Original Article

Modifiable And Non-Modifiable Risk Factors For Pulmonary Morbidity Following Elective Abdominal Surgery

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ABSTRACT

Postoperative pulmonary complications are a major cause of morbidity and mortality following abdominal surgery, prolonging hospital stay and recovery. They result from a combination of modifiable and non-modifiable factors such as age, comorbidities, smoking, nutrition, and perioperative management. Data on these risk factors remain limited in Nigerian surgical populations. This study assessed the determinants of pulmonary morbidity following elective abdominal surgery at the University of Benin Teaching Hospital. A prospective cross-sectional study was conducted between January and June 2025 among 100 adult patients who underwent elective abdominal surgery. Data on socio-demographic variables, comorbidities, intraoperative characteristics and postoperative outcomes were collected using a structured questionnaire. Pulmonary morbidity, including pneumonia, atelectasis, bronchospasm, pulmonary embolism or respiratory failure was defined using the European Perioperative Clinical Outcome criteria. Statistical analysis was performed with SPSS version 26.0 using chi-square and logistic regression, with significance set at $p < 0.05$. The mean age of participants was 49.2 ± 12.9 years, comprising 59 (59.0%) females and 41 (41.0%) males. Pulmonary complications were more frequent in patients older than 60 years (69.6%) and in those with pre-operative shortness of breath (88.9%). Significant predictors included smoking ($p = 0.014$), low serum albumin ($p = 0.021$), COPD ($p = 0.025$), use of long-acting muscle relaxants ($p = 0.048$), prolonged surgery > 2 hours ($p < 0.001$) and elevated pre-operative respiratory rate ($p = 0.010$). ASA Class III patients had the highest complication rate (73.1%). Postoperative pulmonary complications arise from both modifiable and non-modifiable factors. Modifiable risks such as smoking, obesity, poor pulmonary conditioning, and delayed mobilization can be mitigated through preoperative optimization and adherence to perioperative care bundles, whereas non-modifiable factors like advanced age and chronic lung disease require careful risk stratification. Focusing on modifiable factors offers the greatest potential to reduce the burden of POPCs and improve surgical outcomes, especially in resource-limited settings.

Keywords: Abdominal surgery, Morbidity, Post-operative Pulmonary complications, Risk factors

INTRODUCTION

Postoperative pulmonary complications (POPCs) remain a leading cause of morbidity and mortality after major abdominal surgeries worldwide. They include a range of respiratory events such as atelectasis, pneumonia, bronchospasm, pulmonary embolism and respiratory failure, which significantly delay recovery, increase healthcare costs and elevate the risk of postoperative death.[1,2] Globally, POPCs occur in approximately 5–40% of surgical patients, depending on population characteristics and definitions used.[3,4] Despite improvements in surgical techniques, anesthesia and perioperative care, these complications continue to pose serious challenges in both developed and developing countries' health systems.

International studies have identified both modifiable and non-modifiable risk factors that influence pulmonary outcomes following surgery. Non-modifiable factors such as advanced age, sex, genetic predisposition and pre-existing comorbidities (including chronic obstructive pulmonary disease, cardiovascular disease or diabetes) are inherent characteristics that cannot be altered. [5,6] In contrast, modifiable risk factors, such as cigarette smoking, obesity, poor nutritional status, prolonged operative time, suboptimal anesthesia, inadequate pain control and lack of early postoperative mobilization, are preventable through timely intervention and perioperative optimization[7.7] Evidence from high-income countries has demonstrated that structured prehabilitation, lung-protective ventilation and enhanced recovery protocols markedly reduce POPCs and improve outcomes.[8,9]

Across Africa, the burden of postoperative pulmonary morbidity remains high due to limited resources, delayed

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preoperative optimization and shortages of trained perioperative personnel. Many African hospitals face challenges, including late patient presentation, lack of preoperative screening for respiratory risks and inadequate postoperative monitoring facilities. Studies from countries such as South Africa, Ethiopia and Ghana report POPC rates ranging from 15% to 35%, often higher than those in high-income settings.[10,11] Contributing factors include high prevalence of smoking, malnutrition, anemia, and unrecognized respiratory diseases such as tuberculosis or chronic bronchitis.[12,13] Moreover, restricted access to intensive care units and limited use of evidence-based perioperative protocols have compounded these risks.

