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By

Ghaida'a F. Al-Mutairi
Ibrahim M. Abdul-Halim
Abdulmohsen A. Albawi
Medhat K. El-Shazly
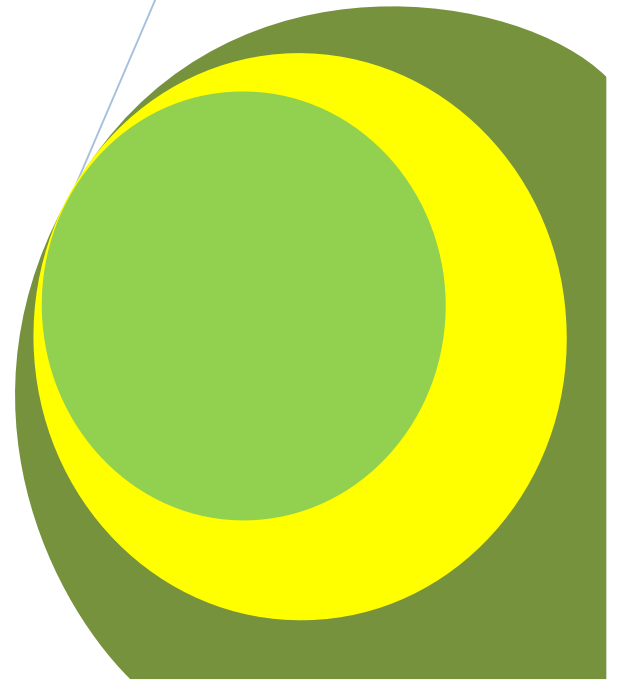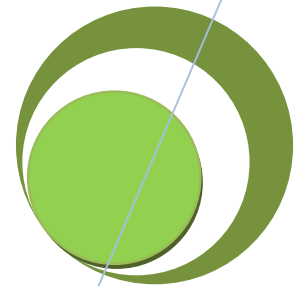
Research Article

Knowledge of primary health care workers regarding HbA$_{1c}$ as a diagnostic and monitoring test for type 2 diabetes mellitus

[1]Ghaida'a F. Al-Mutairi, [2]Ibrahim M. Abdul-Halim, [3]Abdulmohsen A. Albawi, [4*]Medhat K. El-Shazly

[1,2,3]MRCGP – International, Al-Sawaber Family Practice Health Center, PHC, MOH, Kuwait.
[4*]MD, Department of Medical Statistics, Medical Research Institute, Alexandria University, Egypt. & Department of Health Information and Medical records, MOH, Kuwait.

[4*]Corresponding Author's E-mail : medshaz@yahoo.com

ABSTRACT

Background: **In 2010, the American Diabetes Association adopted the use of the Glycosylated hemoglobin (A1C) test to diagnose diabetes, with a threshold of ≥6.5%.**
Objective: **The aims of this study was to evaluate physicians' knowledge regarding A1C as a diagnostic and monitoring test for type 2 diabetes mellitus (T2D) in primary health care (PHC) centers in Kuwait.**
Methods: **This study was a cross-sectional survey that was conducted in Capital PHC centers in Kuwait using a self-administered questionnaire that was distributed to all currently working physicians in the selected centers. Beside personal characteristics and working conditions, the questionnaire included 10 questions that were related to monitoring value of A1C and 10 questions related to its diagnostic value.**
Results: **The response rate in this survey was 69.9%. The median of the overall knowledge score related to diagnostic value of Hb$_{AC1}$ was three out of ten while this for monitoring value was 6 out of ten. Higher median knowledge scores of diagnostic value of A1C were significantly encountered among those who had any certificate in diabetes, specialized course or lectures in diabetes, those who were aware of general diabetes management and ADA 2010 guidelines and those who requesting A1C to diagnose new diabetic patients .**
Conclusions: **The results showed that physicians' knowledge and awareness about A1C as a diagnostic test were much lower than that about its monitoring value of T2D.**

Keywords: Type 2 Diabetes, HbA$_{1c}$, physicians' knowledge.

