Cardiology and Angiology: An International Journal

Volume 13, Issue 3, Page 29-41, 2024; Article no.CA.118204
ISSN: 2347-520X, NLM ID: 101658392

Prevalence and Hospitalizations of Cardiovascular Disease Complications in Adults with Diabetes: A Comprehensive USDDS Database Analysis

Udoka Charity Ken-Eze [a], Ozojide Kingsley Onyekachukwu [b], Eberechukwu.G. Anamazobi [c], Okelue Edwards Okobi [d*], Adedoyin Olawoye [e] and Ubogun Ogheneakpobor Efe [f]

[a]The Limi Hospital, FCT Abuja, Nigeria.
[b] Nottingham Trent University, Nottingham, United Kingdom.
[c] South Atlanta Primary Care, Atlanta, Georgia, USA.
[d] Larkin Community Hospital, PSC, Miami, USA.
[e] Maimonides Medical Center Brooklyn NY, United States.
[f] Delta State University, Abraka, Nigeria.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: https://doi.org/10.9734/ca/2024/v13i3422

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/118204

Original Research Article

Received: 08/04/2024
Accepted: 12/06/2024
Published: 13/06/2024

**Corresponding author: E-mail: drokelue.e.okobi@gmail.com;*

Cite as: Ken-Eze , Udoka Charity Ken-Eze, Ozojide Kingsley Onyekachukwu, Eberechukwu.G. Anamazobi, Okelue Edwards Okobi, Adedoyin Olawoye, and Ubogun Ogheneakpobor Efe. 2024. "Prevalence and Hospitalizations of Cardiovascular Disease Complications in Adults With Diabetes: A Comprehensive USDDS Database Analysis". Cardiology and Angiology: An International Journal 13 (3):29-41. https://doi.org/10.9734/ca/2024/v13i3422.

ABSTRACT

Background: Cardiovascular disease (CVD) is a significant cause of morbidity and mortality among adults with diabetes. Understanding the prevalence and trends in hospitalizations for CVD complications in this population is crucial for informing healthcare strategies and interventions.
Aim: This study aimed to analyze the prevalence and hospitalization rates of CVD complications among adults with diabetes using data from the USDSS database.
Methods: This retrospective study analyzed USDSS database data from 2000 to 2020, exploring CVD complications' prevalence and hospitalization patterns in adults with diabetes.The study explored prevalence rates of major CVD complications, including heart disease and stroke, alongside demographic factors like age, gender, race/ethnicity, and education level. Hospitalization rates for ischemic heart disease, heart failure, and stroke were calculated. Temporal trends were analyzed graphically, and statistical tests (chi-square, ANOVA) with a significance level of $p<0.05$ were conducted.
Results: The analysis revealed notable temporal trends in major heart disease prevalence and stroke rates among adults with diabetes. Over the study period, major heart disease incidence increased from 2.7 in 2000 to 4.9 in 2022, with an average of 4.22. Prevalence ranged from its lowest at 18.2% in 2014 to its highest at 23.7% in 2001, with the latest at 17.4% in 2022. Stroke cases rose steadily from 1.1 in 2000 to 2.1 in 2022, with the latest prevalence at 7.4%. Subgroup analysis revealed variations across gender, age, race, and education levels. Hospitalization rates for CVD declined from 78.6 per 1,000 in 2000 to 46 per 1,000 in 2020. Rates for ischemic heart disease decreased from 32.2 per 1,000 to 10.2 per 1,000, heart failure from 20.7 per 1,000 to 15 per 1,000, and stroke from 9.4 per 1,000 to 8.4 per 1,000.
Conclusion: This study provides valuable insights into the prevalence and hospitalization trends of cardiovascular disease complications among adults with diabetes in the United States. The findings underscore the importance of targeted interventions to reduce the burden of CVD in this population.

Keywords: USDSS; trend analysis; adults; cardiovascular disease complications; ischemic heart disease; heart failure; stroke; prevalence; hospitalizations.

1. INTRODUCTION

Cardiovascular disease (CVD) stands as a formidable global health challenge, encompassing a spectrum of conditions that impact the heart and blood vessels. Among these major heart disease conditions, ischemic heart disease, heart failure, and stroke reign as prominent complications, significantly contributing to morbidity and mortality rates worldwide [1]. Ischemic heart disease, characterized by diminished blood flow to the heart muscle, can culminate in myocardial infarction and angina pectoris. Heart failure, on the other hand, emerges from compromised cardiac function, resulting in inadequate tissue perfusion-[1a,1b]. Meanwhile, stroke, a cerebrovascular event, manifests due to the interruption of blood supply to the brain, often inflicting severe neurological consequences [2-4].

In the context of diabetes mellitus (DM), existing literature underscores a heightened susceptibility to cardiovascular risk. Within the United States, diabetic individuals exhibit nearly threefold increased vulnerability to heart disease compared to their non-diabetic counterparts [5-6]. Global statistics from the International Diabetes Federation (IDF) reveal that DM affects approximately 8.8% of the population, with projections indicating a surge to 643 million individuals by 2040. The risk disparities with diabetic patients facing a 10% higher risk of CVD, 53% higher risk of myocardial infarction (MI), 58% higher risk of stroke, and 12% higher risk of heart failure compared to non-diabetic individuals [7].

The pathophysiology of CVD in individuals with DM is intricate and multifaceted. Persistent hyperglycemia, insulin resistance, dyslipidemia, and inflammation collectively contribute to endothelial dysfunction, arterial stiffening, and accelerated atherosclerosis [8-9]. These metabolic aberrations foster plaque formation and rupture, precipitating thrombosis and ischemic events. Furthermore, diabetes-related comorbidities such as hypertension and obesity exacerbate cardiovascular risk. [10] The interplay of these factors establishes a proinflammatory and prothrombotic milieu, predisposing individuals with DM to a heightened likelihood of

developing ischemic heart disease, heart failure, and stroke. Hence, targeted interventions addressing these underlying mechanisms assume paramount importance in mitigating CVD risk in this population [11].

