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Diagnosed cardiovascular morbidity and mortality in Lagos State, Nigeria: a retrospective time analysis study

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Abstract

Background: Cardiovascular disease (CDV) is a major public health issue in low- and middle-income countries. Although about 80% of the approximately 20 million annual global cardiovascular disease deaths occur in these countries, there is limited research on its temporal dynamics.

Objective: This study aims to unravel the dynamics of CVD morbidity and mortality in Lagos State, Nigeria, between 2008 and 2018.

Methods: A descriptive time-series analysis of cardiovascular morbidity and mortality in Lagos, Nigeria, and a retrospective review of medical records of patients diagnosed with cardiovascular diseases at a teaching hospital in Lagos State from 2008 to 2018 were conducted. Descriptive time-series analysis was used to identify patterns and trends in incidence and mortality over time.

Results: A total of 6,780 cases diagnosed cardiovascular disease, including 1,528 mortalities, were retrieved from medical records. Females had the highest morbidity rate (51.0%), while males had the highest mortality rate (51.0%). Morbidity was highest among female patients in their 60s, and mortality was highest among male patients in their 50s. An 8-year trend cycle and a January–November seasonality cycle were observed in morbidity, while a January–September seasonality cycle was detected in mortality.

Conclusion: This study reveals sinusoidal fluctuations in cardiovascular morbidity and rising mortality in Lagos State. Time-series analysis effectively identifies these trends, guiding targeted interventions to prevent and manage cardiovascular diseases in Nigeria.

INTRODUCTION

Cardiovascular disease (CVD) is a major public health issue in low- and middle-income countries (LMICs) [1,2]. These countries experience a disproportionate burden of CVD, accounting for approximately 80% of the nearly 20 million cardiovascular-related deaths recorded globally each year. Furthermore, nearly half of these deaths in LMICs occur prematurely, often affecting individuals below the age of 70 years [3,4,5]. The CVD mortality rates in LMICs are rising steadily, contrasting with declining rates in high-income countries. This increase poses a significant challenge to already overburdened health systems and exacerbates

socio-economic problems such as disability, loss of productivity, poverty, and health inequalities [6]. Awareness, detection, and treatment of CVD and its risk factors remain critically low in LMICs due to resource constraints, lack of infrastructure, and limited public health programs, often resulting in late presentation and more expensive treatment [7].

In Nigeria, CVD is a significant public health issue; it ranks among the leading causes of morbidity and mortality in the country, accounting for about 10 – 11% of deaths and a substantial burden of disability-adjusted life years (DALYs) [8,9,10]. Approximately 30% of Nigerian adults have hypertension, a major risk factor for CVD, with urban populations showing higher rates due to lifestyle factors including diet, physical inactivity, and stress [8,11]. There has been a marked increase in CVD prevalence over the past two decades, including hypertension, heart failure,

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stroke, and cardiomyopathies. Nigeria also has the highest global burden of peripartum cardiomyopathy [8,9,11]. Hospital case fatality rates for CVD can be as high as 24 – 30%, with significant mortality within the first year after cardiac events, while CVDs such as ischemic heart disease and stroke are among the top contributors to age-specific mortality [8,10]. To effectively prevent and manage cardiovascular disease (CVD)-related morbidity and mortality in developing countries, it is essential to understand the temporal dynamics and evolving patterns of the disease. Descriptive time-series analysis has the potential to provide such insights, informing the development of relevant interventions. Time-series analysis of routine health data, though often challenging, offers opportunities to understand the dynamics of disease incidence and outcomes, providing evidence to improve healthcare delivery and health system efficiency [12]. Time-series analysis has previously been used to investigate trends in CVD incidence, mortality, and the mortality-to-incidence ratio (MIR) over a 28-year period [13]. Similarly, Sharif Nia et al. used time-series models to predict acute myocardial infarction based on temporal variation in climate risk assessments and religious mourning in northern Iran [14]. Einarson et al. estimated the prevalence of CVD among adults with type 2 diabetes by reviewing literature published within 10 years of their study using time-series analysis [15].

