The Effect of Glycated Hemoglobin on the Prognosis of Diabetic Patients: A Cross-Sectional Observational Study

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ABSTRACT

Objectives: Diabetes mellitus is a chronic metabolic disorder characterized by elevation of blood glucose and a high percentage of glycated hemoglobin A1c. Elevated hemoglobin A1c percentage of more than 7% will result in high production of advanced glycation end-products. The elevated level of advanced glycation end-products in diabetic patients means a high risk for diabetic complications. The primary endpoint was to evaluate the hemoglobin A1c levels among diabetic patients and its effect on the prognosis of this metabolic disease in all regions inside Saudi Arabia.

Methods: This was a cross-sectional observational study conducted between March and August 2018. The study was done by using a questionnaire containing nine questions which planned to involve at least 390 diabetic patients.

Results: Six hundred and ninety-four diabetic patients from Saudi Arabia had answered the nine question questionnaire about hemoglobin A1c percentage and prognosis of diabetes. The mean age of these patients is 43.4 years old and most of those patients (75.5%) were visiting governmental hospitals. The number of diabetic patients having hemoglobin A1c less than 7% are 259 patients with hemoglobin A1c mean 6.66% ± 3.33%, however, there are 435 patients having hemoglobin A1c more than 7% with mean equals 7.75% ± 1.2%, the difference between them is statistically significant (P value < 0.0001).

Conclusion: The glycated hemoglobin of diabetic patients in all regions of Saudi Arabia was significantly elevated and uncontrolled based on most diabetic guidelines and significantly affects the prognosis by causing diabetic complications especially cardiovascular diseases.

Keywords

Hemoglobin A1c; Diabetes; Saudi Arabia.


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The Effect of Glycated Hemoglobin on the Prognosis of Diabetic Patients: A Cross-Sectional Observational Study
A.N. Alkattan et al.

INTRODUCTION

Diabetes mellitus (DM) is a chronic metabolic disorder characterized by elevation of blood glucose and a high percentage of hemoglobin A1c (HbA1c). Diabetes mellitus affects many organs in the human body and may cause macrovascular (cardiovascular) or microvascular (retinal, renal or neural) complications if blood glucose is not controlled and well treated[1].

It is known that there are two main types of diabetes, Type 1 (insulin dependent) and Type 2 (insulin independent) diabetes. The difference between them is in the diagnosis and the treatment. Type 2 diabetes could be resolved and cured if the patient changes the lifestyle and reduces weight, but Type 1 is usually not cured because of destroyed beta-cells in the pancreas by autoimmunity stimulation unless treated with stem cells and immunosuppressant medications[2-4].

Most guidelines recommend the target of glycated HbA1c percentage to be less than 7%. On the other hand, some other guidelines prefer the target of HbA1c percentage for diabetic patients to be less than 6.5%. For diabetic patients with advanced cardiovascular disease, end-stage renal disease, metastatic cancer or recurrent hypoglycemic episodes, the target of HbA1c percentage may reach less than 8%[3].

Elevated HbA1c percentage of more than 7% will result in high production of advanced glycation end-products (AGEs). Advanced glycation end-products are the result of amino acids exposed to a high level of glucose, so amino acids become glycated. The elevated level of AGEs in diabetic patients means a high risk for diabetic complications since AGEs can damage blood vessel walls, increase oxidative stress, damage beta cells in the pancreas, reduce immune cell migration and cell apoptosis[6,7].

Many studies showed that doing daily physical activity for at least 30 minutes could reduce the risk of Type 2 diabetes mellitus, improve insulin sensitivity, glycemic control and reduce obesity. Because of that, diabetes guidelines advise to do physical activity for at least 150 minutes per week[8,9].

American Heart Association (AHA) recommend moderate intensity statin for diabetic patients age ≥ 40 years old and recommend high-intensity statin for diabetic patients with either having elevated LDL ≥190 mg/dl or if estimated atherosclerotic cardiovascular disease risk in the next 10 years is ≥7.5% as primary prophylaxis. On the other hand, low dose aspirin as primary prophylaxis is advised for patients with estimated atherosclerotic cardiovascular disease risk in the next 10 years is ≥10%[10-12].

In Saudi Arabia, there are approximately seven million diabetic patients distributed unequally in Centre, West, East, South and North regions, and considered as one of the top ten countries with high prevalence of DM. Most the diabetic patients in Saudi Arabia are overweight having body mass index ≥ 25, and most of the diabetic overweight patients are women[13,14].

