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Original Article

An exploratory investigation associated with type 2 diabetes mellitus and public awareness regarding diabetes and its complications

Naveena Ponnam [1], Dwaraka Burgula [1], Akhila Marka [1], Sridhar Bathula [2], Shyam Sunder Anchuri [1], Nagesh Adla [1] *

[1] Department of Pharmacy Practice, Balaji Institute of Pharmaceutical Sciences, Warangal, Telangana, India
[2] Department of Medicine, Endocrinologist, Samraksha Diabetes, Thyroid and Endocrine Super Speciality Hospital and Research Centre, Warangal, Telangana, India

* Correspondence to: Nagesh Adla, Department of Pharmacy Practice, Balaji Institute of Pharmaceutical Sciences, Warangal, Telangana, India. E-mail: nagesh.adla@gmail.com

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Abstract

Living with type II diabetes mellitus (DM) involves various challenges, including acute metabolic complications such as diabetic ketoacidosis and hyperosmolar nonketotic coma, as well as chronic systemic complications like retinopathy, diabetic neuropathy, diabetic nephropathy, coronary heart disease, and cerebrovascular disorders. Psychosocial well-being is also impacted, with prevalent concerns like sexual dysfunction and hearing impairment. Our observational study aimed to assess the prevalence of diabetic complications and patient awareness. The study was conducted in Warangal, Telangana, India, from December 2021 to May 2022. We collected data from 300 type II diabetes mellitus patients using designed questionnaires and conducted a statistical analysis using GraphPad Prism 9.4.0, specifically employing a Chi-square test where a P-value less than 0.05 was deemed statistically significant. The study disclosed a higher prevalence of neuropathy (74%) and a heightened awareness of nephropathy's complications compared to neuropathy within the overall population. Among participants, 56.00% were aware of diabetic complications, while 44.00% had no awareness. Rural areas had 63.63% of participants without awareness, while urban areas had 36.3%. Rural females exhibited poorer awareness compared to rural males. Overall, the study emphasizes the significance of managing DM complications, particularly diabetic neuropathy, and the need for enhancing patient education through effective communication between physicians/clinical pharmacists and patients.

Keywords: awareness, communication, cross-sectional study, diabetes mellitus, prevalence, patient education.

Introduction

Diabetes mellitus is a group of metabolic disorders characterized by hyperglycemia brought on by errors in insulin secretion, insulin action, or both. These errors are also linked to abnormalities in the metabolism of carbohydrates, fats, and proteins, which leads to chronic complications like microvascular, macrovascular, and neuropathic disorders. A partial or complete lack of insulin, as observed in diabetes, may result from autoimmune destruction of the pancreatic beta-cells, which causes insulin shortage. Reduced tissue responsiveness to insulin is the outcome of insulin resistance. Deficiencies in both insulin secretion and action can occur in the same patient, making it often challenging to identify which abnormality, if either independently, is the primary cause of hyperglycemia [1].

According to the International Diabetes Federation, the estimated number of people with diabetes has increased from 30 million in 1985 to 150 million in 2000 and then to 246 million in 2007. By 2025, it projects that this figure will reach 380 million. According to the CDC

(Centre for Disease Control and Prevention), 8.7% of Americans have diabetes, and one in three people born in 2000 will develop the disease at some point [2].

Diabetes etiology

It has been determined that a number of factors contributed to elevated blood glucose levels. These include insulin resistance in the liver, adipose tissue, and muscles, increased hepatic glucose generation, impaired incretin responsiveness, accelerated adipose tissue fat breakdown, an excessive release of glucagon by alpha cells, decreased beta cell production of insulin, enhanced reabsorption of glucose from the kidneys, and insulin resistance in the brain. These eight factors comprise the ominous octet that compromises the maintenance of normal blood glucose levels [3].

