COLLEGE OF MEDICINE AND HEALTH SCIENCES DEPARTMENT OF ANESTHESIA AND ANESTHESIOLOGY

PREVALENCE OF IMMEDIATE POSTOPERATIVE HYPERGLYCEMIA AND ITS ASSOCIATED FACTORS AMONG ELECTIVE PEDIATRIC PATIENTS OPERATED IN THE SOUTHERN ETHIOPIA COMPREHENSIVE SPECIALIZED HOSPITALS: A CROSS-SECTIONAL STUDY

BY: MULUALEM BUNARE (MSc candidate in Anesthesia)

A RESEARCH PAPER TO BE SUBMITTED TO HAWASSA UNIVERSITY COLLEGE OF MEDICINE AND HEALTH SCIENCE DEPARTMENT OF ANESTHESIA AND ANESTHESIOLOGY FOR PARTIAL FULFILLMENT OF MASTER's DEGREE IN ADVANCED CLINICAL ANAESTHESIA

JUNE, 2024

HAWASSA, ETHIOPIA

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APPROVAL SHEET-1

This research paper entitled Prevalence of immediate postoperative hyperglycemia and its associated factors among elective pediatric patients operated in southern Ethiopian Comprehensive Specialized Hospitals was prepared and submitted by Mulualem Bunare for partial fulfilment of a Master's degree in advanced clinical Anaesthesia. It was examined and recommended for approval and acceptance by advisors.

Name of advisor Signature Date

1. Dr. Kirubel Tinsae (MD, Assistant professor of Anesthesiology, Critical Care and Pain Medicine) _____ _____

2. Mr. Oliyad Eshetu (BSc, MSc in Clinical Anesthesia)_____ _____

APPROVAL SHEET-2

We, members of the Board of Examiners of the final open defense have read and examined the thesis entitled "prevalence of immediate postoperative hyperglycemia and its associated factors among elective pediatric patients operated in the southern Ethiopia Comprehensive Specialized Hospitals " prepared and submitted by mulualem bunare (MSc Anesthesia student) for partial fulfillment of a master of Science (MSc) degree in clinical anesthesia. This is, therefore, to certify that the thesis has been accepted in partial fulfillment of the requirements for the degree.

Major Advisor	Signature	Date
Internal Examiner-I	Signature	Date
Internal Examiner-II	Signature	Date
External Examiner	Signature	Date
SGS Approval	Signature	Date

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Abbreviations/Acronyms

ASA: American Society of Anesthesiologists

AMI: Acute Myocardial Infarct

BMI: Body Mass Index

CBG: Capillary Blood Glucose

DM: Diabetes Mellitus

EC: Ethiopian Calendar

EMA: European Medicines Agency

FBS: Fasting Blood Sugar

Hga1c: Glycated Hemoglobin

ICU: Intensive Care Unit

PI: Principal Investigator

PACU: Post-Anesthesia Care Unit

SBP: Systolic Blood Pressure

HUCSH: Hawassa University Comprehensive Specialized Hospital

WSUCSH; Wolaita Soddo University Comprehensive Specialized Hospital

WUCSH: Worabe University Comprehensive Specialized Hospital

WHO: World Health Organization

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ABSTRACT

Background: An increase in blood glucose levels immediately after surgery is known as immediate postoperative hyperglycemia, a serious risk for pediatric patients. It is linked to unfavourable results and extended hospital stays. The objective of this study was to assess the prevalence of immediate postoperative hyperglycemia and its associated factors among elective pediatric patients who operated in the southern Ethiopian Comprehensive Specialized Hospitals, 2024 G.C.

Methods: A multi-centre cross-sectional study was conducted among 403 elective surgical pediatric patients in three randomly selected University Comprehensive Specialized Hospitals in southern Ethiopia from February 1 to April 30, 2024. Data were collected using a structured and pretested questionnaire and by reviewing patient charts. Two intern anesthesia students at each site collected data. The primary outcome variable was the prevalence of immediate postoperative hyperglycemia. Data were entered into Epidata version 4.6 and exported to SPSS version 26 for analysis. Binary logistic regression identified factors associated with postoperative hyperglycemia, with multivariable logistic regression using Adjusted Odds Ratios (AOR) and 95% confidence intervals to determine associations and statistical significance at a p-value of less than 5%.

Result: In this study, the prevalence of immediate postoperative hyperglycemia was found to be 35.7%, 95% CI (31.3-40.8). Neonates (AOR: 4, 95% CI; 1.3-12.9), infants (AOR: 3.4, 95% CI; 1.2-9.76), toddlers (AOR: 3.73, 95% CI; 1.29-10.76), early childhood (AOR: 4.02, 95% CI; 1.47-10.96), general (AOR: 7, 95% CI; 2.4 -20) and regional anaesthesia (AOR 5, 95% CI 1.7-19.5), intraoperative dexamethasone (AOR 3.0, 95% CI 1.65-5.46), dextrose solutions (AOR 3.33, 95% CI 1.67-6.65), and neurosurgical (AOR 3.68, 95% CI 1.19-11.33) and general surgery (AOR 3.66, 95% CI 1.24-10.84) were significantly associated to postop hyperglycemia.

Conclusion: The prevalence of immediate postoperative hyperglycemia was 35.7% (95% CI: 31.3-40.8).

Recommendations: vigilant glucose monitoring in high-risk pediatric patients post-surgery. Future research should focus on longitudinal studies and interventions to prevent hyperglycemia.

Keywords: Immediate, Postoperative, Hyperglycemia, Pediatric, Elective, Surgical Patients, Prevalence, Associated factors

INTRODUCTION

1.1 Background

Hyperglycemia, or elevated blood glucose levels, occurs when insulin production is insufficient or cells are resistant to insulin. During stress, such as surgery, the hypothalamic-pituitary-adrenal (HPA) axis activates, releasing cortisol and catecholamines. These hormones increase glucose production in the liver and induce insulin resistance, reducing cellular glucose uptake. Additionally, stress and inflammation can impair insulin secretion. These processes collectively lead to postoperative hyperglycemia, which can negatively impact recovery by increasing infection risk and prolonging hospital stays.(1)

The European Medicines Agency (EMA) defines the pediatric population as individuals from birth to less than 18 years old(2). Pediatrics categorized as term neonatal (Birth– 27 days), Infancy (28 d–12 months), Toddler (13 months–2 years), Early childhood (2–5 years), Middle childhood(6–11 years), Adolescence (12–18 y) (3-5). These age categories help healthcare providers in modifying care according to the developmental stages of children and adolescents. Normal glucose reference ranges for Pediatrics are neonate, 30-60 mg/dl or 1.7-3.3 mmol/l; infant, 40-90 mg/dl or 2.2-5.0 mmol/l; child under 2 years, 60-100 mg/dl or 3.3-5.5 mmol/l; and adult, 74-106 mg/dl or 4.1-5.9 mmol/l(6, 7).

The immediate postoperative period is the period from the patient's admission to the postoperative care unit until the nurse takes the patient's first vital signs and blood glucose levels (8, 9). Immediate postoperative hyperglycemia is associated with an increased risk of renal failure, infection, and prolonged hospital stays. Effective care is necessary to improve patient outcomes(10, 11). Studies have indicated a clear association between elevated blood sugar levels and worse outcomes in several clinical scenarios, such as sepsis, heart surgery, and traumatic brain injury (12).

In pediatrics, postoperative hyperglycemia is linked to adverse events. Complications include prolonged intubation, extended ICU stays, and adverse outcomes, including increased postoperative complications, hospital stay, medical expenses, and perioperative mortality. Effective management of hyperglycemia in pediatric patients is essential and has demonstrated lower mean postoperative glucose levels and reduced complications, with studies demonstrating the efficacy and safety of insulin therapy protocols in improving outcomes (12, 13).

1.2 Statement of the Problem:

Children are more vulnerable to hyperglycemia due to higher metabolic rates, immature metabolic systems, pronounced stress responses, smaller glycogen stores, and variable insulin sensitivity, all contributing to fluctuations and instability in blood glucose levels during and after surgery(14).

Children undergoing surgery may be at risk for complications related to pediatric immediate postoperative hyperglycemia, a complicated and poorly understood condition. After surgical procedures, the incidence among neonates might reach 54% (15). Studies show a clear association between postoperative hyperglycemia and worse outcomes in some clinical settings, including cardiac surgery, traumatic brain injury, and septic shock(12).

Postoperative hyperglycemia in pediatric surgical patients has been linked to adverse outcomes such as prolonged hospital stays, increased infection risk, and delayed wound healing, and may also affect cognitive development highlighting the significant impact of this medical condition. Postoperative hyperglycemia in pediatric patients poses a risk to overall health and long-term rehabilitation(16).

Through inducing pro-inflammatory events, aggravating ischemic brain injury, raising the risk of thrombosis, increasing oxidative stress through lipid peroxidation, compromising immune function by reducing neutrophil phagocytic activity and oxidative burst of leukocytes, and especially in patients with traumatic brain injury or stroke, hyperglycemia can exacerbate underlying illnesses(17).

Postoperative hyperglycemia in pediatric patients after surgery is associated with prolonged intubation and increased ICU hospitalization, implying potential consequences for long-term recovery. Furthermore, severe hyperglycemia is independently linked to higher morbidity and mortality rates in pediatric surgical patients, indicating potential long-term implications for overall health and well-being(18).

1.3 Justification of Study

Because it significantly affects the outcome of pediatric surgical procedures, research on immediate postoperative hyperglycemia in pediatric patients is essential. There is a significant information gap about the prevalence of this medical condition, its underlying causes, and its overall influence on the short and long-term outcomes of pediatric surgical patients (12, 15).

Particular attention must be paid to this population because pediatric patients have unique physiological and developmental traits that may affect how hyperglycemia manifests and determine its consequences. For pediatric postoperative hyperglycemia, personalized care plans and targeted therapy require the identification of modifiable risk variables. A thorough investigation into the prevalence and risk factors of pediatric postoperative hyperglycemia can inform the development of evidence-based perioperative care protocols, leading to improved patient outcomes (15).

Examining the association between comorbidities and hyperglycemia is essential for risk assessment and the establishment of focused treatment plans. Due to the possibility of altered glucose metabolism from the anaesthetics commonly used in pediatric procedures, anaesthesia and surgical teams need to collaborate in a multidisciplinary approach. More investigation is needed into the complex association between anaesthetic drugs, surgical factors, perioperative glucose supplementation, and pediatric postoperative hyperglycemia(19).