An interrupted time-series design using generalised estimating equations was applied to compare the differences in population-level medication adherence rates before and after the first hospitalisation for CVD [16]. In a study aimed to determine whether time-series cardiovascular health measures could predict receipt of cancer screenings, Guo et al. used a deep learning algorithm to investigate the associations between time-series cardiovascular health measures and cancer screenings in an ambulatory care setting [17]. To understand the impact of the COVID-19 pandemic on CVD prevention and management in the three nations of the United Kingdom, Dale et al. used medication data as a proxy for CVD management and fitted time-series models to each CVD medication subgroup [18]. Although the study by Mbakwem et al. did not use time-series analysis, it reviewed CVD admissions in Lagos over a 16-year period, analysing temporal trends in admissions and deaths on a quadrennial basis [10]. The study demonstrated a significant exponential increase in CVD admissions and mortality rates over time, reflecting epidemiological transitions in Nigeria. While CVD has been studied in Nigeria, with important insights into prevalence, risk factors, and knowledge levels, the existing literature on CVD remains underinvestigated. Additionally, the adoption of time-series analysis specifically in the study of CVD in Nigeria appears limited. This study, therefore, adopted descriptive time-series analysis to examine the dynamics of CVD morbidity and mortality in Lagos State, Nigeria, from 2008 to 2018.

MATERIALS AND METHODS

Study area
Lagos is a state in southwestern Nigeria (Figure 1) with an estimated population of over 20 million. It is a major African financial centre and the economic hub of Nigeria, accounting for about 10% of the country's economy. It is also a key culture, education, and transportation hub for Nigeria and Sub-Saharan Africa, with the highest literacy rate in Nigeria [19]. Lagos State, comprising 20 local government areas (LGAs) and 26 general hospitals (GHs), has a high prevalence of cardiovascular disease (CVD) [20,21].
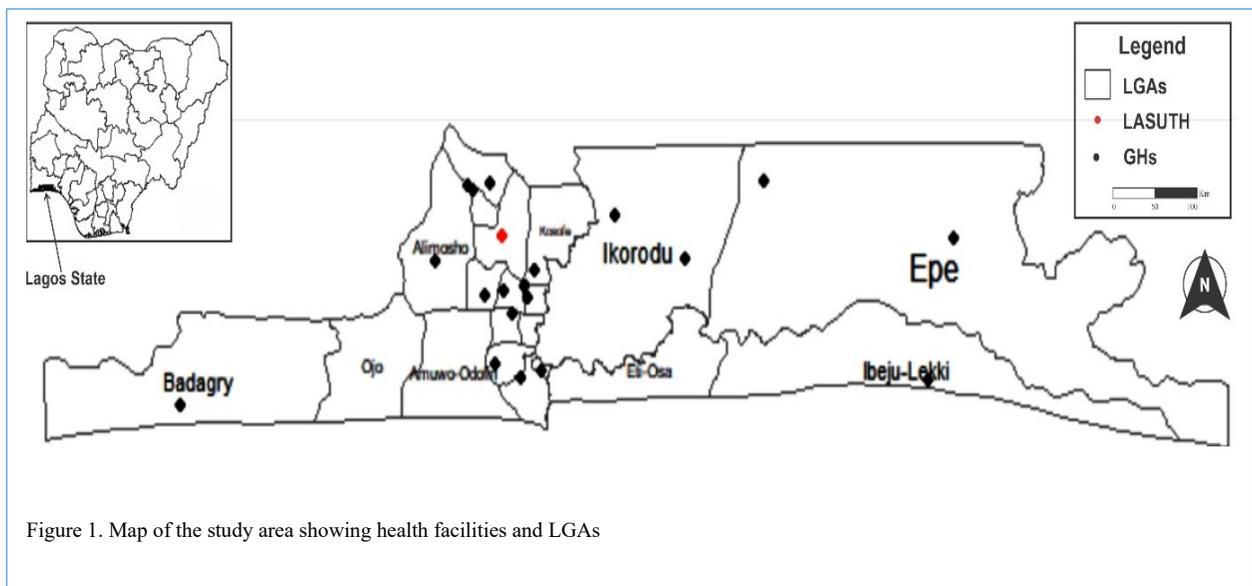

Figure 1. Map of the study area showing health facilities and LGAs

Study population

The study population comprised patients aged ≥18 years who were diagnosed with CVDs in Lagos State from 2008 to 2018 and were attending the Lagos University Teaching Hospital (LASUTH), Ikeja.

