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Research Article

ASSOCIATION BETWEEN ADHERENCE TO DIABETES MEDICATION AND GLYCEMIC CONTROL

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ABSTRACT

Background: One of the most important factors affecting the glycemic control in Middle East is the extent of adherence of the patient to his/her diabetes medication(s).
Objective: This study aimed to assess the level of adherence to diabetes medication and patients' glycemic control and to find out the association between the two variables.
Methods: A Cross sectional study on patients in Delma Hospital in the emirate of Abu Dhabi, United Arab Emirates including those who are 20 years and older and who were diagnosed since 2years or more. The adherence to diabetes medication was measured with Morisky Medication Adherence Scale while Glycated Hemoglobin was the indicator for glycemic control.
Results: 165 patients were interviewed, 15 of them were excluded due to insufficient data. Sample size was one of the limitations of this study generalizability. 40.7% of the studied population was between 51 to 65 years; more than 2/3 was male. 51.3% were using 4-6 medicines daily. Only 22% completed academic education. The mean (± SD) adherence score was 2.73 (± 2) while the mean (±SD) HbA1c was 7.58% (± 1.76%). The readings of HbA1c were significantly correlated with medication adherence score ($P \leq 0.01$; $r = 0.649$).
Conclusion: The adherence to medications showed low to medium adherence. The good glycemic control group (HbA1c < 6.5%) constituted only 26.7% of the studied samples versus 73.3% were in poor glycemic control (HbA1c ≥ 6.5%). The overall findings of this study showed low glycemic control and low adherence of patients to their medications.
Keywords: Glycemic control, Glycated Hemoglobin, diabetes medication, Delma Hospital.

INTRODUCTION

The prevalence of Diabetes Mellitus (DM) is globally expected to jump from 171 million diabetic patients in the year 2000 to 366 million in 2030 (Wild S et al., 2004). Unfortunately, the previous figure was surmounted before reaching 2030, exactly in 2012, when International Diabetes Federation (IDF) published its 2012-report about diabetes in the globe (International Diabetes Federation, 2012). According to this report, the global figure is three hundred seventy one million cases of diabetes with prevalence of 8.3%. Undiagnosed cases were 187 million. Deaths recorded because of diabetes were 4.8 million and the total healthcare expenditure was 471.6 billion US dollars. The statistics in Middle-East and North Africa (MENA) region shows that more than 34.2 million people have diabetes with the highest prevalence of 11% in adults (20-79 years) and the number of diabetes cases may move up to 59.7 million in 2030. The prevalence in the Middle East Arab countries represents a big problem and controlling diabetes there is a great challenge. In United Arab Emirates (UAE), there were 827,000 people with diabetes, 430,000 of these patients are undiagnosed. The prevalence is 13.16% (UAE comes in

rank 7 within MENA region after Saudi Arabia 19.42%, Kuwait 18.85%, Bahrain 18.34%, Qatar 17.57%, Lebanon 16.60% and Egypt 15.27%). One thousand seven hundred fifty two deaths were recorded in UAE during 2012 because of diabetes. The mean healthcare expenditure per capita with diabetes was 1775 USD (approximately 6500 Arab Emirates Dirhams, AED). One of the main terms in DM self-management is medication adherence and diabetes education (Funnell MM et al., 2008). Improving adherence of the patient to recommendations of the healthcare provider receives world-wide attention. In 2003, the World Health Organization (WHO) stated that "increasing the effectiveness of adherence interventions may have a far greater impact on the health of the population than any improvement in specific medical treatments" (World Health Organization, 2003). Good glycemic control in diabetic patients is a major concern for healthcare providers to avoid the complications, both macro- and microvascular, related to poor glycemic control as proved by many randomized clinical trials (Skyler, 2004). Therefore, interventional studies, including overt diabetes as well as pre-diabetes, will help eliminating the poor prognosis through optimizing the glycemic control. Many studies (Krapek K et al., 2004; Rhee MK et al., 2005 and Simpson et al., 2006) evaluated the health outcomes and mortality rates between high versus low diabetes medication-adherent patient groups. These studies revealed a proportional relationship between highly adherent patient groups and positive health outcomes and inverse proportion with mortality rates and vice versa. The present study aimed to assess the association between adherence to diabetes medication(s) and glycemic control and to explore the relationship between these two variables in a UAE population living in Delma Island, Abu Dhabi, UAE.

