

Treatment compliance among type 2 Diabetes Mellitus patients in a rural area of Delhi: A community-based cross-sectional study

Authors:

Mohd Alam,¹ Richa Kapoor²

¹Department of Community Medicine, Vardhman Mahavir Medical College (VMMC) & Safdarjung Hospital (SJH), 110029, Delhi.

²Director professor, Department of Community Medicine, Vardhman Mahavir Medical College (VMMC) & Safdarjung Hospital (SJH), 110029, Delhi.

Corresponding Author:

Mohd Alam

Department of Community Medicine, Vardhman Mahavir Medical College (VMMC) & Safdarjung Hospital (SJH), 110029, Delhi.

Article Received: 01-12-2022

Revised: 18-12-2022

Accepted: 09-01-2023

ABSTRACT:

Introduction: India has been regarded as the Diabetic capital of the world and surprisingly one-third of those affected with diabetes (approximately 122.5 million) are not aware of their status. Studies conducted across the world suggested poor treatment compliance among diabetic patients. Most of the available literature on treatment compliance is either hospital based or done in an urban area. Therefore, a community-based study on treatment compliance among type 2 diabetes mellitus patients was conducted. **Materials & methods:** A cross-sectional study was conducted in 5 villages among 260 Type 2 diabetes mellitus patients from 1st January to 31st December 2021. Compliance to medication, physical activity and diet was measured using medication compliance scale, global physical activity questionnaire (GPAQ), and 24-hour recall method. The data was analysed using licensed SPSS software version 21.0 and appropriate test of significance like chi-square test was applied. A P-value of <0.05 was taken significant. Ethical clearance was obtained from institutional ethical committee. **Results:** Out of 260 study participants, 229 (88.1%) were on treatment of which 122 (53.3%) were found to be moderately compliant, 96 (41.9%) had good compliance while only 11 (4.8%) had poor compliance to medication. More than half of the study participants 145 (55.7%) and 70 (26.9%) were found to be compliant to physical activity and diet respectively. Overall compliance to medication, physical activity and diet among study participants was found to be 15.8%. Participants age, diabetes duration had significant association (P<0.05) with treatment compliance. **Conclusion:** More than one third of the study participants were found non-compliant to either medicine, physical activity or diet. This highlights the importance of proper counselling, regular follow-up, health education and awareness activities in the community to bring about the improvement in treatment compliance.

Keywords: Diabetes Mellitus type 2, Treatment compliance, Reasons for non compliance.

INTRODUCTION:

Diabetes mellitus is a term that describes a spectrum of metabolic disorders that have hyperglycaemia as a characteristic phenotype. There is a rapid rise in cases of Diabetes mellitus in low and middle income countries like India. It is expected that people living with diabetes will rise to 101 million by 2030 and 134.2 million people by 2045 in India. With such a high number of cases India has been regarded as Diabetic capital of the world and surprisingly one-third of those affected with diabetes (approximately 122.5 million) are not aware of their status. Diabetes causes both macrovascular and microvascular complications like retinopathy, nephropathy and neuropathy which is caused by damage to small blood vessels due to prolonged hyperglycaemia. To prevent these

complications, diabetic patients have to undergo a lifelong lifestyle modification like increase physical activity, dietary modification, tobacco & alcohol cessation and more importantly compliance to anti-diabetic medicines. Studies conducted across the world suggested poor medication compliance among diabetic patients. Adherence rate of 20% to 92.5% was reported in a systematic review conducted in Asia by Wibowo et al. Most of the available literature on treatment compliance is either hospital based or done in urban area. Therefore, a community-based study on treatment compliance among type 2 diabetes mellitus patients in a rural area of Delhi was conducted.

MATERIAL AND METHODS:

Study type and setting:

This cross-sectional community-based study was conducted in rural areas under the Primary Health Centre, Fatehpur area, Delhi. There are 5 villages and 6 towns under Fatehpur according to census 2011 [1]. The study was conducted in 5 villages between January to December 2021 among type 2 diabetic Mellitus patients residing in the study area for a period of a minimum of 6 months.

