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International Journal of Pharmaceutical Research & Allied Sciences, 2022, 11(4):1-13
https://doi.org/10.51847/7RUJh8q1hg

Original Article

ISSN : 2277-3657
CODEN(USA) : IJPRPM

Drug Utilization Evaluation of Antidiabetic Agents in Primary Care Clinics of a South Indian Rural Province

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ABSTRACT

A cross-sectional study was conducted to analyze the utilization of antidiabetic agents among patients with Type-2 Diabetes Mellitus in primary care clinics of a South Indian rural province of Erode district, Tamilnadu, India. The study was conducted for a period of one year using a structured validated questionnaire. There was a total of 487 diabetic patients residing in the rural area of a south Indian state were included in this drug utilization evaluation.

Majority of the diabetic patients in this study were female (n= 279; 57.28%), married (n=463; 95%), unemployed (n=272; 55.85%), and illiterate (n=180; 36.96%), between the age of 51-60 years (175; 35.93%), and has past medical history of T2DM (n=328; 67.35%). All of them were diagnosed with T2DM (n=487; 100%). The majority of the diabetes patients were receiving oral hypoglycemic agents (OHA) (n=433; 88.91%), among these, 125 (25.66%) were treated with a single anti-diabetic agent as monotherapy, 208 (42.71%) were treated with two-drug regimens, and 136 (27.92%) were treated with three-drug regimens. There was an increasing trend of diabetes among the rural population. It was mainly due to their inappropriate lifestyle habits and lack of awareness of diabetes and its complications among the poor general population of this district. Polypharmacy was commonly seen among diabetes patients and the majority were receiving more than 2 antidiabetic medications. A well-structured health interventional program is warranted to reduce the increasing trend of diabetes and to reduce negative health outcomes.

Key words: *Comorbidities, Complications, Hyperglycemia, Lifestyle, Quality of life*

INTRODUCTION

The global prevalence of diabetes mellitus (DM) is rapidly increasing by two to three folds in the last few decades. According to the report of the International Diabetes Federation 2022, 537 million people have diabetes globally and among these 90 million people are in the south-east Asian (SEA) Region; by 2045 this will rise to 151.5 million. The prevalence of diabetes in adults was 8.3% and the total cases of diabetes in adults were 774,194,700 [1]. Indians are more prone to diabetes because of obesity and change in lifestyle patterns. Type 1 DM affects 8% of everyone with diabetes while type 2 DM affects about 90% of the overall diabetes population. Even though, the symptoms of Type-2 DM are similar to Type-1 DM but are often less marked. Consequently, the disease may be diagnosed several years after onset, once complications have become apparent [2, 3]. The lack of compliance toward diabetes could lead to chronic complications, including macrovascular and microvascular [4-6]. Most diabetic patients have relatively poor glycaemic control and are presented with multiple co-morbidities like Hypertension, Dyslipidaemia, Coronary artery disease, and other complications [7-9].

Drug Utilization Evaluation (DUE) is defined as an authorized, structured, ongoing review of healthcare provider prescribing, pharmacist dispensing, and patient use of medication. DUE involves a comprehensive review of

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patients' prescription and medication data before, during, and after dispensing to ensure appropriate medication decision-making and positive patient outcomes [10, 11]. DUE studies are powerful tools to ascertain the role of drugs in society. The World Health Organization (WHO) specifies drug use indicators for adoption in drug utilization studies. Drug utilization studies have the potential to make objective evaluations and analyses of health professionals' work and provide them with feedback to stimulate thinking about their practice and look for ways to improve their performance. To improve the overall drug use, especially in developing countries, international agencies like the WHO and the International Network for the rational use of drugs (INRUD) have applied themselves to evolve standard drug use indicators. Drug therapy is a major component of patient management in healthcare settings, including primary healthcare. The introduction of potent drugs with an increased incidence of adverse drug reactions, the high cost of medication, and a focus on drug use outcomes and the clinical misuse of drugs may result in preventable patient morbidity and mortality, costly remedial care, additional cost for diagnosis and management of iatrogenic disease and unnecessary wastage of health resources. In recognition of this problem, DUE has been recommended as a method for identifying inappropriate or unnecessary drug use that monitor, evaluates, and promotes rational drug therapy [12, 13].