METHODS

Study design

A cross-sectional study was carried out involving a written questionnaire. The study was carried out in Delma Hospital which is one of Al-Gharbia Hospitals (AGH), one of Abu Dhabi Health Services Company (SEHA) facilities. The patients were mixed UAE nationals and expatriates identified from their health insurance cards. The sample size was 150 regular diabetic patients.

Inclusion criteria

- Patients who were diagnosed as diabetics for not less than 24 months as those patients have a good try in self-management.
- Patients older than 20 years as at this age the population is mature enough and expected to have good general life knowledge, diabetes knowledge is a part of it.

Data collection

After getting the research ethical approval (Reference # AGH-IREC-013-001) from the Institutional Research Ethics Committee (IREC), the investigator interviewed the target diabetic patients during their regular follow up visit in the internal medicine clinic. They had been asked to participate in the study by answering a questionnaire. If the patient agreed, a written informed consent was obtained. The investigator administered the questionnaire through face-to-face interview with the patient. After finishing, the investigator collected the completed questionnaires and approached the internal medicine clinic to get the last reading of HbA1c from patient medical record. The collected data measured the patients' adherence to diabetes medication(s) in addition to HbA1c as an indicator of the glycemic control:

Medication adherence test

Morisky Medication Adherence Scale (MMAS) was used to assess adherence to medications within selected sample (Morisky DE et al., 2008). It consists of 8 closed-format questions where the first 7 are answered with either Yes or No while the last question is in the form of Likert scale. Each question will be marked zero point if answered correctly and one point if answered wrongly. The score will range from 0 to 8. Thus, lowest scores represent more adherent patients. MMAS score had been categorized into three levels: Low adherence (MMAS score ranges from 3 to 8), Medium adherence (MMAS score ranges from 1 to 2) and High adherence (if MMAS score is Zero) (Morisky et al., 1986).

Glycemic control

As a biochemical indicator, HbA1c was used as a marker for glycemic control among the study patients. The readings were retrieved from patients' medical records where values equal to or more than 6.5% indicate a poor glycemic control and, thus, poor diabetes management while readings less

than 6.5% indicate good glycemic control according to The Global Partnership for Effective Diabetes Management (Del Prato S et al., 2007).

Statistical Analysis:

Descriptive statistics were used to summarize the data concerning the demographic characteristics and disease characteristics in addition to medication adherence score. Categorical variables (like gender, nationality and educational level) were described by using frequencies and percentages while the continuous variables (like HbA1c and MMAS score) were described by using the means and standard deviations.

Mann-Whitney U Test was used as the non-parametric test to compare MMAS scores between 2 independent groups (like male versus female) while Kruskal Wallis Test (also non-parametric test) was used to compare MMAS scores among 3 or more independent groups (like educational levels). Relationship between adherence scores and readings of HbA1c were identified by testing with Spearman Rank Correlation Coefficient (Bivariate Correlation).

The statistical software used to perform all statistical tests was Statistical Product and Service Solutions, initially known as Statistical Package for the Social Sciences, (SPSS) version 20.

A total target patient was 165, out of which 15 patients were excluded due to lack of important data, mainly HbA1c measures. Male and female percentages were 68% and 32%, respectively. Nationality distribution was 59.3% as UAE nationals and 40.7% as Expatriates.

The highest percentage of patients' age lied in the 51-65 years-age-category with male gender comprised more than two-thirds. More than half of patients (51.3%) were using 4-6 medicines per day. Only 22% of patients had university education while 27.3% had no education at all, 28% had secondary school certificates and 22.7% completed elementary education.

BMI: Body Mass Index (kg/m2); HbA1c%: Percentage of Glycated Hemoglobin; MMAS: Morisky Medication Adherence Scale; 25 Percentile (or Quartile 1; Q1): a value below which 25% of the observations may be found; 50 Percentile (or Quartile 2; Q2): a value below which 50% of the observations may be found; 75 Percentile (or Quartile 3; Q3): a value below which 75% of the observations may be found; Inter-Quartile Ratio (IQR): an interval where 50% of the observations may be found (IQR= Q3 – Q1).

Table 1: Demographic and Disease Characteristics of the Studied Population Sample (N = 150).

