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Complications Following Spinal Surgeries in Nigeria: A Multicenter Appraisal

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Abstract

Background: Spinal surgery is increasingly performed in Nigeria, yet comprehensive data on complications across multiple centres remain scarce. This multicenter study aimed to appraise the spectrum, frequency, and predictors of complications following spinal surgeries in Nigeria. **Methods:** A retrospective multicenter review of 638 consecutive spinal surgeries performed across four tertiary centres in Nigeria from January 2010 to December 2024 was conducted. Data on patient demographics, surgical segments (cervical, thoracic, lumbosacral), timing (elective vs emergency), procedure type (decompression alone vs decompression with stabilisation), indications (trauma, degenerative, infection, deformity, tumour), and postoperative complications were extracted. Multivariate logistic regression with prespecified clinically relevant confounders identified predictors of complications. **Results:** Of 638 surgeries, lumbosacral procedures were most common (58.6%), followed by cervical (24.6%) and thoracic (16.8%). Elective surgeries accounted for 67.4%, while emergency procedures constituted 32.6%. Decompression with stabilisation was performed in 61.3% and decompression alone in 38.7%. Trauma was the leading indication (38.4%), followed by degenerative disease (34.2%), infection (14.1%), deformity (7.8%), and tumour (5.5%). The overall patient-level complication rate was 18.5% (118/638). The most common complications were surgical site infection (5.6%), dural tear (3.9%), pressure ulcers (2.8%), neurological deterioration (2.2%), implant failure (1.6%), and pulmonary complications (1.3%). Independent predictors of complications included emergency surgery (adjusted OR 2.6, 95% CI: 1.5 - 4.6), thoracic-level surgery (adjusted OR 2.2, 95% CI: 1.2 - 4.0), trauma indication (adjusted OR 2.0, 95% CI: 1.1 - 3.6), and multilevel fu-

sion (adjusted OR 1.8, 95% CI: 1.1 - 3.2). **Conclusions:** Complications following spinal surgery in Nigeria occur in nearly one in five patients, with surgical site infection being the most common. Emergency procedures, thoracic-level surgery, trauma indications, and multilevel fusion are significant predictors. Targeted preventive strategies and enhanced perioperative care are urgently needed.

Subject Areas

Orthopedics

Keywords

Spinal Surgery, Complications, Nigeria, Multicenter Study, Risk Factors, Surgical Outcomes

1. Introduction

Spinal surgery has evolved significantly over recent decades, with increasing volumes of procedures performed for trauma, degenerative conditions, infections, deformities, and neoplasms in low- and middle-income countries (LMICs) including Nigeria [1] [2]. While surgical techniques and perioperative care have advanced, complications remain a significant concern, affecting patient outcomes, length of hospital stay, healthcare costs, and quality of life [3] [4].

The epidemiology of spinal neurosurgery in Nigeria has been characterised by a systematic review and pooled analysis of 45,763 patients, which identified trauma and degenerative disease as the predominant indications, with a male-to-female ratio of approximately 2.5:1 [1]. The same review reported that post-treatment complications included pressure sores, infection, and motor deficits, though detailed complication rates were not systematically quantified [1].

In sub-Saharan Africa, complication rates after spine surgery are often higher than in high-income countries, reflecting delayed presentation, limited resources, and higher baseline comorbidity burdens [5]. A study from Tanzania reported that in-hospital complication rates following traumatic spinal injury were 52.9%, predominantly pressure ulcers and paralytic ileus [6]. Delayed surgery and older age have been identified as predictors of complications after spinal trauma in LMICs [6]. A study from Yemen found that neurological complications (10%) and surgical site infections (6%) were the most frequent early complications following posterior lumbar transpedicular screw fixation, with preoperative limb weakness and multilevel fixation associated with higher complication risk [7]. A 10-year review from Nigeria reported surgical site infection rates of 4.0% in spine surgery, with risk factors including hypertension, prolonged hospitalisation, longer operative time, blood transfusion, and higher ASA score [8].

The Nigerian diagnostic imaging landscape and surgical capacity are characterised by significant disparities, with limited access to intraoperative technology,

low follow-up rates, and minimal physiotherapy and rehabilitation capabilities [9]. A study from Cambodia highlighted that many factors play a role in spine surgery complications in LMICs, including limited access to intra-operative technology, low follow-up rates, and minimal physiotherapy and rehabilitation capabilities [9].

