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ORIGINAL STUDY

Random Blood Glucose as an Alternative to Glycated Hemoglobin for Assessing Glycemic Control in Diabetes Mellitus Patients. Cross-sectional Study in Babylon Province, Iraq

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Abstract

The relationship between glycated hemoglobin (HbA1c) and diabetes complications was established, emphasizing the importance of good glycemic management. However, due to its high cost, the HbA1c test is considered to be not affordable or not available. The high incidence of diabetes mellitus (DM) and its more risky comorbidities in most populations necessitate the requirement for regarding an alternative test. The aim of the current study was to estimate if there is a relationship between HbA1c and random glucose levels in DM patients. The current study was a cross-sectional study that comprised 106 known diabetic patients of both types (type 1 and type 2). Participants were regarded as having good glycemic control when HbA1c < 8 %, whereas those with HbA1c ≥ 8 % were regarded as having uncontrolled diabetes. Correlation analyses revealed significant direct correlations between HbA1c and RBG ($r = 0.47$, $P < 0.001$). RBG was directly correlated with HbA1c and may be utilized to indicate glycemic control in patients with DM when the accessible to HbA1c test is difficult or not available.

Keywords: Diabetes mellitus, Glycemic control, Glycated hemoglobin, Random blood glucose

Diabetes affected 171 million people worldwide one and a half decades ago, and 366 million people are expected by 2030 [1,2]. According to more recent estimates, the disease will afflict over 640 million people by 2040. Diabetes has clear linkages to several comorbidities, including cardiovascular disorders [3] (which comprise coronary artery disease, hyperlipidemia and stroke), renal disease (which comprises chronic renal insufficiency, dialysis and transplantation), infectious disease and cancer. Two hundred forty five billion dollars were the overall economic cost of diabetes care that was estimated via the American Diabetes Association (ADA) in the United States in 2012, accounting for more than one in every five dollars spent on health care [4]. For decades, it has been considered that the highly significant laboratory medical advancement in diabetes therapy was the HbA1c test. Since its introduction into clinical practice in the 1970s, it has been considered a

Abbreviations: RBG, random blood glucose; DM, diabetes mellitus; HbA1c, glycated hemoglobin; FBG, fasting blood glucose; PPG, postprandial glucose; ADA, American Diabetes Association; IDF, International Diabetes Federation; DCCT, Diabetes Control and Complications Trial; UKPDS, United Kingdom Prospective Diabetes Study; CVD, cardiovascular disease; IQRs, interquartile ranges.

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cornerstone in diabetes patient monitoring and treatment decisions [5]. The Diabetes Control and Complications Trial (DCCT) in type 1 DM [6] and the United Kingdom Prospective Diabetes Study (UKPDS) in type 2 DM [7] both highlighted the importance of HbA1c in diabetes care shortly after [8]. The relationship between HbA1c level rise and DM complications was established, emphasizing the importance of good glycemic management [3]. HbA1c readings can give an idea about average glycemic controls over the previous two to three months and take into consideration both pre- and postprandial blood glucose levels. International guidelines support regular HbA1c testing for all diabetic patients for glycemic control follow up [9,10], because it provides warnings on long-term glycemic status and clearly anticipates diabetes complications risk [9]. Though it has been discovered that following recommendations for medication adjustment and frequency of HbA1c testing is highly related with glycemic control, in fact, only around 3 % of patients adhere to these recommendations [8]. Fasting or any additional preparations are not needed to do the HbA1c test, which can be conducted at any time of the day. Glucose molecules bind to hemoglobin in red blood cells when blood glucose levels are high [11]. When a molecule of haemoglobin becomes glycated, it stays that way. As a result, during red blood cell lifespan, the approximate quantity of glucose to which the cell has been incurred is represented by the accumulation of glycated haemoglobin within it. Glycated haemoglobin measurement is utilized to detect the efficacy of therapy by monitoring long-term blood glucose control [12]. However, as a consequence of its high cost, the HbA1c test is considered to be not affordable or not available. The high incidence of DM and more risky comorbidities in most populations necessitates the requirement for regarding an alternative test such as fasting blood glucose (FBG), random blood glucose (RBG) and 2-h postprandial glucose (PPG) for glycaemic control monitoring. The most favorable test is RBG because of untimed sampling, availability, and affordability [13].

The aim. The current study objective was to estimate if there is a relationship between HbA1c and random glucose levels in diabetes mellitus patients.

1. Materials and methods

The current study was a cross-sectional study that was achieved in the Merjan Medical City laboratory in Al-Hilla city, Iraq, between November 2022 and March 2023. This study comprised 106 known type 1 and type 2 diabetic patients. All of the patients had been taking drugs to treat DM and disease complications. All participants patients signed informed consent. Descriptive data, including age, sex and type of DM (type 1 or type 2), were obtained from all participants. A list of current medications used for DM control and their routes of administration were also obtained. 5 ml of venous blood, was collected from all patients by a laboratory technician to determine random blood glucose and HbA1c levels. Participants were regarded as having good glycemic control when HbA1c was <8 %, whereas those with HbA1c $\geq$ 8 % were regarded as having uncontrolled DM [14].