INTRODUCTION

Diabetes is a serious medical condition for the individual and society. The prevalence among adults aged 20-70 years is expected to rise from 285 million in 2010 to 438 million by the year 2030. (Unwin et al., 2009). The five countries with the highest prevalence rates are Nauru, United Arab Emirates, Saudi Arabia, Bahrain and Kuwait. *(World Health Sciences 2010)*

Currently, glycosylated hemoglobin (A1C) is widely accepted as a measure of glycemic control in established diabetes, an indicator of the risk for development of diabetic complications, and a reflection of the quality of diabetes care (*Zhang et al., 2010*). Epidemiologic datasets showed that the A1C has several advantages to the fasting plasma glucose (FPG) and the 2-h value in the 75-g oral glucose tolerance test (OGTT), including greater convenience, since fasting is not required; evidence to suggest greater pre-analytical stability; and less day-to-day perturbations during periods of stress and illness. These advantages must be balanced by greater cost, the limited availability of A1C testing in certain regions of the developing world, and the incomplete correlation between A1C and average glucose in certain individuals. (Ziemer et al., 2010)

For decades, the diagnosis of diabetes was based on plasma glucose criteria, either the FPG or OGTT *(American Diabetes Association 2010).* In 2009, an International Expert Committee that included representatives of the American Diabetes Association (ADA), the IDF, and the European Association for the Study of Diabetes (EASD) recommended the use of A1C test to diagnose diabetes, with a threshold of ≥6.5% *(International Expert Committee 2009)*, and ADA adopted this criterion in 2010 *(American Diabetes Association 2010).*

Diabetes mellitus is a major public health problem in Kuwait. Physicians' knowledge of the correct methods of diagnosis and proper management of diabetes seems to be indispensable. Because the physicians working at the different PHC facilities are in the first line of treatment in Kuwait, their knowledge is the determining factor in controlling the diabetes. Therefore, the objective of this study was to evaluate physicians' knowledge regarding A1C as a diagnostic and monitoring test for T2D in PHC centers.

SUBJECTS AND METHODS

The health care system in Kuwait is divided into five regional health authorities. PHC is provided through 92 centers distributed in the health regions proportionate to their population. This study was a cross sectional descriptive survey that was conducted from June to August 2012 in all PHC centers located in a randomly selected health region (Capital). The Capital health region contains 24 PHC center, six of these centers include specialized diabetes clinics, other centers mange diabetic patients through GP or FP clinics. The study population was physicians who were currently working in the different PHC centers in the selected region and were involved in the care of patients with diabetes. The target population consisted of 206 physicians 190 GP or FP and 16.

Data of this study was collected through a structured pe-designed questionnaire that was derived from other published studies dealing with the same topic as well as from our own experience. The questionnaire consisting of 45 questions, was designed to collect information on the personal characteristics and working conditions data of the study population, current knowledge about diagnostic values of A1C (10 questions), and management value of A1C (10 questions). Knowledge questions were multiple choice ones, each question was awarded one marks with the correct answer while each wrong or uncertain answer was given a 0 mark.

The participants were assured that the outcome would not be used for performance appraisal of the individuals. The participants were requested to complete the answers without consulting materials, textbooks or fellow staffs. They were given 10 minutes to do so. The answered questionnaires were then returned to the principal investigators.

A pilot study was carried out on 10 physicians. This study was formulated to test the clarity, applicability of the study tools, identify the difficulties that may be faced during the application. Also, the time needed for filling the questionnaire by the staff was estimated during this pilot study. The necessary modifications according to the results obtained were done.

All the necessary approvals for carrying out the research were obtained. The Ethical Committee of the Kuwaiti Ministry of Health approved the research. A written format explaining the purpose of the research was prepared and signed by the physician before filling the questionnaire. In addition, the purpose and importance of the research were discussed with the director of the health center.

Statistical analysis

The Statistical Package for Social Sciences (SPSS-17) was used for data processing. Simple descriptive statistics were used (mean ± standard deviation for quantitative variables and frequency with percentage distribution for categorized variables). Comparison was based on a series of univariate analyses using Chi square test for categorized variables.

Comparison of knowledge score was based on a series of univariate analyses using independent samples Mann-Whitney's U-test for comparison between two sample medians, and Kruskal-Wallis test for comparison among more than two sample medians. A 0.05 level is chosen as a level of significance in all statistical tests used.

