

RESEARCH ARTICLE

Treatment noncompliance level among patients with type 2 diabetes mellitus: A hospital based cross-sectional study in Bangladesh

Ishtiakul Islam Khan^{1*}, Orindom Shing Pullock², Susmita Dey Pinky², Bidduth Barua³, Taslima Ahmed Dola⁴, Pratik Chowdhury⁵, Tapan Seal⁶, Sanzida Salekin⁷, Tarek UI Quader⁸, Ambarish Mitra², M. A. Hassan Chowdhury², Syeda Rumman Aktar Siddiqui⁹

1 Department of Public Health, North South University, Dhaka, Bangladesh, **2** Department of Medicine, Chattogram Medical College Hospital, Chattogram, Bangladesh, **3** Chittagong Medical University, Chattogram, Bangladesh, **4** Department of Community Medicine, East West Medical College and Hospital, Dhaka, Bangladesh, **5** Department of Medicine, Cox's Bazar Medical College Hospital, Cox's Bazar, Bangladesh, **6** Upazilla Health Complex, Rangunia, Chattogram, Bangladesh, **7** KW Clinic, Kitchener, ON, Canada, **8** Department of Anesthesia, Chattogram Medical College Hospital, Chattogram, Bangladesh, **9** Department of Biochemistry, Chittagong Medical College, Chattogram, Bangladesh

* ishtiakul.khan@icddr.org, ishtiak.cmc@gmail.com



OPEN ACCESS

Citation: Khan II, Pullock OS, Pinky SD, Barua B, Dola TA, Chowdhury P, et al. (2022) Treatment noncompliance level among patients with type 2 diabetes mellitus: A hospital based cross-sectional study in Bangladesh. *PLoS ONE* 17(9): e0271107. <https://doi.org/10.1371/journal.pone.0271107>

Editor: Felix Bongomin, Gulu University, UGANDA

Received: December 3, 2021

Accepted: June 24, 2022

Published: September 13, 2022

Copyright: © 2022 Khan et al. This is an open access article distributed under the terms of the [Creative Commons Attribution License](https://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Data Availability Statement: All relevant data are within the paper and the data set file is shared in the following repository S1 Type 2 DM Treatment Noncompliance Data Set <https://doi.org/10.6084/m9.figshare.19957547.v1>.

Funding: The author(s) received no specific funding for this work.

Competing interests: The authors have declared that no competing interests exist.

Abstract

The consequence of good diabetic treatment depends on the patient's commitment to a large degree. Noncompliance leads to inadequacy of metabolic control, which strengthens the advancement and speeds up diabetic complications. The study's main goal was to assess the treatment noncompliance level among patients with type-2 diabetes mellitus (T2DM) in Bangladesh. This descriptive cross-sectional study was conducted at Medical Center Hospital, Chattogram, Bangladesh. The study included two hundred and fifty-nine patients with T2DM. Data regarding sociodemographic factors, patient's characteristics, medication factors, physician-related factors, and noncompliance were collected using a pretested and structured questionnaire. Treatment adherence was assessed by Morisky Medication Adherence Scales (MMAS-8). Data analyses were conducted on SPSS v23.0 Software. The majority of the participants (56%) were in the 40–45 years of age group, followed by 32% in the older age group (≥ 60 years), and 62.5% of them were male. One hundred and sixty-eight (64.86%) patients were considered low adherent as per the response of the MMAS-8 scale (score < 6), followed by 57 (22.0%) patients were regarded as high adherent (score 8) and 34 (13.13%) patients were considered medium adherent (score 6–7) to treatment. Observing the frequency distribution for noncompliance, financial concerns (32.3%), forgetfulness (27.7%), a busy daily schedule (17.7%), and fear of antihyperglycemic drug side effects were all identified as significant explanations. On multivariate analysis, participants aged 60 years or more, monthly family incomes of $< 30,000$ BDT or 30,000–50,000 BDT, smoking, and uncontrolled glycemic status showed higher chances of non-compliance than their counterparts. Patient counseling and awareness programs may enhance treatment adherence among people with T2DM. Our findings will help physicians

and public health workers to develop targeted strategies to increase awareness of the same among their patients.

Introduction

Compliance is typically known as the degree to which a patient's behaviour and action correlate with the healthcare provider's health and medical consultation and recommendations (taking medication, accomplishing behavioural modifications, receiving preventive tests, or sustaining consultation with physicians) [1]. Non-compliant patients are those whose pattern of seeking treatment or maintaining is inconsistent with a health care provider [2]. Patient noncompliance is considered as one of the most common causes of treatment failure and consequently, it poses a pre-eminent challenge to prosperous healthcare service [3]. The result of successful diabetic care outcomes depends on the patient's adherence at a significant level. Noncompliance leads to a lack of metabolic control, which contributes to the development and acceleration of diabetic complications [4].

The prevalence of type 2 diabetes mellitus (T2DM) is soaring worldwide and has become a dominant public health burden. In 2017, approximately 462 million individuals were affected by type 2 diabetes, corresponding to 6.28% of the world's population. The global prevalence is projected to increase to 7079 individuals per 100,000 by 2030, reflecting a continued rise across all regions of the world [5]. Most forms of diabetes mellitus are of type 2, and the most significant number of people with this condition are between 40 and 59 years of age [6]. The increase in type 2 diabetes is linked to obesity, high blood pressure, and a growing elderly population. Despite the presence of an effective guideline for dietary and lifestyle management of diabetes, the practice of leading a disciplined lifestyle, eating a balanced diet, and exercising is rare. As a result, diabetes patients require far more attention and follow-up on a physician's diagnosis and advice to guarantee proper compliance [2, 4, 5].

