

# PREDICTORS OF GLYCAEMIC CONTROL AMONG GHANAIAN TYPE 2 DIABETES PATIENTS USING DIABETES SELF- MANAGEMENT APPROACH

## 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 diabetics using diabetes self-management approach.

**Study design:** 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, clinical and dietary information. A validated Diabetes Self-Management Questionnaire was also used. Serum Glycated haemoglobin (HbA<sub>1c</sub>) was used as the standard for glycaemic control.

**Results:** Mean glycated hemoglobin level for study participants was 7.2%±0.2. Optimal glycaemic control was significantly associated with diabetes self-management ( $r = -.428$ ), diabetes-related distress ( $r = .381$ ) and acceptance and action on diabetes ( $r = .316$ ). In addition to the above associations, diabetes self-management ( $\beta = -.297$ ,  $p = 0.007$ ) and diabetes-related distress ( $\beta = .219$ ,  $p = 0.028$ ) could significantly predict glycated haemoglobin but not acceptance and action on diabetes ( $\beta = .046$ ,  $p = 0.665$ ).

**Conclusion:** All the three study variables correlated with glycated hemoglobin of study participants but only diabetes self-management and diabetes-related distress had predictive value. Further epidemiological study is needed to ascertain strength of 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, glycaemic control, Ghana, diabetes, diabetes self-management.

## 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 population. Of the types, type 2 diabetes, or non-insulin dependent diabetes mellitus (NIDDM), 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 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].

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

45 Programs to support diabetes patients to manage their conditions over the years have produced  
 46 encouraging results and so have been considered as a requirement for successful diabetes  
 47 management notwithstanding the individual's specific needs [12]. The outmoded system whereby  
 48 patients are given information with the aim of improving their knowledge on their conditions is  
 49 gradually being taken over by current systems that focus on changing the behaviour of patients and  
 50 empower them with adequate skills to be able to manage their condition (also known as self-care)  
 51 [13]. As a result of this, a number of national guidelines on management of diabetes including that of  
 52 the American Diabetes Association consider self-management as major part of good diabetes  
 53 management [14, 15].

54 There are contradictions in diabetes patients' capabilities to undertake self-management activities  
 55 [16]. In one study, 0.8% of diabetes patients reported that they did not practice self-monitoring of  
 56 blood glucose weekly and 21.1% said they did not monitor their blood glucose monthly [16]. Also, in  
 57 some other study, there were low adherence to medication, exercise and diet plans. Patients were not  
 58 also committed to taking care of their feet and monitoring their blood glucose [17]. However, a study  
 59 reported that diabetic patients followed diet and exercise plans, took their medication, took care of  
 60 their feet and monitored their blood glucose [18]. A study by [19] showed, self-efficacy was high  
 61 (62.0%) but few patients (30.8%) practiced good self-care behaviours [19]. These studies together  
 62 suggest that diabetics practice various levels of self-management and care.

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

70 If better knowledge and understanding of diabetes lead to higher self-efficacy of self-management  
 71 then adequate self-management should lead to better glycaemic control. This expectation is  
 72 confirmed by available literature. A recent study in Jordan reported a mean score of 62% for self-  
 73 management and concluded that diabetes self-care correlated with but did not predict HbA1c levels  
 74 [17] whereas a previous study reported an overall mean score of 80% for self-management of type 2  
 75 diabetes patients in Toronto, Canada [22]. Another study involving 223 subjects with type 2 diabetes  
 76 concluded that self-management was a better predictor of HbA1c [23]. Also, a study involving 266  
 77 type 2 diabetics revealed that 30.8% had good self-management behaviour and self-management  
 78 emanating from exercise was found to significantly predict glycaemic control [19].

79 Diabetes-related distress among type 2 diabetes patients is a prevalent emotional state as a result of  
 80 lifelong daily demands in terms of adherence to medication, diet and physical activity, and frequent  
 81 monitoring of blood glucose [24, 25]. These emotional conditions are related to a situation of high  
 82 morbidity and deaths [26]. Most studies conducted usually consider diabetes-related distress in  
 83 relation to diabetes management and metabolic disorders and somehow with regards to social  
 84 support [24]. A prospective study involving depression and glycemic control among type 2 diabetics  
 85 reported that depression was significantly related to high blood glucose or poor glycaemic control [27].

