interventions combining diet and physical activity tend to perform better when simultaneously considering prevention of gestational diabetes and restriction of excessive weight gain during pregnancy.[15] These findings support the need for preventive strategies before and during pregnancy, including nutritional counseling, encouragement of safe physical activity, and longitudinal follow-up.

Among the limitations of this study, it should be noted that SISVAN data represent pregnant women monitored and registered in the system, and not necessarily the total population of pregnant women in Brazil.[4] Furthermore, as this is an ecological, retrospective study based on aggregated data, it is not possible to establish causal relationships or evaluate individual characteristics such as age, educational level, race/skin color, parity, socioeconomic conditions, comorbidities, or quality of prenatal care. Data from 2026 should also be interpreted with caution, as they depend on database updates at the time of consultation.

In summary, the reduction in underweight prevalence was not accompanied by maintenance of eutrophy, but rather by a progressive increase in excess weight. This scenario requires food and nutrition surveillance to be used as a health intelligence tool, capable of transforming SISVAN records into concrete actions involving screening, counseling, active case finding, territorial monitoring, and prevention of excessive gestational weight gain. Primary Health Care occupies a strategic position in this process because it integrates reproductive planning, prenatal care, promotion of healthy eating, safe physical activity, and postpartum follow-up.

CONCLUSION

In conclusion, the results of this study demonstrate an important shift in the nutritional profile of pregnant women monitored by SISVAN in Brazil between 2010 and April 2026, characterized by a progressive reduction in the proportions of underweight and adequate/eutrophic nutritional status, alongside a continuous increase in overweight and, particularly, obesity. Obesity showed the most significant increase during the study period, rising from 13.13% to 29.08%, while overweight reached 29.49% in the partial 2026 data. Together, overweight and obesity accounted for more than half of the pregnant women monitored from 2020 onward.

These findings reinforce that excess gestational weight constitutes a relevant public health issue and reflects the national scenario of high prevalence of overweight and obesity among adult Brazilian women. In this context, SISVAN should be valued not only as a data recording system, but also as a strategic tool for food and nutrition surveillance, identification of risk groups, territorial planning, and qualification of prenatal care.

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SCIENTIFIC ARTICLE - CASE REPORT

CORONARY ARTERY ANEURYSM: CASE REPORT OF SURGICAL REPAIR OF AN ANTERIOR DESCENDING CORONARY ARTERY ANEURYSM ASSOCIATED WITH MYOCARDIAL REVASCULARIZATION

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ABSTRACT

Coronary artery aneurysm is an uncommon vascular abnormality characterized by abnormal dilatation of a coronary segment and associated with a wide spectrum of clinical presentations, ranging from incidental findings to myocardial ischemia, thrombosis, distal embolization, or the need for surgical intervention. We report the case of a 47-year-old male patient with a history of systemic arterial hypertension, arrhythmia, venous insufficiency, and previous cranioplasty after traumatic brain injury, on chronic use of carbamazepine, acetylsalicylic acid, and rivaroxaban, who underwent major cardiac surgery for correction of a coronary artery aneurysm associated with myocardial revascularization under cardiopulmonary bypass. The procedure was performed under general anesthesia, with invasive monitoring and support appropriate for the complexity of the intervention. Intraoperatively, median sternotomy, cardiopulmonary bypass, surgical correction of the aneurysm, myocardial revascularization, epicardial pacemaker implantation, thoracic and pericardial drainage, and layered closure were performed. Intraoperative images sequentially documented surgical exposure, progressive dissection of the aneurysmal segment, its intraoperative approach during repair, and the final aspect after vascular reconstruction. Postoperatively, the patient was transferred to the intensive care unit receiving low-dose dobutamine, with transient norepinephrine requirement, and evolved with hemodynamic stability, successful ventilatory weaning, preserved renal function, and no major immediate complications. This case reinforces the importance of individualized perioperative planning in patients with coronary artery aneurysm, highlighting the role of the anesthesiologist in cardiovascular risk assessment, maintenance of hemodynamic stability, management of the balance between myocardial oxygen supply and demand, and safe transition to intensive care.

Keywords: Coronary artery aneurysm, Myocardial revascularization, Cardiopulmonary bypass, Cardiovascular anesthesia, Perioperative care.

INTRODUCTION

Coronary artery aneurysm (CAA) is defined as a focal dilation of a coronary vessel exceeding 1.5 times the diameter of the adjacent normal coronary segment. In extreme presentations, it may be classified as giant, although the literature varies regarding this definition, including diameters greater than four times the reference vessel or absolute measurements exceeding 20 mm in adults. From a morphological standpoint, CAAs may be classified as saccular, when the transverse diameter exceeds the longitudinal diameter, or fusiform, when the opposite occurs. They may also be described as true aneurysms or pseudoaneurysms, depending on the integrity of the vascular wall layers. Despite diagnostic advances in recent decades, there is still no fully established consensus regarding the best therapeutic strategy for this condition.[1-3]

The incidence of CAA varies widely among published series, generally ranging from 0.3% to 5% of patients undergoing coronary imaging studies, with a predominance in males. The most frequently affected vessels are the right coronary artery, followed by the left anterior descending artery and the circumflex artery, particularly in their proximal segments. In most cases, CAAs are asymptomatic and incidentally identified during coronary angiography or coronary computed tomography angiography performed for other clinical indications.[1-3]

Its etiology is heterogeneous. In adults, atherosclerosis is the leading cause, although inflammatory, congenital, traumatic, iatrogenic, and vasculitic etiologies have also been described. In children, Kawasaki disease is among the most relevant causes. From a pathophysiological perspective, inflammatory and degenerative changes in the arterial wall, with destruction of elastic and collagen fibers, vascular remodeling, and consequent structural weakening, appear to play a central role in the development of these aneurysms.[2,3]

When symptomatic, CAA may manifest as angina, acute coronary syndrome, thromboembolic phenomena, and distal myocardial ischemia, as well as, more rarely, compression of adjacent structures or rupture. Diagnosis may be established through coronary angiography, coronary computed tomography angiography, echocardiography, and cardiac magnetic resonance imaging. Its management remains challenging and may involve medical treatment with antiplatelet agents, anticoagulants, statins, and renin–angiotensin–aldosterone system modulators, as well as percutaneous coronary intervention or surgical treatment in selected cases. Therapeutic choice generally depends on the clinical presentation, aneurysm size, anatomical location, thrombotic risk, and the concomitant presence of obstructive coronary artery disease. In this setting, the role of the anesthesiologist becomes particularly relevant, since recognition of the potential hemodynamic and ischemic repercussions of this condition is essential for perioperative risk stratification, individualized anesthetic planning, and management of potential cardiovascular complications during diagnostic, interventional, or surgical procedures.[2-3]

Therefore, CAA remains an uncommon entity with variable clinical presentation and no definitive standardized therapeutic approach, requiring individualized management and decision-making based on anatomical characteristics, clinical context, and the expertise of the multidisciplinary team.[2,3] From this perspective, in addition to its cardiological relevance, its importance to anesthetic practice should also be emphasized, particularly regarding preoperative evaluation, definition of anesthetic strategy, hemodynamic monitoring, and surveillance of perioperative cardiovascular outcomes. This report aims to present a case of CAA, emphasizing its diagnostic and therapeutic aspects, as well as discussing, in light of the case, the implications

of this condition for anesthesiologists involved in perioperative management.

CASE REPORT

A 47-year-old male patient was admitted to the intensive care unit (ICU) in the postoperative period following major cardiac surgery, after surgical repair of a coronary artery aneurysm associated with myocardial revascularization under cardiopulmonary bypass.

His past medical history included systemic arterial hypertension, arrhythmia, venous insufficiency, and previous neurosurgery with cranioplasty after traumatic brain injury secondary to a gunshot wound, with a history of seizures. There was also a history of neuropathic pain under outpatient follow-up. His regular medications included carbamazepine 200 mg, acetylsalicylic acid 100 mg, and rivaroxaban 20 mg daily, with no history of drug allergy.

In the preoperative period, the patient was in fair general condition, conscious, oriented, and cooperative, without relevant complaints, hemodynamically stable, eupneic on room air, and afebrile. He was tolerating oral diet and maintained adequate glycemic control. Physical examination revealed mildly decreased vesicular breath sounds at the lung bases, normal heart sounds, a soft abdomen with present bowel sounds, absence of tenderness on palpation, and well-perfused extremities without inflammatory signs at vascular access sites.

Complementary evaluation with chest computed tomography demonstrated bilateral laminar pleural effusion with adjacent atelectatic areas, as well as a small pericardial effusion associated with pericardial leaflet thickening, without evidence of acute structural complications. No extensive consolidations or severe pulmonary involvement were observed.

The procedure was performed under general anesthesia with advanced monitoring compatible with the complexity of the surgery, including continuous electrocardiography, pulse oximetry, invasive arterial pressure monitoring, capnography, temperature monitoring, and urine output assessment, in addition to large-bore peripheral venous access and central venous catheterization. Anesthetic induction was preceded by preoxygenation and performed with sedoanalgesia and neuromuscular blockade, followed by maintenance with balanced anesthesia and continuous infusions.

After median sternotomy, wide exposure of the operative field allowed identification of the mediastinal structures and planning of the surgical approach. This initial stage was documented in the first panel of the figure, which demonstrates the anatomical exposure of the field and the need for careful management given the complexity of the coronary lesion (Figure 1A).

As dissection progressed, the aneurysmal segment was more clearly individualized, allowing direct assessment of its relationship with adjacent cardiovascular structures and the affected coronary artery course. This step was essential in guiding the correction strategy and its association with myocardial revascularization, particularly considering the risk of distal coronary flow impairment (Figure 1B).

Subsequently, after surgical field preparation and establishment of cardiopulmonary bypass, direct aneurysm repair was undertaken. Intraoperative visualization demonstrated the anatomical appearance of the lesion prior to reconstruction, highlighting the need for surgical correction in the context of associated coronary artery disease and concomitant indication for myocardial revascularization (Figure 1C).

During the repair, careful manipulation of the aneurysmal segment was performed,

preserving adjacent structures and maintaining adequate surgical field control. This represented the central stage of the intervention, in which aneurysm correction and myocardial revascularization strategy were conducted in an integrated manner under cardiopulmonary bypass support (Figure 1D).