There are many oral antidiabetic drugs (OADs) currently available for the treatment of diabetes. Whereas biguanides (BGs) and sulfonylureas (SUs) were the most commonly used OADs. OADs with different actions, such as a-glucosidase inhibitors (aGIs), thiazolidinediones (TZDs), and glinides, were launched in 1999. Dipeptidyl peptidase-4 inhibitors (DPP4is) were launched in 2009, and sodium-glucose transporter 2 inhibitors (SGLT2is) were launched in 2014; However, general clinicians who do not specialize in diabetes often find it difficult to choose OADs [14-16]. Countries around the world are preparing their DM treatment guidelines, useful for providing appropriate treatment. All guidelines, excluding the Japanese guidelines, positioned BGs, especially metformin, as the first-line OAD, and other OADs as the second-line agents for add-on therapy according to the presence of diabetic complications [17, 18]. Many countries have different practices in utilizing the drug for the treatment of diabetes, however, the proper use of drugs is still questionable [19, 20]. Hence, a study was aimed to analyze the utilization of antidiabetic agents among patients with Type-2 Diabetes Mellitus in primary care clinics of a South Indian rural province of Erode district, Tamilnadu, India.

MATERIALS AND METHODS

A cross-sectional study was conducted for one year among the rural population who visited the rural primary care clinic for the treatment of T2DM. A convenience sampling method was adopted to recruit the study participants. There were 487 T2DM patients enrolled in this study. Patients who were above the age of 18, diagnosed with T2DM for more than a year, received at least one oral hypoglycemic agent (OHA) and or Insulin therapy, and were willing to participate in this study were included. The patients who did not meet the inclusion criteria were excluded. Patients who visited the primary care clinic were approached and written informed consent was obtained before being included in this study. A structured and validated questionnaire was used to collect the participant's demographic details, history of diabetes, diagnosis, laboratory parameters, comorbidities, complications of diabetes, and treatments provided. This study was approved by the Institutional Review Board of Vivekanandha Medical Care Hospital, Elayamabalayam, Tiruchengode (No. SVCP/IEC/JAN/2021/15), and the study was performed in accordance with the principles of the Declaration of Helsinki.

RESULTS AND DISCUSSION

This prospective cross-sectional study aimed to analyze the utilization of antidiabetic agents among patients with Type-2 Diabetes Mellitus in primary care clinics of a South Indian rural province of Erode district, Tamilnadu, India. In this study, out of 487 patients, majority of them were female (*n*= 279; 57.28%), married (*n*=463; 95%), unemployed (*n*=272; 55.85%), illiterate (*n*=180; 36.96%), did not smoke and drink alcohol (*n*=332; 68.17%), and practice non-vegetarian diet (*n*=304; 62.42%). The demographic details are presented in **Table 1**.

Table 1. Demographic characteristics of the participants (*n*=487)

Description	Number	Percentage	P-value
Gender			
Male	208	42.71	0.000*
Female	279	57.28	

Marital Status			
Married	463	95.07	0.000*
Unmarried	24	4.92	
Educational Status			
Primary	122	25.05	0.001*
Secondary	100	20.53	
Graduate	85	17.45	
Illiterate	180	36.96	
Social habits			
Smoking	50	10.26	0.000*
Drinking	33	6.77	
Both	72	14.78	
None	332	68.17	
Dietary pattern			
Vegetarian	183	37.57	0.000*
Non-vegetarian	304	62.42	

*P < 0.05 is considered as statistically significant

Among the patients with diabetes, most were aged between 51-60 years (175; 35.93%), had T2DM for about 5-10 years (*n*=223; 45.79%), and had undergone at least one stressful life event in the past (*n*=299; 61.39%), and had a family history of T2DM (*n*=245; 50.30%). The details are presented in **Table 2**.

