Research Article

UTILIZATION PATTERN AND MEDICATION ADHERENCE OF ORAL ANTI-DIABETIC MEDICATIONS AMONG TYPE 2 DIABETES MELLITUS PATIENTS IN RURAL AREAS OF KARNATAKA, SOUTH INDIA.

Ujwal Teja Y[1*], Abino Denny[1], Kishore Kumar M.G[1], Nasrin Alyan[1],Dr. Mahesh N.M[2], Dr. Chaluvaraj T.S[3], Dr. Vidya Alex[4].

[1]Pharm.D Interns, Krupanidhi College of Pharmacy, Bangalore.

[2]HOD, Pharmacy Practice, Krupanidhi College of Pharmacy, Bangalore.

[3]Assistant Professor, Department of Community Medicine, M.V.J Medical College and Research Hospital, Hoskote, Bangalore.

[4]Assistant Professor, Pharmacy Practice, Krupanidhi College of Pharmacy, Bangalore.

ABSTRACT

Objective: To assess the utilization pattern and medication Adherence of oral anti-diabetic medications among patients with type 2 diabetes mellitus in rural areas of Bangalore East. **Methodology:** A prospective observational house-hold study was carried out on type 2 diabetic patients in rural areas of Bangalore east for a period of six months. Out of 162 patients screened 148 patients were enrolled in the study and a specially prepared case report form and structured questionnaire was used to collect the data on medications, lifestyle, and diet and medication adherence respectively. **Results:** A total of 148 patients were included in the study of which 56.75% are males and 43.24% were females. 52.7% of the enrolled patients were in 41 to 60 years of age. Hypertension was the most common co morbid condition (49%) followed by hyperlipidemia and hypertension (12%). Metformin was commonly prescribed drug among diabetic patients. In combination therapy, glimepiride and metformin combination (51.80%) were mostly consumed followed by glipizide and metformin (14.4%) and sitagliptin and metformin combination (6.02%). Adherence to the medications were also checked using Morisky medication adherence scale before and after counseling of which 63.51% diabetic patients were in high adherence, 25% were in medium adherence and 11.48% were in low adherence after two counseling sessions in 60 days. **Conclusion:** Metformin was the most commonly utilized drug as alone and Metformin and glimepiride combination was the most commonly utilized combination. Patient education and counseling resulted in improvement in medication adherence.

Keywords: Utilization pattern, Type 2 Diabetes mellitus, Medication adherence.

INTRODUCTION:

Diabetes mellitus is defined by World Health Organization as a metabolic disorder of multiple causes characterized by chronic hyperglycemia with disturbances of carbohydrate, fat and protein metabolism resulting from defects in the insulin secretion, insulin action, or both. [1] Although the prevalence of type 1 is increasing in number but still the number is small while the type 2 in other hand accounts for 90-95% among diabetic population [2]. In developing country like India, the majority of diabetics are in the age group of 45-64 years which is in contrast to developed countries where the prevalence is in age group of 65 years. [3] According to Diabetes Atlas published by International Diabetic Federation suggests that there are about 415 million people living with diabetes worldwide and they presume that it is likely to increase to 642 million by 2040. In India it is estimated that 9.3% of population are living with diabetes and it is presumed to reach 10.9% by 2040. [4] In regard to the Indian scenario, there has been a marked increase in the prevalence of diabetes in both the rural as well as the urban setting with a clear spike in the southern region of India. The incidence of Type 2 Diabetes mellitus in the urban southern metros is approaching figures similar to those quoted in the affluent Indian migrants with the urban population having a total prevalence rate of 2.5% and the rural area with 1.5% [5]. The incidence is increasing in rural parts of

India due to urbanization, obesity, unsatisfactory diet, sedentary life style. [6]

