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Introduction

Diabetes mellitus (DM) is a group of metabolic diseases of prolonged hyperglycemia due to either the pancreas not producing enough insulin, or the cells of the body not responding properly to the produced insulin [1]. It is a major public health problem that is approaching epidemic proportions worldwide [2] and largely associated with lifestyle changes in emerging economies, a double edged sword [3]. Globally, diabetes has killed 4.6 million people in 2013 alone [4]. More than 77% of morbidity [5] and 88% of mortality [6] due to DM occur in low- and middle-income countries.

Different researchers had shown that poor glycemic control of DM leads to micro vascular and macro vascular complications. However, lowering hemoglobin A1c (HbA1c) concentrations by tight glycemic control significantly reduces the rate of progression of micro vascular complications. For instance, dropping HbA1c from 9.1–7.3% reduces the risk of macro vascular disease by 41%, retinopathy by 63% and neuropathy by 60% and nephropathy by 54%. Every increase in HbA1 can increase the cardiovascular event rate by up to 18% and the micro vascular event rate by up to 30% [7-9].

Evidences showed that the magnitude of poor glycemic control in DM patients in different parts of the world is high. For instance, a study conducted in Malaysia showed 75.3%, in Spain 45%, in Jordan 65.1% and in Ethiopia 94% [10-13]. The standard DM management in sub-Saharan Africa (SSA) was extremely limited because of insufficient healthcare systems; scarcity of professionals with satisfactory training in DM diagnosis and treatment; scarcity or unaffordability of medication, glucometer strips and scarcity of diagnostic tools and other equipment [14-15]. Moreover, health care in SSA is epidemiologically known with a high burden of communicable diseases and scarcity of financial and human resources. DM presents an additional challenge by accounting for the 75% of deaths in people due to DM under the age of 60 annually [6,16].

For provision of standard care for the patients, objective information regarding the magnitude of poor glycemic control is needed. However, studies on the assessment of glycemic control using HbA1c in Ethiopia are very scarce. Limited research done on glycemic control and its associated factors among glucometer user and non-user DM patients in the study area. Therefore, the finding of this study will fill the information gap about glycemic control and its associated factors among
glucometer user and non-user DM patients as a point of care testing.

Methods and materials

Study design, settings

A prospective comparative cross-sectional study was conducted in Ayder comprehensive specialized hospital on DM patients from March 1 to April 30, 2017. The hospital is found in Mekelle town, Tigray region, Northern part of Ethiopia. It is located around 780 kilometers from Addis Ababa, the capital city of Ethiopia. The city has one referral hospital, three general hospitals. It serves up to 8 million populations in its catchment areas of the Tigray region, North-eastern Amhara and Northern Afar regions.

Participants and sample size

All type I and type II DM patients’ age ≥ 18 years old on follow up who were glucometer users as point of care testing (POCT) and non-glucometer users were targeted. Patients using glucometer as POCT ≥ 6 months were included in the study as adequate time needs for assessing adherence. Those who were critically ill, severe mental illness, newly diagnosed DM patients, other chronic diseases (Thyroid dysfunction, AIDS, Liver problem) were excluded from the study.

The sample size was determined using the two population means formula with specified precision by Open-Epi version 2.3 statistical software based on the following assumptions: the mean and standard deviation (SD) of glucometer users and non-users, (HbA1c) were (9.5,2.4) and (10.5,3.1) respectively [17].

The desired degree of precision was 5%, 95% confidence interval and for 90% power value is 1.28. An equal number of the sample size was taken from each group. So that a total sample size was (168+168) = 336. From both groups’ age and gender matched quota sampling technique was used.

Data collection and laboratory methods

Study participants were given an orientation on the protocol and specific details concerning participation in the study. Data was collected by trained nurses using a pre-tested and structured questionnaire. Anthropometric measurements were taken using standardized techniques and calibrated equipment. Weight was taken to the nearest 0.1 kg. Height was measured using a stadiometer to the nearest 0.5 centimeter. Every patient was aware of the fasting for a minimum of 8 hours prior to the laboratory test. Verbal confirmation was obtained prior to the blood test. Clinical characteristics of Type 1 and Type 2 DM patients were collected from the hospital chart.

