# Predictors of Glycaemic Control among Ghanaian Type 2 Diabetes Patients Using Diabetes Self-Management Approach

***Original Research Article***


## ABSTRACT

**Aims:** Management of a complex metabolic disease like diabetes can be very challenging since it involves a careful combination of medication, exercise, diet and regular monitoring of blood glucose in order to achieve good glucose control. The study aimed at determining predictors of glycaemic control of type 2 diabetes patients using diabetes self-management approach.
**Study Design:** A Cross-sectional study.
**Place and duration of study:** Diabetes clinic at two selected district hospitals in Ashanti region of Ghana.
**Methodology:** A structured questionnaire was used to collect demographic, medical history and dietary information. A validated Diabetes Self-Management Questionnaire was also used. Serum glycated haemoglobin ($HbA_{1c}$) was used as the standard for glycaemic control.
**Results:** Mean glycated haemoglobin level for study participants was 7.2%±0.2. Optimal glycaemic control was significantly associated with diabetes self-management (r= -0.428), diabetes-related distress (r= 0.381) and acceptance and action on diabetes (r= 0.316). In. addition to the above associations, diabetes self-management (β= -0.297, p=0.007) and diabetes-related distress (β= 0.219, p=0.028) could significantly predict glycated haemoglobin but not acceptance and action on diabetes (β= 0.046, p=0.665).
**Conclusions:** All the three study variables correlated with glycated haemoglobin of study participants but only diabetes self-management and diabetes-related distress had predictive value. Further, an epidemiological study is needed to ascertain the strength of the effects. Various health stakeholders should encourage diabetes patients to understand the importance of diabetes self-management which may help in better glycaemic control, disease management and better quality of life.



*Keywords: Predictors; glycemic control; Ghana; diabetes; diabetes self-management.*


## ABBREVIATIONS

*DSM - Diabetes Self-Management*
*BMI - Body Mass Index*
*$HbA_{1c}$ - Glycated Haemoglobin*
*DSMQ - Diabetes Self-Management Questionnaire*
*PCA - Principal Component Analysis*
*DDS - Diabetes Distress Scale*
*AAD - Acceptance and Action on Diabetes*

## 1. INTRODUCTION

Diabetes is a significant global health problem because it affects a large proportion of the world's population, which is estimated at approximately 48.8 million people or 18.3% of the world's population. Of the types, type 2 diabetes accounts for 90 to 95% of all diagnosed cases of diabetes in adults [1]. The prevalence of diabetes has reached a nearly epidemic level with about 425 million people between age 20 and 79 years in the world having the disease in


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2017. The number is estimated to rise to 629 million by 2040 [2]. The developing world is not left out in this epidemic as it has been reported that the prevalence is increasing considerably in developing countries [3].

In Ghana, the International Diabetes Federation reports that a total of 266,200 representing 1.9% of adult age 20 years to 79 years were estimated to have diabetes in 2015 [4]. Ghana also recorded 8,529 diabetes-related deaths in the same year. These figures are expected to double over the next two decades, thereby threatening most of the development success attained by Ghana and Africa at large [4].

Diabetes mellitus management aims at glycemic control, prevention of acute and chronic complications and enhancing the quality of life for patients [5] and currently, programs to educate people about diabetes self-management have become the focus of attention among health care professionals especially for type 2 diabetes individuals [6]. Management of a complex metabolic disease like diabetes can be very challenging since it involves a careful combination of medication (orthodox or herbal therapy), regular exercise, weight management, diet and regular monitoring of blood glucose in order to achieve good glycaemic control [7, 7b]. Diabetes as in the case of other chronic disease requires that the patient takes control of a greater part of the treatment responsibilities. This includes making some lifestyle modifications in terms of diet and exercise and also adherence to medication regimen. Though proper management of diabetes improves glycaemic control, some studies have reported the association between non-compliances of treatment schedules and poor glycaemic control in some patients [8, 9]. A study involving 276 diabetes patients in Ethiopia reported 24.3% prevalence of non-adherence of treatment schedules [10]. Low adherence rates among diabetes patients should be taken seriously since the consequences of poor management are devastating [11].

Health programs to support diabetes patients to manage their conditions over the years have produced encouraging results and as a matter of fact, considered as a requirement for successful diabetes management notwithstanding the individual's specific needs [12]. The outmoded system whereby patients are given information with the aim of improving their knowledge on their conditions is gradually being taken over by current systems that focus on changing the behaviour of patients and empower them with adequate skills to be able to manage their condition (also known as self-care) [13]. As a result of this, a number of national guidelines on the management of diabetes including that of the American Diabetes Association consider self-management as a major part of good diabetes management [14, 15].

There are contradictions in diabetes patients' capabilities to undertake self-management activities [16]. In one study, 0.8% of diabetes patients reported that they did not practice self-monitoring of blood glucose weekly and 21.1% said they did not monitor their blood glucose monthly [16]. Also, in another study, there was low adherence to medication, exercise and diet plans. Patients were not also committed to taking care of their feet and monitoring their blood glucose [17]. However, a study by Arcury et al. [18] reported that diabetes patients who followed diet and exercise plans took their medication, took care of their feet and monitored their blood glucose had good glycaemic control. A study by Nyunt et al. [19] showed, self-efficacy was high (62.0%) but few patients (30.8%) practiced good self-care behaviours [19]. These studies together suggest that diabetes patients practice various levels of self-management and care.