Diabetes mellitus etiological classification

A complete lack of insulin characterizes type 1 diabetes (T1DM) due to the loss of beta cells. It can be classified into two main subtypes. The immune-mediated subtype is influenced by both genetic and environmental factors, with about a third of the disease's susceptibility attributed to hereditary factors and another third linked to environmental triggers. The remaining third of cases need a clear etiology. In contrast, the idiopathic subtype accounts for approximately 5% of cases and lacks evidence of pancreatic beta-cell autoimmunity despite presenting insulinogenic and ketoacidosis symptoms.

Type 2 diabetes (T2DM), on the other hand, encompasses a spectrum ranging from primarily secretory dysfunction to predominantly insulin-resistant conditions, often accompanied by some degree of insulin deficiency.

Pregnancy-related diabetes mellitus (GDM) constitutes another distinct form of diabetes occurring during pregnancy. Moreover, there are additional specific types of diabetes. Patients with maturity-onset diabetes of the young (MODY) stand out for their non-obese status and hyperglycemia resulting from diminished insulin secretion in response to glucose. Rare forms like mutant insulin-related diabetes mellitus associated with mitochondrial DNA mutations and conditions like Wolfram syndrome contribute to the diversity of diabetes presentations [1, 4].

Agents of type 2 diabetes risk

The risk of developing type 2 diabetes (T2DM), particularly the insulin-resistant variant, is influenced by a range of risk factors. Some of these risk factors are non-modifiable, such as age (being 45 years old), having close relatives with diabetes, belonging to certain ethnic groups (such as Asian Indians, African Americans, Latin Americans, and Native Americans), having a history of impaired glucose tolerance (IGT), impaired fasting glucose (IFG), or a HbA1c level between 5.7 and 6.4%, experiencing pregnancy-related gestational diabetes or being born with a birthweight exceeding 4 kg (9 lb), and having conditions like ovarian polycystic syndrome or acanthosis nigricans, which are linked to insulin resistance. Hypertension, dyslipidemia (with triglyceride levels above 250 mg/dL or HDL levels below 35 mg/dL), and a history of cardiovascular disease also contribute to the risk [5].

Additionally, there are modifiable risk factors for type 2 diabetes mellitus that individuals can influence. These include dietary habits, obesity, particularly in the abdominal region (with a BMI over 25 kg/m^2), biological factors, lifestyle choices like alcohol consumption and smoking, and a sedentary lifestyle marked by physical inactivity [5].

T2 DM consequences

a. Acute metabolic consequences, including hyperosmolar nonketotic coma, hyperglycemia, and diabetic ketoacidosis [5];
b. Long-term, systemic consequences microvascular issues include ocular problems, which include glaucoma, cataracts, and retinopathy, both proliferative and non-proliferative. Alzheimer's disease: peripheral neuropathy, including sensory and motor (mono- and polyneuropathy), diabetic kidney disease, coronary heart disease, peripheral artery disease, and cerebrovascular disease are examples of macrovascular problems. Other conditions include gastroparesis and diarrhea of the gastrointestinal tract, genitourinary (uropathy/sex dysfunction), infections of the skin, periodontal disease, and hearing loss [4, 5].

HbA1C 6.5% as a criterion for diabetes mellitus

A technique that is National Glycohemoglobin Standardisation Programme (NGSP) accredited and standardized to the DCCT assay should be used to conduct the test in a lab (or) diabetic symptoms plus a plasma glucose concentration of 200 mg/dl (11.1 mmol/L), (or) 126 mg/dl (7.0 mmol/L) for fasting plasma glucose,

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(or) 200 mg/dl (11.1 mmol/L) for 2 hours post-load glucose during an OGTT [1]. As recommended by the WHO, the test should involve administering a glucose load equivalent to 75 g of anhydrous glucose dissolved in 300 ml of water. For children, 1.75 grams of glucose per kilogram of ideal body weight should be provided [6]. To confirm criteria 1 through 3, repeat testing is necessary in the absence of clearly defined hyperglycemia [5].

