

## Medication Adherence among Type 2 Diabetes Mellitus Patients: A Cross Sectional Study in Rural Karnataka (India)

By Hemant Kumar<sup>\*</sup>, Rufaidha Amara Abdulla<sup>±</sup> & Heena Lalwani<sup>‡</sup>

*India currently represents 17% of the world's diabetes burden, with an estimated 77 million cases in 2019, a figure expected to almost double to 134 million by 2025. Currently, one in every four persons under 25 has adult-onset diabetes, a condition more usually seen in 40–50 year old people. A hospital-based cross-sectional study conducted among diabetes type 2 patients in a rural field practice area of the A.J. Institute of Medical Sciences & Research Centre, Mangalore, Karnataka. Medication adherence and factors associated with non-adherence to medication were determined using self-structured validated questionnaire. A total of 206 patients with type 2 diabetes were recruited. In the present study 49% of the patients were found to be having poor medication adherence, while 50.9% were found to be with good adherence. However, none of the patients showed perfect adherence. A significant association was observed between medication adherence and age of patients, their gender, information about the disease, family support, personal motivation, literacy status and cost of treatment.*

**Keywords:** medication adherence, type 2 diabetes mellitus, self-care practices, prevalence

### Introduction

Diabetes is a chronic, metabolic disorder characterized by elevated levels of blood glucose, which leads over time to serious damage to the heart, blood vessels, eyes, kidneys, and nerves. It is estimated that in 2019 approximately 9.3% (463 million adults) (20–79 years) were living with diabetes, 1 in 2 (232 million) people with diabetes were undiagnosed while there were 4.2 million deaths. The prevalence is higher in urban (10.8%) than rural (7.2%) areas, and in high-income (10.4%) than low-income countries (4.0%) and it is estimated to further increase to 10.2% (578 million) by 2030 and 10.9% (700 million) by 2045. Further, the global prevalence of impaired glucose tolerance (IGT) is estimated to be 7.5% (374 million) in 2019 and projected to reach 8.6% (548 million) by 2045 (IDF 2019a). Annual global health expenditure on diabetes is estimated to be USD 760 billion. It is projected that expenditure will reach USD 825 billion by 2030 and USD 845 billion by 2045 (IDF 2019b).

Diabetes has become a huge public health problem in India, with over 77 million individuals with diabetes already in 2019, while this number is predicted

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<sup>\*</sup>Professor & Head, Department of Community Medicine, A.J. Institute of Medical Sciences & Research Centre, Mangalore, Karnataka, India.

<sup>±</sup>Clinical Tutor, Department of Community Medicine, A.J. Institute of Medical Sciences & Research Centre, Mangalore, Karnataka, India.

<sup>‡</sup>Clinical Tutor, Department of Community Medicine, A.J. Institute of Medical Sciences & Research Centre, Mangalore, Karnataka, India.

to further increase to 134 million by the year 2045. The numbers place India among the top 10 countries for people with diabetes, coming in at number two while China leads the list with over 116 million diabetics (Kannan 2019). According to a report by "National Diabetes and Diabetic Retinopathy Survey" released in October 2019, by the health and family welfare ministry the prevalence of diabetes in India has remained at 11.8% during last four years. The males showed a similar prevalence of diabetes (12%) as females (11.7%). Known diabetics comprised 67.3% participants, while 32.7% were new diabetics. Highest prevalence of diabetes was observed in 70–79 years age group at 13.2%. Prevalence of blindness among diabetic patients was 2.1% and visual impairment was 13.7%. The study evaluated that in the 15 to 49-year age-group, Goa had the highest prevalence of diabetes (8.6%), followed by Andaman & Nicobar Islands (8.3%) and Kerala (7.5%). Further, the southern states were found to be having higher prevalence- Andhra Pradesh (6.6%), Karnataka (4.6%), Tamil Nadu (6.8%) Telangana (4.8%); while northern states i.e., Uttar Pradesh (2.4%) Rajasthan (1.8%) and Bihar (3%) reported relatively lower prevalence (Joan et al. 2008).