Following correction, the immediate appearance of the vascular reconstruction demonstrated an adequate suture line and anatomical reorganization of the treated segment. The intraoperative documentation illustrates the surgical result obtained after exclusion/correction of the aneurysm and reconstruction of the involved vascular bed (Figure 1E).

At the conclusion of the reconstructive stage, the final appearance of the vascular repair before layered closure demonstrated satisfactory hemostasis and absence of significant active bleeding within the operative field. This final image reinforces the immediate anatomical result achieved after surgical correction (Figure 1F).

The intervention therefore included median sternotomy, institution of cardiopulmonary bypass, surgical correction of the coronary artery aneurysm, myocardial revascularization, weaning from cardiopulmonary bypass, implantation of an epicardial pacemaker, placement of intracavitary catheters, pericardial and thoracic drainage, and layered closure. Cardiopulmonary bypass and aortic cross-clamp times were compatible with a medium- to high-complexity combined cardiac surgery, without significant refractory intraoperative hemodynamic instability.

At the end of the procedure, the patient was transferred to the ICU receiving low-dose dobutamine, with transient need for low-dose norepinephrine during the initial postoperative evolution, remaining hemodynamically stable and without signs of persistent shock. Drainage output was adequately controlled, urine output was preserved, and renal function remained stable, with serum creatinine within normal limits.

In the early postoperative period, the patient evolved satisfactorily after weaning from mechanical ventilation, transitioning to spontaneous ventilation while remaining conscious, oriented, and cooperative. Peripheral oxygen saturation remained adequate, without signs of significant respiratory failure, and cardiovascular stability was maintained, with blood pressure and heart rate within acceptable limits. Cefuroxime prophylaxis was administered for 24 hours, without initial need for expanded therapeutic antibiotic coverage, in addition to standard measures for venous thromboembolism prophylaxis and gastric protection.

During the ICU stay, hemodynamic, neurological, infectious, respiratory, and renal surveillance were maintained, together with analgesia, respiratory and motor physiotherapy, monitoring of drain output, and follow-up by the cardiac surgery team. Clinical evolution was favorable, with progressive withdrawal of intensive support, maintenance of effective spontaneous ventilation, adequate spontaneous diuresis, and absence of evidence of acute kidney injury or acute neurological complications. Progressive reduction in thoracic drainage was also observed.

The respiratory status evolved with expected postoperative findings, including laminar atelectasis and small pleural and pericardial effusions, managed conservatively. Progressive clinical improvement was observed, without the need for surgical reintervention and without occurrence of major bleeding, cardiac tamponade, deep infection, or other severe immediate complications, allowing discharge planning from the unit.

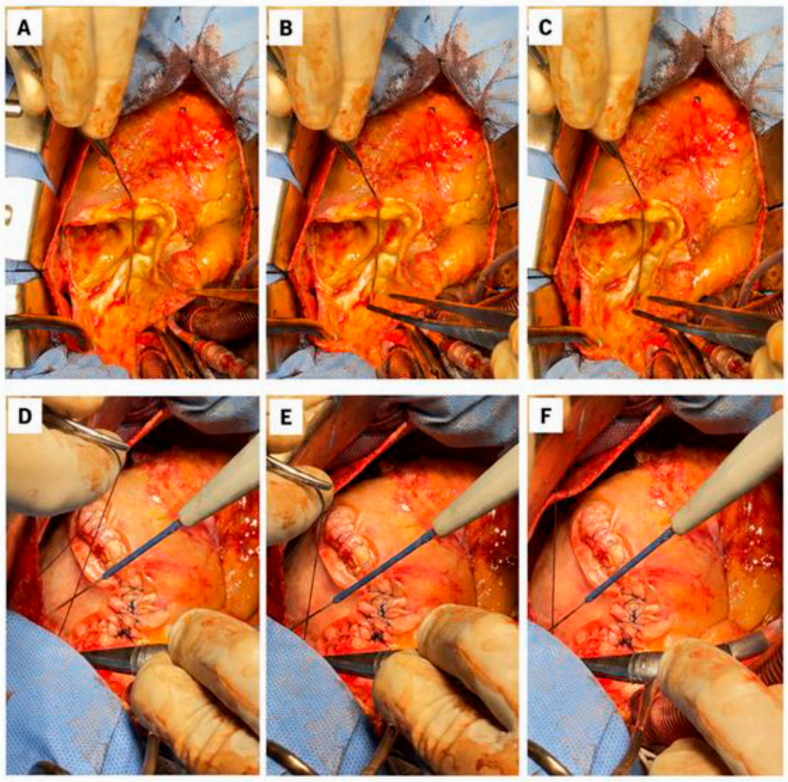

Figure 1: Intraoperative aspects of surgical correction of the coronary artery aneurysm. A: Initial exposure of the operative field after median sternotomy, allowing identification of mediastinal structures and planning of the surgical approach to the coronary artery aneurysm. B: Progressive dissection and individualization of the cardiovascular structures, with improved exposure of the aneurysmal coronary segment. C: Intraoperative appearance of the coronary artery aneurysm prior to reconstruction, highlighting the anatomical complexity of the lesion. D: Surgical manipulation of the aneurysmal segment during the central stage of repair under cardiopulmonary bypass. E: Appearance after surgical correction, demonstrating vascular reconstruction and the suture line at the treated segment. F: Immediate final anatomical result after vascular repair, with satisfactory hemostasis before layered closure.

DISCUSSION

For The present case illustrates a scenario of high perioperative complexity in which surgical correction of a coronary artery aneurysm (CAA) was associated with myocardial revascularization. This combination is particularly relevant because CAAs are uncommon entities with heterogeneous presentation, lacking definitive therapeutic standardization, and whose management depends on the correlation between anatomical characteristics, clinical manifestations, thrombotic risk, and the presence of associated coronary artery disease. The reviews by Pham et al. and Matta et al. emphasize precisely this difficulty in establishing uniform therapeutic approaches, while the report by Schonarth et al. reinforces, in a real clinical context, the need for individualized management given the anatomical and evolutionary variability of these aneurysms.[1-3]

From an anesthetic perspective, the relevance of this case derives from the fact that coronary aneurysmal disease may be associated with local thrombosis, distal

embolization, myocardial ischemia, arrhythmias, and, more rarely, rupture, making the perioperative period particularly sensitive to hemodynamic fluctuations and loss of balance between myocardial oxygen supply and demand. In light of these characteristics, advanced monitoring and anesthetic management tailored to the different phases of the procedure assume a central role, especially during anesthetic induction, cardiopulmonary bypass, weaning from bypass, and the first hours of intensive postoperative recovery. This interpretation is consistent with the pathophysiological mechanisms, complications, and therapeutic possibilities described in the reviews supporting this manuscript.[2,3]

In addition to the anatomical and surgical complexity, the patient's clinical profile further increased perioperative vulnerability. Systemic arterial hypertension, arrhythmia, and neurological history with seizures required greater caution regarding preservation of cardiovascular stability and systemic perfusion, while chronic use of rivaroxaban and acetylsalicylic acid raised additional concerns regarding hemostasis. Although reviews on CAA primarily emphasize the thrombotic and ischemic risks inherent to the disease, they also make clear that therapeutic decision-making must consider the patient's overall clinical context and the balance between thrombotic and hemorrhagic complications, particularly when invasive or surgical treatment is selected. In this regard, meticulous anesthetic evaluation, preparation for possible transfusion management, and continuous surveillance for bleeding become natural extensions of the individualized perioperative strategy advocated in the literature.[2,3]

The surgical indication observed in this case is also consistent with the current literature. Although many CAAs are diagnosed incidentally and may receive conservative management in selected situations, more complex, symptomatic, larger aneurysms associated with higher risk of complications or concomitant obstructive coronary artery disease generally favor operative management. Pham et al. emphasize that in giant aneurysms, the risks of thrombosis, embolization, rupture, and compression of adjacent structures weigh heavily in therapeutic decision-making, whereas Matta et al. reinforce the absence of a single standard strategy and the importance of individualizing the choice among medical treatment, percutaneous intervention, and surgery.[2,3]

In the postoperative period, the patient's evolution was also supported by the cardiac surgery literature. Small pleural and pericardial effusions, as well as laminar atelectasis, are relatively common findings after median sternotomy, pericardial manipulation, and cardiopulmonary bypass. Ashikhmina et al. demonstrated that pericardial effusion is a recognized complication after cardiac surgery, with risk factors related to the clinical profile and type of operation, while Brookes et al. highlighted that pleural effusion after myocardial revascularization is a common event with potential impact on respiratory recovery and hospital length of stay. Thus, in the absence of significant hemodynamic or respiratory repercussions, conservative management associated with adequate analgesia, respiratory physiotherapy, and serial monitoring appears appropriate and consistent with the management adopted in this case.[4,5]

Finally, the patient's favorable evolution, with progressive withdrawal of vasoactive drugs, preservation of renal function, satisfactory ventilatory recovery, and absence of major immediate complications, reinforces the importance of an integrated perioperative approach. The report by Schonarth et al. already demonstrates, on an individual scale, the need for management tailored to the anatomical and clinical particularities of CAA, while the reviews

by Pham et al. and Matta et al. support the concept that variability in presentation and treatment requires multidisciplinary evaluation and individualized decision-making. When this reasoning is applied to the anesthetic setting, it becomes evident that the anesthesiologist's role extends beyond administration of anesthetic agents and includes risk stratification, hemodynamic planning, preparation for cardiovascular and hemorrhagic complications, and active participation in the safe transition to intensive care.[1-3]

CONCLUSION

Surgical correction of coronary artery aneurysm associated with myocardial revascularization represents a significant perioperative challenge, requiring individualized planning and integrated management involving cardiac surgery, anesthesia, and intensive care teams. The favorable evolution observed in this case, without major immediate complications, highlights the importance of thorough preoperative evaluation, appropriate monitoring, and careful anesthetic management throughout the perioperative period. In a context lacking standardized therapeutic approaches, the anesthesiologist assumes a central role in maintaining clinical stability, preventing complications, and promoting safe postoperative recovery.

