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Original Article

Determinants of Surgical Wound Infection at the University of Port Harcourt Teaching Hospital, Port Harcourt, Nigeria.

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Abstract

Background: This study determined the prevalence and associated risk factors of surgical wound infections (SWI) among adult patients who underwent general surgery at the University of Port Harcourt Teaching Hospital (UPTH), Nigeria. Ethical approval for this study was obtained from the UPTH Ethics Committee.

Methodology: A retrospective cross-sectional study was conducted using medical records of 440 adult patients (≥18 years) who underwent surgery between 2018 and 2023. Data on demographics and clinical characteristics were extracted following the United States Centers for Disease Control and Prevention criteria. Chi-square tests, t-tests, and multivariable logistic regression were used to identify independent predictors of SWI.

Results: Overall SWI prevalence was 7.3% (32/440; 95% CI: 5.0-10.1%). Mean age was 41.9 (14.1) years, and 60.0% were female. All patients received postoperative antibiotic prophylaxis. Patients with SWI were younger (mean: 35.0 vs 42.8 years; $p < 0.001$) and had longer hospital stays (median: 11 vs 7 days; $p = 0.004$). In multivariable analysis, each additional year of age reduced SWI odds by 5% (adjusted OR = 0.95; 95% CI: 0.92-0.98; $p = 0.004$), while gender and surgery type were not significant. Assessment of comorbidities (diabetes, smoking, obesity) was precluded by incomplete documentation (60% missing) and very low documented prevalence (3-4% vs expected 10-30%). No significant temporal trend in SWI prevalence was observed from 2018 to 2023 ($p = 0.43$).

Conclusion: SWI prevalence at UPTH was 7.3%, with younger age identified as an independent risk factor. Improved preoperative screening and prospective surveillance with targeted preventive measures for younger surgical patients may help reduce SWI rates.

Keywords: Surgical wound infection, Surgical site infection, Risk factors, Determinants, Surgery

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Introduction

Surgery as a branch of medicine plays a pivotal role in modern healthcare. It provides solutions for a wide range of health conditions that cannot be treated effectively with medications or non-invasive therapies. Since its inception as far back as 6500 BC, up until ancient Egypt in 1500 BC, surgery has proven to be a life-saving intervention in modern medicine [1]. However, despite its life-saving potential, surgery carries inherent risks. One of the many risks is surgical wound infection (SWI).

Surgical wound infection, also known as Surgical Site Infection (SSI), occurs when a patient becomes infected with a disease-causing pathogen, typically within 30 days after surgery. It is a leading cause of postoperative morbidity and mortality, with a pooled incidence of 5.6 per 100 surgical procedures [2]. Risk factors, including patient factors (such as diabetes, obesity, and immunocompromised status), procedure factors (like prolonged operative time, inadequate antibiotic prophylaxis), and environmental factors (such as poor sterilization and suboptimal infection control), contribute to the development of SWI. The World Health Organization (WHO), in a systematic review of literature and meta-analyses, reported that Surgical Wound Infection is the most surveyed and most frequent health-care-associated infection in Low- and Middle-income Countries (LMICs), affecting up to a third of patients who have surgery [2]. Recent studies from some tertiary healthcare institutions in Nigeria revealed a consistently high prevalence of surgical wound infection. Chukwuma and colleagues reported a 12.3% prevalence of surgical wound infection at the Lagos University Teaching Hospital [3]. A 9.8% occurrence of surgical wound infection was reported at the Obafemi Awolowo University Teaching Hospitals Complex (OAUTHC), Ile-Ife, Nigeria, following a prostatectomy [4]. Similarly, a 25.2% incidence of SWI was recorded at Aminu Kano Teaching Hospital and Murtala Mohammed Specialist Hospital in Kano State, Nigeria [5]. In another study, a 13.0% incidence of SWI was observed at the Olabisi Onabanjo University Teaching Hospital, Sagamu, Nigeria [6].

