Knowledge of primary health care workers regarding HbA1c as a diagnostic and monitoring test for type 2 diabetes mellitus

By

Ghaida'a F. Al-Mutairi
Ibrahim M. Abdul-Halim
Abdulmohsen A. Albawi
Medhat K. El-Shazly
Knowledge of primary health care workers regarding HbA$_{1c}$ as a diagnostic and monitoring test for type 2 diabetes mellitus

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

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

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 HbA$_{1c}$ 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 centers, six of these centers include specialized diabetes clinics, other centers manage 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

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

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, 89.6% 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

<table>
<thead>
<tr>
<th>Working conditions</th>
<th>No.</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Experience in DM (years)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No experience</td>
<td>60</td>
<td>41.7</td>
</tr>
<tr>
<td>1-</td>
<td>37</td>
<td>25.7</td>
</tr>
<tr>
<td>≥5</td>
<td>47</td>
<td>32.6</td>
</tr>
<tr>
<td><strong>Do you have any certificate in diabetes?</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>no</td>
<td>125</td>
<td>86.8</td>
</tr>
<tr>
<td>yes</td>
<td>19</td>
<td>13.2</td>
</tr>
<tr>
<td><strong>Did you received any diabetes specialized course</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>no</td>
<td>87</td>
<td>60.4</td>
</tr>
<tr>
<td>yes</td>
<td>57</td>
<td>39.6</td>
</tr>
<tr>
<td><strong>Did you attend diabetes lectures or presentation?</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>no</td>
<td>17</td>
<td>11.8</td>
</tr>
<tr>
<td>yes</td>
<td>127</td>
<td>88.2</td>
</tr>
<tr>
<td><strong>Do you have special interest in diabetes?</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>no</td>
<td>30</td>
<td>20.8</td>
</tr>
<tr>
<td>yes</td>
<td>114</td>
<td>79.2</td>
</tr>
<tr>
<td><strong>Are you aware of diabetes guidelines?</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>no</td>
<td>18</td>
<td>12.5</td>
</tr>
<tr>
<td>yes</td>
<td>126</td>
<td>87.5</td>
</tr>
<tr>
<td><strong>Are you aware of ADA 2010 guidelines?</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>no</td>
<td>45</td>
<td>31.3</td>
</tr>
<tr>
<td>yes</td>
<td>99</td>
<td>68.8</td>
</tr>
<tr>
<td><strong>Do you request HbA₁ccoli to monitor control of your diabetic patient</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>no</td>
<td>4</td>
<td>2.8</td>
</tr>
<tr>
<td>yes</td>
<td>140</td>
<td>97.2</td>
</tr>
<tr>
<td><strong>Do you request HbA₁ccoli to diagnose new pre-diabetic patients</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>no</td>
<td>31</td>
<td>21.5</td>
</tr>
<tr>
<td>yes</td>
<td>113</td>
<td>78.5</td>
</tr>
<tr>
<td><strong>Do you request HbA₁ccoli to diagnose new diabetic patients</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>no</td>
<td>15</td>
<td>10.4</td>
</tr>
<tr>
<td>yes</td>
<td>129</td>
<td>89.6</td>
</tr>
<tr>
<td><strong>Do you use HbA₁ccoli as a screening test for diabetes?</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>no</td>
<td>65</td>
<td>45.1</td>
</tr>
<tr>
<td>yes</td>
<td>79</td>
<td>54.9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>144</td>
<td>100.0</td>
</tr>
</tbody>
</table>

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 HbA1c in type 2 diabetes mellitus

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

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 HbA1c in the diagnosis of type 2DM.

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 HbA1c in type 2 diabetes mellitus

<table>
<thead>
<tr>
<th>Monitoring value of HbA1c (monitoring control)</th>
<th>No.</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>− The target level of A1C which indicates diabetes control is 7.0%</td>
<td>61</td>
<td>42.4</td>
</tr>
<tr>
<td>− A1C test measures the average amount of sugar in blood over the last 3 months.</td>
<td>139</td>
<td>96.5</td>
</tr>
<tr>
<td>− An increase of A1C by 1% will approximately correspond to an increase in blood sugar by: 2.0 mmol.</td>
<td>27</td>
<td>18.8</td>
</tr>
<tr>
<td>− In an overweight adult, second degree relative with diabetes is not an additional risk factors for diabetes that warrants testing</td>
<td>70</td>
<td>48.6</td>
</tr>
<tr>
<td>− Insulin should not be considered, as the initial therapy in a newly-diagnosed type 2 diabetes patient with ketonuria.</td>
<td>69</td>
<td>47.9</td>
</tr>
<tr>
<td>− A1C is the best laboratory parameters to assess glycemic control in a patient with Alzheimer disease with type 2 diabetes.</td>
<td>110</td>
<td>76.4</td>
</tr>
<tr>
<td>− 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</td>
<td>40</td>
<td>27.8</td>
</tr>
<tr>
<td>− The result of HbA1c measurement is not overestimated in the Sickle-cell anemia.</td>
<td>16</td>
<td>11.1</td>
</tr>
<tr>
<td>− If HbA1c in pregnant lady is 9.5%, the risk of anomaly in the fetus will be 2.0%.</td>
<td>9</td>
<td>6.3</td>
</tr>
<tr>
<td>− Vitamin E supplement is not the measures to delay type 2 diabetes.</td>
<td>95</td>
<td>66.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>144</td>
<td>100.0</td>
</tr>
</tbody>
</table>