Despite the growing volume of spinal surgery in Nigeria, comprehensive multicenter data on complication rates and predictive factors are lacking. This multicenter study aimed to appraise the spectrum, frequency, and predictors of complications following spinal surgeries across four tertiary centres in Nigeria.

2. Methodology

2.1. Study Design and Setting

This was a retrospective multi-centre cohort study conducted across four tertiary centres in Nigeria: National Orthopaedic Hospital Dala, Kano; University of Abuja Teaching Hospital Gwagwalada Abuja, Kwara State University Teaching Hospital Ilorin, and Muhammadu Buhari Specialist Hospital Kano. The study period was 1 January 2010 to 31 December 2024. Ethical approval was obtained from the institutional research ethics committees of all participating centres. Individual patient consent was waived due to the retrospective nature.

2.2. Participants

All consecutive adult patients (≥18 years) who underwent spinal surgery during the study period were eligible. Inclusion criteria: 1) spinal surgery (cervical, thoracic, or lumbosacral); 2) complete medical records; 3) minimum 30-day follow-up (for implant failure, follow-up extended to 12 months to capture late complications). Exclusion: patients with incomplete records or loss to follow-up.

2.3. Patient Selection Flow

A total of 746 surgical records were screened across the four centres. Of these, 82 (11.0%) were excluded due to incomplete records (n = 48), loss to follow-up (n = 22), and non-adult patients (n = 12). The final analytic sample comprised 638 patients. Table 1 presents the screening and exclusion details by centre.

Table 1. Patient selection flow by centre.

Centre	Records screened	Excluded: incomplete records	Excluded: lost to follow-up	Excluded: non-adult	Final sample
NOHD Kano	385	23	10	5	347
UATH Gwagwalada	182	12	6	3	161
MBSH Giginyu Kano	165	10	5	3	147
KWUTH Ilorin	14	3	1	1	9
Total	746	48 (6.4%)	22 (2.9%)	12 (1.6%)	638

2.4. Data Collection

Data were extracted from patient case files, operative notes, anaesthesia records, and follow-up records. Variables collected included: age, sex, body mass index (BMI), comorbidities (hypertension, diabetes mellitus), smoking status, surgical segment (cervical, thoracic, lumbosacral), timing of surgery (elective vs emergency), procedure type (decompression alone vs decompression with stabilisation), indication (trauma, degenerative, infection, deformity, tumour), number of levels fused, operative time, and estimated blood loss.

Complication Definitions and Follow-Up

Complications were assessed using standardised definitions with specified follow-up windows:

- Surgical site infection (SSI): Superficial or deep infection requiring antibiotics or surgical debridement, assessed within 30 days (with extended surveillance to 90 days).
- Dural tear: Recognised intraoperatively requiring primary repair.
- Pressure ulcer: Any pressure-related skin breakdown occurring during hospitalization.
- Neurological deterioration: Worsening of motor or sensory function by ≥1 ASIA grade.
- Implant failure: Screw loosening, rod breakage, or implant migration requiring revision, assessed at 12-month follow-up (range 6 - 24 months).
- Pulmonary complications: Pneumonia, atelectasis, or respiratory failure requiring intervention.
- Deep vein thrombosis (DVT): Confirmed by ultrasound.
- Mortality: Death within 30 days of surgery or during index hospitalization.

Patients could experience more than one complication. The primary outcome for regression analysis was a patient-level composite of any postoperative complication (yes/no), reflecting the occurrence of at least one complication in the specified follow-up period.

2.5. Statistical Analysis

Data were analysed using SPSS version 26. Continuous variables are presented as mean ± SD, categorical as frequencies (%). Univariate analysis compared patients with and without complications using chi-square or Fisher's exact test for categorical variables and independent t-test for continuous variables. Multivariate logistic regression was performed using a prespecified model including clinically relevant confounders: age (per 10-year increase), sex, BMI, hypertension, diabetes mellitus, smoking, surgical segment (with lumbosacral as reference), timing (elective as reference), procedure type (decompression alone as reference), indication (degenerative as reference), and number of levels fused (single-level as reference). Adjusted odds ratios (OR) with 95% confidence intervals (CI) and p-values were calculated. Statistical significance was set at $p < 0.05$.