The United States Diabetes Surveillance System (USDSS) serves as a comprehensive repository that aggregates and analyzes data pertaining to diabetes prevalence, incidence, risk factors, and complications across the nation. It furnishes invaluable insights into the epidemiology of diabetes and its associated health outcomes, thereby facilitating research endeavors and informing public health policies and interventions [12,13].

Given the substantial burden of CVD in individuals with DM, there exists an imperative to comprehensively explore the prevalence and hospitalization patterns of CVD complications within this demographic. Consequently, the objective of this retrospective study is to understand the prevalence rates of major heart disease and stroke among adults diagnosed with DM, evaluate trends in hospitalizations for these conditions over time, and scrutinize demographic and clinical factors associated with an elevated risk of CVD complications within this cohort.

2. METHODS

2.1 Study Design

This retrospective study utilized data extracted from the USDSS database to investigate the prevalence and hospitalization patterns of CVD complications in adults diagnosed with DM. The study spanned a specified period, ranging from 2000 to 2022, allowing for comprehensive analysis of trends over time.

2.2 Study Population and Inclusion Criteria

The study cohort comprised adults aged 18 years and above who had a documented diagnosis of diabetes mellitus within the USDSS database during the specified study period. Individuals with missing or incomplete data pertinent to the study objectives were excluded from the analysis to ensure data integrity and reliability.

2.3 Study Variables

This study delved into several pivotal variables including the prevalence rates of major CVD complications, encompassing major heart disease and Stroke. Furthermore, demographic factors such as age, gender, race/ethnicity, and education level were examined to elucidate any disparities for these complications. Additionally, hospitalization rates for specific CVD complications, including ischemic heart disease, heart failure and Stroke, were assessed. Through comprehensive analysis of these variables, the study aimed to understand the epidemiological patterns, demographic discrepancies, and temporal trends surrounding CVD complications in the diabetic population.

2.4 Data Extraction and Analysis

Data extraction from the USDSS database followed standardized protocols to ensure precision and consistency. Relevant data, including prevalence rates for CVD complications across demographic characteristics, education status, as well as hospitalization data for ischemic heart disease, heart failure, and stroke, were extracted for analysis. The process ensured the retrieval of accurate and comprehensive data points essential for the study objectives. Descriptive statistics were utilized to summarize demographic characteristics for each complication. Hospitalization rates were calculated by dividing admissions for each complication by total person-years of observation, multiplied by 1,000. Temporal trends in hospitalizations were scrutinized using graphical representations. Statistical methods, including chi-square and ANOVA tests with a significance level of $p<0.05$, were employed to identify significant associations and predictors of hospitalization.

3. RESULTS

3.1 Major Heart Disease Prevalence and Temporal Trends

Analysis of the USDSS database from 2000 to 2022 unveiled notable temporal trends in the prevalence of major heart disease among adults. Over the study period, the incidence of major heart disease per 1,000,000 individuals exhibited an upward trend, increasing from 2.7 in 2000 to 4.9 in 2022, with an average of 4.22. Prevalence displayed fluctuating patterns, attaining its lowest point of 18.2% in 2014 and peaking at 23.7% in 2001. Notably, the most recent recorded prevalence stood at 17.4% in 2022 (Table 1).

Table 1. Major heart disease prevalence data- based on gender, age groups, race, educational level