The World Health Organization (WHO) defines drug utilization study (DUS) as the marketing, distribution, prescription and use of the drugs in a society considering its consequences, either medical, social, and economic.[7] DUS is an essential part of pharmaco-epidemiology as it describes the extent, nature and determinants of drug exposure and it is used to identify treatment adherence problems.[6] People living with type 2 DM are more vulnerable to both short and long-term complications, which often lead to their premature death. This vulnerability to increased morbidity and mortality is seen in patients with type 2 DM because of the commonness of this type of DM, its insidious onset and late recognition, especially in rural areas in India and resource-poor developing countries like Nigeria.[8] WHO defines Adherence as the extent to which a person's behavior taking medication, following a diet, and/ or executing lifestyle changes, corresponds with agreed recommendations from a health-care provider''.[9] Adherence rates are typically higher among the patients with acute conditions when compared with those with chronic conditions; persistence among patients with chronic conditions is critically low.[10] As diabetes is very common in elderly patients and various factors influence them to non-adherent like cognitive impairment, poly-pharmacy due to co-morbid conditions and cost of therapy especially in rural areas where affordability is comparatively low to urban areas. So, Adherence to one's medication regimen is a primary determinant of successful management. Diabetes Mellitus is commonly associated with unhealthy diets, sedentary lifestyles, obesity; thus lifestyle modification is considered as an important measure in addressing the problem. [11] Adherence to medication therapy is generally low for common chronic conditions such as hypertension and diabetes approximately 50% to 65% on average. When conditions are under treated, symptoms and complications may worsen, leading to increased use of hospital, emergency room services, office visits, and other medical resources. This suggests that adherence to the medications decreases the expenses for some chronic conditions.[12] The reports of World Health

Organization have emphasized that increasing the effectiveness of adherence interventions may have a far greater impact on the health of the population than any improvement in specific medical treatments. [13] Diabetes is a chronic morbid condition which requires lifelong treatment. So the cost of anti-diabetic drug is the major deciding factor for the patient's compliance. Selection of oral anti-diabetic drugs as first-line drug or combined therapy should be based on both the pharmacological properties of the compounds like efficacy, safety profile and also on clinical characteristics of a patient such as stage of disease, body weight and Body Mass Index. There are many studies carried out on drug utilization in diabetic patients in hospitals but a limited number of studies had focus on utilization and adherence to treatment in rural areas. [3] The regular utilization of drugs by the patients is very important factor for the chronic diseases like diabetes. So this study is conducted to evaluate the regular utilization pattern of anti-diabetic drugs including their adherence to medications.

METHODOLOGY

Study Design and period: Prospective observational House-hold study for 6 months (Nov 2015 to May 2016).

Study Population and sites:148rural population of Bangalore East, Karnataka(Mullur, Kachamaranahalli, Ambedkar Nagara).

Study Criteria:

Inclusion Criteria: Patients having type 2 diabetes mellitus of either sex who are aged above 18 years. Patients on oral anti-diabetes medications along with common co-morbid conditions.**Exclusion Criteria:** Those patients who are not willing to give informed consent. Patients with gestational diabetes mellitus.Patients with type-I diabetes mellitus.

Ethical approval:

The protocol relating to the current study was submitted for ethical approval to the ethical head of MVJ Medical college and research hospital, Hoskote. The study was accepted by the board of members and the ethical clearance certificates were issued on 21.11.15.

Method:

A Prospective-Observational house hold study was conducted after approval by the human institutional ethical board of M.V.J medical college and research hospital, Hoskote. A door to door visit in rural areas is made to identify eligible patients into our study. The patients who are satisfying the study criteria were enrolled in the study after taking informed consent by verbally translating it into Kannada language. Clinical, demographic, medication, dietary and life style data was collected and documented into specifically prepared case report form. Blood Glucose levels are measured using Glucometer. Adherence to the medication was assessed using Morisky Medication Adherence scale (MMAS) by translating it into Kannada language on 0th day and 60th day to assess the impact of counseling on adherence. Patient education and counseling on disease, diet control, medication use and life style changes was done on 0th day and 30th day by verbal communication with help of patient information leaflet prepared in Kannada and English language.

Assessment of Medication Adherence:

The Questionnaires (MMAS) answered by the participants were scored 0 for correct and 1 for incorrect answers. These scores were added up and participants are categorized based on them i.e. 0 for High Adherence, 1 - 3 for Moderate Adherence and > 3 for Poor Adherence.

Analysis of data:

The data obtained from the patients were analyzed using basic descriptive analysis using Microsoft Word Excel 2010. The effect of counseling on medication adherence after 60 days was analyzed using chi-square test.

RESULTS

Demographic data:

Samples were obtained from 3 specific rural areas of Bangalore east. Majority (53%) of the samples were from Mullur village followed by Kachamaranahalli (37%) and Ambedkar Nagara with 10%. A total of 148 participants were enrolled into the study. Majority of these were males. Mainstream of patients were from the age group of 41-60years followed by 61-80years, 20-40years

and >80years. Obesity is one of the leading causes for the increased prevalence of diabetes. An analysis of Body Mass Index (BMI) ratio showed that majority of them are normal followed by obese however, few were found to be underweight.

Likewise, weighty numbers of patients were found to be Non-smokers and Non-alcoholics. A person is considered as illiterate if he/she cannot read and write with understanding; a person who can merely read but cannot write is treated as literate [14]. A chief representation in secondary education level was seen trailed by illiterates.