86 Another study that investigated the association between diabetes-related distress and glycemic  
 87 control revealed a significant relationship [28]. Also, a study that assessed diabetes-related distress  
 88 among diabetes patients identified that more than half of the patients reported to have distress  
 89 relating to at least one of the diabetes-related activities [29]. A cross-sectional study of 165 type  
 90 2 diabetic patients concluded that there was a significant relationship between distress and HbA1c in type 2  
 91 diabetes [30].

92 The exigencies of diabetes self-care (adherence to medication, exercise, diet and self-monitoring of  
 93 blood glucose) cause diabetes patients to avoid, deny or take their minds of any fears or worries that they  
 94 have diabetes and they consider the routine diabetes self-management as reminders that they have  
 95 the condition. This could lead to good glycaemic control and subsequently reduce risk of diabetic  
 96 complications. For instance, a randomized control trial involving 81 type 2 diabetes patients showed a  
 97 positive impact of changes in diabetes acceptance on HbA1c [31]. A recent study conducted by  
 98 Schmitt and colleagues, concluded that higher diabetes non-acceptance had a significant correlation  
 99 with decreased self-care and higher HbA1c, and higher diabetes-related distress [32]. Also, non-  
 100 acceptance had a higher correlation with diabetes self-care and glycaemic control and could predict  
 101 the above better than diabetes distress [32].

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

## 110 2. MATERIAL AND METHODS

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### 112 2.1 Study design and period

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

### 117 2.2 Study population and Eligibility

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

### 125 2.3 Ethical consideration

126 Approval from the Committee on Human Research, Publication and Ethics at School of Medical  
 127 Sciences and Komfo Anokye Teaching Hospital and the selected hospitals was obtained. Then  
 128 participant information leaflet was given to study subjects who could read after which the consent form  
 129 was signed. However, for subjects who could not read, the participant information leaflet was  
 130 translated to them in a language that they understood and their consent sought by a thumbprint  
 131 before participating in the study. Participants were informed that participation in this study was  
 132 voluntary and would not affect their medical treatment, and that withdrawal from the research was  
 133 without any consequences.

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## 135 2.4 Sampling method

136 Random sampling was used to recruit participants at the two health facilities this done by  
 137 randomly selecting patients to be recruited from the diabetes clinic records. Patients who declined to  
 138 participate after being selected were replaced through another random selection process.

## 139 2.5 Data collection tools

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

### 147 2.5.1 Diabetes Self-Management Questionnaire




148 The final section of the questionnaire used for this study was the Diabetes Self-Management  
 149 Questionnaire (DSMQ) developed by Schmitt et al. [34] at the Research Institute of the Diabetes  
 150 Academy Mergentheim to aid the collection of appropriate data that can be used to evaluate self-care  
 151 behaviours and relate them to glycated hemoglobin levels. The validated scale for full psychometric  
 152 assessment regarding diabetes has 16 items and 4 subscales: healthcare patronage (3 items;  
 153 3,7,14), glucose management (5 items; 1,4,6,10,12), physical activity (3 items; 8,11,15) and dietary  
 154 control (4 items; 2,5,9,13) and item 16 is the patient's overall rating of his/her diabetes self-  
 155 management and it is added to the 'Sum Scale' score. In terms of what is regarded as effective  
 156 diabetes self-care, seven items are formulated positively and the remaining nine negatively. The  
 157 DSMQ has a four-point Likert scale that starts from 0= does not apply to me, 1= applies to me to  
 158 some degree, 2= applies to me to a considerable degree and 3=applies to me very much. For  
 159 individual analysis to be possible, a box is put below each item for ticking if that item is not required in  
 160 their treatment.

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

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

177 Another section of the study questionnaire was on diabetes non-acceptance where the Acceptance  
 178 and Action Diabetes Questionnaire developed by Gregg et al. [31] and validated and evaluated by  
 179 Schmitt et al. [32] was used. The questionnaire has a seven-point Likert scale (1= never true to  
 180 7=Always true) on which study subjects indicated the extent to which they go through a number of  
 181 diabetes non-acceptance behaviours. The sum score was calculated by adding the eleven items  
 182 score and then dividing by eleven (number of items) which produced sum scores ranging from 1 to 7.  
 183 Higher values after adding up item scores showed greater non-acceptance and sum score greater  
 184 than 3 indicated non-acceptance [32].

## 185 2.6 Glycated haemoglobin assessment

186 Three ml of blood samples  patients were colle  and their glycated haemoglobin determined  
187 using Fast Ion-Exchange Resin Separation Method  A1c < 6.5% was referred as normoglycaemia  
188 and HbA1c ≥ 6.5% was termed as hyperglycaemia [36].