Several studies have shown that attitudinal issues such as carelessness, a lack of knowledge, financial problems, physiologic and physical factors, as well as social and family problems, can frequently act as a barrier to drug adherence in type 2 diabetes mellitus patients [7, 8]. Mann et al. (2009) conducted a cross-sectional study to identify potentially modifiable patient conditions and drug beliefs associated with poor medication adherence among people with diabetes [9]. They discovered that believing to have diabetes only when blood sugar levels rise, medication avoidance habit, adverse effect-related worries, and the belief that medicines are difficult to take are all linked to poor medication adherence. But some countries like Ethiopia depicted high compliance (85.1%) among diabetes patient and education, duration of diabetes and knowledge about DM and its medications are significant factors related to adherence [10]. A study by Mumu and Saleh portrayed that most of the T2DM patients remained non-adhere to their diet (88%), foot care (70%), routine blood glucose testing (32%) and exercise (25%) [11].

Diabetes is a significant public health issue with a high economic burden in Bangladesh. In a sample of 56 452 individuals, the pooled prevalence of diabetes in the general population was 7.8% (95% CI: 6.4–9.3) in Bangladesh, with a significant difference between rural and urban areas [12]. A current study of T2DM patients visiting an urban clinic in the capital Dhaka found that nearly two-thirds of patients had uncontrolled diabetes [13]. Additionally, another study reported poor lifestyle and medication adherence among patients with T2DM in Bangladesh resulting in overall poor quality of life [14]. A further study by Saha et al. [15] found out that in Bangladesh 44% of the patients were considered moderately adherent and 19% were poorly adherent. Moreover, they found out significant ($p < 0.05$) relation between

noncompliance and quality of life in diabetic patients in Bangladesh [16]. The development and improvement of interventions toward better control of T2DM and the prevention of its complications are vital requirements for the country. Without these, soon, the private and public financing of diabetes treatment will be severely constrained, representing a health threat for the Bangladeshi population [17].

Adherence to medicines and lifestyle changes has an important impact on the outcome of diabetes treatment along with their quality of life. However, it is claimed that the patients' expectations are often overlooked in the scheme of the treatment, resulting in nonadherence. It is therefore important to understand the perspective of patients on diabetes, its medicines, and the significance of adherence to glycemic control medications to facilitate effective and optimal diabetes treatment. Till now, there has been less reliable evidence on the pattern of treatment in compliance on Bangladeshi T2DM patients. Therefore, the present study is designed to address some of these knowledge gaps and to better understand the current compliance of T2DM patients in urban Bangladesh. It is anticipated that the essential findings of this proposed study will figure out patients' knowledge about the benefit of following treatment and their attitude towards the currently prescribed treatment. This will overview the current status of diabetic patients' treatment adherence level and associated factors influencing stoppage or discontinuing the treatment protocol.

Methodology

Study design

This is a descriptive type of cross-sectional study took place in a tertiary care medical center that provide a comprehensive healthcare service for the people of Chattogram, the southern part of Bangladesh. The main aim of this study is to describe the current treatment noncompliance level among Type-2 diabetes mellitus patients and its associated factors. The study population comprised the diagnosed patients with T2DM attending Indoor patient department (IPD) and outdoor patient department (OPD). The study was conducted from April 2020 to August 2020. Data were collected for three months within the five months study period. Convenient type of sampling method was used and data was collected by face-to-face interview with maintaining proper safety measures for limiting COVID-19 exposure. Ethical approval for this study was received from North South University Institutional Review Board (Approval no 2021/OR-NSU/IRB/1925458080). Written informed consent was taken from the study participants. Since prevalence of type-2 diabetes is low among < 30 years aged group, patient aged 30 and above and patients who had been diagnosed with diabetes for at least six months from the date of interview were included in the study [18]. Pregnant or lactating women up to 12 weeks post-partum were excluded due to the possible pregnancy-related impaired glucose tolerance status in this group.

Sample size

In total, two hundred and sixty (260) diabetic patients from the selected hospital were included by assuming a confidence interval of 95% and a power of 80%, prevalence of 21%. According to a study conducted by Shaha et al., the prevalence of treatment noncompliance among T2DM patients in the Bangladeshi population was found at 21% [15]. For calculation of the sample size, the following formula was used:

$$n = \frac{z^2 \times p \times q}{d^2}$$

Here,

n = desired sample size

z = standard normal deviate; set at 1.96, which correspond to 95% confidence level. $P = 0.21$ (prevalence of treatment Noncompliance among T2DM patients among Bangladeshi population is 21%) [15]

$q = 1 - p = 1 - 0.21 = 0.79$

d = Allowable margin error = 5% = 0.05

So,

$$n = \frac{(1.96)^2 \times 0.21 \times 0.79}{(0.05)^2} = 254.9 = 255$$

The final sample size was 260 patients.

Data collection tools

Data for this descriptive cross-sectional study were collected via a structured pretested questionnaire. It had three sections: The first section included questions regarding sociodemographic factors, the second section contained questions regarding clinical factors, and the third section was the adherence assessment tool known as Morisky Medication Adherence Scales (MMA-8) [19]. The MMAS-8 has far greater sensitivity and specificities of 93% and 53% and the alpha value of 0.83 of Cronbach respectively [20]. The first seven items are dichotomous categories with either yes or no, and the last item examines how often the respondents skip the daily doses of medicines with five different responses and their corresponding scores. The MMAS-8 is a self-report questionnaire with 8 questions (items) whose wording of the questions/items are formulated to avoid answering “yes” to questions regardless of their content. Items 1 through 7 have response choices “yes” or “no” whereas item 8 has a 5-point Likert response choice. Each “no” response is rated as “1” and each “yes” is rated as “0” except for item 5, in which each response “yes” is rated as “1” and each “no” is rated as “0”. For item 8, if a patient chooses response “0”, the score is “1” and if they choose response “4”, the score is “0”. Responses “1, 2, 3” are respectively rated as “0.25, 0.75, 0.75”. Total MMAS-8 scores can range from 0 to 8 and have been categorized into three levels of adherence: high adherence (score = 8), medium adherence (score of 6 to < 8), and low adherence (score < 6).