Sample size:

A sample size of 260 type 2 diabetes mellitus patients was obtained on 62% prevalence of compliance to anti-diabetic drugs reported in a community-based study conducted by Padmanabhan et al in Bengaluru, south India [2]. Patients from 5 villages were enrolled using probability proportional to size (PPS). Patients with type 1 diabetes, very sick bedridden patients, and patients with gestational diabetes were excluded from the study.

Operational definitions:

Compliance to treatment is the extent to which a patient's behaviour matches their prescribed advices [3]. Treatment compliance to the medication was decided on the basis of score from the medication compliance scale. compliance to physical activity was considered when a patient reported at least 150 minutes of moderate-intensity physical activity, spread over at least 3 days/ week with no more than 2 consecutive days without activity or at least 75 minutes of vigorous-intensity physical activity in a week. Compliance to diet was defined as if a patient is

consuming expected calories, that is 25kcal/kg ideal body weight/day. Ideal body weight (IBW)= (height in cm – 100) * 0.9 [Indian Council of Medical Research (ICMR) guideline for management of type 2 DM 2018] [4].

Study tool:

A semi-structured interviewer-administered questionnaire was administered to consenting individuals. The questionnaire comprised of questions pertaining to the individuals' sociodemographic profile, medication compliance scale, 24-hour dietary recall and physical activity, based on global physical activity questionnaires (GPAQ) [5]. Based on the score obtained, each patient was categorized as good compliance (2-5 score), moderate compliance (6-11 score), and poor compliance (12-15 score). Patients who either did not start treatment since diagnosis or those who started treatment but were not on treatment currently were considered non-compliant.

Statistical analysis:

Data was analysed using licensed SPSS software version 21.0. The Chi-square test (Pearson's Chi-square or Fisher's exact test) was used to find out the statistical association between compliance and different demographic and socioeconomic variables. A *P* value <0.05 was considered significant.

Ethics clearance:

Ethical clearance was obtained from Institute Ethics Committee VMMC & SJH (Ref. no. IEC/VMMC/SJH/Thesis/2020-11/CC-79. Written informed consent was obtained from all participants.

RESULTS:

A total of 260 types 2 diabetes mellitus patients residing in 5 villages were selected. The age of study participants was 51.7 ± 11.8 years within a range of 32-90 years.

Table 1. Distribution of the study participants according to socio-demographic characteristics (N=260).

Characteristics	Number (n)	Percentage (%)
Age of the participant (in completed years)		
30-40	53	20.4
41-50	86	33.1
51-60	64	24.6
>60	57	21.9
Gender		
Females	168	64.6
Male	92	35.4
Religion		
Hinduism	199	76.5
Islam	61	23.5
Occupation		
Homemaker	160	61.5
Gainfully employed (n=80)	80	30.8
Not working	20	7.7
Educational status of participants		

Illiterate	141	54.2
Literate	119	45.8
Marital Status		
Married	221	85
Widowed	39	15
Type of family		
Nuclear	109	41.9
Joint	151	58.1
Socio-economic status (As per Modified BG Prasad Scale 2021)		
Upper class	165	63.5
Lower class	95	36.5

Table 2: Distribution of the study participants according to the duration of diabetes mellitus. (N=260)

Duration of diabetes (in years)	n	%
<3	74	28.5
3-6	90	34.6
7-10	46	17.7
>10	50	19.2
Total	260	100

The mean duration of diabetes was 6.6 ± 5.94 years.