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## 190 2.7 Data analysis


191 Data collected from the study participants were entered into Statistical Package for Social Sciences  
192 (SPSS version 20) for analysis. Outliers and missing data were checked by screening and cleaning  
193 the data. No outlier was identified but there was one missing data on HbA1c for one participant. This  
194 occurred as a result of phlebotomist inability to draw blood from the patient after several attempts due  
195 to collapsed veins. Characteristics of study participants and scales were described by using  
196 descriptive analyses that indicated percentages, frequencies, means, standard error of means and  
197 standard deviations. Means of variables for various groups were compared by deploying the use of  
198 ANOVA and any comparison with a p-value <0.05 was referred to as statistically significant. To  
199 measure the correlation between DSM, AAD, DDS and HbA1c, Pearson correlation analyses was  
200 done. Pearson analysis was also done to evaluate the association between subscales of the various  
201 instruments as well as relationship between age, BMI, duration of diabetes, DSM and HbA1c.  
202 Reliability test was also conducted to check the internal consistency and reliability of the DMSQ, AAD  
203 and DDS tools. In order to ascertain the predictors of good glycemic control or HbA1c, standard  
204 multiple linear regression analysis was done.

## 205 3. RESULTS AND DISCUSSION

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### 207 3.1 Sociodemographic characteristics of study Participants

208 A total of 115 were involved in the study and as shown in Table 1, female patients represented 71.3%  
209 of the patients sampled. In terms of education, 68.7% of respondents had senior high school and  
210 below education whilst 13.9% never had any education at all. The mean number of people living in  
211 the households of respondents was  $6.1 \pm 0.31$  and 50.4% of them lived with their immediate family  
212 members. Also, out of the 115 respondents, 20.0% widowed, 12.2% divorced and then 0.8% were  
213 single. Majority (55.7%) had hypertension and 50.4% had lost usual weight due to diabetes, while  
214 52.2%, 29.6% showed symptoms of high blood glucose and frequent urination/thirst respectively  
215 (Table 1).

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

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238 **Table 1: Socio-demographic characteristics of subjects**

Variable	Number of participants (%)
<b>Gender</b>	
Male	33 (28.7)
Female	82 (71.3)
<b>Marital status</b>	
Married	77 (67.0)
Widowed	23 (20.0)
Single	1 (0.8)
Divorced	14 (12.2)
<b>Educational level</b>	
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)
<b>Patients living with;</b>	
Immediate family members	58 (50.4)
Both immediate and external relations	57 (49.6)
<b>Symptoms and co-morbidities</b>	
Gained weight	39 (33.9)
Lost weight	58 (50.4)
High Blood glucose (HbA <sub>1c</sub> )	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)
<b>Co-morbidities</b>	
Hypertension	64 (55.7)
Ulcers	5 (4.3)
Neuropathy	5 (4.3)
At least two of the above	7 (6.1)
No co-morbidity	34 (29.6)

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**3.2 Anthropometric and biochemical parameters of participants**



242 Participant's mean age was 58.4 years but the mean age for males was 0.8 years higher than that of  
 243 females. Their mean BMI was 27.1±0.58kg/m<sup>2</sup>, 1.7% were below 18.5 kg/m<sup>2</sup>, 35.7% were within the  
 244 normal range (18.5-24.9 kg/m<sup>2</sup>) and majority (62.6%) were overweight or obese. The mean duration  
 245 of diabetes was 6.7±0.57 years, HbA<sub>1c</sub>, 7.2%±0.2 and mean fasting blood glucose (FBG) was 9.9  
 246 mmol/L and Systolic Blood Pressure 135.4±1.9 mmHg. There was no significant difference between  
 247 males and females with regards to duration of diabetes, age, HbA<sub>1c</sub>, fasting blood glucose, systolic  
 248 and diastolic blood pressure and weight. However, a significant (p=0.004) difference existed between  
 249 male and female patients in terms of their body mass index (BMI), with females having a higher BMI  
 250 than males (Table 2).

251 A greater proportion of study participants (52.2%) had poor glycaemic control; HbA<sub>1c</sub> above 6.5%  
 252 and that does not conform to International Diabetes Federation recommendation that stipulates that  
 253 HbA<sub>1c</sub> less than 6.5% is a desirable goal for diabetes management. This finding is lower to that  
 254 reported by Asamoah-Boakyee et al. [42] in Ghana, and Ahmad et al. [43] where 64.6% and 76.7%  
 255 respectively of diabetes patients respectively had poor glycaemic control. The relatively high poor  
 256 glycaemic control among study participants could be attributed to the fact that 62.6% of them were  
 257 either overweight or obese since people in this group have been associated with poor glycaemic  
 258 control.