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SCIENTIFIC ARTICLE - CASE REPORT

VANCOMYCIN INFUSION REACTION: A REVIEW AND CASE REPORT

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ABSTRACT

Introduction: Although widely used as an alternative for surgical antibiotic prophylaxis in allergic patients to penicillin, the use of vancomycin can carry significant risks, such as a vancomycin infusion reaction that can be confused with an anaphylactic reaction. This case report and review of the topic are highly relevant to the daily practice of anesthesiologists. Case report: An ASA 1 15-year-old male patient undergoing laparoscopic cholecystectomy received vancomycin as antibiotic prophylaxis due to a history of penicillin allergy. During the infusion, he presented with a skin rash, hypotension, and tachycardia. After the medication was discontinued and an antihistamine was administered, the symptoms were resolved, and the surgical procedure and subsequent discharge from the post-anesthesia care unit occurred without any incidents. Discussion: Vancomycin infusion reaction is a non-IgE mediated event primarily associated with rapid drug infusion. The symptoms can mimic an anaphylactic reaction, with the main difference being that this is IgE-mediated. The reported case reinforces the importance of early recognition and management of the condition, as well the discussion about the real need to change surgical antibiotic prophylaxis in patients with a history of penicillin allergy, which can lead to unnecessary changes and compromise effective antimicrobial coverage.

Keywords: Vancomycin, Exhanthema, Allergy and imunollogy, Drug hypersensivity, Anaphylaxis.

INTRODUCTION

Vancomycin infusion reaction is a condition that commonly occurs when this antibiotic is administered rapidly (within one hour), although cases have been reported even days after infusion. It is characterized by a variety of symptoms, sometimes resembling an anaphylactic reaction, including erythematous rash involving the face, neck, and chest, as well as angioedema. For this reason, the reaction was previously referred to as “Red Man Syndrome.” Other manifestations include pruritus, weakness, chest pain, hypotension, shock,

and even risk of cardiopulmonary arrest. The crucial difference between the two conditions lies in their underlying mechanisms. In anaphylaxis, the reaction is IgE-mediated and requires prior exposure, whereas vancomycin infusion reaction is an anaphylactoid hypersensitivity reaction caused by histamine release from mast cells and basophils.[1]

Vancomycin infusion reaction usually occurs after parenteral administration; however, cases have also been reported following oral, topical, and even intraperitoneal administration. Its prevalence is not well established, ranging from approximately 5% to 50% among hospitalized patients requiring vancomycin infusion. Certain characteristics may predict a higher likelihood of this event, including age between 2 and 40 years, previous similar reactions, high drug doses, Caucasian ethnicity, and prolonged treatment duration.[1]

Although controversial, the use of antibiotics other than cefazolin for surgical prophylaxis in patients with a history of penicillin allergy is not recommended. There remains a widespread belief regarding a high rate of cross-reactivity between these antibiotics; however, this has not been supported by more recent studies.[2] Vancomycin is commonly administered in such cases in an attempt to maintain adequate prophylactic coverage, although this practice may increase the risk of surgical site infections caused by methicillin-sensitive Staphylococcus aureus and Gram-negative bacteria.[3]

Therefore, the present case report and literature review are considered relevant because they describe a patient with penicillin allergy who received vancomycin as an alternative agent, while also addressing antibiotic prophylaxis, a topic routinely encountered in anesthesiology practice.

CASE REPORT

A 15-year-old male patient, weighing 55 kg, underwent cholecystectomy due to cholelithiasis. The patient had no comorbidities (ASA I) and no previous surgical procedures. He reported a history of allergy to amoxicillin, manifested by rash. Laboratory tests showed no significant abnormalities.

The patient was taken to the operating room, positioned supine, and standard multiparameter monitoring was applied, including electrocardiography, noninvasive blood pressure, and pulse oximetry. Peripheral venous access was established with a 20G catheter in the left upper limb.

Due to the history of amoxicillin allergy, the surgeon opted to administer intravenous vancomycin 1 g as antibiotic prophylaxis for the procedure. Therefore, infusion of the antibiotic was initiated together with dexamethasone 10 mg diluted in 100 mL of 0.9% saline solution.

During the infusion, intravenous anesthetic induction was performed with propofol 120 mg, sufentanil 15 mcg, and cisatracurium 6 mg. Orotracheal intubation was performed under direct laryngoscopy, with a Cormack–Lehane grade I view, using an 8.0-mm cuffed endotracheal tube, with placement confirmed by capnography, without complications. Anesthesia was maintained with 2.0% sevoflurane.

Shortly after induction, the patient developed a cutaneous rash involving the face and trunk, associated with hypotension and tachycardia, as demonstrated in Figures 1 and 2. Respiratory auscultation revealed no adventitious sounds. At that moment, the vancomycin infusion was discontinued, after having been administered over approximately 20 minutes. Intravenous diphenhydramine 50 mg was then administered. Approximately 15 minutes later, vital signs had returned to normal limits, and the rash had almost completely resolved.

The surgery proceeded without further complications. The patient was extubated at the end of the procedure and transferred to the Post-Anesthesia Care Unit (PACU), being discharged after 1 hour without complications.

Figure 1: Example of cutaneous rash in a patient during vancomycin infusion reaction, similar to that observed in the patient described in our case report.[4]

Figure 2: Actual monitor image showing the patient's vital signs during the vancomycin infusion reaction. Persistent tachycardia and a trend toward hypotension can be observed in the preceding minutes.

DISCUSSION

The use of antibiotics for surgical site infection prophylaxis is a fundamental measure to ensure safety in several surgical procedures. Currently, cefazolin is the antibiotic of choice according to multiple guidelines for a wide range of procedures. However, in patients with penicillin allergy associated with severe IgE-mediated reactions (bronchospasm, urticaria, documented elevated tryptase after a previous reaction, DRESS syndrome, hemolytic anemia, nephritis, anaphylaxis), replacement with non–beta-lactam antibiotics such as vancomycin or clindamycin is recommended because of the possibility of cross-reactivity between penicillins and cephalosporins. Historically, this cross-reactivity was estimated to occur in approximately 10% of cases; however, more recent studies suggest that this rate is considerably lower.[2,3]

Although the prevalence of penicillin allergy in the general population is estimated to range from 8% to 15%, most cases are not IgE-mediated or related to immediate

hypersensitivity reactions, instead presenting milder symptoms such as morbilliform rash, gastrointestinal symptoms, isolated pruritus, or headache. This may be explained by the high rate of antigen desensitization over time, as well as misunderstanding by patients regarding whether they truly have a penicillin allergy.[2,5]

According to Sexton et al., the use of alternative antibiotic prophylaxis instead of cefazolin in penicillin-allergic patients is associated with a higher risk of surgical wound infection. This increased risk may be related to differences in antimicrobial spectrum coverage, in addition to unfamiliarity with alternative dosing regimens and administration schedules.[3]

Discovered in 1953 and initially used for the treatment of Staphylococcus aureus infections resistant to penicillin, vancomycin provides coverage against Gram-positive bacteria. However, it is not the preferred treatment for methicillin-sensitive Staphylococcus aureus (MSSA) and does not provide Gram-negative coverage, unlike cefazolin. Therefore, it may require combination with a second antibiotic when Gram-negative pathogens are involved.[3,4]

Previously known as "Red Man Syndrome" since its first description in the New England Journal of Medicine in 1985, the condition was officially renamed "vancomycin infusion reaction" in 2021, as the former term was considered stigmatizing and potentially offensive toward Native American Indigenous peoples.[4]

Vancomycin infusion reaction is a non–IgE-mediated reaction characterized by histamine release from basophils and mast cells, without the need for prior antigen exposure, potentially causing erythema, pruritus, and hypotension, as observed in the patient described in our case.[6]

The reaction typically occurs when vancomycin is infused rapidly (1 g intravenously in less than 30 minutes), although this is not an absolute rule. Cases have been reported with daily oral vancomycin administration and even several days after drug exposure. Nevertheless, current recommendations advocate slow infusions, such as 15–20 mg/kg diluted in 250 mL administered over approximately 2 hours.[6,7]

Most episodes develop within 10 minutes after the start of infusion and resolve within approximately 20 minutes. Management essentially consists of supportive measures commonly used in allergic reactions, including continuous monitoring, supplemental oxygen, interruption of the infusion, administration of antihistamines, and positioning the patient in Trendelenburg position. Ideally, the initial dose should be administered and the patient observed for some time before anesthetic induction, a consideration that could have been applied in our case.[1,6]

Importantly, vancomycin may be slowly restarted after the episode, which generally lasts around 20 minutes, and does not necessarily need to be permanently discontinued, since this is a non–IgE-mediated reaction. This approach may avoid unnecessary changes in antibiotic therapy and consequent alterations in the antimicrobial spectrum.[6] Subsequent doses may be administered over a longer period, such as 2 hours, in addition to prophylactic antihistamine administration before vancomycin infusion.[1,8] In contrast, anaphylaxis is an IgE-mediated reaction that requires prior exposure to the antigen and presents with symptoms similar to vancomycin infusion reaction, but with more severe manifestations such as angioedema and stridor. In such cases, treatment should follow anaphylaxis protocols, including administration of epinephrine.[1]

Thus, we believe that our patient indeed experienced a vancomycin infusion reaction. The symptoms were self-limited and without severe consequences, differing from an

anaphylactic reaction. As a criticism of the management, we may point out the short infusion time (approximately 20 minutes), which might have prevented the reaction had the infusion been administered over a longer period. Furthermore, it is debatable whether vancomycin was truly necessary based solely on the reported history of penicillin allergy.

CONCLUSION

Antibiotic prophylaxis is part of the anesthesiologist's daily routine, as is the need to replace drugs in patients reporting allergies to commonly used antibiotics. Therefore, this case highlights the discussion regarding whether antibiotic substitution is truly necessary, as well as the importance of recognizing and managing vancomycin infusion reaction and its main differential diagnosis, anaphylactic reaction. Failure to distinguish between these conditions may lead to inappropriate discontinuation of therapy and the use of less effective agents for surgical prophylaxis.

