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Research Article

Keywords: Non-communicable diseases, NCD, hospital admissions, in-hospital mortality, case-fatality, kidney diseases, temporal trends, seasonality, northeastern Nigeria

Posted Date: November 16th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-11132131/v1

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Additional Declarations: No competing interests reported.

Burden, Temporal Trends, and Seasonality of Non-Communicable Disease Admissions and Outcomes in Northeastern Nigeria: A Seven-Year Time-Series Analysis

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Abstract

Background

Non-communicable diseases (NCDs) are major drivers of morbidity and mortality, with a disproportionate burden in sub-Saharan Africa. Although NCD admission patterns have been described in parts of Nigeria, data from the northeast remain limited. We examined NCD burden, admission patterns, and clinical outcomes at a tertiary hospital over seven years.

Methods

This retrospective study analysed 8,254 adult medical admissions (≥18 years) from January 2019 to December 2025. Admissions were classified as NCD or communicable disease (CD), with NCDs further categorised using World Health Organization classifications as a general guide. Annual admission trends were assessed using Poisson regression, with negative binomial regression as a sensitivity analysis. Case-fatality proportions (CFPs) were calculated annually and by season. Monthly seasonality was assessed using Seasonal-Trend decomposition using LOESS (STL), complemented by the Kruskal–Wallis test. Logistic regression identified predictors of in-hospital mortality.

Results

NCDs accounted for 5,965 (72.3%) of all adult medical admissions. Kidney disease (KD) was the leading NCD category (2,991; 50.1%), followed by cardiovascular diseases (CVD) (1,580; 26.5%) and chronic liver and gastrointestinal diseases (384; 6.4%). NCD admissions increased by 9.4% annually (IRR = 1.094; 95% CI 1.080–1.108; P < 0.001). The overall in-hospital CFP was 9.7% (95% CI 9.0–10.4%), and NCD-related CFR was significantly higher than the CD CFR (10.5% [95% CI 9.6–11.3%] vs. 7.9% [95% CI 6.7–9.1%]; $\chi^2 = 10.56$, P = 0.001). Compared with KD, CVD (aOR 0.68, 95% CI 0.54–0.86), endocrine/metabolic (aOR 0.44, 95% CI 0.25–0.77), and haematological disorders (aOR 0.44, 95% CI 0.24–0.79) were independently associated with lower odds of in-hospital death. STL demonstrated moderate seasonality (seasonal strength=0.391), with peak admissions during the rainy season. However, seasonal variation in both admission and CFP was not significant (*P*=0.595).

Conclusion

NCDs, primarily KD and CVD, make up a significant portion of the adult medical inpatient burden at the study center. NCD admissions increased by approximately 9% per year from 2019 to 2025, though not statistically significant. The in-hospital case fatality proportion for NCDs remains high and has not shown a significant decrease. Future research should extend beyond single-centre hospital-based analyses to multi-centre and population-based surveillance, evaluate post-discharge outcomes, and investigate the drivers of the exceptionally high CKD burden in northeastern Nigeria.

Keywords: Non-communicable diseases, NCD, hospital admissions, in-hospital mortality, case-fatality, kidney diseases, temporal trends, seasonality, northeastern Nigeria.

Introduction

Non-communicable diseases (NCDs) have emerged over the past decades as the primary drivers of global ill-health and mortality, representing one of the greatest public health challenges of the 21st century.[1] According to estimates from the Global Burden of Disease (GBD) study, NCDs accounted for over 43 million deaths and 1.73 billion disability-adjusted life years (DALYs) worldwide in 2021.[2,3] The global burden of NCDs is dominated by cardiovascular diseases (CVD), neoplasms, chronic respiratory diseases, and diabetes, which were responsible for an estimated 19 million, 10 million, 3.97 million, and over 2 million deaths, respectively.[1,4] Despite global efforts, NCD burden continues to rise at an alarming rate, largely driven by population aging, rapid urbanization, epidemiological transition, and increasing exposure to modifiable risk factors such as unhealthy diets, physical inactivity, tobacco use, biomass fuel, and metabolic-related disorders.[5] This burden is disproportionately concentrated in low- and middle-income countries (LMICs), which account for more than 70% of all NCD-related deaths worldwide.[1,3] Moreover, nearly 18 million (41.9%) NCD mortalities occurred prematurely among individuals aged 30–69 years, with approximately 82% of these deaths occurring in LMICs.[1]

This growing inequity is more pronounced in sub-Saharan Africa (SSA), where the burden of NCDs increased by approximately 67% between 1990 and 2017, raising the proportion of total DALYs attributable to these conditions in the region from 18% to 30%.[6] Similarly, NCD-related mortality has risen significantly across the African continent, with the proportion of all deaths attributable to NCDs increasing by 53.3% over the last two decades.[7] The increase in NCD-related morbidity and mortality in Africa and other LMICs is linked to the epidemiological transition, where emerging chronic conditions coexist alongside a persistent burden of infectious diseases.[8,9] This creates a complex, diverse epidemic landscape that further strains already underfunded healthcare systems in the region.[8,9]

NCDs are a major health concern in Nigeria. As Africa's most populous country, Nigeria faces a disproportionate burden of the regional NCD crisis, exerting enormous stress on the country's fragile healthcare system and socioeconomic development.[10] Between 2010 and 2019, NCD-related DALYs in Nigeria increased by 21.3%, predominantly driven by CVD among middle-aged adults aged 45–65 years.[10] According to the World Health Organization (WHO), NCDs

accounted for an age-standardised mortality rate of 565 and 546 deaths per 100,000 population among males and females, respectively, in Nigeria in 2021.[11] Earlier WHO estimates further showed that NCDs were responsible for approximately 29% of the total disease burden in the country, with CVD contributing 11%, cancers 4%, and diabetes mellitus 2%.[12]

Although several studies have investigated the burden of NCDs in Nigeria, existing evidence remains fragmented and geographically limited. Most published studies have focused on community-based estimates of NCD prevalence and associated risk factors[13–16] or have examined specific disease groups[17,18] and selected populations, such as older adults,[16,19] university staff,[20] or civil servants.[21] Hospital-based studies from both southern and northern Nigeria have largely been descriptive, reporting the distribution of admissions and clinical outcomes without evaluating long-term temporal changes and seasonal disease patterns.[19,22–26] Furthermore, some of these studies were conducted over a decade ago, such as the work of Unachukwu and colleagues,[27] limiting their relevance to the evolving epidemiology of NCDs in Nigeria.

In addition, evidence from Northeastern Nigeria is particularly scarce, despite the region's unique challenges, including nearly two decades of protracted armed conflict, population displacement, limited resources, seasonal flooding, and other effects of climate change on food security and health.[28,29]A recent study reported a high burden of NCD risk factors in the region,[24] yet no study had quantified the burden in the region.[30,31] To our knowledge, no previous study has comprehensively quantified the burden of NCD admissions, temporal trends in admissions and in-hospital mortality, and seasonal patterns of NCDs in this region. This study aimed to determine the burden of NCD admissions and assess the temporal trends in admissions and in-hospital outcomes over seven years using time-series analytical methods.

Methodology

Study design and setting

This hospital-based retrospective observational study evaluates the burden, temporal trends, and outcomes of medical admissions among adults at Yobe State University Teaching Hospital (YSUTH), Damaturu, Yobe State, Northeastern Nigeria. The study covers seven-year period, from 1st January 2019 to 31st December 2025. YSUTH is a tertiary healthcare facility serving as the major referral centre for Yobe State and its neighbouring states in northeaster Nigeria as well as Republic of Niger to the north. The hospital provides comprehensive specialist and general

medical services through departments including Internal Medicine, Family Medicine, Surgery, Obstetrics and Gynaecology, Paediatrics, Anaesthesiology, Intensive Care, Pathology, Radiology, and other support services. As the principal referral institution in the state, the hospital receives patients from both urban and rural communities, making it an appropriate setting for evaluating long-term patterns of NCD-related hospital admissions.

Study population and eligibility

The study population comprises all adult patients of 18 years or older admitted to the medical wards during the study period with a documented diagnosis of one or more NCDs. Consecutive admissions from 1 January 2019 to 31 December 2025 were retrieved and included. Duplicate records and those with missing or grossly incomplete information on primary study variables, including diagnosis, admission date, discharge date, or hospital outcome, were excluded.