Table 2. Description of age group, duration and family history of diabetes, and history of stressful life events among the participants (*n*=487)

Description	Number	Percentage	Mean ± SD	P-value
Age group (in years)				
< 30	09	1.84	27.89 ± 3.37	0.002*
31-40	35	7.18	36.94 ± 2.78	
41-50	114	23.40	46.69 ± 2.69	
51-60	175	35.93	55.92 ± 2.93	
61-70	120	24.64	65.00 ± 2.57	
> 70	34	6.98	73.41 ± 2.38	
Duration of diabetes (in years)				
< 5	147	30.18	2.90 ± 0.83	0.005*
5-10	223	45.79	7.32 ± 1.76	
11-15	107	21.97	12.63 ± 1.30	
16-20	10	2.05	18.20 ± 1.99	
> 20	Nil	0	0.00 ± 0.00	
Family history of diabetes				
Yes	245	50.30		0.126*
No	242	49.69		
History of Stressful life events				
Yes	299	61.39		0.001*
No	188	38.60		

*P < 0.05 is considered as statistically significant

Among the study participants, an equal proportion were having normal (*n*=235; 48.25%) and over body weight (*n*=201; 41.27%). Majority of them had elevated fasting blood sugar (FBS) (*n*=476; 97.74%), postprandial blood sugar (PPBS) (*n*=485; 99.58%), and elevated HbA1c (*n*=320; 65.70%) levels. A total of 232 (47.62%) respondents had elevated systolic blood pressure (SBP), and 178 (36.54%) had elevated diastolic blood pressure (DBP) levels. Around 15 (3.08%) participants had elevated total cholesterol (TC), 17 (3.47%) with higher triglycerides (TG), 5

(1.02%) with elevated low-density lipoprotein (LDL), and 15 (3.08%) with higher very-low-density lipoprotein VLDL, whereas 21 (4.31%) had a low level of high-density lipoprotein (HDL). The data are presented in **Table 3**.

Table 3. Body mass index and laboratory parameters among the study participants (*n*=487)

Description	Number	Percentage	Mean±SD	P-value[#]
BMI				
Underweight (<18.5)	02	0.41	17.88±0.29	0.002*
Normal (18.5-24.9)	235	48.25	22.53±1.56	
Overweight (25.0-29.9)	201	41.27	27.33±1.51	
Obese (> 30)	49	10.06	31.69±2.74	
Blood Glucose Measurement				
FBS				
70-110 mg/dl (Normal)	11	2.25	100.00±12.77	0.000*
>110 mg/dl (Elevated)	476	97.74	233.95±71.33	
PPBS				
100-140 mg/dl (Normal)	02	0.41	133.50 ± 0.71	0.000*
>140 mg/dl (Elevated)	485	99.58	335.45±87.05	
HbA1C				
<7.5 (Normal)	167	34.29	6.62 ± 0.64	0.005*
>7.5(Elevated)	320	65.70	9.56 ± 1.58	
Blood pressure measurement				
JNC-8 guidelines (Systolic)				
<120 mm/Hg (Normal)	33	6.77	109.39 ± 2.42	0.061
120-139 mm/Hg (Pre –Hypertension)	162	33.26	126.31 ± 4.83	
140-149 mm/Hg (Stage I)	67	13.75	147.15 ± 4.76	
≥160 (Stage II)	03	0.61	176.67 ± 5.77	
Non-Hypertensive	222	45.58	0.00 ± 0.00	
JNC-8 guidelines (Diastolic)				
<80 mm/Hg (Normal)	21	4.31	69.52 ± 1.50	0.082
80-89 mm/Hg (Pre- Hypertension)	84	17.24	81.96± 2.46	
90-99 mm/Hg (Stage I)	49	10.06	90.06 ±0.32	
≥ 100 mm/Hg (Stage II)	45	9.24	103.33±4.77	
Non-Hypertension	288	59.13	0.00 ± 0.00	
Lipid profile				
Total cholesterol				
150-200 mg/dl (Normal)	11	2.25	173.55±22.00	0.062
>200 mg/dl (Elevated)	15	3.08	234.67±45.46	
Unknown	461	94.66	0.00 ± 0.00	
Triglyceride				
40-150 mg/dl (Normal)	09	1.84	127.00±11.43	0.025*
>150 mg/dl (Elevated)	17	3.49	307.42±146.10	
Unknown	461	94.66	0.00 ± 0.00	
HDL				
>40 mg/dl (Normal)	05	1.02	54.80±17.61	0.041*
<40 mg /dl (Low)	21	4.31	34.57±3.12	