The detailed illustration of demographic data is in table no 1

Table 1: Demographic data (N=148)

Gender	No.of patients (%)
Males	**84(56.75%)**
Females	64(43.24%)
Age in Years	
20-40	16(10.81%)
41-60	**78(52.70%)**
61-80	53(35.81%)
>80	1(0.67%)
BMI	
Obese (>25)	**56(37.8%)**
Overweight (23-24.9)	21(14.1%)
Under Weight (<18)	**5(3.3%)**
Normal (18-22.9)	66(44.5%)
Social Habits	
Smoker	28(18.91%)
Non Smoker	**120(81.09%)**
Alcoholic	25(16.89%)
Non-Alcoholic	**123(83.10%)**
Level of Education	
Illiterate	41 (27.70%)
Primary(1st -7th std)	34 (22.97%)
Secondary(8th -10th)	**46 (31.08%)**
Pre-University(11th - 12th)	19 (12.83%)
Graduates	8 (5.40%)

The participants were differentiated into groups depending on the number of years they had been

suffering from diabetes. Majority of the study sample had been diagnosed with diabetes for the past 1-10years with the second highest representation being in the <1year category followed by 11-20years as shown in Fig-1
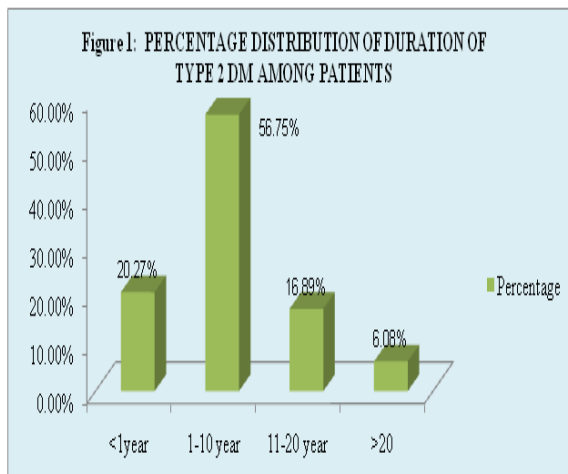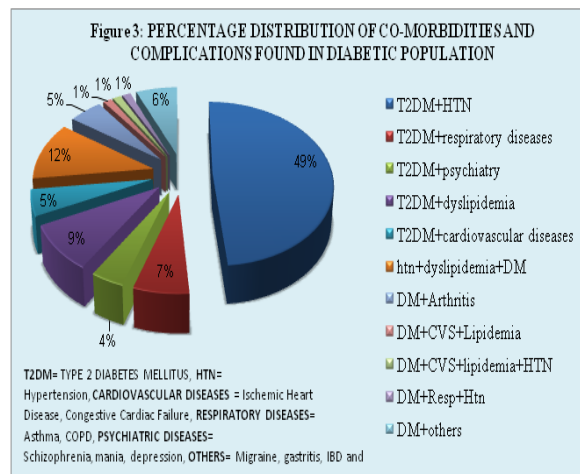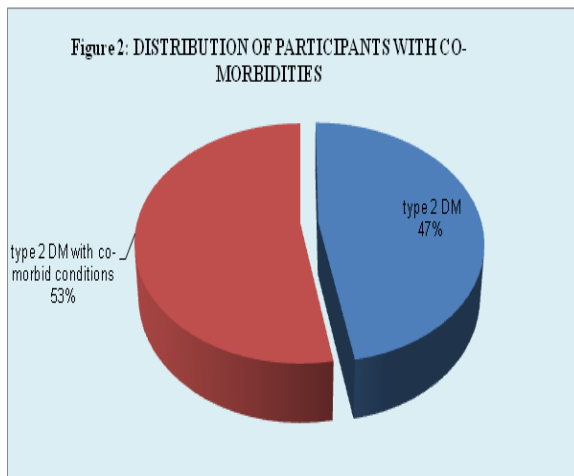

Fig-2 and 3 shows that total of 79 patients had other co-morbidities or complications along with their diabetic disorder. Whereas, 69 patients had diabetes alone. Among 79 patients having co-morbidities majority 39 patients suffered from Hypertension in combination with Type II DM followed by hypertension and hyperlipidemia.

Utilization Pattern of Oral Anti-Diabetic Medications:

Among 148 patients enrolled in the study most of the patients were on monotherapy which means the patient is on single anti-diabetic drug apart from medications taken for other co-morbid conditions which is followed by combination therapy with two and three drug therapy as illustrated in table 2.Out of which 79 patients who are having diabetes alone 40 patients are on single drug regimen remaining patients are on two and three drug anti-diabetic combinations.