In Nigeria, postoperative pulmonary complications represent a significant yet often under-reported aspect of surgical morbidity. The country's growing volume of elective abdominal surgeries has increased the clinical relevance of understanding pulmonary risks. Nigerian studies have documented several contributory factors, including smoking, obesity, prolonged anesthesia, poor postoperative pain control and inadequate physiotherapy.[14,15] Non-modifiable risks such as advancing age and chronic respiratory or cardiac illness further increase susceptibility and limited awareness of preoperative risk stratification tools, inadequate patient education and resource constraints in public hospitals have also been highlighted as persistent challenges.[14]

Identifying both modifiable and non-modifiable risk factors within the Nigerian surgical population is crucial for improving outcomes. By recognizing these determinants early, healthcare teams can implement targeted preventive measures such as preoperative pulmonary assessment, smoking cessation programs, use of incentive spirometry, early ambulation and appropriate analgesia. Strengthening perioperative care through evidence-based strategies will not only reduce pulmonary morbidity but also enhance recovery and resource utilization across Nigerian tertiary hospitals.

MATERIALS AND METHODS

Study Area

The study was conducted at the University of Benin Teaching Hospital (UBTH), Benin City, Edo State, Nigeria, a major tertiary institution serving Edo and neighboring states. The hospital provides a full range of surgical services, including general, urologic and gynecologic surgeries. Benin City is cosmopolitan, with diverse ethnic groups such as the Benin, Esan and Etsako. The predominant languages are English and Nigerian Pidgin. Within UBTH, elective abdominal surgeries are performed by consultant surgeons and resident doctors in well-equipped operating theatres, with postoperative care delivered in surgical wards and the intensive care unit.

Study Design

This was a prospective cross-sectional study carried out over an 8-month period among adults who underwent elective abdominal surgery under general or regional anesthesia. Participants were aged 18 years and above. Only patients who gave informed consent were included, while those undergoing emergency procedures or with acute respiratory distress or unstable medical conditions were excluded. Eligible patients were recruited consecutively until this number was attained.

Data Collection

Information was obtained using a structured interviewer-administered questionnaire and perioperative observation form. Data collected included sociodemographic details, comorbidities, smoking status, nutritional state, anesthesia type, operative duration and postoperative factors such as pain control and mobilization. Patients were followed up for seven days post-surgery and assessed for pulmonary morbidity, defined by the European Perioperative Clinical Outcome (EPCO) criteria, pneumonia, atelectasis, bronchospasm, pulmonary embolism or respiratory failure. Diagnosis was based on clinical findings, pulse oximetry and chest imaging where necessary.

Data Analysis

Data were analyzed using SPSS version 26.0. Descriptive statistics summarized variables as means, standard deviations, frequencies and percentages. Associations between categorical variables were tested with chi-square or Fisher's exact test, while logistic regression identified independent predictors of pulmonary morbidity. Statistical significance was set at $p < 0.05$.

Ethical Considerations

Approval for the study was obtained from the UBTH Health Research and Ethics Committee, and written informed consent was obtained from all participants. Confidentiality was maintained throughout the study. Also, participants were informed of their right to withdraw from the study at any time, without consequences.

RESULTS

Socio-Demographic Characteristics of Respondents

A total of 100 patients who underwent elective abdominal surgery were included in the study. The age distribution showed that 10 (10.0%) were between 20–30 years, 17 (17.0%) were between 31–40 years, 25 (25.0%) were within 41–50 years, 25 (25.0%) were between 51–60 years, and 23 (23.0%) were above 60 years. The mean age of respondents was 49.16 ± 12.9 years.