According to studies, a significant number of children had an increase in blood sugar following surgery. This emphasizes how important it is to monitor blood glucose levels constantly during the perioperative period. Over time, children's regular usage of glucose-containing intraoperative fluids has decreased, most likely as a result of stress-induced hyperglycemia and insulin resistance. To create evidence-based perioperative treatment plans, however, more research is necessary to precisely determine the effect of various glucose-containing fluids, such as 40% glucose, on the postoperative hyperglycemia of pediatric patients (19-21). Therefore, the aim of this study was to assess the prevalence of immediate postoperative hyperglycemia and its associated factors among elective pediatric patients operated in the Southern Ethiopian Comprehensive Specialized Hospitals, in 2024.

Literature Review

2.1. Prevalence of immediate postoperative hyperglycemia among pediatric surgical patients

Pediatric immediate postoperative hyperglycemia is a prevalent and concerning issue. Studies have shown that it affects estimates ranging from 52% to as high as 90%. According to the study by Mekitarian Filho et al, which was conducted in Santa Catarina Hospital, Sao Paulo, Brazil, in 2011 the prevalence of postoperative hyperglycemia was 62.6% (12). A study by Yang Wu et al. at Sichuan University in Chengdu, China, in 2013 found that approximately 64.8% of children experienced postoperative hyperglycemia (22). Another study in Rotterdam, Netherlands by Verhoeven et al reported hyperglycemia in 52% of children after surgery (18). Also Study in Toronto, Ontario, Canada by Moga et al demonstrated postoperative hyperglycemia in 90% of their study patients (15).

2.2 Factors associated with immediate postoperative hyperglycemia among pediatric surgical patients

The relevance of age as an independent variable of the relationship between hyperglycemia and worse outcomes following surgery was emphasized in a 2011 research by Moga MA et al. The study's findings emphasize the role of age on the consequences of immediate postoperative hyperglycemia (15). In a 2015 study, Krueger J et al assessed the effect of postoperative hyperglycemia on children who underwent surgery for congenital heart disease. this study showed Age and developmental characteristics can have an impact on the long-term consequences of hyperglycemia (20).

Alaei F et al. (2012) conducted a prospective cohort study to assess the morbidity and mortality among pediatric patients who developed hyperglycemia after surgery. The results of the study indicated a strong link between severe hyperglycemia and higher rates of morbidity and mortality, suggesting that hyperglycemia may have an impact on postoperative outcomes. Depending on the patient's age and level of hyperglycemia, these associations might change(18).

According to a study by Mekitarian Filho et al., which was conducted in Santa Catarina Hospital, Sao Paulo, Brazil, in 2011 hyperglycemia after neurosurgery occurred in 62.6% of patients, particularly in procedures like craniosynostosis, supratentorial tumour resection, and craniotomies, characterized by longer durations and higher complication rates (12). In a study by Yang Wu et al.

at Sichuan University in Chengdu, China, in 2013 after abdominal surgery, approximately 64.8% of children in the PACU experienced hyperglycemia, impacting length of stay and wound infection rates (22).

Surgery lasting more than an hour was linked to a 3.9-fold higher incidence of postoperative hyperglycemia, according to research done in 2022 by Desalegn M et al. This shows that longer surgical durations are associated with a greater incidence of postoperative hyperglycemia. So, during surgery, careful blood glucose monitoring and management are crucial, especially for longer procedures (8).

In an article authored by Duggan EW et al in 2017, the influence of anaesthesia type on the hyperglycemic response during surgery is discussed. It is noted that general anaesthesia is more commonly associated with hyperglycemia and elevated levels of cortisol and glucagon compared to local or epidural anaesthesia (10).In a study by Desalegn M et al published in 2022, it was found that patients who underwent general anaesthesia were 5.8 times more likely to develop postoperative hyperglycemia than those who underwent regional anaesthesia (8). A study done at the University of Kentucky, USA by Prerna Dogra et al 2024 emphasizes that the severity of hyperglycemia depends on the type of anaesthesia and surgery, with increased glucose elevations seen in cases of general anaesthesia or thoracic/abdominal surgeries(23).

A prospective observational study in Bangkok, Thailand by Varunya et al in 2022 reported that intraoperative blood transfusion was identified as an independent risk factor for intraoperative hyperglycemia (24). A prospective observational study in 2019 from Singapore by Vikaesh Moorthy et al identified intraoperative blood transfusion as an independent risk factor for postoperative hyperglycemia. The study also highlighted the association between postoperative hyperglycemia and adverse outcomes such as cardiac arrhythmias, acute kidney injury, and prolonged hospitalization (25).

The use of dexamethasone during surgery is associated with an increased risk of postoperative hyperglycemia in pediatric patients. Studies by O'Connell RS et al 2018, and Bonilla JLet al 2022 have shown higher incidence rates in patients who received dexamethasone, both in the first 24 and 72 hours after surgery. Diabetic patients receiving dexamethasone perioperatively also exhibit a heightened likelihood of developing postoperative hyperglycemia (26, 27).

According to a study in Atlanta, USA by Scott E Kolesky et al 2020, a retrospective observational study the concentration and rate of dextrose administration during surgery impact the prevalence of hyperglycemia, with higher concentrations and rates correlating with an increased risk. Adjustments in preoperative dextrose rates have been linked to changes in postoperative hyperglycemia rates in neonates that halving the preoperative dextrose rate was associated with decreased postoperative hyperglycemia in pediatric patients undergoing exploratory laparotomies (28).

A study in 2017 by Duggan EW from Atlanta, Georgia, found that intraoperative hyperglycemia was reported by twenty to forty percent of patients after general surgery. An extended hospital stay, a higher risk of surgical infections, and even mortality have all been linked to this condition. The impact of anaesthetic type, length of operation, and patient characteristics on the incidence of hyperglycemia during and after surgery were also highlighted in the study (10).

A prospective observational study in Bangkok, Thailand by Varunya Sermkasemsin et al 2022 reported that intraoperative hyperglycemia was associated with multiple postoperative complications, including surgical site infection, myocardial infarction, and stroke. The study identified independent risk factors for intraoperative hyperglycemia, including intraoperative vasopressor use. These findings suggest that the management of intraoperative vasopressor use may impact the incidence of postoperative hyperglycemia (24).

According to a study conducted in Seoul, Korea by Sojin Kim et al. in 2021, intraoperative hyperglycemia was linked to a higher risk of myocardial infarction following surgery (29). Moreover, Sermkasemsin et al showed that a length of anaesthesia of > 3 hours was found to be an independent risk factor for intraoperative hyperglycemia in patients(24). Intraoperative hyperglycemia may be caused by surgical variables such as blood loss and the length of anaesthesia. It requires more investigation to be managed successfully. Overall, the type of surgery, patient age, specifics of the procedure, the use of dexamethasone, and the pace of dextrose delivery all affect pediatric postoperative hyperglycemia. Understanding these variables is essential for managing and regulating their influence on results.

Conceptual framework ((8, 10, 12, 15, 20))

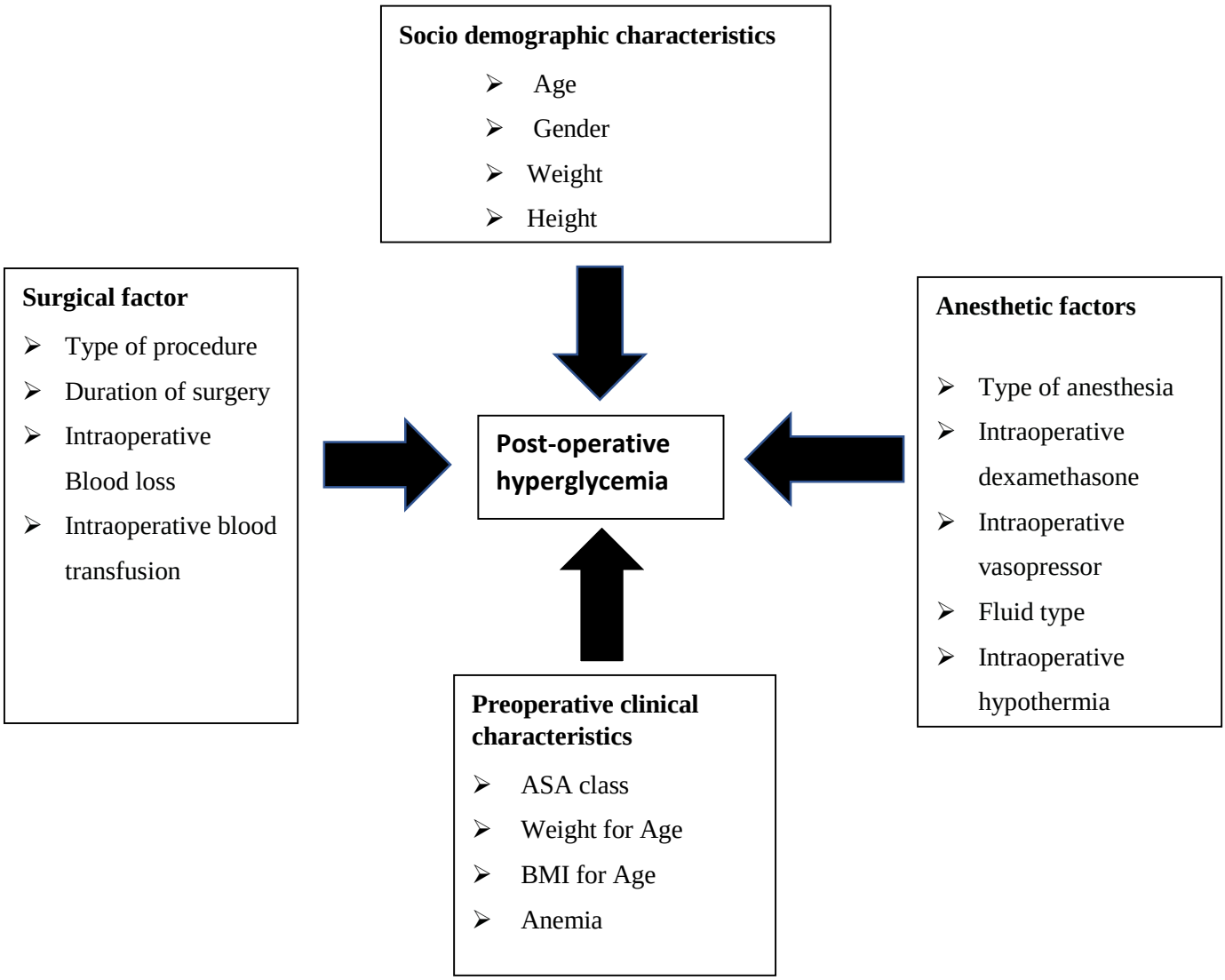

Figure 1. The conceptual framework developed by an exhaustive search of the literature

