ORIGINAL RESEARCH ARTICLE

Prehospital Care and Clinical Characteristics of Patients with Diabetic Emergencies at a Tertiary Care Hospital in Mysuru, India: An Observational Study with Emphasis on Geo-spatial Analysis

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ABSTRACT

Background: Diabetes Mellitus is a chronic, progressive disease with serious complications, and its prevalence is rising, especially in India. This study evaluates the clinical characteristics, prehospital care, and proximity to healthcare facilities among patients presenting with diabetic emergencies at a tertiary care hospital.

Methodology: A cross-sectional study was conducted with 70 diabetic emergency patients (hyperglycemia, hypoglycemia, and DKA). Data were collected using a semi-structured questionnaire assessing clinical characteristics, prehospital care, and health-seeking behavior. Geospatial analysis measured the distance from patients' residences to the hospital.

Results: Among the 70 participants, 36 (51.4%) were over 60 years old, and 55 (78.6%) were male. The most common symptoms were polyuria (85.7%) and excessive thirst (57.1%). Hyperglycemia was diagnosed in 68 (97.1%) cases, with 46 (65.7%) showing high random blood sugar levels (>200 mg/dl). Severe symptoms led 55 (78.6%) to seek emergency care, with 17 (24.3%) requiring ambulance services. Geospatial analysis revealed that 50% of patients lived 1-50 km from the hospital.

Conclusion: The study emphasizes the need for improved access to diabetes care near patients' homes to prevent emergencies, highlighting the importance of decentralizing services to improve health outcomes.

Keywords: Diabetic emergencies, prehospital care, health-seeking behavior, diabetes management, emergency department, geospatial analysis, healthcare proximity

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INTRODUCTION

Diabetes Mellitus (DM) is a chronic disease characterized by the pancreas either failing to produce enough insulin or the body being unable to use the insulin it produces effectively. Insulin is a hormone that regulates blood sugar levels.[1] Globally, Non-communicable diseases (NCDs) affect 41 million people annually, accounting for 71% of all deaths. Major NCDs, including diabetes, share behavioural risk factors such as an unhealthy diet, lack of physical activity, and the use of tobacco and alcohol.[2] Diabetes is a significant contributor to morbidity and mortality, with an estimated 382 million people affected in 2013, a number expected to double by 2035, particularly in low- and middle-income countries.[3]

India often referred to as the diabetes capital of the world, India had an estimated 77 million adults with diabetes in 2019, the second-highest number globally after China. Additionally, nearly 25 million people in India are prediabetic, placing them at a higher risk of developing diabetes in the near future. More than 50% of individuals are unaware of their diabetic status, which can lead to severe health complications if not detected and treated early. Adults with diabetes have a two- to three-fold increased risk of heart attacks and strokes.[1]

DM is a progressive disease that can lead to both microvascular and macrovascular complications, affecting the eyes, kidneys, lower extremities, and heart. These complications are likely to develop over time due to poor glycemic control.[4] Patients with poorly controlled diabetes often visit the ED for the management of hyperglycemic episodes, including DKA, hypoglycemia, and hyperglycemic hyperosmolar state.[5] Diabetic Emergencies (DE) encompass conditions such as Hypoglycemia, Hyperglycemia, Diabetic ketoacidosis (DKA), and Hyperglycemic Hyperosmolar Syndrome (HHS). The clinical presentations of DE vary and depend on the time between the onset of metabolic disturbance and presentation to the ED.[6]

In A Study The burden of diabetic emergencies is significant, with a high prevalence rate, including DKA (48.7%), uncomplicated hyperglycemia (22.8%), and severe hypoglycemia (22.3%). Among these, DKA stands out as one of the most fatal acute complications among DM patients, with mortality rates ranging from 2 to 5 percent in developed countries and 6 to 24 percent in developing countries.[7] Patients from lower socioeconomic backgrounds or those with limited access to primary care often utilize emergency services more frequently for diabetes management, highlighting disparities in healthcare accessibility.[8-10]

Geographical Information Systems (GIS) offer valuable tools for analyzing these disparities by mapping the distribution of diabetic emergencies and identifying areas with limited access to specialized care. Through spatial analysis, GIS can reveal patterns and trends in diabetic emergencies, facilitating the identification of high-risk regions and underserved areas. This technology enables healthcare providers to track patient movements, analyze travel distances to healthcare facilities, and visualize the spatial distribution of diabetic emergencies. By incorporating GIS into healthcare studies, we can better understand the geographic and sociodemographic factors influencing health-seeking and treatment-seeking behaviors during diabetic emergencies.[11-12] Diabetic emergencies necessitate treatment at specialized healthcare facilities, imposing increased financial burdens that can impact individuals socially and economically.