259 All participants were on anti-diabetes medication and greater proportion of them (81.7%) were on  
 260 metformin either as a single drug or in combination with other anti-diabetes medication.

261 **Table 2: Clinical characteristics of Study participants**

Variable	N	Mean (SEM)	Males	Females	P value
Duration of Diabetes	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 <sub>1c</sub> (%)	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 <sup>2</sup> )	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


262 P-value is significant at p ≤ 0.05

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 264 **3.3 Diabetes self-management score and its association with glycaemia**

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

274 **Table 3: Principal Component Analysis of Diabetes Self-management scores**

Component Matrix <sup>a</sup>						
Variable	Component pattern					
	Component 1 Excellent self mgmt	Component 2 Poor diet, poor healthcare	Component 3 Good glucose mgt, poor	Component 4 Good dietary mgt	Component 5 Poor diet, good health care,	Component 6 Good diet but poor health care

		, poor glucose control	PA		admitted poor overall Self-mgt	
% 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.	.791		.310			
The food I choose to eat makes it easy to achieve optimal blood sugar levels.	.649			.378		.359
I keep all doctors' appointments recommended for my diabetes treatment.	.657					-.385
I take my diabetes medication (e. g. insulin, tablets) as prescribed.	.723					
Occasionally I eat lots of sweets or other foods rich in carbohydrates.		.585		-.362	.316	
I record my blood sugar levels regularly (or analyse the value chart with my blood glucose meter).	.781					
I tend to avoid diabetes-related doctors' appointments.	-.407				-.401	.662
I do regular physical activity to achieve optimal blood sugar levels.	.651		-.485			
I strictly follow the dietary recommendations given by my doctor or diabetes specialist.	.597		-.338			
I do not check my blood sugar levels frequently enough as would be required for achieving good blood glucose control.	-.413		-.505	.528		
I avoid physical activity, although it would improve my diabetes.	-.540		.514	.425		
I tend to forget to	-.362	.438	-.494			



take or skip my diabetes medication (e. g. insulin, tablets).						
Sometimes I have real 'food binges' (not triggered by hypoglycaemia).		.819				
Regarding my diabetes care, I should see my medical practitioner(s) more often.		-.337			.713	
I tend to skip planned physical activity.	-.592		.408	.311		
My diabetes self-care is poor.	-.658				.403	

275 PA-Physical activity

276 Among the six patterns, only excellent self-management had significant inverse correlation  
 277 with HbA<sub>1c</sub> (r= -0.495, p-value= 0.000) (Table 4).

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**Table 4: Association between PCA Components and HbA<sub>1c</sub>**

Component pattern		HbA <sub>1c</sub> (%)
Excellent self mgt	Pearson Correlation	-.495**
	P value	.000
Poor diet, poor healthcare, poor glucose mgt	Pearson Correlation	-.012
	P value	.903
Good glucose mgt, poor PA	Pearson Correlation	-.067
	P value	.477
Good dietary mgt	Pearson Correlation	-.057
	P value	.546
Poor diet, good health care, admitted poor overall Self-mgt	Pearson Correlation	-.031
	P value	.743
Good diet but poor health care	Pearson Correlation	-.039
	P value	.683

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\*\*P-value is significant at p<0.05 (sig. 2-tailed)

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**3.4 Association between study variables**

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When the correlation was controlled for age, gender, duration of diabetes, BMI and metformin use the association between HbA<sub>1c</sub> and other study variables in descending order 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<0.001) (Table 5).

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Pearson Correlation analysis adjusted for age & gender & duration of diabetes & BMI & metformin use revealed a statistically significant negative relationship between HbA<sub>1c</sub> and diabetes self-management (r= -0.419, p< 0.001) which is consistent with the result of Schmitt et al. [34]. Patients'

292 healthcare seeking behaviour was the second strongest correlation with HbA1c and this could be  
 293 linked to the fact that patients who are regular at diabetes related appointment stand a higher chance  
 294 of receiving adequate information on how to manage their condition and this could translate into good  
 295 self-care and subsequently good glycaemic control. Also, diabetes-related distress ( $r= 0.368, p<$   
 296  $0.001$ ) and acceptance and action on diabetes scores ( $r= 0.342, p< 0.001$ ) had weak, positive  
 297 correlation with HbA1c. This means diabetes-related distress and acceptance and action on diabetes  
 298 may influence poor glycaemic control.