Random Blood Sugar Measuring Machine was used in the survey day, to measure the random blood sugar level (RBS) of the diabetic patients. Measuring tape and weight machines were used to measure height and weight to detect the current Body mass index (BMI). The study was conveyed after obtaining permission from the concerned authorities and the participants as well.

Data management & analysis plan

After the collection of data, they were checked and verified for consistency and reduction of errors. Data entry and analysis were completed by Statistical Packages for Social Sciences (SPSS) version 23.00. The continuous variables were categorized and descriptive statistics were calculated (presented as frequencies). Various variables such as demographics (age categorized as <40 years, 40–59 years or ≥60years and gender), monthly income categorized as <30,000 Bangladeshi Taka (BDT), 30,000–50,000 BDT, and >50,000 BDT, and education split into two categories; less than higher secondary education and education up to higher secondary and above), smoking status (never smoker and smoker), marital status (married and unmarried which included separated, divorced, widowed and widower) comorbidities, were the independent variables. Univariate analyses (Chi-square or Fisher’s exact test) were performed to assess

the association of each of the independent variables and treatment compliance (compliant versus non-compliant). To determine which factors were predictive of non-compliant when adjusted for other predictors, a multiple binary logistic regression was performed. Explanatory variables were selected using liberal criteria ($P < 0.05$) for inclusion in the multivariate regression model. Odds ratios (ORs) and 95% confidence intervals (CIs) were calculated for all comparisons. For all statistical analyses, significance was accepted as $p < 0.05$. A p -value of < 0.05 was regarded as statistically significant for all analyses.

Result

This study included 260 patients, one of whom did not have complete information regarding medication adherence. Therefore, finally, 259 patients were analyzed. The sociodemographic characteristics of the participants are summarized in Table 1. The majority of the participants were 40–45 years of age, followed by 32% in the older age group (≥ 60 years). More than 62% (62.5%) of them were male. Most participants were married (94.2%) and educated up to the higher secondary school level and above (67.2%). The majority of the patients' (55.2%) monthly income was below BDT 30,000 (Table 1).

Only 23.9% of patients had no other comorbid conditions, but 39% had more than one comorbid condition. Near about three-fourths of the participants (74.1%) reported having a positive family history of T2DM. Nearly one-fourth (23.9%) were smokers, and more than three-fourths of the participants were overweight (Table 2).

Disease duration was less than ten years in the majority of the patients (82.2%), and 69.2% were on oral hypoglycemic agents only. One-third (33.2%) of the patients had uncontrolled glycemic status at data collection (Table 3).

Table 1. Socio-demographic characteristics of the study participants (n = 259).

Variables	n (%)	Compliant (n = 91)	Noncompliant (n = 168)	P value
Age group				
30–39 years	31 (12.0)	19 (20.9)	12 (7.1)	0.001
40–59 years	145 (56.0)	53 (58.2)	92 (54.8)	
60 years or more	83 (32.0)	19 (20.9)	64 (38.1)	
Sex				
Male	162 (62.5)	51 (56.0)	111 (66.1)	0.111
Female	97 (37.5)	40 (44.0)	57 (33.9)	
Marital status				
Married	244 (94.2)	84 (92.3)	160 (65.2)	0.336
Unmarried	15 (5.8)	7 (7.7)	8 (4.8)	
Education level				
Below HSC	85 (32.8)	18 (19.8)	67 (39.9)	0.001
HSC and above	174 (67.2)	73 (80.2)	101 (60.1)	
Monthly income				
Below 30,000	143 (55.2)	42 (46.2)	101 (60.1)	0.025
30,000–50,000	89 (34.4)	34 (37.4)	55 (32.7)	
More than 50,000	27 (10.4)	15 (16.5)	12 (7.1)	
Occupation				
Business	64 (24.7)	15 (16.5)	49 (29.2)	0.055
Service	92 (35.5)	41 (45.1)	51 (30.4)	
Housewife	61 (23.6)	20 (22.0)	41 (24.4)	
Others	42 (16.2)	15 (16.5)	27 (16.1)	

<https://doi.org/10.1371/journal.pone.0271107.t001>

Table 2. Clinical characteristics of the study participants (n = 259).

Variables	n (%)	Compliant (n = 91)	Noncompliant (n = 168)	P value
Comorbidity				
No	62 (23.9)	32 (35.2)	30 (17.9)	<0.001
One	96 (37.1)	38 (41.8)	58 (34.5)	
More than one	101 (39.0)	21 (23.1)	80 (47.6)	
Family history of DM				
Absent	67 (25.9)	19 (20.9)	48 (28.6)	0.177
Present	192 (74.1)	72 (79.1)	120 (71.4)	
Smoking status				
Non-smoker	197 (76.1)	76 (83.5)	121 (72.0)	0.039
Smoker	62 (23.9)	15 (16.5)	47 (28.0)	
BMI category				
<25.0 kg/m ²	61 (23.6)	22 (24.2)	39 (23.2)	0.862
≥25.0 kg/m ²	198 (76.4)	69 (75.8)	129 (76.8)	

<https://doi.org/10.1371/journal.pone.0271107.t002>

Out of 259 patients, 168 (64.86%) were considered low adherent as per the response of the MMAS-8 scale (score <6). Only 57 (22.0%) patients were considered high adherent (score 8) and 34 (13.13%) patients were considered medium adherent (score 6–7) (Fig 1). For further analysis, participants of this study were grouped as treatment non-compliant (low medication adherence) and compliant (medium/high medication adherence). Fig 2 reveals that 168 (64.9%) participants were classified as non-compliant, while the remaining 91 (35.1%) were classified as complying.

Financial problems (32.3%), forgetfulness (27.7%), busy daily schedule (17.7%), and fear of side effects of antidiabetic drugs were considered as major reasons for being non-compliant with antidiabetic treatment (Fig 3).