RESULTS

Out of 206 eligible physicians in the Capital health region, 144 agreed to participate in the study, answered the questionnaire and returned it back with 69.9% response rate.
The personal characteristics and working conditions of the participants were illustrated in table 1.

Table 1: Personal characteristics and working conditions of the study participants

Characteristics	No.	%
Age groups (years)		
<30	28	19.4
30-	67	46.5
40-	30	20.8
≥50+	19	13.2
Gender		
M	54	37.5
F	90	62.5
Nationality		
K	91	63.2
NK	53	36.8
Marital status		
single	21	14.6
Ever married	123	85.4
Education		
Bachelor	38	26.4
Master	47	32.6
Doctorate	59	41.0
Income		
<1000	21	14.6
1000-1499	30	20.8
≥1500	93	64.6
BMI categories		
Normal	53	36.8
Overweight	56	38.9
Obese	35	24.3
Smoking status		
No	125	86.8
Yes	19	13.2
Specialty		
GP	60	41.7
FP	77	53.5
Diabetologist	7	4.9
Place of working		
GP clinic	49	34.0
FP clinic	85	59.0
Diabetes clinic	10	6.9
Years of experience in work		
<5	36	25.0
5-	34	23.6
10-	36	25.0
≥20	38	26.4
Working hours per week		
<20	34	23.6
20-	58	40.3
≥40	52	36.1
Total	144	100.0

The mean age of the participants was 37.3± 9.6 years, the mean working years was 12.7± 10.3 years, and the mean working hours per week was 30.9±15.8 hour. About two thirds of the participants (62.5%) were

females, 63.2% were Kuwaiti, 85.4% have ever married, 73.6% had master or doctorate degree, 53.5% were family physicians (FP), only 6.9% worked in diabetic clinic and a few (4.9%) were diabetologists.

Table 2 revealed that the mean years of experience in diabetes was 6.3±8.1, with 41.7% with no experience in this field, only 13.2% of the participants have a certificate in diabetes, 39.6% had received diabetes specialized course, 88.2% attended diabetes lectures or presentation, 79.2% had special interest in diabetes, 87.5% stated that they were aware of diabetes guidelines, 68.8% aware of 2010 ADA guidelines, 97.2% requested A1C to monitor control of their diabetic patient,78.5% requested A1C to diagnose new pre-diabetic patients, 89.6% requested A1C to diagnose new -diabetic patients and 54.9% used A1C as a screening test for diabetes

Table 2: Distribution of the study participants according to their experience in the field of diabetes

Working conditions	No.	%
Experience in DM (years)		
No experience	60	41.7
1-	37	25.7
≥5	47	32.6
Do you have any certificate in diabetes?		
no	125	86.8
yes	19	13.2
Did you received any diabetes specialized course		
no	87	60.4
yes	57	39.6
Did you attend diabetes lectures or presentation?		
no	17	11.8
yes	127	88.2
Do you have special interest in diabetes?		
no	30	20.8
yes	114	79.2
Are you aware of diabetes guidelines?		
no	18	12.5
yes	126	87.5
Are you aware of ADA 2010 guidelines?		
no	45	31.3
yes	99	68.8
Do you request HbA$_{1c}$ to monitor control of your diabetic patient		
no	4	2.8
yes	140	97.2
Do you request HbA$_{1c}$ to diagnose new pre-diabetic patients		
no	31	21.5
yes	113	78.5
Do you request HbA$_{1c}$ to diagnose new diabetic patients		
no	15	10.4
yes	129	89.6
Do you use HbA$_{1c}$ as a screening test for diabetes?		
no	65	45.1
yes	79	54.9
Total	**144**	**100.0**

Concerning knowledge about diagnostic value of A1C, presented in table 3, 59.7% of participants answered correctly that the 2010 ADA Standards set the diagnostic cutoff point of A1C to diagnose diabetes is 6.5%, and 54.9% of them knew that A1C level at 5.7 – 6.4% was recognized by The Expert Committee on the Diagnosis and Classification of Diabetes Mellitus to diagnose pre-diabetes. Only 8.3% of physicians answered correctly that high pressure liquid chromatography is considered to be a reference method to measure the concentration of A1C.