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SCIENTIFIC ARTICLE - CASE REPORT

KARTAGENER SYNDROME AND ANESTHETIC IMPLICATIONS: PATHOPHYSIOLOGICAL REVIEW AND CASE REPORT IN ANTERIOR CERVICAL ARTHRODESIS

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ABSTRACT

Primary ciliary dyskinesia (PCD) is an inherited disorder in which motile cilia have structural and/or functional defects, impairing mucociliary clearance and promoting secretion retention, bacterial colonization, recurrent infections, and chronic inflammation from childhood, with potential progression to bronchiectasis and respiratory failure. Kartagener syndrome (KS) is the classic form associated with PCD, combining chronic respiratory disease with laterality defects such as situs inversus totalis or dextrocardia, which affects the interpretation of ECG, auscultation findings, and imaging studies. Diagnosis is multimodal (clinical features plus specialized tests), and management aims to relieve symptoms and prevent exacerbations (vaccination, respiratory physiotherapy, and airway clearance). We report the case of a 50-year-old patient with KS undergoing anterior cervical fusion, clinically stable and without recent exacerbation. Total intravenous anesthesia (TIVA) with propofol/remifentanil was performed, with rocuronium titrated under train-of-four (TOF) monitoring and depth-of-anesthesia monitoring, alongside lung-protective ventilation and periodic recruitment maneuvers. The course was uneventful, and extubation was performed under strict criteria after complete neuromuscular blockade reversal to ensure effective cough and reduce the risk of mucus plugging/atelectasis. The discussion emphasizes that perioperative complications in KS are predominantly respiratory (atelectasis, bronchospasm, infection) and highlights humidification, secretion management, lung-protective ventilation, complete neuromuscular reversal, adequate analgesia, and early respiratory physiotherapy as key safety measures.

Keywords: Kartagener syndrome, Ciliary motility disorders, Anesthesia, Rare diseases, Dextrocardia, Situs inversus.

INTRODUCTION

Primary ciliary dyskinesia (PCD) is a hereditary disease, predominantly autosomal recessive, in which motile cilia present structural or functional abnormalities. Because

these cilia are essential for mucociliary clearance, impairment of their movement reduces airway clearance and facilitates the accumulation of secretions in the upper and lower respiratory tract. In practice, this favors bacterial colonization, recurrent respiratory infections, and chronic inflammation. For this reason, the clinical picture usually begins early in life, often during childhood, with chronic rhinosinusitis, recurrent otitis, and frequent episodes of bronchitis or pneumonia. Over the years, persistent inflammation may lead to bronchiectasis and recurrent exacerbations, and in more advanced cases it may progress to chronic respiratory failure, pulmonary hypertension, and cor pulmonale.[1]

Kartagener syndrome (KS) is the classic presentation associated with PCD and is characterized by the combination of chronic respiratory disease with laterality abnormalities. Among these alterations, situs inversus totalis and dextrocardia stand out. Situs inversus totalis refers to the "mirror-image" inversion of the position of thoracic and abdominal organs, involving the heart and viscera. Dextrocardia specifically describes the heart located in the right hemithorax, with the apex pointing to the right. Dextrocardia may occur as part of situs inversus totalis, but it can also occur in isolation, which requires additional attention during anatomical and cardiological evaluation. Although a significant proportion of patients with PCD present situs inversus, KS should be understood as a spectrum, because the triad is not always present in its complete form, which may delay clinical recognition.[1]

Historically, Kartagener described the clinical triad in 1933, and later the understanding of the syndrome advanced with the identification of cilia axonemal abnormalities, such as the absence of dynein arms, as well as the association with infertility, particularly in males.[2,3]

The diagnosis of PCD and KS is challenging because there is no single test considered a gold standard in all contexts. Current recommendations emphasize integrating the clinical picture with specialized complementary tests, such as nasal nitric oxide measurement, high-speed video analysis of ciliary beating, transmission electron microscopy, immunofluorescence, and genetic testing, depending on the availability and expertise of the center. Guidelines from the European Respiratory Society (ERS) and the American Thoracic Society (ATS) reinforce this multimodal diagnostic reasoning and the classification of diagnosis based on probability.[4,5]

Because there is no specific curative treatment, management is aimed at reducing symptoms, preventing exacerbations, and limiting the progression of bronchial damage. This strategy includes vaccination, respiratory physiotherapy, and bronchial hygiene, in addition to early treatment of exacerbations and measures directed at chronic colonization when indicated.[1,5]

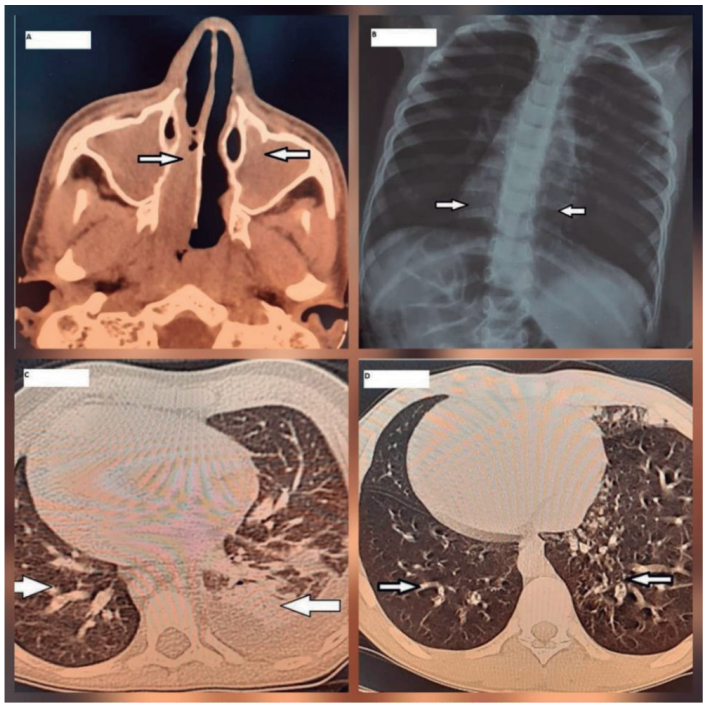

Figure 1. Illustrative images of Kartagener Syndrome. A) CT scan showing chronic sinusitis with nasosinusal polyposis. B) Chest X-ray showing a case of dextrocardia with findings of pneumonia and minimal pleural effusion in the left upper lobe. C) Thoracic CT demonstrating situs inversus, bronchial dilation, and left laterobasal empyema. D) Chest CT demonstrating bronchial dilation associated with situs inversus.[6]

CASE REPORT

A A 50-year-old patient with KS underwent anterior cervical arthrodesis. In the immediate preoperative period, she was stable, without signs of recent respiratory exacerbation and without hypersecretion on the day of the procedure; therefore, no additional tests were requested at that time. Nevertheless, considering the baseline risk of secretion retention and atelectasis during controlled ventilation, anesthetic management was planned with a focus on ventilatory stability and prevention of pulmonary complications.

TIVA was performed using target-controlled infusion of propofol and remifentanil, associated with rocuronium, with neuromuscular blockade titration guided by train-of-four (TOF) monitoring. The anesthetic plan was monitored with SedLine, a processed electroencephalogram monitor used to estimate hypnotic depth, with a purpose similar to BIS, assisting in the titration of the anesthetic depth. The airway was managed with orotracheal intubation, and during maintenance protective ventilation was used, with periodic alveolar recruitment maneuvers, aiming to reduce alveolar collapse and maintain an adequate ventilation–perfusion relationship.

The intraoperative period was uneventful, and at the end of the procedure the patient presented a smooth emergence, without bronchospasm and without hypoxemia. Considering that the anterior cervical approach may be associated with local edema and, more rarely,

hematoma with potential airway compromise, extubation was performed using strict criteria, prioritizing complete ventilatory recovery and full reversal of neuromuscular blockade. In KS, this precaution is particularly relevant, as effective cough and full spontaneous ventilation reduce the risk of mucous plugging and postoperative atelectasis.

DISCUSSION

The pathophysiological basis of KS can be understood through a relatively simple cycle: retained secretions favor infection, infection fuels inflammation, and inflammation, over time, promotes remodeling and structural damage. The failure of mucociliary clearance leaves secretions more stagnant and difficult to remove, creating an environment conducive to recurrent infections and perpetuation of the inflammatory process. This mechanism explains why bronchiectasis and chronic sinus disease are so common, in addition to the risk of progressive loss of functional respiratory reserve in some patients.[3]

Laterality abnormalities also have practical implications in the perioperative setting. When dextrocardia is present, for example, a standard electrocardiogram (ECG) lead placement may suggest abnormalities that actually reflect the "mirror-image" anatomy. The same reasoning applies to the location of auscultation foci, interpretation of imaging studies, and some decisions regarding equipment positioning. Therefore, identifying in advance whether the patient has situs inversus totalis or isolated dextrocardia helps avoid confusion and improves perioperative planning.[1,4,5]

In anesthesia, the central issue is the increased respiratory risk. Impaired mucociliary clearance favors mucous plugs and atelectasis during mechanical ventilation. In addition, chronic inflammation may be associated with bronchial hyperreactivity, increasing the risk of bronchospasm and hypoxemia during airway manipulation. In patients with bronchiectasis and bacterial colonization, the risk of respiratory infection and postoperative exacerbation is also higher. A systematic review of published cases shows that respiratory complications account for most of the perioperative events described in KS.[6]

In practice, this means that preoperative evaluation is guided by the patient's current clinical status. If there are signs of recent exacerbation, such as fever, increased sputum production, wheezing, or worsening dyspnea, the usual approach is to optimize bronchial hygiene and respiratory physiotherapy before the procedure and consider additional evaluation depending on severity. When there is no exacerbation, management focuses on the prevention of intraoperative and postoperative complications.[5,7]

During general anesthesia, some measures are particularly consistent with the underlying pathophysiology. Humidification of inspired gases helps prevent secretions from becoming thicker and more difficult to mobilize. Protective ventilation strategies, with alveolar recruitment maneuvers adjusted to the clinical context, help reduce atelectasis. Airway suctioning should be performed judiciously, with particular attention at the end of the procedure, avoiding mucous plugs and minimizing airway trauma. Postoperatively, the focus is on restoring full spontaneous ventilation and effective coughing, as these help compensate, at least partially, for impaired mucociliary clearance.[7]

At this point, complete reversal of neuromuscular blockade is essential. Monitoring with train-of-four (TOF) allows safer titration and reduces the risk of residual neuromuscular

blockade, which is particularly relevant in KS because effective coughing and secretion mobilization are key to preventing atelectasis and mucus retention in the postoperative period. Adequate analgesia and early respiratory physiotherapy complete this strategy, as they facilitate deep ventilation, pulmonary expansion, and bronchial hygiene.[7]

It is also pertinent to consider the impact of anesthetic technique on mucociliary transport. A clinical trial demonstrated worse mucus transport with inhalational anesthesia compared with total intravenous anesthesia (TIVA) using propofol and remifentanil.[8] In parallel, experimental studies suggest that propofol may modulate ciliary motility through the nitric oxide (NO) and cyclic guanosine monophosphate (cGMP) pathway, a mechanism that supports the biological plausibility of this choice in patients with impaired mucociliary clearance.[9] Taken together, reviews and case reports describe TIVA as an appropriate strategy in KS, provided it is combined with consistent measures for secretion management and prevention of respiratory complications.[7,10,11]

In situations requiring selective intubation, such as thoracic surgery, situs inversus may require specific planning and careful confirmation of device positioning, ideally with bronchoscopy when available, to reduce the risk of inadequate ventilation.[12]

CONCLUSION

Kartagener syndrome is a condition associated with primary ciliary dyskinesia (PCD), characterized by chronic respiratory disease and laterality abnormalities in some cases. In the perioperative setting, the risk is mainly related to respiratory complications, particularly atelectasis, bronchospasm, and infection, in addition to specific considerations in the interpretation of diagnostic tests when dextrocardia and, especially, situs inversus totalis are present. Safe anesthetic management depends on recognizing and optimizing exacerbations, carefully managing secretions, ensuring adequate humidification, applying protective ventilation strategies, and performing extubation only after complete recovery from neuromuscular blockade, in addition to effective analgesia and early respiratory physiotherapy. In the presented case, the strategy using TIVA, protective ventilation, and appropriate monitoring was consistent with the pathophysiology of KS and the available literature, contributing to a favorable perioperative outcome.