Poor medication adherence in diabetes is a worldwide problem as nearly 50% of the patients are non-compliant to treatment while the situation in developing countries like India is even worse, and this can lead to a failure to reach the desired glycemic targets, resulting in vascular complications with an associated increase in morbidity, mortality, and health costs (Sharma et al. 2014, WHO 2003). According to World Health Organization, treatment adherence is a multidimensional phenomenon determined by the interplay of five sets of factors, termed as "dimensions", i.e., Social and economic factors, Health care team and system-related factors, Condition-related factors, Therapy-related factors and Patient-related factors. Out of these patient-related factors are just one determinant and the common belief that patients are solely responsible for taking their treatment is misleading and most often reflects a misunderstanding of how other factors affect people's behavior and capacity to adhere to their treatment (WHO 2003).

Research Objective of the study was to assess medication adherence among type 2 diabetes patients under study and identify factors associated with non-adherence.

## Literature Review

Diabetes mellitus (DM) is a serious and a rapidly growing public health problem that affects millions of people. It usually co-exists with other medical conditions, and its prevalence is increasing year by year reaching epidemic proportions. Besides, leading to multiple long term complications, diabetes mellitus also leads to increased hospitalization rates causing huge financial burden on the families as well as on the state, while the cost of treatment many a times may push families from Above Poverty line (APL) to below poverty line (BPL) as brought out by some studies that due to increased health spending about 55 million Indians were pushed into poverty in a single year because of having to fund their own healthcare and 38 million of them fell below the poverty line due to

spending on medicines alone, a study by three experts from the Public Health Foundation of India has estimated (Nagarajan 2018).

In 2019, Switzerland spent some 12,000 U.S. dollars on each diabetic patient on treatment, making it the country with the highest average cost per person followed by United States and Norway who spent over nine thousand U.S. dollars per patient. Among the countries with lowest spending per patient on diabetes Bangladesh stood at the bottom, with average annual expenditures amounting to some 64 U.S. dollars, while India spent 91.6 U.S. dollars per patient (Elflein 2020).

The management of diabetes is multifaceted and includes lifestyle modifications, besides pharmacotherapy and strict "medication adherence" which is defined by the World Health Organization as "the degree to which the person's behavior corresponds with the agreed recommendations from a health care provider" (Cramer 2004). Needless to say that poor adherence to prescribed regimens can result in serious health consequences which include higher risk of hospitalization which can be more than double in patients with diabetes mellitus, hypercholesterolemia, hypertension, or congestive (De Geest 2003, Jimmy and Jose 2011). Further, poor adherence or non-adherence could occur at different stages of their treatment and these include not starting the treatment at all, decision not to fill their prescription in the pharmacy, taking the wrong dose, or discontinue the treatment earlier than the last date (Aminde et al. 2019). Effective diabetes management mandates good provider – patient relationship, and compliance to therapies is one of the significant aspects of the relation (Elsous et al. 2017).

Achieving glycemic control and preventing early complications are the ultimate targets of diabetes management which depends on patient's adherence to regimens. Poor medication adherence, especially when co-morbidities exist, can be influenced by several factors which are broadly divided into five categories i.e., (i) patient-centered factors: which include age and gender, ethnicity, educational level, marital status, psychological factors, (patient's beliefs – patient feels susceptible to the illness or its complication or feels disease could have severe consequences for his health), patient-prescriber relationship, health literacy and knowledge about the disease, smoking or alcohol intake, forgetfulness and negative attitude towards therapy (ii) therapy-related factors: which include route of administration, complexity of treatment, medication side effects, degree of behavioral change required, duration of the treatment period (iii) health care system factors: which include availability and accessibility of health care facility, long waiting time for clinic visits, difficulty in getting prescriptions and unhappy or unsatisfactory clinic visits – all contributed to poor compliance, (iv) Social and economic factors which include time commitment cost of therapy, income and social support and finally (v) disease-related factors which include disease severity based on clinical evaluation comply better with medications than healthier ones. Patients who are suffering from diseases with fluctuation or absence of symptoms (at least at the initial phase), such as asthma and hypertension, might have a poor compliance (Jin et al. 2008).