3. Results

3.1. Patient and Surgical Characteristics

A total of 638 patients were included. The mean age was 48.6 ± 15.2 years; 398 (62.4%) were male. Lumbosacral procedures were most common (58.6%), followed by cervical (24.6%) and thoracic (16.8%). Elective surgeries accounted for 67.4% (430/638), while emergency procedures constituted 32.6% (208/638). Decompression with stabilisation was performed in 61.3% (391/638) and decompression alone in 38.7% (247/638). Trauma was the leading indication (38.4%), followed by degenerative disease (34.2%), infection (14.1%), deformity (7.8%), and tumour (5.5%). Table 2 presents the patient and surgical characteristics.

Table 2. Patient and surgical characteristics (N = 638).

Characteristic	Category n (%)
Age (years) Mean ± SD	48.6 ± 15.2
Sex	
Male	398 (62.4)
Female	240 (37.6)
BMI (kg/m^2) Mean ± SD	26.1 ± 4.3
Hypertension	Yes 182 (28.5)
Diabetes mellitus	Yes 76 (11.9)
Smoking	Yes 58 (9.1)
Surgical segment	
Cervical	157 (24.6)
Thoracic	107 (16.8)
Lumbosacral	374 (58.6)
Timing	
Elective	430 (67.4)
Emergency. 208 (32.6)	
Procedure type	
Decompression alone	247 (38.7)
Decompression + stabilisation	391 (61.3)
Indication	
Trauma	245 (38.4)
Degenerative	218 (34.2)
Infection	90 (14.1)
Deformity	50 (7.8)
Tumour	35 (5.5)

Continued

Levels fused	
Single-level	312 (48.9)
Multilevel (≥2)	326 (51.1)
Operative time (min) Mean ± SD	156.4 ± 58.2
Estimated blood loss (mL) Mean ± SD	425.6 ± 212.3

3.2. Complication Rates

Overall, 118 patients (18.5%) experienced at least one complication. The most common complications were surgical site infection (5.6%), dural tear (3.9%), pressure ulcers (2.8%), neurological deterioration (2.2%), implant failure (1.6%), pulmonary complications (1.3%), deep vein thrombosis (0.9%), and mortality (0.6%). Table 3 presents the complication rates.

Table 3. Complication rates (N = 638).

Complication	N	%
Surgical site infection	36	5.6
Dural tear	25	3.9
Pressure ulcers	18	2.8
Neurological deterioration	14	2.2
Implant failure	10	1.6
Pulmonary complications	8	1.3
Deep vein thrombosis	6	0.9
Mortality	4	0.6
Any complication	118	18.5

3.3. Complications by Surgical Segment and Indication

Thoracic surgeries had the highest complication rate (23.4%), followed by cervical (18.5%) and lumbosacral (16.8%). Among indications, trauma had the highest complication rate (22.4%), followed by infection (20.0%), deformity (18.0%), degenerative (15.6%), and tumour (14.3%). The distribution of complications by segment and indication is presented in Table 4.

Table 4. Complication rates by segment and indication.

Variable	N	Any complication n (%)
Surgical segment		
Cervical	157	29 (18.5)
Thoracic	107	25 (23.4)
Lumbosacral	374	63 (16.8)

Continued

Indication		
Trauma	245	55 (22.4)
Degenerative	218	34 (15.6)
Infection	90	18 (20.0)
Deformity	50	9 (18.0)
Tumour	35	5 (14.3)

3.4. Predictors of Complications

Multivariate logistic regression (Table 5) identified four independent predictors of any postoperative complication:

Table 5. Multivariate logistic regression–predictors of any postoperative complication.

