RESEARCH ARTICLE

# Prevalence of anemia and its correlation with HBA1c of patients in Type-II diabetes mellitus: A pilot study

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## ABSTRACT

Background: Decrease in oxygen carrying capacity of the blood due to deficient erythropoietin is the characteristic of chronic kidney disease. Furthermore, the diabetic nephropathy secondary to uncontrolled diabetes mellitus (DM) leads to anemia in patients. Many reports suggest the presence of anemia in patients with diabetes with renal insufficiency while few studies indicating the incidence of anemia in diabetic patients before renal impairment. Aims and Objective: The aims of this study were to find out the prevalence of anemia among patients with Type 2 diabetes with and without renal insufficiency. Materials and Methods: It is a cross-sectional study including 54 Type 2 diabetic patients in 3 months period, visiting the Department of Medicine. Hemoglobin percentage, HbA1c, and serum creatinine were found out after collecting blood. Alcoholic, smokers, patients on hematinic, and liver disease were excluded from the study. All data were analyzed using Epi-info software. Analysis was performed using chi-square test. $P$ values < 0.05 were considered to be statistically significant. Result: The mean age of the study population was $51.39 \pm 8.8$ years. The overall prevalence of anemia was found to be 67%, which includes 20 patients with renal insufficiency and 34 with normal kidney status, with 70% and 58.8% prevalence of anemia, respectively. There was no statistical significant difference between these two groups ($P$ > 0.05). Anemia was more common in male (66.7%) compared to female (57.1%) diabetic population. Conclusion: Poor glycemic control is related to the prevalence of anemia in patients with DM.

KEY WORDS: Diabetes Mellitus; Glycosylated Hemoglobin; Hemoglobin; Prevalence

## INTRODUCTION

Anemia is defined as a reduction of the total circulating red cell mass below normal limits. It reduces the oxygen-carrying capacity of the blood, leading to tissue hypoxia.[1] It is associated with increased perinatal mortality, immune incompetence, impaired mental development, and decreased performance at work.[2] It is key indicator of chronic kidney disease (CKD) and an important cardiovascular risk factor.[3,4] It is said to be highly prevalent affecting developing and developed countries causing public health problem.[5]

Diabetes mellitus (DM) also has a high prevalence worldwide.[6] It leads to various complications when poorly controlled such as nephropathy, neuropathy, and retinopathy as well as several metabolic disorders. The Type 2 diabetes affects 7% of the population.[7] Epidemiological data showed that in 2010, there were 285 million people affected with the disease in the world and it is estimated that in the year of 2030, we will have about 440 million diabetes.[8]

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| **Website:** www.njppp.com | **Quick Response code** |
| **DOI:** 10.5455/njppp.2018.8.0621511072018 | |

Anemia is one of the most common blood disorders seen in diabetic patients.[9] Many studies have reported the presence of anemia mostly in patients with diabetes having renal insufficiency[10] and very few mentioned diabetics before evidence of renal impairment. Anemia said to be occurred earlier and in gradation with the patients presenting with diabetic nephropathy than those presenting with other cause of renal failure.[11] Well-known cause of nephropathy is poorly controlled diabetes; also other factors suggested for the earlier onset of anemia in diabetic patient include severe symptomatic autonomic neuropathy, causing efferent sympathetic denervation of the kidney along with loss of appropriate erythropoietin; damage to the renal interstitium; systemic inflammation; and inhibition of erythropoietin release.[12]

Glycosylated hemoglobin (HbA1c) is time-tested parameter to rule out controlled diabetes and found to be associated diabetic nephropathy. As the blood hemoglobin percentage (Hb%) depends on the functioning of the kidney, we hypothesized that HbA1c would be a poor indicator in the diabetic nephropathy patients where the patients are bound to be severe-to-moderate anemic. Moreover, there is also little evidence of occurrence of anemia in diabetes without renal insufficiency. Hence, to find out the association of anemia with and without renal impairment, and its correlation with HbA1c, the present study had undertaken.

### Aims and Objective

1. To find the prevalence of anemia in Type 2 Diabetic patient of both sexes by finding out Hb%.
2. To find the prevalence of renal insufficiency (kidney disease) in the diabetic patient by finding out serum creatinine for GFR.
3. To find out the association of anemia with and without renal insufficiency.

### MATERIALS AND METHODS

The study was a cross-sectional study conducted between the month of July and September 2017. Approval to conduct the study was obtained from the Institutional Ethical Committee, and the study was carried out in Medicine and Physiology Department. The present study included 54 patients of Type 2 DM patient who was attending the medicine OPD, of which 33 were male and 21 were female, with age group of $50.46 \pm 9.37$ years and $52.95 \pm 8.00$ years, respectively.