OBJECTIVES OF THE STUDY

3.1 General Objective

To assess the prevalence of immediate postoperative hyperglycemia and its associated factors among elective pediatric patients operated in southern Ethiopia Comprehensive Specialized Hospitals, Ethiopia, 2024

3.2 Specific Objectives

1. To determine the prevalence of immediate postoperative hyperglycemia among elective pediatric patients operated in southern Ethiopia Comprehensive Specialized Hospitals, Ethiopia, 2024
2. To identify the factors associated with immediate postoperative hyperglycemia among elective pediatric patients operated in southern Ethiopia Comprehensive Specialized Hospitals, Ethiopia, 2024

Methods and Materials

4.1 Study Area and Period

The study was conducted in southern Ethiopia's randomly selected (with lottery method) three from five University Comprehensive Specialized Hospitals from February 1 to April 30, 2024, G.C. Hawassa University Comprehensive Specialized Hospital (HUCSH), Wolaita Sodo University Comprehensive Specialized Hospital and Worabe University Comprehensive Specialized Hospital were the selected sites. Hawassa University Comprehensive Specialized Hospital (HUCSH) in Hawassa is located 273km south of Addis Ababa city and it is one of the biggest government hospitals in Ethiopia serving as a catchment area of 18 million people with 400 beds and 10 operation rooms, offering specialized services serving as a teaching and referral hospital since 2005 E.C (30). Wolaita Sodo University Comprehensive Specialized Hospital, situated 165 km east of Hawassa, features 350 beds. It offers a wide range of medical services to both in and out-patients of all ages in its roughly two million-person catchment area (31). Worabe University Comprehensive Specialized Hospital is located at Worabe town, the capital of Silte zone in SNNPR, located 147 km from Hawasa with a population of 29,600, including 4618 under-five children (32)

4.2 Study Design

Multicenter cross-sectional study

4.3 Study Population

4.3.1 Source Population:

All elective pediatric patients operated in the southern Ethiopia comprehensive specialized hospitals.

4.3.2 Study Population:

All pediatric patients who underwent elective surgery in the selected southern Ethiopia comprehensive specialized hospitals during data collection.

4.3.3 Study participants

Every pediatric surgical patient was a member of the study population and data was obtained from the selected hospitals during the data collection period.

4.4 Inclusion and Exclusion Criteria:

4.4.1 Inclusion Criteria:

Pediatric patients up to 18 years old.

Elective cases among pediatric surgical patients.

4.4.2 Exclusion Criteria:

Patients with baseline hyperglycemia or hypoglycemia.

Patients with a history of Diabetes mellitus

4.5 Sample Size and Sampling Technique:

The sample size for the study was determined using the single population proportion method. Due to the lack of related studies globally, a conservative approach was taken with P=0.5 to maximize variability. The calculation was based on a 95% confidence level, a 5% margin of error, and an additional 5% for incomplete or contingency data. This ensures a robust sample size estimation for assessing postoperative hyperglycemia after elective surgery.

$$n = \frac{(z\alpha \therefore 2)^2 \times (p \times q)}{d^2}$$

$$n = \frac{1.962^2 \times (0.5 \times 0.5)}{0.05x0.05}$$

n =384

Adding 5 % contingency n= **403**

The situational analysis revealed that in the past three months, the respective totals from the surgery logbooks of HUCSH, WSUCSH, and WUCSH are **350, 240, and 210.**

Ultimately, the sample size is proportionally distributed among the hospitals, considering their average three-month reports. With a total of **800** elective pediatric surgeries conducted across these hospitals, and a calculated sample size of **403**, the proportional allocation is determined. The distribution is as follows: **176 in HUCSH, 121 in WSUCRH, and 106 in WUCSH, ensuring a representative and balanced sampling approach.**

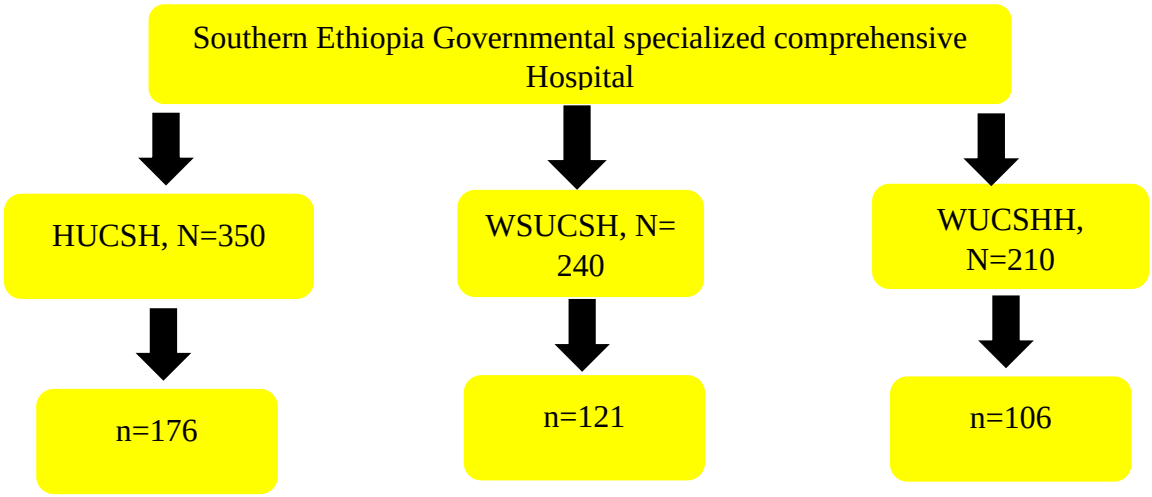

Figure 2**:** Proportional allocation for sample size

4.5.1 Sampling Technique:

The **interval (k)** is determined as the ratio of total pediatric surgeries in the last three months **(N = 800) to the sample size (n = 403),** resulting in a value of approximately **1.99 (rounded to 2).** The first study participant was selected by simple random sampling from the first two patients. Then, the study participants were selected by using systematic random sampling until the required sample size was achieved.

4.6 Study Variables:

4.6.1 Dependent Variable:

Post-operative hyperglycemia.

4.6.2 Independent Variables:

Socio-demographic factors such as age, gender, weight, height.

Anaesthetic Factors such as type of anaesthesia, intraoperative dexamethasone, intraoperative hypothermia, intraoperative vasopressor, and fluid types.

Preoperative Clinical Characteristics such as ASA class, BMI (Body Mass Index), and anaemia.

Surgical Factors such as type of procedure, duration of surgery, intraoperative blood loss, and intraoperative blood transfusion.

4.7 Data collection tools and techniques

Data was collected using a structured, pretested standardized questionnaire and by reviewing patients' cards. Data collectors were two intern anaesthesia students at each site. The data collection period spans from February 01 to April 30, 2024. The questionnaire covers sections on socio-demographic data including age, gender, and weight. The preoperative factors including ASA class, BMI for Age, Weight for Age and anaemia were reviewed from the patient chart and recorded. Intraoperative anaesthesia and surgical data such as type of anaesthesia, intraoperative dexamethasone, intraoperative blood transfusion, intraoperative vasopressor, intraoperative dextrose, type of procedure, duration of surgery, intraoperative hypothermia, and intraoperative blood loss were derived from the intraoperative anaesthesia chart. Two intern anaesthesia students at each site conducted data collection on the morning of surgery, during the intraoperative period, and immediately after surgery at the Post-Anesthesia Care Unit (PACU). Upon the patient's transfer to the PACU, the data collector recorded the fasting blood glucose level, measured by the PACU nurse using a glucometer. The completeness of data was checked by 3 supervisors one for each site daily, ensuring the accuracy and reliability of the collected information.

4.8. Data Processing and Analysis

The collected data underwent a systematic process to ensure accuracy and completeness. Before coding was applied, checks for errors and missing data were conducted. Data were entered into Epidata version 4.6 and exported to SPSS version 26 for data analysis. Data were summarized by using frequency and percentage and presented by using bar and pie charts. Binary logistic regression was conducted to identify the factors associated with postoperative hyperglycemia. Bivariable logistic regression was conducted to select the candidate variables for multivariable logistic regression and to see the crude association. Variables with a p-value of less than 25% in the bivariate logistic regression were entered into the multivariable logistic regression. Before fitting into the final model, the goodness of fit test was checked by Hosmer and Lemeshow test, and multicollinearity was checked by the Variance inflation factor and Tolerance test. Multivariable logistic regression analyses were conducted to explore independent factors associated with postoperative hyperglycemia and to control confounders. In the final model, Adjusted Odds Ratios (AOR) and 95% confidence intervals were used to determine the presence of association and statistical significance at a p-value of less than 5%.

4.9. Data Quality Control

Data were collected using a pretested structured questionnaire with multiple choices and open-ended questions on respondents' socio-demographic characteristics, and preoperative and intraoperative variables. To ensure the quality of the data, a pretest was done at Wachamo University Comprehensive Specialized Teaching Hospital and the data collection tool (questionnaire) was tested on 5% of pediatric patients. The Cronbach's alpha value was 0.82 (82%). Then, possible amendments were made. Regular supervision and follow-up were made during data collection. In case of missed measurement during the intra-operative period, electronic data stores were recalled and back traced and data was filled. The data collectors were instructed to write card numbers on the questionnaire during the data collection if further cross-checking is needed. After the questionnaire was checked manually for completeness and coded, data were entered into Epidata statistical software (version 4.6.0.) and exported to SPSS Windows statistical software (version 26.0) for data processing and performing other statistical analyses.

4.10 Ethical approval

An ethical clearance to conduct this study was obtained from Hawassa University's institutional review board (IRB). After the aim and benefits of the study were explained, written informed consent was obtained from each family member, relative and legal guardian. The confidentiality of the participants was maintained.

4.11 Dissemination plan

The research will be submitted to Hawassa University Comprehensive Specialized Hospital (HUCSH). The findings will be presented to the Department of Anesthesia as part of the MSc. in Advanced Clinical Anaesthesia thesis. Additionally, efforts will be undertaken to publish the study's results.

4.12 Operational Definitions:

Paediatrics: every human being below the age of 18 years (2, 33, 34)

Hyperglycemia: a blood sugar level higher than the normal range.

The normal **glucose reference ranges** are as below (6).