Directives for continual medical care of diabetic patients

HbA1c testing (2–4 times annually) and blood glucose self-monitoring at a frequency that the patient determines, annual patient education on managing diabetes, annual eye and foot exams, annual medical nutrition therapy and education, and annual patient foot examinations, yearly testing for diabetic nephropathy measurement of blood pressure (quarterly), Lipid profile, serum creatinine (estimate GFR) (annual), and vaccination against influenza and pneumococcal disease [5].

Education and self-care for patients

Regarding Medical Nutrition Therapy, the previously recommended exchanges are based on the amount of carbohydrates in various foods to regulate blood glucose levels. An alternative approach is the Carbohydrate Counting Method, emphasizing the importance of consistent carbohydrate intake during meals and snacks for effective glycaemic control, particularly for postprandial blood glucose (PPBG) levels. Foods like bread, milk, fruits, rice, beans, corn, and potatoes should be avoided. Another method is the Plate Method, involving half the plate with non-starchy vegetables (*e.g.*, broccoli, salad, cabbage), one-fourth with meat (3oz, cooked), and one-fourth with starch (*e.g.*, potatoes, beans, bread, noodles). Combining a serving of fruits with the meal is also recommended.

Physical exercise

To fulfill the target of engaging in at least 150 minutes of moderate-intensity aerobic activity per week, strength training activities should be carried out at least twice a week. At every chance, evaluating the prevention, identification, and management of acute hypoglycaemic and hyperglycaemic episodes is important. Reduction of risk factors that can be changed in order to lessen or stop the emergence of chronic problems, to investigate the impact of illness, food decisions, stress, and physical activity on the capacity to achieve and maintain glycaemic targets, pattern control putting into practice the following self-care practices: dental, eye, and foot care [3].

This study has two primary objectives. First, it aims to gain a deeper understanding of the complications associated with Type 2 diabetes and identify the factors that contribute to their onset. Second, it seeks to inform individuals with Type 2 diabetes about these complications and provide guidance on preventing them. By doing this, the study helps doctors better treat their patients and helps people with diabetes take care of themselves. The goal is to make life better and healthier for those with type 2 diabetes by giving them useful information.

Material and methods

This Prospective cross-sectional study was conducted from December 2021 to May 2022 to estimate the prevalence of diabetic complications, to determine the Urban-Rural differences in the incidence of diabetic complications and to create awareness among the complications of type 2 diabetic patients of Warangal region in Telangana State, India.

The study enrolled a sample size of 300 patients. Inclusion criteria consisted of patients aged 25 to 80 years with type 2 diabetes mellitus and concurrent conditions such as neuropathy, nephropathy, retinopathy, hypertension, and cerebrovascular accidents. Exclusion criteria encompassed patients with type 1 diabetes mellitus, gestational diabetes, lactating mothers, individuals below 25 years or above 80 years of age, and those without diabetes mellitus.

The study was conducted at "Samraksha Diabetes, Thyroid and Endocrine Superspeciality Hospital and Research Centre". The hospital's ethical committee gave written ethical approval. Prior to the study, all patients gave written informed consent.

Type 2 diabetic patients were selected, and data was collected according to our designed questionnaires regarding demographic details (age, gender, body weight, height, residence), chief complaints, past medical history, family history, social history, and disease knowledge. The selected patients were made aware of diabetes and its complications.

All the obtained data was initially entered into the Microsoft Excel database. Statistical analysis of the data