Surgical wound infections typically present with characteristic clinical manifestations, including redness, warmth, swelling around the incision site, purulent discharge, localized pain or tenderness, fever, and delayed wound healing [13]. At the University of Port Harcourt Teaching Hospital, these adverse outcomes result in prolonged hospital stay, high re-admission rates, additional surgical interventions, increased healthcare costs, and significant strain on limited resources. Despite these pressing challenges, limited scholarly research has comprehensively examined the determinants of SWI at UPTH. This study aims to fill this gap by investigating the prevalence, characteristics, risk factors, and complications of surgical wound infections at UPTH. The findings from this study will provide evidence-based insights for targeted prevention strategies to enhance surgical outcomes and patient safety.

Research Methods and Design

Study Design

The study employed a retrospective cross-sectional study design using primary data collected from patient folders over a six-year period (2018-2023) to identify predisposing factors to surgical wound infections in patients who underwent surgeries in the general surgical services department of UPTH. The study period was selected to provide a sufficient sample size for robust statistical analysis while ensuring recent surgical practices and data completeness.

Setting

The study was conducted within the premises of the University of Port Harcourt Teaching Hospital, a tertiary healthcare institution serving over 7 million residents of the state. Established in April 1980 and officially commissioned by the federal government of Nigeria in 1985, the University of Port Harcourt Teaching Hospital performs over 3,000 surgeries per year, ranging from minor to major surgeries.

Study population and sampling strategy

The target population was patients above 18 years who underwent surgical operations in the general surgical services department at the University of Port Harcourt Teaching Hospital from the year 2018 to 2023. The inclusion of adult patients ensures a comprehensive examination of surgical wound infections across various age groups and underscores the relevance of the study's findings for the broader adult population served by the hospital. Patients with active infections at the time of surgery, patients who are currently undergoing chemotherapy for cancer treatment, and patients with incomplete medical records or missing data necessary for analysis were excluded from the study.

The sample size for the study was determined using the Cochran formula. Based on a previously reported study in 2022 [7], the prevalence of surgical wound infection was assumed to be 5% (p = 0.5) to maximize sample size. Using a 95% confidence level (Z = 1.96) and a margin of error of 5% (E = 0.05), the required sample size was calculated as:

$$n = \frac{Z^2 . p(1-p)}{E^2}$$

$$n = \frac{1.96^2 \times 0.5 \times (1-0.5)}{0.05^2}$$

$$n = \frac{3.8416 \times 0.25}{0.0025}$$

$$n = \frac{0.9604}{0.0025}$$

$$n = 384.16$$

Thus, a minimum sample size of 384 patient records was required. To account for potential exclusions due to incomplete documentation, the sample size was increased to 440 patient folders.

Data Collection and Data Analysis

Medical records with incomplete patient information, missing surgical details, or inadequate post-operative documentation were excluded from the study. Data collection was conducted by the principal investigator following the United States Centers for Disease Control and Prevention (CDC) criteria, assisted by two trained graduate students from the University of Port Harcourt. The investigator, alongside the assistants, worked under the guidance of staff from the General Surgery Record Department, and collectively, they retrieved patient folders within the study period for assessment.

Specific data variables extracted included: Patient ID, age, gender, type of surgery (elective/emergency), year of surgery, surgical procedure type, preoperative antibiotic use (yes/no), postoperative antibiotic use (yes/no), prevalence of surgical wound infections (yes/no), length of hospital stay (days), severity of infection, outcome (N/A/under treatment/deceased/discharged home), comorbidities (yes/no), diabetes (yes/no), smoking status (yes/no), and obesity (yes/no).

Patient details were systematically extracted from medical records and input into a standardized proforma spreadsheet, ensuring uniformity in data extraction and systematic capture of variables of interest. Data were stored securely in password-protected databases with restricted access and patient coding for confidentiality.