There were 41 (41.0%) males and 59 (59.0%) females, giving a male-to-female ratio of approximately 1:1.4. Most of the respondents were married 66 (66.0%), while 23 (23.0%) were single, 6 (6.0%) widowed, and 5 (5.0%) separated.

With respect to educational attainment, 4 (4.0%) had no formal education, 15 (15.0%) attained primary education, 42 (42.0%) had secondary education, while 39 (39.0%) had tertiary education.

The ethnic distribution revealed that 41 (41.0%) were Benin, 18 (18.0%) Esan, 9 (9.0%) Etsako, 7 (7.0%) Igbo, 6 (6.0%) Yoruba, and 3 (3.0%) Hausa, while 16 (16.0%) belonged to other ethnic groups. Regarding religion, the majority 86 (86.0%) were Christians, followed by 9 (9.0%) who practiced African Traditional Religion, and 5 (5.0%) who were Muslims. (Table 1)

Pre-Operative Risk Assessment

Assessment of pre-operative respiratory symptoms showed that a large proportion of patients, 71 (71.0%), had no respiratory symptoms prior to surgery. Among those who reported symptoms, 18 (18.0%) had snoring, 8 (8.0%) experienced shortness of breath, 2 (2.0%) had wheezing, while 1 (1.0%) presented with cough. Regarding past

medical history, 67 (67.0%) of the respondents had hypertension, 22 (22.0%) were obese, and 16 (16.0%) had diabetes mellitus.

Evaluation of serum biochemical parameters revealed that 3 (3.0%) had elevated serum urea levels above 50 mg/dl, while 42 (42.0%) had low serum albumin levels below 34 g/l. According to the American Society of Anesthesiology (ASA) classification, 26 (26.0%) of patients were categorized as Class I, 49 (49.0%) as Class II, and 25 (25.0%) as Class III**.** (Table 2)

Procedure Related Risk Assessment

Analysis of intraoperative variables showed that the majority of patients, 82 (82.0%), received short-acting muscle relaxants, while 18 (18.0%) received long-acting agents during anesthesia.

The duration of surgery was less than two hours in 68 (68.0%) of the cases, whereas 32 (32.0%) of the procedures lasted longer than two hours. (Table 3)

Association Between Indications for Surgery and Post-Operative Pulmonary Complications

Assessment of the relationship between surgical indications and the occurrence of post-operative pulmonary complications showed varying outcomes across diagnostic categories. Among patients who underwent surgery for intra-abdominal malignancy, 16 (48.5%) developed pulmonary complications, while 17 (51.5%) did not, a difference that was not statistically significant (χ^2 = 2.298, p = 0.188). Similarly, complications were observed in 8 (25.8%) of those operated on for hernia and absent in 23 (74.2%), with no significant association (χ^2 = 2.835, p = 0.120).

For cholelithiasis, pulmonary morbidity occurred in 6 (35.3%) compared with 11 (64.7%) without complications (χ^2 = 0.064, p = 0.515), and in cholecystitis, 3 (30.0%) developed complications whereas 7 (70.0%) did not (Fisher's exact = 0.302, p = 0.738). Among patients with anterior abdominal wall mass, 1 (20.0%) had complications and 4 (80.0%) did not (Fisher's exact = 0.724, p = 0.647).

However, a statistically significant association was observed in those with liver abscess, where all 3 (100.0%) patients developed post-operative pulmonary complications (Fisher's exact = 5.046, p = 0.047). In contrast, the single patient operated on for adhesive small bowel obstruction developed complications (Fisher's exact = 1.648, p = 0.380), but this was not statistically significant. (Table 4)

Association Between Risk Factors and Post-Operative Pulmonary Complications

Analysis of risk factors associated with post-operative pulmonary complications revealed several significant relationships. Patients aged above 60 years had a notably higher occurrence of pulmonary morbidity, with 16 (69.6%) developing complications compared with 23 (29.9%) among those aged 60 years and below. This association was statistically significant (χ^2 = 9.232, p = 0.003).