Case definition and disease classification

NCDs were defined according to the WHO classification as chronic conditions that are generally of long duration and are not transmitted from person to person.[32] Diagnoses were based on the final discharge diagnosis documented by the managing team. For analysis, individual diagnoses were grouped into predefined disease categories, including: cardiovascular diseases (CVD), endocrine and metabolic disorders (including diabetes mellitus), chronic kidney diseases, chronic respiratory diseases, malignancies, neurological disorders, gastrointestinal diseases, rheumatological and musculoskeletal diseases, and haematological disorders.

We chose to refer to kidney disease instead of chronic kidney disease because the study cohorts included patients with both chronic kidney disease (CKD) and acute kidney disease (AKD) as defined by Kidney Disease Improving Global Outcomes (KDIGO).[33] Where multiple diagnoses are present, the principal diagnoses responsible for admission were used for disease classification, while documented comorbidities were analysed separately.

Data sources and data collection

Data were retrieved from multiple hospital data sources, including admission and discharge registers, patients' case notes, nurses' ward registers, mortality registers, and archived medical records. Electronic medical records were accessed for admissions beginning in May 2022, when the hospital transitioned to an electronic health record (EHR) system. Where information was available from more than one source, records were cross-checked to improve completeness and accuracy.

A standardized data extraction form was used to ensure consistency of data collection. Extracted variables included: Sociodemographic characteristics (age, sex, ethnicity, occupation where available), admission date, clinical characteristics (principal diagnosis, comorbidities, final diagnosis), clinical outcomes (length of hospital stay, discharged alive, died, referred, discharged against medical advice, absconded, and date of discharge). Patients' IDs were used for tracking purposes in the initial data extraction form, but all extracted data was later anonymised before entry into statistical software to maintain confidentiality.

Statistical analysis

All statistical analyses and graphical visualisations were executed in R version 4.6.1 (64-bit architecture; R Foundation for Statistical Computing, Vienna, Austria) using the RStudio environment. The flow diagram (**Figure 1**) was prepared using Python (matplotlib)

Descriptive analysis

Continuous variables, such as length of hospital stay, were summarised as medians with interquartile ranges (IQR). Categorical variables were presented as frequencies and percentages. Baseline characteristics were compared between NCD and CD admissions using the chi-square test for categorical variables (sex, age group, in-hospital outcome) and the Mann–Whitney U test for continuous variables. Age was analysed as a categorical variable (18–29, 30–39, 40–49, 50–59, 60–69, ≥70 years), as actual ages were not available in some parts of the source data.

Outcome measures

In-hospital mortality was calculated as the proportion of NCD admissions that resulted in death during hospitalization. In-hospital case-fatality proportion (CFP) was calculated as the number of deaths divided by the number of admissions with a known outcome (discharged or died), excluding those who left against medical advice, were referred, or had missing outcome data. Wilson 95% confidence intervals (CIs) were computed for all case-fatality estimates. This approach was used rather than a case-fatality rate, as the denominator reflects completed episodes of care rather than person-time at risk.

Temporal trend analysis

Annual NCD admission counts were modelled using Poisson regression with calendar year (centred at 2019) as the sole predictor, yielding an incidence rate ratio (IRR) per one-year increase. Model adequacy was assessed by examining the ratio of deviance to residual degrees of freedom; a negative binomial model was fitted as a sensitivity analysis to account for potential

overdispersion. Annual case-fatality trends were assessed by logistic regression of in-hospital mortality on calendar year among NCD admissions with known outcomes, yielding an odds ratio (OR) per one-year increase.

Seasonality assessment

Seasonal patterns in NCD admissions were assessed using three complementary methods. First, Seasonal and Trend decomposition using LOESS (STL) was applied to the monthly NCD admission time series (period = 12, robust fitting) to decompose the series into trend, seasonal, and residual components. The seasonal strength was quantified as $1 - \mathrm{Var}(\text{residual}) / \mathrm{Var}(\text{seasonal} + \text{residual})$. Second, the Kruskal–Wallis H test was used to compare monthly admission counts across calendar months. Third, admissions were grouped by the three recognised seasons of northeastern Nigeria, Harmattan (November–February), Dry/Hot (March–May), and Rainy (June–October). The seasonal case-fatality rates were compared using the chi-square test. LOWESS smoothing (fraction = 0.3) was applied to the monthly time series for visual trend assessment.

Predictors of in-hospital mortality

Logistic regression was used to examine factors associated with in-hospital mortality among NCD admissions. Crude odds ratios were computed for each candidate predictor individually (year of admission, sex, age group, multiple diagnoses, disease category, season). A multivariable model was then fitted including year of admission, sex, age group (reference: 18–29), multiple diagnoses (≥2 coded diagnoses vs. single diagnosis), disease category (reference: kidney diseases), and season (reference: Harmattan). We reported results as adjusted odds ratios (aOR) with 95% CIs.

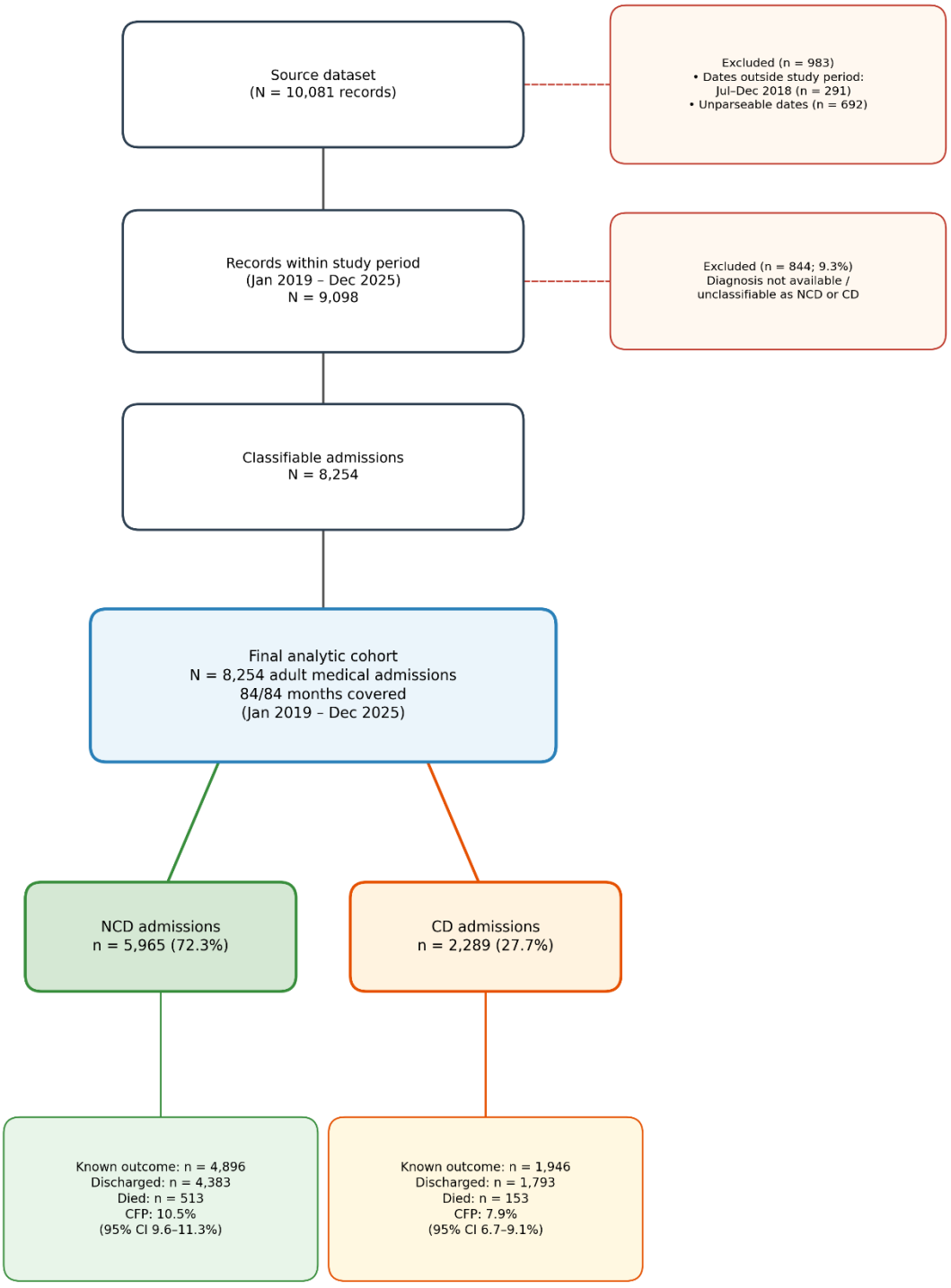
RESULTS

Study cohort

Of the 10,081 records in the dataset, 983 were excluded for dates outside the study period (291 records from July–December 2018) or unparseable date entries (692 records), leaving 9,098 admissions within January 2019 to December 2025. Another 844 records (9.3%) were excluded because the diagnosis was not provided or the text could not be reliably classified as NCD or CD. The final analytic cohort comprised 8,254 adult medical admissions spanning all 84 months of the study period. **Figure 1** below demonstrates how the final study participants were determined.