Categories	Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	P value
Major Heart Disease - Overall	Number in 1000000s	2.7	3.1	3.3	3.3	3.5	3.7	3.9	3.5	4.3	4.2	4.7	5	4.7	4.8	4.3	4.9	4.5	4.4	5.2	4.9	4.7	4.6	4.9	-
	Percentage	21.1	23.7	23.1	22.4	21.5	22.2	21.8	19.2	22	19.7	21.5	22.8	21.4	20.7	18.2	18.9	18.4	17.4	18.3	19.2	17.1	17.3	17.4	-
	95% Lower Limit	18.9	21.4	20.9	20.4	19.5	20.2	19.5	17.1	19.8	17.7	19.7	21	19.3	19	16.5	17.2	16.6	15.6	16.6	17.5	15.4	15.8	15.7	-
	95% Upper Limit	23.5	26.1	25.4	24.6	23.7	24.5	24.3	21.5	24.3	21.8	23.5	24.7	23.8	22.5	20	20.8	20.4	19.5	20.2	21	19	19	19.3	-
Major Heart Disease Percentage-Based on Gender	Male	24.4	28	26.7	26.7	25.8	24.5	24.6	22	26.9	23.9	24.4	27.5	25.3	23.8	20.9	21.6	22.3	19.6	22.8	22.2	19.7	19.1	20.9	P<0.05
	Female	17.7	19.4	19.2	18.2	17.2	20.2	19.4	16.5	17.5	15.1	18.6	18	17.7	17.5	15.3	16.2	14.6	15	13.6	16.2	14.3	15.6	13.6	
Major Heart Disease Percentage-Based on Age	35-64	17	20.1	18.2	18.2	17.1	18.3	18	15.6	17.7	16	18.2	18.8	18.2	17.1	14.9	15	15.2	13.5	14	15.8	13	14	13.4	P<0.05
	65-74	33.5	30.4	35.5	31.6	31.5	34.5	30.9	31.1	32.2	25.5	28.7	31.6	26.1	26.8	25.1	28.4	23.7	24.3	26.8	25.8	24.6	23.2	24.8	
	75+	33.7	39.1	40.9	39.1	38.7	33.8	36.5	29.4	38.2	36.7	34.5	39.1	37	36.8	31.2	33.4	33.5	35	36.2	33.7	34.8	32	34.9	
Major Heart Disease Percentage-Based on Race	Hispanic	14.6	13.9	13.7	16.4	19.9	16.5	14.3	16.9	19.6	17.4	12.6	18.5	15.1	17.1	13.3	17.3	17.9	14.3	17.6	14.1	11.4	11.6	14.6	P<0.05
	Non-Hispanic White	22.3	26.6	25.7	23.5	23.6	23.6	25	20.5	24.1	20.4	24.1	25.1	23.9	22.8	19.8	20.3	20.1	17.5	19.3	23.1	20.8	19.2	19.8	
	Non-Hispanic Black	19.8	18.7	16.9	20.2	13.8	20.7	18.9	17.2	19	20.6	19.8	21	17.2	21.7	19.6	16.2	15	21.1	17.4	16.3	13.8	19.6	13.2	
	Non-Hispanic Asian	**	6.7	**	**	**	**	**	**	**	**	20.6	12.3	19.1	10.4	9.1	**	**	16.7	14.6	**	9.5	**	16.7	
Major Heart Disease Percentage-Based on Education	< High School	24.8	24.2	25.9	28.8	24	28.5	26.5	23.1	25.7	19.2	24.3	27.1	24.3	24	19.5	19.3	21.1	17.4	19	21	18.6	20.7	19.4	P<0.05
	High School	20.2	22.4	21.6	21.7	23.3	20.2	23.1	18.9	20.1	20.1	19.6	20.9	21.8	22.4	19.2	19.5	19.3	20.1	22.7	20.4	18.1	18.9	18	
	> High School	19.5	24.7	23.7	20	19.6	20.8	18.7	17	21.6	19.7	22.2	22.5	20.1	18.4	16.8	18.8	17	15.8	15.9	17.8	16.3	15.3	16.6	

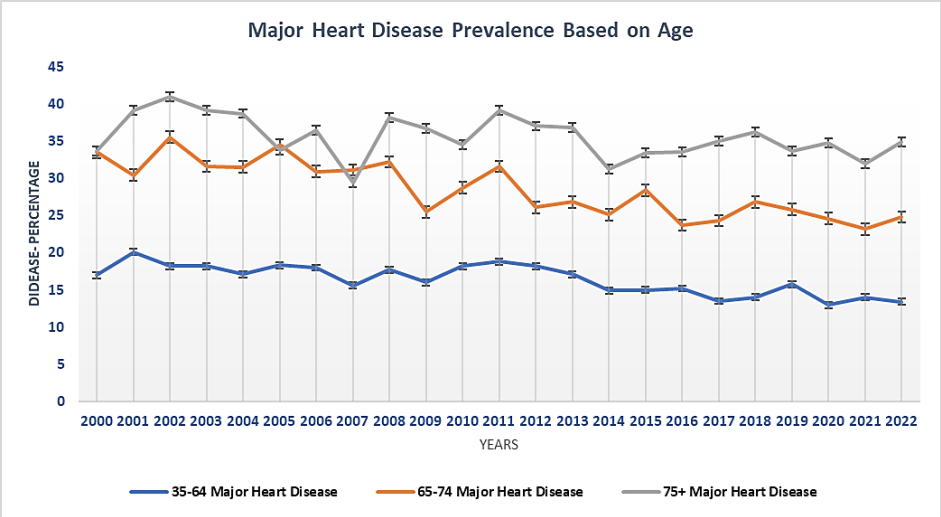

Fig. 1. Major heart disease prevalence based on age

Subgroup analyses based on gender, age, race/ethnicity, and education level revealed notable variations in major heart disease prevalence among adults with diabetes. Among males, prevalence rates ranged from 19.1% in 2021 to 28% in 2001, while for females, they varied from 13.6% in 2021 to 20.2% in 2005. Male prevalence (23.63%) exceeded that of females (16.74%), showcasing diverse trends over the years.

Fig. 1 presents data on the prevalence of major heart disease categorized by age groups. Regarding age groups, individuals aged 35-64 age group, percentages ranged from 13.4% in 2022 to 20.1% in 2001. Ages 65-74 exhibited rates from 23.2% in 2022 to 35.5% in 2002, while ages 75 and above ranged from 32% in 2022 to 40.9% in 2002. The lowest prevalence was in the 35-64 age group (16.40%), while the highest was in the 75 and above group (35.65%), with an average of 28.27% for ages 65-74 ($p<0.05$) (Fig. 1).

Similarly, variations were observed across racial/ethnic groups. Hispanic individuals showed percentages ranging from 11.4% in 2020 to 19.9% in 2004, ending at 14.6% in 2022. Non-Hispanic White individuals ranged from 17.5% in 2017 to 26.6% in 2001, ending at 19.8% in 2022. Non-Hispanic Black individuals ranged from 13.2% in 2022 to 21.7% in 2012. The lowest average prevalence was observed in non-Hispanic Asian (13.57%), followed by non-Hispanic Black (18.12%) and Hispanic (15.59%), while non-Hispanic White individuals had the highest prevalence (22.13%) (Table 1).