Table 3: Distribution of the study participants according to the status of treatment for diabetes mellitus. (N=260)

Treatment status	n	%
Taking treatment (compliant)	229	88.1
Currently not on treatment* (non-compliant)	19	7.3
Never started treatment (non-compliant)	12	4.6
Total	260	100

*Previously were on treatment

Table 4. Distribution of the study participants according to score obtained from the treatment compliance scale of diabetes mellitus (N=229)

Treatment compliance score (2-15)	n	%
Good compliance (2-5)	96	41.9
Moderate compliance (6-11)	122	53.3
Poor compliance (12-15)	11	4.8
Total	229	100

The reasons reported for non-compliance were, usage of either home remedies and/or the AYUSH system of medicine (80.6%), perception that they did not have any serious symptoms related to disease (6.5%), lack of family support for treatment (6.5%), and no belief in disease or belief that treatment did not cure diabetes (6.5%). Besides these, forgetfulness to take medicine

either due to work, travelling, or attending social functions (45.5%), skipping medicines when they have no symptoms (27.3%), non-availability of medicines at the health facility (18.2%) and high cost of medicines (9.1%) were reported as the reasons for poor compliance.

Figure 1: Distribution of study participants according to compliance to physical activity. (N=260)

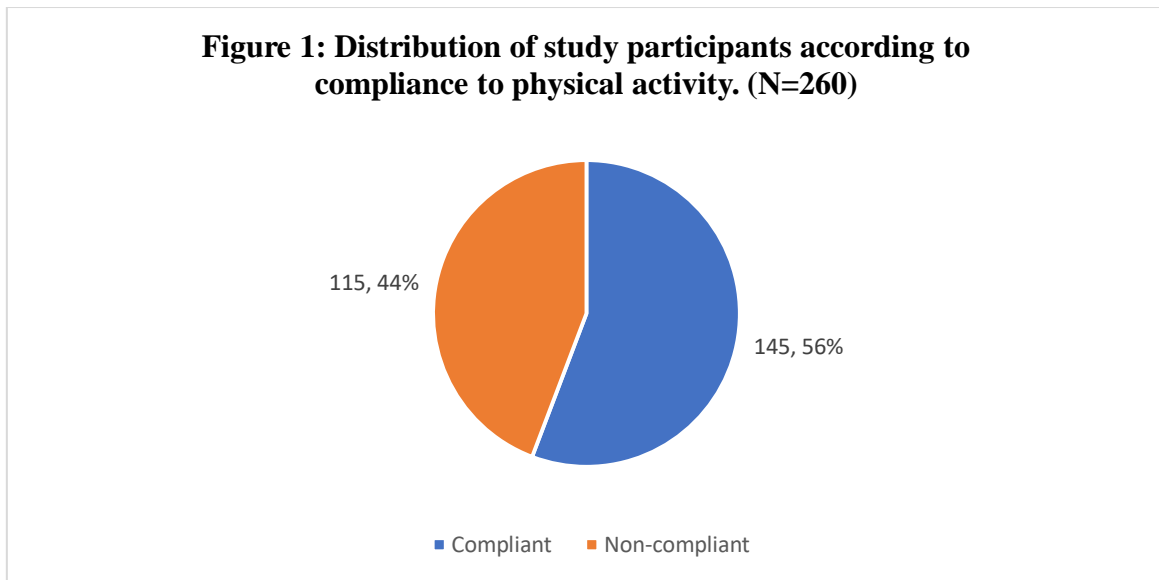
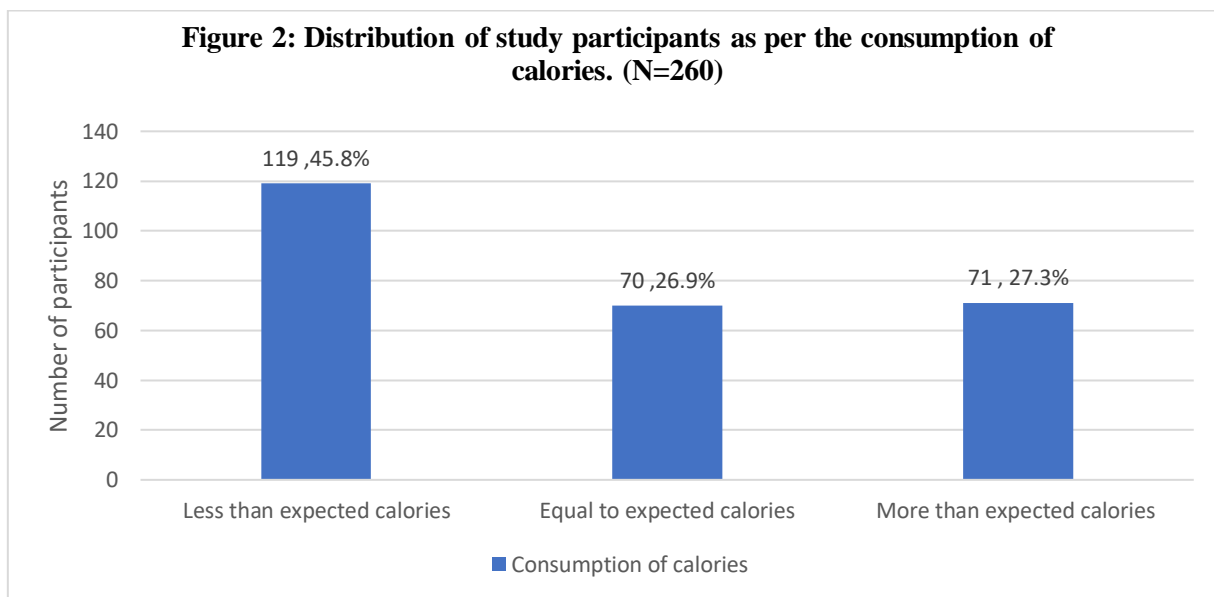