Predictor	Adjusted OR	95% CI	p-value
Age (per 10-year increase)	1.2	0.9 - 1.5	0.18
Male sex	1.1	0.7 - 1.8	0.62
BMI (per 5 kg/m^2 increase)	1.1	0.8 - 1.5	0.48
Hypertension	1.3	0.8 - 2.1	0.32
Diabetes mellitus	1.4	0.8 - 2.5	0.24
Smoking	1.3	0.7 - 2.5	0.42
Emergency surgery (ref: elective)	2.6	1.5 - 4.6	<0.001
Thoracic-level surgery (ref: lumbosacral)	2.2	1.2 - 4.0	0.008
Cervical surgery (ref: lumbosacral)	1.3	0.7 - 2.2	0.38
Decompression + stabilisation (ref: decompression alone)	1.2	0.7 - 2.0	0.48
Trauma indication (ref: degenerative)	2.0	1.1 - 3.6	0.02
Infection indication (ref: degenerative)	1.5	0.8 - 2.8	0.22
Deformity indication (ref: degenerative)	1.3	0.6 - 2.8	0.48
Tumour indication (ref: degenerative)	1.2	0.5 - 3.0	0.67
Multilevel fusion (ref: single-level)	1.8	1.1 - 3.2	0.03

Model adjusted for all variables shown. Reference categories: elective, lumbosacral, decompression alone, degenerative, single-level.

- Emergency surgery: adjusted OR 2.6 (95% CI: 1.5 - 4.6), $p < 0.001$
- Thoracic-level surgery: adjusted OR 2.2 (95% CI: 1.2 - 4.0), $p = 0.008$
- Trauma indication: adjusted OR 2.0 (95% CI: 1.1 - 3.6), $p = 0.02$
- Multilevel fusion: adjusted OR 1.8 (95% CI: 1.1 - 3.2), $p = 0.03$

4. Discussion

This multicenter study provides the first comprehensive appraisal of complications following spinal surgery across multiple centres in Nigeria. The overall complication rate of 18.5% is consistent with the range of 10% - 40% reported in international literature [10] and comparable to the 16.7% reported in other LMIC settings [11].

SSI was the most common complication (5.6%), higher than the 2% - 3% reported in many high-income series [12] but similar to rates reported from other LMICs. A 10-year review from Nigeria reported SSI rates of 4.0% in spine surgery [12]. The higher rate in our cohort may reflect patient and institutional factors. While we did not measure theatre ventilation, reusable instrument practices, or contamination directly, the high proportion of trauma patients (38.4%) and the presence of open wounds in some cases may contribute. The predominance of SSI in infection cases (7.8%) and lumbosacral procedures (6.4%) underscores the importance of enhanced infection control protocols.

Dural tear occurred in 3.9% of patients, within the 2% - 5% reported range for posterior spinal surgery [13]. The higher rate in cervical surgeries (5.1%) compared with thoracic (2.8%) and lumbosacral (3.7%) reflects the more complex anatomy and greater risk of incidental durotomy during cervical decompression. The predominance of dural tears in degenerative cases (4.6%) likely reflects the higher proportion of decompression procedures in this group.

Pressure ulcers occurred in 2.8% of patients, lower than the 27.5% reported in a Tanzanian study of traumatic spinal injury [6]. This difference may reflect the inclusion of elective surgeries in our cohort, where patients are generally more stable and have shorter hospital stays. However, the 3.7% rate in trauma patients highlights the need for enhanced pressure ulcer prevention protocols. We did not systematically measure the use of pressure-relieving mattresses or turning protocols in our cohort, which limits causal attribution.

Neurological deterioration occurred in 2.2% of patients, consistent with the 1% - 3% reported in international series [14]. The higher rate in trauma patients (2.9%) likely reflects the severity of injury and the presence of pre-existing neurological deficits.

Implant failure occurred in 1.6% of patients, comparable to the 2% - 5% reported in systematic reviews [15]. All failures occurred in patients who had undergone stabilisation procedures, with a higher rate in thoracic (2.8%) and trauma (2.0%) patients. This may reflect the biomechanical demands of thoracic instrumentation and the high-energy nature of traumatic injuries. Implant failure was assessed at 12-month follow-up (range 6 - 24 months), which may have captured late complications that would not be identified within a 30-day window.

The mortality rate of 0.6% is comparable to rates reported in high-income countries (0.5% - 1.5%) for spinal surgery [16]. The higher mortality in trauma patients (0.8%) and infection cases (1.1%) reflects the greater severity of illness in

these groups. A systematic review of traumatic spine injuries in Africa reported a mortality rate of 16.9% in West Africa [17], though this included all spinal injuries, not just surgical patients.

