ORIGINAL ARTICLE

Association Between Haemoglobin Levels and HbA1c in Diabetic Patients: Insights from a Tertiary Care Hospital in Lahore

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ABSTRACT

Objective: To determine the correlation between haemoglobin and HbA1c level in diabetic patients in Lahore
Methodology: Cross sectional study conducted in Pathology Department, Shalamar Hospital, Lahore from July to November 2023. Participants above 14 years of age, of all genders having both haemoglobin and HbA1c level analyzed, were included in this study. Patients below 14 years of age, those with history of haemoglobinopathies, acute or chronic blood loss, acute and chronic renal failure, alcoholism, and pregnant females were excluded. Data was entered and analyzed using SPSS version 25. The inferential statistics were used to correlate the significance of Haemoglobin and HbA1c.
Results: Of the total 312 study subjects, the mean age was 48.14±13.42 years, with 154(49%) males and 158(51%) females. Mean Hb level in males was 14.17±2.02g/dl while in females, mean haemoglobin level was 12.73±1.50g/dl with statistically significant difference of mean Hb level with respect to gender (p value <0.001). Mean HbA1c level in males was 9.09±2.12%. While in females mean HbA1c level was 8.60±2.21% with statistically significant difference of mean HbA1c % with respect to gender (P value 0.047). Positive correlation has been found between haemoglobin and HbA1c levels in diabetic patients in this study.
Conclusion: Significant positive correlation has been found between haemoglobin and HbA1c levels among female diabetic patients. The effect of low haemoglobin should be kept in mind while evaluating the HbA1c results in diabetic patients to monitor glycemic status, as misinterpretation leads to mismanagement of diabetic patients.

Keywords: Diabetes mellitus, glycosylated haemoglobin (HbA1c), haemoglobin

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INTRODUCTION

Patients with diabetes mellitus (DM) bear a heavy financial burden in addition to having a substantial impact on their life quality and duration[1,2]. In Pakistan, the prevalence of diabetes in adult population is rising (17.1%)[3]. Non communicable diseases, such as diabetes mellitus, are becoming more common in all nations, regardless of their level of development. There is strong evidence that developing nations have a higher prevalence of diabetes mellitus and the complications it causes, and that these differences can be prevented and controlled[4].

Protein glycation in diabetes is caused by hyperglycemia, and blood glucose levels are correlated with this process. An increase in the concentration of glycated haemoglobin [HbA1c] is linked to hyperglycemia. The most common kind of haemoglobin in HbA1 fractions is HbA1c[5]. The gold standard test

for diagnosis of diabetes mellitus and glycemic status monitoring is glycated haemoglobin (HbA1c). Since haemoglobin (Hb) is a necessary component of HbA1c, anemia may have an impact on HbA1c levels in addition to the numerous other factors[6].

Since iron deficiency anaemia (IDA) and diabetic mellitus (DM) are common worldwide, there is a considerable likelihood that these two conditions may coexist. Many patients would benefit from any clinical findings indicating a relationship between the body's iron level and glycosylated haemoglobin (HbA1c)[7]. Since the haemoglobin molecule participates in the non-enzymatic glycation reaction, it is expected that both blood glucose concentrations and the total haemoglobin concentration may have an impact on the HbA1c value[8].

The impact of a lower haemoglobin level on the HbA1c value has not been thoroughly studied up to this point, despite the high prevalence of anaemia. Owing to a high prevalence of diabetes and anaemia in our country, there is a need to study this correlation in our population, which can have significant impact in diagnosis and management of diabetic patients with anaemia. Only a few research studies have found a connection between anaemia caused by iron deficiency and HbA1c levels[8,9]. HbA1c readings may be impacted by any circumstances that affect haemoglobin characteristics, erythrocyte turnover, and haemoglobin glycation, regardless of glycemia. As a result, not everyone will have the same association between mean glycemia and the HbA1c value. Since the HbA1c result is determined by dividing total haemoglobin by glycated haemoglobin, it is possible that haemoglobin level influences HbA1c test findings separately from glycemia. That being said, no research has been done on the possible correlation between haemoglobin levels and HbA1c readings[10-12].

The study aims to determine the correlation between low haemoglobin and HbA1c levels in patients with type 2 diabetes mellitus. As deranged haemoglobin levels affect the glycosylated haemoglobin results which is used for monitoring the glycemic status, it may lead to misinterpretation of HbA1c results and mismanagement of diabetic patients.

METHODOLOGY

IRB/ERC Approval:

A cross sectional study was conducted in the Department of Pathology, Shalamar Hospital Lahore from July to November 2023. Data was collected after ethical approval from institutional review board vide Ref. No. SSAHS-IRB/AL/07/2023.