Table 1 which shows normal glucose reference ranges

Age Groups (3-5)	**Normal Range, Hyperglycemia** (6, 7)
Neonatal (1-2 months)	30-60 mg/dL , > 60 mg/dL
Infancy (2-6 months)	40-90 mg/dL , > 90 mg/dL
Toddlers (6 - 24 months)	60-100 mg/d L ,> 100 mg/dL
Early Childhood (2-72 months)	60-100 mg/dL, > 100 mg/dL
Middle Childhood (6-144 months)	60-100 mg/dL, > 100 mg/dL
Adolescence (12-216 months)	74-106 mg/dL, > 106 mg/dL

ASA status: This is a surgical risk stratification validated by the American Society of Anesthesiologists; described in annex (23).

Elective surgery: Non-emergency surgery which is planned, allowing the doctor and the patient the best time and place for it (35).

Preoperative: The time that extends from the decision to have surgery to the induction of anaesthesia (36).

Postoperative: Period after the patient is transferred to PACU (37).

Hypothermia: Core body temperature below 36 degrees Celsius (38).

Anaemia in paediatrics: Pediatric anaemia is characterized by low levels of haemoglobin in children's blood, leading to symptoms like fatigue and pale skin.

The normal haemoglobin reference ranges for pediatric patients are as follows

Table 2 which shows hemoglobin level reference ranges

Age Group	**Hemoglobin Level (g/dL)** (46, 47)
Neonates (up to 1 month)	13.5 - 24.0
Infants (1-2 months)	9.5 - 13.5
Infants (2-6 months)	9.5 - 14.0
Children (6 months - 24 months)	9.5 - 14.0
Children (2-72 months)	10.5 - 14.5
Children (6-144 months)	11.5 - 15.5
Adolescents (12-216 months)	12.0 - 16.0

Mild anaemia in children aged 1 month to 5 years is indicated by haemoglobin levels of 10-10.9 g/dL, while severe anemia is below 7 g/dL(39).

Mildanaemiaa in children aged 5-14 years has a haemoglobin level of 11-11.4 g/dL, and severe anaemia is less than 8 g/dL(40).

Immediate postoperative period: The time that extends from patient admission to PACU until the first vital sign and blood glucose level is taken by a nurse(8, 9).

Duration of surgery: The time that extends from surgical incision to end of surgery (skin closure) (41).

Results

5.1 Socio-demographic characteristics of study participants

A total of 403 pediatric patients were included in the study making a 100% response rate. Nearly two-thirds (62.8%)of the participants were male and the remaining were females. Regarding the age of the study participants, one-fourth (25.3%), of the groups were adolescents, followed by middle childhood (21.8%), early childhood (14.4%), infancy (14.6%), toddlers (12.7%), and neonatal (11.2%) (Table 3).

Table 3 A Cross-Tabulation of the Socio-demographic characteristics among elective pediatric patients operated in three randomly selected southern Ethiopian Comprehensive Specialized Hospitals, 2024 (n=403)

Variables	**Categories**	**Frequency (%)**	**Hyperglycemia (%)**	
			Yes(n=144)	No (n=259)
			144 (35.7%)	259 (64.3%)
Gender	Male	253(62.8)	81 (32)	172 (68)
	Female	150(37.2)	63 (42)	87 (58)
Age	Neonatal	45(11.2)	29 (64.4)	15 (34.1)
	Infancy	59(14.6)	31 (52.5)	34 (44.7)
	Toddlers	51(12.7)	25 (49)	26 (50)
	Early Childhood	58(14.4)	31 (53.4)	24 (41.4)
	Middle Childhood	88(21.8)	12 (13.6)	78 (98.7)
	Adolescence	102(25.3)	16 (15.7)	86 (84.3)
Weight-for-Age Percentiles (0-2 years)	Underweight	29 (19.6%)	20 (13.5)	9 (6)
	Normal	98 (66.2)	27 (18.2)	71 (48)
	Overweight	20 (13.5)	8 (5.2)	12 (8.3)
	Obesity	1 (0.7)	1 (0.7)	0 (0)
BMI-for-age percentiles (> 3years)	Underweight	48 (18.8)	13(5)	35(13.7)
	Healthy Weight	130 (51.0)	50(19.6)	80(31.4)
	Overweight	56 (22.0)	17(6.6)	39(15.3)
	Obesity	21 (8.2)	8(3)	13(4.8)

In the neonatal stage, 64.4% were associated with immediate postoperative hyperglycemia and during infancy, 52.5% were associated with immediate postoperative hyperglycemia. For toddlers, 49% were associated with immediate postoperative hyperglycemia. In early childhood, 53.4% is associated with immediate postoperative hyperglycemia. In middle childhood 12 (13.6%) were associated with immediate postoperative hyperglycemia lastly, adolescence had 16 (15.7%) associated with immediate postoperative hyperglycemia (Table 3).

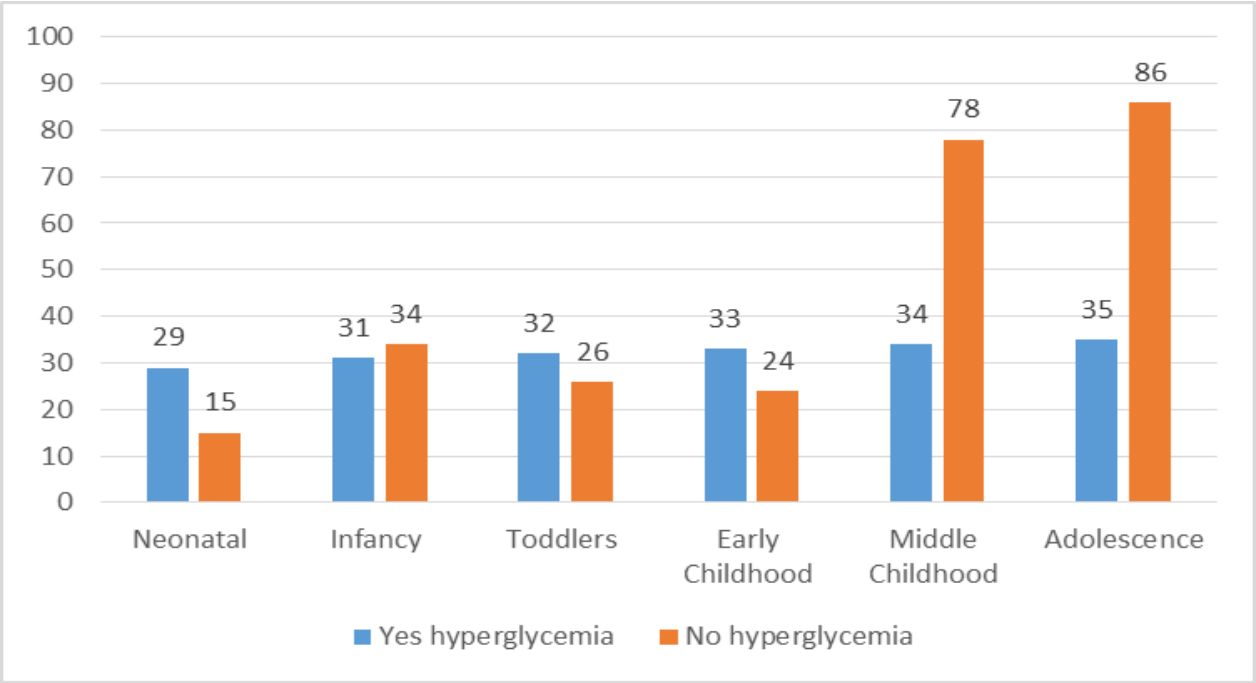

Figure 3 Distribution of age groups with immediate postoperative hyperglycemia among elective pediatric patients operated in three randomly selected southern Ethiopian Comprehensive Specialized Hospitals, 2024.

5.2 Preoperative Factors

Among participants, the majority, accounting for more than half (62.8%), were classified as Class I in terms of ASA status, followed by 125 (31%) in Class II and 25 (6.2%) in Class III. Regarding anaemia, 88 (21.8%) were anaemic. Concerning preoperative fasting time in hours, 58 participants (14.4%) fasted for over 2 hours, 137 (34.0%) for over 4 hours, 118 (29.3%) for over 6 hours, and 90 (22.3%) for over 8 hours (Table 3).

Table 4 A Cross-Tabulation of the preoperative factors among elective pediatric patients operated in three randomly selected southern Ethiopian Comprehensive Specialized Hospitals, 2024 (n=403)

Variables	**Categories**	**Frequency (%)**	**Hyperglycemia (%)**	
			Yes(n=144)	No (n=259)
			144 (35.7%)	25(64.3%)
ASA status	Class I	253 **(**62.8**%)**	(76, 21.7%)	(177, 50.6%)
	Class II	125 **(**31**%)**	(59, 16.9%)	(66, 18.9%)
	Class III	25 **(**6.2**%)**	(9, 2.6%)	(16, 4.6%)
Anemia	Yes	88**(**21.8**%)**	(33, 9.5%)	(55, 15.7%)
	No	315**(**78.2**%)**	(111, 31.8%)	(204, 58.3%)
Preoperative fasting time (in hrs.)?	>2 hours	90**(**22.3**%)**	(32, 9.2%)	(58, 16.6%)
	>4 hours	137**(**34.0**%)**	(48, 13.7%)	(89, 25.4%)
	>6 hours	118**(**29.3**%)**	(46, 13.2%)	(72, 20.6%)
	>8 hours	58**(**14.4**%)**	(18, 5.2%)	(40, 11.4%)

5.3 Anesthetic characteristics of patients

In terms of the type of anaesthesia administered, the majority, more than half (61.3%) of participants received general anaesthesia, followed by 104 (25.8%) under regional anaesthesia, and 52 (12.9%) under combined anaesthesia. During the intraoperative period, more than half (60.5%) received intraoperative dexamethasone. Regarding the use of intraoperative vasopressor, 75 (18.6%) received vasopressor. In terms of the type of intraoperative fluid administered, the majority (53.6%) received normal saline, followed by 109 (27.0%) receiving dextrose-containing fluid, and 78 (19.4%) received other types of fluid like ringer lactate and mannitol (Table 5).