However, the ability of a patient to practice adequate self-management of the condition may be associated with levels of knowledge and understanding of the disease. Studies carried out on knowledge of patients with diabetes about their disease condition have reported knowledge deficits in the areas of medication administration, glucose testing, diet planning and appropriate foot care among adults and children with diabetes [ 20, 21]. Moreover, the likelihood that diabetes patients will put their knowledge and understanding of the disease into appropriate self-management practices is also dependent on their level of self-efficacy.

If better knowledge and understanding of diabetes lead to higher self-efficacy of self-management then adequate self-management should lead to better glycaemic control. This expectation is confirmed by the available literature. A recent study in Jordan reported a mean score of 62% for self-management and concluded that diabetes self-care correlated with but did not predict $HbA_{1c}$ levels [17] whereas a previous study reported an overall mean score of 80% for self-management of type 2 diabetes patients in Toronto, Canada [22]. Another study involving 223 subjects with type 2 diabetes

concluded that self-management was a better predictor of $HbA_{1c}$ [23]. Also, a study involving 266 type 2 diabetes patients revealed that 30.8% had good self-management behaviour and self-management emanating from exercise was found to significantly predict glycaemic control [19].

Diabetes-related distress among type 2 diabetes patients is a prevalent emotional state as a result of lifelong daily demands in terms of adherence to medication, diet and physical activity, and frequent monitoring of blood glucose [24, 25]. These emotional conditions are related to a situation of high morbidity and deaths [26]. Most studies conducted usually consider diabetes-related distress in relation to diabetes management and metabolic disorders and somehow with regards to social support [24]. A prospective study involving depression and glycemic control among type 2 diabetes patients reported that depression was significantly related to high blood glucose or poor glycemic control [27]. Another study by Ramkisson et al. [28] conducted in South Africa, which investigated the association between diabetes-related distress and glycemic control revealed a significant relationship. Also, a study that assessed diabetes-related distress among diabetes patients identified that more than half of the patients reported having distress relating to at least one of the diabetes-related activities [29]. A cross-sectional study of 165 patients with type 2 diabetes concluded that there was a significant relationship between distress and $HbA_{1c}$ in type 2 diabetes [30].

The exigencies of diabetes self-care (adherence to medication, exercise, diet, and self-monitoring of blood glucose) cause diabetes patients to avoid, deny or take their minds of any fears or worries that they have diabetes and they consider the routine diabetes self-management as reminders that they have the condition. This could lead to good glycaemic control and subsequently reduce the risk of diabetic complications. For instance, a randomized control trial involving 81 type 2 diabetes patients showed a positive impact of changes in diabetes acceptance on $HbA_{1c}$ [31]. A recent study conducted by Schmitt and colleagues concluded that higher diabetes non-acceptance had a significant correlation with decreased self-care and higher $HbA_{1c}$, and higher diabetes-related distress [32]. Also, non-acceptance had a higher correlation with diabetes self-care and glycaemic control and could predict the above better than diabetes distress [32].

Notwithstanding the above, other factors such as duration of diabetes, gender, age, total cholesterol, Body Mass Index (BMI), and HDL levels, have been found to influence glycaemic control [33]. This study, therefore, sought to ascertain the diabetes self-management knowledge, skills, and practices among type two diabetes patients attending some selected diabetes clinics and how that is reflected in their glycaemic control, especially in Ghanaian setting where information on diabetes self-management is lacking. It, therefore, bridges the gap between knowledge, policy, and practices for diabetes and provides some information that will contribute to ensuring that future national guidelines and programs for diabetes management in Ghana include self-management.

## 2. MATERIALS AND METHODS

### 2.1 Study Design and Period

A cross-sectional study design was employed in 2015 to ascertain diabetes non-acceptance, self-management and related distress and how these impact on diabetics' glycaemic control. Data collection was done through a face-to-face interview and medical records review between July and September 2015 at Ejisu government hospital and Kumasi South hospital.

### 2.2 Study population and Eligibility

The study population included outpatient with diabetes attending diabetic clinics of the two hospitals. The outpatient diabetic clinic registers of the two hospitals were used as the sample frame after the inclusion criteria were applied. The inclusion criteria included: 1) an adult (18 years and above), 2) known type 2 diabetes patients, 3) duration of diabetes should be at least year, and 4) accept to participate in the research. Exclusion criteria included: 1) diabetes pregnant women, 2) Gestational diabetes patients and type 1 diabetics, 3) Inpatient diabetics, 4) Newly diagnosed diabetes patients, and 5) diabetes patients with some form of severe mental or cognitive retardation.

### 2.3 Ethical Consideration

Approval from the Committee on Human Research, Publication and Ethics at the School of Medical Sciences and Komfo Anokye Teaching Hospital and the selected hospitals was obtained (CHRPE/AP/308/15). Then the

participant information leaflet was given to study subjects who could read after which the consent form was signed. However, for subjects who could not read, the participant information leaflet was translated to them in a language that they understood and their consent sought by a thumbprint before participating in the study. Participants were informed that participation in this study was voluntary and would not affect their medical treatment, and that withdrawal from the research was without any consequences.