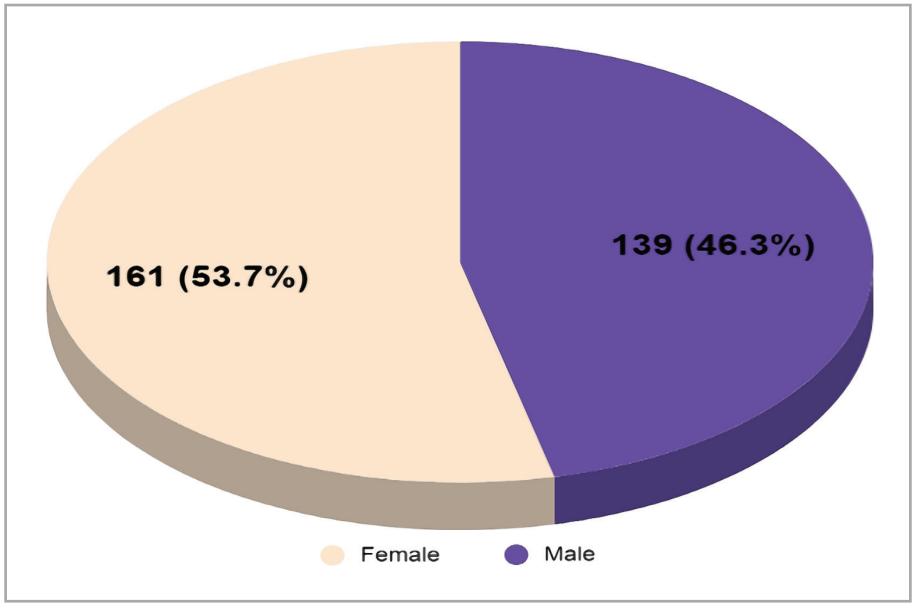

Figure 1: Gender distribution in the study sample.

was performed through GraphPad Prism 9.4.0. Statistical comparisons were carried out using the chi-square test. In association, the P-value of <0.05 was considered statistically significant, and our results P-value of <0.0001 was considered as highly significant.

Results

In this cross-sectional study, we recruited 300 participants. Of these participants, 53.7% (n=161) were females, while 46.3% (n=139) were males. Figure 1 depicts the Detailed Gender distribution of the study sample.

Figure 2 conveys the prevalence of diabetic complications, including Diabetic Neuropathy, which was the most prevalent at 74%, while cerebrovascular Attacks were the least common at 3%. Other complications included Nephropathy at 12%, retinopathy at 13%, coronary artery diseases at 8%, Erectile Dysfunction at 5%, Foot Ulcer at 6%, Urinary Tract Infection at 26%, and Other Infections at 14%.

The pie chart (Figure 3) depicts information about the percentages of rural and urban populations involved in the study. Overall, the rural population (n=160) was larger than the urban population (n=140). In detail, out of 100% of the Population, 53.3% was rural, and 46.7% was urban.

The prevalence of types of Diabetic complications in males and females in our study is represented in Table 1. Among females, the mean value was 25.8, with

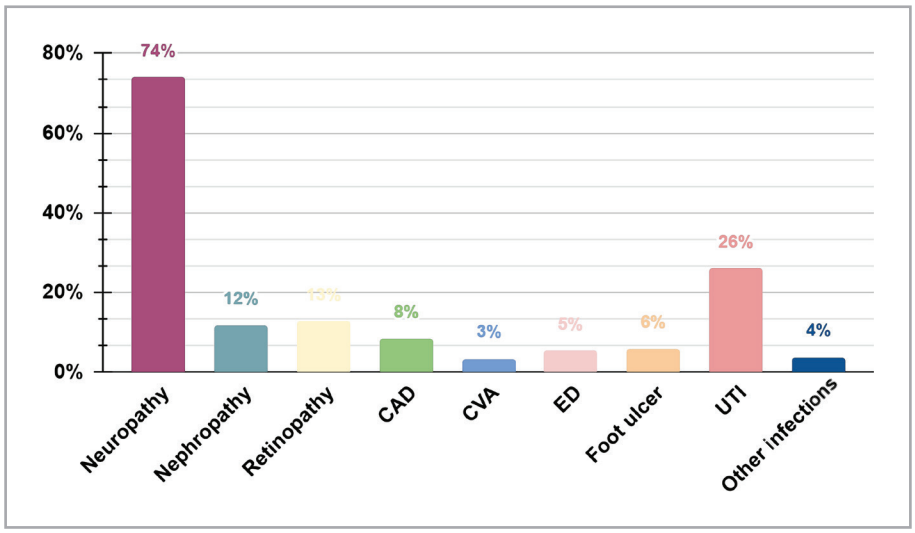

Figure 2: Percentage of the overall complications of diabetes mellitus.