Baseline characteristics

Of the 8,254 admissions, 5,965 (72.3%) were classified as NCD and 2,289 (27.7%) as CD, as shown in **Figure 2 and Table 1**. The sex distribution was similar between groups, with females comprising 50.6% of NCD and 52.5% of CD admissions (P = 0.148). The age distribution differed significantly (P < 0.001): NCD admissions had a lower proportion of patients aged 18–29 years (14.6% vs. 26.0%) and a higher proportion aged 50–69 years (33.0% vs. 22.1%) compared with CD admissions. Age data were missing for 377 patients (4.6%).


Source dataset
(N = 10,081 records)
Excluded (n = 983)
• Dates outside study period:
Jul–Dec 2018 (n = 291)
• Unparseable dates (n = 692)
Records within study period
(Jan 2019 – Dec 2025)
N = 9,098
Excluded (n = 844; 9.3%)
Diagnosis not available /
unclassifiable as NCD or CD
Classifiable admissions
N = 8,254
Final analytic cohort
N = 8,254 adult medical admissions
84/84 months covered
(Jan 2019 – Dec 2025)
NCD admissions
n = 5,965 (72.3%)
CD admissions
n = 2,289 (27.7%)
Known outcome: n = 4,896
Discharged: n = 4,383
Died: n = 513
CFP: 10.5%
(95% CI 9.6–11.3%)
Known outcome: n = 1,946
Discharged: n = 1,793
Died: n = 153
CFP: 7.9%
(95% CI 6.7–9.1%)

1

Figure 1. Study cohort selection and participant flow diagram. It illustrates how the final analytic cohort of 8,254 adult medical admissions was obtained, including NCD (n = 5,965; 72.3%) and CD (n = 2,289; 27.7%) with their respective in-hospital case-fatality proportions. CFP, case-fatality proportion; CI, confidence interval; CD, communicable disease; NCD, non-communicable disease.

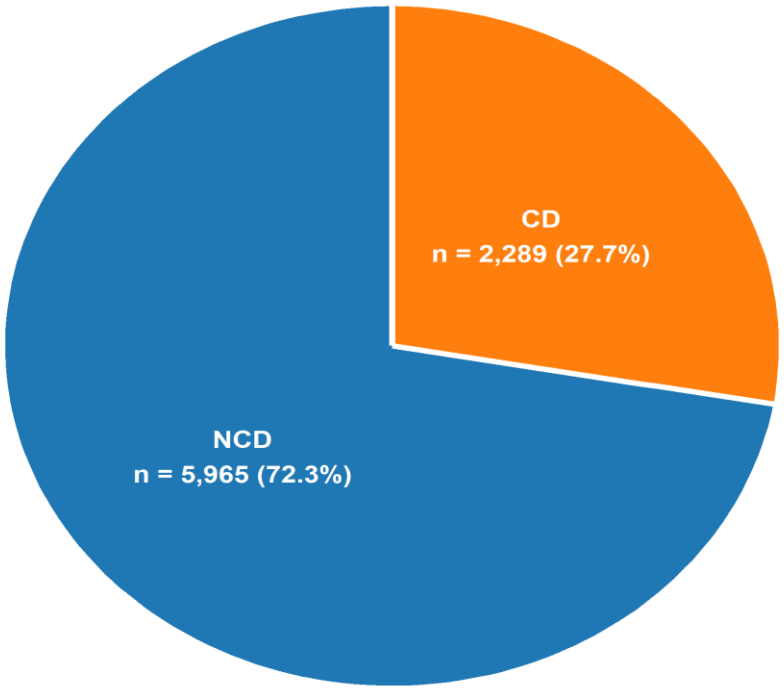


Figure 2: Distribution of broad disease categories in the admitted cohort.

A Pie chart showing the proportional distribution of 8,254 adult medical admissions classified as NCD (n = 5,965, 72.3%) or CD (n = 2,289, 27.7%) over the seven-year study period (2019–2025).

The overall median length of stay was 6 days (IQR 3–10). NCD admissions had a significantly longer median stay than CD admissions (6 days [IQR 3–11] vs. 4 days [IQR 2–8]; P < 0.001). Length-of-stay data were unavailable for 625 admissions (7.6%).

In-hospital outcomes

Among all admissions, 6,202 (75.1%) were discharged, 667 (8.1%) died, 1,261 (15.3%) left against medical advice, were discharged against medical advice, or were referred, and 123 (1.5%) had unknown outcomes **(Table 1)**. The overall in-hospital case-fatality proportion was 9.7% (95% CI 9.0–10.4%). The NCD case-fatality proportion was significantly higher than the CD case-fatality proportion (10.5% [95% CI 9.6–11.3%] vs. 7.9% [95% CI 6.7–9.1%]; χ^2 = 10.56, P = 0.001).

Table 1: Sociodemographic and clinical characteristics

Characteristic	**All (N=8254)**	**NCD (n=5965)**	**CD (n=2289)**	**P-value**
Total admissions, n	8254	5965	2289	
Sex, n (%)				**χ^2=2.10, P=0.148**
Male	4022 (48.7)	2935 (49.2)	1087 (47.5)	
Female	4217 (51.1)	3016 (50.6)	1201 (52.5)	
Age group, n (%)				**χ^2=195.29, P<0.001**
18–29	1464 (17.7)	870 (14.6)	594 (26.0)	
30–39	1343 (16.3)	926 (15.5)	417 (18.2)	
40–49	1278 (15.5)	940 (15.8)	338 (14.8)	
50–59	1334 (16.2)	1049 (17.6)	285 (12.5)	
60–69	1138 (13.8)	919 (15.4)	219 (9.6)	
≥70	1320 (16.0)	963 (16.1)	357 (15.6)	
Length of stay				**U=7198365, P<0.001**
Days, median (IQR)	**6 (3–10)**	**6 (3–11)**	**4 (2–8)**	
In-hospital outcome, n (%)				
Discharged	6202 (75.1)	4384 (73.5)	1818 (79.4)	
Died	667 (8.1)	512 (8.6)	155 (6.8)	

DAMA/LAMA/Referred	1261 (15.3)	990 (16.6)	271 (11.8)	
Case-fatality				**χ^2=10.56, P=0.001**
Proportion, % (95% CI)	9.7 (9.0–10.4)	10.5 (9.6–11.3)	7.9 (6.7–9.1)	

Missing data: sex: 15 unknown/unassigned (14 NCD, 1 CD); age group: 377 missing (298 NCD, 79 CD); Length of stay: 625 missing (471 NCD, 154 CD); outcomes: 123 unknown (78 NCD, 45 CD).

NCD disease category distribution

Kidney diseases constituted the largest NCD category, accounting for 2,991 admissions (50.1%), followed by cardiovascular diseases (CVD) with 1,580 admissions (26.5%). Together, these two categories accounted for over three-quarters (76.6%) of all NCD admissions. The remaining categories were chronic liver and gastrointestinal diseases (384; 6.4%), endocrine and metabolic diseases (270; 4.5%), haematological disorders (250; 4.2%), malignancies (248; 4.2%), neurological disorders (129; 2.2%), chronic respiratory diseases (69; 1.2%), other NCDs (32; 0.5%), and rheumatological and musculoskeletal diseases (12; 0.2%). **Figure 3** summarises these

details.