Among pre-operative symptoms, shortness of breath showed a strong relationship with postoperative pulmonary complications, as 8 (88.9%) of those who reported this symptom developed complications compared with 31 (34.1%) among those without it (Fisher's exact = 9.044, p = 0.004). Other symptoms such as snoring, cough and wheezing were not significantly associated with postoperative pulmonary morbidity (p > 0.05).

Although pulmonary complications occurred more frequently among hypertensive patients, 17 (51.5%) compared to those without hypertension, 22 (32.8%), this difference was not statistically significant (p = 0.051).

Chronic Obstructive Pulmonary Disease (COPD) showed a significant association, with 6 (75.0%) of affected patients developing complications compared with 33 (35.8%) of those without COPD (χ^2 = 5.053, p = 0.025). Diabetes mellitus, asthma, heart failure and HIV infection did not show statistically significant relationships (p > 0.05).

Body mass index also showed no significant association, though complications occurred more frequently among respondents with BMI below 30 kg/m², 33 (42.3%), than among those with BMI ≥ 30 kg/m², 6 (27.3%) (p = 0.136). However, smoking status was significantly related to postoperative pulmonary morbidity, as complications occurred in 7 (77.8%) of smokers compared with 32 (35.2%) of non-smokers (χ^2 = 6.642, p = 0.014).

Intraoperative factors demonstrated clear associations. Surgical procedures lasting two hours or more were more frequently complicated by pulmonary events, 20 (64.5%), compared with 19 (26.5%) among those with shorter duration of surgeries (p < 0.001). Similarly, the use of long-acting muscle relaxants was associated with higher complication rates, 13 (72.2%), compared with 26 (31.7%) among those who received short-acting agents (χ^2 = 7.657, p = 0.005).

According to American Society of Anesthesiologists (ASA) classification, complications occurred in 3 (11.5%) of patients in Class I, 17 (35.4%) in Class II, and 19 (73.1%) in Class III. The relationship between ASA class and postoperative pulmonary morbidity was statistically significant (χ^2 = 12.027, p = 0.001). (Table 5)

Predictors of Post-Operative Pulmonary Complications

Patients who did not report shortness of breath pre-operatively had significantly lower odds of developing pulmonary complications (OR = 1.008, 95% CI: 0.009–0.886, p = 0.040) compared with those who presented with shortness of breath. Likewise, non-smokers were significantly less likely to develop pulmonary morbidity compared with smokers (OR = 1.019, 95% CI: 0.030–1.149, p = 0.043).

The use of long-acting muscle relaxants remained an independent predictor of pulmonary complications, with an odds ratio of 1.231 (95% CI: 0.145–2.290, p = 0.048), indicating a higher likelihood of adverse respiratory outcomes compared to those who received short-acting agents. Prolonged duration of surgery beyond two hours was also significantly associated with pulmonary morbidity (OR = 1.000, 95% CI: 0.076–0.735, p = 0.010).

Patients with low pre-operative serum albumin levels demonstrated a higher risk of pulmonary complications (OR = 1.021, 95% CI: 0.866–0.922, p = 0.021), suggesting the role of poor nutritional status in respiratory outcomes. Similarly, those without radiological features of fibrosis (OR = 1.010, 95% CI: 0.025–0.743, p = 0.019) and

hyperinflation (OR = 1.019, 95% CI: 0.011–0.998, p = 0.049) showed lower odds compared with patients in whom these features were present.

Pre-operative respiratory rate was another significant predictor (OR = 1.883, 95% CI: 1.173–3.038, p = 0.010), indicating that an increased respiratory rate before surgery was associated with a higher risk of pulmonary morbidity. Although age, body mass index, oxygen saturation and pre-operative temperature showed trends toward significance, their associations did not reach statistical significance (p > 0.05). (Table 6)