Table 3: Proportion of participants answered correctly statements regarding diagnostic value of HbA$_{1c}$ in type 2 diabetes mellitus

Diagnostic value of HbA1c	No.	%
− The 2010 ADA Standards set the diagnostic cut-off point of diabetes at 6.5% A1C	86	59.7
− High pressure liquid chromatography is a reference method to measure the A1C	12	8.3
− The range of A1C to diagnose pre-diabetes is 5.7 – 6.4%	79	54.9
− The result of A1C measurement is not underestimated in B12 deficiency anemia	38	26.4
− A1C has not Less potential of systematic error than fasting and 2-hours glucose measurements	16	11.1
− To diagnose diabetes, fasting plasma glucose measurement may be combined with A1C	55	38.2
− high sensitivity of A1C is not a disadvantage of the test in developing countries	36	25.0
− Repeat the test is usually not needed with A1C as diagnostic and screening test.	37	25.7
− There is a reasonable concordance between A1C and impaired fasting glucose in diabetes screening	22	15.3
− Uremia, hypertriglyceridemia, vitamin C ingestion and iron deficiency do not cause false low results of HbA$_{1c}$ in the diagnosis of type 2DM	22	15.3
Total	**144**	**100.0**

Also, 26.4% of the participants were aware that the result of A1C measurement is not underestimated in B12 deficiency anemia. Only 11.1% reported correctly that A1C has not less potential of systematic error than fasting and 2-hours glucose measurements, 38.2% were aware that to diagnose diabetes, fasting plasma glucose measurement may not be combined by A1C test, 25.0% were aware that high sensitivity of A1C is not a disadvantage of the test in developing countries, 25.7% knew that repeating the A1C test is usually not needed for diagnosis of diabetes.

Only 15.3% were aware that there is no reasonable concordance between A1C and IFG in pre-diabetes and 15.3% were aware that uremia, hypertriglyceridemia, vitamin C ingestion and iron deficiency do not cause false low results of A1C in the diagnosis of T2D.

Regarding management value of A1C, table 4 revealed that 42.4% of the participants reported correctly that 7.0% was the target level of A1C which indicates diabetes control, 96.5% knew that A1C test measures the average amount of sugar in blood over the last 3 months, 18.8% knew correctly that an increase of A1C by 1% will approximately correspond to an increase in blood sugar by 2.0 mmol.

Table 4: Proportion of participants answered correctly statements regarding monitoring value of HbA$_{1c}$ in type 2 diabetes mellitus

Monitoring value of HbA1c (monitoring control)	No.	%
– The target level of A1C which indicates diabetes control is 7.0%	61	42.4
– A1C test measures the average amount of sugar in blood over the last 3 months.	139	96.5
– An increase of A1C by 1% will approximately correspond to an increase in blood sugar by: 2.0 mmol	27	18.8
– In an overweight adult, second degree relative with diabetes is not an additional risk factors for diabetes that warrants testing	70	48.6
– Insulin should not be considered, as the initial therapy in a newly-diagnosed type 2 diabetes patient with ketonuria.	69	47.9
– A1C is the best laboratory parameters to assess glycemic control in a patient with Alzheimer disease with type 2 diabetes.	110	76.4
– Based on ADA guidelines, performing A1C test at least 2 times a year in patients who are meeting treatment goals and who have stable glycemic control is true	40	27.8
– The result of HbA$_{1c}$ measurement is not overestimated in the Sickle-cell anemia	16	11.1
– If HbA$_{1c}$ in pregnant lady is 9.5%, the risk of anomaly in the fetus will be 2.0%	9	6.3
– Vitamin E supplement is not the measures to delay type 2 diabetes	95	66.0
Total	144	100.0

Moreover, 48.6% of participants knew correctly that second degree relative in an overweight adult is not an additional risk factors for diabetes that warrants testing, 47.9% knew correctly that presence of ketonuria is a condition in which insulin should not be considered, along with lifestyle modifications, as the initial therapy in a newly-diagnosed patient with T2D, 76.4% answered correctly that A1C is the best laboratory parameters used to assess glycemic control in a patient with Alzheimer disease who has T2D for 10 years.