Sample size of 312 diabetic patients was calculated using online WHO sample size calculator with 5% margin error and 95% confidence interval. Participants above 14 years of age, of all genders having both haemoglobin and HbA1c levels performed in the lab were included in this study. While the patients below 14 years of age, those with history of haemoglobinopathies, acute or chronic blood loss, acute and chronic renal failure, alcoholism, and pregnant females were excluded. Non-probability consecutive sampling technique was used and data was recruited from Laboratory Information Management system. All data was anonymized and no additional testing was performed. Demographic data such as educational status, marital status, physical activity, and laboratory results were recorded on predesigned proforma. Standard operating procedures were followed by phlebotomist to collect the blood sample using aseptic techniques. Sterile syringes were used to draw blood of 5ml volume and injected it into pre labelled purple capped vials containing EDTA anti-coagulant. After injecting blood into vials, samples were mixed properly to avoid clot formation. All samples then brought to their concerned sections in the laboratory to carry out the haematologic and biochemical tests. Haemoglobin was determined using Sysmex XN-1000 by using SLS haemoglobin method. The HbA1c was analyzed on System reactive on Beckman coulter AU analyzer in human blood for the quantitative measurement of HbA1c. Data was entered and analyzed using SPSS version 25. Quantitative variables were presented in terms of mean and SD while qualitative variables were presented in terms of frequency and percentages. The inferential statistics were used to correlate the significance of Haemoglobin and HbA1c.

RESULTS

Of the total 312 study subjects, mean age was 48.14±13.42years with 134(43%) were =40 years of age while 178(57%) were >40 years age. Total 154(49%) were males while 158(51%) were females (Table 1). Demographic findings and distribution of study subjects with respect to different variables such as marital status, education, occupation, socioeconomic status, physical activity, past medical and drug history, comorbidities other than diabetes and BMI has been shown in Table 1. Table 2 shows the distribution of study subjects with respect to HbA1c and haemoglobin levels. Table 3 shows the comparison of mean haemoglobin level and mean HbA1c % with respect to gender. Mean Hb level in males was 14.14±2.02g/dl while mean HbA1c level was 9.09±2.12% with p value <0.001. While in females, mean haemoglobin level was 12.73±1.50g/dl while HbA1c level was 8.60±2.21% with p value 0.047 (Table 3). Scatter diagram in figure 1 shows positive correlation between haemoglobin and

Table 1: Distribution of study subjects with respect to Age, Gender, Marital status, Education, Occupation, Socioeconomic status, Physical activity, Past medical history, BMI and Comorbidities (n=312)

Variable	Subgroups	Frequency	%
Age (years) 48.14±13.42	=40	134	43
	>40	178	57
Gender	Male	154	49
	Female	158	51
Marital status	Married	254	82
	Unmarried	58	18
	Illiterate	72	23
Education	Elementary (1-8)	130	42
	Secondary School	98	32
	College or more	12	3
Occupation	Health worker	15	5
	Civil servant other than health worker	22	7
	Merchant	2	1
	Student	10	3
	Unemployed	108	35
	Housewife	128	41
	other	27	8
Socioeconomic status	Low	280	89
	Middle	20	7
	High	12	4
Physical Activity	H/o Regular Exercise	94	30
	No H/o Regular Exercise	218	70
Past Medical history/Drug history	H/O heart attack	81	26
	Taking Insulin	59	19
	Taking Glucophage	147	47
	Not taking medicine regularly	25	8
Comorbidities other than diabetes reported by the patients	Hypertension	215	69
	Retinopathy	28	9
	Nephropathy	19	6
	Ischemic heart disease	50	16
BMI	Normal	109	35
	Overweight	81	26
	Obese	122	39

Table 2: Distribution of study subjects with respect to haemoglobin(g/dl) and HbA1c (%) levels (n=312)

Variable	Subgroups	Frequency	Percentage
Haemoglobin (g/dl)	=10	147	47
13.44±1.91	>10	165	53
HbA1c (%)	=8	174	56
8.85±2.17	>8	138	44

Table 3: Comparison of mean haemoglobin and HbA1c level with respect to Gender (n=312)

Variable	Subgroups	Haemoglobin		HbA1c		Pearson correlation	*P* value
		Mean	SD	Mean	SD		
Gender	Male	14.17	2.02	9.09	2.12	0.081	0.315
	Female	12.73	1.50	8.60	2.21	0.175	0.029
P value		<0.001*		0.047		---	