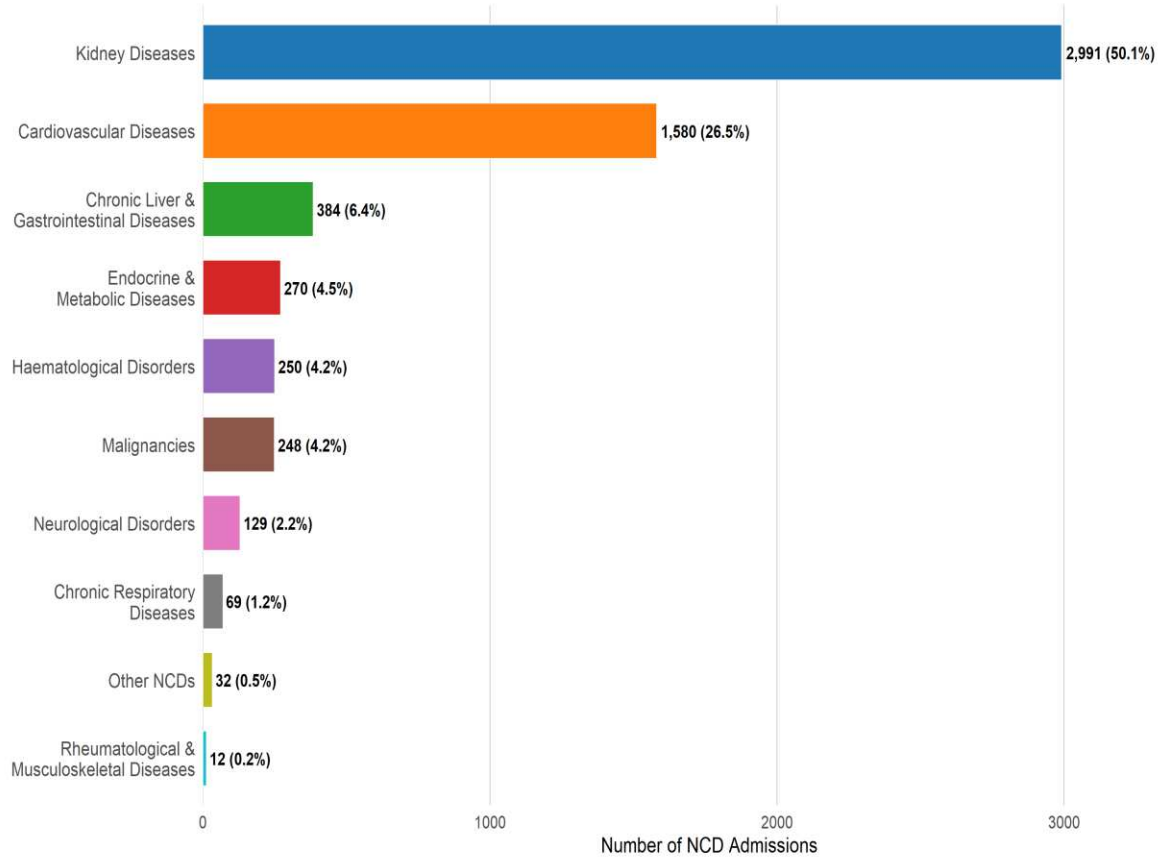


Figure 3: Distribution of NCD admissions by disease category. *A horizontal bar chart depicting the frequency distribution of 5,965 NCD admissions across various NCD disease categories.*

Annual trends in NCD admissions

NCD admissions increased from 606 in 2019 to 1,004 in 2025, with 2024 emerging as the peak year at 1,190 admissions **(Figure 4)**.

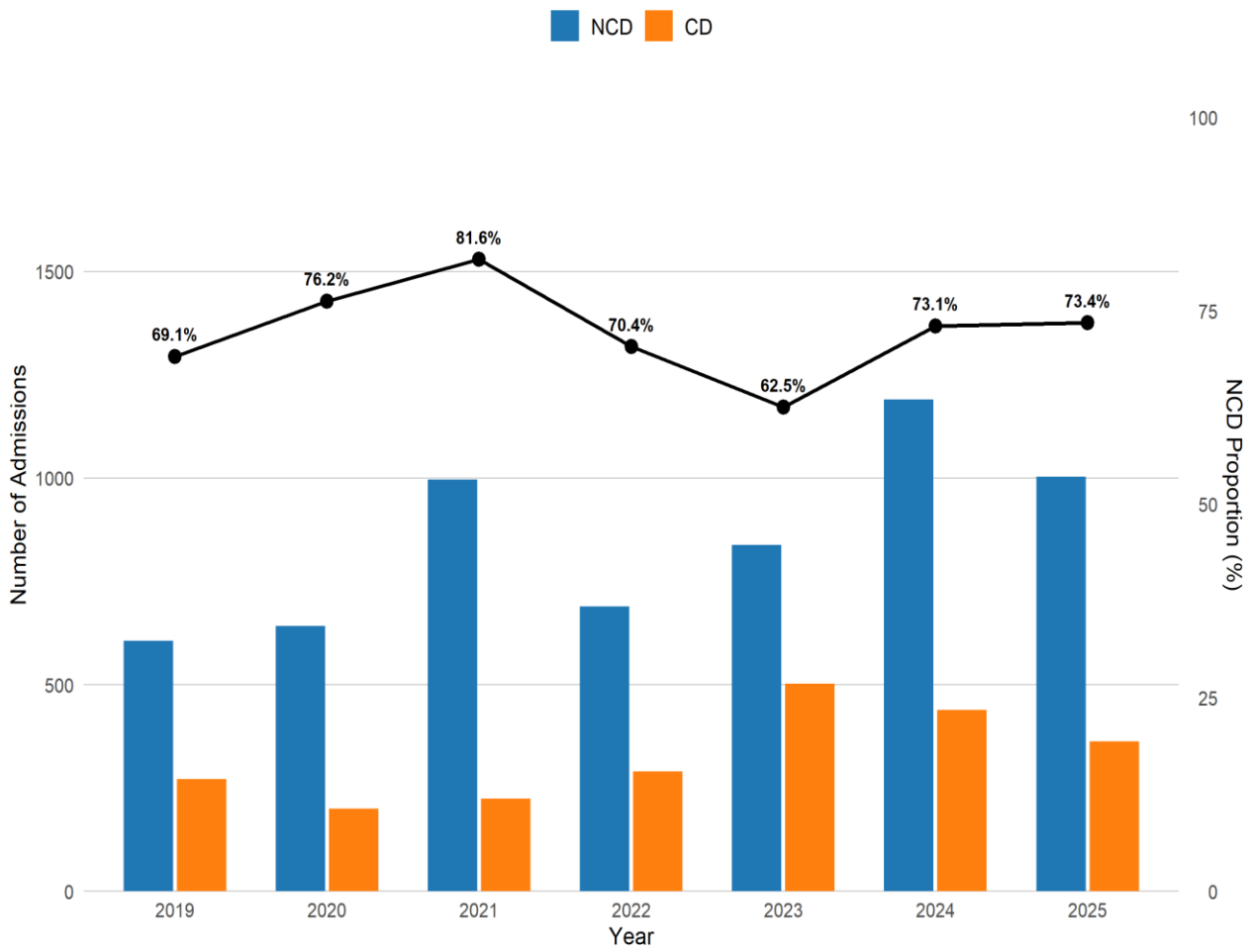


Figure 4. Annual trends in NCD and CD admissions with NCD proportion (2019–2025). *Grouped bar chart showing annual NCD (blue) and CD (orange) admission counts with a superimposed line depicting the NCD proportion of total admissions (right axis), demonstrating a significant upward trend in NCD admissions.*

Poisson regression demonstrated a statistically significant upward trend, with an estimated 9.4% annual increase in NCD admissions (IRR = 1.094; 95% CI 1.080–1.108; $P < 0.001$). The deviance-to-degrees-of-freedom ratio (29.2) indicated substantial overdispersion; however, a negative binomial model yielded a comparable IRR of 1.096 with a wider confidence interval (95% CI 0.757–1.588), confirming the trend direction. The NCD proportion of total admissions fluctuated between 62.5% (2023) and 81.6% (2021), without a consistent directional trend.