Age group, educational level, and monthly family income had a significant association with the compliance to treatment in diabetic patients (Table 1). On the other hand, gender, marital status, and occupation had no association with compliance to treatment in diabetic patients. The frequency of patients with more than one comorbid condition was higher in the non-compliant group ($p < 0.001$) and in smokers ($p = 0.039$) compared to their counterparts (Table 2). On the other hand, though the frequency of non-compliant was higher in patients without any family history of DM and patients with BMI <25 kg/m² compared to their counterparts, these differences failed to reach statistical significance ($p > 0.05$).

Table 3. Distribution of the patients according to present treatment-related factors (n = 259).

Variables	n (%)	Compliant (n = 91)	Noncompliant (n = 168)	P value
Duration of diabetes				
< 10 years	213 (82.2)	79 (86.8)	134 (79.8)	0.156
10 years or more	46 (17.8)	12 (13.2)	34 (20.0)	
Current treatment				
Diet and exercise only	5 (1.9)	4 (4.4)	1 (0.6)	0.053
OHA only	179 (69.2)	70 (76.9)	109 (64.9)	0.045
Insulin only	26 (10.0)	8 (8.6)	18 (10.7)	0.623
Combinations of OHA and insulin	49 (18.9)	9 (9.9)	40 (23.6)	0.006
RBS, mmol/l				
Controlled (<11.1)	173 (66.8)	73 (80.2)	100 (59.5)	0.001
Uncontrolled (≥11.1)	86 (33.2)	18 (19.8)	68 (40.5)	

<https://doi.org/10.1371/journal.pone.0271107.t003>

Pattern of medication adherence to anti-diabetic drugs (n=259)

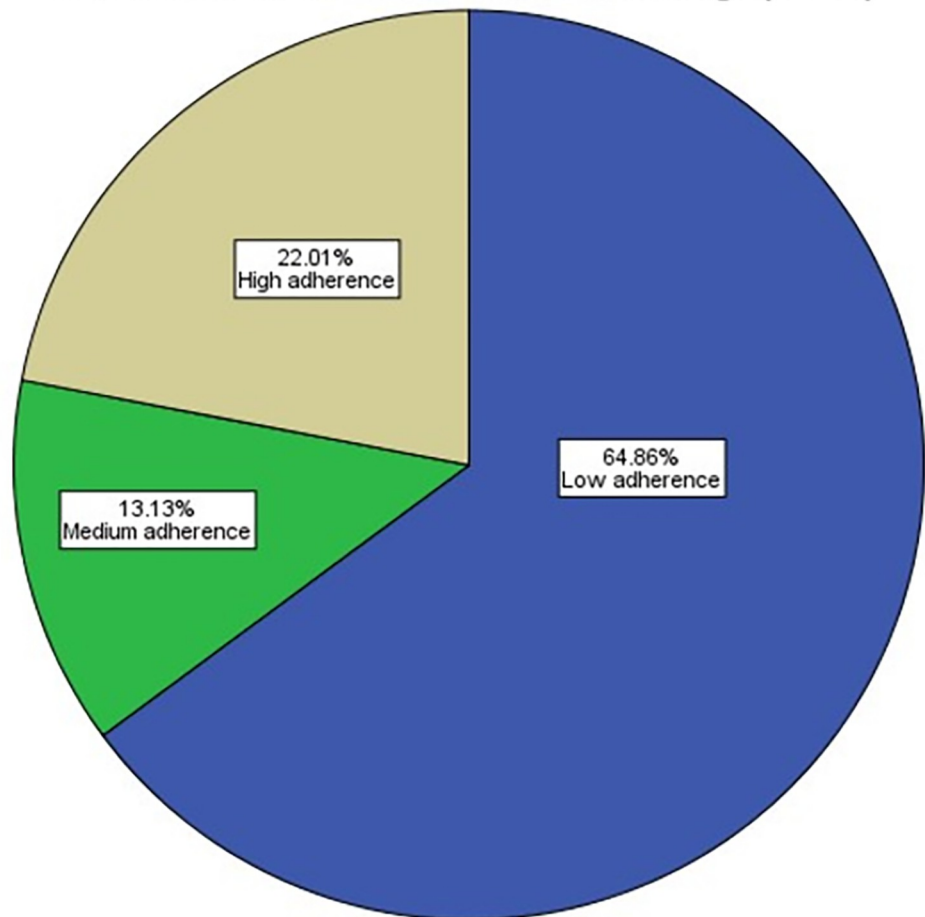


Fig 1. Distribution of patients according to the pattern of medication adherence to anti-diabetic drugs.

<https://doi.org/10.1371/journal.pone.0271107.g001>

The study diseases duration category (<10 yrs. versus \geq 10 yrs.) had no association with treatment compliance. The current treatment pattern had a significant association with treatment compliance, and noncompliance was associated with the glycemic status of the patients (Table 3).

As per the adjusted bivariate logistic regression analyses, participants aged 60 years or more had 3.83 times (95% CI:1.35–10.85; $p = 0.012$) higher odds of noncompliance than the participants. Participants with monthly family incomes of <30,000BDT or 30,000–50,000 BDT were 6.08 times (95% CI: 2.19–16.82) and 4.9 times (95% CI: 1.45–11.51) more likely to have non-compliance, respectively, as compared to those with a monthly family income of >50,000BDT. In addition, smokers (OR: 2.1, 95% CI: 1.05–4.59) and had uncontrolled glycemic status (OR: 2.38, 95% CI: 1.10–5.18) showed higher chances of noncompliance compared to their counterparts (Table 4).