* Significant p value

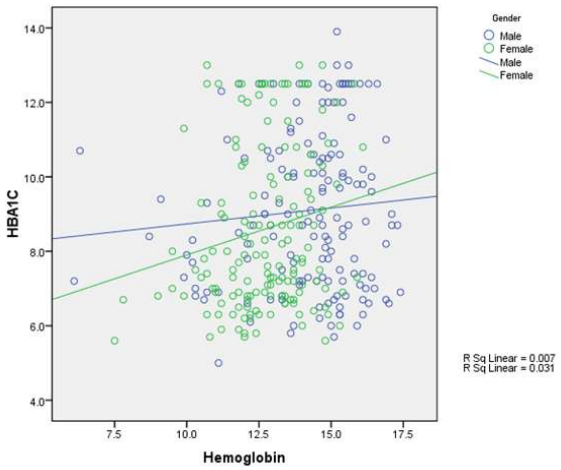

Figure 1: Scatter Diagram Showing Positive Correlation Between Hb and HbA1c

HbA1c levels. By applying Pearson correlation, we found positive correlation between haemoglobin and HbA1c i.e., r = 0.154, p-value (0.007). On stratifying, there was no significant correlation among males, r = 0.081, p-value > 0.05 while positive correlation between Haemoglobin and HbA1c was seen among female cases i.e. r = 0.175, p-value < 0.05 (Table 3).

DISCUSSION

In this study, we determined the correlation of haemoglobin and HbA1c in participants at primary healthcare level. Results indicated that 278 (89%) of 312 study participants had high levels of HbA1c. Those participants who had high levels of HbA1c observed that they had previous history of diabetes, hypertension, not regularly doing their exercise, not taking their routine medicine. Statistically significant correlation

of haemoglobin and HbA1c has been found with respect to gender in our study while a similar study was conducted with different results had shown negative correlation between haemoglobin and HbA1c and no significant difference in HbA1c values[13].

On the basis of our study, positive correlation between haemoglobin and HbA1c was seen. While classifying on the basis of gender, no significant correlation between haemoglobin and HbA1c was seen among males while among female positive correlation was seen between haemoglobin and HbA1c. The findings are inconsistent with the study conducted by Bhutto et al in which the study population had a mean HbA1c of 8.278±5.015%, with a maximum value of 16.2%, indicating moderately uncontrolled HbA1c. While the mean random blood sugar was 236±57.390 mg/dl, the mean fasting blood sugar was 158±39.50 mg/dl. While other RBCs and/or haematological measures, such as MCV, haemoglobin, and platelets, indicated no significant link, the statistical analysis showed that the correlation between HbA1c and RDW was significant (p-0.035)[14]. Findings are inconsistent with another study conducted by Mustapha et al[15].

Another study conducted by Arif et al has established the association of Red-cell distribution Width with the glycemic control and long-term complications of diabetes mellitus in which they have found the statistically significant association with p value <0.001[16]. While these findings are inconsistent with another study conducted by Zhang et al[17]. In our study, we found that BMI was clinically significant for diabetes. Overweight participants had higher risk of developing diabetes. At the same time, another study showed that BMI was strongly significant with diabetes in those patients who were diabetic, hypertensive, and had cardiovascular disease. Higher than average BMI was continuously linked to a higher likelihood of receiving a type 2 diabetes diagnosis as demonstrated by Gray et al in their study. On the basis of their study, it was suggested that women were more likely than men to be diagnosed with diabetes mellitus among overweight people. Men became at an increased risk of diabetes (HR=1.34) in the top range of the overweight group (27.5 = BMI = 29.99), while women became at an increased risk of diabetes (HR=1.31) when they are just slightly overweight (25 = BMI = 27.49). For both men and women, the risk of getting diabetes mellitus at 30 < BMI = 39.99 was almost equal to that of those with a normal BMI (HR=1.98 for males vs. HR=1.96 for women). Men had a greater chance of developing diabetes mellitus (DM) at BMI = 40 (HR=2.85 for men vs. HR=2.51 for women). Additionally, a higher cumulative risk for all DM complications was linked to elevated BMI. Women were more likely than males to be diagnosed with a DM complication if they were overweight[18].

The findings are consistent with another study conducted by Ohno et al[19]. Numerous epidemiologic researches have revealed that diabetes was a continuous risk factor for many diseases and that people with diabetes had multiple times higher chances of cardiovascular illness. The result of the glycation reaction between glucose and haemoglobin amidogen under non-enzymatic catalysis is HbA1c, which is a significant indicator of glycol-metabolism capacity. The majority of diabetic patients have aberrant HbA1c levels, which are thought to be a useful indicator for tracking the therapeutic effects of medication and glycol-stability. This index is also characterized by fast operating times and straightforward procedures, and it remains unaffected by recent dietary changes and medication[20].

Our study had certain limitations. The effect of deranged haemoglobin was not evaluated at different levels to see the discrepancy in HbA1c results which might help in evaluation of HbA1c results especially in the setting of low haemoglobin. It is recommended to further evaluate the validity of results with larger sample size and discrepancy should be evaluated further.

CONCLUSION

We concluded that significant positive correlation has been found between haemoglobin and HbA1c level among female diabetic patients. Deranged haemoglobin level in case of anaemia, influence the HbA1c results which are used for monitoring the glycemic status in diabetic patients. The effect of decreased haemoglobin should be kept in mind while evaluating the HbA1c results in diabetic patients to monitor glycemic status, as misinterpretation leads to mismanagement of diabetic patients.

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