Case-fatality proportions across NCD categories

Case-fatality proportions (CFP) varied across NCD categories, as shown in **Table 2**. Kidney diseases had the highest absolute number of deaths (295) and a case-fatality proportion of 12.2% (95% CI 11.0–13.6%) followed by malignancies with a CFP of 12.1% (95% CI 8.2–17.5%), chronic liver and gastrointestinal diseases 10.5% (95% CI 7.6–14.5%), and CVD 8.9% (95% CI 7.5–10.6%). The lowest case-fatality proportions were observed for chronic respiratory diseases (5.1%; 95% CI 1.7–13.9%) and haematological disorders (5.7%; 95% CI 3.3–9.5%).

Table 2: Proportions of NCD admissions and deaths, with case-fatality proportions for each category

Disease Category	n	% of NCD	Deaths	Known Outcome	CFP (%)	95% CI
Kidney Diseases	2991	50.1	295	2410	12.2	11.0–13.6
Cardiovascular Diseases	1580	26.5	117	1314	8.9	7.5–10.6
Chronic Liver & Gastrointestinal Diseases	384	6.4	32	304	10.5	7.6–14.5
Endocrine & Metabolic Diseases	270	4.5	15	240	6.2	3.8–10.1
Haematological Disorders	250	4.2	13	229	5.7	3.3–9.5
Malignancies	248	4.2	23	190	12.1	8.2–17.5
Neurological Disorders	129	2.2	10	112	8.9	4.9–15.7
Chronic Respiratory Diseases	69	1.2	3	59	5.1	1.7–13.9
Other NCDs	32	0.5	3	29	10.3	3.6–26.4
Rheumatological & Musculoskeletal Diseases	12	0.2	1	9	11.1	2.0–43.5
Total NCD	5965	100.0	512	4896	10.5	9.6–11.3

NCD-related case fatality proportions

The NCD case-fatality proportion showed a declining trajectory over the study period, from 11.0% in 2019, a peak of 12.9% in 2021, to 8.1% in 2025. Logistic regression confirmed a

significant annual reduction in the crude odds of in-hospital death (OR = 0.94 per year; 95% CI 0.90–0.99; P = 0.010), **as shown in Figure 5.**

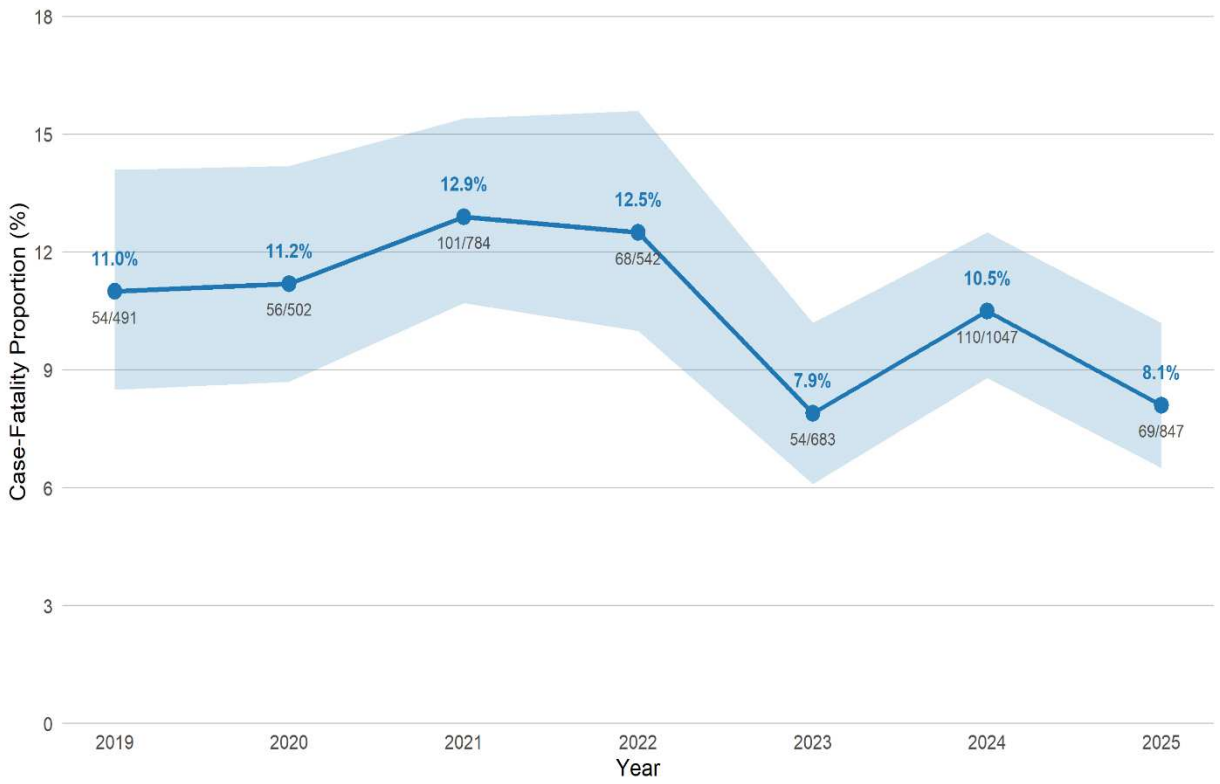


Figure 5. Annual trend in NCD-related case-fatality proportion (2019–2025). *Line chart showing the annual NCD case-fatality proportion with 95% confidence intervals (shaded area) and the number of deaths over known outcomes annotated at each year, declining from 11.0% in 2019 to 8.1% in 2025 (crude OR = 0.94 per year, 95% CI 0.90–0.99, P = 0.010).*

Seasonality

STL decomposition yielded a seasonal strength of 0.391, indicating a moderate seasonal component in the monthly NCD admission time series (**Figure 6)**. However, the Kruskal–Wallis test showed no significant difference in monthly admission counts across calendar months (H = 5.75, P = 0.89)**.** When admissions were stratified by the three climatological seasons, the Rainy season accounted for the largest share of NCD admissions (2,457; 41.2%), followed by the Harmattan season (2,151; 36.1%) and the Dry/Hot season (1,357; 22.7%); these proportions were

broadly consistent with the number of months in each season (5, 4, and 3 months, respectively). Case-fatality proportions did not differ significantly across seasons: Harmattan 11.0%, Dry/Hot 9.9%, and Rainy 10.3% ($\chi^2 = 1.04$, P = 0.595) **(Figure 7).**