## 2.4 Sampling Method

Simple random sampling was used to recruit participants at the two health facilities. Simple random sampling was used to select type 2 diabetes patients from the diabetes clinic record to partake in the study. Some participants selected declined, so another random selection was done to recruit new participants. In this sampling, the names of the study population collected from the clinic record book were written on a piece of paper and placed in a bowl. An independent, unknown person was chosen to select participants from the bowl. These participants were called on the phone and the study protocol and aim was explained to them to partake in the study.

## 2.5 Data Collection Tools

The questionnaire that was used in the data collection during this study had four sections. The first part solicited demographic information such as age, sex, ethnic background, marital status, number of household members, educational background, occupation, duration and type of diabetes and patient understands of diabetes. The second section collected clinical data which included; systolic and diastolic blood pressure, a 24-hour dietary recall and blood glucose levels recorded in the morning of the data collection. The frequency of urination during day and night, other medical conditions (co-morbidities), and anti-diabetes medication formed the third section.

### 2.5.1 Diabetes self-management questionnaire

The final section of the questionnaire used for this study was the Diabetes Self-Management Questionnaire (DSMQ) developed by Schmitt et al. [34] at the Research Institute of the Diabetes Academy Mergentheim to aid the collection of appropriate data that can be used to evaluate self-care behaviours and relate them to glycated haemoglobin levels. The validated scale for full psychometric assessment regarding diabetes has 16 items and 4 subscales: healthcare patronage (3 items; 3,7,14), glucose management (5 items; 1,4,6,10,12), physical activity (3 items; 8,11,15) and dietary control (4 items; 2,5,9,13) and item 16 is the patient's overall rating of his/her diabetes self-management and it is added to the 'Sum Scale' score. In terms of what is regarded as effective diabetes self-care, seven items are formulated positively and the remaining nine negatively. The DSMQ has a four-point Likert scale that starts from 0= does not apply to me, 1= applies to me to some degree, 2= applies to me to a considerable degree and 3=applies to me very much. For individual analysis to be possible, a box is put below each item for ticking if that item is not required in their treatment.

During the scoring, all negative word items were reversed such that higher score indicated more effective self-care. Sums of item scores were calculated to give scale scores and then converted into a scale that ranges from 0 to 100 (raw score/theoretical maximum score *100). In a situation where 'it is not required as part of my treatment' is marked, that item is excluded from the calculation and the theoretical maximum scores reduces accordingly. At the end of the data collection, all responses were converted so that the higher the scores, the more effective one's self-care. Schmitt et al. [34] reported the Cronbach's alpha for DSMQ as 0.84 while this research had 0.71 as its Cronbach's alpha.

The section of the questionnaire employed the use of The Diabetes-related Distress Scale (DDS) which was developed by Polonsky et al. [35]. DDS contains 17-items with four subscales: physician-related distress (4 items), emotional burden (5 items), family distress relating to diabetes care (3 items) and regimen distress (5 items). This scale has six points Likert scale that starts from 1= not a problem to 6=A very serious problem and the scores for each patient were calculated by summing all the scores and dividing by the number of items the participant responded to. It, therefore, gives a sum score range from 1 to 6. A higher sum score indicates great distress and the cut-off point that requires clinical attention is ≥ 3 [35]. For the diabetes distress scale, the Cronbach's alpha was 0.95 [35] but this study recorded a Cronbach's alpha of 0.925 indicating good internal consistency and reliability.

Another section of the study questionnaire was on diabetes non-acceptance where the Acceptance and Action Diabetes Questionnaire developed by Gregg et al. [31] and validated and evaluated by Schmitt et al. [32] was used. The questionnaire has a seven-point Likert scale (1= never true to 7=Always true) on which study subjects indicated the extent to which they go through a number of diabetes non-acceptance behaviours. The sum score was calculated by adding the eleven items score and then dividing by eleven (number of items) which produced sum scores ranging from 1 to 7. Higher values after adding up item scores showed greater non-acceptance and sum score greater than 3 indicated non-acceptance [32].

### 2.6 Glycated Haemoglobin Assessment

Participants who agreed on the phone conversation to partake in the study were told to fast overnight so that blood sample can be taken from them when attending the diabetes clinic. Blood samples were taken early in the morning. Three ml of venous blood samples of patients were collected and their glycated haemoglobin determined using Fast Ion-Exchange Resin Separation Method. HbA1c < 6.5% was referred as normoglycaemia and HbA1c ≥ 6.5% was termed as hyperglycaemia [36].

### 2.7 Data Analysis

Data collected from the study participants were entered into the Statistical Package for Social Sciences (SPSS version 20) for analysis. Outliers and missing data were checked by screening and cleaning the data. No outlier was identified but there was one missing data on $HbA_{1c}$ for one participant. This occurred as a result of phlebotomist inability to draw blood from the patient after several attempts due to collapsed veins. Characteristics of study participants and scales were described by using descriptive analyses that indicated percentages, frequencies, means, standard error of means and standard deviations. Means of variables for various groups were compared by deploying the use of ANOVA and any comparison with a p-value less than 0.05 was referred to as statistically significant. To measure the correlation between DSM, AAD, DDS, and $HbA_{1c}$, Pearson correlation analysis was done. Pearson analysis was also done to evaluate the association between subscales of the various instruments as well as the relationship between age, BMI, duration of diabetes, DSM and $HbA_{1c}$. The reliability test was also conducted to check the internal consistency and reliability of the DMSQ, AAD and DDS tools. To ascertain the predictors of good glycemic control or $HbA_{1c}$, standard multiple linear regression analysis was done.