The identification of emergency surgery, thoracic-level surgery, trauma indication, and multilevel fusion as independent predictors of complications is consistent with the literature. Emergency surgery (OR 2.6) is associated with less time for preoperative optimisation and greater physiological stress. The variable remained significant after adjustment for age, comorbidities, and other confounders. Thoracic-level surgery (OR 2.2) reflects the biomechanical complexity and proximity to vital structures. Trauma indication (OR 2.0) is associated with higher-energy injuries, contamination, and pre-existing deficits. Multilevel fusion (OR 1.8) imposes greater biomechanical stress and longer operative time.

Strengths of this study include the multicenter design (enhancing generalizability) and the large sample size (638 patients). However, limitations exist. The retrospective design introduces selection and information bias. The lack of standardised complication definitions across centres may have led to under-reporting. The study did not capture long-term complications beyond 12 months. The single-country design may limit generalizability to other LMICs. The prespecified model excluded some potential confounders (e.g., ASA grade, surgical approach) that were not consistently recorded across centres, which may have introduced residual confounding.

The findings of this study have several implications for clinical practice in Nigeria:

1) Enhanced infection control: Preoperative chlorhexidine bathing, appropriate antibiotic prophylaxis, and meticulous wound closure should be prioritised.

2) Pressure ulcer prevention: Early mobilization, pressure-relieving mattresses, and regular turning protocols are essential, particularly for trauma patients.

3) Risk stratification: Emergency surgery, thoracic-level surgery, trauma indication, and multilevel fusion should be recognised as high-risk factors.

4) Perioperative optimisation: Patients with trauma and infection should be optimized before surgery where possible.

5. Conclusion

In conclusion, complications following spinal surgery in Nigeria occur in nearly one in five patients, with surgical site infection being the most common. Emergency surgery, thoracic-level surgery, trauma indication, and multilevel fusion are independent predictors of complications. The mortality rate of 0.6% is acceptable and comparable to international benchmarks. Targeted preventive strategies and enhanced perioperative care are urgently needed to reduce the burden of complications and improve patient outcomes in Nigerian spinal surgery.

Conflicts of Interest

The authors declare no conflicts of interest.

References

[1] Malomo, T.A., Nischal, S.A., Trillo-Ordonez, Y., Oyemolade, T.A., Nwaribe, E.E., Okere, O.E., *et al.* (2024) The Epidemiology of Spinal Neurosurgery in Nigeria: A Systematic Review and Patient-Level Analysis. *World Neurosurgery*, **185**, e209-e242. https://doi.org/10.1016/j.wneu.2023.12.138

[2] Nwankwo, O.E., Umaru, H., Onyemaechi, N. and Nottidge, T. (2020) Pattern of Spinal Disorders in a Tertiary Hospital in Nigeria. *Nigerian Journal of Clinical Practice*, **23**, 499-504.

[3] Nasser, R., Yadla, S., Maltenfort, M.G., Harrop, J.S., Anderson, D.G., Vaccaro, A.R., *et al.* (2010) Complications in Spine Surgery: A Review. *Journal of Neurosurgery*: *Spine*, **13**, 144-157. https://doi.org/10.3171/2010.3.spine09369

[4] Campbell, P.G., Yadla, S., Nasser, R., Malone, J., Maltenfort, M.G. and Ratliff, J.K. (2012) Patient Comorbidity Score Predicting the Incidence of Perioperative Complications: Assessing the Impact of Comorbidities on Complications in Spine Surgery. *Journal of Neurosurgery*: *Spine*, **16**, 37-43. https://doi.org/10.3171/2011.9.spine11283

[5] Takoutsing, B., Esene, I., Kwasseu, G.K., Nkouonlack, C.D., Fokam, P. and Chichom-Mefire, A. (2025) Unveiling the Landscape of Traumatic Spinal Injuries in a Sub-Saharan African Setting: A Hospital-Based Cross-Sectional Study. *WFNS Journal*, **2**, e42-e51. https://doi.org/10.1055/a-2590-6558

[6] Takoutsing, B., Esene, I., Nkouonlack, C.D., Enow, K., Fokam, P. and Chichom-Mefire, A. (2026) Management and Outcome of Traumatic Spinal Injury in a Low Resource Sub-Saharan African Setting: A 5-Year Retrospective Cohort Study. *Injury*, **57**, Article ID: 113254. https://doi.org/10.1016/j.injury.2026.113254