Data analysis

Data were sourced from patients' medical records, and the extracted information included sex, age at diagnosis, and CVD risk factors presented at diagnosis, as determined by the attending physicians. The body mass index (BMI) was computed for each case. Due to time and logistical constraints, data for 2011 could not be retrieved from the medical records archive as of the time of this study. The period 2008-2018 was chosen on account of the increased CVD incidence worldwide since 2008 [22].

Both morbidity and mortality data were stratified on age basis as Adolescents (18 – 19), Twenties (20 – 29), Thirties (30 – 39), Forties (40 – 49), Fifties (50 – 59), Sixties (60 – 69), Seventies (70 – 79), Eighties (80 – 89) Nineties (90 – 99), Hundreds ≥ 100; NA = Not Available. The monthly figures of both phenomena were then computed for the study period; these served as input for the time-series analysis, which combined them chronologically into two separate columns: morbidity and mortality. Using the zoo package in R [23], the time component for 2008 - 2018 was generated with the ISOdate function. Since the package does not allow missing data and zero cannot be used as a replacement because it would amount to falsification (as zero is itself data), the figures for December 2010 were brought forward to replace the missing data for 2011, using the na.locf function. The zoo function was then used to run the time-series analysis. The time series were decomposed into seasonal, trend, and random effects to detect additional hidden information in the datasets using the decompose function. For seasonality, the month with the highest value corresponds to the peak, while the month with the lowest value corresponds to the base.

RESULTS

There were 6,780 morbidities (48.9% males; 51.0% females) and 1528 mortalities (51.0% males; 49% females). The mean age of patients with CVD morbidities was higher in males than in females (53.4 ± 15.6 vs. 52.9 ± 15.7), while the mean age of CVD mortality was similarly higher in males compared to females (54.4 ± 16.1 vs. 54.3 ± 16.2). The mean weight of patients with CVD was 73.5 ± 14.7 kg (males: 75.0 ± 13.9 kg; females: 72.2 ± 15.4 kg). Among CVD patients who died, the mean weight was higher at 76.3 ± 15.8 kg (males: 77.2 ± 15.4 kg; females: 77.3 ± 16.1 kg). The mean height among patients with CVD morbidity was 1.66 ± 0.1 m (males: 1.68 ± 0.1 m; females: 1.63 ± 0.1 m), and the mean height of CVD patients who died was similar at 1.66 ± 0.1 m (males: 1.69 ± 0.10 m; females: 1.64 ± 0.09 m). Regarding body mass index (BMI), CVD patients with morbidities had a mean BMI of 26.9 ± 5.2 (males: 26.6 ± 4.8; females: 26.7 ± 2.7), while those who died showed a slightly higher mean BMI of 27.6 ± 5.8 (males: 27.5 ± 5.2; females: 28.2 ± 6.1).

Considering the data on a monthly basis for each year of the study period, the lowest minimum number of morbidities was zero, and was observed in January, while the highest minimum was in March (48); the least average number of morbidities was in January (47.6), the highest mean was in August (63.3). The months of September and October had the lowest median number of mortalities (2), while the highest median (8.5) occurred in February. The least maximum number of mortalities was in September (19), and the highest maximum was in July (110) (Table 1). Morbidities were more in the Fifties age group (1442), while mortalities were more in the Sixties age group (313). The Hundreds (1), Nineties (38) and Adolescents groups (51) had the lowest observed morbidities. The same age groups had the fewest cases of mortalities; Hundreds (1), Nineties (14) and Adolescents (11). For sex, morbidity was

Table 1. Monthly descriptive statistics of diagnosed CVD morbidities and mortalities