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’ HbA1c knowledge score by personal characteristics and working conditions

<table>
<thead>
<tr>
<th>Variables</th>
<th>Knowledge score</th>
<th>Diagnostic value of HbA1c</th>
<th>Monitoring value of HbA1c</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min</td>
<td>Max</td>
<td>Median</td>
</tr>
<tr>
<td>Age:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;30</td>
<td>0</td>
<td>5</td>
<td>1.50</td>
</tr>
<tr>
<td>30-</td>
<td>0</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>40-</td>
<td>0</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>≥50</td>
<td>1</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>0</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>Female</td>
<td>0</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>Nationality</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kuwaiti</td>
<td>0</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>Non-Kuwaiti</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bachelor</td>
<td>0</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>Master</td>
<td>0</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>Doctorate</td>
<td>0</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>Specialty</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GP</td>
<td>0</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>FP</td>
<td>0</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>Diabetologist</td>
<td>1</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Clinic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GP</td>
<td>0</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>FP</td>
<td>0</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Diabetic</td>
<td>1</td>
<td>6</td>
<td>3.5</td>
</tr>
<tr>
<td>Years of experience</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;5</td>
<td>0</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>5-</td>
<td>0</td>
<td>6</td>
<td>2.5</td>
</tr>
<tr>
<td>10-</td>
<td>0</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>≥15</td>
<td>0</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>Working hours/week</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;20</td>
<td>0</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>20-</td>
<td>0</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>≥40</td>
<td>0</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>Overall</td>
<td>0</td>
<td>7</td>
<td>3</td>
</tr>
</tbody>
</table>

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’ HbA1c knowledge score by their experience in the field of diabetes

<table>
<thead>
<tr>
<th>Variables</th>
<th>Knowledge score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Diagnostic value of Hb\textsubscript{A1c}</td>
</tr>
<tr>
<td></td>
<td>Min</td>
</tr>
<tr>
<td>Experience in diabetes</td>
<td></td>
</tr>
<tr>
<td>no</td>
<td>0</td>
</tr>
<tr>
<td>1-</td>
<td>0</td>
</tr>
<tr>
<td>≥5</td>
<td>0</td>
</tr>
<tr>
<td>Having any certificate in diabetes:</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>0</td>
</tr>
<tr>
<td>Yes</td>
<td>1</td>
</tr>
<tr>
<td>Receiving any diabetes specialized course</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>0</td>
</tr>
<tr>
<td>Yes</td>
<td>0</td>
</tr>
<tr>
<td>Attending diabetes lectures or presentation</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>0</td>
</tr>
<tr>
<td>Yes</td>
<td>0</td>
</tr>
<tr>
<td>Having special interest in diabetes</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>0</td>
</tr>
<tr>
<td>Yes</td>
<td>0</td>
</tr>
<tr>
<td>Awareness of diabetes guidelines</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>0</td>
</tr>
<tr>
<td>Yes</td>
<td>0</td>
</tr>
<tr>
<td>Aware of ADA 2010 guidelines</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>0</td>
</tr>
<tr>
<td>Yes</td>
<td>0</td>
</tr>
<tr>
<td>Requesting HbA1c to monitor control of your diabetic patient</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>1</td>
</tr>
<tr>
<td>Yes</td>
<td>0</td>
</tr>
<tr>
<td>Requesting HbA1c to diagnose new pre-diabetic patients</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>0</td>
</tr>
<tr>
<td>Yes</td>
<td>0</td>
</tr>
<tr>
<td>Requesting HbA1c to diagnose new -diabetic patients</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>0</td>
</tr>
<tr>
<td>Yes</td>
<td>0</td>
</tr>
<tr>
<td>Use HbA1c as a screening test for diabetes</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>0</td>
</tr>
<tr>
<td>Yes</td>
<td>0</td>
</tr>
</tbody>
</table>

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. (Råtsep 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.

**REFERENCES**