Five milliliters of venous blood was drawn from each patient using a disposable plastic syringe by senior laboratory technologist. About two milliliters of venous blood poured into EDTA test tube for the determination of HbA1c. The HbA1c was measured by Huma Meter analyzer (HUMAN Diagnostics, Germany). About three milliliters of venous blood poured into Serum Separate Test tube and then centrifuged after it has been clotted. Serum fasting blood sugar (FBS) and lipid profile were measured by ABX PENTRA 400 clinical chemistry analyzer (HORIB ABX Diagnostics, France), according to the manufacturer’s procedures.

In accordance with American Diabetes Association (ADA) guidelines, glycemic status was categorized as good glycemic control if HbA1c < 7% and poor glycemic control if HbA1c ≥7%, abnormal lipid profile was also defined as Total Cholesterol (TC) ≥200 mg/dl, high density lipoprotein(HDL-c) <40 mg/dl for male, HDL-c <50 mg/dl for female, low density lipoprotein (LDL-c) ≥130 mg/dl, and Triglyceride(tg) ≥150mg/dl [18].

Data management and quality control

Two nurses and two medical laboratory technologists together with the principal investigator were involved in the data collection. Both the data collectors and supervisor were trained to keep uniformity of the data collection process, blood specimen collection, processing, and analysis. Before the actual data collection, the questionnaire was pre-tested on 5% of the study participants to check clarity, acceptability, and consistency of the structured questionnaire in Qiuha hospital. Necessary corrections were taken before the actual data collection.

To maintain the quality of test results, the standard operation procedure and manufacturer’s instructions were strictly followed. The automation was calibrated using an appropriate calibrator. Quality control materials (normal control and pathological control) were run at least once each day to verify each procedure. The frequency of quality controls and the confidence intervals were corresponding to laboratory guidelines. The results were within the range of the defined confidence limits (within ±2SD). For those results that were out of these confidence limits, correction was done based on the established procedure before reporting.

Data analysis and interpretation

All the data was cleaned, edited, coded and analyzed using SPSS version 20 statistical package. Frequencies
and cross tabulations were used to summarize descriptive statistics. Independent t-tests were used to compare the mean of laboratory test results and clinical characteristics between glucometer users and non-users of study participants. Categorical and continuous variables were described as proportions and means respectively. Bivariate and Multivariable logistic regression analysis were done to see the association between the independent variable and outcome variables. Odds ratio with 95% CI was used for measuring the strength of association. A P value < 0.05 was considered as statistically significant.

**Ethical consideration**

Ethical clearance was obtained from Ethical Review Committee of School of Biomedical and Laboratory Sciences, University of Gondar. Permission was obtained from Ayder Comprehensive Specialized Hospital medical director to conduct the study. After informing about the objective of the study and the confidentiality of the data, written consent was taken from all study participants. To ensure confidentiality of data, study participants were identified using codes and unauthorized persons were not having access to the collected data.

**Result**

A total of 336 DM patients were included in this study; of these, 168 (50%) were glucometer users. One hundred sixty (47.6%) were at the age range of 45–64 years. The mean age of participants were 49.25 ± 15.9 for glucometer users and non-users respectively. Majority, 311 (92.6%) of study participants were urban residents; 139 (41.4%) were educated college and above level; 106 (31.6%) of participants were government employees and 163 (48.5%) had medium monthly income (Table 1).

Overall 208 (61.9%) of the study participants had poor glycemic control. The poor glycemic control was significantly higher in glucometer non users 120 (71.4%) than users 88 (52.4%) [P < 0.001]. From the total study participants type -II DM patients accounts 264 (78.6%) and more than half of males 98 (55.4%) had low value of high-density lipoprotein (HDL). There was significant difference in FBS level >130mg/dl in glucometer non users 110(65.5%) than users 88(52.4%) [p = 0.020] (Table 2).