Unknown	461	94.66	0.00 ± 0.00	
LDL				
<175 mg/dl (Normal)	21	4.31	109.40± 35.37	0.000*
>175 mg/dl (Elevated)	05	1.02	212.08± 51.62	
Unknown	461	94.66	0.00 ± 0.00	
VLDL				
<35 mg/dl (Normal)	11	2.25	27.85±3.86	0.063
>35 mg/dl (Elevated)	15	3.08	76.41±25.64	
Unknown	461	94.66	0.00 ± 0.00	

*P < 0.05 is considered as statistically significant

The assessment of past medical history showed 328 (67.35%) patients were having pre-existing T2DM, 127 (26.07%) with hypertension, 15 (3.08%) with hyperlipidemia, and 2 (0.41%) patients with asthma, either alone or in combination with other conditions. All the respondents were having T2DM (*n*=487; 100%) at the time of enrolling in this study. The current diagnosis revelated that 265 (54.41%) patients were having hypertension, 32 (6.57%) with hyperlipidemia and hypertension, 15 (3.08%) with hyperlipidemia, 12 (2.46%) with stroke and hypertension, and 9 (1.84%) with angina pectoris and hypertension. In terms of complications of diabetes, out of 487, 114 (23.40%) were diagnosed with microvascular complications and 55 (11.29%) with macrovascular complications. The details are presented in **Table 4**.

Table 4. Past medical history, current diagnosis, comorbidities, and complications of diabetes among the study participants (*n*=487)

Description	Number	Percentage
Past Medical History		
Type II Diabetes Mellitus	487	100
Hypertension	127	26.07
Hyperlipidemia	15	3.08
Asthma	02	0.41
Rheumatoid Arthritis	01	0.20
Tuberculosis	02	0.41
Hyperthyroidism	01	0.20
Hypothyroidism	05	1.02
CVA &Hypertension	01	0.20
Angina Pectoris& Hypertension	01	0.20
Hyperlipidemia &Hypertension	11	2.25
Current Medical Diagnosis		
Type-2 diabetes	487	100
Hypertension	265	54.41
Hyperlipidemia	15	3.08
Hypothyroidism	05	1.02
Hyperthyroidism	01	0.20
Myocardial Infarction	01	0.20
Angina Pectoris	02	0.41
CVA & Hypertension	12	2.46
Angina Pectoris &Hypertension	09	1.84
Hyperlipidemia &Hypertension	32	6.57
Pre-existing comorbidities		

Hypertension	265	54.41
Hyperlipidemia	47	9.65
Myocardial Infarction	02	0.41
Angina Pectoris	11	2.25
Stroke	12	2.46
Nil	150	30.80
Complications of diabetes		
Microvascular complications	114	23.40
Diabetic Neuropathy	82	16.83
Diabetic Nephropathy	23	4.72
Diabetic Retinopathy	09	1.84
Macrovascular complications	55	11.29
Coronary Artery Disease	22	4.51
Congestive Cardiac Failure	16	3.28
Myocardial infarction	02	0.41
Angina pectoris	11	2.25
Both Macro and Micro-vascular Complications	04	0.82

The drug utilization evaluation among the diabetes patients in this study revelated that, the majority (*n*=433; 88.91%) were treated with orally administered antidiabetic medication or oral hypoglycemic agents (OHA), however, 49 (10.06%) of them were treated with insulin plus OHA. Surprisingly, only 5 (1.02%) patients were treated with insulin alone as parenteral monotherapy. Among the diabetes patients, 125 (25.66%) were treated with a single antidiabetic agent as monotherapy, 208 (42.71%) were treated with two-drug regimens, and 136 (27.92%) were treated with three-drug regimens. A detailed description of the drugs used in the treatment of diabetes is presented in **Tables 5 and 6**.