Discussion

A total number of 259 participants were interviewed during the study period. The present study showed that more than half of the participants with T2DM (64.86%) had low treatment

Compliance pattern of the participants to anti-diabetic treatment (n=259)

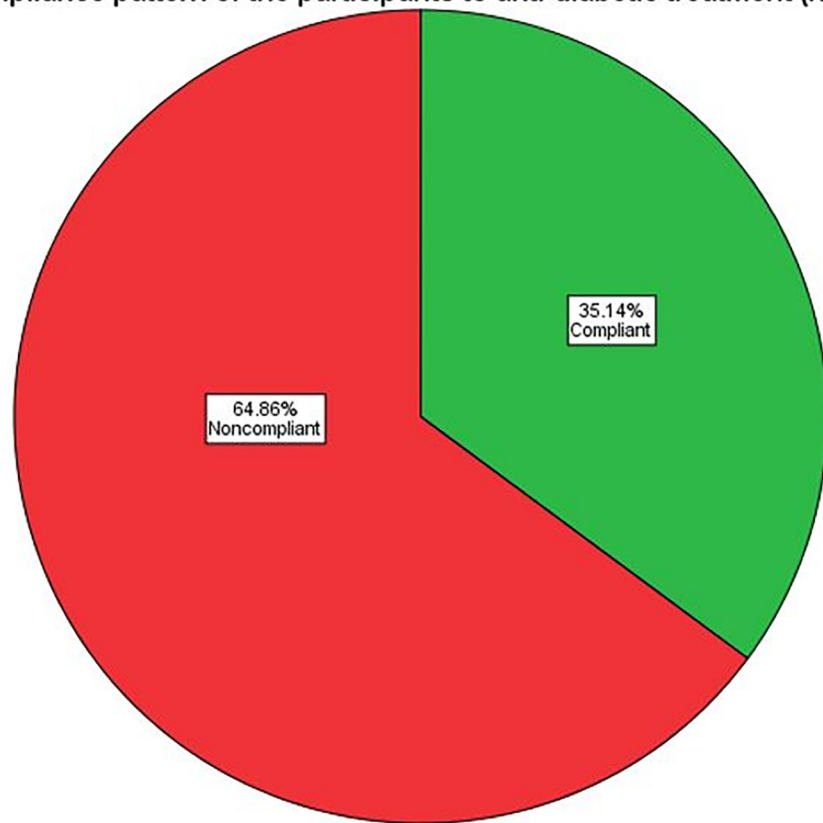


Fig 2. Distribution of patients according to pattern of compliance to anti-diabetic treatment.

<https://doi.org/10.1371/journal.pone.0271107.g002>

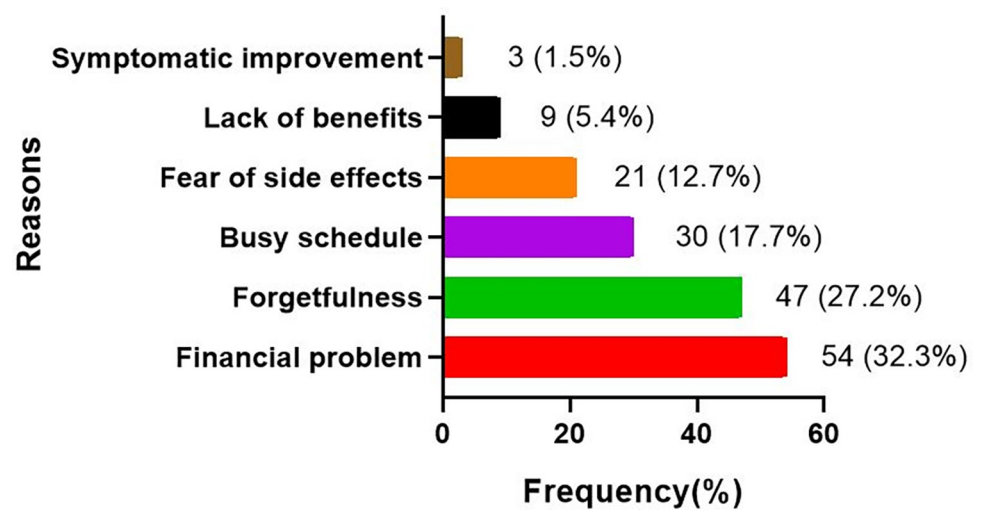


Fig 3. Reasons for not taking anti-diabetic treatment in non-compliant patients (n = 168).

<https://doi.org/10.1371/journal.pone.0271107.g003>

Table 4. Factors associated with Noncompliance to treatment among diabetes patients.

	Unadjusted OR (95% CI)	P value	Adjusted OR (95% CI)	P value
Age group				
30–39 years	Reference		Reference	
40–59 years	2.75 (1.24–6.10)	0.013	2.30 (0.96–5.54)	0.063
60 years or more	5.33 (2.20–12.93)	0.001	3.83 (1.35–10.85)	0.012
Education level				
Blow HSC	2.69 (1.48–4.91)	0.001	1.42 (0.71–2.84)	0.329
HSC and above	Reference		Reference	
Monthly income				
Below 30,000	3.01 (1.29–6.96)	0.010	6.08 (2.19–16.82)	0.001
30,000–50,000	2.02 (0.84–4.83)	0.113	4.09 (1.45–11.51)	0.008
More than 50,000	Reference		Reference	
Comorbidity				
No	Reference		Reference	
One	1.63 (0.86–3.10)	0.138	1.39 (0.68–2.89)	0.364
More than one	4.06 (2.03–8.12)	<0.001	2.68 (1.21–5.95)	0.016
Smoking status				
Non-smoker	Reference		Reference	
Smoker	1.97 (1.03–3.76)		2.19 (1.05–4.59)	0.037
Combination treatment				
No	Reference		Reference	
Yes	2.85 (1.31–6.18)	0.008	2.03 (0.64–6.47)	0.230
Only OHA				
No	1.80 (1.01–3.23)	0.047	1.43 (0.78–3.91)	0.485
Yes	Reference		Reference	
RBS, mmol/l				
Controlled (<11.1)	Reference		Reference	
Uncontrolled (\geq 11.1)	2.76 (1.51–5.03)		2.38 (1.10–5.18)	<0.001