Data collected were summarized using descriptive statistics, including mean, standard deviation (SD), medians, frequencies, and percentages. SWI prevalence was estimated with 95% confidence intervals. Group comparisons were conducted using Chi-squared tests for categorical variables and appropriate parametric or non-parametric tests for continuous variables. Multivariable logistic regression was performed to identify independent predictors of SWI, with results reported as adjusted odds ratios and 95% confidence intervals. Temporal trends were assessed across study years. Analyses were performed in R version 4.4.2 (R Core Team 2024) and relevant packages. A *p*-value of less than 0.05 was considered statistically significant.

Ethical Considerations

Ethical approval was obtained from the University of Port Harcourt Teaching Hospital Ethics Committee (Protocol No. UPTH/ADM/90/S.11/VOL.XI/1794; July 1, 2024) prior to data collection. Two senior clinicians provided ethical oversight during record review, making sure patient confidentiality was maintained.

Results

Demographic Characteristics of Patients within the Study Period

Table 1. Demographic, Clinical, and Surgical Characteristics of Study Participants (N =440)

Characteristic	Value
Study population	
Total patients	440
Study period	2018 - 2023
Age (years)	
Mean (SD)	41.9 (14.1)
Median [IQR]	41 [31-50]
Range	18 - 85
Age group, n (%)	
18-39 years	203 (46.1)
40-50 years	127 (28.9)
51-65 years	87 (19.8)
>65 years	23 (5.2)
Gender, n (%)	
Female	264 (60.0)
Male	176 (40.0)
Type of surgery, n (%)	
Elective	414 (94.1)
Emergency	26 (5.9)
Surgical wound infection (SWI), n (%)	
No	408 (92.7)
Yes	32 (7.3)
Prevalence (95% CI)	7.3% (5.0-10.1)
Length of hospital stay (days) (n=115)	
Median [IQR]	7 [5-12]
Mean (SD)	10.0 (8.0)

Characteristic	Value
Antibiotic use	
Preoperative antibiotic use† (n=181)	
• No	151 (83.4)
• Yes	30 (16.6)
Postoperative antibiotic use	440 (100.0)
Comorbidity status† (n=176)	
Any comorbidity - Yes (%)	148 (84.1)
No (%)	28 (15.9)
Missing (%)	264 (60.0)
Diabetes - Yes (%)	1.59
No (%)	38.41
Missing (%)	60.0
Smoking - Yes (%)	1.14
No (%)	38.86
Missing (%)	60.0

This table summarizes the baseline demographic, clinical, and surgical characteristics of adult patients who underwent general surgical procedures at UPTH between 2018-2023. Variables include age distribution, gender, type of surgery, SWI status, length of hospital stay, antibiotic use patterns, and comorbidity profile. †Percentages are presented using available data denominators where missing values occurred.

Classification of surgical Wound Infections according to Types, Patterns, and Attributes

Table 2: Classification of surgical Wound Infections according to United States Center for Disease Control (CDC) Types, Surgical Patterns, and Clinical Attributes (N = 440)

CDC SSI Classification	Examples of Surgical Procedures	Frequency (n)	Percentage (%)	Typical Clinical Patterns	Key Clinical Attributes
Superficial Incisional SSI (Class I)	Appendectomy, cholecystectomy, hemorrhoidectomy, herniorrhaphy,	249	56.6	Mild redness, localized swelling, mild tenderness,	Lower infection severity; usually responds well to standard

CDC SSI Classification	Examples of Surgical Procedures	Frequency (n)	Percentage (%)	Typical Clinical Patterns	Key Clinical Attributes
	hydrocelectomy, prostatectomy, rectopexy, myomectomy, lobectomy, thyroidectomy			minimal discharge	postoperative wound care
Deep Incisional SSI (Class II)	Exploratory laparotomy, colostomy, hemicolectomy, fistulectomy, gastrojejunostomy, ileostomy, lymphadenectomy, splenectomy	136	30.9	Moderate pain, fever, localized swelling, tenderness, and possible wound separation	Higher infection severity requires close clinical monitoring and targeted antibiotic therapy
Organ/Space SSI (Class III)	Traumatic injuries (e.g., gunshot wounds, machete injuries, abdominal stab wounds), gastrostomy	55	12.5	Severe pain, purulent discharge, abscess formation, systemic symptoms	Highest infection severity; often requires surgical drainage or debridement
Total	—	**440**	**100.0**	—	—

Classification based on the United States Center for Disease Control and Prevention (CDC) surgical site infection surveillance definitions.