This study aims to assess the sociodemographic characteristics of patients experiencing diabetic emergencies and describe their clinical profiles, prehospital care, and health-seeking behaviors at a tertiary healthcare facility. By evaluating appropriate prehospital care measures and utilizing GIS for spatial analysis, the study aims to provide a comprehensive understanding of the factors influencing health-seeking and treatment-seeking behavior during diabetic emergencies.

METHODOLOGY

This hospital-based cross-sectional study was conducted at a tertiary care hospital in Mysuru, which serves over 16,000 outpatients and 3,500 inpatients monthly. The study focused on diabetic patients (hyperglycemia, hypoglycemia, and diabetic ketoacidosis) who visited the emergency department and were later transferred to other departments within the hospital.

A purposive sampling method was employed, with data collected twice a week on Tuesdays and Thursdays over a three-month period from January to March 2024. A total of 70 participants were included. Patients with diabetes who visited the emergency department for hypoglycemia, hyperglycemia, or diabetic ketoacidosis were eligible for the study, while those under 18 or did not consent were excluded.

Data were gathered using a semi-structured validated questionnaire, which assessed sociodemographic characteristics, clinical features, prehospital care, and health-seeking behavior of patients presenting with diabetic emergencies.

Ethical approval was obtained from the Institutional Ethics Committee (IEC No: JSS/MC/PG/91/2022-24), and informed consent was obtained from all participants before inclusion in the study.

Operational Definitions

Hypoglycemia: "Low blood glucose, also called low blood sugar or hypoglycemia, occurs when the level of glucose in your blood drops below what is healthy for you. For many people with diabetes, this means a blood glucose reading lower than 70 milligrams per deciliter (mg/dL)".[13]

Hyperglycemia: "Blood glucose levels above 125 mg/dL when fasting and above 180 mg/dL two hours after a meal are considered hyperglycemia".1[4]

Diabetic ketoacidosis: "Blood glucose levels above 250 mg/dl, arterial pH below 7.3, serum bicarbonate below 15 mEq/l, and the presence of ketonemia or ketonuria are considered standard criteria for diabetic ketoacidosis".[15]

HbA1C: "A measure of average blood glucose levels over the past two to three months. Diabetes is diagnosed at an HbA1C of greater than or equal to 6.5%".[16]

Random blood glucose: "A blood glucose test taken at any time of day without fasting. Diabetes is diagnosed at a blood glucose of greater than or equal to 200mg/dl".[16]

Fasting blood glucose: "A blood glucose test conducted after at least 8 hours of fasting. Diabetes is diagnosed at fasting blood glucose of greater than or equal to 126mg/dl".[16]

Post-prandial blood glucose: "A blood glucose test conducted two hours after a meal. Diabetes is diagnosed at postprandial blood glucose of greater than or equal to 200mg/dl".[16]

Data Collection: All participants meeting the inclusion criteria were enrolled in the study. Once the patient was stable and shifted to other wards, their written informed consent was obtained, and data were collected from the wards of General Medicine, Nephrology, Geriatrics, Gastroenterology, and Urology. Sociodemographic and prehospital details were collected through one-on-one interviews, while clinical characteristics were collected from the participants' case sheets.

Statistical Analysis: The data obtained were entered into MS Excel 2010 for cleaning and coding. The data were then imported and analyzed using IBM SPSS (Statistical Package for Social Science) software version 22 (licensed to JSS AHER). Descriptive statistics like frequency & percentage, mean, and standard deviation were applied to describe the sociodemographic and clinical characteristics of patients with diabetic emergencies.

Geospatial Proximity Analysis of Patient Travel Distances: ArcGIS Pro version 10.8.21 was employed to analyze patient travel distances and transportation routes from residences to a tertiary care hospital. The ArcGIS Pro Business Analyst extension was utilized for advanced geoprocessing and network analysis. This extension enabled precise calculations of distances between patients' residences and the hospital. Geographic coordinates of both the patients' residences and the hospital were used to compute network distances. The analysis incorporated ArcGIS's online routing services to determine the travel routes and calculate travel times. This methodology facilitated a comprehensive assessment of the spatial proximity and accessibility for patients, providing valuable insights into travel patterns and healthcare access.