<https://doi.org/10.1371/journal.pone.0271107.t004>

adherence, and another 13.13% had medium treatment adherence. Only 22.0% of patients were revealed as having high treatment adherence in the current study. In a recent study in Bangladesh, Saleh et al. found that patients with T2DM had higher medication adherence, with just 20% of the participants failing to take their oral medications [16], which is much lower than our findings. This could be attributable to the fact that they did not employ a standardized questionnaire to assess adherence. Our findings remained in accordance with a report from India that used a standard medication-adherence tool and found more than half (51.7%) of their participants to have low adherence [21]. Another report from Saudi Arabia reported that only a third of patients had high adherence to their prescribed antidiabetic medications [22]. Moreover, a high prevalence of low-treatment adherence in T2DM patients, as revealed by the current study, is confirmed by another recent study from Bangladesh, which reported that the overall prevalence of low adherence was 46.3% of participants and medium-to-high adherence was 53.7% in patients with T2DM [23]. The study finding was consistent with our study since the data was collected from the same geographical area using standardized questionnaire.

In the present study, a high proportion (56%) of patients were in the age group of 40–59 years of age, and the proportion of elderly (age \geq 60 years) patients was low (32%). However, older age was a significant predictive factor for treatment noncompliance in the current study. This finding could be because younger patients take better care of their health to ensure a long

healthy life, and the elderly seem to fear complications and adverse effect from lifelong medications. This reported adherence rate was consistent with the previous study findings [24, 25]. Furthermore, elderly patients with comorbidities often be offered more drugs, as polypharmacy is a risk factor for drug nonadherence [26]. In contrast to these findings, AlQarni et al. revealed that treatment adherence was positively associated with patient age, implying that patients became more adherent as they became older [22]. The disparity discovered can be attributed to free health care, social and psychological support for the elderly, which are primarily found in emerging high-income countries [27].

In this current study, low medication adherence was significantly associated with low educational level. In line with previous research, we discovered that patients who had only received elementary school had significantly lower medication adherence [28–30]. For example, a patient's faith in a physician may be determined by educational qualifications as well as other characteristics such as age, income, and the amount of care received [2, 31]. In addition, patient education is critical for increased understanding of the disease and treatment process [20].

Our Study has revealed that patients with low monthly family income were more likely to be non-compliant to treatment than the participants with high monthly family income. The cost of medication is a militating factor affecting patients' adherence to their medications. According to a study carried out by Awodele et al., more than half of the patients (51.32%) viewed their drugs as unaffordable [27]. In the current study, the financial problem was the main reason stated for treatment non-compliant. Interestingly, low adherence is not the case in population with a high income and access to health insurance, according to studies [30].

It has been reported that people with diabetes who smoke are less likely to engage in self-care or follow diabetes treatment guidelines [32]. In the present study, diabetic patients who smoked were 2.19 (95% CI:1.05–4.59) times more likely to have treatment non-compliant than those who never smoked in their lifetime. Since the smoker patients have higher psychological imbalance, treatment nonadherence can be prevalent. Because smokers have a higher level of psychological instability, treatment nonadherence is more likely [33].

The current study found noncompliance to be associated with more than one comorbidity. Patients with more than one additional comorbid condition were 2.68 (1.21–5.95) times more likely to be non-compliant than those with no other comorbid condition. Diabetic patients with multimorbidity had to take multiple medications in addition to antidiabetic medicines. Similarly, Shams et al. also reported that diabetic patients with different associated comorbid conditions like ischemic heart disease, hypertension, and patients taking >4 drugs were more likely to report nonadherence to medication [26]. Here, multi-drug regimen simplification and tablet load reduction, as well as clearer explanations of the reasons for drugs, might promote adherence [34].

Importantly, this study demonstrated that treatment compliance plays a vital role in maintaining blood sugar levels within the normal range. This study found patients with uncontrolled glycemic status were 2.38 (95% CI:1.10–5.18) times more likely to be treatment non-compliant than patients with reasonable glycemic control. Similarly, Rana et al. [24] found a strong adverse connection between high adherence scores and lower tested values of HbA1C and FBS [24].

However, there are inconsistencies in the literature when it comes to the factors that influence treatment adherence [2]. It's due to a lack of standard procedures for measuring adherence, as well as variances in sample demographics and glycemic control standards.

Limitations

There are several limitations to this study. Participants in our study came from urban health care centers in the city, who are more likely to have better awareness regarding T2DM and

financial and educational stability. Additionally, we have a small sample size. Furthermore, patients' treatment adherence may have been exaggerated in their assessments, despite the fact that more accurate adherence testing could not verify these findings. Despite its flaws, the study used a standardized way to assess adherence and metabolic markers, making it a unique approach in this field for understanding treatment noncompliance among T2DM patients in Bangladesh.

Conclusion

Older age, a household income of less than 30,000 BDT, education below the HSC level, being a smoker, and having more than one comorbid condition were all found to be linked with low medication adherence among diabetics in the current study. These diabetic patients should be considered at high risk of nonadherence and are likely to require more creative and consistent clinical interventions. These findings should aid health professionals and policymakers in developing holistic management strategies for chronic diseases such as Diabetes Mellitus, with the objective of enhancing patient adherence.

Acknowledgments

We acknowledge the dedications, commitments and the contributions of the patients who took part in this study. We are grateful for the valuable contribution from the study site management authority for granting us the permission for data collection.

Author Contributions

Conceptualization: Ishtiakul Islam Khan, Susmita Dey Pinky, M. A. Hassan Chowdhury, Syeda Rumman Aktar Siddiqui.

Data curation: Ishtiakul Islam Khan, Orindom Shing Pulock, Bidduth Barua, Taslima Ahmed Dola, Pratik Chowdhury, Tapan Seal, Sanzida Salekin, Tarek Ul Quader.