Figure 2: Distribution of study participants as per the consumption of calories. (N=260)



*Based on 24- hour recall

In the present study, only 70 (26.9%) of study participants were consuming calories as expected and were considered compliant to the diet.

Table 5: Distribution of the study participants according to the overall compliance to medications, physical activity, and diet (N=260)

Overall compliance	n	%
Medicine + physical activity	98	37.7
Medicine + physical activity + diet	41	15.8
Medicine + diet	19	7.3
Physical activity + diet	1	0.4
Non-compliant to either medicine/physical activity/ diet	101	38.8
Total	260	100

In the present study age of the participants (P=0.007), Duration of diabetes (P=0.008) were found to have significant association with treatment compliance.

Table 6: Association between diabetes duration and treatment compliance among the study participants. (N=260)

		Treatment compliance		Total (%)	Significance
		Compliance	Non compliance#		
Diabetes duration	<3	54(72.9%)	20(26.1%)	74(100%)	Chi-square= 11.825, P= 0.008
	3-6	81(90%)	9(10%)	90(100%)	
	7-10	37(80.4%)	9(19.6%)	46(100%)	
	>10	46(92%)	4(8%)	50(100%)	
Total		218(83.8%)	42(16.2%)	260(100%)	

DISCUSSION:

The mean age of the study participants was 51.73±11.48 years which is comparable to studies of Kumar et al. and Garg et al with mean age of the (51±11.3) and (52±10.13) years respectively [6, 7], whereas Padmanabha et al in their study reported a lower mean age of (60.93±10.1).² This difference may be attributed to the fact that the study by Padmanabha et al included participants of age more than equal to 30 years from both rural and urban [2]. More than half (168; 64.6%) of the study participants in present study were females while (92; 35.4%) were males in the present study. This finding was consistent with the finding of the study by Achappa et al in which 60% of the study participants were females [8]. The mean duration of diabetes in the present study was (6.6± 5.9) years and these findings were comparable to the pan India prospective LANDMARC (Longitudinal Nationwide study on Management And Real-world outcomes of diabetes) trial done by Das et al in which the mean duration of diabetes was reported (8.6± 5.6) years [9]. Similarly, Garg et al in their study reported the mean duration of diabetes (6± 5.3) years [7]. In the present study majority (229; 88.1%) of the study participants were on treatment and only a few (31,11.9%) were found who were not taking treatment. Similar findings were reported by D’souza et al in which 91.7% of the study participants were on treatment while 8.3% were not under treatment [10]. Besides this Mathur et al from a countrywide national NCD monitoring survey (NNMS) reported that 79.1 % of urban adults (18-69 years) sought treatment for diabetes [11] and Prenissl et al in a secondary data analysis of a population-based household survey of India (NFHS) found that 11% of participants who were aware of their diabetic status were lost to treatment which were comparable to present study findings [12]. However STEPS survey in Punjab conducted by Thakur et al, reported that all known cases of diabetes were on treatment [13]. This difference may be due to a very small number of known diabetics in their study. Out of those study participants who were compliant to the treatment in the present study, almost half (122; 53.3%) were moderately compliant to treatment, (96; 41.9%) had good compliance, and very few (11; 4.8%) were found to have poor treatment compliance. The findings of the present study were consistent with the