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SCIENTIFIC ARTICLE - CASE REPORT

POSTOPERATIVE COMPLICATION RATES IN PATIENTS UNDERGOING URGENT AND ELECTIVE VIDEOLAPAROSCOPIC CHOLECYSTECTOMY

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ABSTRACT

This study analyzed the epidemiological profile and postoperative complications of patients undergoing urgent and elective laparoscopic cholecystectomy at a tertiary public hospital in the Central-Northern region of Goiás. This was a cross-sectional, analytical, and comparative study, with retrospective data collection from medical records of patients aged ≥18 years who underwent surgery between 2023 and 2024. The variables evaluated included demographic characteristics, operative time, self-limited intraoperative bleeding, complications, length of hospital stay, need for ICU admission, and mortality.

A total of 524 patients were included, with a predominance of females (79.8%) and a mean age of 50.8 ± 15.3 years. The overall complication rate was low (1.7%), but higher in the urgent group (3.9%) compared to the elective group (1.3%). Operative time was significantly longer in urgent procedures, exceeding 45 minutes in 93.4% of cases, compared to 78.3% in elective surgeries ($p < 0.01$).

In the multivariate analysis, urgent surgery (OR = 7.98; $p = 0.014$), ICU admission (OR = 6.03; $p < 0.001$), and self-limited intraoperative bleeding (OR = 5.28; $p < 0.001$) were independently associated with complications. Prolonged hospital stay (≥3 days) was associated with urgent surgery, ICU admission, operative time >45 minutes, male sex, and complications.

In conclusion, laparoscopic cholecystectomy showed a low complication rate. Urgent procedures, intensive care, and self-limited intraoperative bleeding represent markers of greater clinical and technical complexity and are associated with a higher risk of adverse events. These factors, together with male sex and prolonged operative time, were also associated with longer hospital stays.

Keywords: Cholelithiasis, Laparoscopic cholecystectomy, Postoperative complications, Emergency surgery, Elective surgery, Morbidity.

INTRODUCTION

Cholelithiasis is a highly prevalent disease. It is estimated that approximately 10–15% of the North American population is affected by the disease. A Brazilian necropsy

study reported that between 9% and 20% of the population older than 20 years of age is diagnosed with cholelithiasis.[1]

Most individuals with cholelithiasis do not present symptoms, and it is expected that 20% of these patients will develop typical symptoms during their lifetime, while 1–2% progress with some complication of the disease each year.[2]

Cholecystectomies can be categorized as elective or urgent, where elective surgeries are those in which it is possible to choose the most appropriate date for the surgical procedure, whereas urgent and emergency procedures cannot wait and must be performed during the same hospitalization. Elective surgeries are predominantly performed after examinations that confirm the patient has achieved the best possible health condition, minimizing as much as possible the risk of complications. Meanwhile, urgent and emergency surgeries are carried out when the patient presents with a severe condition, such as acute cholecystitis, making immediate intervention necessary.[3]

Historically, open surgery was the standard method for cholecystectomy. However, due to advances in minimally invasive techniques, laparoscopy emerged as a widely chosen option because of its clinical, aesthetic, and functional benefits, such as shorter hospitalization time, reduced postoperative pain, and faster recovery.[4,5,6]

In contrast, open cholecystectomy is generally reserved for more complex cases, such as severe acute cholecystitis, gallbladder perforation, or when the laparoscopic approach is not possible. This technique involves a larger incision in the abdominal wall in order to allow direct access to the gallbladder and the biliary ducts.[7]

Although laparoscopic cholecystectomy is a well-established and safe surgical approach, complications have been described in both elective and urgent procedures, such as bleeding from the hepatic bed, diffuse and intense abdominal pain, hypotension, urinary retention, post-extubation bronchospasm, hemodynamic instability, acute renal failure, central cyanosis, and necrosis of the extremities.[8]

JUSTIFICATION

The study on this topic is justified because, by critically analyzing patients undergoing urgent or elective cholecystectomy, it is expected to provide valuable insights for surgeons as well as for healthcare professionals involved in the management of cholelithiasis, helping them to make informed decisions and optimize patient care.

In this context, it is evident that postoperative complications of cholecystectomy, although infrequent, require careful attention from the surgical team, since they may compromise the patient's recovery and require additional interventions. Furthermore, they may present clinical implications in the medium and long term, supporting the need for careful follow-up of these patients, even after a successful surgical procedure.

OBJECTIVES

General objetive

The present study aims to analyze the epidemiological profile of patients undergoing emergency and elective laparoscopic cholecystectomies, treated in the General Surgery Department of a tertiary public hospital in the Central-North region of Goiás, between 2023 and 2024.

Specific objetives

• To compare postoperative complications associated with elective and emergency laparoscopic cholecystectomies;

• To compare clinical and demographic data, surgical time, and conversion rates to open surgery between patients undergoing elective and emergency cholecystectomy;

• To compare the results with data reported in the literature.

METHODOLOGY

This was a cross-sectional cohort, analytical and comparative study, with retrospective data collection through medical record review, in which patients who underwent laparoscopic cholecystectomy between January 2023 and December 2024 at a tertiary public hospital in the Central-North region of Goiás were evaluated. Data collected included identification variables (age and sex), duration of the procedure, occurrence of self-limited intraoperative bleeding, postoperative complications (Figure 1), conversion to open surgery, need for hemotransfusion, need for hematimetric monitoring, length of hospital stay, admission to the intensive care unit (ICU) (in days), and deaths.

For the purposes of analysis, the term "bleeding" was considered a self-limited intraoperative event identified in the medical record, resolved with local hemostasis during the surgical procedure, without hemodynamic instability, without the need for hemotransfusion, and without clinical repercussions in the immediate postoperative period; therefore, it was not classified as a complication. "Intra-abdominal hemorrhage," in turn, was defined as an early complication characterized by bleeding with clinical repercussions and/or the need for reintervention, according to the criteria described in the list of complications of the study (Figure 1).

Patients older than 18 years, treated in the General Surgery Unit of the Hospital Estadual do Centro-Norte Goiano between 2023 and 2024, who underwent elective or emergency laparoscopic cholecystectomy, were included. Medical records with insufficient or incomplete information were excluded from the study.

Statistical analysis was conducted using the Statistical Package for the Social Sciences (SPSS), version 26.0 (IBM Corporation, Armonk, NY, USA). The significance level adopted was 5% ($\alpha = 0.05$) with two-tailed tests. Initially, the sample was described using descriptive statistics. Continuous variables were presented as mean ± standard deviation (SD), and categorical variables as absolute frequency (n) and relative frequency (%). Comparisons between the elective surgery and emergency surgery groups were performed using the Pearson chi-square test for categorical variables and the Student's t-test for independent samples for continuous variables.

To investigate factors associated with the study outcomes, binary logistic regression models were fitted considering the following dependent variables: presence of complications (yes/no) and length of hospital stay (≤ 2 days vs. ≥ 3 days). The independent variables included in the models were: age group (< 50 years vs. ≥ 50 years), sex (female/male), type of surgery (elective/emergency), ICU admission (yes/no), surgical procedure time (≤ 45 min vs. > 45 min), and occurrence of bleeding (yes/no). Results were expressed as odds ratios (OR) with their respective 95% confidence intervals (95% CI). For the complications model, Firth's penalized logistic regression was used due to the presence of complete or quasi-complete separation in some categories, in order to reduce bias and allow stable estimates of OR and 95% CI.

The research was conducted in accordance with the Guidelines and Regulatory Standards for Research Involving Human Subjects (Resolution 466/2012 of the Brazilian National Health Council), ensuring confidentiality, privacy, protection of image, and non-stigmatization of the participants, guaranteeing that the information would not be used to the detriment of the individuals involved, including aspects related to self-esteem, prestige, and/or economic and financial issues. No photographic records or filming of questionnaires or identification forms were performed. The study was approved by the Research Ethics Committee for Human Subjects under CAAE: 92301025.2.0000.5082.

RESULTS

During the study period, 448 elective surgeries and 76 emergency surgeries were performed. Table 1 presents the characterization of the demographic profile of patients who underwent surgical procedures, totaling 524 individuals. The sample showed a mean age of 50.82 ± 15.30 years, with no statistically significant difference between the groups (51.21 ± 15.17 in elective procedures vs. 48.53 ± 15.92 in emergency procedures; p = 0.17, Student's t-test).

Regarding age distribution by groups, a predominance of individuals between 40 and 59 years old was observed (43.3% of the total), followed by the groups 18 to 39 years (26.3%) and 60 to 69 years (17.9%). Individuals 70 years or older accounted for 12.4% of the sample. The distribution of age groups did not differ between elective and emergency surgeries (p = 0.34, chi-square test), although a numerically higher proportion of patients 18 to 39 years old was observed in the emergency group (32.9%) compared with the elective group (25.2%).

Regarding sex, there was a predominance of female patients in the cohort (79.8%), with a similar distribution between groups (80.6% in elective surgeries vs. 75.0% in emergency surgeries; p = 0.33, chi-square test). Male patients represented 20.2% of the total sample, with a numerically higher proportion in emergency surgeries (25.0%) compared with elective surgeries (19.4%), without statistical significance.