Table 2: Utilization pattern of oral Anti-diabetic medications

UTILIZATION PATTERN		NO.OF PARTICIPANTS(N =148)
Monotherapy		73 (49.32%)
Combination therapy	Two drug	62 (41.89%)
	Three drug	13 (8.78%)

The most commonly utilized class of anti-diabetic medication is shown in Table-3. Assessment has been done on 148 study participants by counting the number of times a particular class of drug was prescribed. Study showsthere were 268 oral anti-diabetic drugs utilized and most utilized class was Biguanides followed by Sulfonylureas, Thiazolidinediones, DPP-4 inhibitors and α-Glucosidase inhibitors. Commonly utilized drug was Metformin among Biguanides followed by Glimepiride among Sulfonylureas and Pioglitazone among TZD's

Table 3: Percentage of various oral anti-diabetic drugs by class (N=148)

Class	Drug	No. of times
Biguanides	Metformin	**136 (50.7%)**
Sulphonylureas	Glimepiride	59 (22.01%)
	Glipizide	12 (4.47%)
	Glibenclamide	12 (4.47%)
	Gliclazide	8 (2.98%)
	Total	**91 (33.95%)**
Thiazolidinediones	Pioglitazone	**16 (5.97%)**
Alpha-glucosidase inhibitors	Voglibose	11 (4.10%)
	Acarbose	01 (0.37%)
	Total	**12 (4.47%)**
DPP-4 inhibitors	Vildagliptin	07 (2.61%)
	Sitagliptin	05 (1.86%)
	Saxagliptin	01 (0.37%)
Total		**13 (4.85%)**
Total no. of drugs		**268**

Study on 148 patients shows the most utilized single drug therapy was metformin followed by Glimepiride, Voglibose and Pioglitazone and least utilized was Saxagliptin and Acarboseas shown in table-4.

Table 4: Percentage of Monotherapy utilized among participants

Utilized as single medication	No. of times
Metformin	53 (58.24%)
Glimepiride	9 (9.89%)
Voglibose	8 (8.79%)
Pioglitazone	6 (6.59%)
Glibenclamide	5 (5.49%)
Gliclazide	5 (5.49%)
Vildagliptin	3 (3.29%)
Acarbose	1 (1.09%)
Saxagliptin	1 (1.09%)
Total	**91**

Combined drug therapy utilization on 148 patients is presented in table 5. In two drug therapy Metformin& Glimepiride were mostutilized followed by Glipizide and Metformin, Sitagliptin and Metformin ,Vildagliptin and Metformin and Pioglitazone and Metformin were least utilized. In three drug therapy Glimepiride, Metformin and Pioglitazone and Glibenclamide, Metformin and Pioglitazone were equally utilized.

Table 5: Percentage of combination therapy utilized

Combination therapy		No. of times prescribed
Two drug	Glimepiride+Metformin	43 (51.80%)
	Glipizide+Metformin	12 (14.45%)
	Sitagliptin+Metformin	5 (6.02%)
	Vildagliptin+Metformin	4 (4.81%)
	Glibenclamide+Metformin	3 (3.61%)
	Gliclazide+Metformin	3 (3.61%)
	Pioglitazone+Metformin	2 (2.40%)
	Total	**72 (86.74%)**
Three drug	Glimepiride+metformin+pioglitazone	4 (4.81%)
	Glibenclamide+metformin+pioglitazone	4 (4.81%)
	Voglibose+pioglitazone+metformin	3 (3.61%)
	total	**11 (13.25%)**
Total		**83**

Distribution of blood glucose levels among the participants:

Table 6 shows blood glucose levels of 148 participants. It was observed that majority have uncontrollably high levels of blood glucose and very limited had normal random blood glucose levels. Similarly, few had high blood glucose levels.

Table 6: Blood sugar levels among study participants

BLOOD GLUCOSE LEVELS	NO.OF PATIENTS(N=148)
70-140mg/dl	38 (25.67%)
140-200mg/dl	28 (18.91%)
>200mg/dl	82 (55.40%)

Co-relation of monitoring blood sugar levels in patients using glucometer and other means:

The monitored data is elucidated in table 7.The participants having glucometer at home are very few. As we tried to co-relate the participants using glucometer at home and other means we found that former are checkingonce a week, once a month or once in 6 months whereas the later mostly once in 6 months in various places like diagnostic centers, hospitals etc. It was observed few patients were not even checking their sugar levels as they have to visit the hospital for same as it is difficult in rural areas.