## 3. RESULTS

### 3.1 Sociodemographic Characteristics of Study Participants

A total of 115 were involved in the study and as shown in Table 1, female patients represented 71.3% of the patients sampled. In terms of education, 68.7% of respondents had senior high school and below education whilst 13.9% never had any education at all. The mean number of people living in the households of respondents was 6.1±0.31 and 50.4% of them lived with their immediate family members. Also, out of the 115 respondents, 20.0% widowed, 12.2% divorced and then 0.8% were single. The majority (55.7%) had hypertension and 50.4% had lost usual weight due to diabetes, while 52.2%, 29.6% showed symptoms of high blood glucose and frequent urination/thirst respectively (Table 1).

### 3.2 Anthropometric and Biochemical Parameters of Participants

Participant's mean age was 58.4 years but the mean age for males was 0.8 years higher than that of females. There was a significant (p=0.004) difference between male and female diabetes patients in terms of their body mass index (BMI), with females having a higher BMI than males (Table 2).

**Table 1. Socio-demographic characteristics of participants**

| Variable | Number of participants (%) |
|---|---|
| **Gender** | |
| Male | 33 (28.7) |
| Female | 82 (71.3) |
| **Marital status** | |

| | |
|---|---|
| Married | 77 (67.0) |
| Widowed | 23 (20.0) |
| Single | 1 (0.8) |
| Divorced | 14 (12.2) |
| **Educational level** | |
| Primary | 22 (19.1) |
| Junior high | 31 (27.0) |
| Senior high | 26 (22.6) |
| Tertiary | 15 (13.0) |
| Informal | 5 (4.3) |
| None | 16 (13.9) |
| **Patients living with**; | |
| Immediate family members | 58 (50.4) |
| Both immediate and external relations | 57 (49.6) |
| **Symptoms and co-morbidities** | |
| Gained weight | 39 (33.9) |
| Lost weight | 58 (50.4) |
| High Blood glucose ($HbA_{1c}$) | 60 (52.2) |
| Frequent Urination/Thirst | 34 (29.6) |
| Fatigue, dizziness, and Hunger | 7 (6.1) |
| At least two of the above | 4 (3.5) |
| No idea | 10 (8.7) |
| Co-morbidities | |
| Hypertension | 64 (55.7) |
| No co-morbidity | 34 (29.6) |

**Table 2. Clinical characteristics of Study participants**

| Variable | N | Mean (SEM) | Males | Females | P-value |
|---|---|---|---|---|---|
| Duration of diabetes (years) | 115 | 6.7 (0.57) | 7.9 | 6.2 | 0.175 |
| Age (years) | 115 | 58.4 (1.10) | 59.0 | 58.2 | 0.725 |
| $HbA_{1c}$ (%) | 114 | 7.2 (0.20) | 7.7 | 7.0 | 0.080 |
| Fasting blood glucose (mmol/L) | 115 | 9.9 (0.40) | 9.2 | 10.1 | 0.323 |
| Systolic blood pressure (mmHg) | 115 | 135.4 (1.87) | 133.8 | 136.1 | 0.579 |
| Diastolic blood pressure (mmHg) | 115 | 83.3 (0.97) | 83.7 | 83.1 | 0.785 |
| Body Mass Index ($Kg/m^2$) | 115 | 27.1 (0.58) | 24.6 | 28.2 | 0.004 |
| Weight (Kg) | 115 | 68.1 (1.40) | 67.0 | 68.5 | 0.614 |
| No. of household members | 115 | 6.1 (0.31) | 5.9(0.58) | 6.1(0.37) | 0.807 |

*P-value is significant at $p < 0.05$*

### 3.3 Diabetes Self-management Score and Its Association with Glycaemia

Table 3 presents the principal component analysis of diabetes self-management score (DSM). The principal component analysis showed six components and with percentage of variances: 31.6%, 10.6%, 10.0%, 8.2 %, 6.9% and 6.6%. Also, six patterns were developed which consisted of excellent self-management (pattern 1), poor diet, healthcare and poor glucose control (pattern 2), good glucose management and poor physical activity (pattern 3), good dietary management (pattern 4), poor diet, good health, admitted poor overall self-management (pattern 5) and good diet but poor healthcare (pattern 6). The patterns were grouped according to correlation coefficient factor ≥ 0.3 for positive and negative values. Prior to performing principal component analysis, the suitability of the data for factor analysis was assessed (Table 3).

Among the six patterns, only excellent self-management had significant inverse correlation with $HbA_{1c}$ ($r = -0.49$, p-value < 0.05) (Table 4).

### 3.4 Association between Study Variables

When the correlation was controlled for age, gender, duration of DM, BMI and metformin use the association between $HbA_{1c}$ and other study variables were as follow; diabetes self-management ($r = -0.419$), diabetes-related distress ($r = 0.368$) and acceptance and action on

diabetes scores (r= 0.342) with statistical significance (p<0.01) (Table 5).