Table 5. A Cross-Tabulation of the Anesthetic characteristics among elective pediatric patients operated in three randomly selected southern Ethiopian Comprehensive Specialized Hospitals, 2024. (n=403)

Variables	Categories	Frequency (%)	Hyperglycemia n(%)	
			Yes(n=144)	No (n=259)
			144 (35.7%)	25(64.3%)
Type of anaesthesia	Combined	52 (12.9%)	9 (17.3%)	43 (82.7%)
	Regional	104 (25.8%)	30 (28.8%)	74 (71.2%)
	General	247 (61.3%)	105(42.5%)	142(57.5%)
Intraoperative Dexamethasone	Yes	244(60.5%)	108(44.3%)	136 (55.7%)
	No	159(39.5%)	36(22.6%)	123(77.4%)
Intraoperative Vasopressor	Yes	75 (18.6%)	41 (54.7%)	34 (45.3%)
	No	328 (81.4%)	103(31.4%)	225 (68.6%)
Intraoperative fluid type	Normal Saline	216 (53.6%)	57(52.3%)	52(47.7%)
	Dextrose-containing	109 (27.0%)	57(52.3%)	52(47.7%)
	Others	78 (19.4%)	57(52.3%)	52(47.7%)

5.4 surgical characteristics of patients

In terms of Type of Procedure, in the general surgery category, there were 83 (20.6%) procedures, with 63.9% associated with hyperglycemia. In the Orthopedic category, 84 (20.8%) procedures were performed, with 11 (13.1%) associated with hyperglycemia. Neuro procedures counted 64 (15.9%), with 57.8% associated with immediate postoperative hyperglycemia. Other procedures like plastic, cardiothoracic, and urological accounted for 46 (11.4%), with 9 (19.6%) associated with immediate postoperative hyperglycemia.

Intraoperative Blood Transfusion was administered in 134 (33.3%) cases, with 41.0% of this associated with immediate postoperative hyperglycemia (Table 6).

Table 6 A Cross-Tabulation of the surgical characteristics among elective pediatric patients operated in three randomly selected southern Ethiopian Comprehensive Specialized Hospitals, 2024. (n=403)

Variables	Categories	Frequency (n) (%)	Hyperglycemia n(%)	
			Yes(n=144)	No (n=259)
			144 (35.7%)	25(64.3%)
Type of Procedure	Orthopedic	84(20.8%)	11 (13.1%)	73 (86.9%)
	General	83(20.6%)	53 (63.9%)	30 (36.1%)
	EENT	55(13.6%)	12 (21.8%)	43 (78.2%)
	Ophta	71(17.6%)	22 (31.0%)	49 (69.0%)
	Neuro	64(15.9%)	37 (57.8%)	27 (42.2%)
	Other	46(11.4%)	9 (19.6%)	37 (80.4%)
Intraoperative Blood Loss	Mild	198(49.1%)	63(15.6%)	135 (33.4%)
	Moderate	183(45.4%)	74(18.4%)	109 (27%)
	Severe	22(5.5%)	7(1.75%)	15 (3.75%)
Intraoperative Blood Transfusion	Yes	134(33.3%)	55 (41.0%)	79 (59.0%)
	No	269(66.7%)	89 (33.1%)	9 (41.5%)
Intraoperative Hypothermia	Yes	120 (29.8%)	54 (45.0%)	66 (55.0%)
	No	283(70.2%)	90 (31.8%)	193 (68.2%)
Duration of surgery	Short	87(21.6%)	31(35.6%)	56(64.4%)
	Moderate	228(56.6%)	68(30.0%)	159(70.0%)
	Long	88(21.8%)	50 (51.0%)	43(48.9%)

Intraoperative Hypothermia occurred in 120 (29.8%) cases, with 54 (45.0%) associated with immediate postoperative hyperglycemia. Regarding the duration of surgery, short surgeries were reported in 87 (21.6%) cases, with 31 (35.6%) associated with hyperglycemia. Moderate surgeries were performed in 228 (56.6%) cases, with 68 (30.0%) associated with immediate postoperative

hyperglycemia. Long surgeries were conducted in 88 (21.8%) cases, with 50 (51.0%) associated with immediate postoperative hyperglycemia. (Table 6).

Prevalence of immediate postoperative hyperglycemia

In the present study, the prevalence of immediate postoperative hyperglycemia among the study participants is 35.7%, 95% CI (31.3-40.8) (Figure 4) with 32% of them being male and 63% of them being female.

In the neonatal stage, 64.4% were associated with immediate postoperative hyperglycemia and during infancy, 52.5% were associated with hyperglycemia. For toddlers, 49% are associated with hyperglycemia. Early childhood is 53.4% associated with hyperglycemia. In middle childhood 12 (13.6%) were associated with hyperglycemia lastly, adolescence had 16 (15.7%) were associated with immediate postoperative hyperglycemia (Table 3).

Among General anaesthesia cases, 42.5% were associated with Hyperglycemia. From Regional 30 (28.8%) associated with Hyperglycemia. And from combined anaesthesia cases, 9 (17.3%) were associated with immediate postoperative hyperglycemia. According to Intraoperative dexamethasone, 44.3% is associated with Hyperglycemia. For Intraoperative Vasopressor usage 54.7% associated with Hyperglycemia. Regarding Intraoperative fluid type dextrose-containing fluid was 52.3% associated with Hyperglycemia. From types of procedures general surgery was 63.9% associated with Hyperglycemia and Neuro procedures with 57.8% associated with immediate postoperative hyperglycemia.

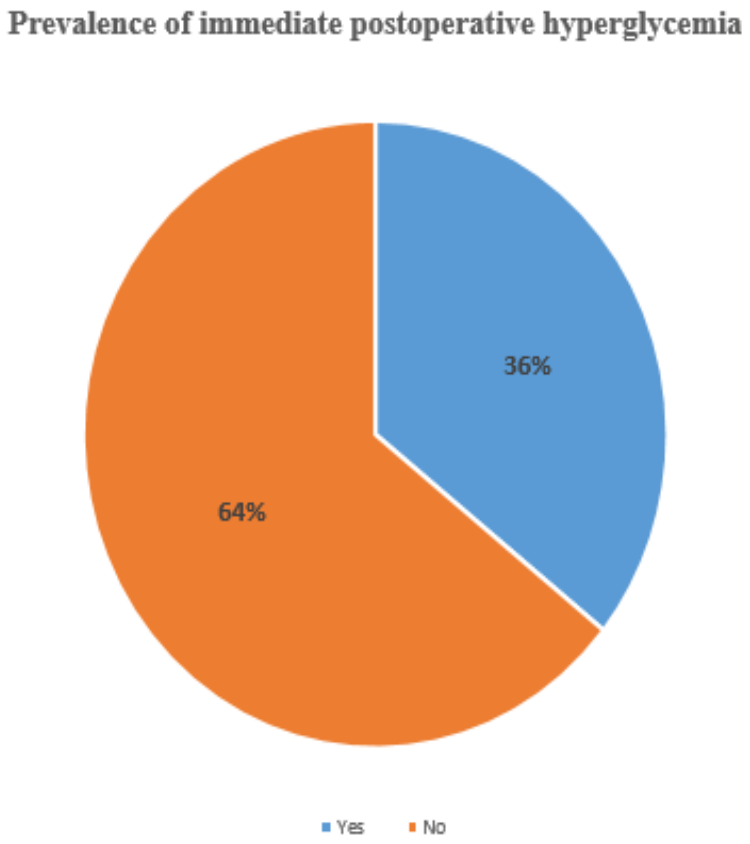

Figure 4: Prevalence of immediate postoperative hyperglycemia among elective pediatric patients operated in three randomly selected southern Ethiopian Comprehensive Specialized Hospitals, 2024

5.4. Factors associated with immediate postoperative hyperglycemia among elective pediatric patients operated in three randomly selected southern Ethiopian Comprehensive Specialized Hospitals

5.4.1. Results of bivariable Logistic Regression of factors associated with immediate postoperative hyperglycemia among elective pediatric patients operated in three randomly selected southern Ethiopian Comprehensive Specialized Hospitals

Bivariate logistic regression was conducted to select the candidate variables for multivariable logistic regression and to see the crude association. Accordingly, gender, age groups, ASA Class, Type of Anesthesia, Intraoperative Factors, Fluid Type, Type of Procedure, and Duration of Surgery were associated with immediate postoperative hyperglycemia at a p-value of less than 25% and inserted into the multivariable logistic regression (Table 5).

Table 7. Results of bivariable logistic regression of factors associated with immediate postoperative hyperglycemia among elective pediatric patients operated in the three randomly selected southern Ethiopian Comprehensive Specialized Hospitals, 2024. (n=403)

Variables	**Category**	**Hyperglycemia n(%)**		**COR (95% CI)**	**P-value**
		Yes(n=144)	**No (n=259)**		
		144 (35.7%)	**25(64.3%)**		
Gender	Male	81 (32.0%)	172 (68.0%)	0.65 (0.428 - 0.988)	0.044
	Female	63 (42.0%)	87 (58.0%)	1	
Age	Neonates	29 (64.4%)	15 (34.1%)	9.74 (0.33 - 21.916)	**0.000**
	Infants	31 (52.5%)	34 (44.7%)	5.95 (2.84 -12.458)	**0.000**
	Toddlers	25 (49.0%)	26 (50.0%)	5.168 (2.40 -11.113)	**0.000**
	Early Childhood	31 (53.4%)	24 (41.4%)	6.171 (2.938 -12.96)	**0.000**
	Middle Childhood	12 (13.6%)	78 (98.7%)	0.849(0.378−1.907)	0.691
	Adolescenc	16 (15.7%)	86 (84.3%)	1	
ASA Class	Class III	9 (36.0%)	16 (64.0%)	1.310(0.554−3.095)	0.538

	Class II	59 (47.2%)	66 (52.8%)	2.082(1.338−3.240)	**0.001**
	Class I	76 (30.0%)	177 (70.0%)	1	Class I
Type of Anesthesia	General Anesthesia	105(42.5%)	142(57.5%)	3.533(1.650−7.565)	**0.001**
	Regional Anesthesia	30 (28.8%)	74 (71.2%)	1.937(0.841−4.461)	**0.120**
	Combined	9 (17.3%)	43 (82.7%)	1	
Intraop blood transfusion	Yes	55 (41.0%)	79 (59.0%)	1.408(0.918−2.160)	**0.117**
	No	89 (33.1%)	9 (41.5%)	1	
Intraop Hypothermia	Yes	54 (45.0%)	66 (55.0%)	0.570(0.368−0.883	**0.012**
	No	90 (31.8%)	193 (68.2%)	1	
Intraop Dexamethasone	Yes	108(44.3%)	136 (55.7%)	2.713(1.731−4.252)	**0.000**
	No	36(22.6%)	123(77.4%)	1	
Intraop Vasopressor	Yes	41 (54.7%)	34 (45.3%)	2.000(1.197−3.341)	0.008
	No	103(31.4%)	225 (68.6%)	1	
Fluid Type	Others (Ringer, Mannitol...)	57(52.3%)	52(47.7%)	2.996(1.737−5.169)	**0.000**
	Dextrose containing	57(52.3%)	52(47.7%)	3.639(2.227−5.947)	**0.000**
	Normal saline	57(52.3%)	52(47.7%)	1	
Type of Procedure	General surgery	53 (63.9%)	30 (36.1%)	7.263(3.089−17.080)	**0.000**
	Ophta	22 (31.0%)	49 (69.0%)	1.846(0.762−4.473)	0.175
	EENT	12 (21.8%)	43 (78.2%)	1.147(0.435−3.025)	0.781
	Orthopedic	11 (13.1%)	73 (86.9%)	0.619(0.236−1.627)	0.331
	Neuro	37 (57.8%)	27 (42.2%)	5.634(2.334−13.601)	**0.000**

	Other(plastic,urology,thoracic)	9 (19.6%)	37 (80.4%)	1	
Duration Of Surgery	Short	31(35.6%)	56(64.4%)	0.529(0.289−0.970)	0.039
	Moderate	68(30.0%)	159(70.0%)	0.409(0.247−0.677)	**0.001**
	Long	50 (51.0%)	43(48.9%)	1	

N.B. 1-Reference group on bivariable Logistic Regression.