Newer treatment methods are constantly in the process of development to address many of the poor medication adherence factors. While drugs that are administered daily or even weekly for type 2 diabetes have not shown substantial

benefits with respect to improved adherence and persistence, new products are expected to become available in the market that are likely to be administered at monthly or even longer intervals which would address some of the important barriers to maintaining good medication adherence, though these newer sustained delivery agents are also required to be effective, safe, affordable and lead to sustained reduction in Glycated hemoglobin (HbA1c) levels. In addition, another approach which is also being tried in our various national programmes like National Tuberculosis Elimination Programme (NTEP) is fixed dose and drug combinations which in a retrospective analysis of patients with T2D has shown significantly ( $P < 0.001$ ) greater adherence (57.0% vs 50.7%) and persistence (32% vs. 27%). It may be brought out here that, number of fixed-dose combinations of oral anti-diabetic agents and insulin formulations are now available and are being used (Polonsky et al. 2016, Lokhandwala et al. 2016, Buysman et al. 2015).

One of the biggest challenges for health care providers today is addressing the continued needs and demands of individuals with chronic illnesses like diabetes. Studies have reported that strict metabolic control can delay or prevent the progression of complications associated with diabetes. However, some of the Indian studies have revealed very poor adherence to treatment regimens due to poor attitude towards the disease and poor health literacy among the general public. Because the vast majority of day-to-day care in diabetes is handled by patients or families, there is a need for "self-care of diabetes", which is defined as, "an evolutionary process of development of knowledge or awareness by learning to survive with the complex nature of the diabetes in a social context" and includes seven essential self-care behaviors i.e., healthy eating, being physically active, monitoring of blood sugar, compliant with medications, good problem-solving skills, healthy coping skills and risk-reduction behaviors. Studies have brought out that majority of patients with diabetes can significantly reduce the chances of developing complications by improving self-care activities (Shrivastava et al. 2013, Cooper et al. 2003, Paterson and Thorne 2000, Johnson 1994, McNabb 1997).

As diabetes self-care activities can have a dramatic impact on achieving target glycemic goals, the healthcare providers and educators should educate patients about self-care behaviors. However, patients often look to healthcare providers for guidance, which more than often remains un-discussed. Further, multiple demographic and social support factors can be considered as positive contributors in facilitating self-care activities in diabetic patients, the role of clinicians in promoting self-care is crucial (Peel et al. 2007).

## **Methods**

### *Conduct of Study*

A cross sectional study was conducted among type 2 diabetes patients attending out-patient department (OPD) at AJIMS & RC Rural Health Training Centre (RHTC) in Pane Mangalore, Karnataka (India). Written informed consent

from the subject patients was taken before the conduct of the study. "STROBE" guidelines were used while making reports of present study.

#### *Selection of Place of Study*

Place of study was selected as it falls under the jurisdiction of our own institution and training of interns and post-graduates is done in the above cited centre only, while the patients are given free consultation, besides many routinely used drugs.

#### *Calculation of Sample Size*

Convenience sampling method was used. All laboratories confirmed cases of diabetes type 2, except pregnant women and un-willing patients; who attended the RHTC OPD during the period of study i.e., from 1 March 2019 to 30 May 2019 were included in the study. Further, patients who were on allopathic drugs only were included in the study and no patients on "AYUSH" drugs were part of study. A total of 237 patients were enrolled in the study initially, however, after excluding unwilling and pregnant patients a total of 206 patients were finally included in the study.

#### *Scoring Criteria*

Medication adherence was determined using a self-designed, validated, structured self-reported proforma with scores from 1–10. The scores of less than 5 were considered poor, while scores of 6–8 and of more than 8, were considered as good and excellent, respectively.

#### *Ethical Clearance*

Ethical clearance from the Institution was taken before the conduct of the study.

#### *Operational Definition*

Patients with pre-prandial plasma glucose value of 80–130 mg/dL. Post-prandial value of less than 180 mg/dL and HbA1c less than 7.0% were considered to be having satisfactory glycemic control (American Diabetes Association 2018).

#### *Statistical Analysis*

The data were analyzed using SPSS version 20. Level of significance less than 5% was considered as statistically significant. Descriptive statistics has been reported using frequencies and proportions. Pearson's Chi-square test has been used to find the association between the glycemic control and some selected

variable which had influence on medication adherence. P values of less than 0.05 were regarded as statistically significant.