A predesigned questionnaire was filled after taking detail history. All Type 2 DM diagnosed patients were informed, and consent was taken before the collection of blood samples. The Type 1 diabetics, gestational diabetics, patients on ACE inhibitors, hematinic, liver disease, and malignancy were excluded from the study. Intravenous glycemic status

and HbA1c of the patients were found out by Siemen's Kit. The selected patients Hb% were found out using Sahali's method to categorize the patient into anemic and non-anemic for which hemoglobin level <130 g/l for male and <120 g/l for female was considered according to WHO.[13] The above patient were segregated into non-renal insufficient and renal insufficient by finding the GFR using CKD-EPI equation[14] and considering creatinine level 0.6–1.2 mg/dl for males and 0.4–1.0 mg/dl for females.[15]

All data subjected for statistical analysis and were analyzed using EPI-INFO software, Version 7. Analysis was performed using chi-square test. $P < 0.05$ was considered to be statistically significant.

### RESULTS

The present study carried out on 54 Type 2 DM diagnosed patients who include 33 males and 21 females. The mean and standard deviation of age, height, weight Hb%, and HbA1c of males were $50.46 \pm 9.37$, $162.80 \pm 8.55$, $60.42 \pm 15.47$, $12.12 \pm 2.10$, and $9.30 \pm 2.45$ and that of females were $52.95 \pm 8.00$, $153.61 \pm 10.13$, $66.07 \pm 14.83$, $11.6 \pm 2.08$, and $9.21 \pm 1.86$, respectively [Table 1]. Of total 54 sample size, overall anemia was found to be in 63%, in which 37% showed renal insufficiency, 63% did not [Tables 2 and 3]. With cross-tabulation of renal insufficiency with anemia; of 37% kidney disease patient 70% were anemic, and 30% were in the range of normal hemoglobin, while of 63% non-kidney disease patient, 58.8% were anemic and 41.2% were non-anemic ([Table 4], $P > 0.05$). The gender-wise distribution of anemia was 66.7% and 57.1%, respectively, for male and female across the studied population [Table 5]. The presence of anemia is negatively correlated with HbA1c. [Table 6 and Figure 1, $t = -1.94$, $P = 0.057$).

### DISCUSSION

Of 54 Type 2 diabetic patients that include 33 males and 21 females had mean HbAlc $9.30 \pm 2.45$ and $9.21 \pm 1.86$, respectively, suggesting of poor diabetes control [Table 1]. The overall percentage distribution of anemia found to be 63%
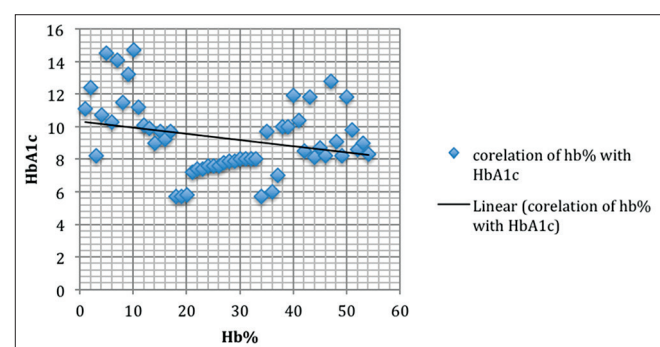


**Figure 1:** Correlation of hemoglobin percentage with glycosylated hemoglobin

**Table 1:** Mean and standard deviation of studied parameters

| Gender | Sample (n) | Age | Height | Weight | Hb% | HbA1c |
|---|---|---|---|---|---|---|
| Male | 33 | 50.46±9.37 | 162.80±8.55 | 60.42±15.47 | 12.12±2.10 | 9.30±2.45 |
| Female | 21 | 52.95±8.00 | 153.61±10.13 | 66.07±14.83 | 11.6±2.08 | 9.21±1.86 |

Hb%: Hemoglobin percentage, HbA1c: Glycosylated hemoglobin

**Table 2:** Frequency distribution of anemia in studied patients

| Anemia | Frequency (%) |
|---|---|
| Absent | 20 (37.0) |
| Present | 34 (63.0) |
| Total | 54 (100.0) |

**Table 3:** Cross tabulation of gender distribution with anemia

| Gender | Anemia | | Total |
|---|---|---|---|
| | Absent | Present | |
| Female | | | |
| Count | 9 | 12 | 21 |
| % within gender | 42.9 | 57.1 | 100.0 |
| Male | | | |
| Count | 11 | 22 | 33 |
| % within gender | 33.3 | 66.7 | 100.0 |
| Total | | | |
| Count | 20 | 34 | 54 |
| % within gender | 37.0 | 63.0 | 100.0 |

**Table 4:** Frequency distribution of renal insufficiency in studied patients

| Renal insufficiency | Frequency (%) |
|---|---|
| No | 34 (63.0) |
| Yes | 20 (37.0) |
| Total | 54 (100.0) |