Also, 27.8% of the participants reported that performing the A1C test at least 2 times a year in patients who are meeting treatment goals and who have stable glycemic control was stated by the ADA standards, 11.1% reported correctly that Sickle-cell anemia does not overestimate the result of A1C measurement, only 6.3% knew that A1C level of 9.5%, in a pregnant woman, indicates the risk of congenital anomaly in the fetus by 2.0%. However, 66.0% knew correctly that vitamin E supplement is not one of the measures that may delay T2D.

Table 5 illustrated personal characteristics and working conditions that could affect physicians' knowledge. The overall median knowledge score for diagnostic value of A1C was only 3 out of 10 and that for management and monitoring value of A1C was 6 out of 10. Concerning diagnostic value of A1C, no significant association between the knowledge score and the studied variables except for age and education whereas younger physicians were less knowledgeable (P=0.005), and those having doctorate degree showed high level of knowledge than others (P=0.030). Regarding monitoring value of A1C, no significant difference could be found between knowledge score and the studied variables.

Table 5: Participants' Hb$_{A1c}$ knowledge score by personal characteristics and working conditions

Variables	Knowledge score								
	Diagnostic value of Hb$_{A1c}$					Monitoring value of Hb$_{A1c}$			
	Min	Max	Median	P		Min	Max	Median	P
Age:									
<30	0	5	1.50	0.005		3	10	7	0.10
30-	0	7	3			2	10	6	
40-	0	5	3			4	10	6	
≥50	1	7	3			3	10	6	
Gender									
Male	0	7	2	0.28		3	10	7	0.37
Female	0	7	3			2	10	6	
Nationality									
Kuwaiti	0	7	3	0.35		3	10	6	0.49
Non-Kuwaiti	0	7	2			2	10	7	
Education									
Bachelor	0	7	2	0.03		3	10	7	0.07
Master	0	6	2			2	10	7	
Doctorate	0	7	3			3	10	6	
Specialty									
GP	0	7	2	0.09		2	10	7	0.28
FP	0	7	3			3	10	6	
Diabetologist	1	6	3			4	7	6	
Clinic									
GP	0	7	2	0.17		2	10	7	0.40
FP	0	6	3			3	10	6	
Diabetic	1	6	3.5			4	7	6	
Years of experience									
<5	0	7	2	0.39		3	10	7	0.41
5-	0	6	2.5			4	10	6	
10-	0	6	3			2	10	6	
≥15	0	7	3			3	10	6	
Working hours/week									
<20	0	6	2	0.31		3	10	7	0.28
20-	0	7	3			2	10	6	
≥40	0	7	3			4	10	7	
Overall	0	7	3			2	10	6	

Table 6 illustrated the median knowledge score and physicians' experience in the field of diabetes. Higher levels of knowledge score were significantly encountered among physicians who have any certificate in diabetes (P=0.05), received any diabetes specialized course (P=0.05), attended diabetes lectures or presentation (P=0.05), were aware of diabetes guidelines (P=0.04), aware of ADA 2010 guidelines (P<0.001) and requested A1C to diagnose new pre-diabetic patients (P=0.03).

Table 6: Participants' Hb$_{A1c}$ knowledge score by their experience in the field of diabetes

Variables	Knowledge score								
	Diagnostic value of Hb$_{A1c}$					Monitoring value of Hb$_{A1c}$			
	Min	Max	Median	P		Min	Max	Median	P
Experience in diabetes									
no	0	7	2	0.15		2	10	7	0.34
1-	0	6	3			3	10	6	
≥5	0	7	3			4	10	6	
Having any certificate in diabetes:									
No	0	7	2	0.005		2	10	7	0.04
Yes	1	6	4			4	10	6	
Receiving any diabetes specialized course									
No	0	7	2	0.05		3	10	7	0.10
Yes	0	6	3			2	10	6	
Attending diabetes lectures or presentation									
No	0	5	2	0.05		4	8	7	0.25
Yes	0	7	3			2	10	6	
Having special interest in diabetes									
No	0	6	3	0.28		2	10	7	0.30
Yes	0	7	3			3	10	6	
Awareness of diabetes guidelines									
No	0	7	1.5	0.04		4	10	7	0.03
Yes	0	7	3			2	10	6	
Aware of ADA 2010 guidelines									
No	0	7	2	<0.001		4	10	7	0.002
Yes	0	7	3			2	10	6	
Requesting HbA1c to monitor control of your diabetic patient									
No	1	3	2.5	0.52		4	7	6.5	0.62
Yes	0	7	3			2	10	6	
Requesting HbA1c to diagnose new pre-diabetic patients									
No	0	7	2	0.11		3	10	7	0.18
Yes	0	7	3			2	10	6	
Requesting HbA1c to diagnose new -diabetic patients									
No	0	4	2	0.03		4	10	8	0.004
Yes	0	7	3			2	10	6	
Use HbA1c as a screening test for diabetes									
No	0	7	3	0.72		3	10	6	0.80
Yes	0	6	3			2	10	6	