The mean HgA1c level was significantly higher among glucometer non users than users (8.4 ± 2.24 vs. 7.68 ±1.95) [p-value<0.001]. Likewise, the level of FBS was higher among glucometer non-users (176.2 ± 71.7) than users (152.3 ± 65.4) [p = 0.002]. However, the mean BMI was higher among glucometer users (24.6 ± 3.6) than non-users (23.8 ± 3.9) [P = 0.047] (Table 3). Pearson correlation test showed that HbA1c was significantly and positively correlate with total cholesterol (r = 0.283, P < 0.001), Triglyceride (r = 0.252, P < 0.001), LDL (r = 0.254, P < 0.001), and glucose (r = 0.906, P < 0.001). Whereas, it was negatively correlated with HDL level (r = -0.041, P = 0.459) (Table 4).

It was found that age, income, the number of visits in DM clinics, the level of triglyceride, level of LDL-c and non-use of glucometer were significantly associated with poor glycemic control. Those who were in medium income category had 2.5 times (AOR: 2.5; 95% CI: 1.3– 4.8) developing poor glycemic control than those who were on low income category. Participants with higher triglyceride and LDL-c level had 2.29 times (AOR: 2.29; 95%CI: 1.25- 4.2) and 4.1 times (AOR: 4.1; 95%CI: 1.48–11.4) developing poor glycemic control

### Table 1. Socio-demographic characteristics of study participants in Ayder Comprehensive Specialized Hospital, Mekelle-Ethiopia, 2017.

| Variables                      | Glucometer Users n (%) | Glucometer Non-users n (%) | Total: n (%) | P-value |
|-------------------------------|------------------------|-----------------------------|--------------|---------|
| Age (years)                   |                         |                             |              |         |
| < 25                          | 23 (13.7)               | 23 (13.7)                   | 46 (13.7)    |         |
| 25–44                         | 36 (21.4)               | 34 (20.2)                   | 70 (20.8)    | .994    |
| 45–64                         | 79 (47.0)               | 81 (48.2)                   | 160 (47.6)   | .001    |
| 65+                           | 30 (17.9)               | 30 (17.9)                   | 60 (17.9)    |         |
| Sex                           |                         |                             |              |         |
| Male                          | 89 (53.0)               | 88 (52.4)                   | 177 (52.7)   | 1.00    |
| Female                        | 79 (47.0)               | 80 (47.6)                   | 159 (47.3)   |         |
| Residence                     |                         |                             |              |         |
| Urban                         | 162 (96.4)              | 149 (88.7)                  | 311 (92.6)   | .013    |
| Rural                         | 6 (3.6)                 | 19 (11.3)                   | 25 (7.4)     |         |
| Educational status            |                         |                             |              |         |
| Unable to read and write      | 12 (11.9)               | 29 (17.3)                   | 41 (12.2)    |         |
| Write and read                | 10 (6.0)                | 7 (4.2)                     | 17 (5.1)     |         |
| Primary                       | 30 (17.9)               | 29 (17.3)                   | 59 (17.5)    | .008    |
| Secondary                     | 34 (20.2)               | 46 (27.4)                   | 80 (23.8)    |         |
| College and above             | 82 (48.8)               | 57 (33.9)                   | 139 (41.4)   |         |
| Occupation                    |                         |                             |              |         |
| Student                       | 20 (11.9)               | 21 (12.5)                   | 41 (12.2)    |         |
| Government employee           | 59 (35.1)               | 47 (27.9)                   | 106 (31.6)   | .029    |
| Private                       | 19 (11.3)               | 31 (18.5)                   | 50 (14.9)    |         |
| Merchant                      | 20 (11.9)               | 8 (4.8)                     | 28 (8.3)     |         |
| Unemployed                    | 14 (8.3)                | 13 (7.7)                    | 27 (8.0)     |         |
| Housewife                     | 24 (14.3)               | 23 (13.7)                   | 47 (14.0)    |         |
| Monthly income                |                         |                             |              |         |
| Low                           | 33 (19.6)               | 56 (33.3)                   | 89 (26.5)    | <.001   |
| Medium                        | 77 (45.8)               | 86 (51.2)                   | 163 (48.5)   |         |
| High                          | 58 (34.5)               | 26 (15.4)                   | 84 (25.0)    |         |
| Has family history of DM      |                         |                             |              |         |
| Yes                           | 55 (32.7)               | 36 (21.4)                   | 91 (27.1)    | .027    |
| No                            | 113 (67.3)              | 132 (78.6)                  | 245 (72.9)   |         |
| Marital status                |                         |                             |              |         |
| Single                        | 28 (16.7)               | 26 (15.5)                   | 54 (16.1)    | .247    |
| Married                       | 105 (62.5)              | 120 (71.4)                  | 225 (67.0)   |         |
| Divorced                      | 16 (9.5)                | 11 (6.5)                    | 27 (8.0)     |         |
| Widowed                       | 19 (11.3)               | 11 (6.5)                    | 30 (8.9)     |         |