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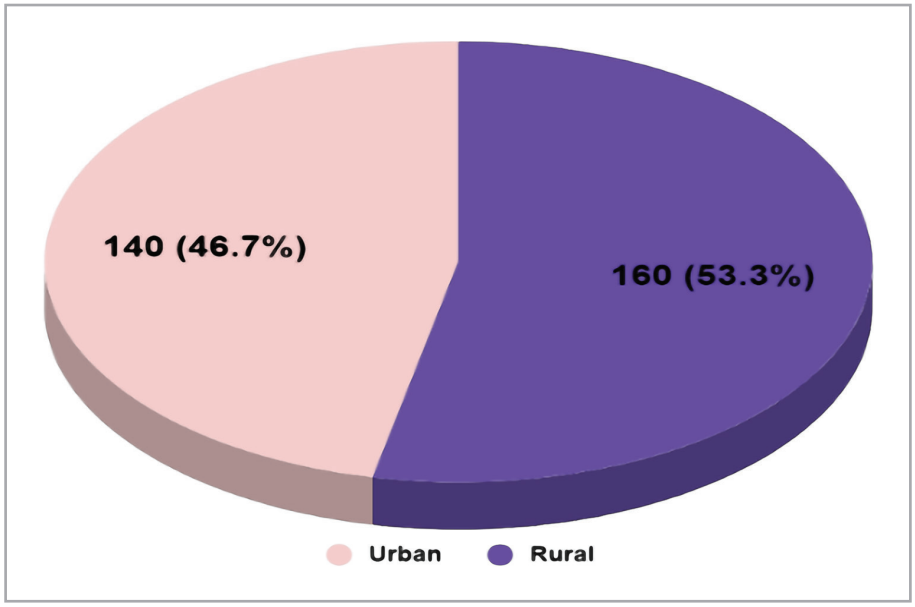

Figure 3: Percentage distribution of residence.

a standard deviation of 40.821. For males, the mean value was 24.3, with a standard deviation of 27.626. Statistical comparisons were conducted using the Chi-square test. A P-value of <0.05 was considered significant, but our results showed a highly significant P-value of <0.0001.

Figure 4 shows the percentage of participants aware of diabetic complications. Most participants were well-informed about nephropathy, whereas awareness of neuropathy was comparatively lower. In detail, 51.7% were aware of Nephropathy, 36% of retinopathy, 33.7% of coronary artery diseases, 16.7% of Cardiovascular Attacks, 26% of Foot Ulcers, and 44% had no awareness of any complications. Neuropathy awareness stood at 14%. The column graph (Figure 5) shows participant awareness of diabetic complications. Most participants (56%, n=168) were aware, while 44% (n=132) were unaware of complications.

The column graph (Figure 6) displays the percentage of participants who are unaware of diabetic complications, specifically focusing on residence. Rural participants showed a higher lack of awareness. In total, 132 participants (100%) had no awareness of diabetic complications, with 84 (63.63%) being rural and 48 (36.3%) urban. The column graph (Figure 7) shows the residence distribution of participants with no awareness of diabetic complications. It highlights that most rural female participants lacked awareness about DM complications. Out of 132 participants (100%) with no awareness, rural males accounted for 20.45%,

Table 1: Prevalence of types of diabetic complications in males and females.