Figure 1. Demographic profile of patients undergoing elective and emergency surgery (n = 524).

Type of Surgery	Total p	Elective	Emergency
Age group n (%)			
18 to 39 years	138 (26.3)	113 (25.2)	25 (32.9)
40 to 59 years	227 (43.3)	197 (44.0)	30 (39.5)
60 to 69 years	94 (17.9)	79 (17.6)	15 (19.7)
70 or more	65 (12.4)	59 (13.2)	6 (7.9)
Mean ± SD	50.82 ± 15.30	51.21 ± 15.17	48.53 ± 15.92
Sex n (%)			
Female	418 (79.8)	361 (80.6)	57 (75.0)
Male	106 (20.2)	87 (19.4)	19 (25.0)

*Chi-square test; **Student's t-test; n, absolute frequency; %, relative frequency; SD, standard deviation.

In the total sample of 524 patients, the overall occurrence of complications was low (9 cases; 1.7%) (Table 2). A tendency toward a higher frequency of complications was observed in the emergency group (3.9%) compared with the elective group (1.3%), although without statistically significant difference (p = 0.25, chi-square test). Similarly, early complications occurred in 6 patients (1.1%), with nearly identical proportions between elective surgeries (1.1%) and emergency surgeries (1.3%; p = 1.00). Meanwhile, late complications were rare (0.4% overall), also showing no difference between the groups (0.2% in elective procedures vs. 1.3% in emergency procedures; p = 0.67) (Table 2).

Regarding the need for intensive care, 22 patients (4.2%) required ICU admission, with a similar distribution between elective surgeries (4.5%) and emergency surgeries (2.6%; p = 0.67). Among patients admitted to the ICU, 100% remained for ≥ 3 days in both groups, with no records of ICU stays lasting 1 to 2 days (Table 2). All ICU admissions were due to preexisting comorbidities (20 patients) or anesthetic complications (2 patients).

When analyzing length of hospital stay, marked differences were observed according to the type of surgery. Most patients in the elective group had a hospital stay ≤ 2 days (89.7%), whereas in the emergency group there was a predominance of hospital stays ≥ 3 days (93.4%), showing a statistically significant association (p < 0.01, chi-square test). Consistently, the mean length of hospital stay was significantly longer in emergency surgeries (7.39 ± 4.49 days) compared with elective surgeries (2.32 ± 3.47 days), with an overall mean of 3.06 ± 4.05 days (p < 0.01, Student's t-test) (Table 2).

Figure 2. Clinical care characteristics of patients undergoing elective and emergency surgery (n = 524).

Variable	Elective (n=448)	Emergency (n=76)	Total (n=524)	p
Complications n (%)				
Global	6 (1.3)	3 (3.9)	9 (1.7)	0.25*
Early	5 (1.1)	1 (1.3)	6 (1.1)	1.00*
Late	1 (0.2)	2 (2.6)	3 (0.4)	0.67*
ICU admission n n (%)				
Yes	20 (4.5)	2 (2.6)	22 (4.2)	0.67*
No	428 (95.5)	74 (97.4)	502 (95.8)	
Length of hospital stay n (%)				
≤ 2 days	402 (89.7)	5 (6.6)	407 (77.7)	<0.01*
≥ 3 days	46 (10.3)	71 (93.4)	117 (22.3)	
Mean ± SD (days)	2.32 ± 3.47	7.39 ± 4.49	3,06 ± 4.05	<0.01**

*Chi-square test; **Student's t-test; n, absolute frequency; %, relative frequency; SD, standard deviation.

Table 3 presents the data related to the surgical care of patients undergoing elective and emergency surgery. In the evaluation of intraoperative events, the occurrence of complications was very low. Bleeding was observed in 2 patients (0.4%), both in the elective surgery group (0.4% vs. 0.0% in the emergency group; p = 1.00, chi-square test). Similarly, the need for local hemostasis was also recorded in 2 cases (0.4%), likewise restricted to the elective group (p = 1.00). The use of packed red blood cells was a rare event (1 patient; 0.2%) and occurred only in the emergency group (1.3% vs. 0.0% in elective procedures), with no evidence of statistical association (p = 0.31).

Regarding procedure duration, a significant difference was observed between the groups. Considering the 45-minute cutoff point, 93.4% of emergency surgeries had a duration > 45 minutes, whereas in the elective group this proportion was 78.3% (p < 0.01, chi-square test). Consistently, the mean procedure time was significantly longer in emergency surgeries (80.42 ± 31.36 min) compared with elective surgeries (65.33 ± 27.06 min), with an overall mean of 67.52 ± 28.20 min (p < 0.01, Student's t-test).

Figure 3. Surgical care characteristics of patients undergoing elective and emergency surgery (n = 524).

Variable	Eletctive (n=448)	Emergency (n=76)	Total (n=524)	p
Self-limited intraoperative bleeding, n (%)	2 (0.4)	0 (0.0)	2 (0.4)	1.00*
Use of packed red blood cells, n (%)	0 (0.0)	1 (1.3)	1 (0.2)	0.31*
Local hemostasis, n (%)	2 (0.4)	0 (0.0)	2 (0.4)	1.00*
Fundus-first cholecystectomy, n (%)	0 (0.0)	0 (0.0)	0 (0.0)	1.00*
Conversion to open surgery, n (%)	0 (0.0)	0 (0.0)	0 (0.0)	1.00*
Hemotransfusion, n (%)	0 (0.0)	0 (0.0)	0 (0.0)	1.00*
Hematimetric monitoring, n (%)	0 (0.0)	0 (0.0)	0 (0.0)	1.00*
Procedure time, n (%)				
≤ 45 min	97 (21.7)	5 (6.6)	102 (19.5)	<0.01*
> 45 min	351 (78.3)	71 (93.4)	422 (80.5)	
Mean ± SD (min)	65.33 ± 27.06	80.42 ± 31.36	67.52 ± 28.20	<0.01**

*Chi-square test; **Student's t-test; n, absolute frequency; %, relative frequency; SD, standard deviation; NA, not applicable.

Figure 1 presents the results of the logistic regression analysis of the variables. In the total sample (n = 524), 9 complications (1.7%) were observed. In the multivariable analysis using Firth's penalized logistic regression (to address complete separation), relevant associations between complications and clinical/perioperative variables were identified, as follows:

1. Age group: Patients aged ≥ 50 years accounted for the largest proportion of complications (66.7% of cases), whereas those aged < 50 years represented 33.3%. However, there was no statistically significant association between age and complications (OR = 1.45; 95% CI 0.68–4.89; p = 0.363), suggesting no robust evidence of increased risk at the adopted cutoff point.

2. Sex: A higher proportion of male patients was observed among cases with complications (44.4%) compared with their proportion among individuals without complications (19.8%). Nevertheless, the association did not reach statistical significance (OR = 3.25; 95% CI 0.70–15.14; p = 0.134), indicating a tendency toward higher risk among males, although with wide imprecision (broad 95% CI).

3. Type of surgery: A significant association was observed between emergency surgery and the occurrence of complications. Among patients who developed complications, 33.3% underwent emergency surgery, whereas among those without complications this proportion was 14.2%. In terms of magnitude, emergency surgery was associated with an approximately eightfold higher risk of complications compared with elective procedures (OR = 7.98; 95% CI 1.52–14.97; p = 0.014), indicating a clinically meaningful and statistically consistent effect.

4. ICU admission: The need for ICU admission showed a strong association with the occurrence of complications: among patients with complications, 44.4% required ICU admission, compared with only 3.5% among those without complications. This finding translated into a substantial increase in risk, with patients admitted to the ICU presenting 6.03 times higher odds of complications (OR = 6.03; 95% CI 3.93–9.73; p < 0.001). This factor showed one of the most robust associations, both in magnitude and statistical significance.

5. Procedure time: All complications occurred in procedures lasting > 45 minutes (100.0%), whereas no complications occurred in procedures ≤ 45 minutes (0.0%), reflecting a pattern of risk concentrated in longer procedures. However, in the penalized model the estimate did not show a statistically significant association (OR = 3.46; 95% CI 0.15–9.53; p = 0.437), consistent with high uncertainty due to the low frequency of the outcome and the absence of events in the shorter-duration stratum.

6. Self-limited intraoperative bleeding: The variable self-limited intraoperative bleeding showed a significant association with the occurrence of postoperative complications. Among patients who developed complications, 22.2% experienced intraoperative bleeding, whereas in the group without complications this proportion was 0.0%, indicating a higher frequency of this technical event among cases with adverse outcomes. In Firth's penalized logistic regression, the presence of self-limited intraoperative bleeding was associated with a 5.28-fold increase in the odds of complications (OR = 5.28; 95% CI 2.33–9.90; p < 0.001), suggesting that intraoperative bleeding episodes, even when controlled, represent a marker of greater surgical complexity and risk of postoperative events.

Overall, the results indicate that in this cohort emergency surgery, ICU admission, and bleeding showed the most consistent associations with complications (large effect sizes and p < 0.05), whereas age, sex, and procedure time did not demonstrate statistically significant

associations in the adjusted model.

In the cohort (n = 524), 407 patients (77.7%) had a hospital stay ≤ 2 days, while 117 (22.3%) had a length of stay ≥ 3 days. In the multivariable logistic regression analysis (Figure 2), clinical and care-related determinants strongly associated with prolonged hospitalization were identified as follows:

1. Age group: Patients aged ≥ 50 years represented 55.6% of the group with prolonged hospitalization (≥ 3 days), compared with 50.6% in the group with stays ≤ 2 days. Despite this higher representation in the longer-stay group, no statistically significant association was observed between age and prolonged hospitalization (OR = 1.22; 95% CI 0.81–1.84; p = 0.346).

2. Sex: A higher proportion of male patients was observed among those with hospitalization ≥ 3 days (27.4%) compared with those with stays ≤ 2 days (18.2%). Male sex was significantly associated with higher odds of prolonged hospitalization (OR = 1.69; 95% CI 1.05–2.73; p = 0.031), indicating approximately a 69% greater likelihood of remaining hospitalized for ≥ 3 days compared with females.

3. ICU admission: ICU admission showed one of the strongest associations: only 0.7% of patients with stays ≤ 2 days were admitted to the ICU, whereas in the ≥ 3 days group this proportion was 16.2%. This pattern translated into a marked increase in risk, with patients requiring ICU admission having 6.11 times higher odds of hospitalization ≥ 3 days (OR = 6.11; 95% CI 3.57–9.00; p < 0.001).