Significant differences in major heart disease prevalence were observed based on education level among adults with diabetes. Among individuals with less than a high school education, rates ranged from 18.6% in 2021 to 28.8% in 2003. High school graduates had rates from 18% in 2022 to 23.3% in 2004. Those with education beyond high school showed rates from 15.3% in 2021 to 24.7% in 2001. On average, prevalence was lowest for those with education beyond high school, at 19.03%, followed by high school graduates at 20.48% (Table 1). Conversely, the highest average prevalence occurred among those with less than a high school education, at 22.88%. The p-value for the trend analysis of major heart disease prevalence across different gender, age groups, races, and education levels from 2000 to 2022 was found to be less than 0.05, indicating statistical significance. These findings highlight the impact of education level on major heart disease prevalence among individuals with diabetes, with lower educational attainment associated with higher prevalence rates.

3.2 Stroke Prevalence and Temporal Trends

The comprehensive analysis revealed fluctuating prevalence rates over the years, indicating the significant burden of stroke within this demographic during the specified period. The incidence of stroke cases per 1,000,000 individuals exhibited a steady increase from 1.1 in 2000 to 2.1 in 2022. However, the latest recorded percentage showed a slight decrease to 7.4%, compared to the preceding years' averages (Table 2).

Table 2. Stroke prevalence data: Based on gender, age groups, race, educational level

Categories	Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	P value
Stroke - Overall	Number in 1000000s	1.1	1.2	1.3	1.4	1.4	1.4	1.5	1.6	2.1	1.7	1.9	2	2	2.1	1.9	2.1	2	2.3	2.4	2.2	1.8	2.1	2.1	-
	Percentage	8.7	8.2	8.9	9.1	8.2	7.6	7.2	8.5	10.5	7.9	9.1	9	8.9	8.9	8.2	8.2	7.9	9.7	8.7	8.7	6.7	7.7	7.4	-
	95% Lower Limit	7.1	7	7.6	7.8	7	6.4	6.1	7.1	9	6.7	7.8	7.8	7.7	7.6	7	7.1	6.8	8.1	7.4	7.5	5.6	6.6	6.3	-
	95% Upper Limit	10.6	9.5	10.4	10.7	9.6	8.9	8.6	10.2	12.2	9.3	10.5	10.4	10.4	10.4	9.4	9.5	9.2	11.5	10.1	10.1	8	9.1	8.8	-
Stroke - Based on Gender	Male	9.7	8.2	9.9	9.2	8.7	6.7	7.2	7.9	12.1	6.4	9.8	8.1	8	8.5	7.4	8	7.3	11.5	9.6	7.9	6.3	7.6	7.3	0.9907
	Female	7.5	8.1	7.8	9	7.6	8.3	7.3	9	9.1	9.5	8.3	9.9	9.9	9.3	8.9	8.4	8.5	7.5	7.7	9.4	7.1	7.8	7.5	
Stroke - Based on Age	35-64	6.6	6	6.7	6.8	5.9	5	4.2	6.7	8.2	5.8	8	7.3	7.8	7.2	7	6.6	6.2	8.7	6.8	7.5	5.4	6.4	5.6	P<0.05
	65-74	13.5	12.4	14.3	16.7	13.2	12.5	14.7	12.5	14.7	9.6	8.5	12.8	10.8	12	9.5	10.4	11.6	10.5	12.7	9.4	10.1	10.3	11.2	
	75+	16.9	17.2	16.9	15.6	17.8	18.5	18.2	15.7	20.4	19.4	16.8	15.5	14.2	16.5	13.8	16	15	15.3	16.2	15.1	11.3	13.2	14.7	
Stroke - Based on Race	Hispanic	7.2	11.1	11.2	9.8	10.7	6.5	4.6	7.1	7.2	6.5	7.3	11	10.1	11	7.5	6.2	7.4	10.5	6.9	7.3	5.1	8.9	6.9	P<0.05
	Non-Hispanic White	7.9	7.1	8.7	8	8	7.7	6.7	7.7	11.4	8.3	8.7	7	8.4	7.9	6.3	8.3	7.8	9.5	8.4	8.7	7.5	6.7	7.2	
	Non-Hispanic Black	12.2	9.9	8.9	13.1	7.5	7.6	10.9	11.1	10.5	9.6	12.8	14.2	11	9.5	15.2	11.5	9.6	10	12.9	13	8	9.4	10.5	
	Non-Hispanic Asian	**	7.1	**	**	**	**	**	**	**	**	**	7.5	**	**	**	**	**	**	**	**	**	**	**	
Stroke - Based on Education	< High School	12.2	9.9	13.9	11.2	12.6	9.9	10.9	10	14.2	8.2	9.4	11.2	11.3	11.9	8.9	10.2	8.5	12.4	12.2	8.3	8.3	12.1	9.8	P<0.05
	High School	7.1	7.5	7.7	11.1	7.8	7.9	7.2	9	9.4	8	9.5	8.9	8.9	8.8	8.4	5.7	8.5	9.4	8.5	10.6	6.5	7.9	7.5	
	> High School	6.7	7.8	6.4	6.1	6.2	6	5.3	7.1	8.9	7.8	8.5	7.7	7.9	7.6	7.7	8.7	7.4	8.4	7.7	7.7	5.9	6.3	6.3	