BMI was higher among glucometer users (24.6 ± 3.6) than non-users (23.8 ± 3.9) [P = 0.047] (Table 3). Pearson correlation test showed that HbA1c was significantly and positively correlate with total cholesterol (r = 0.283, P < 0.001), Triglyceride (r = 0.252, P < 0.001), LDL (r = 0.254, P < 0.001), and glucose (r = 0.906, P < 0.001). Whereas, it was negatively correlated with HDL level (r = -0.041, P = 0.459) (Table 4).
than normal counterparts (triglyceride<150 and LDL<150) respectively. No use of Glucometer for self-monitoring had 2.7 times (AOR: 2.7; 95%CI: 1.58-4.64) risk of developing poor glycemic control than those who use glucometer for self-monitoring (Table 5).

Discussion

Diabetes is a chronic disease significantly affecting the quality of life of many people [18]. Its prevalence rate is increasing in epidemic proportion in the globe. DM incidence is predicted to increase from 2.8% in 2000 to 4.4% in 2030 across the world of all age-groups [19]. In the present study, glycemic control and its associated factors among glucometer users and non-users were evaluated in DM study participants.

In this study, 208(61.9%) of the study subjects had poor glycemic control which was comparable to studies conducted in Gondar, Ethiopia, 64.7% [20], Jimma, Ethiopia 58.2% [21] and Jordan 65.1% [22]. However, the current study was lower than other studies conducted in India (74%), Cameroon (78.6%) and Saudi Arabia(78%) [23-25]. The difference in variation might be explained by the differences in study designs, characteristics of the study populations. Furthermore, differences in race and ethnicity of the study populations, dosage for oral medication, compliance with regimens, self-monitoring of blood glucose and socioeconomic status leading to greater improvements in glycemic control in some groups but not in others. Furthermore, this study showed a higher proportion of poor glycemic control than the study conducted in Ambo, Ethiopia, which was 50% [26]. The discrepancy between the findings of the current study and Ambo might be explained by the fact that, we used the recommended [5]. HbA1c test for glycemic control, whereas in the Ambo study they used FBS. Moreover, in Ambo they included only Type 2 DM patients.

In this study Poor glycemic control was significantly higher in glucometer non users (71.4%) than glucometer users (52.4%) [P<0.001]. This finding was consistent with the studies conducted in Jamaica (61.9% vs. 52.5%) [27] and Jordan (71.4% vs. 51.1%) [13] for glucometer non users and users respectively. However, in this study, the proportion of poor glycemic control among glucometer user was higher than a study conducted in Italy 38.1% [28]. The difference might be due to, socioeconomic status which may influence diabetes management and control since it is often associated with access to health care, healthcare utilization, use of medication, and access to good nutrition.
Poor glycemic control among glucometer non-users in this study was similar to the previous study in Jordan which was 71.4% [13]. However, the current study was higher than a study conducted in Jamaica 61.9% [27]. On the other hand, this study was lower than the study conducted in Italy which was 80% [28]. The difference might be due to the difference in study design, lifestyle, and socioeconomic status, race/ethnic group leading to greater improvements in glycemic control in some groups but not in others.

In this study, non-using of glucometer was significantly associated (p = 0.000) with the poor glycemic control which was similar to the studies conducted in Germany, [29] Jordan [22], Jamaica [27] and Hawasa, Ethiopia [30]. Different studies have shown that glucometer use was associated with better glycemic control, improved medication compliance and increased the frequency of visit to health institution [18, 29]. However, the controversial result was reported from Italy where self-monitoring of blood glucose frequency/1 time per day.