RESULTS

A total of 70 study participants were enrolled in the study. Table 1 presents the sociodemographic characteristics of the study participants. The mean age of the study participants was 59.30 ± 12.27 years. Around half of the participants, i.e., 36 (51.4%), were in the age group of more than 60 years, and only 6 (8.6%) of them were in the age group of less than 40 years. The majority, 55 (78.6%), of the participants were males, and most of the study subjects, 52 (74.3%), were residing in rural areas. The majority of the participants, 65 (92.9%), were married; 40 (57.1%) had primary or intermediate education; and 11 (15.7%) had a degree or higher education. Around 31 (44.3%) were involved in agriculture, 16 (22.9%) were professionals, and 9 (12.9%) and 4 (5.7%) were unemployed. Around 22 (31.4%) of them were from the lower middle class, and only 4 (5.7%) of them were from the upper class. The majority, 50 (71.4%), of the study subjects did not have health insurance.

Table 1: Sociodemographic profile of patients with diabetes emergencies (n=70)

Variables	Patients (%)
Age group (in years)	
Mean age	(59.30±12.27)
<40	6 (8.6)
40-60	28 (40)
>60	36 (51.4)
Gender	
Male	55 (78.6)
Female	15 (21.4)
Residence	
Urban	18 (25.7)
Rural	52 (74.3)
Marital status	
Married	65 (92.9)
Single	3 (4.3)
Divorced/Widowed	2 (2.9)
Education	
Illiterate	19 (27.1)
Primary school/Intermediate	40 (57.1)
Degree and above	11 (15.7)
Occupation	
Agriculture	31 (44.3)
Professional	16 (22.9)
Semiskilled	9 (12.9)
Unskilled	6 (8.6)
Skilled	4 (5.7)
Unemployed	4 (5.7)
Socioeconomic status	
Upper class	4 (5.7)
Upper middle class	19 (27.1)
Middle class	17 (24.3)
Lower middle class	22 (31.4)
Lower class	8 (11.4)
Health Insurance	
Insured	20 (28.6)
Uninsured	50 (71.4)

Table 2: Clinical characteristics of patients with diabetes emergencies (n=70)

Variables	Patients (%)
Vitals	
Heart rate(bpm)	86.47 ± 9.40
Systolic Pressure (mmHg)	153.80±21.35
Diastolic pressure(mmHg)	77.79±12.77
Temperature (°F)	95.47±1.32
Diagnosed Diabetic emergencies	
Hyperglycemia	68 (97.1)
Hypoglycemia	1 (1.4)
Diabetic Ketoacidosis	1 (1.4)
Family history of diabetes	
Yes	19 (27.1)
No	51 (72.9)
Microvascular Complications	
Nephropathy	2 (2.9)
Chronic kidney disease	8 (11.4)
No complications	60 (85.7)
Macrovascular Complications	
Cardiovascular Accidents	7 (10)
Ischemic Heart disease	8 (11.4)
No complications	55 (78.6)
Complications at the time of admission	
Polyuria	60 (85.71)
Sweating	43 (61.42)
Polydipsia	40 (57.14)
Blurred Vision	31 (44.2)
Dizziness	25 (35.71)
Edema	17 (24.2)
Comorbidities	
Hypertension	52 (74.3)
Hyperlipidemia	6 (8.6)
No comorbidities	12 (17.1)
Biochemical parameters	
HbA1C level (%)	
6.5 – 10 (Uncontrolled)	58 (82.9)
>10 (Severe uncontrolled)	12 (17.1)
Random Blood sugar	
>200mg/dl	46 (65.7)
<200mg/dl	16 (22.9)
Not done Random Blood Sugar	8 (11.4)
Fasting Blood Sugar	
Above 126mg/dl	27 (38.6)
Below 126mg/dl	1 (1.4)
Not done Fasting Blood Sugar	42 (60)
Post-prandial blood sugar	
> 200mg/dl	7 (10)
< 200mg/dl	4 (5.7)
Not done post-prandial blood sugar	59 (84.3)

Table 3: Prehospital care and health-seeking behavior of patients with diabetic emergencies (n=70)