Table 1: Sociodemographic characteristics of the respondents

Variable	Freque ncy(N=100)	Percentage (%)
Age Group (years)		
20 – 30	10	10.0
31 – 40	17	17.0
41 – 50	25	25.0
51 – 60	25	25.0
> 60	23	23.0
Mean Age (years)	49.16 ± 12.9	
Sex		
Male	41	41.0
Female	59	59.0
Marital Status		
Married	66	66.0
Single	23	23.0
Widow ed	6	6.0
Separated	5	5.0
Level of Education		
No formal education	4	4.0
Primary	15	15.0
Secondary	42	42.0
Tertiary	39	39.0
Ethnicity		
Bini	41	41.0
Esan	18	18.0
Etsako	9	9.0
Igbo	7	7.0
Yoruba	6	6.0
Hausa	3	3.0
Others	16	16.0
Religion		
Chr istianity	86	86.0
African traditional religion	9	9.0
Islam	5	5.0

Table 2: Pre-Operative Risk Assessment

Risk Factors	Frequency (n = 100)	Percentage (%)
Pre-operative Respiratory Symptoms*		
No symptoms	71	71.0
Snoring	18	18.0
Shortness of breath	8	8.0
Wheezing	2	2.0
Cough	1	1.0
Past Medical History		
Hypertension	67	67.0
Obesity	22	22.0
Diabetes mellitus	16	16.0
Serum studies		
Elevated serum urea (> 50mg/dl)	3	3.0
Low serum albumin (< 34g/l)	42	42.0
American Society of Anesthesiology Class		
I	26	26.0
II	49	49.0
III	25	25.0

Multiple responses

Table 3: Procedure Related Risk Assessment

Risk	Frequency (n=100)	Percentage (%)
Muscle Relaxants		
Short acting	82	82.0
Long acting	18	18.0
Duration of Surgery		
< 2 hours	68	68.0
> 2 hours	32	32.0

Table 4: Association Between Indications for Surgery and Post Operative Pulmonary Complications

Diagnosis	Post-Operative Pulmonary Complications		Test Statistic	p-value
	Present Freq (%)	Absent Freq (%)		
Intra-abdominal malignancy	16 (48.5)	17 (51.5)	2.298[a]	0.188
Hernia	8 (25.8)	23 (74.2)	2.835[a]	0.120
Cholelithiasis	6 (35.3)	11 (64.7)	0.064[a]	0.515
Cholecystitis	3 (30.0)	7 (70.0)	0.302[b]	0.738
Anterior abdominal wall mass	1 (20.0)	4 (80.0)	0.724[b]	0.647
Liver abscess	3 (100.0)	0 (0.0)	5.046[b]	0.047
Adhesive small bowel obstruction	1 (100.0)	0 (0.0)	1.648[b]	0.380

[a]Chi Square, [b] Fischers test

Table 5: Association Between Risk Factors and Post-Operative Pulmonary Complications

Risk Factors	POPCs		Test statistic	p-value
	Present Freq (%)	Absent Freq (%)		
Age (years)				
. . .	23 (29.9)	54 (70.1)	9.232[a]	0.003
> 60	16 (69.6)	7 (30.4)		
Pre-operative Symptoms				
Snoring				
Yes	7 (38.9)	11 (61.1)	0.007[a]	0.932
No	32 (39.0)	50 (61.0)		
Shortness of breath				
Yes	8 (88.9)	1 (11.1)	9.044[b]	0.004
No	31 (34.1)	60 (65.9)		
Cough				
Yes	1 (100.0)	0 (0.0)	1.648[b]	0.380
No	38 (38.3)	61 (61.7)		
Wheezing				
Yes	2 (100.0)	0 (0.0)	3.330[b]	0.068
No	37 (37.7)	61 (62.3)		
Hypertension				
Yes	17 (51.5)	16 (48.5)	3.819[a]	0.051
No	22 (32.8)	45 (67.2)		
Diabetes				
Yes	8 (50.0)	8 (50.0)	1.164[a]	0.281
No	31 (36.9)	53 (63.1)		
Heart failure				
Yes	2 (100.0)	0 (0.0)	3.330[b]	0.068
No	37 (37.7)	61 (62.3)		
Asthma				
Yes	4 (57.1)	3 (42.9)	1.171[a]	0.279
No	35 (37.6)	58 (62.4)		
COPD				
Yes	6 (75.0)	2 (25.0)	5.053[a]	0.025
No	33 (35.8)	59 (64.2)		
HIV				
Yes	4 (40.0)	6 (60.0)	0.019[a]	0.891
No	57 (63.3)	33 (36.7)		
BMI (kg/m^2)				
<30	33 (42.3)	45 (57.7)	2.792[a]	0.136
. . .	6 (27.3)	16 (72.7)		
Smoking status				
Smokers	7 (77.8)	2 (22.2)	6.642[a]	0.014
Non-smokers	32 (35.2)	59 (64.8)		
Surgery Duration (hours)				
< 2	19(26.5)	50(73.5)	11.989[a]	<0.001
≥2	20(64.5)	11(35.5)		
Muscle Relaxants				
Short acting	26(31.7)	56(68.3)	7.657[a]	0.005
Long acting	13(72.2)	5(27.8)		
ASA Class				
I	3(11.5)	23(88.5)	12.027[a]	0.001
II	17(35.4)	31(64.6)		
III	19(73.1)	7(26.9)		
[a]Chi Square, [b] Fischers test				