Findings of correlation analysis revealed total score DSM had strong, positive correlation with dietary score (r= 0.799, p < 0.01), glucose management score (r= 0.671, p < 0.01), healthcare score (r= 0.675, p < 0.01) and physical activity score (r= 0.669, p < 0.01). HbA1c had inverse correlation with total score DSM (r= -0.428, p < 0.01), glucose management score (r= -0.415, p < 0.01), healthcare score (r= -0.386, p < 0.01) and physical activity score (r= -0.328, p < 0.01) (Table 6).

### 3.5 Predictors of $HbA_{1c}$ (Glycemic control)

The prediction model was statistically significant (F=10.63, p<0.001, $R^2$ =0.225) and explains 22.5% of the variability in $HbA_{1c}$ level. The level of $HbA_{1c}$ or glycaemic control was predicted by diabetes self-management and diabetes-related distress with diabetes self-management being the strongest predictor (β=-0.297, p=0.007) and then diabetes-related distress (β=0.219, p=0.028). However, acceptance and action on diabetes could not predict glycaemic control in the study participants (Table 7).

## 4. DISCUSSION

This cross-sectional study explored predictors of glycaemic control among Ghanaian type 2 diabetes patients using the diabetes self-management approach. Mean age of 58.4 years was higher as compared to the results reported in two previous studies [37, 38]. Majority of the respondents were women which is consistent with two recent studies involving type 2 diabetes patients [16, 39]. Women tend to seek health care more than men, and since the study was carried out at the outpatient diabetes clinic, they represented the greater proportion of the sampling frame [39]. The result also conforms to the report by Wild et al. [40], which states that although diabetes prevalence in men is high, there are fewer men with diabetes than women. The illiteracy rate was lower than the national average of 23.5%, and this could be attributed to the fact that the study areas were urban in nature. Moreover, the prevalence of diabetes has been found to be linked to increasing educational level [41].

**Table 3. Principal Component Analysis of Diabetes Self-Management scores**

| Variable | Component Matrix[a] | | | | | |
|---|---|---|---|---|---|---|
| | Component pattern | | | | | |
| | **Component 1** | **Component 2** | **Component 3** | **Component 4** | **Component 5** | **Component 6** |
| | Excellent self-management | Poor diet, poor healthcare, poor glucose control | Good glucose management, poor PA | Good dietary management | Poor diet, good health care, admitted poor overall Self-management | Good diet but poor healthcare |
| % Variance | 31.6 | 10.6 | 10.0 | 8.2 | 6.9 | 6.6 |
| I check my blood sugar levels with care and attention. Blood sugar measurement is not required as a part of my treatment. | 0.79 | | 0.31 | | | |
| The food I choose to eat makes it easy to achieve optimal blood sugar levels. | 0.65 | | | 0.38 | | 0.36 |
| I keep all doctors' appointments recommended for my diabetes treatment. | 0.65 | | | | | -0.38 |
| I take my diabetes medication (e. g. insulin, tablets) as prescribed. | 0.72 | | | | | |
| Occasionally I eat lots of sweets or other foods rich in carbohydrates. | | 0.58 | | -0.36 | 0.31 | |
| I record my blood sugar levels regularly (or analyse the value chart with my blood glucose meter). | 0.78 | | | | | |
| I tend to avoid diabetes-related doctors' appointments. | -0.40 | | | | -0.40 | 0.66 |
| I do regular physical activity to achieve optimal blood sugar levels. | 0.65 | | -0.48 | | | |
| I strictly follow the dietary recommendations given by my doctor or diabetes specialist. | 0.59 | | -0.34 | | | |
| I do not check my blood sugar levels | -0.41 | | -0.50 | 0.53 | | |

| Component Matrix[a] | | | | | | |
|---|---|---|---|---|---|---|
| **Variable** | **Component pattern** | | | | | |
| | **Component 1** | **Component 2** | **Component 3** | **Component 4** | **Component 5** | **Component 6** |
| frequently enough as would be required for achieving good blood glucose control. | | | | | | |
| I avoid physical activity, although it would improve my diabetes. | -0.54 | | 0.51 | 0.42 | | |
| I tend to forget to take or skip my diabetes medication (e. g. insulin, tablets). | -0.36 | 0.44 | -0.49 | | | |
| Sometimes I have real 'food binges' (not triggered by hypoglycaemia). | | 0.82 | | | | |
| Regarding my diabetes care, I should see my medical practitioner(s) more often. | | -0.33 | | | 0.71 | |
| I tend to skip planned physical activity. | -0.59 | | 0.41 | 0.31 | | |
| My diabetes self-care is poor. | -0.66 | | | | .40 | |

*PA-Physical activity*

**Table 4. Association between Principal Component Analysis (PCA) components and $HbA_{1c}$**

| Components | $HbA_{1c}$r (P-value) |
|---|---|
| Excellent self-management | -0.49** (0.000) |
| Poor diet, poor healthcare, poor glucose management | -0.01 (0.903) |
| Good glucose management, poor PA | -0.06 (0.477) |
| Good dietary management | -0.05 (0.546) |
| Poor diet, good health care, admitted poor overall self-management | -0.03 (0.743) |
| Good diet but poor healthcare | -0.04 (0.683) |