Month	Morbidity				Mortality			
	Min	Median	Max	Mean	Min	Median	Max	Mean
Jan	0	53.5	82	47.6	0	4	82	19.9
Feb	9	55	100	53.7	0	8.5	64	19.4
Mar	48	57	88	62	0	8	54	13.7
Apr	32	61	90	59.1	0	7.5	52	12.1
May	9	49	94	52.2	2	6	89	16.4
Jun	32	65.5	99	63.2	0	5.5	103	17.5
Jul	5	68	110	58.9	0	5.5	110	17.9
Aug	9	66.5	110	63.3	0	4	45	11.1
Sep	29	47.5	77	50.7	0	2	19	6.4
Oct	37	47.5	102	58.2	0	2	29	7.4
Nov	29	57.5	101	62.7	0	5	47	10.7
Dec	8	39.5	160	49.6	0	5	36	10.1

highest among females in their sixties, and mortality was higher among males in their fifties (Figure 2). No age data were available for 17 morbidities and 3 mortalities. Decomposing the time-series additive for morbidities (Figure 3A) showed that the trend was almost sinusoidal, with crests in 2010 and 2018, suggesting an 8-year cycle of fluctuation. Regarding seasonality, there was a January–November cycle in morbidity from diagnosed CVDs in Lagos State, with January as the base and November as the peak. Similarly, the decomposition of the additive time series of mortalities (Figure 3B) revealed that mortality fluctuated strongly during the study period without any obvious trend cycle; it increased sharply between 2017 and 2018. The overall trend increased over the study period, with a January–September seasonality cycle, with January as the peak and September as the base. With respect to the risk factors identified by attending physicians at diagnosis among the patients who died (Table 2), the most common