Table 4. Pearson Correlation tests between lipid profiles and Glucose with HbA1c level among DM subjects in Ayder Comprehensive Specialized Hospital, Mekelle, Ethiopia, 2017.

| Variables          | T. cholesterol | Triglyceride | LDL & HDL | Glucose |
|--------------------|----------------|--------------|-----------|---------|
| HbA1c              | Correlation (r)| 0.283**      | 0.252**   | 0.254** | −0.041  |
|                   | Coefficient    | 0.000        | 0.000     | 0.000   | 0.459   |
|                   | P. value       | 0.000        | 0.000     | 0.000   | 0.000   |

*LDL- Low Density Lipoprotein, *HDL- High Density Lipoprotein.

Table 5. Factors associated with poor glycemic control among DM subjects in Ayder Comprehensive Specialized Hospital, Mekelle, Ethiopia, 2017.

| Variables          | Good: n (%) | Poor: n (%) |COR 95%(CI) | AOR 95%(CI) | P-value |
|--------------------|-------------|-------------|------------|-------------|---------|
| Age (years)        |             |             |            |             |         |
| < 25               | 14(30.4)    | 32(69.6)    | 1          |             |         |
| 25–44              | 26(37.1)    | 44(62.9)    | 1.8(0.81–3.98) |             | .67     |
| 45–64              | 62(38.8)    | 98(61.2)    | 1.7(0.58–2.36) |             |         |
| 65+                | 26(43.3)    | 34(56.7)    | 1.1(0.62–2.06) |             |         |
| Residence          |             |             |            |             |         |
| Rural              | 6(24.0)     | 19(76.0)    | 1          | 1           |         |
| Urban              | 122(39.2)   | 189(60.8)   | 2.04(0.7–5.26) | 1.78(0.59–5.3) | .064    |
| Monthly income     |             |             |            |             |         |
| Low                | 38(42.7)    | 51(57.3)    | 1          | 1           |         |
| Medium             | 51(31.3)    | 112(68.7)   | 1.6(0.96–2.79) | 2.5(1.3–4.89) | .002    |
| High               | 39(46.4)    | 45(53.6)    | 0.8(0.47–1.57) | 1.69(0.74–3.81) | .217    |
| Number of visits per last 6 months | | | | | |
| ≥ 6 times          | 95(54.2)    | 115(45.8)   | 1          | 1           |         |
| < 6 times          | 33(26.2)    | 93(73.8)    | 0.49(0.2-0.69) | 0.55(0.3–0.94) | .034    |
| Alcohol Intake     |             |             |            |             |         |
| No                 | 111(41.6)   | 156(58.4)   | 1          | 1           |         |
| Yes                | 17(24.6)    | 52(75.4)    | 2.2(1.1–3.96) | 1.5(0.75–3.0) | .343    |
| Triglyceride       |             |             |            |             |         |
| Normal (<150)      | 89(48.9)    | 93(51.1)    | 1          | 1           |         |
| High (≥150)        | 39(25.3)    | 113(74.7)   | 2.8(1.77–4.49) | 2.29(1.25–4.2) | .005    |
| LDL                |             |             |            |             |         |
| Normal (<130)      | 120(43.8)   | 154(56.2)   | 1          | 1           |         |
| High (≥130)        | 8(12.9)     | 54(87.1)    | 5.26(2.4–11.5) | 4.1(1.48–11.4) | .001    |
| Glucometer use     |             |             |            |             |         |
| Yes                | 80(47.6)    | 88(52.4)    | 1          | 1           |         |
| No                 | 48(28.6)    | 120(71.4)   | 2.3(1.45–3.57) | 2.7(1.58–4.64) | .000    |
| T. cholesterol     |             |             |            |             |         |
| Normal (<200)      | 114(45.8)   | 146(54.2)   | 1          | 1           |         |
| High (≥200)        | 14(18.4)    | 62(81.6)    | 3.45(1.84–6.49) | 1.2(0.490–2.94) | .690    |
| Hypertension       |             |             |            |             |         |
| Yes                | 71(42.5)    | 97(57.7)    | 1.4(9.6–2.219) | 1.4(8.3–2.57) | .189    |
| No                 |             |             |            |             |         |
| Type of DM         |             |             |            |             |         |
| Type II            | 102(38.6)   | 162(61.4)   | 1          |             |         |
| Type I             | 26(36.1)    | 46(63.9)    | 0.25(0.75–2.20) |             | .364    |
| Type of medication |             |             |            |             |         |
| Insulin            | 46(39.7)    | 70(60.3)    | 1          |             | .420    |
| OHA/tabs           | 86(42.4)    | 117(57.6)   | 0.63(21–1.92) |             | .303    |
| combination        | 5(29.4)     | 12(70.6)    | 0.56(19–1.67) |             |         |