This is the first study in Saudi Arabia to evaluate the HbA1c and prognosis of diabetic patients in all regions. The aim of this study is to evaluate HbA1c levels among diabetic patients and its effect on the prognosis of this metabolic disease. The results of this study will decide if internal medicine practice regarding the treatment of diabetes mellitus in Saudi Arabia is good enough or needs to be improved and make additional programs in order to prevent or reduce diabetic complications.

METHOD

Study Design

This was a cross-sectional observational study conducted between March and August 2018. The study was done by using a questionnaire containing nine questions which planned to involve at least 390 diabetic patients. However,
The Effect of Glycated Hemoglobin on the Prognosis of Diabetic Patients: A Cross-Sectional Observational Study

A.N. Alkattan et al.

This questionnaire was answered by 516 Type 1 and 178 Type 2 diabetic patients randomly chosen from all regions inside Saudi Arabia. Exclusion criteria include any diabetic patient with advanced cardiovascular disease, end-stage renal disease or metastatic cancer (see Table 1).

The Questionnaire

This was an online and direct interview-based questionnaire done in social media and in some governmental hospitals. The questionnaire contained nine questions that reflect on the prognosis of diabetic patients in Saudi Arabia.

Endpoint Assessment

The primary endpoint was to evaluate the HbA1c levels among diabetic patients and its effect on the prognosis of this metabolic disease in all regions inside Saudi Arabia. The secondary endpoints: 1) Evaluate whether internists in Saudi Arabia prescribe aspirin and statin medications for diabetic patients based on AHA Guidelines; 2) Evaluate the physical activity status in diabetic patients.

Statistical Analysis

As per the previous statistical studies in Saudi Arabia, there are about seven million people with diabetes, and it was planned to have the ideal sample size to be at least 390 samples, but the actual sample size in this study upgraded to be 694 samples from all regions inside Saudi Arabia. The number of samples needed in each region including center, west, east, south, and north areas were at least 102, 128, 64, 58 and 25 samples, respectively, but the actual samples in these different areas were more. Statistical analysis used chi-squared test, ANOVA and t-test. Statistical analysis and graphs were done by using Microsoft Excel, 2013 (Microsoft Corp., Redmond, Washington USA).

RESULTS

Six hundred and ninety-four diabetic patients from all around Saudi Arabia had answered the nine-question questionnaire about HbA1c percentage and prognosis of diabetes. The mean age of these patients is 43.4 years old and most (75.5%) of those patients were visiting governmental hospitals. The number of diabetic patients having HbA1c less than 7% are 259 patients with HbA1c mean 6.66% ± 3.33%, however, there are 435 patients having HbA1c more than 7% with mean equals 7.75% ± 1.2%, and the difference between them is considered to be extremely statistically significant (P-value < 0.0001) (Fig. 1). However, the study didn’t show any statistical difference in HbA1c between patients who didn’t do any physical activities or doing physical activities for less than 30 minutes per day and patients who did physical activities for more than 30 minutes per day (P-value > 0.05) (Fig. 2). In addition, there is no significant difference in HbA1c between Type 1 and Type 2 diabetic patients (P-value > 0.05) (Fig. 3), and no statistical difference in HbA1c between diabetic patients age less than 40, more than 40 and more than 60 years old (P-value > 0.05) (Fig. 4). Also, there is no significant difference in HbA1c between diabetic patients from different regions in Saudi Arabia (P-value > 0.05) (Fig. 5).

On the other hand, 35.55% of the internists in Saudi Arabia are applying AHA Guidelines recommendations for their diabetic patients, whereas 64.45% of the internists are not, and there is a significant difference between them (P-value < 0.0035) (Fig. 6).
The Effect of Glycated Hemoglobin on the Prognosis of Diabetic Patients: A Cross-Sectional Observational Study

A.N. Alkattan et al.

**FIGURE 4.** Hemoglobin A1c results among diabetic patients based on age.

**FIGURE 5.** Hemoglobin A1c difference between diabetic patients from all regions in Saudi Arabia.

**FIGURE 6.** Percentage of internists who applied American Heart Association recommendations for diabetic patients in Saudi Arabia.

**FIGURE 7.** Hypertension and dyslipidemia prevalence among diabetic patients.

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The Questionnaire

**The Effect of Glycated Hemoglobin on the Prognosis of Diabetic Patients: A Cross-Sectional Observational Study**

Q1. Age of the diabetic patient:
   - Less than 40 y/o
   - between 40-60 y/o
   - more than 60 y/o

Q2. Gender:
   - Male
   - Female

Q3. Region in Saudi Arabia:
   - North
   - West
   - Central
   - East
   - South

Q4. Type of diabetes:
   - Type-1
   - Type-2

Q5. Level of A1c:
   - Less than 5.7%
   - Less than 6.5%
   - Less than 7%
   - More than 7%
   - More than 10%