4. Procedure time: Procedures lasting > 45 minutes were more frequent among prolonged hospitalizations (88.9%) than among hospitalizations ≤ 2 days (78.1%). Duration > 45 minutes was significantly associated with prolonged stay (OR = 2.24; 95% CI 1.20–4.17; p = 0.011), suggesting more than twice the odds of hospitalization ≥ 3 days compared with procedures ≤ 45 minutes.

5. Type of surgery: The variable with the greatest proportional contrast was type of surgery: among patients with hospitalization ≤ 2 days, 98.8% underwent elective surgery, whereas in the ≥ 3 days group 60.7% underwent emergency surgery (vs 1.2% in the ≤ 2 days group). This pattern was supported by a highly significant association, with emergency surgery associated with a 4.10-fold higher likelihood of prolonged hospitalization (OR = 4.10; 95% CI 2.67–7.07; p < 0.001).

6. Presence of complications: The occurrence of complications was substantially more frequent in the ≥ 3 days group (6.0%) than in the ≤ 2 days group (0.5%). The presence of complications was associated with 8.89 times higher odds of prolonged hospitalization (OR = 8.89; 95% CI 2.64–12.91; p = 0.002), indicating that adverse events in the perioperative period are a key determinant of longer hospital stay.

In summary, male sex, ICU admission, procedure time > 45 minutes, emergency surgery, and the presence of complications were factors significantly associated with a higher likelihood of hospital stay ≥ 3 days, with particular emphasis on the impact of complications and ICU admission (largest effect sizes). Age was not significantly associated with prolonged hospitalization in the adjusted model.

DISCUSSION

Based on the proposed methodology, a survey of the epidemiological characteristics of patients undergoing emergency and elective laparoscopic cholecystectomy was conducted. Medical records of 524 patients followed at a tertiary public hospital in the Central-North region of Goiás were analyzed. It was observed that the majority of patients in the present study

were female (79.8%), with a similar distribution between groups (80.6% in elective surgeries vs. 75.0% in emergency surgeries; p = 0.33, chi-square test).

Corroborating these findings, in the study by Felicio et al. (2017)[9], among a population of 86,519 patients, 82.8% (71,652) were women, with a predominance in the 45–54-year age group (22.4%). Mesquita & Iglesias (2018)[10] also reported that among 345 patients undergoing laparoscopic cholecystectomy, 80% were female.

Regarding age group, a predominance was observed between 40 and 59 years (43.3% of the total), followed by 18 to 39 years (26.3%) and 60 to 69 years (17.9%). Individuals 70 years or older represented 12.4% of the sample. Moss et al. (2025)[11] corroborate the findings of the present study, reporting a mean patient age of 49 years. In contrast, Mesquita & Iglesias (2018)[10] found that most patients were concentrated in the 60–69-year age group (62%). Thus, it is considered that elderly patients present a more exacerbated response to the surgical trauma of laparoscopic cholecystectomy, with an inflammatory response that persists for a longer period.[12]

Regarding clinical complications associated with the surgical procedure, the present study showed that the overall occurrence of complications was low, with a tendency toward a higher frequency of complications in the emergency group (3.9%) compared with the elective group (1.3%), although without statistically significant difference (p = 0.25, chi-square test). In addition, only 22 patients (4.2%) required ICU admission, with a similar distribution between elective (4.5%) and emergency surgeries (2.6%; p = 0.67). Among patients admitted to the ICU, 100% remained for ≥ 3 days in both groups, with no records of ICU stays lasting 1 to 2 days. Similarly, in the study by Felicio et al. (2017)[9], the authors found that 760 patients (0.0087%) required ICU admission.

Data from the present study also corroborate Felicio et al. (2017) [9], showing that patients undergoing emergency surgery had a longer mean length of hospital stay (7.39 ± 4.49 days) compared with those undergoing elective surgery (2.32 ± 3.47 days). For the authors, the mean length of hospital stay differed from that observed in the group undergoing elective laparoscopic cholecystectomy, which was 2.32 days.

This difference was also evidenced in the categorical analysis: 93.4% of patients in the emergency surgery group remained hospitalized for 3 days or more, whereas the majority of patients in the elective surgery group (89.7%) were discharged within 2 days (p < 0.01).

Findings in the literature indicate that emergency surgery is associated with a higher probability of developing postoperative complications and with longer hospital stays. Emergency surgery has been independently associated with higher complication rates and increased length of hospitalization.[13]

CONCLUSION

In the present sample, a low rate of complications was observed in laparoscopic cholecystectomies. Emergency surgery and the need for admission to the intensive care unit were the main factors independently associated with the occurrence of postoperative complications. In addition, the presence of self-limited intraoperative bleeding was associated with a higher risk of adverse outcomes, constituting a marker of greater technical complexity of the procedure.

Regarding length of hospital stay, emergency surgery, the need for intensive care, prolonged operative time, and male sex were associated with longer hospitalization, reflecting greater clinical severity and perioperative complexity in these patients.

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SCIENTIFIC ARTICLE - REVIEW

POINT-OF-CARE ULTRASONOGRAPHY IN THE DIAGNOSIS OF ACUTE DYSPNEA IN ADULTS: A SYSTEMATIC REVIEW

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ABSTRACT

Introduction: Acute dyspnea is a frequent cause of emergency care, associated with severe cardiopulmonary diseases. Traditional imaging methods present diagnostic and operational limitations. In this context, point-of-care ultrasonography (POCUS) emerges as a rapid, safe tool performed at the bedside. Protocols such as BLUE and FATE have demonstrated usefulness in cardiopulmonary assessment and in guiding therapeutic management in patients with acute dyspnea.
Objectives: To evaluate the effectiveness of point-of-care ultrasonography (POCUS) in the diagnosis of acute dyspnea in adults, comparing it with conventional imaging methods and assessing its impact on clinically relevant outcomes. **Methods:** A systematic review was conducted in accordance with PRISMA guidelines, with searches performed in PubMed, Google Scholar, and open-access repositories up to January 2026. Randomized controlled trials, observational studies, and meta-analyses evaluating the use of POCUS in adults (≥18 years) with acute dyspnea in emergency or intensive care settings were included. Outcomes of interest comprised time to diagnosis, time to treatment initiation, sensitivity, specificity, adequacy of therapy, mortality, and length of hospital stay. **Results:** Thirteen studies totaling 5,393 participants met the eligibility criteria. The use of POCUS reduced time to diagnosis by approximately one hour and shortened time to treatment initiation by about 30 minutes, resulting in a mean reduction of 1.27 days in intensive care unit length of stay and a higher likelihood of appropriate therapy prescription[1]. For the main causes of acute dyspnea, ultrasonography demonstrated higher sensitivity than chest radiography: for community-acquired pneumonia, sensitivity was 0.95 and specificity 0.90[2]; for cardiogenic pulmonary edema, sensitivity reached 94% with specificity of 92%[3]; and for traumatic pneumothorax, sensitivity was 83% and specificity 99%[4]. No significant differences were observed in mortality or readmission rates. **Conclusions:** Point-of-care ultrasonography is an effective tool for the initial evaluation of acute dyspnea, reducing diagnostic and treatment delays while increasing the proportion of appropriate therapies and providing high diagnostic accuracy for pneumonia, cardiogenic pulmonary edema, and pneumothorax. Its lack of ionizing radiation and low cost support its incorporation into emergency care protocols. Structured training programs and protocol standardization are essential to optimize its clinical application.

Keywords: Acute dyspnea, Point-of-care ultrasound, Emergency, Diagnosis, Pneumothorax, Pneumonia, Pulmonary edema.

INTRODUCTION

Acute dyspnea is one of the leading causes of emergency department visits and is frequently associated with potentially life-threatening cardiopulmonary conditions such as pneumonia, congestive heart failure, pneumothorax, and pulmonary thromboembolism. Rapid and accurate identification of the underlying etiology is essential for the implementation of appropriate therapeutic strategies and for reducing morbidity and mortality. However, conventionally used imaging methods present important limitations: chest radiography has limited sensitivity for several conditions, whereas computed tomography, despite its greater diagnostic accuracy, requires patient transport and is associated with exposure to ionizing radiation. In this context, point-of-care ultrasonography has emerged as a promising diagnostic tool, performed at the bedside, with rapid access, wide availability, and safety.

In recent years, well-established protocols such as Bedside Lung Ultrasound in Emergency (BLUE) and Focus Assessed Transthoracic Echocardiography (FATE) have demonstrated that it is possible to evaluate the lungs, heart, and vessels rapidly, safely, and without radiation.[1] Recent systematic reviews suggest that POCUS accelerates diagnosis and guides therapy; however, there is methodological heterogeneity and variability among operators, requiring a critical analysis of the literature.[2]

Theoretical basis of lung ultrasonography

Lung ultrasonography is based on the interaction of high-frequency sound waves with the pleura-air interface. In normally aerated lungs, most of the waves are reflected back to the transducer, resulting mainly in the formation of artifacts rather than the direct visualization of anatomical structures. When there is a reduction in pulmonary air content, such as in interstitial or alveolar syndromes, the pattern of these artifacts changes, allowing the underlying pathophysiology to be inferred.

It is a rapid, repeatable, low-cost method free of ionizing radiation, with superior performance compared to physical examination and chest radiography in detecting several respiratory conditions. The examination is generally performed using a low-frequency curvilinear transducer (3–6 MHz), with standardized assessment points.

The BLUE protocol evaluates three points in each hemithorax (upper anterior, lower anterior, and posterolateral regions), enabling a rapid assessment of patients with acute dyspnea. The main findings include the bat sign, A-lines (aerated lung), pleural sliding — whose presence practically excludes pneumothorax — and B-lines, which indicate increased pulmonary density, as observed in pulmonary edema and pneumonia. The presence of three or more B-lines within the same intercostal space is considered significant; these lines are absent in pneumothorax because they depend on contact between the pleural layers.

Other signs, such as the curtain sign, the seashore sign, and the barcode sign, assist in differentiating pleural effusion, pulmonary consolidation, and pneumothorax. Although training is required, the BLUE and FALLS protocols have a short learning curve and high diagnostic

accuracy, exceeding 90% for common causes of acute dyspnea in the emergency setting, and are recommended by scientific societies for the evaluation of critically ill patients.