**Table 5:** Cross tabulation of renal insufficiency with anemia

| Kidney disease (KD) | Anemia | | Total |
|---|---|---|---|
| | Absent | Present | |
| No | | | |
| Count | 14 | 20 | 34 |
| % within KD | 41.2% | 58.8 | 100.0 |
| Yes | | | |
| Count | 6 | 14 | 20 |
| % within KD | 30.0% | 70.0 | 100.0 |
| Total | | | |
| Count | | 34 | 54 |
| % within KD | | 63.0 | 100.0 |

Chi-square>0.05

**Table 6:** Correlation of Hb% with HbA1C

| Correlation | Hb% | HbA1C |
|---|---|---|
| n | 54 | |
| Mean | 10.8741 | 9.2722 |
| Variance | 8.3465 | 4.9515 |
| Standard deviation | 2.889 | 2.2252 |
| Standard error | 0.3931 | 0.3028 |
| T | −1.94 | |
| Df | 52 | |
| P | 0.057812 | |

HbA1C: Glycosylated hemoglobin, Hb%: Hemoglobin percentage

that include 12 females and 22 males [Tables 2 and 3], while deranged kidney function found to be 37% [Table 4] in the studied patient. The prevalence of anemia found to be 70.0% and 58.8% with and without kidney disease, respectively [Table 5]. The gender-wise distribution of anemia was found to be 57.1% for females and 66.0% for males, [Table 3] suggesting males are more vulnerable. The Hb% is negatively correlated with the HbA1c, implying the anemia is significantly correlated with poor diabetic controlled.

Anemia in patients with Type 2 diabetes is an increasingly acknowledged entity.[16] This condition may lead to various risk factors which affect the vascular complications. It is also reported that patient suffering from anemia have relatively less lifespan than those without anemia.[17]

In present cross-sectional study, patients have a higher incidence of anemia (63%) among diabetes patients which is supported by Sharif et al. and is contrary to Adejumo et al. (15.3%) and Bonakdarna (19.6%).[18,19] Different factors are responsible for the development of anemia in diabetes such as symptomatic autonomic neuropathy which can lead to efferent sympathetic denervation of patient's kidney, further leading to loss of required erythropoietin production.[12] Diabetes patients taking metformin have high chances of B12 deficiency leading to clinical symptoms of anemia.[20] Of total anemic diabetic patients, the prevalence of anemia in males (66.7%) population is more than that of females (57.1%), which was different from the study done by Rathod et al. whose prevalence of anemia was almost same for males and females.[21] Similar to our findings Griac et al. reported higher prevalence of anemia in males (17.8%) population than that of females (11.8%).[22] In present study, mean hemoglobin level was significantly higher in male (12.12 ± 2.10 g/dL) population compared to female (11.6 ± 2.08 g/dL) (P <0.05), but no statistically significant difference found in HbA1c, though 90.74% studied population

reported poorly controlled diabetes (HbA1c≥7%) unlike the Sharif *et al*. study.[16] Like previous studies, our study also reported a positive correlation between HbA1c and hemoglobin concentration in patients with iron deficiency anemia and, therefore, HbA1c could be a poor indicator in anemic subjects [Table 6]. Koga *et al*. also suggested to monitor while diagnosis in patients with low or high concentration of hemoglobin at HbA1c level close to 5.7% or 6.5%, respectively.[23]

As anemia is important marker of CKD which occurs earlier in the progression of diabetic kidney disease and perhaps more severe than formerly realized.[4,24] In patients with diabetes, anemia may be the result of decreased erythropoietin production by the failing kidney. In our study, we also found that the occurrence of anemia was also present in patients without renal impairment (*n*=20, 58.8%) thus, concluding that anemia can occur in diabetic patient before renal problem occurs. A previous study[20] also reported 7.2% of anemia with normal renal function.

Our study found high prevalence of anemia which may be due to small number of studied subjects, with fairly high poorly controlled diabetes, who may be vulnerable to impaired erythropoietin production and release due to diabetic neuropathy.[25,26] In contrast, prevalence of 20% and 19.6% have been reported, respectively, in diabetics with renal insufficiency by other studies.[9,20]

The present study had limitations like small sample size as it was carried out only for 3 months as part of the undergraduate research. The most of the patients had poor diabetic control. The study requires large sample size to confirm the present study findings.

## CONCLUSION

Overall high prevalence of anemia was observed in Type 2 diabetic patients with slightly higher in renal insufficiency than patients with normal kidney function. The incidence of anemia in Type 2 diabetics with and without normal kidney function is associated with uncontrolled glycemia. To minimize diabetic complications, improvement in anemia may play a significant role; thus, we suggested that treatment protocol for diabetes should have routine hematological tests along with check on poor glycemic control, to make ideal therapeutic choices for the treatment of DM in adults.

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