Q6. Do you have other disease(s)?
   - No
   - Yes (mention the disease(s))

Q7. Are you taking aspirin or cholesterol lowering agents?
   - No
   - Yes (mention them clearly)

Q8. I have my prescription for my medications from...
   - Governmental hospital
   - Private hospital
   - Outside Saudi Arabia

Q9. How much time you take for doing physical activities per day?
   - I don’t do any physical activity per day
   - Less than 30 minutes per day
   - More than 30 minutes but less than 1 hour per day
   - More than 1 hour per day
   - More than 2 hours per day
An also interesting result found in this study was the significant increase in the incidence of hypertension and dyslipidemia after 40 years of age (P-value < 0.0001). However, there was a significant increase in the incidence of hypertension only after 60 years of age (P-value < 0.0199) (Fig. 7 and Fig. 8).

DISCUSSION

This was the first study in Saudi Arabia to evaluate the effect of HbA1c on the prognosis in diabetic patients in all regions. Since HbA1c is significantly related to the prognosis of diabetes, it is important to keep it below 7% based on most diabetes guidelines. Unfortunately, this study showed elevated HbA1c (more than 7%) based on the average results of 694 diabetic patients and that strongly relates to other results in this study which showed an increased incidence of hypertension and dyslipidemia after reaching 40 years of age. However, AHA gave recommendations to prevent diabetic complications, but only 35.55% of internists in this study was applying these recommendations for diabetic patients, and most of these cases were from governmental hospitals.

Unlike other previous studies’ results[15,16], this study showed that physical activity had no significant effect on HbA1c in diabetic patients. This result could be more specific for Type 1 diabetes since the majority of samples were Type 1 diabetic patients.

CONCLUSION

The glycated hemoglobin of diabetic patients in all regions of Saudi Arabia was significantly elevated and uncontrolled based on most diabetic guidelines and significantly affects the prognosis by causing diabetic complications especially cardiovascular diseases. This study supports AHA Guidelines by recommending to give statin and aspirin for specific diabetic patients.

Acknowledgment

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Conflict of Interest

The authors have no conflict of interest.

Disclosure

The authors did not receive any type of commercial support either in forms of compensation or financial for this study. The authors have no financial interest in any of the products or devices, or drugs mentioned in this article.

Ethical Approval

Obtained.

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تأثير الهيموجلوبين السكري على تطور الحالة الصحية لمرضى ارتفاع السكر مستمعة

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المستخلص:

الخلفية: داء السكري هو اضطراب استقلالي مزمن يتميز بارتفاع نسبة الجلوكوز في الدم ونسبة عالية من الهيموجلوبين السكري. إن نسبة الهيموجلوبين السكري المرتفعة أكثر من 7% سوف تزيد تكوين الأجسام المناعية للسكري. وتعتبر المنطقة السكرية في مرضى السكري تزيد من مخاطر مضاعفات السكري.

الهدف: كان الهدف الأول لهذا البحث هو تقديم معلومات الهيموجلوبين السكري بين مرضى السكري وتأثيرها على تطور الحالة الصحية للمريض السكري في جميع المناطق داخل المملكة العربية السعودية.

الطريقة: كانت هذه دراسة مراقبة مقطعية مستمعة على 390 مريضاً كان من الصعب استخدام استبيان يحتوي على 9 أسئلة خطط لإشراف مراقبة للعلاج. النتائج: قد أجاب سبعة واربعة وتسعماء مريض بالسكري من جميع أنحاء المملكة العربية السعودية على استبيان الأسئلة التسعة حول نسبة الهيموجلوبين السكري والتأثير بالحالة الصحية لمرضى السكري. وبلغ متوسط عمر هؤلاء المرضى 43.4 سنة وكان معظمهم يبلغ الERENCE على 75% وواربعة في النسبة الهيموجلوبين السكري لديهم أقل من 7% وحديد. وكان متوسط النسبة الهيموجلوبين السكري يساوي 9.67 ± 3.37%, ومن جهة أخرى، هناك 45 مريض كانت نسبة الهيموجلوبين السكري أكثر من 7% وفارغ 37.5% ± 1.2%، والفرق بينهما يعتبر فرق جوري، حيث كانت الربحة الإحتمالية أقل من 0.001 .

الاستنتاج: كان الهيموجلوبين السكري لدى مرضى ارتفاع السكري في جميع مناطق المملكة العربية السعودية مرتفعًا بشكل كبير بناءً على معظم التوصيات الإرشادية لمرضى السكري ويشير بشكل كبير على الحالة الصحية من خلال التسبب مضاعفات السكري وخاصة أمراض القلب والأوعية الدموية.