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Original Article

Predictors of Glycated Hemoglobin among Jordanian Diabetic Patients

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Abstract

Background: We explored the level of Jordanian patients' knowledge, diabetes related distress, self-management activities and these effects on the A1C level.

Methodology: This descriptive cross-sectional correlational design (conducted in 2013) was utilized to recruit 289 diabetic patients from outpatient diabetes clinics, using self-reported questionnaires (Diabetes Knowledge Test, Diabetes Distress Scale, and Diabetes Self-Management Questionnaire) in addition to chart review for selected variables.

Results: Participants' had mean glycated hemoglobin of 7.88%. Good glycemic control was significantly associated with higher self-management activities (r= -.147), high income (r= -.171), older age (r= -.252), shorter duration of illness (r= .153), and low levels of distress. Despite these relationships only age, duration of illness and income significantly predicted A1C (F (5, 284) = 11.57, P<.001, R^2 = .17). Further, diabetes knowledge, diabetes-related distress, and self-management could not predict A1C level.

Conclusion: Only diabetes-related distress and self-management correlated with patients' A1C, with no predictive power. Thus, further research is required to shed the light on the large unexplained components of the A1C variance.

Keywords: Glycated hemoglobin, Diabetes related distress, Self-management, Diabetes

Introduction

Diabetes mellitus (DM) is an overwhelming chronic disease that affects 366 million people, and by 2030, this number will rise to be 552 million (1). Between 2010 and 2030, the prevalence of DM in developed countries will be 20% compared to the developing countries which are expected to have 69% increases in the number of diabetic cases (2). In Jordan, there is a significant increase (31.5%) on the prevalence of DM. Around 45% of 195 diabetic patients previously diagnosed, had unsatisfactory glycemic control (3). Poorly controlled diabetes leads to depression (4), end stage renal disease (5) diabetic foot syndrome (6) and diabetic retinopathy (7).

Due to these serious complications, patients' self-management can affect their health. Self-management is considered as the cornerstone of the chronic care model for patients who are suffering from chronic illnesses (8). The capabilities of diabetic patients' to perform self-management activities are contradictory. Diabetic patients adhered to blood glucose monitoring, feet care, diet plan, medication, and participated in an exercise program (9-10). In contrast, diabetic patients were not committed to diet and exercise plan (11-12), medication (13) blood glucose monitoring, and feet care (14).

The objective and standard measure that corroborate with better management of diabetes is glycated hemoglobin (A1C). The level of A1C was determined to be less than 7% as a target for diabetic management (15). In general, diabetic patients failed to achieve an optimal glycemic target (16-23). Achieving the target glycemic control could be influenced by many factors. For instance, A1C was significantly associated with self-management activities (diet and exercise behaviors) (16, 23), lower body mass index (BMI), and shorter duration of illness (23-24).

Regarding diabetic knowledge, the results in literature is contradictory. For instance, a strong positive relationship was found between diabetes knowledge and A1C level (25). In contrast, a significant negative relationship was found between knowledge score and A1C (26), whereas no relationships were found between patients' knowledge, self-care, and their A1C levels (18).

The level of diabetes knowledge varied among patients in different countries. For instance, patients had low level of knowledge regarding diabetes in the United Arab Emirates (18), Iran (27), Nigeria (13), and in Kuwait (28). On the other hand, a good level of knowledge was reported among diabetic patients in Qatar (29), Malaysia (22) and Pakistan (30). A good level of knowledge regarding DM was found to affect patients' adherence to pharmacological therapy (25, 31), self-care activities (18, 32) and good glycemic control (33). Furthermore, lack of knowledge regarding specific diet and care plan was the main barrier to engage in self-management activities among diabetic patients (34). In spite of having a good level of knowledge among diabetic patients, their self-care practices were found to be unsatisfactory (35-36).

Psychological problems were considered as barriers for diabetic patients to engage in self-management activities (37-38). In literature, diabetic patients had either depression or diabetes related distress (21, 39). Lower level of diabetes related distress was strongly associated with good self-management and good glycemic control (23, 40-41). Many factors have been identified to predict good glycemic control such as diet self-efficacy and diet self-management (16), higher diabetic knowledge and perceived health status (33), higher diabetic knowledge, higher medication adherence, and using mono-therapy (10, 25). Other factors included older age, higher education, shorter duration of diabetes, lower BMI, lower diabetes related distress (23), and higher blood glucose monitoring (10).