Table 5. Utilization of antidiabetic drugs as monotherapy among the study participants (*n*=487)

Name of the drug	Number	Percentage
a. Parenteral formulation		
Huminsulin 30/70	2	0.41
Huminsulin 50/50	1	0.21
Isophane Basel Insulin	2	0.41
b. Oral formulation		
Acarbose	16	3.29
Glibenclamide	2	0.41
Glyburide	4	0.82
Glimepiride	4	0.82
Glipizide	1	0.21
Metformin	74	15.20
Teneligliptin	8	1.64
Voglibose	11	2.26

Table 6. Utilization of antidiabetic drugs as combination therapy among the study participants (*n*=487)

Name of the drug	Number	Percentage
a. Parenteral and oral formulations		
Biphasic Insulin + Metformin	1	0.21
Biphasic Insulin + Metfomin+ Alogliptin	1	0.21
Biphasic Insulin + Metfomin+ Glibenclamide	1	0.21

Biphasic Insulin + Metfomin+ Voglibose	2	0.41
Biphasic Insulin + Metfomin+Glibenclamide+Voglibose	1	0.21
Biphasic Insulin + Vildagliptin	1	0.21
Biphasic Insulin + Vildagliptin+ Voglibose	1	0.21
Huminsulin 30/70+Acarbose	1	0.21
Huminsulin 30/70+Alogliptin	1	0.21
Huminsulin 30/70+Glipizide+Dapagliflozin	1	0.21
Huminsulin 30/70+Metformin	1	0.21
Huminsulin 30/70+Metformin+Dapagliflozin	1	0.21
Huminsulin30/70+Metformin+Glibenclamide+Dapagliflozin	1	0.21
Huminsulin 30/70+Metformin+Gliclazide+Alogliptin	1	0.21
Huminsulin 30/70+Metformin+Voglibose	3	0.62
Huminsulin 30/70+Tenegliptin	3	0.62
Huminsulin 30/70+Voglibose	2	0.41
Huminsulin 50/50+Acarbose	1	0.21
Huminsulin 50/50+Gliclazide+Metformin	1	0.21
Huminsulin 50/50+Gliclazide+Metformin+Acarbose	1	0.21
Huminsulin 50/50+Glimepride+Metformin+Acarbose	1	0.21
Huminsulin 50/50+Metformin	3	0.62
Huminsulin 50/50+Metformin+Acarbose	1	0.21
Huminsulin 50/50+Metformin+Gliclazide+Voglibose	1	0.21
Huminsulin 50/50+Tenegliptin	1	0.21
Huminsulin 50/50+Vildagliptin	1	0.21
Huminsulin 50/50+Voglibose	3	0.62
Isophane Basel Insulin+Alogliptin+Acarbose	1	0.21
Isophane Basel Insulin+Metformin	2	0.41
Isophane Basel Insulin+Metformin+Acarbose	4	0.82
Isophane Basel Insulin+Metformin+Alogliptin	1	0.21
Isophane Basel Insulin+Metformin+Gliclazide	1	0.21
Isophane Basel Insulin+Voglibose	1	0.21
Isophane Basel Insulin+ Metformin+Pioglitazone+ Acarbose	1	0.21
Isophane Basel Insulin+Tenegeliptin	1	0.21
b. Oral formulation		
Acarbose+Alogliptin	4	0.82
Acarbose+Alogliptin+Metformin	1	0.21
Acarbose+Glimepride+Metformin	2	0.41
Acarbose+Metformin	2	0.41
Acarbose+Pioglitazone	1	0.21
Acarbose+Tenegliptin	1	0.21
Acarbose+Vildagliptin	3	0.62
Alogliptin+Pioglitazone	1	0.21
Alogliptin+Pioglitazone+Voglibose	1	0.21
Dapagliflozin+Metformin	1	0.21
Dapagliflozin+Metformin+Voglibose	1	0.21
Glibenclamide+Alogliptin	2	0.41
Glibenclamide+Metformin	30	6.16
Glibenclamide+Metformin+Acarbose	22	4.52
Glibenclamide+Metformin+Alogliptin	2	0.41