***P-value is significant at p < 0.05 (sig. 2-tailed), r- Pearson correlation co-efficient*

**Table 5. Summary of inter-correlation among study variables (adjusted)**

| | 1 | 2 | 3 |
|---|---|---|---|
| HbA1C (%) | | | |
| Self-management | -0.419** | | |
| Diabetes-related distress | 0.368** | -0.431** | |
| Acceptance and action on diabetes | 0.342** | -0.584** | 0.428** |

*** - Correlation is significant at* p < *0.01 level (2-tailed).*

*Control Variables: age & gender & duration of diabetes & BMI (Kg/m$^2$) & metformin*

**Table 6. Association between glycemic control ($HbA_{1c}$) and Diabetes Self-Management and subscales score (adjusted)**

| Variable | | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| $HbA_{1c}$ (%) | Pearson Correlation | | | | | |
| | Sig. (2-tailed) | | | | | |
| Total Score DSM | Pearson Correlation | -.428** | | | | |
| | Sig. (2-tailed) | .000 | | | | |
| Glucose | Pearson Correlation | -.415** | .799** | | | |
| Management Score | Sig. (2-tailed) | .000 | .000 | | | |
| Dietary Control Score | Pearson Correlation | -.167 | .671** | .259** | | |
| | Sig. (2-tailed) | .076 | .000 | .005 | | |
| HealthCare Score | Pearson Correlation | -.386** | .675** | .544** | .263** | |
| | Sig. (2-tailed) | .000 | .000 | .000 | .004 | |
| Physical Activity | Pearson Correlation | -.328** | .669** | .429** | .269** | .273** |
| Score | Sig. (2-tailed) | .000 | .000 | .000 | .004 | .003 |

***- Correlation is significant at p < 0.01 level (2-tailed), DSM-Diabetes Self-Management, Control Variables: age & gender & duration of diabetes & BMI (Kg/m$^2$) & metformin*

**Table 7. Predictors of glycated haemoglobin**

| Variable | B | Std. Error | Beta | t value | P-value |
|---|---|---|---|---|---|
| Constant | 10.091 | 1.954 | | 5.164 | .000 |
| Self-management | -0.053 | .019 | -0.297 | -2.745 | .007 |
| Diabetes-related distress | 0.781 | .352 | 0.219 | 2.222 | .028 |
| Acceptance and action on diabetes | 0.077 | .176 | 0.046 | .434 | .665 |

*P-value is significant at p < 0.05.*

A greater proportion of study participants (52.2%) had poor glycaemic control; HbA1c above 6.5% and that does not conform to International Diabetes Federation recommendation that stipulates that HbA1c less than 6.5% is a desirable goal for diabetes management. This finding is lower to that reported by Asamoah-Boakye et al. [42] in Ghana, and Ahmad et al. [43] in Malaysia, where 64.6% and 76.7% respectively of diabetes patients respectively had poor glycaemic control. The relatively high poor glycemic control among study participants could be attributed to the fact that 62.6% of them were either overweight or obese since people in this group have been associated with poor glycemic control. Generally, participants were taking anti-diabetes medication and none were on insulin therapy. A greater proportion of them (89.6%)

were on metformin either as a single drug or in combination with other anti-diabetes medication.

The PCA analyses identified 6 components, which explained a very higher percent variability of 73.9% in the study population, higher than in similar a study, which used PCA analysis of DSMQ responses and explained 61% of variability (39). This implies that the 6 DSM patterns observed were adequate to explain the reported behaviour of the majority of the study participants. Also, the first pattern revealed in the PCA had a strong positive association with positive self-management practices and a strong negative association with negative self-management behaviour in all the four subscales. The strong negative correlation between this pattern of diabetes self-care and $HbA_{1c}$ indicates that a combination of all the four parts of diabetes self-management is the best way to ensure that diabetes patients have their blood glucose under control. All positive coefficient values in the component matrix show participants were likely to practice responses given on diabetes self-management questions and negative coefficient values mean participants were unlikely to follow/practice responses given on diabetes self-management questions. Likewise, the PCA component (pattern) reflecting excellent DSM showed a negative correlation with $HbA_{1c}$ ($r = -0.495$, $p<0.001$). This means that whichever way things are looked at, good overall diabetes self-management is associated with a good glycaemic control. Also, the other PCA component only reflected good or poor management in specific areas of DSM scale and not on all four areas. Our analysis did not show any significant association between these patterns, reflecting specific areas of diabetes management and glycaemic control. This goes to confirm that good overall management in all the four areas of diabetes self-management and not just some areas is needed to control glycaemia among the study participants. Since the PCA takes into account any inter-correlations between variables in the model (in this case 16 variables of the DSMQ), the patterns observed may reflect the true patterns of DSM practices in the study population. So, the findings of the correlations between the PCA patterns and $HbA_{1c}$ may be truer than that of the mere mean scores for the four areas of the DSMQ. Thus, our logical explanation above may hold.