1.1. Statistical analysis

IBM SPSS software (version 26) was used to carry out the statistics of the current study. The Kolmogorov-Smirnov test was utilized to verify if all variables had a normal distribution. Frequencies and percentages were utilized to represent qualitative variables, whereas means ± standard deviation, medians, and [IQRs] (interquartile ranges) were utilized to represent continuous variables. The values of significance of qualitative variables were determined via the Chi-square test, while the values of significance of continuous variables were determined via the Mann-Whitney *U* test. The Spearman's correlation test was employed to analyze the correlation between HbA1c and RBG's values. A P-value of less than 0.001 specified that the results were statistically significant.

2. Results

2.1. Characteristics of participants

The age ranges of participants were (18–75 years), with most participants aged 40–59 years. The number of males and females who participated was 50 and 56, respectively. Most participants (85) had type 2 DM. The median RBG was 197.50 (254–170) mg/dL, while the mean HbA1c was 8.11 ± 1.95 %. The mean HbA1c in participants on sulfonylurease therapy was 8.31 ± 2.25 %, on metformin therapy was 7.17 ± 1.35 %, and on sitagliptin therapy was 9.26 ± 1.95 %. The characteristics of the participants regarding their glycemic control (HbA1c <8 % or ≥8 %) are mentioned in Table 1.

2.2. Association of HbA1c with RBG

As appeared in Table 1, the HbA1c level was significantly declined in participants with good glycemic control (52.5 ± 0.73) compared with those with glycemic uncontrolled 156.47 ± 1.57 ($P < 0.001$). Also RBG levels were significantly lower in

Table 1. Characteristics of the participants patients regarding to the glycemic control.

Characteristics	HbA1c (n = 106)		
	Good glycemic control, HbA1c <8 %	Glycemic uncontrolled, HbA1c ≥ 8 %	P-value
	53 (50 %)	53 (50 %)	1.000[a]
Age (years)			
20–39	19 (86.4 %)	3 (13.6 %)	**<0.001**[a]
40–59	26 (40.6 %)	38 (59.4 %)	
≥60	8 (40 %)	12 (60 %)	
Sex			
Male	21 (42 %)	29 (58 %)	0.431[a]
Female	32 (57.1 %)	24 (42.9 %)	
Type of DM			
Type 1	18 (85.7 %)	3 (14.3 %)	**<0.001**[a]
Type 2	34 (40 %)	51 (60 %)	
RBG (mg/dL)	185 (250-150)	212 (300-180)	**<0.001**[b]
HbA1c (%)	±52.550.73	156.47 ± 1.57	**<0.001**[c]
Antidiabetic drugs			
Sulfonylurease	14.50 ± 0.59	44.50 ± 1.75	**<0.001**[c]
Metformin	0.86 ± 22.00	55.500.48±	**<0.001**[c]
Sitagliptin	±5.500.69	33.50 ± 1.63	**<0.001**[c]

The bold values indicate that the differences observed for those characteristics have a p<0.05. Statistically significant.
[a] Chi-square values are indicated by frequency (%).
[b] Mann-Whitney values are indicated by median (IQRs).
[c] Mann-Whitney values are indicated by mean ± standard deviation.

participants with good glycemic control 185 (250-150) compared with those with glycemic uncontrolled 212 (300-180) (P < 0.001).

Table 2. Correlation of HbA1c and RBG levels.

Variables	r	P-value
HbA1c (%) RBG (mg/dL)	0.47	**<0.001**

Spearman's correlation test was used for calculation of P-value. r is correlation coefficient.
The bold values indicate that the differences observed for those characteristics have a p<0.05. Statistically significant.

2.3. Effect of antidiabetic drugs on HbA1C levels

As shown in Table 1, the effects of antidiabetic drugs (sulfonylurease, metformin and sitagliptin) revealed significant lowering of HbA1c levels in participants with good glycemic control compared with those with glycemic uncontrolled (p < 0.001).

Correlation of HbA1c with RBG. Correlation analyses confirmed significant direct correlations between HbA1c and RBG (r = 0.47, P < 0.001) as explained in Table 2 and Fig. 1.