igure 2. A) Age distribution of morbidities B) Age distribution of mortalities
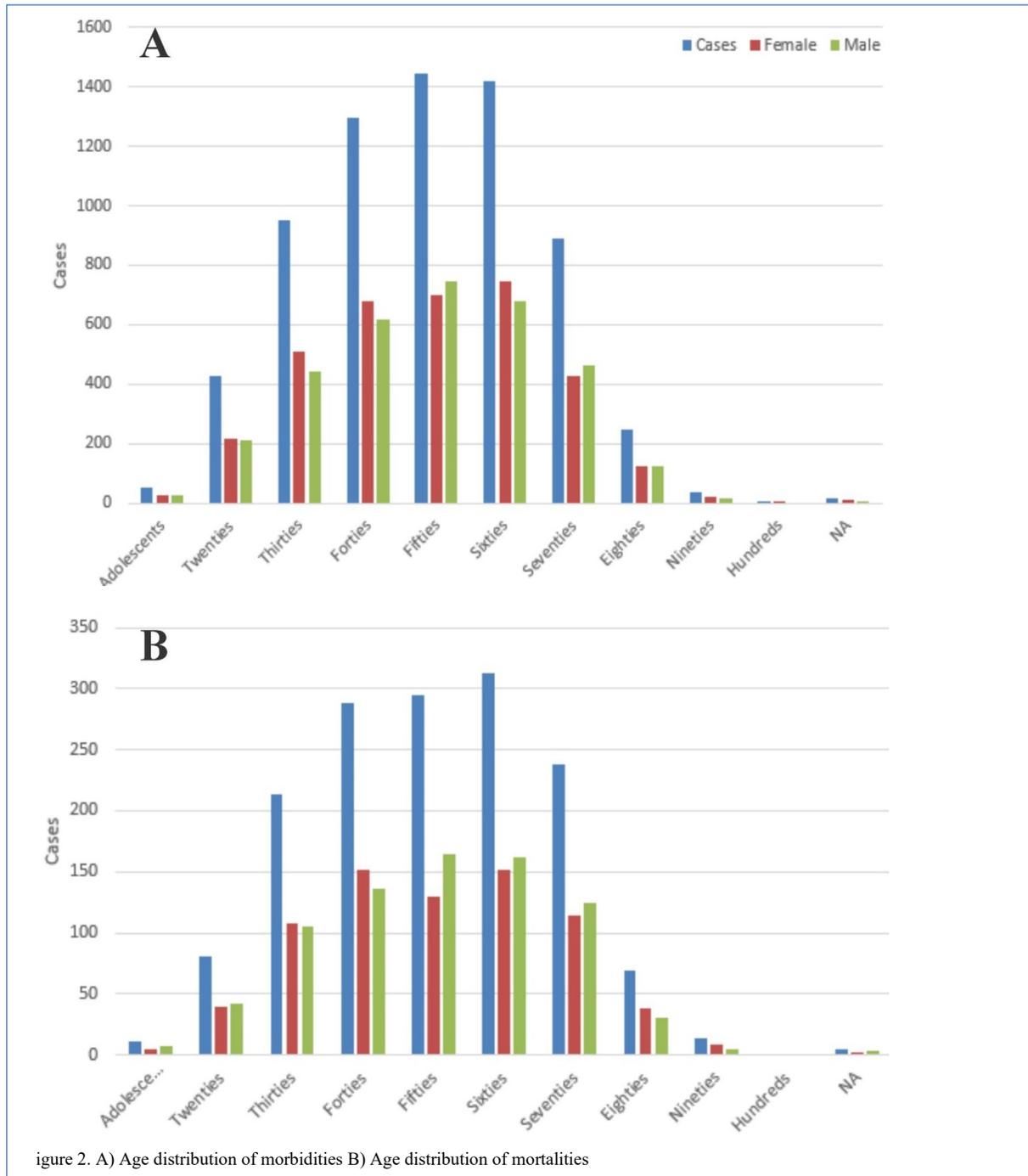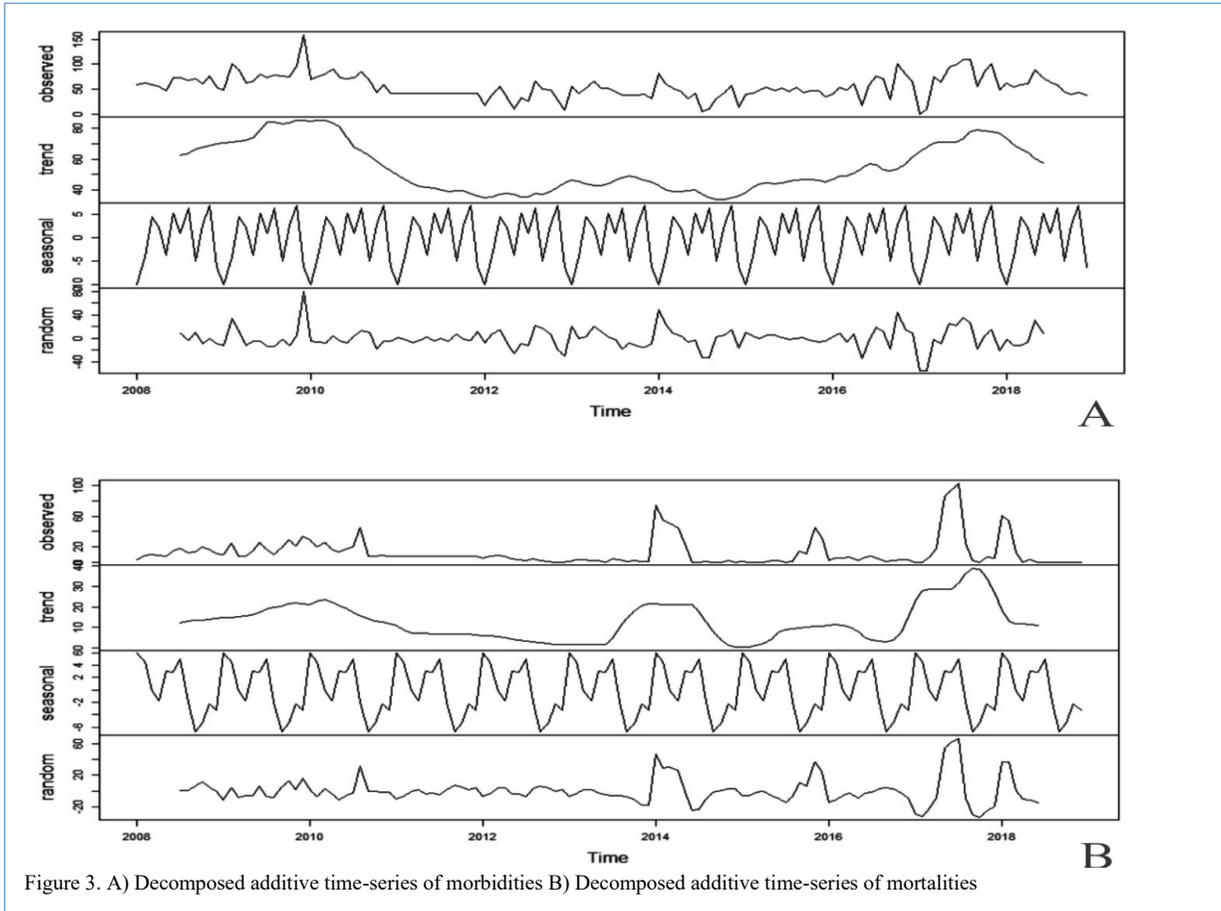
Figure 3. A) Decomposed additive time-series of morbidities B) Decomposed additive time-series of mortalities