studies, by Mishra et al where 44% of the participants had good adherence to treatment, and by Fadare et al in which 40.6% had good adherence to medication [14, 15]. In the study by Srividya et al moderate compliance of 60.6% similar to the present study was reported among the participants [16]. Similarly chinnakali et al in their hospital-based cross-sectional study reported poor treatment compliance in 10.3% of the study participants [17]. However, Rajashekar s et al in their study poor treatment adherence of 59% ,moderate compliance of 33.5%, and this difference may be due to the fact that the study by Rajashekar s et al was a hospital-based study [18]. In the present study we tried to find out the reasons for non compliance and found that the majority 25 (80.6%) of non compliant participants were using either home remedies and/or AYUSH system of medicine which is comparable to the finding reported by Thapa s et al in their study where 91% of the non-compliant participants were using home remedies and/or AYUSH [19]. Other reasons for non-compliance in the present study were lack of family support for treatment, perception that they don’t have any serious symptoms related to disease and certain false beliefs that treatment does not cure diabetes. Similar reasons were reported by Mukherjee et al and Prithika et al where participants reported feeling well and lack of family support as reasons for non-compliance in their studies respectively [20, 21]. Palathingal et al and Pattnaik et al also reported certain false beliefs like medication to be ineffective and the disease to be asymptomatic in nature as the reasons of non-compliance in their studies [22, 23]. In the present study, participants who had poor compliance the majority of them 5 (45.5%) reported that they forget to take medicine when they are either busy with work, traveling, or attending social functions, 3 (27.3%) participants reported that they skipped medicine when they had no symptoms, 2 (18.2%) participants reported non-availability of medicines at the health facility whereas only 1 (9.1%) reported the cost of medicines as one of the reasons for poor compliance. These findings were consistent with the findings of the study by Mukherjee et al in which they reported the most common reason for poor compliance to be forgetfulness (44.7%) [20]. Misra et al in their study reported ‘feeling of better’ (30.6%) and non-availability of medicine (13.9%) as the

reasons for poor compliance which are comparable to the present study [24]. However, Patnaik et al in their study reported resolution of signs and symptoms of disease (60%), high cost of medicines (33.7%), and non-availability of medicines (6.7%) as reasons for poor compliance [23]. The difference in the above-mentioned studies may be due to the difference in age of the participants, health services provided in the area of study. In the present study, compliance to physical activity was found to be (145; 55.7%) (i.e., doing physical activity as recommended) whereas only (70; 26%) study participants were found compliant to diet. This finding was consistent with those reported by Parajuli et al study in which (57.6%) of study participants were compliant to physical activity and Alhariri et al study in which compliance to diet was (21%) [25, 26]. However study by Ramadhan et al reported that (30%) of the study participants were compliant to exercise which is less as compared to the present study [27]. Similarly Karthik et al in their reported dietary compliance of (35.2%) which is higher compared to the present study [28]. This difference in the findings of the studies by Ramadhan et al and Karthik et al can be attributed to the fact that study by Ramadhan et al had more elderly participants whereas Karthik et al in their study had greater number of literate study participants [27, 28]. In the present study, a significant association was found between the age of the participants and treatment compliance ($p=0.007$). Treatment compliance was found to increase with age however after the age of 60 years compliance to treatment was found to be less than in younger age groups. Patnaik et al, Suzuki et al, Arulmozhi et al and Mukherjee et al also reported a similar significant association between the treatment compliance and the age of the participant which was significant ($P<0.05$) [23, 20]. Also, a significant association was found between the duration of diabetes and treatment compliance ($p = 0.008$). It was found that treatment compliance increases with the increase in the duration of diabetes and was highest among the study participants who had diabetes for more than 10 years. This finding was consistent with those reported in the studies by Misra et al, and Mukherjee et al. who reported a significant association between the duration of diabetes and treatment compliance in their studies [24, 20].