Table-7Co-relation of monitoring blood sugar levels in patients using glucometer and other means.

Glucometer	Monitoring of blood glucose levels(N=148)	
Yes	Once in a week	12 (23.07%)
	Once in a month	25 (48.07%)
	Once in 6 months	15 (28.84%)
Total		52
No	Once in a week	00
	Once in a month	39 (37.50%)
	Once in 6 months	49 (51.04%)
	None	08 (8.33%)
Total		96

Medication adherence among participants:

The level of the medication adherence of the study population was attempted to understand by using validated MMAS questionnaire. We found that a majority of the patients were found to be highly adherent to their medication regimen followed by patients with low and medium adherence levels. [Fig-4]

Figure 4: MEDICATION ADHERENCE AMONG PARTICIPANTS
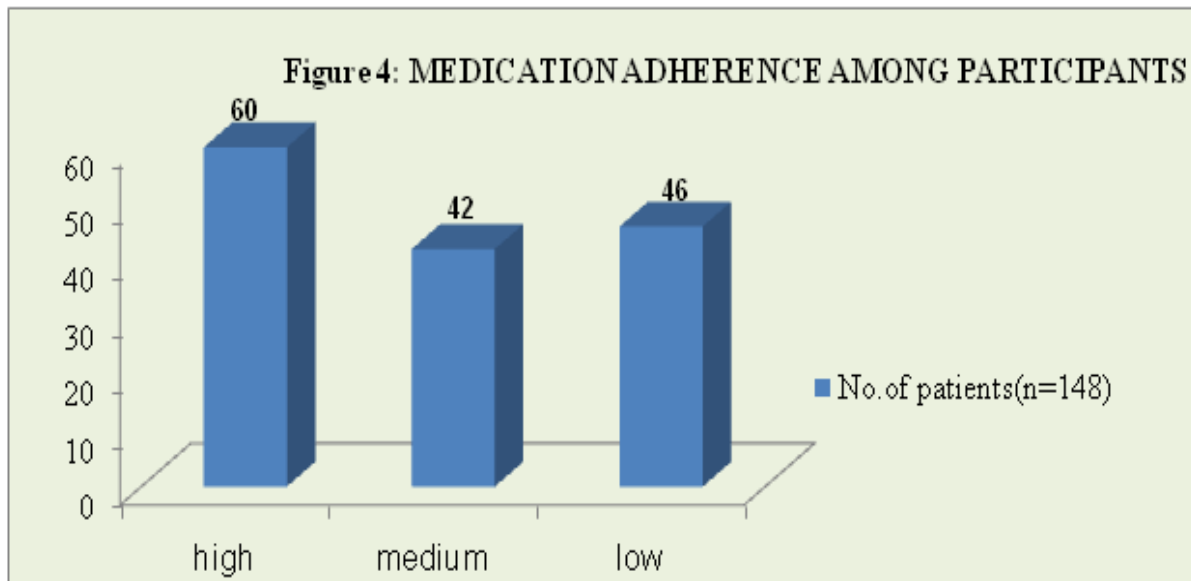
Out of total 148 participants, 60 patients were adherent and 46 were non-adherent. After 60 days of exposure of education and counseling MMAS was again administered to participants. The scoring showed that 94 participants were highly adherent, of which 25 patients of medium and 9 patients from low adherence showed improvement to high adherent whereas 20 patients of low adherent showed improvement to medium adherence and 17 patients remain non-adherent. Among 17 patients 10 patients were not present at the time of follow up. The major reason for 17 patients who remained as medium adherence even after the counseling was forgetfulness as those patients were diagnosed 1-4 months back and responded as they were hassled over taking medications. Few responded as they forget to take medications while they travel. This improvement was assessed using **chi-square test** and was found to be very significant. (P-value= 0.0001) as shown in table 8.

Table 8: Changes in adherence before and after counseling

ADHERENCE	NO. OF PATIENTS(0ᵗʰ DAY)	NO. OF PATIENTS (60ᵗʰ DAY)
High	60	94
Medium	42	37
Low	46	17

Statistical Analysis:

Effect of counseling on medication adherence:

On analyzing the results from the questionnaire and analyzing them using Chi square test (n=148, p= <0.0001), we observed that there is a significant positive relationship between counseling concerning the disease, life style, drug and the adherence towards their medication regimen. We attempted to relate the variables medication adherence and the blood glucose levels to bring about a relationship among them but we weren't successful in relating due to use of GRBS rather than HbA1c values since GRBS can be affected by many factors (food, physical activity and fasting).