Glibenclamide+Metformin+Alogliptin+Voglibose	1	0.21
Glibenclamide+Metformin+Dapagliflozin+Pioglitazone	1	0.21
Glibenclamide+Metformin+Tenegliptin	4	0.82
Glibenclamide+Metformin+Vildagliptin	2	0.41
Glibenclamide+Metformin+Voglibose	13	2.67
Glibenclamide+Metformin+Voglibose+Vildagliptin	3	0.62
Glibenclamide+Voglibose	3	0.62
Gliclazide+Metformin	4	0.82
Gliclazide+Metformin+Acarbose	1	0.21
Gliclazide+Metformin+Alogliptin	3	0.62
Gliclazide+Metformin+Dapagliflozin	3	0.62
Gliclazide+Metformin+Tenegliptin	2	0.41
Gliclazide+Metformin+Vildagliptin	1	0.21
Gliclazide+Metformin+Vildagliptin+Voglibose	2	0.41
Gliclazide+Metformin+Voglibose	1	0.21
Glimepride+Acarbose	2	0.41
Glimepride+Metformin	12	2.46
Glimepride+Metformin+Acarbose	3	0.62
Glimepride+Metformin+Acarbose+Alogliptin	1	0.21
Glimepride+Metformin+Alogliptin+Voglibose	1	0.21
Glimepride+Metformin+Dapagliflozin	1	0.21
Glimepride+Metformin+Tenegliptin	2	0.41
Glimepride+Metformin+Voglibose	2	0.41
Glimepride+Pioglitazone+Dapagliflozin	2	0.41
Glimepride+Pioglitazone+Tenegliptin	1	0.21
Glimepride+Tenegliptin	1	0.21
Glipizide+Alogliptin	3	0.62
Glipizide+Dapagliflozin	1	0.21
Glipizide+Metformin	13	2.67
Glipizide+Metformin+Acarbose	6	1.23
Glipizide+Metformin+Aloglitptin	2	0.41
Glipizide+Metformin+Dapagliflozin	1	0.21
Glipizide+Metformin+Pioglitazone+Voglibose	1	0.21
Glipizide+Metformin+Tenegliptin	3	0.62
Glipizide+Metformin+Vildagliptin	1	0.21
Glipizide+Metformin+Voglibose	7	1.44
Glipizide+Tenegliptin	1	0.21
Glipizide+Tenegliptin+Acarbose	1	0.21
Glipizide+Vildagliptin	1	0.21
Glipizide+Voglibose	1	0.21
Metformin+Acarbose	33	6.78
Metformin+Acarbose+Dapagliflozin	1	0.21
Metformin+Alogliptin	10	2.05
Metformin+Alogliptin+Acarbose	5	1.03
Metformin+Alogliptin+Voglibose	4	0.82
Metformin+Dapagliflozin	15	3.08
Metformin+Glibenclamide+Tenegliptin	3	0.62
Metformin+Glicalzide+Voglibose	1	0.21

Metformin+Gliclazide	1	0.21
Metformin+Glimepride+Tenegliptin	1	0.21
Metformin+Glimepride+Voglibose	2	0.41
Metformin+Glipizide	1	0.21
Metformin+Glipizide+Voglibose+Alogliptin	1	0.21
Metformin+Pioglitazone+Acarbose	1	0.21
Metformin+Pioglitazone+Vildagliptin	1	0.21
Metformin+Pioglitazone+Voglibose	1	0.21
Metformin+Tenegliptin	11	2.26
Metformin+Tenegliptin+Voglibose	3	0.62
Metformin+Tenegliptin+Acarbose	1	0.21
Metformin+Vildagliptin	6	1.23
Metformin+Voglibose	19	3.90
Metformin+Voglibose+Vildagliptin	2	0.41
Voglibose+Alogliptin	1	0.21
Voglibose+Vildagliptin	1	0.21

The prospective cross-sectional study conducted among the diabetes population of the rural areas of Tamilnadu province of South India revealed that the prevalence and incidence of T2DM are more common among the female population of this locality. These findings are similar to other previous studies in which the majority of the diabetes population in Klang Valley, Malaysia (*n*=234, 58.5%) [21], Turaif, Saudi Arabia (*n*=249, 61.9%) [22], and Bangladesh (*n*=10,901, 58%) [23] are females. The majority of participants in this study were above the age of 50, which is consistent with previous studies conducted in India and Bangladesh, where the senior population predominantly has diabetes (*n*=624; 71.8%, and *n*=495; 42.1%, respectively) [24, 25]. These findings are evidence that diabetes is more common in older women. This could be since the female population in this province was obese and had undergone at least one stressful life event in the past. These problems are greatly associated with the quality of life and have a direct impact on the development of diabetes.