METHODS

Search strategy and inclusion criteria

A systematic search was conducted to identify relevant studies on the use of point-of-care ultrasonography in the evaluation of acute dyspnea. The PubMed, Google Scholar, and open-access repositories databases were searched without language restrictions through January 2026. Terms related to lung ultrasonography and acute dyspnea were used, including "point-of-care ultrasonography," "lung ultrasound," "dyspnea," "pneumonia," "heart failure," and "pneumothorax," in addition to a manual search of the references of the selected articles.

Randomized clinical trials and prospective or retrospective observational studies evaluating adults (≥18 years) with acute dyspnea in emergency departments, intensive care units, or prehospital settings were included. Point-of-care ultrasonography had to be used either as the primary diagnostic method or compared with conventional strategies such as clinical examination, chest radiography, or computed tomography. Case reports, narrative reviews, and studies conducted exclusively in pediatric populations, pregnant women, or victims of penetrating trauma were excluded.

Data extraction and analysis

Study selection and data extraction were performed independently by two reviewers. Information regarding study type, patient profile, ultrasonography protocol, and evaluated outcomes was collected. Disagreements between reviewers were resolved by consensus.

The analyzed outcomes included time to diagnosis and initiation of treatment, length of hospital stay, diagnostic performance of ultrasonography (sensitivity and specificity), mortality, and appropriateness of therapeutic management.

Whenever possible, study results were analyzed jointly using appropriate statistical models, with estimates presented alongside 95% confidence intervals. For the main conditions associated with acute dyspnea, such as pneumonia, cardiogenic pulmonary edema, and pneumothorax, the diagnostic accuracy measures of point-of-care ultrasonography were compared with those of conventional methods.

The presence of differences among studies was assessed using heterogeneity tests. The risk of bias of the included studies was evaluated using specific tools for clinical trials and observational studies, and the overall quality of evidence was classified according to methodologies widely recognized in the literature.

RESULTS

Included studies

The Foram identificados 11.630 registros nas bases de dados pesquisadas. Após a remoção de duplicatas e a triagem de títulos e resumos, 32 artigos foram selecionados para leitura na íntegra. Ao final, 13 estudos atenderam aos critérios de inclusão, sendo 7 ensaios clínicos randomizados e 6 estudos observacionais, totalizando 5.393 participantes.

Main studies and results

The meta-analysis by Szabó et al. (2023), which included 13 studies and 5,393 patients with acute dyspnea, demonstrated that the use of point-of-care ultrasonography (POCUS) reduced the time to diagnosis by approximately 63 minutes and anticipated treatment initiation by about 27 minutes. In addition, a reduction of 1.27 days in intensive care unit length of stay and a significant increase in the likelihood of appropriate therapy prescription (OR 2.31) were observed, without significant impact on mortality or readmission rates.[2]

In the evaluation of community-acquired pneumonia, the meta-analysis by Ye et al. (2015), involving 742 patients, demonstrated a sensitivity of 95% and specificity of 90% for lung ultrasonography, outperforming chest radiography, which showed a sensitivity of 77% and specificity of 91%. In patients requiring computed tomography, ultrasonography maintained superior performance compared with chest radiography.[3]

Regarding cardiogenic pulmonary edema, the meta-analysis by Al Deeb et al. (2014), which evaluated seven studies including 1,075 patients, demonstrated high diagnostic accuracy of bilateral B-lines, with a sensitivity of 94.1% and specificity of 92.4%, showing consistent results across different clinical settings and examination protocols.[4]

Comparative studies also reinforced the performance of ultrasonography in heart failure. The prospective study by Miger et al. (2025) demonstrated that POCUS achieved an area under the curve (AUC) of 0.82, outperforming chest radiography and approaching the performance of low-dose computed tomography.[5] Similarly, the randomized trial by Pivetta et al. (2019), involving 518 emergency department patients, demonstrated that integrating lung ultrasonography into clinical assessment significantly improved diagnostic accuracy for acute heart failure decompensation compared with the traditional strategy using chest radiography and NT-proBNP.[6]

The pragmatic multicenter trial by Riishede et al. (2021) showed that the addition of cardiopulmonary ultrasonography to standard assessment resulted in a higher proportion of patients receiving appropriate treatment within the first four hours and in shorter hospital stays, without increasing adverse events or negatively affecting mortality.[7]

For the diagnosis of pneumothorax, the meta-analysis by Ebrahimi et al. (2014) demonstrated significantly greater sensitivity of ultrasonography compared with chest radiography, while maintaining specificity close to 100%, particularly when the examination was performed by emergency physicians. Similar findings were observed in trauma patients and in prehospital settings.[8]

In the evaluation of pleural effusion, the meta-analysis by Yousefifard et al. (2016) demonstrated a sensitivity of 94% and specificity of 98% for ultrasonography, clearly surpassing chest radiography. More recent studies have confirmed these findings regardless of patient positioning.[9]

Observational studies have also demonstrated that POCUS can be performed rapidly and effectively by physicians in training. The study by O'Brien et al. (2025) showed that ultrasonography performed by trained students maintained high diagnostic accuracy for different causes of dyspnea, with a mean examination time significantly shorter than that required for chest radiography acquisition[10].

Overall, the included studies indicate that point-of-care ultrasonography demonstrates high diagnostic accuracy for the main causes of acute dyspnea, reduces the time required for clinical decision-making, and improves therapeutic appropriateness without increasing patient risk.

Impact of POCUS on clinical outcomes

Overall, improvement in clinical outcomes was observed with the use of bedside ultrasonography. The reduction in time to diagnosis and in time to treatment initiation translated into shorter stays in intensive care units. The higher proportion of appropriate therapy suggests that POCUS assists in the earlier selection of adequate treatment. However, there was no evidence of a significant reduction in mortality or hospital readmission rates.

Diagnostic performance of ultrasonography in specific conditions pneumonia

Lung ultrasonography demonstrates high sensitivity for the detection of peripheral consolidations, making its performance comparable to that of computed tomography in cases of superficial pneumonia. In the meta-analysis conducted by Ye et al., the sensitivity and specificity of ultrasonography were 0.95 and 0.90, respectively, whereas chest radiography showed lower sensitivity (0.77) and similar specificity (0.91). In subgroups of patients undergoing computed tomography, ultrasonography maintained high sensitivity (0.93), reinforcing its usefulness as an initial diagnostic tool.

It should be emphasized, however, that deep or central lesions may not be detected by this method. Therefore, computed tomography remains indicated when ultrasonography is negative but clinical suspicion persists.[3]

Cardiogenic pulmonary edema and heart failure

The presence of multiple bilateral B-lines, associated or not with pleural effusion, constitutes an ultrasonographic marker of pulmonary congestion. The meta-analysis by Al Deeb et al. demonstrated a sensitivity of 94.1% and a specificity of 92.4% for the diagnosis of cardiogenic pulmonary edema.[4] Similar findings were observed in the more recent meta-analysis by Rahmani et al., which reported a sensitivity of 0.92, specificity of 0.90, and an area under the curve of 0.96, indicating high overall diagnostic accuracy of the method.[11]

Likelihood ratios suggest that ultrasonography is particularly useful for ruling out heart failure when the examination is negative. In patients without a previous diagnosis of heart failure, chest radiography may demonstrate similar or slightly superior performance, as observed by Miger et al.[5] Nevertheless, the randomized clinical trial by Pivetta et al.[6] demonstrated that integrating ultrasonography into clinical assessment significantly improved diagnostic accuracy and increased the proportion of appropriate treatments in cases of acute heart failure decompensation.

Pneumothorax

The main ultrasonographic findings of pneumothorax include the absence of pleural sliding, the presence of A-lines, and identification of the lung point. In the meta-analysis by Ebrahimi et al., ultrasonography demonstrated a sensitivity of 0.87 and specificity of 0.99, whereas chest radiography showed significantly lower sensitivity (0.46), with a specificity of 1.00. These findings support ultrasonography as the preferred initial examination for the diagnosis of pneumothorax, especially in trauma patients.

Pleural Effusion

Lung ultrasonography is capable of identifying small volumes of pleural fluid with high accuracy.

The meta-analysis by Yousefifard et al. demonstrated a sensitivity of 0.94 and specificity of 0.98 for the method, clearly outperforming chest radiography, which showed a sensitivity of only 0.51 and specificity of 0.91.[9] The performance of ultrasonography was even better when performed by radiologists or intensivists, although it remained high even among other trained operators.

Acute respiratory distress syndrome (ARDS)

Although less extensively studied in the context of acute dyspnea, ultrasonography may contribute to the evaluation and classification of ARDS. The meta-analysis by Boumans et al. found moderate sensitivity (0.63) and high specificity (0.94), suggesting that the method has good ability to confirm the diagnosis, but limited sensitivity to rule it out when used in isolation.[12]

DISCUSSION

This systematic review demonstrates that point-of-care ultrasonography reduces the time to diagnosis and treatment initiation, resulting in shorter intensive care unit stays and a higher proportion of appropriate therapies. In the main causes of acute dyspnea — pneumonia, cardiogenic pulmonary edema, and pneumothorax — ultrasonography shows greater sensitivity than chest radiography and approaches the accuracy of computed tomography, with the additional advantages of avoiding radiation exposure and allowing serial reassessments. These findings reinforce the value of POCUS as a fundamental tool in the initial evaluation of dyspnea.

However, the performance of POCUS depends on operator experience and adherence to standardized protocols. The heterogeneity of the analyzed studies reflects variability in protocols, equipment, and levels of training. Structured training programs and certification are essential to ensure proper interpretation of findings and integration with the clinical context. Despite the demonstrated benefits, conventional imaging methods remain relevant: chest radiography continues to play a complementary role with high specificity, while computed tomography remains the gold standard in complex cases or when ultrasonography is inconclusive. Biomarkers and detailed clinical assessment should always be considered in the differential diagnosis.

CONCLUSION

Point-of-care ultrasonography is a useful tool in the diagnosis of acute dyspnea in adults. It reduces the time to diagnosis and treatment initiation, improves the appropriateness of therapies, and demonstrates high accuracy for pneumonia, cardiogenic pulmonary edema, and pneumothorax. Although there is no robust evidence of mortality reduction, the absence of radiation exposure, immediate availability, and low cost support its incorporation into clinical workflows in emergency departments and intensive care units. To maximize its benefits, investment in professional training and protocol standardization is recommended.

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