Figure 5: EFFECT OF COUNCELLING ON MEDICAL ADHERENCE

Chi-square 21.1722
p-value is 0.000025
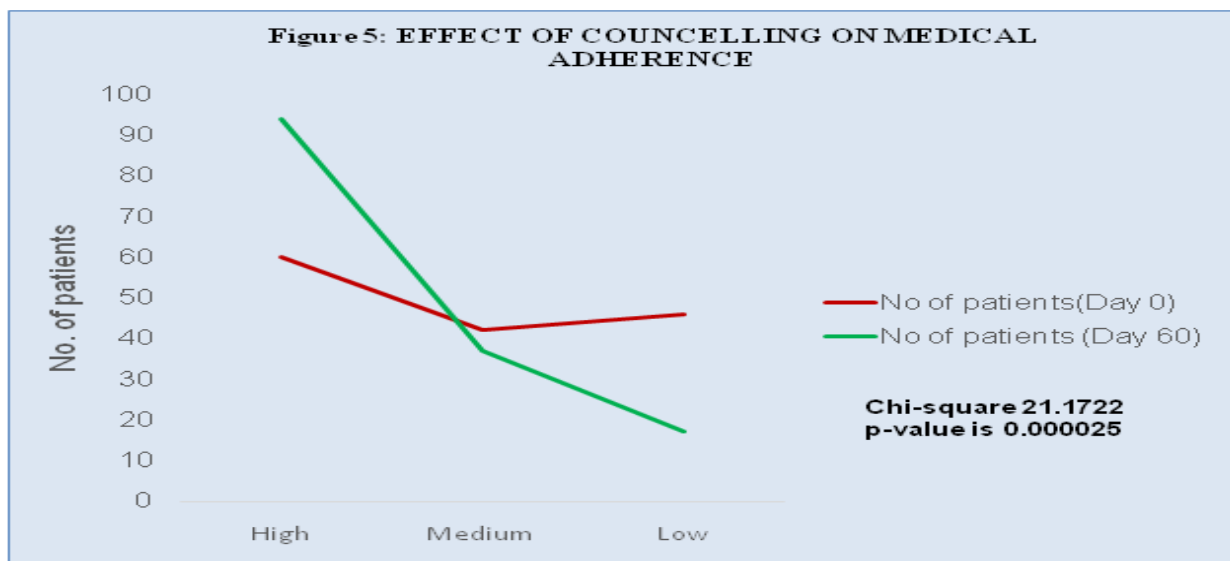
DISCUSSION

This study was carried out to analyze the utilization pattern of oral anti-diabetic medications and to evaluate the adherence of diabetic populations towards their therapy. As we know diabetes is a major public health problem which requires lifelong treatment. Although lifestyle modifications remain cornerstone for the management of the disease, drugs are unavoidable in order to maintain the normal blood glucose levels in diabetic populations.

The study was conducted among the diabetic patients for a period of 6 months. A total of 148 patients were enrolled from rural areas of Bangalore east to our study. Males predominated in the study population which is in agreement with the results of various studies [15, 16].Out of the total diabetic patients studied, majority of the patients were found in 41-60 years of age group indicating that the risk of type-II DM increases after the age of 40 years, this result was similar to study of Roy V et al [17]. Obesity, physical inactivity, inappropriate dietary habits are some of the risk factors that have increased the occurrence of the disorder.

Duration of disease also play an important role in the management of disease .So in the patients with a long duration of diabetes, strict glycemic control results in a reduced incidence of complications. Our study showed that most patients had a diabetic history of 1-10 years, similar result was obtained by the study conducted by Upadhyay D et al [18].

Study participants were derived from different backgrounds with regard to education. We had a majority of participants who completed their basic schooling (66%), 29.72% of illiterate individuals and very few graduates (5.4%). Obesity has always been associated with an increased risk for developing chronic illnesses like Type 2 DM, Hypertension, Dyslipidemia and other diseases which can be measured using BMI (Body mass Index). BMI can be defined as a simple index of weight-for-height that is commonly used to classify underweight, overweight and obesity in adults. It is defined as the weight in kilograms divided by the square of the height in metre (kg/m2).The results of our study showed that 37.83% were found to be obese, 14.18% overweight, 3.37% underweight and 44.5% found to be normal thereby firming the statement that increased BMI is a clear risk factor for type 2 DM [19].