Diabetic patients' knowledge, diabetes related distress, and self-management activities had an impact on the level of A1C. Besides, the levels of knowledge, diabetes distress, and self-management activities among diabetic patients were contradictory. Among Jordanian diabetic patients, self-management, patients' attitude toward diabetes, barriers to adherence, and socio-demographic variables were studied and predicted A1C level, yet there is unexplained variance in the previous results. In addition, there is a gap in literature regarding the impact of diabetes knowledge and diabetes related distress on the A1C level among Jordanian patients.

In this study, we explored the level of Jordanian patients' knowledge, diabetes related distress, self-management activities and these effects on the A1C level.

Materials and Methods

Design

In 2013 a Descriptive, cross sectional, correlational design was used to assess knowledge, diabetes related distress, and self-management among Jordanian patients with DM and their relation to glycated hemoglobin. Data were collected using face-to-face interview from Jordanian patients diagnosed with DM. Besides, data regarding glycated hemoglobin and BMI were extracted from patients' medical records.

Setting

Outpatient clinics from different hospitals in Jordan were approached to collect data from diabetic patients.

Population

A convenience sampling technique was used to approach adult patients with type I and type II diabetes mellitus. The inclusion criteria included:

1) at least 18 years old, 2) have been diagnosed primarily with DM, 3) able to read in Arabic language, and 4) accept participation. Exclusion criteria include having severe mental, physical, or cognitive deterioration.

Sample size

According to G-Power 3.0.3 (42) and using the regression model for predicting the dependent variable with a medium effect size of 0.15, at power of 0.95 and at 0.05, two-tailed level of significance, a total sample of at least 160 participants was needed. Estimating a 50% participation rate, at least 320 participants have to be approached for possibility of participation.

Ethical notes

Approval from the Scientific Research Committees at the Faculty of Nursing and targeted hospitals was obtained. Then each participant was asked to read a cover letter and to sign a written consent form before participation in the study. The cover letter included information related to the title of the study, its purpose, significance and a statement informing the participants that their privacy would be protected. Participants were advised that participation in the study was voluntary and would not affect their medical treatment, and that they can withdraw from the study without any consequences.

Data collection

A pilot study was carried out to test the feasibility of the study and to perform psychometric properties of the scales. Patients were screened for eligibility by the data collector. Those who met study inclusion criteria were invited to participate voluntarily in the study. Those who agreed to participate in the study were asked to read the cover letter and sign the consent form. Data collection was performed in a scheduled manner during patients' visits to the outpatient units. The time of the interview took from 30 - 40 min.

Instruments/tools

The questionnaire package of this study consisted of four sections. The first section require participants to answer questions regarding their demographic details such as age, gender, marital status, level of education, type of insurance, medical diagnosis, and co-morbidities, duration of having diabetes, and smoking history. The second section used The Diabetes Knowledge Test, which consists of 24 knowledge test items (43). These 24 items are closed ended questions and the response of each item were (yes, no, and don't know). Each item was recoded to the correct answer and don't know answer was considered as a wrong answer. The total score was calculated out of 24.

The third section used The Diabetes Distress Scale (44) which has17-items and four subscales: emotional burden (5 items), physician-related distress (4 items), regimen distress (5items) and diabetes-related interpersonal distress (3items). This scale uses a five point likert scale ranging from 1= strongly disagree to 5= strongly agree, and scale scores were transformed to (0 –100) scale, with 100 indicating greater distress. The Cronbach's alpha for diabetes related distress scale was 0.95 (44). In this study, the Cronbach's alpha for diabetes related distress scale was 0.83. The fourth section is Diabetes self-Management Questionnaire (DSMQ) (45). It included 16 item and four subscales: glucose management (five items), dietary control (four items), physical activity (three items), and healthcare use (three items) and the final item to be calculated only with total score. This questionnaire uses a four point likert scale ranging from 1= do not apply to me to 4= very much applied to me and the total score and its subscale were transformed to be out of 10. The Cronbach's alpha for DSMQ was 0.84 (45), while in this study, the Cronbach's alpha for DSMQ was 0.75. The negative items of the DSMQ and its subscale were recoded before calculating the total score. A panel of two doctoral prepared nurses and two nurses specialized in DM translated and back translated the questionnaires. Any discrepancies between the translated and the original questionnaire were reconsidered. In addition to theses scales, the principle investigator extracted the level of A1C, patients' weight and height (to calculate the BMI) from their medical record.