5.4.2 Results of multivariable Logistic Regression of factors independently associated with immediate postoperative hyperglycemia among elective pediatric patients operated in the three randomly selected southern Ethiopian Comprehensive Specialized Hospitals

Multivariable logistic regression analyses were conducted to explore independent factors associated with postoperative hyperglycemia and to control confounders. Accordingly, the age of study participants, (neonates, infants, toddlers, early childhood), types of anaesthesia (general anaesthesia and regional anaesthesia), intraoperative dexamethasone administration, dextrose-containing solutions, neurosurgical procedures and general surgery were significantly associated with immediate postoperative hyperglycemia in a multivariable logistic regression at a p-value of less than 5%.

Age of study participants, neonates were 4 times (AOR: 4, 95% CI; 1.3-12.85), infants were 3.39 times (AOR: 3.39, 95% CI; 1.18-9.76), toddlers four times (AOR: 3.73, 95% CI; 1.29-10.76), and early childhood were four times (AOR: 4, 95% CI; 1.48-10.96), more likely experienced postop hyperglycemia as compared to adolescents. General anaesthesia was 7 times (AOR: 7, 95% CI; 2.41-20) and regional anaesthesia 5 times (AOR: 5, 95% CI; 1.77-19.48) showed higher odds of hyperglycemia compared to combined anaesthesia type. The use of dexamethasone is associated with approximately three times higher odds of postoperative hyperglycemia (AOR: 3, 95% CI; 1.65-5.46) as compared with those not received. Dextrose-containing solutions were associated with approximately three times (AOR: 3.33, 95% CI; 1.67-6.65) higher odds of hyperglycemia compared to normal saline. Neurosurgical procedures (AOR: 3.68, 95% CI; 1.194-11.34) and general surgery (AOR: 3.66, 95% CI; 1.238-10.84) were associated with approximately four times higher odds of hyperglycemia compared to other procedures. (Table 9).

Table 8. Results of multivariable logistic regression of factors associated with immediate postoperative hyperglycemia among elective pediatric patients operated in three randomly selected southern Ethiopian Comprehensive Specialized Hospitals, 2024 (n=403)

Variable	**Category**	**Hyperglycemia n(%)**		**AOR (95% CI)**
		Yes(n=144)	No (n=259)	
		144 (35.7%)	259 (64.3%)	
Age	Neonatal	29 (64.4%)	16 (35.6%)	4 (1.28−12.85)*
	Infancy	31 (52.5%)	28 (47.5%)	3.4 (1.18−9.76)
	Toddlers	25 (49.0%)	26 (51.0%)	3.7 (1.3−10.7)*
	Early Childhood	31 (53.4%)	27 (46.6%)	4 (1.475−10.96)
	Adolescence	16 (15.7%)	86 (84.3%)	1
Type of Anesthesia	General	105 (42.5%)	142 (57.5%)	7 (2.4−20)**
	Regional	30 (28.8%)	74 (71.2%)	5 (1.7−19.5)*
	Combined	9 (17.3%)	43 (82.7%)	1
Intraop Dexamethason	Yes	108 (44.3%)	136 (55.7%)	3 (1.7−5.5)**
	No	36 (22.6%)	123 (77.4%)	1
Fluid Type	Dextrose containing	57 (52.3%)	52 (47.7%)	3.3(1.7−6.7)**
	Normal saline	50 (23.1%)	166 (76.9%)	1
Type Of Procedure	Neuro	37 (57.8%)	27 (42.2%)	**3.68 (1.2−11.34)**
	General Surgery	30 (36.1%)	53 (63.9%)	3.6 (1.24−10.8)*
	Others	9(19.6%)	37 (80.4%)	1

Key: **: Highly significant in the Multivariate logistic regression (p-value < 0.001), AOR adjusted odds ratio, COR crude odds ratio, CI confidence interval.

DISCUSSION

In the present study, the prevalence of immediate postoperative hyperglycemia among the study participants is 35.7%, 95% CI (31.3-40.8). This finding is in line with a study conducted in Atlanta, Georgia USA 2013 by Umpierrez et al. in a community pediatric hospital, which found that hyperglycemia is present in 38% of children admitted to the hospital had hyperglycemia, most of them without a history of diabetes before admission (42).

The finding of the present study is relatively higher as compared with a study in Zurich, Switzerland in 2015 by Julia J Krueger et al on postoperative hyperglycemia in children operated for congenital heart disease, which reported a prevalence of postoperative hyperglycemia of 14%. The possible explanation for this discrepancy may be the difference in the type of surgical procedures(20).

The current study's prevalence of 35.7% is lower than the 84% reported in a study by Catherine et al 2009 on glycemic control following pediatric surgery, which was carried out in Atlanta, USA. This difference could be the consequence of the prior study's specific focus on a patient receiving high-risk surgery which is cardiac surgery, while the current study examined a broader spectrum of elective surgeries (13). The present study's prevalence of 35.7% is also lower than the 90% reported in a 2016 study by Wu Y et al. from Sichuan University in China on the Glycemic Stress Index in pediatric cardiac surgery. The cardiac study focused on patients who, in comparison to general surgical patients, frequently had more serious diseases and a higher prevalence of hyperglycemia (22). The wide variation in prevalence can be attributed to differences in study populations, surgical procedures, study design and definitions of hyperglycemia used in each study.

Age of study participants, neonates were 4 times (AOR: 4.06, 95% CI; 1.28-12.85), infants were 3.39 times (AOR: 3.39, 95% CI; 1.18-9.76), toddlers four times (AOR: 3.73, 95% CI; 1.29-10.76), and early childhood were four times (AOR: 4.02, 95% CI; 1.475-10.963), were more likely experienced postop hyperglycemia as compared to adolescents. The findings of our study are consistent with previous study conducted in Toronto, Ontario, Canada.by Moga MA, et al 2011(15), which also identified age as a significant predictor of postoperative hyperglycemia in pediatric patients. Neonates and young infants have immature glucose homeostasis mechanisms, including reduced insulin sensitivity and impaired insulin secretion, which predispose them to postoperative hyperglycemia. As children grow older, their glucose regulation and metabolic

processes become more mature, making them less susceptible to postoperative hyperglycemia compared to younger age groups(16).

General anaesthesia approximately seven times (AOR: 7, 95% CI; 2.413-20.080) higher odds of hyperglycemia compared to combined anaesthesia type, as supported by Moga MA et al. (2011)(15). This finding aligns with previous studies by Dugan V et al. (2017)(10) and Dougherty SM et al. (2021)(43). The key mechanism is general anaesthesia can induce a stress response leading to increased release of counterregulatory hormones like cortisol, catecholamines, and glucagon, which promote hyperglycemia(44). On the other hand regional anaesthesia when compared to general anaesthesia, was linked to around two times lower risks of hyperglycemia (AOR: 5, 95% CI; 1.774-19.475) as indicated by Datta PK et al. (2019) (19). According to Desalegn M et al 2022 patients who underwent general anaesthesia were 5.8 times more likely to develop postoperative hyperglycemia compared to those who received regional anaesthesia (8).

According to a study by O'Connell RS et al. (2018) in Virginia, USA, postoperative hyperglycemia is approximately three times more likely to occur when dexamethasone is administered (AOR: 3.002, 95% CI; 1.651-5.460)(26). This result is consistent with research from Pakistan by Shirazi M et al. (2016) which also showed a link between dexamethasone therapy and hyperglycemia in pediatric populations (45). Dexamethasone is a synthetic glucocorticoid that can prevent insulin synthesis and glucose utilization, which can lead to elevated blood glucose levels. When dexamethasone is administered, it may trigger a stress reaction that increases the synthesis of substances that counteract it, including cortisol, glucagon, and catecholamines and results in hyperglycemia (26).

Compared to normal saline, solutions containing dextrose were linked to around three times higher risks of hyperglycemia (AOR: 3.336, 95% CI; 1.673-6.653). This result is consistent with research conducted in Sao Paulo, Brazil by Mekitarian et al. (2011) and Miller TE et al. (2019) which also demonstrated an association between dextrose-containing fluids and postoperative hyperglycemia in pediatric patients (12, 46). Infusing dextrose-containing solutions during surgery can lead to increased blood glucose levels due to the metabolic response to surgical stress. This response involves the release of counterregulatory hormones like cortisol, catecholamines, and glucagon, which promote glycogenolysis, gluconeogenesis, proteolysis, and lipolysis, ultimately increasing blood glucose levels(47). Higher infusion rates can lead to more pronounced hyperglycemia,

especially in nondiabetic patients and using dextrose-containing solutions with higher concentrations, such as 5% dextrose in 0.45% NaCl, can lead to higher blood glucose levels compared to lower concentrations(48)

The risk of postoperative hyperglycemia is also affected by the type of surgery that is done. In particular, there was a four-fold increase in the likelihood of hyperglycemia following neurosurgery procedures (AOR: 3.679, 95% CI; 1.194-11.339) and general surgery (AOR: 3.664, 95% CI; 1.238-10.842) as compared to other procedures. These results are in line with other studies conducted in Sao Paulo, Brazil by Mekitarian Filho et al. (2011) which also identified specific surgical procedures as risk factors for postoperative hyperglycemia in pediatric patients (12). Compared to other surgical specialities, neurosurgery and general surgery operations might involve higher metabolic and physiological demands, which could increase the risk of postoperative hyperglycemia (8)

6.1 Strength of the Study:

Using a multicenter approach and providing a baseline for future research are two benefits of our work. The multicenter approach makes our conclusions more broadly applicable and provides a framework for further research.

6.2 Limitations of the Study:

The observational methodology employed in the study may provide limitations as it only shows relationships rather than causality. The effects of postoperative hyperglycemia on pediatric surgery patients have not been investigated; a longitudinal investigation is necessary to ascertain the short- and long-term consequences. The observed associations between variables may be affected by confounding or unmeasured variables.