Patients with long-standing duration of diabetic disease are at an increased risk for getting the complications. Hypertension and hyperlipidemia are the most common complications of diabetes mellitus. In our study Hypertension accounted for 48.71% of total complications among the diabetic patients which is in agreement with published standards where Hypertension being the most common condition followed by hypertension with hyperlipidemia [6].

Diabetes is a complex, chronic illness requiring continuous medical care with multifactorial risk-reduction strategies beyond glycemic control. Ongoing patient self-management education and support are critical for preventing acute complications and reducing the risk of long-term complications. Although lifestyle modifications play an important role in diabetes management, drugs become unavoidable in many patients [3]. 49.32% of the study participants were on mono-therapy, 41.89% of the patients were prescribed with two drug regimen (OHA) 18.78% was prescribed with three drug regimen.

In this study most utilized diabetic drug was metformin belonging to the class of Biguanides followed by Glimepiride which was most utilized drug among Sulfonylureas. Similar results were obtained in a study conducted by Adibe M.O on outpatient utilization of Anti-diabetic Drugs.

On evaluation of anti-diabetic prescriptions which also suggests that combination of Biguanides and sulfonylureas were most frequently used combination and are most effective. In our study 2-drug combination Metformin, Glimepiride was most commonly prescribed than other combinations like Metformin, Glibenclamide, Metformin, Pioglitazone, Metformin, Glipizide, a common finding identified with early study of Bela Patel et.al on patterns of anti-diabetic drugs. In 3-drug combination Metformin, Glimepiride and Pioglitazone was most commonly prescribed than other combinations. Metformin is considered to be the best anti-diabetic drug due to its efficacy, safety, cost and low incidence of adverse effects which could be the probable reason for these results.

Along with the history of medical, medication, lifestyle and dietary pattern we also interviewed participants few other questions and were responded in the following manner. Among 148 patients enrolled 75 responded that they don't do any kind of exercises and 73 responded they do exercise every day like brisk walking being the most common exercise. Out of 148 participants 43 were having hypoglycemic episodes and 105 were not having episodes of hypoglycemia in the last 6 months from interview. Those 43 participants responded that they used to carry candies and sugar to manage the condition.

Medication adherence is an important issue and a huge problem in our healthcare system. The dominance of economic variability, low literacy level, and restricted access to healthcare facilities might have led to the increase incidence of medication non-adherence. Medication adherence is defined as the extent to which patients take medications as prescribed by their health care providers. We were able to assess the participant's level of medication adherence with the help of Morisky Medication Adherence Scale. They were grouped into categories based on their test scores as having High Adherence (HA), Moderate Adherence (MA) and Poor Adherence (PA). In this study adherence to the therapy is calculated using Morisky Scale and we found that 63.5% patients show good adherence and 11.4% patients show poor adherence to therapy and remaining show medium adherence after 60 days of counseling. We went on to look into the factors that could

influence the patient's adherence. On analyzing the data, we were able to find different challenging factors that are lead to their non-adherence. About 79.25% of our sample population was found to be non-adherent because of forgetfulness and 23.6% because of lack of finance. So there is a need of Clinical monitoring of patient's adherence to the prescribed treatment to achieve good glycemic control. This can be improved by educating and counseling the patients on the various aspects of the drugs, disease conditions and lifestyle modifications as done in this study.

Co-relating the age and adherence we found that 51.66% of the high adherence participants were in age group of 61-80years followed by 41-60 years. Also correlating the education level and adherence we were able to find that 66.6% of high adherent participants are literates and 33.34% were from illiterates. Hence, education level plays a role in understanding the disease which indirectly has an impact on adherence to medications.

Limitations of the study includes sample size was small due to limited time period. So if the study was conducted for a longer time period on a larger sample size, then the results would have been improved. Measurement of HbA1c level, which is considered as the standard and gives better judgment about glycemic control, was not done due to its high cost. Accu-check active glucometer was used for the measurement of blood glucose. Hence if HbA1c is done the results will be more accurate and easier to correlate between medication adherence and blood glucose levels.

CONCLUSION

This study showed that most commonly used oral hypoglycemic class of drugs was Biguanides followed by Sulphonylureas, TZDs, DPP-4 inhibitors and Alpha glucosidase inhibitors. Metformin was the most commonly utilized drug among diabetic population. Glimepiride and Metformin were the most commonly prescribed anti-diabetic combination. It also shows that patients are consuming the cost efficient class of anti-diabetics. Present study created awareness about the drug treatment and diabetic complications among rural population. Most patients know about the disease but they were not aware of the diet to be followed

and lifestyle changes hence this study improved their understanding on how diet and lifestyle can cause change in adherence and to maintain the glycemic control. The best way that health professionals can challenge adherence problem is by quality education and counseling as done in this study. Hence, health education and counseling resulted in increased adherence rate. This study suggests that the choice of drug should be based on the economic status of the patient and associated conditions.