Note: COR: Crude Odds Ratio; AOR: Adjusted Odds Ratio; LDL- Low-Density Lipoprotein; OHA: Oral Hypoglycemic Agents.
day has been shown significantly associated with higher HbA1c, distress, worries and depressive symptoms in non-insulin treated DM patients [31].

In this study, age has no significant association with glycemic control. The ent with similar studies conducted San Diego, USA [32], Netherlands [33], Iraq [34] and Gondar, Ethiopia [20].

In addition, DM participants that were in medium income category had 2.5 times (AOR: 2.5; 95%CI: 1.3–4.89) developing poor glycemic control than who were on low income category. This finding was similar to a study done in Haririri, Ethiopia [35].

In the present study, high triglyceride and LDL level were significantly associated with poor glycemic control. The finding was similar to a study conducted in Jordan [13] and Hawassa, Ethiopia [36]. This might be explained by the fact that chronic entry of fatty acids into β-cells (i.e. β-cell lipotoxicity) is believed to be involved in its pathogenesis and cause pancreatic β-cell failure resulting in poor glycemic control [37].

Strengths and limitations
This study determined HbA1c test which is one of the primary techniques to assess the effectiveness of the management plan on glycemic control. However, study participants were from a single hospital-based specialty clinic, thus findings could not be generalized beyond this study site.

Conclusion and recommendation
In this study, a higher proportion of DM patients had poor glycemic control. The poor glycemic control was significantly higher in non-glucometer users than glucometer users. Age, income, the number of visits, the level of triglyceride, the level of low-density lipoprotein, and glucometer non-use were significantly associated with poor glycemic control. So using glucometer for achieving glycemic control should be considered by healthcare practitioners as part of DM management and initiate DM patients to use glucometer. Implementation of HbA1c measurement in the routine follow up of DM patients as a tool for estimation of the long-term diabetes control is highly recommended.

Authors’ contributions
SM: was responsible for commencement of the idea and write up of the proposal and conduct the laboratory work. SM, SA, BB and HWB: were responsible in designing the study and drafting the manuscript. SM, SA, BB and HWB: were responsible in analysis and interpretation of the data, and correction of the final draft of the manuscript. All authors read and approved the final manuscript.