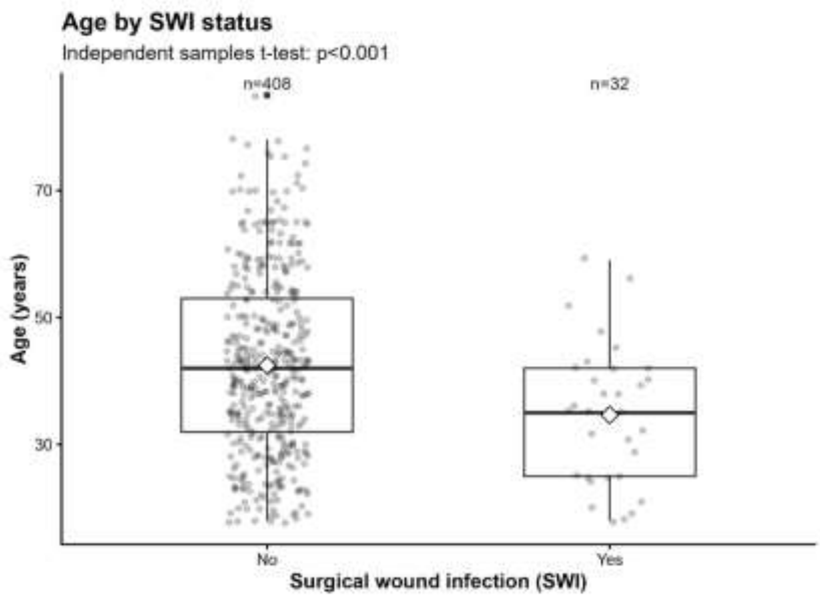

Figure 1: Age Distribution by Surgical Wound Infection Status

The boxplot compares the age distributions between patients with and without SWI. Patients who developed SWI were significantly younger than those without infection (independent samples t-test, p < 0.001). The box represents the interquartile range (IQR), the horizontal line indicates the median, and the diamond markers show the mean age. Individual data points are displayed for distribution visualization.