299 Diabetes Self-management has been observed to have positive correlation with good glycaemic  
 300 control, reduced possibility of complication and improved quality of life [44]. Good diabetes self-  
 301 management has to do with a patient taking control of his condition and adhering to the four thematic  
 302 areas (dietary control, glucose management, physical activity and seeking care from health  
 303 professionals) in diabetes management. Our correlation analysis showed a negative significant  
 304 correlation (adjusted for age & gender & duration of diabetes & BMI (kg/m<sup>2</sup>) & metformin use)  
 305 between overall DSM and HbA1c ( $r=-0.428, p<0.001$ ). When analyzed individually, glucose  
 306 management score had weak, inverse correlation ( $r=-0.415, p<0.000$ ) with HbA1c. This implies that a  
 307 good glucose management practice may influence decreased glycated haemoglobin. Additionally,  
 308 healthcare seeking score ( $r= -0.386, p<0.000$ ), physical activity score ( $r= -0.328, p<0.000$ ) and dietary  
 309 control score ( $r=-0.167, p=0.076$ ) showed weak, inverse correlation with HbA1c. This also explain that  
 310 seeking good health care, increasing physical activity and good dietary practices may influence in  
 311 reduction in glycated haemoglobin. Hence, advocating for diabetes self-management practices can be  
 312 considered necessary counselling tool to help participants and diabetics as a whole manage the  
 313 condition. The fact that the 4 subscales were inter-correlated suggests that practicing one self-  
 314 management component led practicing the other. For example, patients who seek healthcare,  
 315 keeping to medical appointment are likely to receive adequate information on how to manage their  
 316 condition and this could translate into good self-care (glucose management, dietary control and  
 317 physical activity) and subsequently good glycaemic control.

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

	1	2	3
HbA1C (%)			
Self-management	-.419**		
Diabetes-related distress	.368**	-.431**	
Acceptance and action on diabetes	.342**	-.584**	.428**

\*\* - Correlation is significant at the 0.01 level (2-tailed).

319 *Control Variables: Age & Gender & Duration of Diabetes & BMI (kg/m) & Metformin*

320 Findings of correlation analysis revealed total score DSM had strong, positive correlation with dietary  
 321 score ( $r= 0.799, p\text{-value}= 0.000$ ), glucose management score ( $r= 0.671, p\text{-value}= 0.000$ ), healthcare  
 322 score ( $r= 0.675, p= 0.000$ ) and physical activity score ( $r= 0.669, p\text{-value}= 0.000$ ). HbA1c had inverse  
 323 correlation with total score DSM ( $r= -0.428, p\text{-value}= 0.000$ ), glucose management score ( $r= -0.415,$   
 324  $p\text{-value}= 0.000$ ), healthcare score ( $r= -0.386, p\text{-value}= 0.000$ ) and physical activity score ( $r= -0.328, p\text{-}$   
 325  $\text{value}= 0.000$ ) (Table 6)

327 **Table 6: Association between glycaemic control (HbA1c) and Diabetes Self-Management and**  
 328 **subscales score (adjusted)**

Variable	1	2	3	4	5
HbA <sub>1c</sub> (%)					
Pearson Correlation					
Sig. (2-tailed)					
Total Score DSM					
Pearson Correlation		-.428**			
Sig. (2-tailed)		.000			

Glucose Management Score	Pearson Correlation		-.415**	.799**			
	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 Score	Pearson Correlation		-.328**	.669**	.429**	.269*	.273**
	Sig. (2-tailed)		.000	.000	.000	.004	.003

329 \*\* - Correlation is significant at the 0.01 level (2-tailed), DSM-Diabetes Self-Management, Control Variables:  
 330 Age & Gender & Duration of Diabetes & BMI (kg/m) & Metformin

331  
 332  
 333

**3.5 Predictors of HbA1c (Glycemic control)**

334 The prediction model was statistically significant (F=10.63, p<0.001, R2=0.225) and explains 22.5% of  
 335 variability in HbA1c level. The level of HbA1c or glycaemic control was predicted by diabetes self-  
 336 management and diabetes-related distress with diabetes self-management being the strongest  
 337 predictor ( $\beta=-0.297$ , p=0.007) and then diabetes-related distress ( $\beta=0.219$ , p=0.028). However,  
 338 acceptance and action on diabetes could not predict glycaemic control in the study participants (Table  
 339 7).