Table 6: Multivariate Logistic Regression Analysis for the Significant Predictors of Post-Operative Pulmonary Complications.

Predictor	B (Regression Coefficient)	Odds Ratio (OR)	95% CI For OR		p-value
			Lower	Upper	
Age (years)					
. . . .		1			
> 60	-1.049	0.345	0.105	1.165	0.085
Shortness of Breath					
Yes*		1			
No	-2.422	1.008	0.009	0.886	0.040
Smoking					
Yes		1			
No	-1.729	1.019	0.030	1.149	0.043
Muscle Relaxants					
Short acting*		1			
Long acting	-0.55	1.231	0.145	2.29	0.048
Duration of Surgery (hours)					
< 2 *		1			
> 2	-1.433	1.000	0.076	0.735	0.010
BMI (kg/m^2)	-0.110	0.895	0.795	1.008	0.068
Low serum albumin (g/l)	-0.061	1.021	0.866	0.922	0.021
FEV_1	0.163	1.009	0.008	165.837	0.988
FEV_1/FVC ratio	-5.426	0.001	0.000	940.901	0.320
PEF	-0.004	0.997	0.981	1.009	0.569
Fibrosis					
Yes*		1			
No	-1.957	1.010	0.025	0.743	0.019
Hyperinflation					
Yes*		1			
No	-2.145	1.019	0.011	0.998	0.049
Liver Abscess					
Yes*		1			
No	-19.523	0.000	0.000	.	0.999
Respiratory Rate					
Pre-op	0.633	1.883	1.173	3.038	0.010
O_2 Saturation					
Pre-op	-0.148	0.858	0.509	1.474	0.590
Temperature					
Pre-op	1.325	3.775	0.612	23.162	0.149

Reference category

DISCUSSION

This study assessed the modifiable and non-modifiable risk factors associated with pulmonary morbidity following elective abdominal surgery at the University of Benin Teaching Hospital. The findings highlight the complex interplay of demographic, clinical and procedural factors that contribute to the occurrence of post-operative pulmonary complications (POPCs). The mean age of participants was 49.16 ± 12.9 years, and most respondents were between 41 and 60 years of age. Also, majority of participants were married and educated, reflecting the general sociodemographic pattern of patients attending tertiary hospitals in southern Nigeria.

Pre-operative evaluation revealed that over two-thirds of patients had no respiratory symptoms prior to surgery, suggesting that most presented for non-thoracic conditions with relatively stable respiratory status. Pulmonary complications were observed to occur following elective abdominal surgery, with multiple clinical and procedural factors contributing to their development. Advancing age was a major determinant, as complications were more frequent among patients over 60 years. This agrees with reports that advancing age is one of the strongest non-modifiable predictors of postoperative respiratory events due to physiological decline in lung elasticity, reduced cough reflex and impaired mucociliary clearance.[16] Older adults also tend to have comorbidities that further compromise pulmonary reserve.