Disclosure of potential conflicts of interest

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References

[1] World Health Organization. Diabetes Fact Sheet World Health Organization, 2013; No312. Available at; http://www.who.int/en/news-room/fact-sheets/detail/diabetes
[2] Tabish SA. Is diabetes becoming the biggest epidemic of the twenty-first century? Int J Health Sci. 2007;1(2):5–5.
[3] Cheng D. Prevalence, predisposition and prevention of type II diabetes. Nutrition Metab. 2005;2:29. doi:10.1186/1743-7075-2-29.
[4] Aschner P, Beck-Nielsen H, Bennett P, Boulton A, Colagiuri R. Diabetes and impaired glucose tolerance. 5th ed. Brussels: IDF Diabetes Atlas; 2012.
[5] IDF. Diabetes and impaired glucose tolerance. 6th ed. Brussels: Diabetes Atlas; 2013.
[6] Mathers CD, Loncar D. Projections of global mortality and burden of disease from 2002 to 2030. PLoS Med. 2006;3(11): e442. https://doi.org/10.1371/journal.pmed.0030442.
[7] Selvin E, Steffes MW, Zhu H, et al. Glycated hemoglobin, diabetes, and cardiovascular risk in non-diabetic adults. N Engl J Med. 2010;362(9):800–11. https://doi.org/10.1056/NEJMoa0908359.
[8] Stratton IM, Adler AI, Neil HA, et al. Association of glycaemia with macrovascular and microvascular complications of type 2 diabetes (UKPDS 35): prospective observational study. BMJ. 2000;321(7258):405–412. https://doi.org/10.1136/bmj.321.7258.405.
[9] UK Prospective Diabetes Study (UKPDS) Group. Intensive blood-glucose control with sulphonylureas or insulin compared with conventional treatment and risk of complications in patients with type 2 diabetes. Lancet. 1998;352(9131): 837–853. https://doi.org/10.1016/S0140-6736(98)07019-6.
[10] Hasimah I, Muhamad H, Siti S, et al. Control of glycosylated hemoglobin (Hba1c) among type 2 diabetes mellitus patients attending an urban health clinic in Malaysia. Med Health Sci J. 2011;9:58–65. https://doi.org/10.15208/mhsj.2011.179.
[11] Rodriguez A, Calle A, Vazquez L, et al. Blood glucose control and quality of health care in non-insulin-treated patients with type 2 diabetes in Spain: a retrospective and cross-sectional observational study.
Diabet Med. 2011;28(6):731–40. https://doi.org/10.1111/j.1464-5491.2011.03258.x.
[12] Gill G, Gebrekidan A, English P, et al. Diabetic complications and glycemic control in remote North Africa. Oxford University Press on behalf of the Association Physicians.
[13] Maysaa K, Yousef S, Abdelkarim A, et al. Factors associated with poor glycemic control among patients with type 2 diabetes. J Diabetes Complications. 2010;24(2):84–9. https://doi.org/10.1016/j.jdiacomp.2008.12.008.
[14] Sarah W, Gojka R, Anders G, et al. Global prevalence of diabetes: estimates for the year 2000 and Projections for 2030. Diabetes Care. 2004;27(5):1047–1053. https://doi.org/10.2337/diacare.27.5.1047.
[15] World Diabetes Foundation, International Diabetes Federation, Novo Nordisk, Diabetes South Africa. Diabetes: the hidden pandemic and its impact on Sub-Saharan Africa – Document prepared for the Diabetes Leadership Forum Africa. 2010. Available at: https://www.health24.com/Medical/Diabetes/News/Diabetes-Africas-hidden-pandemic-20120721
[16] Beran D, Yudkin J. Diabetes care in sub-Saharan Africa. Lancet. 2006;368(9548):1689–95. https://doi.org/10.1016/S0140-6736(06)69704-3.
[17] Heather E, Sharon A, Alexandra A, et al. Blood Glucose Self-Monitoring Patterns in Mexican Americans: Further Lessons from the Starr County Border Health Initiative. Diabetes Technol Therapeutics. 2015;17(2):105–111. https://doi.org/10.1089/dia.2014.0147.
[18] America Diabetes Association. Standards of Medical Care in Diabetes. Diabetes Care. 2014;37(1):14–80.
[19] World Health Organization. Diabetes scale up prevention, care and control in Sub-Saharan Africa: the issue of limited access to an HbA1c test. Diabetes Africa. 2015;4:141–1870. https://doi.org/10.1186/1471-2458-5-36.