Conclusion:

The prevalence of immediate postoperative hyperglycemia among elective pediatric patients operated in three randomly selected southern Ethiopian Comprehensive Specialized Hospitals was `35.5%. associated factors of post-operative hyperglycemia age of study participants, (neonates, infants, toddlers, early childhood), types of anaesthesia (general anaesthesia and regional anaesthesia), intraoperative dexamethasone administration, dextrose containing solutions, neurosurgical procedures and general surgery were significantly associated with immediate postoperative hyperglycemia in a multivariable logistic regression at a p-value of less than 5%.

7.1 Recommendations:

Anesthesia Teams:

Identify high-risk patients preoperatively take appropriate precautions. Should be vigilant in monitoring pediatric patients for hyperglycemic events during the perioperative period, particularly those at an early age, and undergoing general and neurosurgery and under general anesthesia. Special attention should also be paid for fluid particularly dextrose-containing fluids and dexamethasone administration. Develop protocols for managing post-operative hyperglycemia, focusing on monitoring and early intervention.

Surgical Teams:

Focus on minimizing blood loss to reduce reliance on transfusions. Collaborating closely with anesthesia teams, they optimize perioperative care to minimize the need for postoperative transfusions.

"Researchers:

Conduct larger studies to validate findings and explore the effectiveness of interventions for managing post-operative hyperglycemia in pediatric patients. Collaborate with clinicians to design prospective studies aimed at evaluating the efficacy of glycemic monitoring protocols and targeted interventions.

References

1. Janssen J. New Insights into the Role of Insulin and Hypothalamic-Pituitary-Adrenal (HPA) Axis in the Metabolic Syndrome. Int J Mol Sci. 2022;23(15).
2. Agency EM. Guideline on Conduct of Pharmacovigilance for Medicines Used by the Paediatric Population. london united kingdom: European Medicines Agency; 2007. p. 13.
3. Clark R, Locke M, Bialocerkowski A. Paediatric terminology in the Australian health and health-education context: a systematic review. Dev Med Child Neurol. 2015;57(11):1011-8.
4. Althammer A, Pruckner S, Gehring GC, Lieftuchter V, Trentzsch H, Hoffmann F. Systemic review of age brackets in pediatric emergency medicine literature and the development of a universal age classification for pediatric emergency patients - the Munich Age Classification System (MACS). BMC Emerg Med. 2023;23(1):77.
5. Williams K, Thomson D, Seto I, Contopoulos-Ioannidis DG, Ioannidis JP, Curtis S, et al. Standard 6: age groups for pediatric trials. Pediatrics. 2012;129 Suppl 3:S153-60.
6. Pagana KD. Mosby's diagnostic and laboratory test reference: Seventh edition. St. Louis, Mo. : Elsevier Mosby, [2005] ©2005; 2005.
7. Hall JE. Guyton and Hall textbook of medical physiology. 13th edition ed. Philadelphia, PA: Elsevier; 2016.
8. Desalegn M, Shitemaw T, Sitot M, Getachew L. Magnitude and associated factors of postoperative hyperglycemia among an adult nondiabetic patient who underwent surgery at 2 tertiary hospitals in Ethiopia. IJS Global Health. 2022;5(5).
9. Saganski GF, Padilha AP, Rowe MCS, Falkoski A, Vasques JdR. Nursing care in the immediate postoperative period of surgery heart failure in pediatric patients: scoping review. 2022;22.
10. Duggan EW, Carlson K, Umpierrez GE. Perioperative Hyperglycemia Management: An Update. Anesthesiology. 2017;126(3):547-60.
11. Duncan AE. Hyperglycemia and perioperative glucose management. Curr Pharm Des. 2012;18(38):6195-203.
12. Mekitarian Filho E, Carvalho WB, Cavalheiro S, Horigoshi NK, Freddi NA, Vieira GK. Hyperglycemia and postoperative outcomes in pediatric neurosurgery. Clinics (Sao Paulo). 2011;66(9):1637-40.
13. Preissig CM, Rigby MR, Maher KO. Glycemic control for postoperative pediatric cardiac patients. Pediatr Cardiol. 2009;30(8):1098-104.
14. Naghipour B, Bagerpour M, Shadvar K, Golzari SEJ, Faridaalaee G. Effect of hyperglycemia treatment on complications rate after pediatric cardiac surgery. J Cardiovasc Thorac Res. 2022;14(1):18-22.
15. Moga MA, Manlhiot C, Marwali EM, McCrindle BW, Van Arsdell GS, Schwartz SM. Hyperglycemia after pediatric cardiac surgery: impact of age and residual lesions. Crit Care Med. 2011;39(2):266-72.
16. Bischoff AR, Grass B, Fan CS, Tomlinson C, Lee KS. Risk factors for postoperative hyperglycemia in neonates. J Neonatal Perinatal Med. 2021;14(2):183-91.
17. Poddar B. Treating hyperglycemia in the critically ill child: is there enough evidence? Indian Pediatr. 2011;48(7):531-6.
18. Alaei F, Nakhostin Davari P, Alaei M, Azarfarin R, Soleymani E. Postoperative Outcome for Hyperglycemic Pediatric Cardiac Surgery Patients. Pediatric Cardiology. 2012;33(1):21-6.

19. Datta PK, Aravindan A. Glucose for Children during Surgery: Pros, Cons, and Protocols: A Postgraduate Educational Review. Anesth Essays Res. 2017;11(3):539-43.
20. Krueger JJ, Brotschi B, Balmer C, Bernet V, Latal B. Postoperative Hyperglycemia and 4-Year Neurodevelopmental Outcome in Children Operated for Congenital Heart Disease. The Journal of Pediatrics. 2015;167(6):1253-8.e1.
21. Verhoeven JJ, Hokken-Koelega AC, den Brinker M, Hop WC, van Thiel RJ, Bogers AJ, et al. Disturbance of glucose homeostasis after pediatric cardiac surgery. Pediatr Cardiol. 2011;32(2):131-8.
22. Wu Y, Pei J, Yang XD, Cheng ZD, Zhao YY, Xiang B. Hyperglycemia and its association with clinical outcomes for patients in the pediatric intensive care unit after abdominal surgery. J Pediatr Surg. 2013;48(4):801-5.
23. Dogra P, Jialal I. Diabetic Perioperative Management. StatPearls. Treasure Island (FL): StatPearls Publishing

24. Sermkasemsin V, Rungreungvanich M, Apinyachon W, Sangasilpa I, Srichot W, Pisitsak C. Incidence and risk factors of intraoperative hyperglycemia in non-diabetic patients: a prospective observational study. BMC Anesthesiol. 2022;22(1):287.
25. Moorthy V, Sim MA, Liu W, Chew STH, Ti LK. Risk factors and impact of postoperative hyperglycemia in nondiabetic patients after cardiac surgery: A prospective study. Medicine. 2019;98(23).
26. O'Connell RS, Clinger BN, Donahue EE, Celi FS, Golladay GJ. Dexamethasone and postoperative hyperglycemia in diabetics undergoing elective hip or knee arthroplasty: a case control study in 238 patients. Patient Saf Surg. 2018;12:30.
27. Bonilla JL, Rodriguez-Torres JB, Verar GL, Mason-Nguyen J, Moore CB. Perioperative Dexamethasone for Patients With Diabetes and Its Effect on Blood Glucose After Surgery. J Perianesth Nurs. 2022;37(4):551-6.
28. Kolesky SE, Nyshadham S, Williams HO, Trinh TA, Tucker AJ, Lam H, et al. Intraoperative dextrose rate during exploratory laparotomies in neonates and the incidence of postoperative hyperglycemia: A retrospective observational study. Paediatr Anaesth. 2021;31(2):197-204.
29. Kim S, Park J, Kim H, Yang K, Choi JH, Kim K, et al. Intraoperative Hyperglycemia May Be Associated with an Increased Risk of Myocardial Injury after Non-Cardiac Surgery in Diabetic Patients. J Clin Med. 2021;10(22).
30. Hussen I, Worku M, Geleta D, Mahamed AA, Abebe M, Molla W, et al. Post-operative pain and associated factors after cesarean section at Hawassa University Comprehensive Specialized Hospital, Hawassa, Ethiopia: A cross-sectional study. Ann Med Surg (Lond). 2022;81:104321.
31. Bitew Workie S, Mekonen N, Michael MW, Molla G, Abrha S, Zema Z, et al. Modern Health Service Utilization and Associated Factors among Adults in Southern Ethiopia. J Environ Public Health. 2021;2021:8835780.
32. Seramo RK, Awol SM, Wabe YA, Ali MM. Determinants of pneumonia among children attending public health facilities in Worabe town. Scientific Reports. 2022;12(1):6175.
33. (NIH) NIoH. NIH Peer Review Guidelines for the Review of Inclusion on the Basis of Sex/Gender, Race, Ethnicity, and Age in Clinical Research. Reviewers should assess inclusion according to these guidelines and select the following options for the given categories. National Institutes of Health (NIH): National Institutes of Health (NIH)

March 2019. p. 8.
34. Lansdown G, Vaghri Z. Article 1: Definition of a Child. In: Vaghri Z, Zermatten J, Lansdown G, Ruggiero R, editors. Monitoring State Compliance with the UN Convention on the Rights of the Child: An Analysis of Attributes. Cham: Springer International Publishing; 2022. p. 407-12.
35. Abiyu Y, Aderaw Z, Yismaw L, Mengaw M, Demelash G, Siferih M. Time to elective surgery and its predictors after first cancellation at Debremarkos Comprehensive Specialized Hospital, Northwest Ethiopia. PLOS Glob Public Health. 2024;4(1):e0002183.
36. Ziring BS. Chapter 2 - Preoperative Assessment for the Healthy Patient. In: Merli GJ, Weitz HH, editors. Medical Management of the Surgical Patient (Third Edition). Philadelphia: W.B. Saunders; 2008. p. 15-33.
37. Mert S. The Significance of Nursing Care in the Post-anesthesia Care Unit and Barriers to Care. Intensive Care Research. 2023;3(4):272-81.
38. Duong H, Patel G. Hypothermia. StatPearls. Treasure Island (FL): StatPearls Publishing