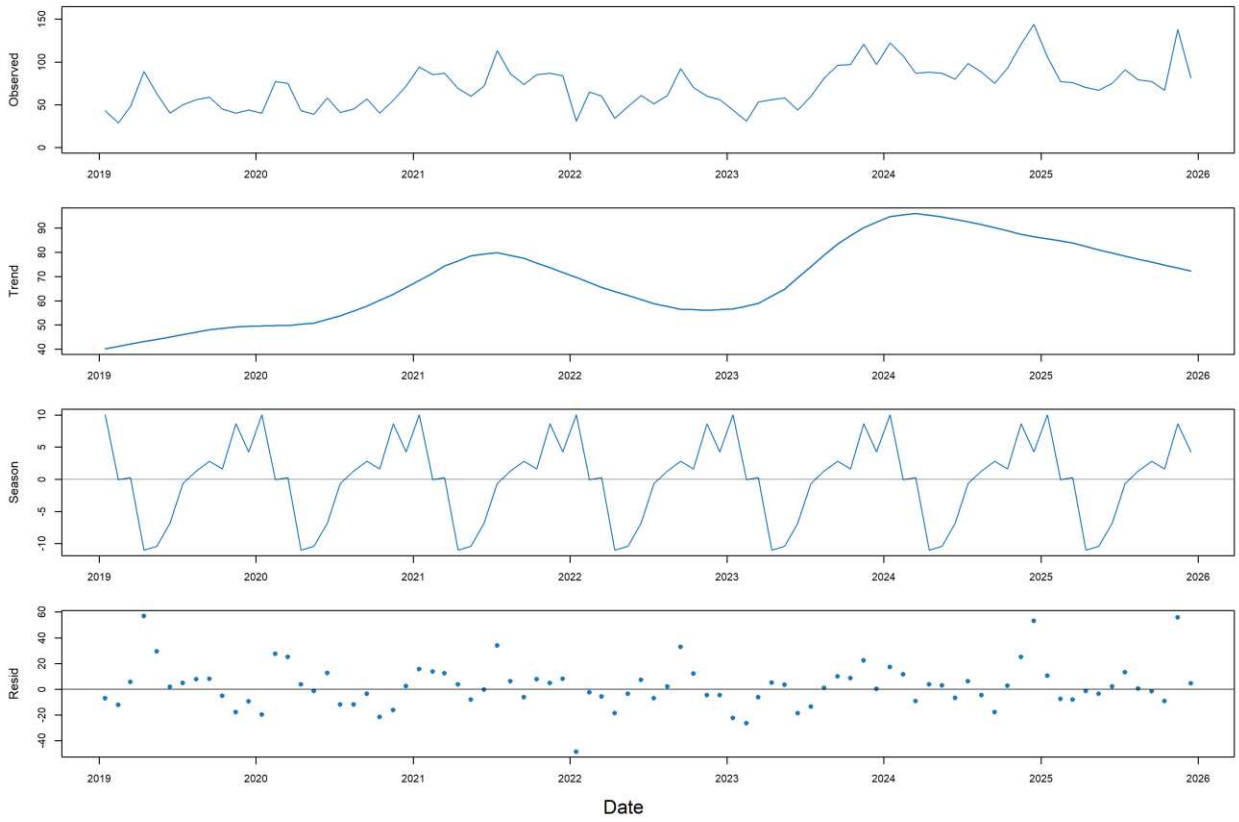


Figure 6a. Seasonal-trend decomposition of monthly NCD admissions (2019–2025). *Left panels show STL decomposition of the monthly NCD admission time series into observed, trend, seasonal, and residual components (seasonal strength = 0.391);*

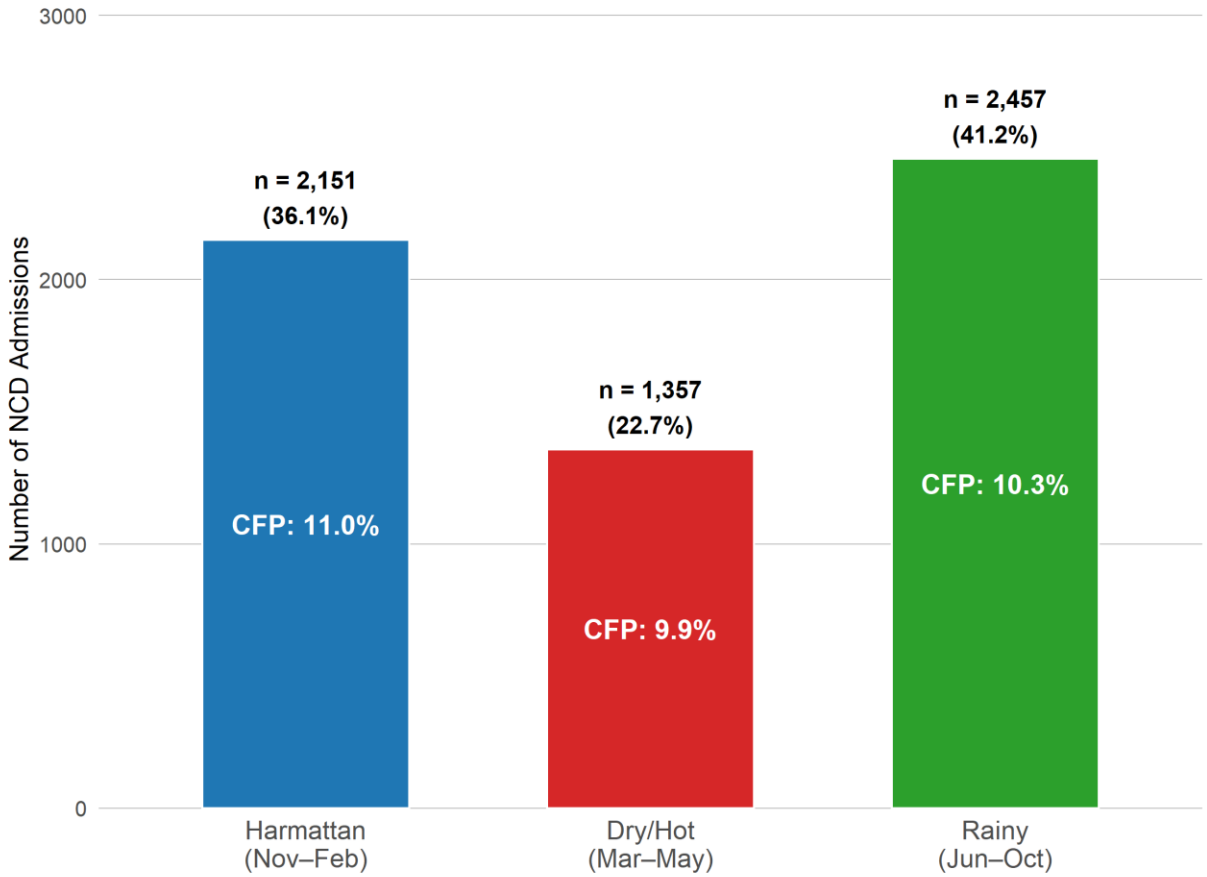


***Figure 7: Bar chart showing* case-fatality proportions by climatological season (2019–2025)**. *The chart displays NCD admissions and case-fatality proportions across the three climatological seasons, with no significant difference in mortality across seasons (chi-squared = 1.04, P = 0.595).*

Predictors of in-hospital mortality

In univariable analysis among the 4,896 NCD admissions with known outcomes, year of admission was associated with decreased odds of death (crude OR = 0.94; 95% CI 0.90–0.99; P = 0.010), while sex was not significantly associated with mortality (crude OR = 1.01; 95% CI 0.84–1.21; P = 0.947). Multiple coded diagnoses (≥2) were not significantly associated with mortality (crude OR = 0.88; 95% CI 0.61–1.29; P = 0.514). Among disease categories (reference: CKD), CVD (crude OR = 0.70; P = 0.002), endocrine and metabolic diseases (crude OR = 0.48; P = 0.007), and haematological disorders (crude OR = 0.43; P = 0.004) were associated with significantly lower odds of death **(Table 3).**

Table 3: Predictors of in-hospital mortality

Variable	Crude OR	95% CI	P-value	Adjusted OR	95% CI (adj)	P-value (adj)
Year (per-year increase)	0.94	0.90–0.99	0.0095	0.96	0.92–1.01	0.1655
Sex						
Female	**Reference**					
Male	1.01	0.84–1.21	0.9474	1.00	0.83–1.20	0.9676
Age group						
18–29	**Reference**					
30–39	0.92	0.67–1.28	0.6309	0.86	0.62–1.19	0.3693
40–49	0.86	0.62–1.19	0.3678	0.79	0.57–1.10	0.1684
50–59	0.76	0.55–1.06	0.1060	0.72	0.52–1.00	0.0515
60–69	1.22	0.89–1.67	0.2111	1.15	0.84–1.59	0.3857
≥70	1.02	0.74–1.40	0.8998	0.98	0.71–1.36	0.9101
Number of diagnoses or comorbidities						
Single diagnosis	**Reference**					
Multiple diagnoses	0.88	0.61–1.29	0.5139	0.92	0.61–1.39	0.6843
NCD categories						
CKD	**Reference**					
CVD	0.70	0.56–0.88	0.0020	0.68	0.54–0.86	0.0013
Endocrine	0.48	0.28–0.82	0.0070	0.44	0.25–0.77	0.0038
Liver/GI	0.84	0.57–1.24	0.3874	0.87	0.59–1.29	0.4950
Haematological	0.43	0.24–0.77	0.0040	0.44	0.24–0.79	0.0061
Malignancies	0.99	0.63–1.55	0.9563	0.95	0.60–1.50	0.8367
Neurological	0.70	0.36–1.36	0.2957	0.60	0.27–1.31	0.1983
Other NCD	0.56	0.26–1.21	0.1415	0.49	0.21–1.14	0.0977

Seasons						
Harmattan	**Reference**					
Dry/Hot	0.92	0.74–1.15	0.4888	0.88	0.68–1.12	0.2989
Rainy	0.97	0.80–1.17	0.7228	0.93	0.75–1.15	0.5138