Formal analysis: Ishtiakul Islam Khan, Orindom Shing Pulock.

Funding acquisition: Ishtiakul Islam Khan, M. A. Hassan Chowdhury, Syeda Rumman Aktar Siddiqui.

Investigation: Orindom Shing Pulock, Bidduth Barua, Taslima Ahmed Dola, Pratik Chowdhury, Tapan Seal, Sanzida Salekin, Tarek Ul Quader, Ambarish Mitra.

Methodology: Ishtiakul Islam Khan, Orindom Shing Pulock, Bidduth Barua, Taslima Ahmed Dola, Pratik Chowdhury, Tapan Seal, Sanzida Salekin, Tarek Ul Quader, Ambarish Mitra.

Project administration: Ishtiakul Islam Khan, M. A. Hassan Chowdhury, Syeda Rumman Aktar Siddiqui.

Resources: Ishtiakul Islam Khan, Orindom Shing Pulock, Susmita Dey Pinky, Bidduth Barua.

Supervision: Tapan Seal, M. A. Hassan Chowdhury, Syeda Rumman Aktar Siddiqui.

Validation: Susmita Dey Pinky.

Visualization: Orindom Shing Pulock.

Writing – original draft: Ishtiakul Islam Khan, Orindom Shing Pulock, Susmita Dey Pinky, Taslima Ahmed Dola, Tapan Seal, Sanzida Salekin, Tarek Ul Quader, Ambarish Mitra.

Writing – review & editing: Ishtiakul Islam Khan, Bidduth Barua, Taslima Ahmed Dola, Pratik Chowdhury, M. A. Hassan Chowdhury, Syeda Rumman Aktar Siddiqui.

References

1. Sackett DL. Introduction. In: Sackett DL, Haynes RB, editors. *Compliance with therapeutic regimens*. Baltimore: Johns Hopkins University Press; 1976. pp. 1–6.
2. Jin J, Sklar GE, Min Sen Oh V, Chuen Li S. Factors affecting therapeutic compliance: A review from the patient's perspective. *Ther Clin Risk Manag*. 2008; 4(1):269–86. <https://doi.org/10.2147/tcrm.s1458> PMID: 18728716
3. Kardas P. Non-compliance—some myths, some facts. *Casopis Lekarů Ceskych*. 2004; 143(8):556–9; discussion 560. PMID: 15446463.
4. Polonsky WH, Henry RR. Poor medication adherence in type 2 diabetes: recognizing the scope of the problem and its key contributors. *Patient Prefer Adherence*. 2016; 10:1299–307. <https://doi.org/10.2147/PPA.S106821> PMID: 27524885
5. Khan MAB, Hashim MJ, King JK, Govender RD, Mustafa H, Al Kaabi J. Epidemiology of Type 2 Diabetes—Global Burden of Disease and Forecasted Trends. *J Epidemiol Glob Health*. 2020; 10(1):107–111. <https://doi.org/10.2991/jegh.k.191028.001> PMID: 32175717
6. IDF Diabetes Atlas. <https://www.idf.org/e-library/epidemiology-research/diabetesatlas/20-atlas-5th-edition.html> (accessed 29 Feb 2020).
7. Davoodi M, Dindamal B, Dargahi H, Faraji-Khiavi F. A phenomenological study on barriers of adherence to medical advice among type 2 diabetic patients. *BMC Endocrine Disorders*. 2022 Dec; 22(1):1–9.
8. Bailey CJ, Kodack M. Patient adherence to medication requirements for therapy of type 2 diabetes: Patient adherence to medication requirements. *International Journal of Clinical Practice* 2011; 65: 314–322.
9. Mann DM, Ponieman D, Leventhal H, Halm EA. Predictors of adherence to diabetes medications: the role of disease and medication beliefs. *J Behav Med*. 2009; 32(3):278–84. <https://doi.org/10.1007/s10865-009-9202-y> PMID: 19184390
10. Abebaw M, Messele A, Hailu M, Zewdu F. Adherence and Associated Factors towards Antidiabetic Medication among Type II Diabetic Patients on Follow-Up at University of Gondar Hospital, Northwest Ethiopia. *Advances in Nursing*. 2016; 8579157:7 pages. Available from: <https://doi.org/10.1155/2016/8579157>
11. Mumu SJ, Saleh F, Ara F, Afnan F, Ali L. Nonadherence to lifestyle modification and its factors among type 2 diabetic patients. *Indian J Public Health*. 2014; 58(1):40–4. <https://doi.org/10.4103/0019-557X.128165> PMID: 24748356
12. Akhtar S, Nasir JA, Sarwar A, Nasir N, Javed A, Majeed R, et al. prevalence of diabetes and pre-diabetes in Bangladesh: a systematic review and meta-analysis. *BMJ Open*. 2020 Sep 9; 10(9):e036086. Available from: <https://doi.org/10.1136/bmjopen-2019-036086>. PMID: 32907898
13. Islam SM, Alam DS, Wahiduzzaman M, Niessen LW, Froeschl G, Ferrari U, et al. Clinical characteristics and complications of patients with type 2 diabetes attending an urban hospital in Bangladesh. *Diabetes Metab Syndr*. 2015; 9(1):7–13. <https://doi.org/10.1016/j.dsx.2014.09.014> PMID: 25450814
14. Saleh F, Mumu SJ, Ara F, Hafez MA, Ali L. Nonadherence to self-care practices & medication and health related quality of life among patients with type 2 diabetes: a cross-sectional study. *BMC Public Health*. 2014 May 7; 14:431. Available from: <https://doi.org/10.1186/1471-2458-14-431>.
15. Shaha KC, Sultana S, Saha SK, Shahidullah SM, Jyoti BK. Patient Characteristics Associated With Medication Adherence to Antidiabetic Drugs. *Mymensingh Med J*. 2019; 28(2):423–428. PMID: 31086161
16. Saleh F, Ara F, Mumu SJ, Hafez MA. Assessment of health-related quality of life of Bangladeshi patients with type 2 diabetes using the EQ-5D: a cross-sectional study. *BMC Res Notes*. 2015;29; 8:497. <https://doi.org/10.1186/s13104-015-1453-9> PMID: 26420245
17. Afroz A, Alam K, Ali L, Karim A, Alramadan MJ, Habib SH, et al. Type 2 diabetes mellitus in Bangladesh: a prevalence based cost-of-illness study. *BMC Health Serv Res*. 2019 Aug 27; 19(1):601. Available from: <https://doi.org/10.1186/s12913-019-4440-3>. PMID: 31455307
18. Mohan V, Sandeep S, Deepa R, Shah B, Varghese C. Epidemiology of type 2 diabetes: Indian scenario. *The Indian journal of medical research*. 2007 Mar 1; 125(3):217–30. PMID: 17496352
19. Morisky DE, Green LW, Levine DM. Concurrent and predictive validity of a self-reported measure of medication adherence. *Med Care*. 1986; 24:67–74. <https://doi.org/10.1097/00005650-198601000-00007> PMID: 3945130
20. Morisky DE, Ang A, Krousel-Wood M, Ward HJ. Predictive validity of a medication adherence measure in an outpatient setting. *J Clin Hypertens*. 2008; 10:348–354.