Type of complication	Females		Males	
	Yes	No	Yes	No
1. Neuropathy	126	35	96	43
2. Nephropathy	13	148	22	117
3. Retinopathy	25	136	13	126
4. Coronary artery diseases	7	154	18	121
5. Cerebrovascular attacks	3	158	7	132
6. Erectile dysfunction	-	-	16	123
7. Foot ulcers	5	156	12	127
8. Urinary tract infections	51	110	27	112
9. Other infections	3	158	8	131

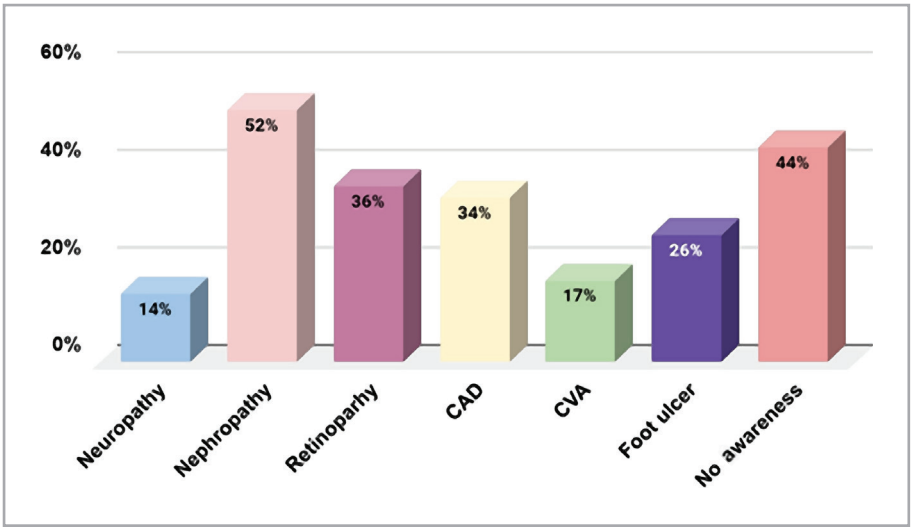

Figure 4: Percentage of participants with awareness of diabetes complications.

rural females 42.42%, urban males 17.42%, and urban females 19.84%.

Discussion

The study was conducted at Samraksha Diabetes, Thyroid and Endocrine Super Speciality and Research Centre. Over the past few decades, the problem of diabetes mellitus and its complications has increased. So, it is essential to study and analyse the complications of type II DM. The purpose of the study is to examine complications and their associated clinical characteristics and to create Awareness of Diabetes and its complications among type II Diabetic patients.

In this study, we assessed the complications of Type II Diabetes Mellitus in the Warangal region. The overall complications observed included Diabetic Nephropathy (12%), Diabetic Neuropathy (74%), Diabetic Retinopathy (13%), Cardiovascular Diseases (8%), Cerebrovascular Attacks (3%), Erectile Dysfunction (5%), Urinary Tract Infection (26%), Foot Ulcers (6%), and other Infections (4%). Notably, our findings highlighted Diabetic Neuropathy (74%) as the most prevalent complication among the participants. Similar to our study, R. Siddarama *et al.* reported a higher prevalence of Diabetic Neuropathy (42.6%) among patients, aligning with our findings [7].

Ulku Turk Boru *et al.* also found a similar trend, concluding that 60% of participants were diagnosed with Diabetic Neuropathy, and its prevalence increased with age and duration of diabetes [8]. Charles Faselis *et al.*'s study supports our findings, showing that Diabetic Neuropathy affects nearly 50% of the diabetic population [9]. Doragolla Bhargavi *et al.* observed a higher prevalence of nephropathy among 400 participants