Shortness of breath was the most important pre-operative symptom associated with pulmonary morbidity. Its presence likely indicates underlying respiratory compromise, which increases the risk of hypoventilation and secretion retention during and after surgery. Similar findings were reported by Wilson et al.[17] and Neder et al.[18], who identified pre-operative dyspnoea as a reliable clinical marker of reduced ventilatory function. In contrast, symptoms such as snoring, wheezing or cough were less predictive.

Low serum albumin was also significantly related to pulmonary complications. Hypoalbuminaemia reduces plasma oncotic pressure, impairs tissue healing, and weakens diaphragmatic performance, thereby predisposing to postoperative atelectasis and infection. Similar observations were made by Llombart et al.[19] and Laskar et al.[20], who noted that hypoalbuminemia contributed significantly to development of post operative complications due to increased rate of infections and reduced wound healing.

Smoking and chronic obstructive pulmonary disease (COPD) were strong modifiable risk factors identified in this study. Smokers and those with chronic airway disease developed more respiratory events than their non-smoking counterparts. Cigarette smoke impairs mucociliary clearance, increases airway reactivity and predisposes to infection, while COPD further worsens gas exchange through airway obstruction. These findings mirror previous studies by Shigeeda et al.[21], which showed that smoking cessation at least four to six weeks before surgery improves pulmonary outcomes.

Intraoperative parameters also played an important role. Pulmonary morbidity was more frequent among patients whose surgeries lasted longer than two hours and among those who received long-acting muscle relaxants. Prolonged surgery and anesthesia are known to depress diaphragmatic motion, promote alveolar collapse and delay respiratory recovery.[22,23] The use of long-acting muscle relaxants, in particular, may contribute to residual neuromuscular blockade and hypoventilation in the immediate postoperative period. These findings are consistent with the work of Miskovic and Lumb[1], who linked extended operative duration and deeper anesthesia levels with increased incidence of atelectasis and postoperative pneumonia.

The American Society of Anesthesiologists (ASA) classification correlated significantly with pulmonary complications, with patients in Class III showing the highest rates. This reflects that increasing systemic disease burden directly affects pulmonary resilience during the perioperative period.[24] The ASA score therefore remains a valid and practical tool for pre-operative risk stratification.

Radiological features such as pulmonary fibrosis and hyperinflation were also associated with increased risk, suggesting that structural lung changes substantially reduce postoperative ventilatory efficiency. Similarly, patients with elevated pre-operative respiratory rates were more likely to develop complications, indicating that subtle derangements in respiratory pattern may serve as early indicators of compromised pulmonary function.

LIMITATIONS OF THE STUDY

This study was limited by its single-center design, which may restrict the generalizability of findings to other settings with different patient populations or perioperative

protocols. Some pre-operative histories, such as smoking duration or prior respiratory illness, were self-reported and subject to recall bias. Despite these limitations, the study provides valuable local evidence on the determinants of postoperative pulmonary morbidity and highlights key targets for preventive intervention in elective abdominal surgery.

CONCLUSION

This study demonstrated that postoperative pulmonary complications remain a significant outcome following elective abdominal surgery. Both modifiable and non-modifiable factors influenced their occurrence, with advancing age, smoking, low serum albumin, prolonged surgery, long-acting muscle relaxants and pre-operative respiratory symptoms emerging as key determinants.

RECOMMENDATIONS

1. Pre-operative optimization should be prioritized for all elective surgical patients, including smoking cessation, nutritional supplementation and spirometric assessment of respiratory function. 2. Anaesthetic teams should favour short-acting muscle relaxants and target operative durations under two hours where clinically feasible, as both were identified as independent predictors of pulmonary morbidity. 3. Tertiary hospitals in Nigeria should adopt standardized perioperative care bundles incorporating incentive spirometry, early ambulation, adequate analgesia and postoperative physiotherapy to reduce pulmonary complications after elective abdominal surgery.

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