Table 2. Distribution of patients that died by risk factors (RF) presented at diagnosis as determined by attending physicians

RF	Mortalities	Female	%	Male	%
Hereditary (Genetic)	276	148	53.6	128	46.4
HBP	239	113	47.3	126	52.7
Diabetes	240	122	50.8	118	49.2
High Cholesterol	124	77	62.1	47	37.9
Alcohol	104	56	53.8	48	46.2
Ageing	103	55	53.4	48	46.6
Stress	96	58	60.4	38	39.6
Excess Weight	91	66	72.5	25	27.5
Smoking	88	7	8.0	81	92.0
Cardiomyopathy	80	38	47.5	42	52.5
Emotional Pain	66	44	66.7	22	33.3
Sleep Apnea	63	31	49.2	32	50.8
Depression	22	14	63.6	8	36.4
Pregnancy	24	24	100.0	0	0.0
Past Heart Dx	11	6	54.5	5	45.5
Anxiety	11	5	45.5	6	54.5
Other	10	7	70.0	3	30.0
Coronary Artery Dx	7	6	85.7	1	14.3
Drug Abuse	3	0	0.0	3	100.0
Kidney Dx	3	0	0.0	3	100.0
Injury	2	0	0.0	2	100.0
Medication	2	1	50.0	1	50.0
Psychological	2	1	50.0	1	50.0
Thyroid Problem	1	0	0.0	1	100.0

* DDM = Dyke-Davidoff-Masson syndrome; HBP = High Blood Pressure; Dx = Disease

were high blood pressure, diabetes, high cholesterol, alcohol use, ageing, and stress. In contrast, the least common risk factors were thyroid disorders, psychological issues, medication, and injury (Table 2).

DISCUSSION

This study aimed to conduct a descriptive time-series analysis of diagnosed cardiovascular morbidity and mortality in Lagos, Nigeria, from 2008 to 2018, adopting a retrospective review of medical records of patients diagnosed with CVDs in a teaching hospital, and found a sinusoidal cycle of fluctuation in morbidity and a general increase in mortality during the study period. The mean ages of morbidity and mortality among individuals who died were consistent with findings from earlier studies, which reported that cardiovascular disease (CVD) cases in low- and middle-income countries (LMICs) tend to occur at younger ages compared with those in high-income countries [24]. These findings also reflect the ongoing epidemiological transition occurring in many developing countries [3]. This transition places additional strain on already burdened health systems, which continue to grapple with a high prevalence of communicable diseases such as malaria, tuberculosis, and HIV [25,26].

In contrast to what is obtainable in developed countries, more adolescents died during the study period compared with patients in their Nineties. This further corroborates the findings that the prevalence of CVD risk factors is increasing among younger populations in developing countries. Therefore, it is imperative to enhance awareness of CVDs among youths by disseminating targeted, evidence-based information via digital platforms, including the Internet and social media, which have high penetration and engagement within this demographic. January, the month with the lowest minimum mortality, was likely an indication of delayed, slower reporting of CVD cases at the beginning of the year, while the months with the highest mean and maximum mortality show that reporting of CVD-related morbidities and mortalities increases as the year progresses. The detected 8-year cycle of fluctuation in the trend of morbidities might indicate that Lagos State may have experienced a gradual decline in morbidities until 2022, after which the upward swing in morbidities may commence with another sharp peak in 2026. While a longitudinal study will confirm and provide a better understanding of this cycle, this trend can be addressed with focused, aggressive interventions, such as taking CVD screening directly to communities and making awareness of the disease, its symptoms, and treatments universal.