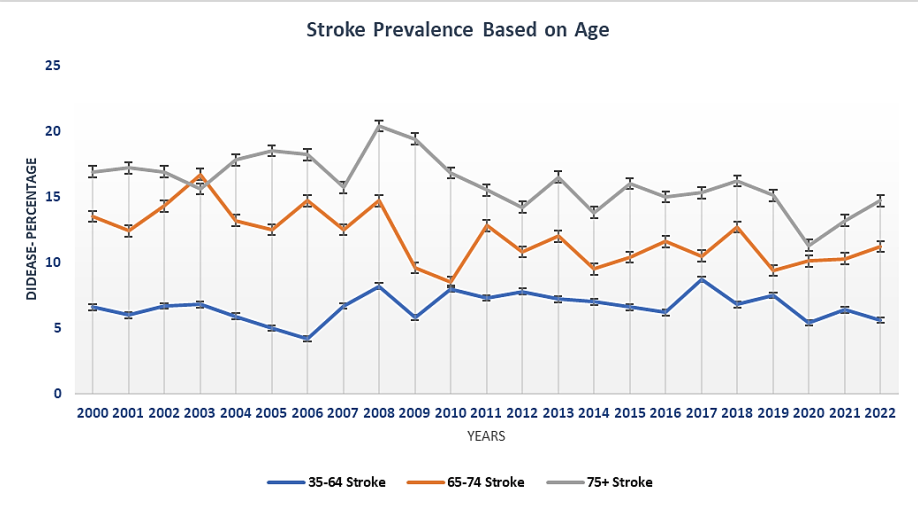

Fig. 2. Stroke prevalence based on age in adults

Fig. 2 illustrates the prevalence of stroke among adults across different age groups. This visual representation allows for a clear understanding of how stroke prevalence varies across the age spectrum. Stroke prevalence exhibits diverse patterns across demographic categories, as revealed by the analysis of the data. In terms of gender, the prevalence among males ranged from 7.3% in 2022 to 9.7% in 2000, with an average of 8.40%. For females, percentages remained consistent, ranging from 7.5% in 2022 to 7.5% in 2000, with an average of 8.38% (Table 2).

Analysis by age groups revealed intriguing patterns. Age plays a significant role in stroke prevalence, with rates varying across different age groups. Among individuals aged 35-64, percentages ranged from 5.6% in 2022 to 8% in 2010. Those aged 65-74 showed rates fluctuating from 10.1% in 2020 to 16.7% in 2003, with the latest at 11.2%. For individuals aged 75 and above, percentages ranged from 11.3% in 2020 to 20.4% in 2008, with the latest at 14.7%. The average prevalence was highest for individuals aged 75 and above (15.98%), followed by those aged 65-74 (11.88%), and lowest among the 35-64 age group (6.62%). These findings suggest that stroke risk increases with advancing age, highlighting the importance of targeted interventions for older adults with diabetes (Fig. 2).

When considering race/ethnicity, Hispanic individuals demonstrated percentages ranging from 5.1% in 2020 to 11.2% in 2002, with the latest at 6.9%. Non-Hispanic White individuals had rates varying from 6.7% in 2021 and 2006 to 9.5% in 2017, with the latest at 7.2%. Among Non-Hispanic Black individuals, percentages ranged from 8% in 2020 to 14.2% in 2012, with the latest at 10.5%. Data for Non-Hispanic Asian individuals were incomplete. The average prevalence was lowest among Non-Hispanic White individuals (7.84%), followed by Hispanic individuals (8.17%), and highest among Non-Hispanic Black individuals (10.83%) (Table 2).

Education level also influenced stroke prevalence, with individuals having less than a high school education exhibiting rates ranging from 8.3% in 2022 to 14.2% in 2008, with the latest at 9.8%. High school graduates saw percentages varying from 6.5% in 2022 to 11.1% in 2003, with the latest at 7.9%. Those with education beyond high school ranged from 5.9% in 2022 to 8.9% in 2008, with the latest at 6.3%. The average prevalence was highest among individuals with less than a high school education (10.76%), followed by high school graduates (8.31%), and lowest among those with education beyond high school (7.19%) (Table 2). The p-value for the trend analysis of stroke prevalence across different age groups, races, and education levels from 2000 to 2022 was found to be less than 0.05, indicating statistical significance. However, p-value comparing stroke prevalence between males and females was 0.9907, suggesting no significant difference based on gender. These findings emphasize the importance of educational attainment in mitigating stroke risk among adults with diabetes.

Table 3. Hospitalization rate for cardiovascular disease

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	P value
Hospitalization for Cardiovascular Disease Total - Rate per 1000	78.6	75.2	74	72.6	67.1	61.2	61.1	59.3	55.7	50.9	47.4	50.9	48.6	45.6	47.5	47.3	48.2	50.2	45.9	51.9	46	-
Total - 95% Lower Limit	72.9	69.8	68.2	67.1	62.3	56.6	55.9	54.1	50.8	46.9	43.9	47.3	46	43.3	44.9	44.6	44.9	46.9	43.4	48.7	43	-
Total - 95% Upper Limit	84.3	80.5	79.8	78.1	71.8	65.8	66.2	64.5	60.6	54.9	50.8	54.5	51.3	48	50.2	50.1	51.5	53.5	48.5	55	49	-
Hospitalization for Ischemic Heart Disease Total - Rate per 1000	32.2	30.6	29.6	28.5	25.6	22.5	22.8	20.4	18.8	16.3	14.1	14.6	14	12.6	12.5	12.1	12.2	12.2	10.9	12.1	10.2	P<0.05
Hospitalization for Heart Failure; Total - Rate per 1000	20.7	19.9	19.6	19.5	18.2	16.8	15.8	15.5	14.1	13.3	12.2	13.2	12.4	12	13	13.1	13.8	15.6	14.8	16.9	15	
Hospitalization for Stroke Total - Rate per 1000	9.4	8.7	8.6	8.2	7.7	7.1	7	7.1	7.2	6.4	6.5	7.1	6.9	6.8	7.2	7.2	8.3	8.5	7.8	8.8	8.4	