340 **Table 7: Predictors of glycated hemoglobin**

Variable	B	Std. Error	Beta	t value	p value
Constant	10.091	1.954		5.164	.000
Self-management	-.053	.019	-.297	-2.745	.007
Diabetes-related distress	.781	.352	.219	2.222	.028
Acceptance and action on diabetes	.077	.176	.046	.434	.665

341

342 The PCA analyses identified 6 components, which explained a very higher percent variability of  
 343 73.9% in the study population, higher than in similar a study, which used PCA analysis of DSMQ  
 344 responses and explained 61% of variability (39). This implies that the 6 DSM patterns observed were  
 345 adequate to explain the reported behaviour of majority of the study participants. Also, the first pattern  
 346 revealed in the PCA had strong positive association with positive self-management practices and  
 347 strong negative association with negative self-management behaviour in all the four subscales. The  
 348 strong negative correlation between this pattern of diabetes self-care and HbA1c indicates that a  
 349 combination of all the four parts of diabetes self-management is the best way to ensure that diabetes  
 350 patients have their blood glucose under control. All positive co-efficient values in the component  
 351 matrix shows participants were likely to practice responses given on diabetes self-management  
 352 questions and negative co-efficient values means participants were unlikely to follow/practice  
 353 responses given on diabetes self-management questions. Likewise, the PCA component (pattern)  
 354 reflecting excellent DSM showed a negative correlation with HbA1c ( $r=-0.495$ , p<0.001). This means  
 355 that whichever way things are looked at, good overall diabetes self-management is associated with  
 356 good glycaemic control. Now, the other PCA component only reflected good or poor management in

357 specific areas of DSM scale and not on all four areas. Our analysis did not show any significant  
358 association between these patterns, reflecting specific areas of diabetes management and glycaemic  
359 control. This goes to confirm that good overall management in all the four areas of diabetes self-  
360 management and not just some areas is needed to control glycaemia among the study participants.  
361 Because the PCA takes into account any inter-correlations between variables in the model (in this  
362 case 16 variables of the DSMQ), the patterns observed may reflect the true patterns of DSM practices  
363 in the population. So, the findings of the correlations between the PCA patterns and HbA1c may be  
364 truer than that of the mere mean scores for the four areas of the DSMQ. Thus, our logical explanation  
365 above may hold.

366 Our findings revealed that level of HbA1c was predicted by diabetes self-management ( $\beta = -0.297$ ,  
367  $p = 0.007$ ) and diabetes-related distress ( $\beta = 0.219$ ,  $p = 0.028$ ). This means that, for every one  
368 percentage increase in diabetes self-management score, one can expect a 0.053 reduction in HbA1c  
369 and for every point increase in diabetes-related distress, one can expect 0.781 increase in HbA1c.  
370 The regression model predicts HbA1c better than the mean HbA1c because p-value for F-test is  
371 statistically significant. The findings suggest that good diabetes self-management is essential for the  
372 diabetics to ensure good glycaemic control. This explains the fact that diabetics can enjoy good  
373 glycaemic control and prevent early complications when all-inclusive diabetes self-management  
374 activities; good dietary behavior, physical activity, healthcare seeking behavior and good glucose  
375 management with medication, are properly and carefully followed.

376 The study revealed that more than half of patients attending diabetes clinic at the two hospitals have  
377 poor glycaemic control despite a high mean score for diabetes self-management, and good  
378 management of all four areas (dietary control, glucose management, healthcare seeking behaviour  
379 and physical activity) was associated with good HbA1c, indicating good glycaemic control. Further  
380 studies are needed to better understand the diabetes management and its effect, especially among  
381 non-hospital-based participants. However, the current findings support the need to empower diabetics  
382 with adequate knowledge and skills to self-manage their condition.

#### 383 **4.0 CONCLUSION**

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

#### 391 **ETHICAL CONSIDERATION**

392 Approval from the Committee on Human Research, Publication and Ethics at the School of Medical  
393 Sciences and Komfo Anokye Teaching Hospital and the selected hospitals was obtained.

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519

520 **ABBREVIATIONS**

521 DSM- Diabetes Self-Management

522 BMI- Body Mass Index

523 HbA<sub>1c</sub>- Glycated Haemoglobin

524 DSMQ- Diabetes Self-Management Questionnaire

525 PCA- Principal Component Analysis

526 DDS- Diabetes Distress Scale

527 AAD- Acceptance and Action on Diabetes