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39. Janus J, Moerschel SK. Evaluation of anemia in children. Am Fam Physician. 2010;81(12):1462-71.
40. Özdemir N. Iron deficiency anemia from diagnosis to treatment in children. Turk Pediatri Ars. 2015;50(1):11-9.
41. Scott CF, Jr. Length of operation and morbidity: is there a relationships? Plast Reconstr Surg. 1982;69(6):1017-21.
42. Palacio A, Smiley D, Ceron M, Klein R, Cho IS, Mejia R, et al. Prevalence and clinical outcome of inpatient hyperglycemia in a community pediatric hospital. J Hosp Med. 2008;3(3):212-7.
43. Dougherty SM, Schommer J, Salinas JL, Zilles B, Belding-Schmitt M, Rogers WK, et al. Immediate preoperative hyperglycemia correlates with complications in non-cardiac surgical cases. J Clin Anesth. 2021;74:110375.
44. Xiong X-H, Chen C, Chen H, Gao R, Deng Q-Y, Cai X-W, et al. Effects of intravenous and inhalation anesthesia on blood glucose and complications in patients with type 2 diabetes mellitus: study protocol for a randomized controlled trial. Annals of Translational Medicine. 2020;8(13):825.
45. Shirazi M, Mahmoudi H, Nasihatkon B, Ghaffaripour S, Eslahi A. Efficacy of dexamethasone on postoperative analgesia in children undergoing hypospadias repair. Pak J Med Sci. 2016;32(1):125-9.
46. Miller TE, Myles PS. Perioperative Fluid Therapy for Major Surgery. Anesthesiology. 2019;130(5):825-32.
47. Torphy RJ, Stewart C, Sharma P, Halpern AL, Oase K, Herter W, et al. Dextrose-Containing Carrier Solution for Hyperthermic Intraperitoneal Chemotherapy: Increased Intraoperative Hyperglycemia and Postoperative Complications. Ann Surg Oncol. 2020;27(13):4874-82.
48. Saringcarinkul A, Kotrawera K. Plasma glucose level in elective surgical patients administered with 5% dextrose in 0.45% NaCl in comparison with those receiving lactated Ringer's solution. J Med Assoc Thai. 2009;92(9):1178-83.

Annexes

Annex:1 Information sheet

Title of the Research Project: prevalence of Immediate Postoperative Hyperglycemia and its Associated Factors among elective pediatric patients operated in southern Ethiopian Comprehensive Specialized Hospitals, 2024

Student Researcher: Mulualem Bunare

Organization: Hawassa University, College of Medicine and Health Science

Introduction: Greetings! I am Mulualem Bunare, a student pursuing an MSc in Advanced Clinical Anesthesia at Hawassa University College of Medicine and Health Science. This study focuses on investigating the prevalence of immediate postoperative hyperglycemia and its associated factors among pediatric patients undergoing surgery.

Purpose of the Research Project: This study aims to enhance the quality of care provided to pediatric surgical patients by exploring the prevalence of postoperative hyperglycemia and its associated factors.

Procedure: Data collection will take place at selected comprehensive specialized hospitals in southern Ethiopia. A standardized questionnaire was employed to gather information from written documents, anaesthetists involved during data collection, and devices used in the surgical and operation rooms.

Risk and/or Discomfort: A minimal discomfort may arise from a finger prick for blood sample collection to check blood sugar. Sterile techniques, including skin cleaning and sterilization using an alcohol swab, were performed, with gentle pressure applied after blood removal.

Confidentiality: Patient names will not be recorded in the questionnaire to ensure confidentiality. All collected data was kept confidential and used solely for research purposes. The thesis was submitted to Hawassa University College of Medicine and Health Sciences Department of Anesthesia and made available in the University Library and website. The study is also intended for submission to scholarly journals.

Right to Refusal or Withdraw: Data collection will commence only upon obtaining approval from the hospital manager and participant consent.

Contact Information: For further inquiries or information about the project, please contact:

1. Mulualem Bunare (Student Researcher): +251929502211

Advisors:

- Dr. Kirubel Tinsae (ASS.PROF.)
- Oliyad Eshetu (B.Sc., M.Sc. in Anesthesia)

Thank you for reviewing this information sheet and for any questions you may have. If you agree to participate, please provide your signature in the space provided

Annex 2: Consent form (English version)

I (caregiver)…….. Give my informed consent and decided to participate in this prospective observational study that will evaluate the incidence and predictors of postoperative pain in children undergoing surgery. I would like to assure you, that your name will not be written on this form and all the information gathered was kept strictly confidential. You can decide whether you want to take part in the questionnaire or not. I would like to assure you that there are no negative impacts you face because of taking part in the study. Please feel free to ask any questions data collector nearby.

You can also contact the principal investigator at the address below:

Mulualem Bunare (Student Researcher): +251929502211

Advisors:

- Dr. Kirubel Tinsae (ASS.PROF.)
- Oliyad Eshetu (BSc, MSc. in Anesthesia)

Participant information and Verbal consent form Amharic version

የተሳታፊ መረጃ እና የቃል ስምምነት ቅጽ ወይም ለ ታካሚ በተሰብ

ሰላምታ

ስሜ _____ ይባላል::

በሀዋሳ ዩኒቨርሲቲ የጤና ሳይንስ እና ህክምና ኮሌጅ የአንስቴዢያ ትምህርት ክፍል ማስተር ኦፍ ሳይንስን ለማሟላት በሕፃናት የድህረ ቀዶ ጥገና የደም ስኳር መጠን ከፍ የማለት ብዛትና ተያያዥ መንስኤዎቻቸው ዙሪያ ምርምር ውጤት "ጥናታዊ መረጃ ሰብሳቢ ነኝ" ። የዚህ ጥናት ዓላማ የድህረ ቀዶ ጥገና የደም ስኳር መጠን ከፍ የማለት ብዛትና ተያያዥ መንስኤዎቻቸው ዙሪያ ምርምር ውጤት መገምገም ነው። ጥቂት ጥያቄዎችን እጠይቅዎታለሁ። የዚህ ጥናት አካል መሆን በዚህ ሆስፒታል በሚያገኙት አገልግሎት ላይ ምንም አይነት ተጽዕኖ የለውም። ከጥናቱ ለመውጣት ነፃነዎት እናም በፈለጉት ጊዜ ለሚጠየቁት ማናቸውም ጥያቄዎች መልስ መስጠት ማቆም ይችላሉ። ሁሉም መረጃዎችዎ ሚስጥራዊናቸው እና እርስዎን የሚለይ ማንኛውም መረጃ ጥቅም ላይ አይውሉም።

ለመሳተፍ ይስማማሉ?

ከ ተስማሙ በ ፊርማዎ ያረጋገጡ / ለ በተሰብ

አዎ---------- ☐ አይ----------☐----------

Annex 3: ASA classification

ASA Class I: A patient who is healthy except for the surgical issue they are experiencing.

ASA Class II: A patient with a mild systemic illness that does not significantly limit their functionality.

ASA Class III: A patient with a severe systemic illness that considerably limits their functionality.

ASA Class IV: A patient with a severe systemic illness that poses a continuous threat to their life.

ASA Class V: A critically ill patient who is not expected to survive without surgical intervention.

Adopted from Paul Barash 5th edition

Annex 4: Data collection questionnaire

The questionnaire was developed for the collection of data for the study of "prevalence of immediate postoperative hyperglycemia and its associated factors among elective pediatric patients who operated in the southern Ethiopian Comprehensive Specialized Hospitals, 2024 ''

Questionnaire

Institute: _____

Address: _____

Dear participant,

Hello! I'm Mulualem Bunare, I am attending a postgraduate program in the field of Anesthesia at Hawassa University. I'm working on my thesis titled "Prevalence of immediate postoperative hyperglycemia and its associated factors among elective pediatric patients who operated in the southern Ethiopian Comprehensive Specialized Hospitals, 2024".

Your help with this study would mean a lot. Your name won't be shared, and everything you tell us will be kept secret. It's up to you if you want to participate. Don't worry, there's no harm in taking part. If you'd like to help, please tick:

YES_____NO_____

If you're okay with it, please sign below to show your agreement:

I (caregiver)…….. Give my informed consent and

Decided to participate in this observational study which will evaluate the prevalence of postoperative hyperglycemia and associated factors among pediatric patients undergoing elective surgery.

Thank you for taking part in the study!!!!

For further questions ask the investigator

Tele - 0929502211

Email: - mulualembunare01@gmail.com

Informed consent verified by an interviewer

Interview date _____Card number_____

Interviewer's name _____Signature_____

Supervisor's name _____Signature_____

Date of check-in_____

Prevalence of postoperative hyperglycemia and associated factors among pediatric patients undergoing elective surgery across selected southern Ethiopian comprehensive specialized hospitals, 2023

Question	Answer
1. What is the Patient's age?	
2. What is the patient's sex?	1. Male 2. Female
3. What is the patient's weight (in kg)?	
4. What is the patient's height (in cm)?	
5. BMI	1 . Underweight 2. Overweight 3. Normal 4. Obese
6. Weight-for-Age Percentiles:	1. Underweight or failure to thrive 2. Normal or healthy weight 3. Overweight or excessive weight 4. Obesity.
7. ASA Class?	1. ASA I 2. ASA II 3. ASA III
8. Preoperative fasting time (in hrs.)?	1. >2 hours 2. >4 hours 3. >6 hours 4. >8 hours
9. Does the patient have a history of diabetes?	1. Yes 2. No
10. Family history of diabetes?	1. Yes 2. No
11. Preoperative haemoglobin?	

12. Anemia?	1. Yes 2. No
13. Does the patient have any other comorbidities other than those listed?	1. Yes 2. No
14. If yes what is the comorbidity?	
15. Preoperative blood glucose?	
16. What type of anaesthesia did the patient receive?	1. General Anesthesia 2. Regional Anesthesia 3. Combined Anesthesia
17. Types of general anaesthesia:	1. Inhalational anaesthesia 2. Intravenous anesthesia 3. Others
18. Induction drugs:	1. Ketamine 2. Propofol 3. Thiopental 4. Halothane 5. Others
19. Intraoperative Hypothermia	1. Yes 2. No
20. Intraoperative Blood Loss:	
21. Intraoperative Blood Transfusion?	1. Yes 2. No
22. Intraoperative Dexamethasone?	1. Yes 2. No
23. Intraoperative Vasopressor?	1. Yes 2. No
24. Intraoperative vasopressors types	1. Epinephrine 2. Phenylephrine 3. Dopamine 4. Others

25. Intraoperative analgesia?	1. Paracetamol 2. Tramadol 3. Morphine 4. Nerve block 5. Others
26. Intraoperative fluid type?	1. Dextrose-containing Solutions 2. Normal Saline 3. Others
27. Type of Procedure	1. Orthopedic 2. General Surgery 3. EENT 4. Pediatrics 5. Neuro 6. Others
28. How long did the surgery last (in min)?	1. Short 2. Moderate 3. Long
29. What was the patient's blood glucose level immediately after surgery at PACU	