## Results

### *Demographic Characteristics of Study Subjects*

A total of 206 patients were enrolled for the study. Out of these, 98 (47.5%) were males while the remaining 108 (52.4%) were females. The mean age of the study population was  $51 \pm 11.3$  years. The majority of them, 135 (65.5%) belonged to upper lower class (Modified BG Prasad). Furthermore, the majority of the subjects (40.1%) had secondary level education while most of them (57.7%) were occupied in elementary and skilled work and sales (Table 1).

**Table 1.** *Demographic Characteristics of Study Subjects (n=206)*

Variable	Frequency	Percentage
<b>Age ( in years )</b>		
< 35	16	7.7
36–50	73	35.4
>50	117	56.7
Mean age		= $51 \pm 11.3$ years
<b>Gender</b>		
Male	98	47.5
Female	108	52.4
<b>Literacy Status of Mother</b>		
Primary & below	68	33.0
Secondary level	91	44.1
Above Secondary	47	25.8
<b>Occupation</b>		
Professionals	11	5.3
Technicians & associate professionals	39	18.9
Skilled Workers and Sales Workers	58	28.1
Elementary Occupation	61	29.6
Unemployed	37	17.9
<b>Socio-economic Status*</b>		
I	22	10.6
II	37	17.9
III	69	33.4
IV	57	27.6
V	21	10.1

\*Modified B.G. Prasad Classification used for SES classification.

### *Characteristics of Type 2 Diabetic Patients*

Table 2 brings out that 57.7% of the diabetic subjects were diagnosed less than five years ago while the majority of them (60.1%) were taking two or more drugs. Fasting glucose levels of 68.9% of the subject patients were found to be more than 130mg /dL, while 65% of patients had random blood glucose levels,

more than 180 mg/dL. Furthermore, their Hb1c levels, brought out that 78.1% of the patients had poor glyceemic controls ( $\geq$  HbA1c 7.0%).

**Table 2.** Characteristics of Type 2 Diabetic Patients (n=206)

S No.	Variable	Frequency	Percentage
1	<b>Duration of Treatment</b>		
	< 5 years	119	57.7
	> 5 years	87	42.2
2.	<b>Number of Anti-diabetic drug(s) prescribed</b>		
	Only one drug	82	39.8
	More than one drug	124	60.1
3.	<b>Blood glucose Pre-prandial</b>		
	< 130 mg /100 ml	64	31.0
	> 130 mg /100 ml	142	68.9
4.	<b>Blood glucose post-prandial</b>		
	< 180 mg/100ml	72	34.9
	> 180 mg/100ml	134	65.0
5.	<b>HbA1c Status</b>		
	Controlled (< 7.0 %)	45	21.8
	Uncontrolled ( $\geq$ 7.0 %)	161	78.1

#### Medication Adherence

Figure 1 shows the level of medication adherence among study subjects. It was observed that nearly 105 (50.9%) had good adherence to medication, while the remaining 101 (49.0%) patients showed poor adherence. No patient was found to be having excellent adherence. Surprisingly none of the patients was found to be having perfect/"Excellent score".

**Figure 1.** Level of Medication Adherence among Study Subjects (n=206)

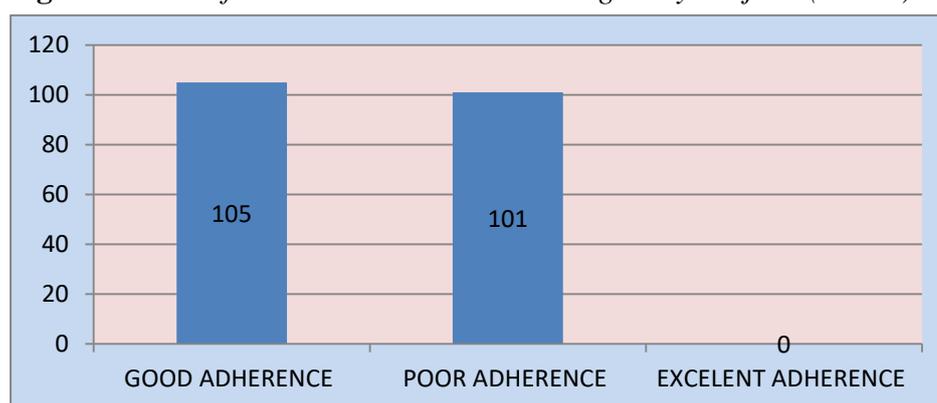


Table 3 shows that among the 101 patients who showed poor adherence to medication, 62 (61.3%) were males and 39 (38.6%) were females. This difference was also found to be statistically significant ( $p < 0.000174$ ). Similarly, age, information about the disease, family support, personal motivation, literacy status and cost of treatment showed a direct association

between these variables and medication adherence and all of these associations were found to be statistically significant (p values = < 0.0300, < 0.00001, < 0.00001, < 0.00553 and < 0.018621, respectively).