On the other hand, no significant associations were observed regarding monitoring value of A1C and physicians' experience in the field of diabetes except for those having any certificate in diabetes (p=0.04),

awarded of diabetes guideline (p=0.03), awarded of ADA 2010 (p=0.002) and requesting A1C to diagnose new pre-diabetic patients (p=0.004)

DISCUSSION

In many developing countries PHC physicians play a major role in the management of patients with diabetes mellitus and providing international standards of care will result in improvement of clinical outcome. The assessment of screening tests for T2D is complicated by uncertainty regarding the most appropriate gold standard for comparison. In the past, the utility of A1C testing was limited in part by relatively poor reproducibility and lack of standardization across laboratories. More recently, widespread adoption of standardized A1C measurements has occurred, and newer techniques for measurement are generally highly reproducible *(Little et al., 2001)*. Therefore, knowledge about these new issues is mandatory for physicians for proper diagnosis; early detection and management of T2D.

In the present study, physicians knew enough about T2D and its monitoring using A1C, however, most of the physicians were not aware of the newer diagnostic criteria of diabetes.

Nowicka et al. 2011 reported that A1C has the advantages of not requiring an overnight fast or a morning blood draw. In addition, it is familiar and generally available to clinicians in developed countries. It is less likely than glucose to be affected by short-term lifestyle changes. A1C is relatively stable at room temperature and shows less intra-individual biologic variability than fasting or post-load glucose levels.(*Droumaguet et al 2006*) In addition, the precision and accuracy of the A1C assay have benefited from an international effort to improve assay standardization.(*Shimazaki et al 2007*) In the present study, participants knowledge score about diagnostic value of A1C was 3 out of 10. Only two questions were answered correctly by more than half of participants, the other 8 questions were answered correctly by lower percentage that may be as lower as 8.3%, 11.1%, 15.3 and 25.0% for statements regarding method of measuring A1C, advantage of A1C over FBG, concordance between A1C and OGTT and sensitivity of the test respectively.

Katulanda et al. 2011 found in their study an appreciable proportion of physicians who were not aware of the new diagnostic role of A1C for diabetes and the respective cut-off values based on current international guidelines. Similarly, in the current study, more than half answered correctly that the diagnostic cutoff point of the A1C in diabetes is 6.5% according to the 2010 ADA standards of medical care in diabetes. *(American Diabetes Association, 2010)* Also, 54.9% were aware that the range of A1C to diagnose pre-diabetes is 5.7 – 6.4% according to The Expert Committee on the Diagnosis and Classification of Diabetes Mellitus (*Nowicka et al 2011*). However, increasing the cutoff value to 7.0% increased the positive predictive value to 90%. A1C values in the high-normal range (5.6% to 6.0%) seem to predict a higher incidence of future diabetes *(Edelman et al 2004, Norberg et al 2006)*. In some assays, vitamin C and vitamin E ingestion have also been reported to falsely lower A1C results. (*Kramer et al 2010, Nowicka et al. 2011*) In the current study only 15.3% of participants answered correctly that uremia, hypertriglyceridemia, vitamin C ingestion and iron deficiency cause false and low results and which are not true regarding the use of A1C in the diagnosis of type T2D. In agreement with *Lippi et al. 2010,* about a quarter of the participants (26.4%) were aware that the result of A1C measurement is not underestimated in B12 deficiency anemia.