Variables	Frequency (*n*)	Percentage (%)
Age Category		
20-35	6	4.0
36-50	52	34.7
51-65	61	40.7
66 or more	31	20.7
Gender		
Male	102	68.0
Female	48	32.0
Nationality		
UAE national	89	59.3
Expatriate	61	40.7
Educational Level		
Not at all	41	27.3
Elementary	34	22.7
Secondary	42	28.0
College or Higher	33	22.0

BMI Category (BMI range)		
Normal (18.5-24.9)	28	18.7
Overweight (25.0-29.9)	73	48.7
Obese (30 or more)	49	32.7
Glycemic Control (HbA1c %)		
Poor (≥ 6.5%)	110	73.3
Good (< 6.5%)	40	26.7
Number of Daily Medications		
1-3 medicines	59	39.3
4-6 medicines	77	51.3
7 or more	14	9.3
Adherence Level (MMAS score)		
Low (3-8)	75	50.0
Medium (1-2)	50	33.3
High (0)	25	16.7

Table 2: Demographic and Disease Characteristics of the Studied Population **Sample (N = 150)**

		Age (years)	BMI	HbA1c%	MMAS score
N		150	150	150	150
Mean		54.91	29.05	7.58	2.73
Standard Deviation (SD)		12.28	5.04	1.76	2.03
Minimum		29	20.3	5.43	0
Maximum		86	52.0	15.35	7
Percentiles	**25**	46.75	25.50	6.43	1.00
	50	53.00	28.30	7.39	2.50
	75	63.25	31.25	8.39	4.00

Table 3: Medians of MMAS score and HbA1c means of the Variables.

Variable	MMAS score Median	HbA1c% Mean
Age Category[a]	**	
20-35	5.0	14.3
36-50	1.5	7.4
51-65	3.0	7.4
66 or more	3.0	6.9
Gender[b]		
Male	2.0	7.4
Female	3.0	7.5
Nationality[b]		
UAE national	3.0	7.41
Expatriate	2.0	7.22
Educational Level[a]	***	**
Not at all	4.0	8.1
Elementary	3.0	7.45
Secondary	2.0	6.94
College or Higher	1.0	6.57
BMI Category (BMI)[a]		
Normal (18.5-24.9)	2.0	7.3
Overweight (25.0-29.9)	3.0	7.4
Obese (30 or more)	2.0	7.5
Glycemic Control (HbA1c readings)[b]	***	
Poor (≥ 6.5%)	3.0	
Good (< 6.5%)	1.0	
Number of Daily Medications[a]	***	***
1-3 medicines	1.0	6.6
4-6 medicines	3.0	7.45
7 or more	4.5	8.25
Adherence Level (MMAS score)[a]		***
Low (3-8)		8.4
Medium (1-2)		6.3
High (0)		6.6

*[a] Kruskal Wallis Test; [b] Mann Whitney U Test; * Significant Difference (P ≤ 0.05); ** Significant Difference (P ≤ 0.01); *** Significant Difference (P ≤ 0.001).*

The mean (± SD) age of the patients was 54.91 (±12.28) years; BMI was 29.05 (± 5.04) (overweight). More than half of patients (51.3%) were using 4-6 medicines per day. Only 22% of patients had university education while 27.3% had no education at all, 28% had secondary school certificates and 22.7% completed elementary education.

Medication adherence

Some of the medication adherence characteristics are in table 1 and 2 (above). A mean (± SD) score of MMAS was 2.73 (± 2). The inter-quartile range (IQR) was 1 to 4. The minimum and maximum scores were 0 and 7, respectively. Table 3 summarizes all of the significant differences.

Age groups showed significant difference ($P \leq 0.01$) in MMAS score medians where the lowest median (1.5) was with 36-50-years-age group while the highest median score (5.0) was with age group ranged between 20-35 years (Kruskal-Wallis one-way nonparametric ANOVA). Significant differences were found ($P \leq 0.001$) among MMAS score medians of educational levels where they were: Not At All = 4; Elementary = 3; Secondary = 2 and College or Higher = 1 (Kruskal-Wallis Test). Additionally, significant differences ($P \leq 0.001$) were found among adherence score medians of categories of daily medications. For patients using 1-3 medicines per day, a median of MMAS score of 1 was recorded while it was 3 for those who were using 4-6 daily medications and, finally, 4.5 for those using 7 or more medicines per day (Kruskal-Wallis Test). Comparing the MMAS scores between good versus poor glycemic control (Mann-Whitney U Test), there was a significant difference ($P \leq 0.001$) between the medians of the 2 groups where good glycemic control group had a median MMAS score of 1 versus 3 for poor glycemic control group.