In the multivariable logistic regression adjusting for year, sex, age group, multiple diagnoses, disease category, and season (N = 4,632 after excluding 264 observations with missing age or unknown sex), year of admission showed an attenuated association with reduced odds of in-hospital death that was no longer statistically significant (adjusted OR = 0.96; 95% CI 0.92–1.01; P = 0.166). Sex was not independently associated with mortality (aOR = 1.00; 95% CI 0.83–1.20; P = 0.968). Age group was not independently associated with mortality in any category compared with the 18–29 reference group, though patients aged 50–59 showed a borderline association (aOR = 0.72; 95% CI 0.52–1.00; P = 0.052). Among disease categories, CVD (aOR = 0.68; 95% CI 0.54–0.86; P = 0.001), endocrine and metabolic diseases (aOR = 0.44; 95% CI 0.25–0.77; P = 0.004), and haematological disorders (aOR = 0.44; 95% CI 0.24–0.79; P = 0.006) were independently associated with lower odds of in-hospital death compared with kidney diseases. Season was not associated with mortality. Multiple diagnoses showed no significant association (aOR = 0.92; 95% CI 0.61–1.39; P = 0.684)**.**

Discussion

We present a seven-year retrospective analysis of 8,254 adult medical admissions at a tertiary hospital in northeastern Nigeria. The study demonstrates that non-communicable diseases (NCDs) constituted nearly three-quarters of all classifiable medical admissions between 2019 and 2025. NCD admissions increased by an estimated 9.4% annually. In-hospital case fatality was significantly higher among NCD than CD admissions, and was mainly driven by kidney disease, which accounted for half of all NCD hospitalisations and carried the highest case-fatality proportion. Although the in-hospital death among NCD admissions declined over the study period (OR = 0.94 per year; P = 0.010), this trend was attenuated and no longer statistically significant after multivariable adjustment. Furthermore, the study demonstrated distinct temporal trends and seasonal variation in NCD admissions and mortality over the study period, highlighting the dynamic nature of the NCD burden in the study setting.

The burden of NCD

The finding that NCDs accounted for 72.3% of adult medical admissions places our facility among those reporting the highest NCD-to-CD ratios in the Nigerian literature. Studies from several tertiary hospitals across the country have consistently documented that NCDs constitute the majority of adult medical admissions, with reported proportions ranging from approximately 56.2% to over 70% depending on the facility and time period.[22,23,25–27,34] Unachukwu and colleagues[27] reported that NCDs accounted for 56.2% of medical admissions at a tertiary centre in Port Harcourt, South-South region, while Ayoola et al[34] found a higher proportion, approximately 71.8%, in a northeastern Nigerian hospital. Our estimate of 72.3% is at the upper end of these reported ranges and may reflect both the advanced stage of the epidemiological transition in this population and the particular disease pattern of Yobe State.

The NCD predominance is consistent with the well-established epidemiological transition in Sub-Saharan Africa, in which chronic diseases have gradually overtaken communicable diseases as the primary causes of morbidity, and perhaps mortality, among the adult population, even though the communicable disease burden persists.[10] The result is a dual burden of disease that places extraordinary strain on already fragile health systems operating under severe resource constraints.[35] In northeastern Nigeria, this challenge is compounded by the protracted armed conflict and humanitarian crises, which have disrupted health infrastructure and healthcare services, displaced millions, and limited access to primary and preventive care.[31] A recent study of conflict-exposed populations in northeastern Nigeria documented a high prevalence of NCD risk factors, including hypertension, diabetes, and obesity, among internally displaced persons, suggesting that the conditions driving NCD burden in this setting are deeply embedded in the humanitarian and demographic context of the region.[24]

Notably, the NCD proportion of total admissions fluctuated between 62.5% and 81.6% across the study years without a consistent directional trend. This indicates that both NCD and CD admissions are growing in absolute terms. The rising NCD admission volume in this cohort therefore does not signal a replacement of the communicable disease burden but rather its superimposition, an additive pattern that intensifies the aggregate demand on hospital bed capacity, diagnostic services, and clinical workforce. This finding supports national and regional evidence suggesting that Nigerian tertiary hospitals are increasingly managing chronic diseases alongside a persistent burden of CD such as HIV/AIDS, TB, and malaria.[26]

A distinctive feature of the NCD profile at our facility is the dominance of chronic kidney disease (CKD), which accounted for about half (50.1%) of all NCD admissions, far exceeding CVD (26.5%), the second largest category. This distribution differs from most published NCD profiles from Nigerian and sub-Saharan African tertiary hospitals, where CVD leads the disease category distribution. For instance, Njoku and colleagues found that CVD accounted for the majority of hospitalisations in north central Nigeria.[26] Several reports from other SSA countries also documented higher prevalence of CVD and/or diabetes compared to other NCD categories.[30,36,37]

The prominence of CKD in our cohort likely reflects a combination of factors. First, the study facility serves as a major regional referral centre for nephrology and haemodialysis services in northeastern Nigeria, which may concentrate CKD patients relative to other tertiary or secondary health facilities in the region. In fact, haemodialysis and related expenses are free of charge, which will likely encourage referrals and utilisation of the facility among patients with advanced kidney disease, contributing to the relatively high burden of kidney disease observed in our cohort.

Second, recent evidence from haemodialysis units across northeastern Nigeria has documented a high burden of chronic kidney disease of unknown cause (CKDu), with a substantial proportion of patients lacking identifiable risk factors.[38] This raises the possibility that either environmental nephropathies or occupational or herbal-medicine-related nephrotoxic exposures may be contributing to excess CKD prevalence in this region.[38,39] Third, in settings with limited outpatient dialysis capacity, patients with end-stage kidney disease are more frequently managed as inpatients. This increases the number of hospital-based CKD cases compared to the overall prevalence in the population. The DISCOVER study, a multinational study conducted in high-income countries, found that hospitalisation rates for CKD more than tripled between the early and late stages of the disease.[40]

NCD-related case-fatality proportion

The overall in-hospital case-fatality proportion of 9.7% likely reflects the severity of illness among patients admitted to this tertiary facility. The NCD case-fatality proportion for NCD was significantly higher than that for CD (7.9%; P = 0.001). This contrasts with the findings of Okoroiwu et al who reported that infectious diseases were the commonest cause of death among adult inpatients.[41] This disparity could be explained by the fact that the majority of NCD patients

in resource-limited settings may present at advanced disease stages due to limited outpatient screening, particularly at the primary care level, delayed referral, and financial barriers to care, resulting in a more critically ill cohort at admission.

Our NCD CFP is broadly consistent with reports from other sub-Saharan African tertiary hospitals. A Tanzanian study documenting in-hospital mortality patterns from 2006 to 2015 found that NCDs accounted for an increasing share of hospital deaths,[42] while a Ugandan referral hospital reported similar or higher NCD case-fatality rates during the COVID-19 pandemic period.[43] However, differences in case-mix, disease classification criteria, and the definition of the case-fatality denominator may complicate direct comparison between these cohorts. Excluding DAMA, LAMA, and referred patients from the denominator in our analysis is a conservative approach that may underestimate the true case-fatality rate if these patients have worse outcomes than those who complete their care episode.

Among disease categories, CKD had the highest case-fatality proportion (12.2%), accounting for the largest absolute number of in-hospital deaths. The multivariable analysis confirmed that patients with kidney disease had significantly higher odds of death than patients with other NCD categories. Patients with CVD and endocrine and metabolic diseases had 32% and 56% lower odds of death compared to those admitted with KD. This finding is consistent with the known challenges of managing advanced renal disease in resource-limited settings, where late presentation, limited access to renal replacement therapy, and the absence of transplantation programmes contribute to high inpatient mortality.[44,45] A cross-sectional study involving more than 19 million hospitalizations in China found that CKD was linked to the longest hospital stay compared to other NCDs and resulted in the second-highest in-hospital mortality rate, surpassed only by cancer.[46] The disproportionate contribution of KD to both admissions and deaths in our facility identifies it as the single most impactful disease category and argues strongly for prioritising CKD prevention, early detection, and expansion of dialysis services in the State and northeastern region.

Temporal trends in NCD admissions

We observed a clear upward trajectory in NCD admissions over the seven-year study period, with annual admissions increasing from 606 in 2019 to 1,190 in 2024, representing an approximate doubling of inpatient NCD volume. In the initial Poisson model, this corresponded to an estimated 9.4% annual increase. However, the model demonstrated substantial

overdispersion, with a deviance-to-degrees-of-freedom ratio of 29.2. This indicates that the variability in annual admission counts was considerably greater than assumed under the Poisson distribution. Accordingly, the negative binomial model was considered more appropriate for inference and yielded a similar point estimate for the direction of the association (IRR = 1.096), but with a substantially wider confidence interval (95% CI, 0.757–1.588). Thus, while the observed data show a substantial increase in NCD admission volume over the study period, the magnitude and statistical certainty of the underlying annual trend should be interpreted with caution given the considerable year-to-year variability.