Pearson Correlation analysis adjusted for age & gender & duration of diabetes & BMI & metformin use revealed a statistically significant negative relationship between $HbA_{1c}$ and diabetes self-management ($r= -0.419$, $p< 0.001$) which is consistent with the result of Schmitt et al. [34]. Patients' health care seeking behaviour was the second strongest correlation with $HbA_{1c}$ and this could be linked to the fact that patients who are regular at diabetes-related appointment stand a higher chance of receiving adequate information on how to manage their condition and this could translate into good self-care and subsequently good glycaemic control. Also, diabetes-related distress ($r= 0.368$, $p< 0.001$) and acceptance and action on diabetes scores ($r = 0.342$, $p< 0.001$) had weak, positive correlation with $HbA_{1c}$. This means diabetes-related distress and acceptance and action on diabetes may influence glycaemic control.

Diabetes self-management has been observed to have a positive correlation with good glycaemic control, reduced the possibility of complication and improved quality of life [44]. Good diabetes self-management has to do with a patient taking control of his condition and adhering to the four thematic areas (dietary control, glucose management, physical activity and seeking care from health professionals) in diabetes management. The correlation analysis showed a negative significant correlation (adjusted for age & gender & duration of diabetes & BMI ($kg/m^2$) & metformin use) between overall DSM and $HbA_{1c}$ ($r = -0.428$, $p<0.001$). When analyzed individually, glucose management score had weak, inverse correlation ($r = -0.415$, $p<0.000$) with $HbA_{1c}$. This implies that a good glucose management practice may influence decreased glycated haemoglobin. Additionally, healthcare seeking score ($r= -0.386$, $p<0.000$), physical activity score ($r= -0.328$, $p<0.000$) and dietary control score ($r = -0.167$, $p = 0.076$) showed weak, inverse correlation with $HbA_{1c}$. This also explains that seeking good health care, increasing physical activity, and good dietary practices may influence the reduction in glycated haemoglobin. Hence, advocating for diabetes self-management practices can be considered necessary counselling tool to help participants and diabetics as a whole manage the condition. The fact that the four subscales were inter-correlated suggests that practising one self-management component leads to practising the other. For example, patients who seek health care, keeping to medical appointment are likely to receive adequate information on how to manage their condition, and this could translate into good self-care (glucose management, dietary control, and physical activity) and subsequently good glycaemic control.

Our findings revealed that level of $HbA_{1c}$ was predicted by diabetes self-management (β = -0.297, p=0.007) and diabetes-related distress (β = 0.219, p=0.028). This means that, for every one percent increase in diabetes self-management score, one can expect a 0.053 reduction in $HbA_{1c}$ and for every point increase in diabetes-related distress, one can expect 0.781 increase in $HbA_{1c.}$ The regression model predicts $HbA_{1c}$ better than the mean $HbA_{1c}$ because p-value for F-test is statistically significant. The findings suggest that good diabetes self-management is essential for the diabetes patients to ensure good glycaemic control. This explains the fact that diabetes patients can enjoy good glycaemic control and prevent early diabetes complications when all-inclusive diabetes self-management activities; good dietary behaviour, physical activity, health care-seeking behaviour and good glucose management with medication, are properly and carefully followed.

The study revealed that diabetes self-management and good management of all four areas (dietary control, glucose management, health care-seeking behaviour and physical activity) was associated with good $HbA_{1c}$, indicating good glycaemic control. However, more than half of patients attending the diabetes clinic at the two hospitals had poor glycaemic control (high blood glucose), which contrast with their diabetes self-management. Further studies are needed to better understand the diabetes self-management and its effect, especially among non-hospital-based participants. However, the current findings support the need to empower diabetes patients with adequate knowledge and skills to self-manage their condition.

## 5. CONCLUSION

More than half of the patients attending diabetes clinic at the two hospitals have poor glycemic control despite high mean score for diabetes self-management. In addition, very few patients were distressed as a result of their diabetes condition. Though a few patients had difficulty in accepting their condition, the effect on their glycaemic control was devastating. Diabetes self-management showed the strongest association with glycemic control after adjusting for age, gender, BMI, duration of DM and treatment. All the three study variables correlated with glycated haemoglobin of study participants but only diabetes self-management and diabetes-related distress had predictive values.

## CONSENT

As per international standard or university standard, patient's written consent has been collected and preserved by the authors.

## ETHICAL APPROVAL

As per international standard or university standard, written approval of Ethics committee has been collected and preserved by the authors.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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## QUESTIONNAIRE