Strengths & Limitation:

The present study is a community-based study with a scientifically sound research methodology and adequate sample size conducted by a single interviewer thus ruling out interobserver bias. A set of inclusion criteria was used to rule out selection bias and ethical clearance was taken which can be taken as the strength of the present study. Despite many strengths present study has certain limitations in that data collection was based upon the responses of the

study subjects and thus the objective correctness of responses cannot be verified.

CONCLUSION:

Out of 260 study participants, 229(88.1%) were found to be taking treatment and the remaining 31(11.9%) either discontinued the treatment or never started the treatment. Besides this out of those taking treatment, 96 (41.9%) were having good compliance to treatment, 122 (53.3%) were found to be moderately compliant and very few participants 11(4.8%) had poor compliance to treatment. Thus, the study shows that there is a need to increase health awareness to bring about improvement in treatment compliance. A total of 101 (38.8%) participants were found non-compliant to either medicine, physical activity, or diet. This highlights the importance of interventions needed to bring about improvement in overall compliance. The suggested measures can be: proper counseling by health care providers at the time of diagnosis and on subsequent follow-ups, health education and awareness activities in the community with the help of peripheral health workers and providing printed IEC materials (containing relevant information about disease prevention and control etc.) to the diabetic patients for their knowledge and awareness. Among the participants having poor compliance, the most common reason reported was forgetfulness i.e., 5 (45.5%). In order to improve these measures may be suggested like mobile app, reminders by SMS, pill box etc. m-health (mobile health app) for sharing of health information, treatment reminders, follow ups via mobile technology. This app may be suggested for monitoring and improving treatment compliance, physical activity, and dietary practices.

Ethics approval and consent to participate:

Human subject: Informed written consent was obtained from all the participants in this study. The Institute ethics committee of Vardhman Mahavir Medical College (VMMC) and Safdarjung Hospital (SJH), New Delhi issued ethical approval IEC/VMMC/SJH/Thesis/2020-11/CC-79. **Animal subject:** All authors have confirmed that this study did not involve animal subjects or tissues.

List of abbreviations: PPS- Probability proportional to size, IBW- Ideal Body Weight, ICMR- Indian council of medical research, GPAQ- Global physical activity questionnaire, SPSS- Statistical package for the social sciences, IEC- Institutional ethical committee, VMMC- Vardhman Mahavir medical college, SJH- Safdarjung hospital, LANDMARC- Longitudinal nationwide study on management and real world outcome of diabetes, NCD- Non communicable diseases, NFHS- National family Health Survey, AYUSH- Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homeopathy

Conflicts of Interest:

The authors declare that there is no conflict of interest regarding the publication of this paper.

Funding statement:

All authors declare that no financial support or financial relationship at present or within the previous three years was received from any organization for the submitted work. All authors declare that there are no other relationships or activities that could appear to have influenced the submitted work.

Authors' contributions:

The authors confirm the contribution as follows

“Mohd Alam ; data collection, analysis and interpretation of results, draft manuscript preparation”

“Richa Kapoor; study conception and design, draft manuscript preparation, reviewed the results and approved the final version of the manuscript.