Variables	Patients (%)
Frequency of doctor visits	
Once a month	22 (31.4)
Every 3 to 6 months	48 (68.6)
Routine Diabetes management	
Intake of tablets	64 (91.4)
Food management	14 (20)
Insulin	24 (34.2)
Place of testing for blood sugar	
At clinics	66 (94.3)
At laboratory	4 (5.7)
Frequency of monitoring sugar levels	
Once a month	20 (28.6)
Once in 2 months	45 (64.3)
Once in 3 months	5 (7.1)
Prehospital care	
Action taken before coming to the emergency dept	
Consumed anti-glycemic drugs	47 (67.1)
Self-administered Insulin	6(8.6)
Called emergency services	17(24.3)
Time elapsed from the onset of symptoms to the presentation at the emergency department	
<1 hour	22 (31.4)
1-3 hours	34 (48.6)
3-6 hours	7 (10)
>12 hours	5 (7.1)
Don't know	2 (2.9)
Nearest healthcare facility to the patient's residence	
PHC	36 (51.4)
CHC	5(7.1)
District Hospital	3(4.3)
Don't know	26(37.1)
Mode of transportation to reach the hospital	
Public vehicle	47 (67)
Private vehicle	21 (30)
Ambulance	2 (2.9)
Adequate Knowledge of diabetes and its symptoms	
Yes	55 (78.6)
No	15 (21.4)
Distance from residence to a healthcare facility	
1-50 km	35(50)
51-100 km	31(44.3)
101-150 km	1(1.4)
>150 km	3(4.3)

Table 2 provides the clinical characteristics of the study participants. At the time of presentation to the emergency department, the mean heart rate was 86.47 ± 9.40 beats per minute (bpm), and blood pressure readings were elevated, with mean systolic and diastolic pressures at 153.80 ± 21.35 mmHg and 77.79 ± 12.77 mmHg, respectively. Hyperglycemia was the predominant diabetic emergency, affecting 68 (97.1%) patients. A significant majority, 51 (72.9%), had no family history of diabetes. Microvascular complications were relatively rare, with 8 (11.4%) experiencing chronic kidney disease, while macrovascular complications included cardiovascular accidents in 7 (10%) and ischemic heart disease in 8 (11.4%). Presenting complaints at the time of admission included polyuria in 60 (85.71%), polydipsia in 40 (57.14%), and sweating in 43 (61.42%) participants. Hypertension was prevalent among 52 (74.3%) participants, with a smaller portion suffering from hyperlipidemia, 6 (8.6%). Glycemic control was generally poor, with 58 (82.9%) having uncontrolled HbA1C levels (6.5-10%) and 12 (17.1%) having severely uncontrolled levels (>10%). High random blood sugar levels (>200 mg/dl) were found in 46 (65.7%) of the participants.

Table 3 summarizes the Prehospital care and health-seeking behavior of patients with diabetic emergencies. Most patients 47 (67.1%) consumed anti-glycemic drugs before the emergency, while a smaller portion 6 (8.6%) self-administered insulin, and 17 (24.3%) called emergency services. Around 22 (31.4%) visited the doctors once a month, and 48

(68.6%) visited once every 3 to 6 months. Most of them 64 (91.4%) managed their diabetes with tablets, 14 (20%) used food management strategies, and 24 (34.2%) used insulin. The majority of patients 66 (94.3%) tested their sugar levels at clinics, with only 4 (5.7%) using laboratories. Sugar levels were monitored once a month by 20 (28.6%) of patients, every two months by 45 (64.3%), and every three months by 5 (7.1%). Around 22 (31.4%) of patients arrived within an hour of symptom onset, 34 (48.6%) within 1-3 hours, 7 (10%) within 3-6 hours,5 (7.1%) took more than 12 hours. Most patients used public vehicles 47 (67%), and private vehicles 21 (30%) for transportation, while only 2 (2.9%) used an ambulance. Around 55 (78.6%) of patients were aware of diabetes and its symptoms, while 15 (21.4%) were not aware of reaching the Emergency Department/Hospital.

Figure 1 depicts the geographic distribution and travel routes of patients presenting with diabetic emergencies to a tertiary care hospital in Mysuru. The blue dots represent the residences of patients, and the red lines illustrate their travel routes to the hospital. The majority of patients reside within a 50 km radius of the hospital, underscoring its accessibility and pivotal role in providing timely medical intervention during diabetic emergencies. The convergence of travel routes towards the hospital signifies its importance as a central healthcare facility for diabetic emergencies in the region.