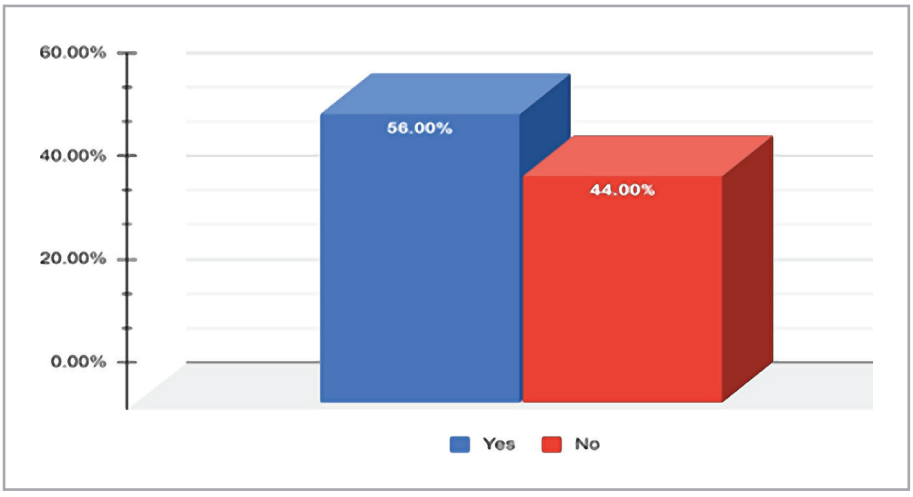

Figure 5: Percentage of participants with awareness of overall diabetes complications.

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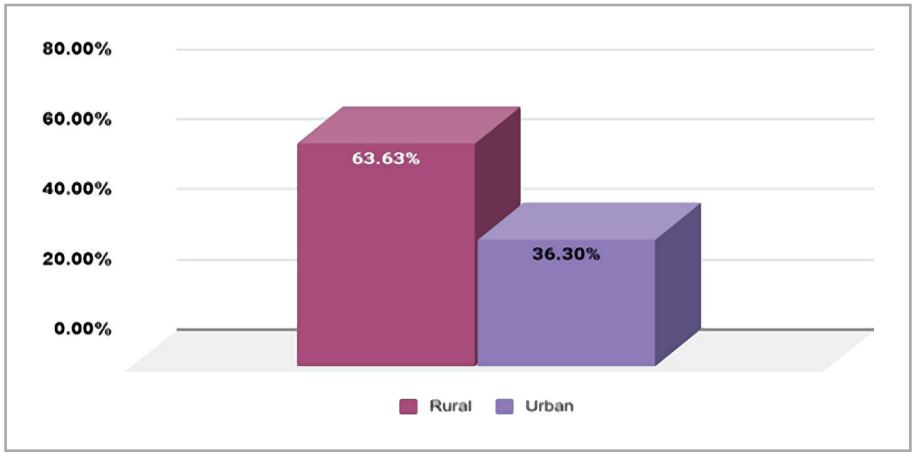

Figure 6: Percentage distribution of participants with residence unaware of diabetes complications.

compared to what was found in our study [10]. In contrast to Ewid *et al.* who demonstrated a higher occurrence of retinopathy complications [11], our study observed a greater occurrence of neuropathy.

Contrary to our findings, Charles Faselis *et al.* reported a prevalence range of 35–90% for Erectile Dysfunction in diabetic men [9]. Zhaolan Liu *et al.* demonstrated a higher occurrence of Cardiovascular diseases, differing from our study [12]. Unlike Russo *et al.*, who reported a higher incidence of cardiovascular complications [13], our study found a greater prevalence of neuropathy. Yongin Cho *et al.* demonstrated a higher occurrence of Neuropathy complications, similar to our study [14]. U Ahmed's research revealed a higher incidence of Diabetic Retinopathy, contrasting our findings [15]. In this study, our results reveal that microvascular complications are more prevalent than macrovascular complications. Fahad S *et al.*'s study indicates that microvascular complications are particularly common among poorly glycemic-controlled patients, which aligns with our findings [16]. Kalayou K Berhee *et al.* revealed a higher incidence of Diabetic Retinopathy, contrasting our findings [17].

In our study, complications were more prevalent among individuals with a rural background than among those from urban areas. This trend aligns with the findings of Shu-Yu Tai *et al.*, who also reported that diabetes-related complications were more prevalent among patients residing in rural areas than in urban areas [18].

In our study, we aimed to raise awareness among participants about diabetic complications. Notably, a significant lack of awareness was observed among rural individuals compared to their urban counterparts. This finding resonates with the research by M Deepa, A Bhansali *et al.*, who noted that knowledge and awareness about diabetes in India, especially in rural areas, are notably deficient [19].