Statistical analyses

Statistical package for social sciences for windows (version 17.0) was used to analyze the data. Data were screened and cleaned, checked for outliers and missing data. The outliers and missing data were managed before the analysis process. The normality of the scales was examined using Pearson measure of skewness and the result revealed that continuous variables were normally distributed.

Descriptive analyses were used to describe the sample and the three scales. Pearson correlation test was used to test the correlation between patients' age, duration of illness, income, BMI, patients knowledge, diabetes related distress, self-management, and glycated hemoglobin. Furthermore, standard multiple linear regression analysis was used to calculate the amount of variance in A1C level that could be explained by clinical variables, knowledge, diabetes related distress, and self-management.

Results

A total of 411 questionnaires were distributed and 325 returned, 36 of the returned questionnaire were excluded from the study due to lack of either A1C results (n=10) or due to incomplete questionnaires (n=26). This led to 289 complete questionnaires that were entered in data analysis with a response rate of 70%. As shown in Table 1, female patients represented 51.2% of the sample.

Table 1: Description of sample characteristics (n=289)

Variable	n (%)	Mean (SD)
Gender		
Male	141 (48.8)	
Female	148 (51.2)	
Age		55.3 yr (13.2)
Body mass index (BMI)		29.7 yr (5.5)
Duration of illness		11.3 (8.7)
Glycated hemoglobin (A1C)		7.88 (1.76)
Income		553 USD (281.2)
Number of person lived with the patients		4.0 (2.4)
Marital status		
Married	217 (75.1)	
Not married	18 (6.2)	
Other (Widowed/Divorced)	54 (18.7)	
Educational level		
High school or below	202 (70)	
Diploma degree	37 (12.8)	
Bachelor degree	33 (11.4)	
Graduate degree	17 (5.9)	
Patients who performed blood sugar test	265 (91.7)	
Frequency of testing blood sugar level		
Daily	59 (20.4)	
Two times/week	42 (14.5)	
Weekly	34 (11.8)	
Every two weeks	23 (8.0)	
Every month	61 (21.1)	
Every two months	47 (16.2)	
Did not check	23 (0.8)	

The majority of the participants were married (n=217, 75.1%) and their educational level was below high school (n=202, 70%). Participants' mean age was 55.3 years (*SD*=13.2), BMI 29.7 (*SD*=5.5), duration of illness 11.3 years (*SD*=8.7), income 553 USD (*SD*=281.2), and A1C level 7.88 (*SD*=1.78). Finally, the frequency of blood glucose monitoring varied between do not check/every two weeks (n=23, 0.8%) and every month (n=61, 21.1%).

Description of the study variables

To answer the research questions number one, two, and three, descriptive analyses were carried out. Results revealed that the mean score for knowledge scale was 16.4 out of 24. Regarding diabetes-related distress, the mean score was 47.2 out of 100 *(SD*=14.5), with the emotional burden subscale had the highest mean score (*M*=15.2, *SD*=6.6) followed by regimen distress (*M*=14, *SD*=5.9), and the inter-personal distress had the lowest score (*M*=7.1, *SD*=3.9) preceded by physician-related distress (*M*=10, *SD*=5.7). Finally, the mean score for self-management scale was 6.2 out of 10 with the following ascending sequence of the subscales; physical activity subscale (*M*=4.5, *SD*=3.1), dietary control (*M*=5.8, *SD*=2.3), and glucose management (*M*=7, *SD*=2.1), and healthcare use (M=7.1, SD=2.1).

Correlations among the Study Variables

Correlation test was carried out to answer the third research questions and to test the relationship among the study variables. As presented in Table 2, participants' age was significantly correlated with duration of illness (*r* =.293, *P*<.001), A1C (*r* =-.252, *P*<.001), BMI (*r* =.164, *P*=.005), and knowledge scale (*r* =-.198, *P*=.001).