The majority of the population in this study was illiterate, had only basic primary education, and had no formal employment. Similar to this, the major proportion of the diabetes population in a study by Fasil *et al*., (*n*=127, 34.6%; *n*=44, 34.6%, respectively) [26] and Suwannaphant *et al*., (*n*=13440, 78.8%; *n*=4677, 27.4%, respectively) [27] had no formal education and employment. This finding is in contrast with the previous studies in which the majority of the population had at least school-level education (*n*=1110, 55.53%; *n*=73, 73%, respectively) [28, 29]. These findings clearly state that poor education and unemployment status have a significant influence on the development of diabetes.

Social habits and diet are key determinants of the emergence of diabetes. In this study, most of the diabetes patients were do not have any social habits such as smoking cigarettes or consuming alcohol, and one-third of the population was nonvegetarian. These findings are similar to an earlier study in which the majority of the diabetes population did not smoke or consume alcohol but ate fatty meals (*n*=387, 96.3%; *n*=269, 66.9%; *n*=183, 96.3% respectively) [30]. This is in contrast to a previous study where most of the diabetes population either smoked or drink alcohol regularly (*n*=118, 84.9%; *n*=54, 38.8% respectively) [31]. These findings show that T2DM is most common among non-smokers, and who drink alcohol, and consume non-vegetarians.

Furthermore, the family history of diabetes has a partial influence on the development of T2DM among the rural population as the number is equally distributed among the patients with or without a family history of diabetes. These findings were in contrast with the previous studies where 68.8% and 43.7% respectively, were having a family history of diabetes [32, 33]. Moreover, another study reported that 83% of participants did not have a family history of diabetes [34]. A family history of diabetes is associated with a range of metabolic abnormalities and is a strong risk factor for the development of type 2 diabetes.

All diabetes populations in this study were having a past medical history of T2DM followed by hypertension. This is consistent with a previous study where 84%, and 62%, were had a past medical history of T2DM and hypertension, respectively [35]. This finding was in contrast to another study in which 7.6%, and 26.5%, were had a past medical history of diabetes and hypertension, respectively [36].

In this study, more than 80% of the patients were having diabetes for more than five years and had elevated FBS,

PPBS, and HbA1c, and 50% were having hypertension. However, very few in this study were having elevated cholesterol levels. These findings are consistent with Pati *et al*., in which the majority of patients were having diabetes and hypertension (84% and 62%, respectively) [35]. Moreover, in a study by Jelinek *et al*., the majority of the population has had diabetes for more than 5 years (68.80%) followed by hyperlipidemia (*n*=18, 4.11%) [37]. This shows that diabetes is a long-term metabolic disorder that often coexists with other issues such as hypertension and hyperlipidemia. This could be because long-term diseases have negative health consequences, such as cardiovascular and metabolic issues.

Micro and macrovascular complications affected a large proportion of this study population. Diabetic neuropathy, diabetic nephropathy, and coronary artery disease were frequently seen among the diabetes population. This is similar to the study by Mantro *et al*., in which diabetic neuropathy (*n*=41, 62.10%), diabetic nephropathy (*n*=28, 42.42%), and macrovascular complications (*n*=11, 16.66%) were the most commonly observed problems associated with diabetes [38]. Long-standing diabetes may cause several complications including diabetic neuropathy, diabetic nephropathy, diabetic retinopathy, and macrovascular complications. These complications may have an adverse impact on the quality of life of the diabetic population and result in elevated morbidity and mortality [39].