**Table 3.** Factors Influencing Non Adherence to Self-Care Practices (n=206)

Characteristics	Medication Adherence				Chi-square / P value
	Poor (n=101)		Good (n=105)		
	Frequency	Percentage	Frequency	Percentage	
<b>Information about the disease</b>					
Poor	87	86.1	21	20.0	87.6574
Good	14	13.8	84	80.0	< 0.00001
<b>Age of the patients</b>					
<35 Years	10	62.5	06	37.5	7.0093
36- 50 years	43	58.9	30	41.0	< 0.0300
>50 years	48	41.2	69	58.9	
<b>Gender</b>					
Male	62	61.3	36	34.2	14.0922
Female	39	38.6	69	65.7	< 0.000174
<b>Family Support</b>					
Present	22	21.7	93	88.5	90.4333
Restricted	79	78.2	12	11.4	< 0.00001
<b>Personal Motivation</b>					
High	07	6.9	99	94.2	153.793
Low	94	93.0	06	5.7	< 0.00001
<b>literacy status</b>					
Primary & below	33	32.6	16	15.2	7.6975
Secondary & above	68	65.3	89	84.7	< 0.00553
<b>Cost of treatment</b>					
Affected treatment	47	46.5	67	63.8	5.5367
No effect	54	53.4	38	36.1	0.018621

## Discussion

India has the dubious distinction of being the world's diabetic capital, as every sixth diabetic patient is from India. In addition, India has a huge burden of undiagnosed cases as well as pre-diabetics. There are several challenges to effective diabetes management and these include both provider- and patient-related issues. Physician barriers include sub-optimal knowledge of guidelines, constraints of time and facilities, and attitudinal issues, while patient related issues include lack of knowledge about diabetes care and lack of ability to manage their disease and poor medication adherence which in turn may lead to increased morbidity and mortality; increased costs of care and hospitalization. Hence barriers to effective diabetes management and poor drug adherence in diabetes mellitus need to be identified to plan good policies and formulate effective strategies to improve overall care of diabetic patients at all levels (Puder and Keller 2003, Heisler et al. 2003).

In our study 49% of the patients were found to be having poor medication adherence, while 50.9% were having good adherence. None of the study subjects showed excellent adherence. Our study further found female gender with significantly higher compliance than their male counterparts, while awareness about the disease, support from the family, literacy status of the patients and cost of treatment were found to be significantly associated with improved treatment compliance. However, in a similar study in a neighboring district by Anurupa et al. (2019) 45% of the patients were found to be having high adherence, 37% with medium adherence while 18% patients showed poor adherence. In another study from Bangalore, Karnataka, Dasappa et al. (2017) found adherence to medication to be 60.73% while some of the socio-demographic factors were found to be associated with good self-care practices which included young age, gender, formal education, occupation, and religion. In a similar study in Ethiopia, by Bongler et al. (2018) it was reported that 83.5% of them did not adhere to self-monitoring of blood glucose level, while 4.3% of the respondents did not adhere to the prescribed medications. In another study in United Arab Emirates, Al-Haj Mohd et al. (2016) reported 64.6% patients to be non-adherent, while 26.5% and 9.0% had low adherence and medium adherence to their medication respectively (Anuruppa et al. 2019, Dasappa et al. 2017).