Glycemic control

The mean (± SD) HbA1c was 7.58% (± 1.76). See table 1 and 2 above. Percentage of patients with HbA1c measures less than 6.5% (good glycemic control group) was 26.7% versus 73.3% of patients have HbA1c equal to or more than 6.5% (poor glycemic control group). Group differences are shown in table 3. Using Mann-Whitney U Test, no significant difference ($P > 0.05$) was found between the nationality medians (UAE nationals = 7.41% and Expatriates = 7.22%) of HbA1c. Using Kruskal-Wallis Test for education categories, a significant difference ($P \leq 0.01$) was found among groups where a median of 8.1% was for non-educated patients, 7.45% for Elementary education, 6.94% for Secondary education and 6.57% for higher education group. The Kruskal-Wallis Test was also used to explore differences among patients using different number of daily medications. Significant difference ($P \leq 0.001$) was found with a median of 6.6% for patient group using 1-3 medicines per day, 7.45% for those using 4-6 medicines daily and 8.25% for patients using 7 or more daily medicines.

There was a significant correlation between MMAS score and HbA1c % ($r=0.65$, $P < 0.001$).

DISCUSSION

The adherence to medications showed low to medium adherence (mean MMAS score = 2.7). This had been confirmed previously (Asche et al., 2011; Briesacher BA et al., 2008 and Cramer JA 2004). Patients aged between 36-50 years showed the highest adherence (MMAS score = 1.5) while age group 20-35 years showed the lowest adherence to medications (MMAS score = 5). Degree of adherence to medications increased as the formal education increases where university graduates showed the highest adherence while the non-educated patients showed the lowest degree of MMAS scores. The degree of adherence decreased inversely with the number of medications taken by the patient increases. This finding confirms Dezii CM et al., 2002 finding. Good glycemic control group patients were more adherent to their medications (MMAS median score = 1; medium adherence) than poor glycemic control group (MMAS median score = 3; low adherence).

The mean HbA1c (7.58%) identified a generally poorly controlled diabetes. The good glycemic control group (HbA1c < 6.5%) constituted only 26.7% of the studied samples versus 73.3% were in poor glycemic control (HbA1c ≥ 6.5%). There was no significant difference between the median HbA1c of UAE nationals (7.41%) and Expatriates (7.22%). Educational levels showed significant differences among HbA1c readings where 8.1% for no formal education group, 7.45% for elementary education group, 6.94% for secondary education group and 6.57% for higher education. Unfortunately, all categories were in poor glycemic control category (HbA1c ≥ 6.50%). There was a significant difference in association between HbA1c values and daily

medications taken by the patient. Patients taking 1-3 medicines a day have HbA1c of 6.6%, 4-6 medicines a day have HbA1c of 7.45% and 7 or more medicines a day have HbA1c of 8.25%. Again, all were in poor control.

There was significant association between different variables. The readings of HbA1c were directly correlated with medication adherence scores ($r = 0.649$). This finding confirms findings by Al-Qazaz HK et al., 2010 on Malaysian population.

Using non-parametric Bivariate Correlation (Spearman Rank Correlation Coefficient [r]), the relationships between medication adherence and HbA1c measures were explored. The readings of HbA1c were significantly correlated with medication adherence score ($P \leq 0.01$; $r = 0.649$).

CONCLUSION

The findings of this study revealed an overall suboptimal glycemic control which can be enhanced through strict adherence to diabetes medications and conducting robust educational programs. The adherence of the patients to their diabetes medications is below minimum. In spite of a slight improvement of adherence to medication with higher formal education, it is still low.

The impact of the above findings necessitates the implementation and conduction of a good sustainable programs that target mainly diabetic patients and, to a lesser extent, healthy individuals to make them aware about diabetes mellitus and encourage more adherence to diabetes medications. More knowledge about diabetes will result in more medication-adherent patients to end with optimal glycemic control.

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