Table 2: Summary of inter-correlations among the study variables

Variable	1	2	3	4	5	6	7
1. Age							
2. Duration of illness	.293***						
3. Income	-.032	-.076					
4. A1C	-.252**	.153**	-.171**				
5. BMI	.164**	-.003	-.007	-.002			
6. Self-management	.023	.024	.083	-.147*	-.196**		
7. Knowledge scale	-.198**	.112	.169**	-.051	-.104	.161**	
8. Diabetes related distress	-.094	-.058	-.184**	.153**	.04	-.31***	-.174**

Note: A1C: glycated hemoglobin, BMI: body mass index//8 P8
*P<.05, **P<.01, ***P<.001 two tailed test.
* P< .05, ** P<.01, *** P<.001

Duration of illness was significantly correlated with A1C (*r* =.153, *P*=.009) while patients' income was correlated with A1C (*r* = -.171, *P*=.004), knowledge scale (*r* =.169, *P*=.004), and diabetes related distress (*r* =-.184, *P*=.002). Besides, there was a negative relationship between self-management and A1C (*r* (287) = -.147, *P*=.013) and positive relationship between A1C and diabetes related distress (*r* =.153, *P*=.009). Self-management negatively correlated to BMI (*r* =-.196, *P*=.001) and DDS (*r* =-.31, *P*<.001) while positively correlated to knowledge scale (*r* =.16, *P*= .03). Finally, a negative relationship was found between knowledge and diabetes related distress (*r* =-.174, *P*=.003).

Predictors of glycemic control

The fourth question in this study was concerned with what are the strongest predictors of the target A1C level. To answer this question standard multiple linear regression analysis was carried out. Five variables (which correlated with A1C) were

entered in the linear regression analysis. The prediction model was statistically significant (F (5, 284) = 11.57, P<.001, R^2 = .17) and accounted for 17% of the variance in the A1C level. The level of A1C was predicted by participants' age, duration of illness, and patients' income variables with the age being the strongest predictors (β = -.318, P<.001) followed by duration of illness (β = .245, P<.001) and income (β = -.138, P=0.014). Self-management and diabetes related distress could not predict glycemic control represented by A1C value. The raw and standardized regression coefficients of the predictors together are shown in Table 3.

Table 3: Predictors of glycated hemoglobin (A1C)

Variable	*B*	*SE*B	B	*t* value	*P* value
Constant	10.364	.774		13.397	
Age	-.042	.008	-.318	-5.585	<.001
Duration of illness	.050	.012	.250	4.307	<.001
Income	-.001	.000	-.140	-2.484	.014
Self-management	-.118	.062	-.108	-1.892	.06
Diabetes related distress scale	.010	.007	.085	1.461	.15
Predictors of A1C final model produced at α=0.05, F=11.57, P<.001, R2 = .17					

Discussion

The majority of diabetic patient (61.1%) A1C levels exceeded 7.1% and thus not in line with the recommendations of the American Diabetes Association in which the level of less than 7% was considered the goal for therapy (15). This result is comparable with the international studies (18-19, 21-22), and with the previous local studies (16-17, 20) in which the majority of diabetic patients A1C levels were higher than the recommended one. One possible explanation of the poor glycemic control is the modest performance of the self-management activities. This is congruent with the finding that patients have a problem in adherence to diet and exercise (11-12, 35), and blood glucose monitoring (14). On the other hand, other studies contradict the finding of this study in which diabetic patients highly adhered to blood glucose monitoring, feet care, and participation in exercise programs (9), diet plan (9-10), and medication (10, 35).

Barriers regarding self-management behaviors were documented in literature and it is out of the scope of this paper. However, 70% of the participants were above 50 years and 83% of them had low income (less than 553 USD). Older age hinder patients from performing physical activities as well as low patients' income was the major barrier for performing self-management activities (10, 14). Financial issues are important factor and essential for transportation and seeking health care, eating healthy food, monitoring blood glucose level, and participation in physical activities. Regarding frequent blood glucose monitoring, a minority of the study participants (20%) monitor their blood glucose daily and other partipants varied in their compliance of blood glucose monitoring. Frequent glucose monitoring increase patients awareness of their glycemic status and allow them to make the needed life style changes. The adherence to healthcare use could be explained by the fact that patients have regular appointments to revisit the clinic in which they got the prescribed medication and perform the required blood investigation such as blood glucose monitoring.