The antidiabetic drug utilization evaluation revealed that the majority of the diabetes patients in this study were prescribed with OHA, in which metformin was the most commonly prescribed monotherapy for treating T2DM, whereas metformin plus acarbose was the utmost commonly prescribed dual OHA therapy. Glibenclamide plus metformin plus acarbose was the preferred triple OHA therapy among the study population. Among the parenteral formulation such as insulin prescribed in this study population, Huminsulin 30/70 and isophane basal insulin was the preferred choice of parenteral antidiabetic drugs. However, in the mixed combination of parenteral and oral therapy, isophane basal insulin plus metformin plus acarbose was the preferred choice. These findings were consistent with an earlier study by Sharma *et al*., in which the majority of the population received metformin as a monotherapy (*n*=230, 85.19%), biguanide plus sulphonylureas as dual drug therapy (*n*=233, 74.92%), and biguanide plus sulphonylurea plus thiazolidinedione as triple antidiabetic therapy [40]. Similar to the current study, only a small proportion of the diabetes population (*n*=129, 31.46%, and *n*=28, 20.17%) was prescribed insulin as monotherapy in previous studies [41, 42]. The majority of the current study population were using OHA as the preferred choice because they are not familiar with insulin injections or parenteral formulations as it requires assistance in injecting the formulations. Most of the patients were treated with multiple antidiabetic medications especially the combinations of metformin and other OHAs to control the hyperglycemia, moreover, hypoglycemia is low when using biguanides (except when used in combination with a sulfonylurea) because of their glucose-dependent mechanism of action. Metformin is endorsed in diabetes treatment guidelines as first-line therapy due to its low cost, favorable safety profile (e.g., low hypoglycemia risk), and potential cardiovascular benefits [43-45].

Recently developed drugs that target incretin hormones (dipeptidyl peptidase 4 [DPP-4] inhibitor and glucagon-like peptide-1 receptor agonist [GLP-1 RA]) and renal glucose reabsorption (sodium and glucose co-transporter 2 [SGLT2] inhibitors) are also commonly used among the study population, as these drugs do not cause hypoglycemia or weight gain, and their positive effects on the risk of cardiovascular events are supported by the results of large clinical trials [46, 47].

DUE programs play a key role in helping managed health care systems, understand, interpret, and improve the prescribing, administration, and use of medications. Employers and health plans find DUE programs valuable because the results are used to foster more efficient use of scarce health care resources. Pharmacists play a key role in this process because of their expertise in the area of pharmaceutical care. DURs allow the managed care pharmacist to identify trends in prescribing within groups of patients such as those with Chronic Diseases such as HIV, cancer, asthma, diabetes, high blood pressure, etc. Pharmacists can then, in collaboration with other members of the health care team, initiate action to improve drug therapy for both individual patients and covered populations. DURs serve as a means of improving the quality of patient care, enhancing therapeutic outcomes, and reducing inappropriate pharmaceutical expenditures, thus reducing overall healthcare costs [48].

Limitation

This study has several limitations. The answers provided by the respondents may not be accurate as they may have recall bias especially when they were asked about their family history of diabetes, social habits, and stressful life events, however, the other response is reliable as it was documented from their prescription and patient's case notes. As the study population is fewer and most are illiterate, this finding may not be the actual reflection of the

entire DM population of the state or country.

CONCLUSION

Drug utilization review plays a major role in the modification of medication use among patients especially those who are on long-term drug therapy like antidiabetics, antihypertensives, and so on. Diabetes was the most common metabolic condition among the population of this rural province, in which T2DM was predominant over other metabolic issues. T2DM was commonly diagnosed among females and the incidence was higher among the overweight population. OHA was the most preferred choice of antidiabetic therapy, in which metformin was the most common monotherapy prescribed to treat diabetes. Polypharmacy was common among the older population with multiple comorbid conditions. The inappropriate lifestyle changes and lack of awareness of diabetes and its complications were the triggering factors that elevated the incidence and prevalence of diabetes and also its comorbid conditions among this population. This is a serious health concern, and it may raise the morbidity and mortality rate if is not addressed immediately. A well-structured health intervention program needs to be implemented in this rural population to reduce adverse health outcomes and improve their quality of life.

ACKNOWLEDGMENTS : The authors thank the management of Karpagam Academy of Higher Education, Coimbatore, and Nandha College of Pharmacy, Erode, for providing the necessary support and permission to carry out this study.

CONFLICT OF INTEREST : None

FINANCIAL SUPPORT : None

ETHICS STATEMENT : This study was approved by the Institutional Review Board of Vivekanandha Medical Care Hospital, Elayamabalayam, Tiruchengode (Ref.No. SVCP/IEC/JAN/2021/15).

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