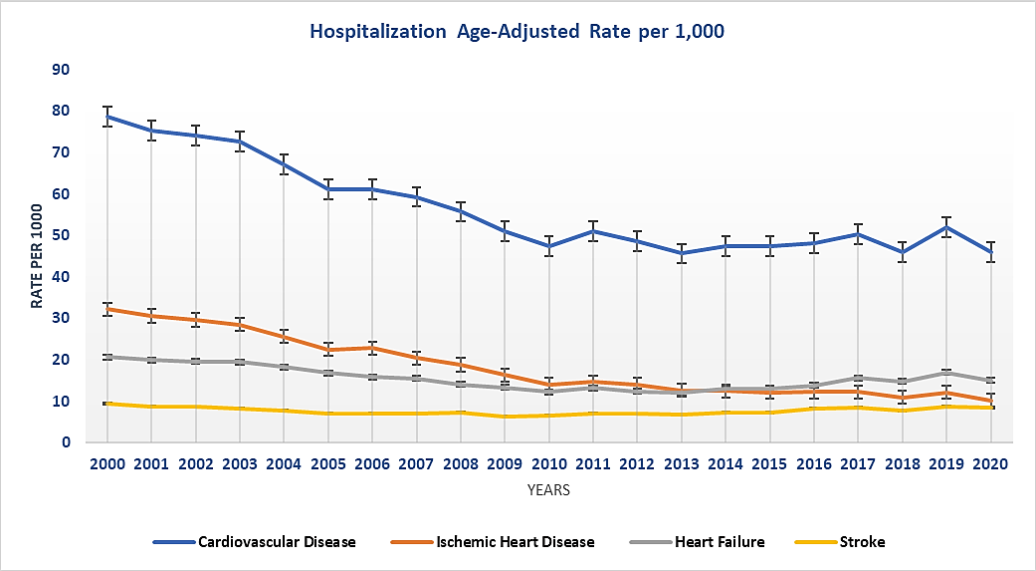

Fig. 3. Age-adjusted (rate per 1000) hospitalization for cardiovascular disease

3.3 Hospitalization for Cardiovascular Disease

Hospitalization for CVD among adults with diabetes, as documented in the USDSS database spanning 2000 to 2020, revealed an age-adjusted rate of 56.4 per 1,000 individuals nationally. This comprehensive analysis underscored the substantial burden of cardiovascular complications in this population over the studied period (Table 3).

In Fig. 3, the hospitalization rate for cardiovascular disease is graphically depicted, providing a visual representation of the frequency at which individuals are admitted to hospitals due to cardiovascular-related conditions. The hospitalization rates for CVD displayed a gradual decline from 78.6 per 1,000 individuals in 2000 to 46 per 1,000 in 2020, with a corresponding decrease in the 95% confidence interval from 72.9 to 84.3 in 2000 to 43 to 49 in 2020. Similarly, hospitalization rates for ischemic heart disease decreased from 32.2 per 1,000 in 2000 to 10.2 per 1,000 in 2020. Heart failure hospitalization rates declined from 20.7 per 1,000 in 2000 to 15 per 1,000 in 2020, while stroke hospitalization rates also decreased from 9.4 per 1,000 in 2000 to 8.4 per 1,000 in 2020 (Figure 3). The p-value for the trend analysis of hospitalization rates for CVD diseases from 2000 to 2020 was <0.05, indicating a significant temporal trend in hospitalization rates. Overall, the analysis reveals substantial improvements in hospitalization rates for CVD , ischemic heart disease, and heart failure over the past two decades. However, stroke hospitalization rates remained relatively stable during the same period. These trends suggest a potential improvement in CVD management and prevention strategies over the past two decades.

4. DISCUSSION

Examining temporal trends in major heart disease and stroke prevalence offers crucial insights into evolving cardiovascular complications, contextualizing findings within broader literature and identifying implications for managing diabetic cardiovascular health.

Previous studies consistently report an increased risk of CVD complications among individuals with diabetes compared to those without [5,14-15]. Our study aligns with these findings, showing notable temporal trends in the prevalence of major CVD complications, including major heart disease and stroke, among adults with diabetes. The observed upward trend in the incidence of major heart disease and stroke cases underscores the ongoing challenge of managing CVD in this population. Several longitudinal observational studies, such as the Framingham Heart Study, NHANES I, Reykjavik Study, and Scottish diabetes mellitus register, indicate a two- to fourfold higher risk of heart failure among individuals with diabetes or prediabetes compared to those without [14-15]. These trends underscore the growing burden of cardiovascular

complications in the diabetic population and highlight the need for targeted interventions to mitigate these risks.

Gender, age, and racial disparities in cardiovascular disease: Consistent with existing literature, our analysis identified gender disparities in the prevalence of both major heart disease and stroke among individuals with diabetes. Males consistently exhibited higher rates than females for both conditions. These disparities emphasize the importance of tailored interventions addressing gender-specific risk factors and management strategies. Recent research suggests that hormonal differences, lifestyle factors, and access to healthcare services may contribute to these disparities and warrant further investigation [6,16-17]. Our study reaffirmed the age-dependent nature of cardiovascular complications among individuals with diabetes. Both major heart disease and stroke exhibited higher prevalence rates in older age groups. This underscores the importance of age-specific risk assessment and intervention strategies. Recent studies have highlighted the role of vascular aging, cognitive impairment, and polypharmacy in shaping cardiovascular risk among elderly diabetic populations, emphasizing the need for comprehensive geriatric assessment and management approaches [18-19].