Similar to our study, Ahmad Ayaz Sabri *et al.* concluded that urban diabetic patients are more aware than rural diabetic patients [20]. Contrary to our findings,

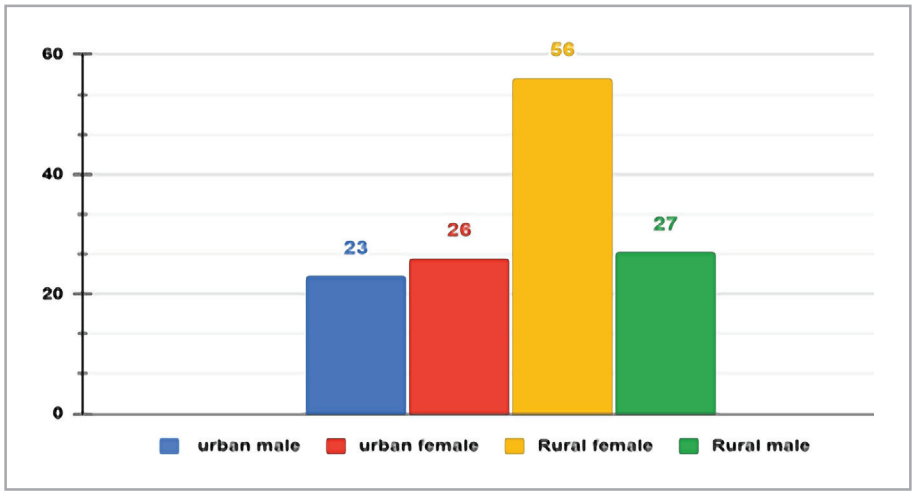

Figure 7: Residence distribution of participants unaware of diabetes complications.

Hassounah *et al*. concluded that patients with Type 2 DM possess generally poor knowledge concerning diabetes-related complications [21].

In this study, we evaluated the level of awareness in rural females (n=56) than in urban females (n=26). Our results were similar to those of Z. Rehman and M. Ashrad *et al*., who showed that the overall level of awareness in both female and male diabetics was low, and female patients exhibited comparatively poorer awareness [22].

In our study, we educated participants who lacked knowledge about diabetes and its complications (n=132). Among these patients, rural individuals numbered 83 (56 females, 27 males), while urban individuals totaled 49 (26 females, 23 males). According to I. Anwer *et al*., the overall level of awareness among people with diabetes was found to be low, indicating a need to educate the population on this topic [23].

According to Richard Adongo Afaya *et al*., more than half of the studied population exhibited inadequate knowledge of diabetes complications. Factors such as female gender, rural residence, and low education level were positively associated with this lack of knowledge [24].

Conclusion

Over a period of 6 months, we examined 300 cases involving possible complications of diabetes (DM), revealing important insights. A variety of DM-related complications were identified, including Diabetic Neuropathy, Nephropathy, Retinopathy, Coronary Artery Diseases, Cerebrovascular Attacks, Erectile Dysfunction, Foot Ulcers, Urinary Tract Infections, and other infections. Notably, Diabetic Neuropathy was the most prevalent complication among the participants. The majority of individuals with diabetes demonstrated a good understanding of the condition and its potential complications.

However, a minority lacked awareness. Interestingly, rural areas had more participants who were unaware compared to urban areas, and rural females exhibited lower awareness compared to rural males. Those who were unaware typically had lower levels of education, struggled with consistent medication usage, lacked sufficient knowledge about the disease and its complications, faced challenges in managing blood sugar levels and often had unrecognized complications that affected their quality of life. It was evident that improving patient knowledge and awareness requires effective communication between healthcare professionals like physicians and clinical pharmacists and the patients themselves. In our capacity as clinical pharmacists, we played a significant role in elevating awareness about diabetes and its associated complications among all the participants.

Conflict of interest

The authors declare no conflict of interest.

Ethics approval

The approval for this study was obtained from the Ethics Committee of the Institutional Ethics Committee (approval ID: BIPS/IEC/2021/P1).

Consent to participate

Written informed consent was obtained from all the participants

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