**Please check this section**

**Diabetes Self-Management Questionnaire (DSMQ)**

| No. | The following statements describe self-care activities related to your diabetes. Thinking about your self-care over the last 8 weeks, please specify the extent to which each statement applies to you. | Applies to me very much | Applies to me to a consider-able degree | Applies to me to some degree | Does not apply to me |
|---|---|---|---|---|---|
| 1 | I check my blood sugar levels with care and attention.<br>☐ Blood sugar measurement is not required as a part of my treatment. | ☐3 | ☐2 | ☐1 | ☐0 |
| 2 | The food I choose to eat makes it easy to achieve optimal blood sugar levels. | ☐3 | ☐2 | ☐1 | ☐0 |
| 3 | I keep all doctors' appointments recommended for my diabetes treatment. | ☐3 | ☐2 | ☐1 | ☐0 |
| 4 | I take my diabetes medication (e. g. insulin, tablets) as prescribed.<br>Diabetes medication / insulin is not required as a part of my treatment. | ☐3 | ☐2 | ☐1 | ☐0 |
| 5 | Occasionally I eat lots of sweets or other foods rich in carbohydrates. | ☐3 | ☐2 | ☐1 | ☐0 |
| 6 | I record my blood sugar levels regularly (or analyse the value chart with my blood glucose meter).<br>☐ Blood sugar measurement is not required as a part of my treatment. | ☐3 | ☐2 | ☐1 | ☐0 |
| 7 | I tend to avoid diabetes-related doctors' appointments. | ☐3 | ☐2 | ☐1 | ☐0 |
| 8 | I do regular physical activity to achieve optimal blood sugar levels. | ☐3 | ☐2 | ☐1 | ☐0 |
| 9 | I strictly follow the dietary recommendations given by my doctor or diabetes specialist. | ☐3 | ☐2 | ☐1 | ☐0 |
| 10 | I do not check my blood sugar levels frequently enough as would be required for achieving good blood glucose control.<br>☐ Blood sugar measurement is not required as a part of my treatment. | ☐3 | ☐2 | ☐1 | ☐0 |
| 11 | I avoid physical activity, although it would improve my diabetes. | ☐3 | ☐2 | ☐1 | ☐0 |
| 12 | I tend to forget to take or skip my diabetes medication (e. g. insulin, tablets).<br>☐ Diabetes medication / insulin is not required as a part of my treatment. | ☐3 | ☐2 | ☐1 | ☐0 |
| 13 | Sometimes I have real 'food binges' (not triggered by hypoglycaemia). | ☐3 | ☐2 | ☐1 | ☐0 |
| 14 | Regarding my diabetes care, I should see my medical practitioner(s) more often. | ☐3 | ☐2 | ☐1 | ☐0 |
| 15 | I tend to skip planned physical activity. | ☐3 | ☐2 | ☐1 | ☐0 |
| 16 | My diabetes self-care is poor. | ☐3 | ☐2 | ☐1 | ☐0 |

**Diabetes Stress Assessment**

| | Not a Problem | A Slight Problem | A Moderate problem | Somewhat Serious Problem | A Serious Problem | A very serious problem |
|---|---|---|---|---|---|---|
| 1. Feeling that my doctor doesn't know enough about diabetes and diabetes care. | 1 | 2 | 3 | 4 | 5 | 6 |
| 2. Feeling that diabetes is taking up too much of my mental and physical energy every day. | | | | | | |
| Not feeling confident in my day-to-day ability to manage diabetes. | | | | | | |
| 4. Feeling angry scared and/or depressed when I think about living with diabetes. | | | | | | |
| Feeling that my doctor doesn't give me clear enough directions on how to manage my diabetes. | | | | | | |
| 6. Feeling that I am not testing my blood sugars frequently enough. | | | | | | |
| 7. Feeling that I will end up with serious long-term complications, no matter what I do. | | | | | | |
| 8. Feeling that I am often failing with my diabetes routine. | | | | | | |
| 9. Feeling that friends or family are not supportive enough of self-care efforts (e.g. planning activities that conflict with my schedule, encouraging me to eat the "wrong" foods). | | | | | | |
| 10. Feeling that diabetes controls my life. | | | | | | |
| 11. Feeling that my doctor doesn't take my concerns seriously enough. | | | | | | |
| 12. Feeling that I am not sticking closely enough to a good meal plan. | | | | | | |
| 13. Feeling that friends or family don't appreciate how difficult living with diabetes can be. | | | | | | |
| 14. Feeling overwhelmed by the demands of living with diabetes. | | | | | | |
| 15. Feeling that I don't have a doctor who I can see regularly enough about my diabetes. | | | | | | |
| 16. Not feeling motivated to keepup my diabetes self management. | | | | | | |
| 17. Feeling that friends or family don't give me the emotional support that I would like. | | | | | | |

**ACCEPTANCE AND ACTION DIABETES QUESTIONNAIRE**

**Below you will find a list of statements. Please rate how true each statement is for you by circling a number next to it. Use the scale below to make your choice.**

**Please check the highlighted area**

| **1** | **2** | **3** | **4** | **5** | **6** | **7** |
|---|---|---|---|---|---|---|
| never true | Very seldom true | Seldom true | Sometimes true | Frequently true | almost always true | Always true |

| **No.** | **Item content** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1 | I try to avoid reminders of my diabetes | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 2 | I have thoughts and feelings about having diabetes that are distressing[a] | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 3 | I do not take care of my diabetes because it reminds me that I have diabetes. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 4 | I eat things I shouldn't eat when the urge to eat them is overwhelming | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 5 | When I have an upsetting feeling or thought about my diabetes, I try to get rid of that feeling or thought. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 6 | I avoid taking or forget to take my medication because it reminds me that I have diabetes. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 7 | I avoid stress or try to get rid of it by eating what I know I shouldn't eat. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 8 | I often deny to myself what diabetes can do to my body. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 9 | I don't exercise regularly because it reminds me that I have diabetes. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 10 | I avoid thinking about what diabetes can do to me. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 11 | I avoid thinking about diabetes because someone I knew died from diabetes | 1 | 2 | 3 | 4 | 5 | 6 | 7 |