Our analysis underscored racial disparities in the prevalence of major heart disease and stroke among individuals with diabetes. Non-Hispanic White individuals exhibited the highest rates of major heart disease, while non-Hispanic Black individuals had the highest rates of stroke, followed by Hispanics and non-Hispanic Whites. These findings highlight the complex interplay of socioeconomic, cultural, and genetic factors in shaping cardiovascular health disparities among diverse racial and ethnic groups. Contrary to previous studies, research by Kamath et al. [20] and others revealed race-related disparities in diabetes prevalence among individuals with heart failure. Black, Hispanic, and Native American populations showed higher diabetes prevalence rates ranging from 47% to 56% compared to other racial groups. Recent research has emphasized the role of social determinants of health, including access to care and neighborhood environments, in driving these disparities and highlighted the potential of culturally tailored interventions to reduce cardiovascular risks among minority populations [21-22].

Socioeconomic factors and hospitalization rates: Consistent with existing literature, our study demonstrated an inverse relationship between educational attainment and the prevalence of major heart disease and stroke among individuals with diabetes. This underscores the critical role of educational interventions in promoting awareness, self-management skills, and access to healthcare services among vulnerable populations. Recent research has emphasized the potential of community-based health literacy programs, patient navigation services, and policy interventions targeting educational inequities to reduce cardiovascular risks among socioeconomically disadvantaged groups [23].

The analysis of hospitalization rates for CVD revealed significant improvements in healthcare outcomes. The age-adjusted hospitalization rate for CVD declined from 78.6 per 1,000 individuals in 2000 to 46 per 1,000 in 2020, reflecting a substantial reduction in the burden of cardiovascular complications in this population. Similarly, hospitalization rates for ischemic heart disease and heart failure exhibited notable declines over the study period. However, stroke hospitalization rates remained relatively stable during the same timeframe. These findings suggest significant progress in CVD management and prevention strategies over the past two decades, possibly driven by advancements in medical care, improved access to healthcare services, and greater emphasis on preventive measures. Continued efforts to monitor and address cardiovascular risk factors among individuals with diabetes are essential to sustain these positive trends and further reduce the incidence of cardiovascular complications in this high-risk population [24-26].

Strength and limitation: While our study provides valuable insights into the epidemiological patterns of major heart disease and stroke among individuals with diabetes, several limitations should be acknowledged. Firstly, the retrospective nature of the study design precludes the establishment of causal relationships between diabetes and cardiovascular outcomes. Additionally, reliance on administrative data from the USDSS may introduce bias and inaccuracies due to variations in coding practices and data collection methods across healthcare facilities. Furthermore, the lack of detailed clinical data in the USDSS limits our ability to assess the impact of potential confounding factors, such as glycemic control

and medication adherence, on cardiovascular outcomes. Despite these limitations, our study contributes to the understanding of cardiovascular complications in diabetes, emphasizing the need for targeted interventions and further research to address existing gaps and disparities in cardiovascular outcomes among individuals with diabetes.

5. CONCLUSION

In summary, our analysis highlights the evolving landscape of cardiovascular complications among adults with diabetes and emphasizes the need for tailored interventions across diverse demographic groups. While improvements in hospitalization rates for cardiovascular diseases signify progress, stable stroke rates underscore the ongoing need for vigilance. Addressing disparities in gender, age, race, and socioeconomic status remains crucial for enhancing cardiovascular outcomes. Continued multidisciplinary efforts are necessary to alleviate the burden of cardiovascular disease in individuals with diabetes. These findings emphasize the importance of ongoing research and clinical practice to improve cardiovascular health in this high-risk population.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

CONSENT

As per international standards or university standards, respondents' written consent has been collected and preserved by the author(s).

ETHICAL APPROVAL

This study used de-identified data from the USDSS database, exempting it from ethical approval. The Institutional Review Board (IRB) acknowledges such analysis as not constituting human subject research, per 45 CFR 46.102, due to the absence of personally identifiable information. Therefore, no IRB review was necessary for this secondary data analysis.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Roth GA, Mensah GA, Johnson CO, et al. Global burden of cardiovascular diseases and risk factors, 1990-2019: Update From the GBD 2019 Study. J Am Coll Cardiol. 2020, Dec 22;76(25):2982-3021. DOI: 10.1016/j.jacc.2020.11.010.

1a. Agarwal SK. Diet and cardiovascular disease: Heart failure part ii: Red meat, micronutrients, special diets, and obesity. Asian Journal of Cardiology Research. 2022;5(1):94–106. Retrieved from Available:https://journalajcr.com/index.php/AJCR/article/view/80

1b. Anderson KM, Odell PM, Wilson PW, Kannel WB. Cardiovascular disease risk profiles. AMERICAN Heart Journal. 1991, Jan 1;121(1):293-8.

2. Severino P, D'Amato A, Pucci M, et al. Ischemic heart disease pathophysiology paradigms overview: From plaque activation to microvascular dysfunction. Int J Mol Sci. 2020, Oct 30;21(21):8118. DOI: 10.3390/ijms21218118.

3. What is Heart Failure?; 2023. Accessed: April 15, 2024. Available:https://www.heart.org/en/health-topics/heart-failure/what-is-heart-failure

4. Coupland AP, Thapar A, Qureshi MI, et al. The definition of stroke. J R Soc Med. 2017, Jan;110(1):9-12. DOI: 10.1177/0141076816680121.

5. Pouya Saeedi, Inga Petersohn, Paraskevi Salpea et al. Global and regional diabetes prevalence estimates for 2019 and projections for 2030 and 2045: Results from the International Diabetes Federation Diabetes Atlas, 9th edition, Diabetes Research and Clinical Practice. 2019; 157:107843. ISSN 0168-8227. Available:https://doi.org/10.1016/j.diabres.2019.107843.