REFERENCES:

1. Census Of India Website: Office of the Registrar General & Census Commissioner, India. Available at :<https://censusindia.gov.in/2011census/Listofvillagesandtowns.aspx>. [Accessed on 22nd October, 2020]
2. Usha Rani S. Padmanabha, Maheswaran R., Shwetha Hiremath, Puneeth N., Renuka Prithviraj. A study to assess the treatment adherence among patients with type 2 diabetes mellitus in rural and urban population of Bengaluru, South India. *International Journal of community medicine and Public Health*. 2020 Aug;7(8):3105-3110.
3. Kiran Panesar, BPharmS (Hons), MRPharmS, RPh, CPh. Patient Compliance and Health Behavior Models. *US Pharm*. 2012;37(4)(Compliance suppl):12-14.
4. MEDBOX | ICMR Guidelines for Management of Type 2 Diabetes 2018 [Internet]. [cited 2022 Jun 19]. Available from: <https://www.medbox.org/document/icmr-guidelines-for-management-of-type-2-diabetes-2018#GO>
5. WHO General Physical Activity Question (GPAQ). Available from: http://www.who.int/chp/steps/resources/GPAQ_Analysis_Guide.pdf. [Last accessed on June 19, 2022]
6. Kumar H, Abdulla RA, Lalwani H. Medication Adherence among Type 2 Diabetes Mellitus Patients: A Cross Sectional Study in Rural Karnataka (India). *Athens Journal of Health & Medical Sciences*. 2021;8(2):107-18.
7. Garg S, Paul B, Dasgupta A, Maharana SP. Assessment of self-care activities: A study among type 2 diabetic patients in a rural area of West Bengal. *Int J Med Sci Public Health*. 2017 Jul 1;6(7):1173-8.
8. Achappa S. Adherence to Medication among the Patients with Type 2 Diabetes Mellitus in a Rural Area: A Community based Study. *Indian Journal of Public Health Research & Development*. 2020 Jul 1;11(7).
9. Das AK, Mithal A, Joshi S, Kumar KP, Kalra S, Unnikrishnan AG, Thacker H, Sethi B, Ghosh R, Kanade V, Nair A. Baseline characteristics of participants in the LANDMARC trial: a 3-year, pan-India, prospective, longitudinal study to assess management and real-world outcomes of diabetes mellitus. *Endocrinology, diabetes & metabolism*. 2021 Jul;4(3):e00231.
10. D'Souza AM, Kundapur R, Kiran NU. A Cross sectional study to determine the prevalence of Diabetes Mellitus and its household awareness in the rural field practice areas of a medical college in Mangalore-A Pilot Study. *Journal of Health and Allied Sciences NU*. 2015 Sep;5(03):043-6.
11. Mathur P, Leburu S, Kulothungan V. Prevalence, awareness, treatment and control of diabetes in India from the countrywide National NCD Monitoring Survey (NNMS). *Frontiers in public health*. 2022 Mar 14:205.
12. Prenissl J, Jaacks LM, Mohan V, Manne-Goehler J, Davies JI, Awasthi A, Bishops AC, Atun R, Bärnighausen T, Vollmer S, Geldsetzer P. Variation in health system performance for managing diabetes among states in India: a cross-sectional study of individuals aged 15 to 49 years. *BMC medicine*. 2019 Dec;17(1):1-2.
13. Tripathy JP, Thakur JS, Jeet G, Chawla S, Jain S, Pal A, Prasad R, Saran R. Prevalence and risk factors of diabetes in a large community-based study in North