ACKNOWLEDGEMENT

CONFLICT OF INTEREST

Authors declare no conflict of interest

REFERENCES

1. Diabetes [Internet]. World Health Organization. 2013 [cited 21 January 2016]. Available from: http://www.who.int/ mediacentre /factsheets/fs312/en/
2. Guidelines for Management of Type 2 Diabetes [Internet]. Icmr.nic.in. 2017 [cited 7 January 2017]. Available from: http:// icmr.nic.in/guidelines_diabetes/guide_diabetes.htm
3. Shah K, Solanki N, Rana D, Acharya K. Evaluation of antidiabetic prescriptions, cost and adherence to treatment guidelines: A prospective, cross-sectional study at a tertiary care teaching hospital. Journal of Basic and Clinical Pharmacy. 2013;4(4):82.
4. IDF Diabetes Atlas Seventh Edition [Internet]. International Diabetes Federation. 2016 [cited 14 June 2016]. Available from: http://www.idf.org/idf-diabetes-atlas-seventh-edition
5. Mohan V, Venkatraman J, Pradeepa R. Epidemiology of Cardiovascular Disease in Type 2 Diabetes: The Indian Scenario. Journal of Diabetes Science and Technology. 2010;4(1):158-170.
6. Sivasankari V, Manivannan E, Priyadarsini SP. Drug utilization pattern of anti-diabetic drugs

in a rural area of Tamilnadu, South India – A prospective, observational study. Int J Pharm BiolSci 2013; 4:514-9.

7. World Health Organization. Introduction to Drug Utilization Research, Oslo; 2003: p 8

8. AwodeleOsuolale J. Medication adherence in type 2 diabetes patients: study of patients in Alimosho General Hospital, Igando, Lagos, Nigeria. African Health Sciences. 2015;15(2):513.

9. World Health Organization-Report on medication adherence: Geneva, [Internet] 2003 Available from:http://whqlibdoc.who.int/publications/2003/9241545992.pdf
Utilization Pattern of Oral Anti-Diabetic medications 66

10. Mathew ERajiah K. Assessment of medication adherence in type-2 diabetes patients on poly pharmacy and the effect of patient counseling given to them in a multispecialty hospital. Journal of Basic and Clinical Pharmacy. 2014;5(1):15.

11. Simpson R, Shaw J, Zimmet P. The prevention of type 2 diabetes — lifestyle change or pharmacotherapy? A challenge for the 21st century. Diabetes Research and Clinical Practice. 2003;59(3):165-180.

12. Sokol M, McGuigan K, Verbrugge R, Epstein R. Impact of Medication Adherence on Hospitalization Risk and Healthcare Cost. Medical Care. 2005;43(6):521-530.

13. Tsoukleris M. Book Review: Adherence to Long-Term Therapies: Evidence for ActionAdherence to Long-Term Therapies: Evidence for Action Edited by SabatéEduardo. Published by the World Health Organization, Geneva, Switzerland, 2003. ISBN 92-4-154599-2. Paperbound, xv + 198 pp. (26 × 20 cm), $27. www.who.ch. Annals of Pharmacotherapy. 2004;38(6):1093-1093.

14. Dharr G.M. Text book of Foundations of Community Medicine. 2nd ed. Elsevier; 2008.

15. Kannan, Arshad, Senthil K. A study on drug utilization of oral hypoglycemic agents in type-2 diabetic patients. Asian J Pharm Clin Res 2011;5:60-4.

16. Adibe M.O, Okonta J.M. Outpatient utilization of anti-diabetic drugs in the south eastern Nigeria. Int .J. Drug Dev and Res, 2009; 1(1):27-36.

17. Roy V, Rewari S. Ambiguous drug pricing: A physician's dilemma. Indian J Pharmacol 1998; 30:404-7.

18. Upadhyay DK, Palaian S, Ravi Shankar P, Mishra P, Sah AK. Prescribing pattern in diabetic outpatients in a tertiary care teaching hospital in Nepal. J ClinDiagn Res 2007;3:248-55

19. Ganz M, Wintfeld N, Li Q, Alas V, Langer J, Hammer M. The association of body mass index with the risk of type 2 diabetes: a case–control study nested in an electronic health records system in the United States. Diabetology& Metabolic Syndrome. 2014;6 (1) :50.