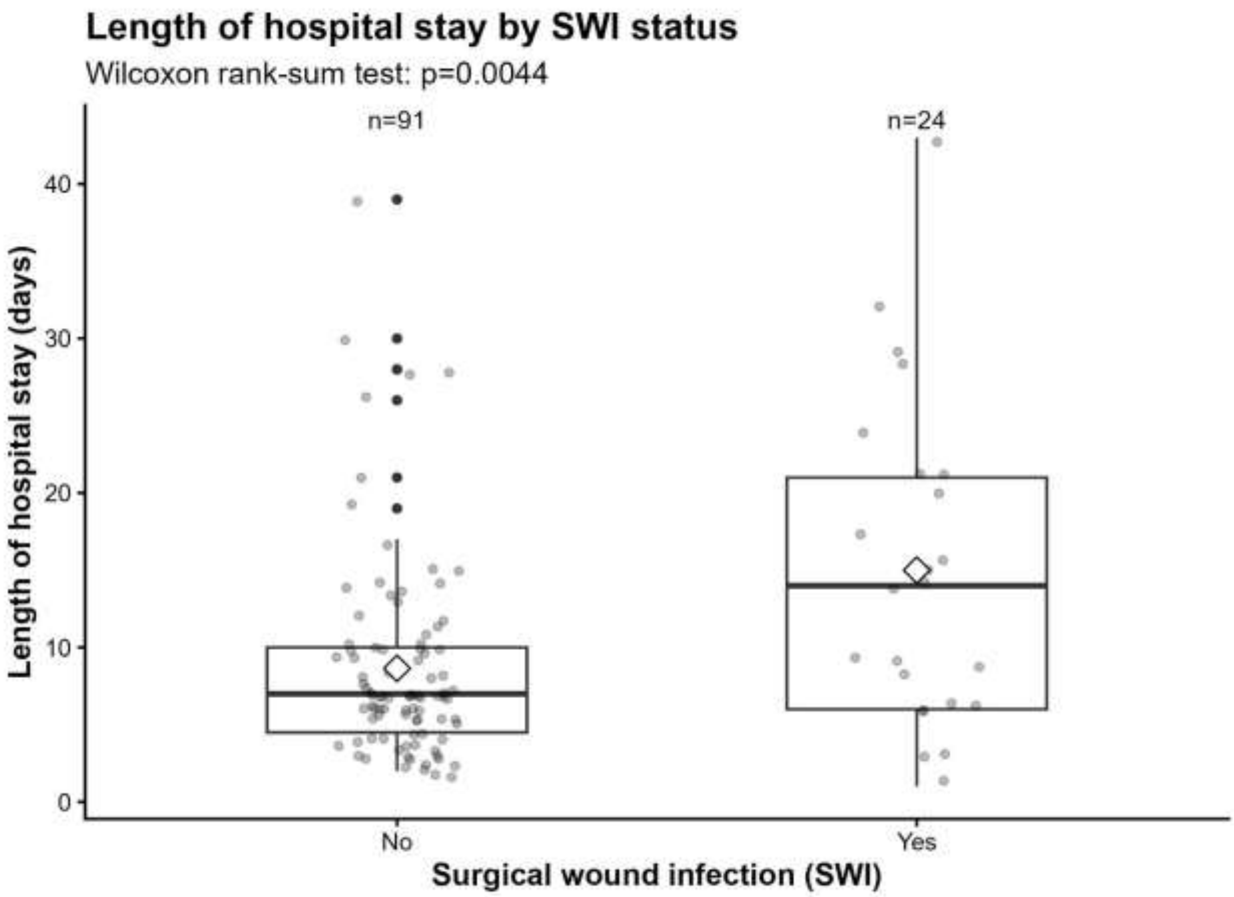

Figure 2: Length of Hospital Stay by Surgical Wound Infection Status

Comparison of hospital length of stay between patients with and without SWI. Patients with SWI had significantly longer hospital stays than those without infection (Wilcoxon rank-sum test, p = 0.0044). Boxes represent IQR, central lines indicate medians, and diamond makers denote mean values. Individual observations are plotted.