6. Bazmandegan G, Abbasifard M, Nadimi AE et al. Cardiovascular risk factors in diabetic patients with and without metabolic syndrome: A study based on the Rafsanjan cohort study. Sci Rep 2023; 13:559. Available:https://doi.org/10.1038/s41598-022-27208-5

7. Diabetes Facts & Figures; 2024. Accessed: April 15, 2024. Available:https://idf.org/about-diabetes/diabetes-facts-figures/

8. Rodriguez-Araujo G, Nakagami H. Pathophysiology of cardiovascular disease

in diabetes mellitus. Cardiovasc Endocrinol Metab. 2018, Feb 14;7(1):4-9.
DOI: 10.1097/XCE.0000000000000141.

9. Nedosugova LV, Markina YV, Bochkareva LA, et al. Inflammatory mechanisms of diabetes and its vascular complications. Biomedicines. 2022, May 18;10(5):1168.
DOI: 10.3390/biomedicines10051168.
10. John R. Petrie, Tomasz J. Guzik, Rhian M. Touyz. Diabetes, hypertension, and cardiovascular disease: Clinical insights and vascular mechanisms. Canadian Journal of Cardiology. 2018;34(5):575-584. ISSN 0828-282X.
Available:https://doi.org/10.1016/j.cjca.2017.12.005.
11. Isordia-Salas I, Galván-Plata ME, Leaños-Miranda A, et al. Proinflammatory and prothrombotic state in subjects with different glucose tolerance status before cardiovascular disease. J Diabetes Res. 2014;2014:631902.
DOI: 10.1155/2014/631902.
12. United States Diabetes Surveillance System; 2024. Accessed: April 15, 2024.
Available:https://gis.cdc.gov/grasp/diabetes/DiabetesAtlas.html
13. Ma CX, Ma XN, Guan CH, et al. Cardiovascular disease in type 2 diabetes mellitus: Progress toward personalized management. Cardiovasc Diabetol. 2022, May 14;21(1):74.
DOI: 10.1186/s12933-022-01516-6.
14. Peters SA, Huxley RR, Woodward M. Diabetes as risk factor for incident coronary heart disease in women compared with men: A systematic review and meta-analysis of 64 cohorts including 858,507 individuals and 28,203 coronary events. Diabetologia. 2014, Aug;57(8): 1542-51.
DOI: 10.1007/s00125-014-3260-6.
15. Pop-Busui R, Januzzi JL, Bruemmer D, et al. Heart failure: An underappreciated complication of diabetes. A Consensus Report of the American Diabetes Association. Diabetes Care. 2022, Jul 7;45(7):1670-1690.
DOI: 10.2337/dci22-0014.
16. Barrett-Connor E, Wingard D, Wong N, et al. Diabetes in America. 3rd ed. Bethesda (MD): National Institute of Diabetes and Digestive and Kidney Diseases (US). 2018. Aug;18. PMID: 33651559.
Available:https://pubmed.ncbi.nlm.nih.gov/33651559/
17. Regensteiner JG, Golden S, Huebschmann AG, et al. Sex differences in the cardiovascular consequences of diabetes mellitus: A scientific statement from the American Heart Association. Circulation. 2015, Dec 22;132(25):2424-47.
Available:https://doi.org/10.1161/CIR.0000000000000343Circulation.
18. Ryan A, Wallace E, O'Hara P, et al. Multimorbidity and functional decline in community-dwelling adults: A systematic review. Health Qual Life Outcomes. 2015, Oct 15;13:168.
DOI: 10.1186/s12955-015-0355-9.
19. Mensah GA, Mokdad AH, Ford ES, et al. State of disparities in cardiovascular health in the United States. Circulation. 2005, Mar 15;111(10):1233-41.
DOI: 10.1161/01.CIR.0000158136.76824.04.
20. Kamath SA, Drazner MH, Wynne J, et al. Characteristics and outcomes in African American patients with decompensated heart failure. Arch Intern Med. 2008, Jun 9;168(11):1152-8.
DOI: 10.1001/archinte.168.11.1152.
21. Shan J, Zhang L, Holmes AA, et al. The impact of race on the prognosis of preclinical diastolic dysfunction: A large multiracial urban population study. Am J Med. 2016, Feb;129(2):222.e1-10. DOI: 10.1016/j.amjmed.2015.08.036.
22. Javed Z, Haisum Maqsood M, Yahya T, et al. Race, racism, and cardiovascular health: applying a social determinants of health framework to racial/ethnic disparities in cardiovascular disease. Circ Cardiovasc Qual Outcomes. 2022, Jan;15(1):e007917.
DOI: 10.1161/CIRCOUTCOMES.121.007917.
23. Gargya Malla, D. Leann Long, Suzanne E. et al Does the association of diabetes with stroke risk differ by age, race, and sex? Results From the REasons for Geographic and Racial Differences in Stroke (REGARDS) Study. Diabetes Care. 2019, October1 ;42(10): 1966–1972.
Available:https://doi.org/10.2337/dc19-0442
24. Slåtsve KB, Claudi T, Lappegård KT, et al. Level of education is associated with coronary heart disease and chronic kidney disease in individuals with type 2 diabetes:

A population-based study. BMJ Open Diabetes Res Care. 2022, Sep; 10(5):e002867.
DOI: 10.1136/bmjdrc-2022-002867.

25. Schmidt M, Ulrichsen SP, Pedersen L, et al. Thirty-year trends in heart failure hospitalization and mortality rates and the prognostic impact of co-morbidity: A Danish nationwide cohort study. Eur J Heart Fail. 2016, May;18(5):490-9.
DOI: 10.1002/ejhf.486.

26. Yun JS, Ko SH. Current trends in epidemiology of cardiovascular disease and cardiovascular risk management in type 2 diabetes. Metabolism. 2021, Oct;123:154838.
DOI: 10.1016/j.metabol.2021.154838.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/118204