The present study showed a statistically significant association between medication adherence and certain demographic variables i.e., gender, information about the disease, family support, personal motivation, literacy status and cost of treatment. In a similar study in South India, Pattnaik et al. (2019) reported 90.3% patients to be compliant to the treatment while the treatment compliance was found to be significantly associated with duration of Diabetes and age, though gender, literacy status, occupation, and socioeconomic status were not found to be significantly associated with treatment compliance. Pattnaik et al. (2019) further showed that the most common causes for non-adherence were the asymptomatic nature of the disease (60%), and high cost of treatment (33.3%). Medi et al. (2015) in another study, showed an overall medication adherence rate of 47.85% while the main factors for non-adherence were found to be lack of finance (55.84%), forgetfulness (46.75%), being busy (44.15%), and inaccessibility to medicines (19.48%). In a similar study by Aminde et al. (2019) in Cameroon, the prevalence of non-adherence to medication was found to be 54.4%, while alcohol consumption and insulin alone therapy were found to be associated with non-adherence and the patients attributed their non-adherence to forgetfulness (55.6%), lack of finances (38.2%) and disappearance of symptoms (14.2%). Godfrey, in a similar study in Tanzania brought out adherence rates to anti-diabetic drugs of 60.2% and 71.2% at one week and three months respectively and reported high cost of medication to be significantly associated with anti-diabetic non-adherence and found that adherence to anti-diabetic drugs also increased with an increase in number of non-diabetic medications (Bongler et al. 2018, Al-Haj Mohd et al. 2016, Pattnaik et al. 2019, Medi et al. 2015, Aminde et al. 2019, Rwegerera 2014).

## Conclusion

The present study has brought out the gender of the patient, knowledge about the disease, family support, literacy status and cost of treatment as significant determinants of treatment adherence. As awareness about the disease has been observed to be an important predictor of medication adherence, there is a need to develop policies and strategies to educate the patients on self-care and medication adherence about diabetes and its benefits and to improve patient outcomes.

## Limitations

The present study had the limitations which are inherent to cross sectional studies and are liable to biases such as recall bias, interviewer bias, respondent bias and social acceptability bias. Not ruling out information bias, the non-adherence was intentional or unintentional could also not be established in many cases. Furthermore, the study did not examine the prevalence of complications and their duration among the study subjects, due to diabetes mellitus. Keeping in view the limited sample size, hospital base of the study and regional variations in self-care practices, the results of the study may not be generalized.

## References

- Al-Haj Mohd MMM, Phung H, Sun J, Morisky DE (2016) Improving adherence to medication in adults with diabetes in the United Arab Emirates. *BMC Public Health* 16(1): 857.
- American Diabetes Association (2018) Glycemic targets: standards of medical care in diabetes. *Diabetes Care* 41(Supplement 1): S55-S64.
- Aminde LN, Tindong M, Ngwasiri CA, Aminde JA, Njim T, Fondong AA et al. (2019) Adherence to antidiabetic medication and factors associated with non-adherence among patients with type-2 diabetes mellitus in two regional hospitals in Cameroon. *BMC Endocrine Disorders* 19(1): 35.
- Anurupa MS, Aditya A, Angadi N (2019) A study of medication adherence and self-care practices among type-2 diabetes patients in Davangere. *National Journal of Community Medicine* 10(1): 12–16.
- Bonger Z, Shiferaw S, Tariku EZ (2018) Adherence to diabetic self-care practices and its associated factors among patients with type 2 diabetes in Addis Ababa, Ethiopia. *Patient Preference and Adherence* 12(Jun): 963–970.
- Buysman EK, Liu F, Hammer M, Langer J (2015) Impact of medication adherence and persistence on clinical and economic outcomes in patients with type 2 diabetes treated with liraglutide: a retrospective cohort study. *Advances in Therapy* 32(4): 341–355.
- Cooper H, Booth K, Gill G (2003) Patients' perspectives on diabetes health care education. *Health Education Research* 18(2):191–206.
- Cramer JA (2004) A systematic review of adherence with medications for diabetes. *Diabetes Care* 27(5): 1218–1224.