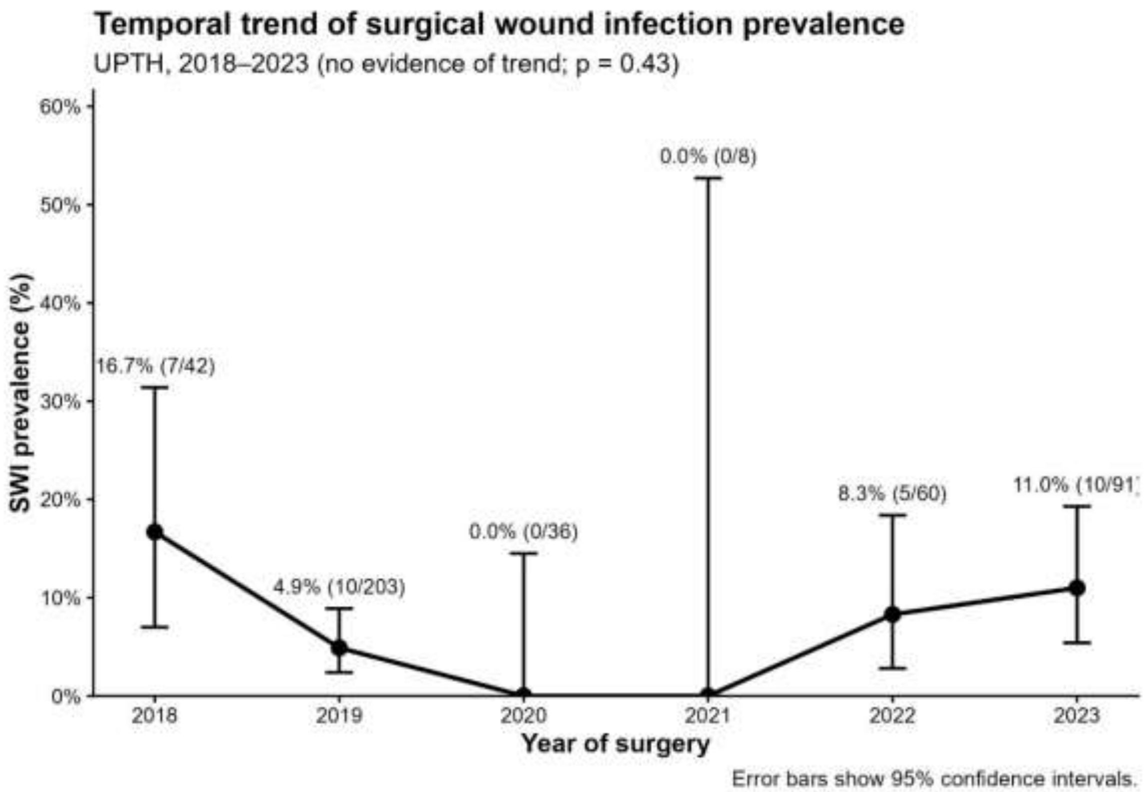

Figure 3: Temporal Trends of SWI Prevalence at UPTH from 2018-2023

Yearly prevalence of SWI among patients who underwent surgery at UPTH between 2018 and 2023. Error bars represent 95% confidence intervals. No statistically significant temporal trend in SWI prevalence was observed during the study period (p = 0.43).

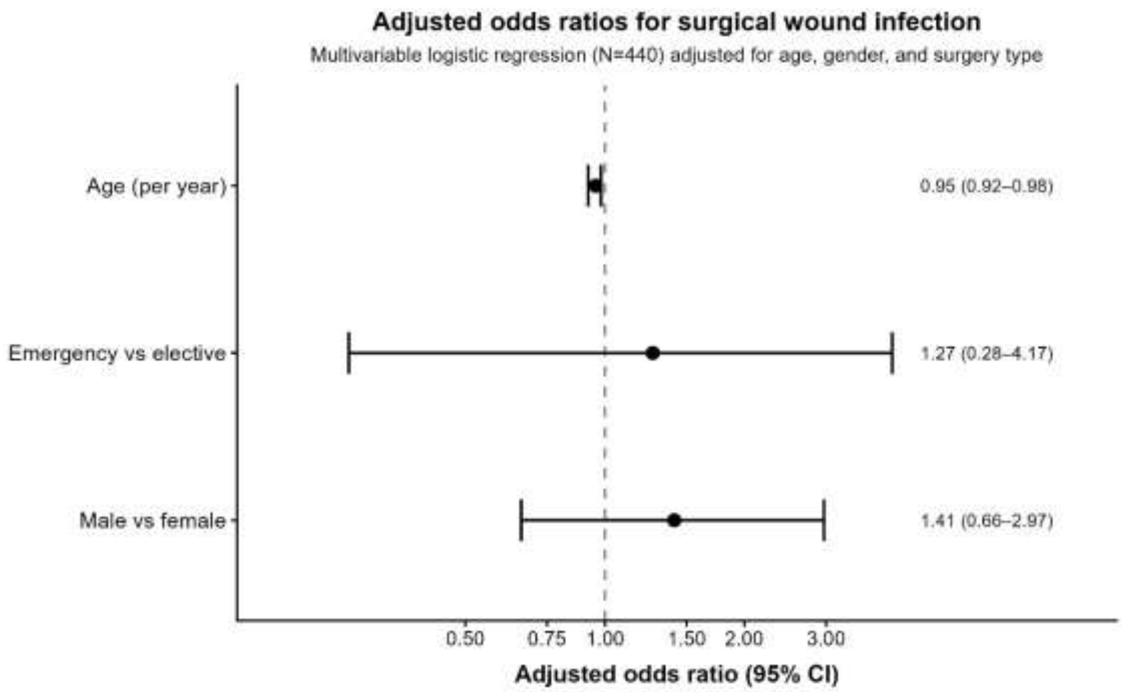

Figure 4: Adjusted Odds Ratios for Risk Factors Associated with SWI

Forest plot showing adjusted odds ratios (AORs) and 95% confidence intervals from multivariable logistic regression analysis of factors associated with SWI. The model was adjusted for age, gender, and type of surgery. Increasing age was significantly associated with reduced odds of SWI, while gender and surgery type were not statistically significant predictors.