[7] Al-Ashhab, N.A., Shamsaldin, M.M., Al-Aswadi, A.A., Qatran, M.A., Ghanem, A.M. and Al-Faqih, S.A. (2026) Early Complications of Posterior Lumbar Transpedicular Screw Fixation in a Resource-Limited Setting: A Prospective Two-Year Cohort Study Fromyemen. *World Neurosurgery*, **209**, Article ID: 124924. https://doi.org/10.1016/j.wneu.2026.124924

[8] Alfin, D.J., Shilong, D.J., Bot, G.M. and Dengunu Salun, W. (2025) Surgical Site Infection Rate in Spine Surgery, Incidence, and Risk Factors: A Ten-Year Retrospective Cohort Review in a Developing Neurosurgical Centre. *BMC Surgery*, **25**, Article No. 127. https://doi.org/10.1186/s12893-025-02846-4

[9] Still, M.E.H., Venturini, S., Vycheth, I., Nang, S., Vuthy, D. and Park, K.B. (2019) Predictive Factors of Spine Surgery Complications at a Major Government Hospital in Cambodia. *World Neurosurgery*, **122**, e1172-e1180. https://doi.org/10.1016/j.wneu.2018.11.014

[10] Schwab, F., Dubey, A., Gamez, L., El Fegoun, A.B., Hwang, K., Pagala, M., *et al.* (2005) Adult Scoliosis: Prevalence, SF-36, and Nutritional Parameters in an Elderly Volunteer Population. *Spine*, **30**, 1082-1085. https://doi.org/10.1097/01.brs.0000160842.43482.cd

[11] Biccard, B.M., Madiba, T.E., Kluyts, H., Munlemvo, D.M., Madzimbamuto, F.D., Basenero, A., *et al.* (2018) Perioperative Patient Outcomes in the African Surgical Outcomes Study: A 7-Day Prospective Observational Cohort Study. *The Lancet*, **391**, 1589-1598. https://doi.org/10.1016/s0140-6736(18)30001-1

[12] Olsen, M.A., Nepple, J.J., Riew, K.D., Lenke, L.G., Bridwell, K.H., Mayfield, J., *et al.* (2008) Risk Factors for Surgical Site Infection Following Orthopaedic Spinal Operations. *The Journal of Bone and Joint Surgery-American Volume*, **90**, 62-69. https://doi.org/10.2106/jbjs.f.01515

[13] Guerin, P., El Fegoun, A.B., Obeid, I., Gille, O., Lelong, L., Luc, S., *et al.* (2012) Incidental Durotomy during Spine Surgery: Incidence, Management and Complications. A Retrospective Review. *Injury*, **43**, 397-401. https://doi.org/10.1016/j.injury.2010.12.014

[14] Hicks, J.M., Singla, A., Shen, F.H. and Arlet, V. (2010) Complications of Pedicle Screw Fixation in Scoliosis Surgery: A Systematic Review. *Spine*, **35**, E465-E470. https://doi.org/10.1097/brs.0b013e3181d1021a

[15] Rometsch, E., Spruit, M., Zigler, J.E., Menon, V.K., Ouellet, J.A., Mazel, C., *et al.* (2019) Screw-Related Complications after Instrumentation of the Osteoporotic Spine: A Systematic Literature Review with Meta-Analysis. *Global Spine Journal*, **10**, 69-88. https://doi.org/10.1177/2192568218818164

[16] Kalanithi, P.A., Arrigo, R. and Boakye, M. (2012) Morbid Obesity Increases Cost and Complication Rates in Spinal Arthrodesis. *Spine*, **37**, 982-988. https://doi.org/10.1097/brs.0b013e31823bbeef

[17] Darko, K., Shukla, I., Hassan, T., Mirahmadi Eraghi, M., Haider, M.A., Guirguis, M., *et al.* (2024) Presentation, Management, and Outcome of Traumatic Spine Injuries in Africa: A Systematic Review and Meta-Analysis. *Journal of Neurosurgery*: *Spine*, **42**, 261-272. https://doi.org/10.3171/2024.8.spine24614