- Dasappa H, Prasad S, Sirisha M, Ratna Prasanna SVN, Naik S (2017) Prevalence of self-care practices and assessment of their sociodemographic risk factors among diabetes in the urban slums of Bengaluru. *Journal of Family Medicine and Primary Care* 6(2): 218–221.
- De Geest S (2003) Adherence to long-term therapies: evidence for action. *European Journal of Cardiovascular Nursing* 2(4): 323–329.
- Elflein J (2020) *Healthcare expenditures to treat diabetes in the U.S. and China in 2019*. Statista.
- Elsous A, Radwan M, Al-Sharif H, Abu Mustafa A (2017) Medications adherence and associated factors among patients with type 2 diabetes mellitus in the Gaza Strip, Palestine. *Frontiers in Endocrinology* 8(Jun): 100.
- Heisler M, Smith DM, Hayward RA, Krein SL, Kerr EA (2003) How well do patients' assessments of their diabetes self-management correlate with actual glycemic control and receipt of recommended diabetes services? *Diabetes Care* 26(3): 738–743.
- International Diabetes Federation – IDF (2019a) *Diabetes facts & figures*. International Diabetes Federation.
- International Diabetes Federation – IDF (2019b) *Atlas: Ninth Edition 2019*. International Diabetes Federation.
- Jimmy B, Jose J (2011) Patient medication adherence: measures in daily practice. *Oman Medical Journal* 26(3): 155–159.
- Jin J, Sklar GE, Min Sen Oh V, Chuen Li S (2008) Factors affecting therapeutic compliance: a review from the patient's perspective. *Therapeutics and Clinical Risk Management* 4(1): 269–286.
- Joan N, Erisa O, Agatha P (2008) Non-adherence to diabetes treatment at Mulago hospital in Uganda: prevalence & associated factors. *African Health Sciences* 8(2): 67–73.
- Johnson SB (1994) Health behavior and health status: concepts, methods and applications. *Journal of Pediatric Psychology* 19(2):129–141.
- Kannan R (2019) *India is home to 77 million diabetics, second highest in the world*. The Hindu.
- Lokhandwala T, Smith N, Sternhufvud C, Sörstadius E, Lee WC, Mukherjee J (2016) A retrospective study of persistence, adherence, and health economic outcomes of fixed-dose combination versus loose-dose combination of oral anti-diabetes drugs. *Journal of Medical Economics* 19(3): 203–212.
- McNabb WL (1997) Adherence in diabetes: can we define it and can we measure it? *Diabetes Care* 20(2): 215–218.
- Medi RK, Mateti UV, Kanduri KR, Konda SS (2015) Medication adherence and determinants of non-adherence among south Indian diabetes patients. *Journal of Social Health and Diabetes* 3(1): 48–51.
- Nagarajan R (2018) *Health spending pushed 55 million into poverty in a year: study*. The Economic Times.
- Paterson B, Thorne S (2000) Developmental evolution of expertise in diabetes self-management. *Clinical Nursing Research* 9(4):402–419.
- Pattnaik S, Ausvi SM, Salgar A, Sharma D (2019) Treatment compliance among previously diagnosed type 2 diabetics in a rural area in Southern India. *Journal of Family Medicine and Primary Care* 8(3): 919–922.
- Peel E, Douglas M, Lawton J (2007) Self-monitoring of blood glucose in type-2 diabetes: longitudinal qualitative study of patients' perspectives. *BMJ* 335(7618): 493.
- Polonsky WH, Henry RR (2016) Poor medication adherence in type 2 diabetes: recognizing the scope of the problem and its key contributors. *Patient Prefer Adherence* 10(Jul): 1299–1307.

- Puder JJ, Keller U (2003) Quality of diabetes care: Problem of patient or doctor adherence? *Swiss Medical Weekly* 133(39–40): 530–534.
- Rwegerera GM (2014) Adherence to anti-diabetic drugs among patients with type 2 diabetes mellitus at Muhimbili national hospital, Dares Salaam, Tanzania - A cross-sectional study. *The Pan African Medical Journal* 17(Apr): 252.
- Sharma T, Karla J, Dhasmana D, Basera H (2014) Poor adherence to treatment: a major challenge in diabetes. *Indian Academy of Clinical Medicine* 15(1): 26–29.
- Shrivastava SR, Shrivastava PS, Ramasamy J (2013) Role of self-care in management of diabetes mellitus. *Journal of Diabetes and Metabolic Disorders* 12(1): 14.
- World Health Organization – WHO (2003) *Adherence to long-term therapies - Evidence for action*. World Health Organization. Retrieved from: <https://apps.who.int/iris/bitstream/handle/10665/42682/9241545992.pdf>. [Accessed 17 March 2020]