This observed increase is broadly consistent with evidence of a growing NCD burden in Nigeria. A recent comprehensive analysis of NCD burden in Nigeria documented an increasing NCD prevalence and associated health service utilisation, driven by population ageing, urbanisation, dietary shifts, and the rising prevalence of risk factors including hypertension, diabetes, dyslipidaemia, and physical inactivity.[10] Similarly, a 2025 Lancet analysis benchmarking global NCD mortality progress from 2001 to 2019 found that sub-Saharan Africa lagged substantially behind other regions in reducing NCD mortality.[47] In our setting, however, the marked year-to-year variability may also reflect contextual influences such as the fluctuations in hospital capacity and service utilisation. These factors were not directly measured in the present study and therefore cannot be established as explanations for the observed variation.

Temporal trends in NCD case-fatality

The crude analysis suggested a modest decline in the odds of in-hospital death over time (OR = 0.94 per year; P = 0.010), corresponding to an approximately 6% reduction in the odds of death for each successive year. However, this association was attenuated after adjustment for sex, age group, disease category, multiple diagnoses, and season, and was no longer statistically significant (aOR = 0.96 per year; P = 0.166). The divergence between the crude and adjusted estimates suggests that the apparent improvement in overall NCD case-fatality was at least partly related to differences in the composition of patients admitted over time rather than a clear reduction in mortality risk within the NCD population.

One potential explanation is temporal variation in case mix, particularly changes in the relative contribution of NCD categories with different underlying risks of in-hospital death. For example, if admissions from lower-case-fatality categories increased over time relative to higher-risk conditions such as KD, the overall crude case-fatality proportion could decline even if mortality

within individual disease categories remained relatively stable. The observed growth in both CVD and KD admissions is consistent with changing disease composition, although the present data do not establish that case-mix change was the sole explanation for the attenuation of the temporal association. Differences in disease severity at admission, referral patterns, access to care, treatment availability, and other unmeasured clinical or health-system factors may also have contributed.

These findings have two important implications. First, the absence of a statistically significant adjusted temporal trend means that the study does not provide sufficient evidence to conclude that in-hospital NCD outcomes improved over the study period. This should not be interpreted as evidence that care did not improve, but rather that any improvement could not be demonstrated after accounting for measured differences in patient and disease characteristics. Second, the contrast between crude and adjusted trends highlights the importance of accounting for case mix when evaluating temporal changes in hospital mortality.[48] In settings where the composition of NCD admissions is changing rapidly, crude mortality trends may obscure whether outcomes within specific disease groups are actually improving, deteriorating, or remaining stable.[48]

Predictors of in-hospital mortality

Sex was not associated with NCD mortality in either crude or adjusted analyses (aOR = 1.00; P = 0.968), despite a roughly equal sex distribution in the NCD cohort (50.6% female). While many studies from high-income settings report sex-based differences in NCD outcomes, often attributing these disparities to differential prevalence of risk factors, health-seeking behaviour, healthcare utilisation, or biological mechanisms,[49,50] the absence of a sex effect in our cohort may reflect the specific disease mix and the hospital-based context. In a cohort dominated by KD, the pathophysiological determinants of in-hospital death, including uraemia, fluid overload, and hyperkalaemia, may be less sex-dependent than those observed in conditions such as acute coronary syndromes.[51] A nationwide study conducted among 97,036 hospitalised adults with CKD reported no sex differences in in-hospital mortality and dialysis- or non-dialysis-related outcomes.[52]

The absence of an independent age-mortality association is less intuitive, given the generally higher mortality expected among older adults with chronic NCDs. Although patients aged 50–59 showed a borderline reduction in odds of death relative to the 18–29 reference group (aOR = 0.72; P = 0.052), no age category reached statistical significance. This could be viewed from two different perspectives. First, our data lacked continuous age in the records. Using categorical age groups (five categories), as a proxy, could substantially reduce statistical power to detect age-mortality gradients. Second, the youngest age group (18–29) may contain a disproportionate representation of aggressive disease phenotypes, such as young patients presenting with advanced KD or malignancy, potentially resulting in a relatively high-mortality reference group against which older patients appear to fare comparatively well. This possibility is consistent with a form of index event bias,[53] whereby conditioning on hospital admission for NCDs may produce an atypical distribution of disease severity across age groups.

The number of coded diagnoses (≥2 vs. single) was also not associated with mortality. This should not be interpreted as evidence that multimorbidity is irrelevant to NCD outcomes. Rather, the number of coded diagnoses in an administrative hospital dataset is a poor proxy for true comorbidity burden.[54] Coding completeness varies with documentation practices, and clinical complexity may not be fully captured in diagnostic labels.[54,55] Similarly, the binary threshold of the comorbidity in our analysis (≥2 vs. 1) may be too coarse to discriminate between relatively low and high comorbidity loads. Consequently, the null association observed here is more appropriately interpreted as a limitation of the available data and how multimorbidity was measured rather than evidence against its prognostic importance.

Strengths and limitations

This study has several strengths. It provides the longest continuous time series of NCD admission data from a tertiary hospital in northeastern Nigeria, a region where epidemiological evidence has been particularly limited. The use of a consistent, validated diagnosis-text-matching algorithm for NCD/CD classification, applied uniformly to all records, avoids the misclassification that would have arisen from reliance on the original coded classification variable. The comprehensive analytical framework, encompassing descriptive statistics, temporal trend modelling, seasonality assessment using three complementary methods, and multivariable

mortality prediction, provides a more complete epidemiological picture than most single-centre studies in the country.

Despite these strengths, several limitations should be acknowledged. This is a single-centre, hospital-based study, and the findings may not be generalisable to other facilities or the general population in the region. Second, the absence of continuous age data limits the precision of age-related analyses and may obscure meaningful age-mortality gradients. Third, several cases had missing diagnoses in the data. The 844 unclassifiable records (9.3%) represent a non-trivial exclusion, though the sensitivity analysis demonstrated that the NCD proportion remained between 65.6% and 74.8% under extreme assumptions about these records. Fourth, the number of coded comorbidities in our analysis is a poor proxy for actual comorbidity burden, and the absence of other relevant demographic, laboratory, and other investigation data, and/or treatment details limits our ability to characterise the clinical severity of admitted patients. Finally, post-discharge outcomes are unknown, meaning the reported case-fatality proportions capture only deaths occurring during the index admission and not the potentially substantial post-discharge mortality, particularly among DAMA patients.

Conclusion

This study reveals that non-communicable diseases (NCDs), primarily chronic kidney disease (CKD) and cardiovascular disease (CVD), make up a significant portion of the adult medical inpatient burden at the study center. NCD admissions increased by approximately 9.4% per year from 2019 to 2025. The in-hospital case fatality rate for NCDs remains high and has not decreased significantly, even after adjusting for case mix. Future research should extend beyond single-centre hospital-based analyses to population-based surveillance, evaluate post-discharge outcomes, and investigate the drivers of the exceptionally high CKD burden in northeastern Nigeria.

Declarations

Ethical approval: Ethical approval was obtained from the Health Research Ethics Committee of Yobe State University Teaching Hospital, Damaturu, Nigeria (Approval number: YSUTH/HREC/EA/057). The study was conducted in accordance with the principles of the

Declaration of Helsinki and applicable ethical standards for research involving human participants.

Consent to participate: As this was a retrospective study of routinely collected hospital records, the requirement for informed consent was waived by the hospital Ethics Committees because there was no direct patient contact and all data were anonymized before analysis.

Consent for publication: Not applicable.

Clinical trial number: Not applicable.

Conflict of Interest

The authors declare none

Funding

We received no funding for this study

Data availability

The dataset supporting the findings of this study can be obtained from the corresponding author upon a reasonable request.

Credit author statement

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Acknowledgement

We express our gratitude to the staff of the Nursing Department and the Medical Records Unit of Yobe State University Teaching Hospital for their immense contributions to this study. We also appreciate Abubakar Idris of the Research and Statistics Unit at the study facility for his invaluable assistance during the data collection process.

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