The present study revealed that the knowledge of physicians related to monitoring and management value of A1C was acceptable, where the overall median knowledge score was 6 out of 10 which was higher than that related to the diagnostic value of the test. The level of A1C provides a measure of the glycemic control of diabetic patients during the previous 2-3 months, and changes of its level at different points of time has certain implications on the diabetic complications; therefore, its routine measurement on time is important. *(Lind et al., 2010)*. Most of the participants in this study knew that A1C test measures the average concentration of blood sugar level over the last 3 months. However, only 42.4% of them were aware that the target level of A1C for control of diabetes is 7%. The present study revealed deficiency of knowledge in certain aspects as only 6.3% of the participants knew that level of A1C of 9.5% indicates the risk of congenital anomalies in the fetus will be 2%. This is most likely due to lack of continuous medical education among PHC physicians. It is well known that effective management of diabetes reduces the incidence and progression of many diabetes related complications (De Berardis, 2004*, Ohkubo et al., 1995*)

Hence, it is important that physicians have sound knowledge and positive attitudes towards all aspects of the management of this chronic disease including all the levels of prevention. There are many studies that have shown that mere availability of guidelines did not improve knowledge of the physicians in the management of T2D. *(Rätsep et al 2006)*.

A study in Al Hasa District of Saudi Arabia, revealed a high response rate, with 99 out of 122 (82%.) answering the questionnaire. The mean of the overall knowledge attitude and practice (KAP) score for all the respondents was 66.6 ± 8.8% (*Khan, et al.2011*). A similar study performed in Pakistan has found the highest KAP score of 65% among the FPs (*Shera et al., 2002)*. This was inconsistent with the results of the current study that revealed a moderate response rate (69.9%) with an overall median knowledge score equal 9 out of 20 questions (45%), which was considered low for the evaluation of knowledge of PHC physicians. This relative low

level score of knowledge could be explained partly by difference in the difficulty of the questions between studies. Also, it should be noted that in the present study, 50% of the questions were related to diagnostic value of A1C which is considered as recent procedure and many physicians were still not familiar with it. This effect was clear when we consider the knowledge scores for diagnostic and monitoring values of A1C separately (the median of the of knowledge score related to diagnostic aspect was 3 out of 10 and that related to the monitoring aspect was 6 out of 10)

Nowicka et al, 2011 reported that A1C should be employed to diagnose diabetes when it is convenient and available. Routine estimation of A1C as a diagnostic test was less frequently used by physicians than as a test of monitoring control of diabetic patients in the current study, whereas the percentages of physicians who requested A1C to diagnose new pre-diabetic patients, new diabetic patients and as screening test for diabetes were 78.5%, 89.6% and 54.9% respectively. Contrary, 97.2% of physicians requested A1C to monitor control of diabetic patients. In a similar study in the USA, it has been found that the performance of A1C as a diagnostic test was higher than 90%, and has increased compared with the early `90s *(Larme and Pugh 1991)*.

The present study revealed no effect of personal characteristics and working conditions on diagnostic knowledge of the participants except age and education where older physicians and those having doctorate certificate were significantly more knowledgeable. This goes in accordance with the finding of another study that was conducted by *Hansen et al 2003.* In a Saudi study, the KAP score of female physicians was significantly lower than that of the male physicians, and the same was true with the Saudi physicians as compared with the non-Saudi physicians (*Khan, et al.2011*). Inconsistently, in the current study, the knowledge score of female physicians did not significantly differ from that of males and the same was true with the Kuwaiti physicians as compared with the non-Kuwaiti physicians.

In the present study, despite the low median knowledge score related to diagnostic values of A1C or the higher score for monitoring value. Higher median knowledge scores of diagnostic value of A1C were significantly encountered among those who had any certificate in diabetes, specialized course or lectures in diabetes, those who were aware of general diabetes management and ADA 2010 guidelines and those who requesting A1C to diagnose new diabetic patients . These finding coincides with the finding of another study that was conducted by *Hansen et al, 2003*.

Given the increasing prevalence of diabetes in Kuwait and the evidence that T2D is mostly diagnosed at PHC, it is mandatory for all the PHC physicians to know the recent diagnostic criteria as laid down by the ADA.

CONCLUSION

The results showed that knowledge and awareness about A1C test as a diagnostic test was poor, but knowledge about monitoring and management value of the test was acceptable. There is an urgent necessity to develop education programs to improve the knowledge of PHC physicians about A1C as a diagnostic test, and subsequently audit their performance.

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