Discussion

This study examined the prevalence and associated risk factors of surgical wound infection among patients who had undergone surgeries in the general surgical services department at UPTH within the period of 2018 to 2023. Of the 440 patient folders assessed for this study, SWI prevalence at UPTH was 7.3% (n =32/440, 95% CI: 5.1-10.1%). Younger age emerged as the only independent predictor of SWI, with each additional year of age associated with 5% lower odds of infection. All patients received postoperative antibiotic prophylaxis, yet 7.3% still developed SWI, suggesting that factors beyond antibiotic use may contribute to infection risk. Patients with SWI had significantly longer hospital stays (median 11 vs 7 days), with important implications for healthcare costs and stress on limited hospital resources. No temporal trend in SWI prevalence was observed from 2018-2023, indicating stable rates despite evolving surgical practices and infection control measures.

Before interpreting the findings of this study in detail, we acknowledge several limitations of our study. First, despite the retrospective design of our study and the substantial missing data in selected variables, which are likely to limit causal inference, this study maintained methodological rigor through the use of standardized US CDC definitions, systematic data extraction, and multivariable regression analysis restricted to reliably documented variables. Second, while the single-center design of our study may limit generalizability, we used a sufficient sample size and a six-year study period to enhance the robustness of our findings. Third, although detailed perioperative and environmental factors were unavailable, we ensured that core demographic and surgical variables were completely assessed. Finally, we could not exclude residual confounders; however, we ensured transparent reporting and cautious interpretation to support the internal validity of the observed associations of this study.

Despite the above limitations, this study provides context-specific evidence that can inform infection prevention and control (IPC) practices, strengthen surveillance systems, and support data-driven policy decisions within similar tertiary healthcare settings. The findings of this study serve as a baseline for prospective studies and quality improvement interventions aimed at reducing SWI, especially among young individuals.

The prevalence of SWI at UPTH from 2018-2023 was estimated to be 7. 27%. This rate is significantly lower than the pooled cumulative national surgical wound infection prevalence of 14.5% (95% CI: 11.3% -18.4%) reported in 2019 [9] and 22.17% (95% CI: 19.96% -24.38%) reported in 2025 [19]. This comparison implies that surgical wound infection rates at UPTH are reasonably managed and are less than the national mean. The comparatively lower prevalence rate could also imply that the UPTH general surgical services department has been implementing good IPC measures that would act as a model for other hospitals and institutions that are willing to reduce their surgical wound infection rates. Infection prevention and control, therefore, defines the measures instituted and complied with to prevent, halt, and/or lessen the occurrence of infections in hospitals or other health care facilities [10].

The outcome of this study is also lower than the result of a prospective similar study in 2017, which reported a 9.1% prevalence rate of surgical wound infection at the University of Port Harcourt Teaching Hospital (UPTH) between 2013 and 2016 [11]. While this study was prospective for 3 years, our study was a retrospective cross-sectional analysis based on data extracted from patients' medical folders covering surgeries conducted over a six-year period. The outcome of both studies highlights the prevalence of SWI at UPTH and calls for urgent intervention to ensure patient safety.