- India: results from a STEPS survey in Punjab, India. *Diabetology & metabolic syndrome*. 2017 Dec;9(1):1-8.
14. Mishra R, Sharma SK, Verma R, Kangra P, Dahiya P, Kumari P, Sahu P, Bhakar P, Kumawat R, Kaur R, Kaur R. Medication adherence and quality of life among type-2 diabetes mellitus patients in India. *World Journal of Diabetes*. 2021 Oct 15;12(10):1740.
 15. Fadare J, Olamoyegun M, Gbadegesin BA. Medication adherence and direct treatment cost among diabetes patients attending a tertiary healthcare facility in Ogbomosho, Nigeria. *Malawi medical journal*. 2015 Aug 7;27(2):65-70.
 16. Srividya V., Balaje R. Adherence to medications among adults with diabetes mellitus in the urban elderly practice area of Raja Rajeswari Medical College and Hospital, Bangalore, Karnataka, India. *International Journal of Public Health Research* 2019 Sep 5;6(5).
 17. Olickal JJ, Chinnakali P, Suryanarayana BS, Saya GK, Ganapathy K, Subrahmanyam DK. Medication adherence and glycemic control status among people with diabetes seeking care from a tertiary care teaching hospital, south India. *Clinical Epidemiology and Global Health*. 2021 Jul 1;11:100742.
 18. Rajashekar S, Ramakrishna S, Shivakumar KM. A study of medication adherence among type 2 diabetes mellitus patients in tertiary care teaching hospital, Mandya, Karnataka. *SAS journal of medicine*. 2020 Feb;6(2):29-37.
 19. Thapa S, Jha N, Baral DD, Pyakurel P. Health care seeking behaviour among people living with Type-2 diabetes in rural area of eastern, Nepal. *Int J Pub Health Safe*. 2018;3(3):166.
 20. Mukherjee S, Sharma SarKar B, Das KK, Bhattacharyya A, Deb A. Compliance to anti-diabetic drugs: observations from the diabetic clinic of a medical college in Kolkata, India. *Journal of clinical and diagnostic research: JCDR*. 2013 Apr;7(4):661.
 21. Prithika UY, Paul CM, Nethaji VS, Vishnu S, Rumaiza W, Manoharan S. A study on noncompliance to treatment in a Chennai based diabetic population. *International Journal of Community Medicine and Public Health*. 2018 Dec;5(12):5465-8.
 22. Palathingal JT, Tom R, Babu VN, Chacko SE, Kumar A, Saravanan M. Assessment of medication adherence in rural population with type 2 diabetes: study in a tertiary care hospital in south India. *Int J Biomed Sci*. 2020;16:21-9.
 23. Pattnaik S, Ausvi SM, Salgar A, Sharma D. Treatment compliance among previously diagnosed type 2 diabetics in a rural area in Southern India. *Journal of Family Medicine and Primary Care*. 2019 Mar;8(3):919.
 24. Misra P, Salve HR, Srivastava R, Kant S, Krishnan A. Adherence to medications among patients with diabetes mellitus (Type 2) at Ballabgarh health and demographic surveillance system: A community based study. *Indian Journal of Community and Family Medicine*. 2018 Jan 1;4(1):24.
 25. Parajuli J, Saleh F, Thapa N, Ali L. Factors associated with nonadherence to diet and physical activity among Nepalese type 2 diabetes patients; a cross sectional study. *BMC research notes*. 2014 Dec;7(1):1-9.
 26. Alhariri A, Daud F, Almaiman A, Saghir S. Factors associated with adherence to diet and exercise among type 2 diabetes patients in Hodeidah city, Yemen. *Life*. 2017;7(3):264-71.
 27. Ramadhan BJ, Alramadan MJ, Alhassan RE, Almajed HA, Khamseen MA, Billah B. Adherence to the recommended physical activity duration among Saudis with type 2 diabetes mellitus. *Journal of Family Medicine and Primary Care*. 2019 Nov;8(11):3668.
 28. Karthik RC, Radhakrishnan A, Vikram A, Arumugam B, Jagadeesh S. Self-care practices among type II diabetics in rural area of Kancheepuram district, Tamil Nadu. *Journal of Family Medicine and Primary Care*. 2020 Jun;9(6):2912.