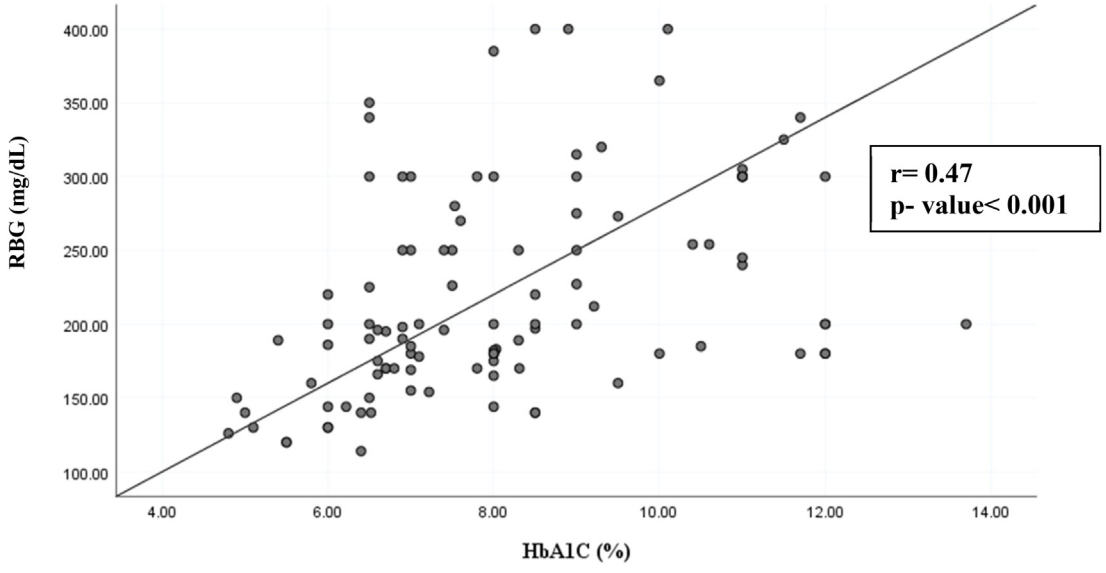

Fig. 1. Correlation of HbA1c and RBG levels (Significant correlation between HbA1c and RBG levels).

3. Discussion

Our study was a cross-sectional study and the aim was to assess if there was an association between HbA1c and RBG levels in adults with DM. It was found that patients with good glycemic control exhibited significantly lower HbA1c and RBG levels compared with patients with uncontrolled DM. In addition, our results indicate that there is a significant direct correlation between HbA1c and RBG. These results were in agreement with the results of other studies. For example, Alkhatatbeh et al. [15] and Asgharzadeh et al. [16] noted a significant low HbA1c level in glycemic control patients compared to those with uncontrolled DM. Also, Bowen et al. [17] found that RBG levels in prediabetes (HbA1c < 6.5 %) were significantly lowered compared with diabetes (HbA1c > 6.5 %). Kasmi et al. [11] concluded that any increase in RBG level was directly proportional to an increase in HbA1c level. Sikaris [18] showed that postprandial glucose (PPG) levels directly correlate with HbA1c better than fasting blood glucose levels. Hershon et al. [19] concluded that PPG is a significant contributor to HbA1c.

Traditional diabetes risk factors, including hypertension, obesity, and atherogenic dyslipidemia, don't completely explain the elevated CVD risk that comes with diabetes. Elevated A1C levels are widely recognized to be linked to an elevated risk of developing cardiovascular disease [20]. Furthermore, the majority of advanced countries have utilized HbA1c, the essential and recently approved fundamental marker for long-term follow up of glycaemic control [13]. The International Diabetes Federation (IDF) is supporting blood glucose measurement as a way of monitoring glycaemic control in individuals with type 2 diabetes when HbA1c is not available [21]. Because the HA1c test is costly, its availability in settings with restricted resources is severely limited [22]. When more sophisticated laboratory testing is not practical, RBG = 160 mg/dL may be a reliable cut-off value to evaluate long-term glycaemic control in a resource-poor setting, as recommended by the IDF [23]. However, as demonstrated by Bleyer et al., The relationship between HbA1c and RBG varies according to ethnicity. Additionally, data from different countries indicates the possibility that the cut-off number for RBG may not be the same as that indicated by the IDF [24–26]. For our study's evaluation, RBG is more accessible than a 2-h PPG since it is an untimed sample. However, information on the effectiveness of RBG as a tool for assessing glycemic control is quite limited.

The present study had some restrictions. First, it was cross-sectional research conducted at a hospital. Second, we have limited data on the duration of the DM, the types of treatments administered, and any existing comorbidities in our participants. In the future, we hope to perform thorough prospective research with a thorough investigation of clinical and demographic data.

4. Conclusion and recommendations

RBG was directly correlated with HbA1c and may be utilized to indicate glycemic control in patients with DM when the accessible to HbA1c test is difficult or not available. Future recommendations encompass further studies that aimed to assess the consistency of the relation between RBG and HbA1c over extended period. This could encompass the inclusion of heterogeneous populations to evaluate demographic contradiction in findings and the consideration of alternative methodologies for glycemic control, like continues glucose monitoring. Furthermore, initiating of clinical trials on RBG measurements is critical for diabetes management improvement. Evaluating their cost effectiveness is fundamental for decision-making.

Ethical approval

This study was ethically approved by the University of Babylon/College of Pharmacy ethical committee (approval no. 2022-C1, date. 17/10/2022).

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Conflict of Interest

No conflict of interest.

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