The mean level of knowledge of the study participants was 16.4 out of 24 which was conflicting with findings in literature. For example, in United Arab Emirates, Iran, Nigeria, and in Kuwait patients had poor level of knowledge (13, 18, 27-28). Whereas good levels of knowledge was reported among diabetic patients in Qatar and Malaysia (22, 29). However, it is difficult to compare these re-

sults with each other since different instruments were used to measure the level of knowledge. It seems that the patients' educational level (the majority of the study sample was less than high school), and their age had an impact on their level of knowledge. Besides, the diversity in patients' insurance lead to differences in the type of information the patients get and whether there were educational program or not.

In literature, diabetes related distress was one of the consequences of diabetes (21, 39). Diabetic patients had low score regarding diabetes related distress with the highest score for emotional burden and regimen distress. Besides, moderate negative relationship was found between distress and self-management. This result was in line with other findings that high level of distress strongly correlated with poor self-management and poor glycemic control (19, 23, 40). It seems that because of the long duration of illness (M=11 years) the patients were able to cope with the disease and get used with its requirements. In addition, high distress level was documented among younger patients (21) and the majority of patients in this study were older than 50 years.

This study indicated that higher self-management activities, high income, older age, shorter duration of illness, and low levels of distress were associated with good glycemic control. These findings were in line with literature in which good glycemic control was associated with older age (10, 23, 46). On the other hand, no relationship was found between age and A1C (26). Diabetic patients experience with the disease management modalities might increase as their age increase. In addition, this study confirmed the result of other studies in which a shorter duration with illness was associated with better A1C control (10, 23-24). Indeed, shorter duration of illness was associated with higher A1C levels (26). On the other hand, no relationship was found between A1C levels and duration of illness (21). This study indicated that as the duration of diabetes increase, the management becomes more complicated and the compliance with the treatments regimen decrease. One explanation is that diabetic patients over time become frustrated from lack of glycemic control or overwhelmed from the requirements of the demanding self-management activities. In addition, a week negative relationship was found between patients' income and A1C level, which was consistent with the finding in literature in which low income was associated with poor glycemic control (14, 47).

In this study, patients' knowledge had no relationship with the A1C. This confirmed the result of other studies in which no relationships were found between patients' knowledge and A1C levels (18, 27). In other studies, a strong positive relationship was found between knowledge and A1C (25, 32), while significant negative relationships was found between knowledge and A1C level (22, 26). This variability in the relationship between level of knowledge and A1C levels highlighted the notion that patient adherence to treatment and commitment to modify their life style according to the target goal of management were insufficient and further investigations are needed to assess these variables.

A positive weak relationship was found between A1C and diabetes related distress, which was in agreement with literature in which lower diabetes distress was strongly associated with good self-management and good glycemic control (23, 40). Indeed, it contradicted the result of other study in which no relationship was found between diabetes distress and A1C (21). It seems that A1C level and distress influenced each other. In other words, high level of distress hinders patients from following the required self-management recommendations with subsequent effect on the A1C level. Similarly, high level of A1C increases the level of emotional distress with subsequent effect on self-management activities.

In spite of the previously discussed relationships, only patients' age, duration of illness, and income were the significant predictors of A1C, which was in line with literature (23). Whereas patients' self-management and diabetes related distress did not significantly predict A1C level. In literature lower BMI and lower diabetes distress (23) and good self-management activities (16) predicted diabetic patients A1C level. However, this model explained 17% of the variance in the A1C level meaning that other factors beyond self-management and dis-

tress level (not included in the model) may be able to predict A1C level. Plausible factors could be lack of resources, patients' compliance and commitments to management activities, social support, and heath care professionals' issues.

Limitations of the study

This is a cross-sectional study, which can demonstrate association not causal relationship. The patients were approached using convenience-sampling technique, which subjected to selection bias. In addition, diabetes self-management questionnaire is a self-reported instrument; these types of instrument may lead to response bias. Thus, in the future it is recommended to utilize an objective measure that evaluates self-management activities.

Conclusion

Jordanian patients failed to achieve the target of glycemic control and their management needs to be re-evaluated. Regarding self-management, patients scored the highest in the health care use and scored the lowest in performing physical activities. In addition, patients' age, duration of illness and income predicted small amount of good glycemic control. Thus, further research is required to shed the light on the large unexplained components of the A1C variance.

Ethics considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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