This study categorized surgical wound infections according to the United States CDC surgical wound classification system [20]. It showed that most infections occurred in Superficial Incisional (Class I) surgeries, such as herniorrhaphy and hemorrhoidectomy, which account for 56.6% of cases. These are generally less severe and tend to occur in simpler procedures. In contrast, Deep Incisional (Class II) surgeries like exploratory laparotomy and colostomy contribute to 30.9% of infections, involving more complex procedures and deeper tissues, requiring more intensive post-operative care. The smallest proportion, 12.5%, involves Organ/Space infections (Class III), associated with more complicated surgeries or trauma, such as gunshot or stab wounds. Our study shows that among patients who developed SWI, superficial incisional infections were the most common type, accounting for 4.1% (n =18) of the total population, followed by deep incisional 1.8% (n =8) and organ/space infection 1.4% (n =6), respectively. This distribution shows that superficial incisional infections were the most common type of SWI, highlighting variation in the clinical depth and severity of SWI.

Our finding that younger patients have higher SWI risk contrasts with most literature, which shows older age as a risk factor [14]. This may be due to emergency or trauma-related procedures in young individuals, selection bias favouring healthier older patients for elective surgery, under documentation of commodities, and potential differences in immune and environmental exposures. However, the findings of our study corroborate with some large procedure-specific studies which reported a higher risk of surgical site infections among younger adults < 45 years [12].

Universal postoperative antibiotic use by all patients (100%) in this study suggests strong adherence to institutional prophylactic practices. However, substantial missing data on preoperative antibiotic use limit the assessment of whether prophylaxis was administered at the optimal timing and with appropriate coverage, which are critical determinants of SWI prevention [13]. Future prospective studies should examine antibiotic selection, timing relative to incision, and duration of therapy to better evaluate adherence to evidence-based recommendations and their impact on infection outcomes.

Although the prevalence of SWI was numerically higher among males (9.3%) compared to females (6.9%), this difference was not statistically significant. Therefore, gender was not identified as an independent predictor of SWI in this study. While some studies, including a long-term surveillance data from Germany, have reported higher infection risk among males [15], our findings did not demonstrate a statistically significant gender difference. This may reflect sample size limitation, substantial missing data, or contextual differences in surgical practices.

Consistent with previous studies [13], patients with SWI experienced significantly longer hospital stays, reflecting increased treatment costs and healthcare resource utilization. Although comorbid data were incomplete (60%), thereby restricting reliable evaluation of their associations with SWI, smoking, obesity, and diabetes remain well-established risk factors of SWI in the literature [16,17,18]. This therefore underscores the importance of comprehensive preoperative assessment of all patients for underlying potential risk factors before surgery.

Conclusion

Surgical wound infection remains a significant challenge at the University of Port Harcourt Teaching Hospital despite universal postoperative antibiotic prophylaxis. Although the overall SWI prevalence at UPTH was lower than the reported national average, younger age emerged as an unexpected independent risk factor, highlighting further investigation. Future prospective studies with improved documentation and standardized surveillance are needed to better evaluate risk factors and optimize infection prevention strategies. Strengthening targeted IPC measures, especially for high-risk surgical populations, may help reduce SWI and improve surgical outcomes in similar healthcare settings.

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Competing interests
The authors declare that they have no financial or personal relationship(s) that may have inappropriately influenced them in writing this article.

Author contributions
Godwin Pius Ohemu and Mary A. Alex-Wele conceptualized the study. Godwin Pius Ohemu collated and analyzed the data and drafted the original manuscript. Kelechi E. Okonta and Kennedy T. Wariso provided secondary supervision and validation. Godwin Pius Ohemu and Mary Alex-Wele reviewed and designed the methodology and edited the final manuscript. Mary A. Alex-Wele provided primary supervision for this study.

Clinical trial number
Not applicable.

Human Ethics and Consent to Participate declaration
Ethical approval was obtained from the University of Port Harcourt Teaching Hospital Ethics Committee (Protocol No. UPTH/ADM/90/S.11/VOL.XI/1794; July 1, 2024) prior to data collection. Two senior clinicians provided ethical oversight during record review, making sure patient confidentiality was maintained.

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Data Availability
The data supporting the findings of this study are not openly available due to the sensitive nature of patient information. However, they are available from the corresponding author, Godwin Pius Ohemu, upon reasonable request.

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