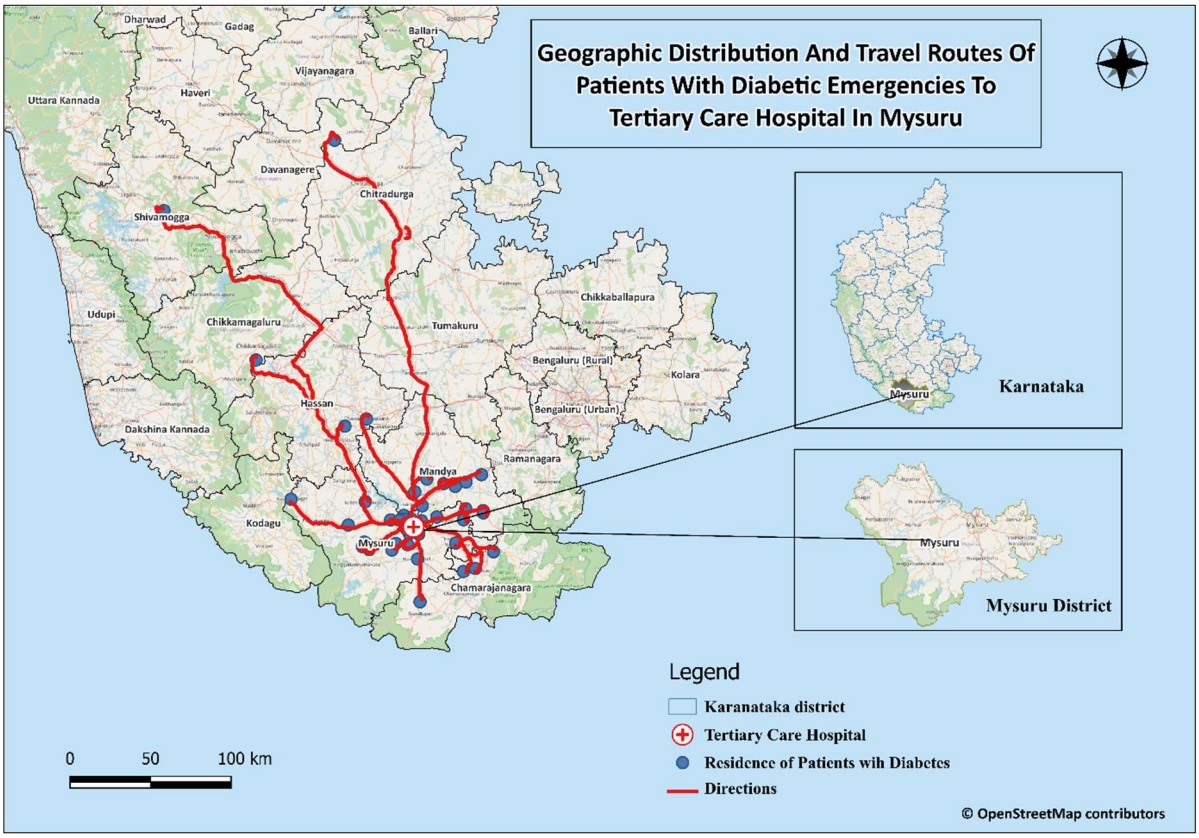

Figure 1: Geographic Distribution and travel routes of patients with diabetic emergencies to a tertiary care hospital in Mysuru

Discussion

Diabetic emergencies, like diabetic ketoacidosis, hyperglycemic hyperosmolar state, and severe hypoglycemia, need immediate medical care to prevent serious illness or death. It's crucial to keep blood sugar levels under control and prevent these emergencies. This study assessed the sociodemographic characteristics, clinical profile, prehospital care, and health-seeking behaviors of the patients presenting with diabetic emergencies.

This study found that the majority of the patients were over 60 years old. In contrast, a study by Yogesh et al in Chennai observed that most participants were younger, aged 21 to 30 years, with a smaller group between 31 and 40 years.[17] This difference highlights the variability in age distribution among diabetic patients in different regions and populations, although it is generally understood that diabetes prevalence increases with age. The gender distribution was skewed towards males (78.6%), which may reflect either a higher prevalence of diabetes in males or possibly greater healthcare-seeking behavior among men in this region. A notable 74.3% of the participants were from rural areas, indicating a higher burden of diabetic emergencies in rural settings. This contrasts with findings by Bedaso et al. at

Hawassa University Comprehensive Specialized Hospital in Ethiopia, where the majority of participants were from urban areas.[18] This discrepancy could be due to limited access to healthcare facilities and diabetes management resources in rural areas.