21. Arulmozhi S, Mahalakshmy T. Self Care and Medication Adherence among Type 2 Diabetics in Puducherry, Southern India: A Hospital Based Study. *JCDR*. 2014; 8(4):UC01–UC3. <https://doi.org/10.7860/JCDR/2014/7732.4256> PMID: 24959496
22. AlQarni K, AlQarni EA, Naqvi AA, AlShayban DM, Ghori SA, Haseeb A, et al. Assessment of Medication Adherence in Saudi Patients With Type II Diabetes Mellitus in Khobar City, Saudi Arabia. *Front Pharmacol*. 2019 Nov 8; 10:1306. Available from: <https://doi.org/10.3389/fphar.2019.01306>. PMID: 31787894
23. Mannan A, Hasan MM, Akter F, Rana MM, Chowdhury NA, Rawal LB, et al. Factors associated with low adherence to medication among patients with type 2 diabetes at different healthcare facilities in southern Bangladesh. *Glob Health Action*. 2021 Jan 1; 14(1):1872895. Available from: <https://www.doi.org/10.1080/16549716.2021.1872895>. PMID: 33475476
24. Rana MM, Islam MS, Akter J, Khatun S. Medication Adherence to Type 2 Diabetic Patients Hospitalized at a Tertiary Care Hospital in Bangladesh: Diabetic Medication Adherence. *JHSCI [Internet]*. 2019; 9(3):159–67. Available from: <https://www.jhsci.ba/ojs/index.php/jhsci/article/view/818>
25. Badi S, Abdalla A, Altayeb L, Noma M, Ahmed MH. Adherence to antidiabetic medications among Sudanese individuals with Type 2 diabetes mellitus: A cross-sectional survey. *J Patient Exp* 2019; Online First:1-6. Available from: <https://doi.org/10.1177/2374373519831073> PMID: 32851136
26. Shams N, Amjad S, Kumar N, Ahmed W, Saleem F. Drug Non-Adherence In Type 2 Diabetes Mellitus; Predictors And Associations. *J Ayub Med Coll Abbottabad*. 2016; 28(2):302–307. PMID: 28718543
27. Awodele O, Osuolale JA. Medication adherence in type 2 diabetes patients: study of patients in Alimosho General Hospital, Igando, Lagos, Nigeria. *Afr Health Sci*. 2015; 15(2):513–22. <https://doi.org/10.4314/ahs.v15i2.26> PMID: 26124798
28. Kalyango JN, Owino E, Nambuya AP. Nonadherence to diabetes treatment at Mulago Hospital in Uganda: prevalence and associated factors. *Afr Health Sci*. 2008; 8(2):67–73. PMID: 19357753
29. Bruce SP, Acheampong F, Kretchy I. Adherence to oral antidiabetic drugs among patients attending a Ghanaian teaching hospital. *Pharm Pract*. 2015; 13(1):533. <https://doi.org/10.18549/pharmpract.2015.01.533> PMID: 25883693
30. Jin H, Kim Y, Rhie SJ. Factors affecting medication adherence in elderly people. *Patient Prefer Adherence*. 2016; 10:2117–2125. Published 2016 Oct 19. <https://doi.org/10.2147/PPA.S118121> PMID: 27799748
31. Zhao DH, Rao KQ, Zhang ZR. Patient trust in physicians: empirical evidence from Shanghai, China. *Chinese medical journal*. 2016 Apr 5; 129(07):814–8. <https://doi.org/10.4103/0366-6999.178971> PMID: 26996477
32. Solberg LI, Desai JR, O'Connor PJ, Bishop DB, Devlin HM. Diabetic patients who smoke: are they different? *Ann Fam Med*. 2004; 2(1):26–32. <https://doi.org/10.1370/afm.36> PMID: 15053280
33. Gonzalez JS, Batchelder AW, Psaros C, Safren SA. Depression and HIV/AIDS treatment nonadherence: a review and meta-analysis. *Journal of acquired immune deficiency syndromes (1999)*. 2011 Oct 1; 58(2). <https://doi.org/10.1097/QAI.0b013e31822d490a> PMID: 21857529
34. Pasina L, Brucato AL, Falcone C, Cucchi E, Bresciani A, Sottocorno M, et al. Medication non-adherence among elderly patients newly discharged and receiving polypharmacy. *Drugs & aging*. 2014 Apr; 31(4):283–9. <https://doi.org/10.1007/s40266-014-0163-7> PMID: 24604085