[20] Solomon M, Yemane B, Alemayehu W, et al. Level of sustained glycemic control and associated factors among patients with diabetes mellitus in Ethiopia: a hospital-based cross-sectional study. Diabetes Metabolic Syndrome Obesity Targets Therapy. 2015;8:65–71. doi:10.2147/DMSTTT.S75467.
[21] Wabe TN, Angamo MT, Hussein S. Medication adherence in diabetes mellitus and self management practices among type2 diabetics in Ethiopia. N Am J Med Sci. 2011;3(9):418–23. https://doi.org/10.4297/najms.2011.3418.
[22] Khattab M, Khader YS, Al-Khawaldeh A, et al. Factors associated with poor glycemic control among patients with type 2 diabetes. J Diabetes Complications. 2010;24(2):84–9. https://doi.org/10.1016/j.jdiacomp.2008.12.008.
[23] Harrabi I, Al Harbi F, Al Ghamdi S. Predictors of glycemic control among patients with Type 2 diabetes in Najran armed forces hospital: A pilot study. J Diabetes Mellitus. 2014;4:141–7. https://doi.org/10.4236/jdm.2014.42021.
[24] Camara A, Balde NM, Sobngwi-Tambekou J, et al. Poor glycemic control in type 2 diabetes in the South of the Sahara: the issue of limited access to an HbA1c test. Diabetes Res Clin Pract. 2015;108(1):187–92. https://doi.org/10.1016/j.diabres.2014.08.025.
[25] Gopinath B, Sri Sai Prasad M, Jayarama N, et al. Study of factors associated with poor glycemic control in Type -2 Diabetic Patients. Global J Med Public Health. 2013;2(2):235–54.
[26] Woldu MA, Wami CD, Lenjisa JL, et al. Factors Associated with Poor Glycemic Control among Patients with Type 2 Diabetes Mellitus in Ambo Hospital, Ambo; Ethiopia. Endocrinol Metab Synd. 2014;3:143. doi:10.4172/2161-1017.1000143.
[27] Francis KK, Coleman NOY, Reid MKT, et al. Relationship between self-monitoring of blood glucose and glycemic control among patients attending a specialist diabetes clinic in Jamaica. Int J Diabetes Dev Ctries. 2014;10:134–222.
[28] Franciosi M, Lucisano G, Pellegrini F, et al. role of self-monitoring of blood glucose and intensive education in patients with Type 2 diabetes not receiving insulin. A pilot randomized clinical trial. Diabetes Care. 2011;28(7):789–96. https://doi.org/10.1111/j.1464-5491.2011.03268.x.
[29] Martin S, Schneider B, Heinemann L, et al. Self-monitoring of blood glucose in Type 2 diabetes and long-term outcome: An epidemiological cohort study. Diabetologia. 2006;49(2):271–8. https://doi.org/10.1007/s00125-005-0083-5.
[30] Tesfaye D, Tessema F, Taha M. Coexistence of Chronic Complications among Diabetic Patients at Nigist Eleni Mohammed Memorial Hospital, Hossana, South Ethiopia. Open Access Library J. 2015;2(1):1–10. e1218. doi:10.4236/oalib.1101218.
[31] Franciosi M, Pellegrini F, De Berardis G, et al. The impact of blood glucose self-monitoring on metabolic control and quality of life in type 2 diabetic patients. Diabetes Care. 2001;24(11):1870–7. https://doi.org/10.2337/diacare.24.11.1870.
[32] Benoit SR, Fleming R, Philis-Tsimikas A, et al. Predictors of glycemic control among patients with Type 2 diabetes: a longitudinal study. BMC Public Health. 2005;5:36. https://doi.org/10.1186/1471-2458-5-36.
[33] Goudswaard AN, Stolk RP, Zuidhoff P, et al. Patient characteristics do not predict poor glycemic control in type 2 diabetes patients treated in primary care. Eur J Epidemiol. 2004;19(6):541–5. https://doi.org/10.1023/B:JEPI.0000032351.42772.e7.
[34] Mansour AA, Aal-Maliky A, Kasem B. Determinants of loss of glycemic control in patients with type 1 diabetes mellitus. Prospective cohort study from Iraq. J Diabetes Res Clin Metab. 2013;2(1):1–4. doi:10.7243/2050-0866-2-21.
[35] Ayele K, Tesfa B, Abebe L, et al. Self care behavior among patients with diabetes in Harari, Eastern Ethiopia. The Health Belief Model Perspective. PLoS One. 2012;7(4):e35515. https://doi.org/10.1371/journal.pone.0035515.
[36] Henock A, Tekalew S, Kinfe L. Dyslipidemia among diabetic patients in Southern Ethiopia: Cross-sectional study. J Diabetes Endocrinol. 2015;6(4):19–24. https://doi.org/10.5897/JDE2015.0086.
[37] Unger R. Lipotoxicity in the pathogenesis of obesity-dependent NIDDM. Genetic and clinical implications. Diabetes. 1995;44(8):863–70. https://doi.org/10.2337/diab.44.8.863.