Concerning the January–November morbidities seasonality cycle, some plausible explanations can be advanced; first is the changes in weather. With the rainy season ending in November, the onset of the dry season, apart from generally increasing temperatures across the state, also aids the rise of fumes from automobile exhausts and industrial concerns in urban areas and bush burning in rural areas, which can

trigger heart-related diseases [27,28]. Second, there is the reduction in income due to the end-of-year cum beginning-of-year expenditures. For many, after spending a substantial part of their income on festivities in December, their accommodation rent is due in January, along with their children's school fees, for those with children. Hence, the cash squeeze does not make for prioritising their health [29]. Third is the time of the year. There is a tendency to take things easy at the beginning of the year, leading to a lackadaisical attitude towards personal healthcare, which might have negatively impacted reported cases. The observed general increase in mortality throughout the study period, and the sharp increase between 2017 and 2018 should be of concern to healthcare managers. This trend suggests that the healthcare system in Lagos State needs to improve advocacy for increased screening of CVDs, as early detection can help reduce mortality rates. Also, there is a need for greater awareness of the disease, its risk factors, and available treatment [1,4,5,6].

It might not be coincidental that mortalities peak in January. The possibility of a lackadaisical attitude towards personal healthcare, as observed in morbidities, might have cost some of the patients their lives. The pressure of the end-of-year season and festivities might also have affected mortality counts. This point is buttressed by looking at the diagnosed CVDs mortality dataset (Table 2) which showed that many men that died during the study period had high blood pressure, which could have been aggravated by the usual stress that goes with the build-up to the end of the year and the start of a new one, especially in a stress-inducing place like Lagos State, given the established connection between CVDs and stress [30]. Steptoe (2013) found that stress, anger and depression, emotional conditions that are in abundance in Lagos State, can trigger cardiovascular events. This is further corroborated by the conclusion of Song (2019) that stress-related disorders are strongly associated with multiple types of CVDs.

Strengths and limitations of this study

The length of the study period provides valuable insight into temporal trends, which many previous studies lacked. The over 6,000 CVD cases analysed enhanced the robustness of findings. The study provided proper context by effectively connecting local data to global and regional epidemiological circumstances. The corresponding analysis of mortality data adds depth to understanding the impact of CVD beyond morbidity rates. However, the findings may not be fully generalisable to other parts of Africa with different demographics or healthcare access because the data came from a single healthcare facility. Also, the retrospective nature of the study design has the potential for incomplete or inconsistent data recording.

Conclusion

The study of cardiovascular disease (CVD) morbidity and mortality in Lagos State, Nigeria, revealed interesting findings. The study detected an 8-year cycle of fluctuation in diagnosed CVD morbidities and an annual January-

November cycle, with January as the base and November as the peak. Similarly, mortalities followed a January-September cycle, with January as the peak and September as the base. The study also found that morbidity was lowest in January, while mortality was highest in that month. The two probable explanations advanced for this phenomenon were weather changes occasioned by the onset of the harmattan season and end-of-year stress. These findings highlight the importance of understanding the temporal patterns of CVD morbidity and mortality, which can inform the development of targeted interventions and policies to reduce the burden of CVD in Lagos State. Further research is needed to investigate the underlying causes of these patterns and to develop effective strategies for CVD prevention and management in Lagos State.

DECLARATIONS

Ethical consideration
Ethical approval was sought and received from the Social Sciences/Humanities Research Ethics Committee of the University of Ibadan, with assigned number: UI/SSHREC/2018/0012. All information extracted from patients' records was treated as confidential.

Consent to publish
All authors agreed on the content of the final paper.

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Competing Interest
The authors declare no conflict of interest

Author contribution
OA and OJT were involved in study design, data interpretation, drafting the article, and critical revision of the manuscript. OA handled data collection and analysis. All contributing authors read and approved the manuscript prior to submission.

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Availability of data
Data is available upon request to the corresponding author.

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