Regarding employment, a high percentage of participants were employed, contrastingly in Villani et al, a study conducted in Australia, most participants were retired. This variation might be due to differences in the work environment, income status, and social determinants of health.[19] Additionally, the majority of participants were married (92.9%) and had a primary or intermediate level of education (57.1%), suggesting that educational interventions might be crucial in improving diabetes management and emergency response. In contrast, a similar study by Hjelm et al, in Uganda revealed differences in marital status. Most were married, had a primary school, and were part of lower socioeconomic class, education levels, and socioeconomic status. These variations can be attributed to differences in disease burden, lifestyle practices, health literacy, and economic conditions.[20]

Fewer participants reported a family history of diabetes similarly a study done by Yan et al, in London Ontario they stated that half of them had a history of diabetes this could be due to genetic factors and geographic distribution differences.[21] The mean systolic (153.80 ± 21.35 mmHg) and diastolic (77.79 ± 12.77 mmHg) blood pressures were common, indicating a high prevalence of hypertension among the participants. The mean systolic and diastolic blood pressures in the current study were comparable to those found by Tripura et al. in West Tripura, India, who reported similar mean systolic and diastolic pressures.[22] Microvascular complications like nephropathy and macrovascular complications such as cardiovascular accidents and ischemic heart disease were observed, these complications are commonly associated with diabetes and increase the risk of complications and disease burden consistent with findings by Summer et al, in Kashmir stated both similar microvascular and macrovascular complications.[23]

Hyperglycaemia was the predominant diabetic emergency (97.1%), with poor glycemic control being a significant issue, as evidenced by 82.9% of participants having uncontrolled HbA1C levels and 17.1% having severely uncontrolled levels. A study by Lage et al. in the USA found a lower mean HbA1C, suggesting variations in biochemical factors and glycemic control across different populations.[24] Transportation to the hospital primarily involved public vehicles (67%) and private vehicles (30%), with minimal use of ambulances (2.9%). This reflects potential barriers to accessing emergency medical services. Awareness about diabetes and its symptoms was high among the participants (78.6%), yet a substantial proportion (21.4%) were unaware of the emergency protocols, highlighting the need for better education on emergency response.

Geographically, most patients in this study resided within a 50 km radius of the tertiary care hospital, underscoring the hospital's crucial role in providing accessible care for diabetic emergencies in the region. The convergence of travel routes towards the hospital indicates its central role in the healthcare network for diabetic patients. Similarly, a study by Olickal et al. in South India found that the median (IQR) travel distance for people with diabetes from their home to the diabetes clinic was 30.5 km, highlighting the significant travel distances patients often undertake to access specialized diabetes care.[25]

However, many people face challenges like poor access to healthcare, inadequate medication, lack of knowledge, and financial barriers that make managing diabetes harder. By addressing these issues through public health programs, we can greatly reduce how often and how severe these emergencies are. Public health efforts that focus on early detection, regular monitoring, and comprehensive diabetes care are vital in reducing these long-term effects.

Limitations of the study include the short duration of the study, and the limited sample size, which may affect the findings. Future studies should consider a longer duration and a larger sample size to achieve more comprehensive and representative results. Additionally, this study focuses on a specific region, which may not reflect the broader population. The findings highlight the need for further research involving diabetes patients to improve prehospital care and address the limitations identified in this study.

Conclusion

The study provided a comprehensive analysis of the sociodemographic and clinical profile of diabetic emergencies and their visit to the emergency department. Most of them were illiterate and few had primary education. Nearly 3/4th of the people did not know about the nearby healthcare facilities. Most participants relied on general practitioners for their diabetes care, primarily used emergency services due to the severity of symptoms, and shortest and longest travel distances to healthcare facilities. Thus, indicating the importance of improving access to specialized diabetes care at primary health centers in rural areas and ensuring timely and adequate management to prevent emergencies. Creating awareness about control of blood sugar & strengthening the primary health care system.

Data Availability Statement

The data used in this study includes sensitive patient information, such as residential addresses, which were crucial for the geospatial analysis conducted. Due to privacy and ethical considerations, these data are not publicly available. Access to the data is restricted to authorized personnel in compliance with

institutional and ethical guidelines. However, de-identified data and aggregated results can be made available upon reasonable request, subject to approval from the ethics committee of JSS Medical College and in accordance with patient confidentiality regulations.

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