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ORIGINAL RESEARCH

Anaemia and Its Associated Factors Among Type 2 Diabetes Mellitus Patients in Eastern India: A Cross Sectional Study

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ABSTRACT

Background: Anaemia is a common diabetes mellitus (DM) consequence that has a negative impact on the progression and development of other diabetes-related problems. Despite this, little is known about the prevalence of anaemia and its associated variables in type 2 diabetes mellitus (T2DM) patients. As a result, the purpose of this study was to look at the prevalence of anaemia and its associated variables in T2DM patients.

Methods: A hospital-based cross-sectional study was carried out on 249 T2DM patients who were chosen by a systematic random sample procedure. Face-to-face interviews, anthropometric measurements, and laboratory testing such as haemoglobin measurements, red blood indices, and serum creatinine analysis were used to collect data. The data were coded and entered into Epi-data management version 4.4.1.0 before being analysed using SPSS version 22. Bivariate and multivariate logistic regression analysis were used to discover the determinants of anaemia. P-values less than 0.05 were considered statistically significant.

Results: According to the findings of the study, 20.1 percent of the individuals were anaemic. Age >60 years (AOR=3.06, 95 percent CI: 1.32–7.11), poor glycemic control (AOR=2.95, 95 percent CI: 1.22–7.15), eGFR 60–89.9 mL/min/1.73m2 (AOR=2.91, 95 percent CI: 1.15–7.37), eGFR 10 years (AOR=2.75, 95 percent CI: 1.17–6.48), and experiencing diabetic complications (AOR=3.81, 95% CI: 1.65–8.81) were significantly associated with anaemia.

Conclusion: Anaemia affected one in every five T2DM patients. Poor glycemic control, reduced eGFR, the prevalence of DM comorbidities, DM duration >10 years, and age >60 years were all related with anaemia in T2DM patients. All T2DM patients should be screened for anaemia on a regular basis to aid in the early detection and management of anaemia.

Keywords: type 2 DM, anaemia, associated factors,Hemoglobin concentration, Renal insufficiency, Diabetes

INTRODUCTION

Diabetes mellitus (DM) is a metabolic condition that affects millions of people worldwide. The rising prevalence of type 2 diabetes (T2DM) has become a major public health issue [1, 2]. The number of diabetic patients has been increasing due to population and urbanisation expansion, an increase in the prevalence of obesity and sedentary lifestyle, and patients with DM living longer lives [3]. Diabetes is a very limiting condition that can result in blindness,

amputations, renal disease, anaemia, and cardiovascular and brain issues, among other things, reducing functional capacity and autonomy, as well as individual quality of life [4].
It should also be highlighted that nephropathy may develop as a result of the development of diabetes mellitus, which further undermines the renal production of erythropoietin, positively contributing to an enhanced anaemic framework [5, 6, 7]. According to Escorcio et al. [8], renal disorders impact around 40% of diabetic patients. The most critical factors in influencing haemoglobin levels in those patients are impaired renal function and proinflammatory cytokines. The inflammatory state caused by renal illness also interferes with intestinal iron absorption and inventory mobilisation [9, 10, 11]. As a result, diabetic patients with kidney impairment are at the greatest risk of developing anaemia [12].
Anaemia in chronic renal disease is defined by the National Kidney Foundation as Hb levels of < 13,5 g/dL in males and 12,0 g/dL in women [13]. Anaemia is a growing global health issue that has a negative influence on quality of life and necessitates a bigger deployment of healthcare resources [14]. The anaemic framework promotes decreased exercise capacity, weariness, anorexia, depression, cognitive dysfunction, decreased libido, and other characteristics that raise cardiac risk patients and lower their quality of life and life expectancy [15].Anaemia in diabetic patients must be treated immediately recognised because it can contribute to the development and progression of cardiovascular disease, as well as significant diabetic nephropathy and retinopathy. Regular screening for anaemia, as well as other diabetes problems, can help reduce the onset of vascular issues in these patients [16].
Anaemia has a significant negative impact on quality of life in diabetics and is associated with disease progression and the development of comorbidities [17], such as obesity and dyslipidemia, which are strongly associated with the diabetic framework and significantly contribute to the risk of cardiovascular disease [18]. This study will provide important information about the burden of anaemia and its associated factors in T2DM patients, which will be used as a baseline for future research. It will also help policymakers and other stakeholders develop interventions that emphasise routine screening and proper management of anaemia in T2DM patients. As a result, the purpose of this study was to assess the prevalence of anaemia and its related variables among T2DM patients at a selected tertiary centre in Patna, India.

METHODS

Over a two-month period, a hospital-based cross-sectional study was done among T2DM patients at DM follow-up clinics at a selected tertiary centre in Patna, India. Using a systematic random sample technique, 249 T2DM patients with more than six months of follow-up at the diabetic clinic were included in the study. The study included all adult T2DM patients (over the age of ≥18) who visited the diabetic clinic during the study periods.Patients with known haematological diseases, patients who had a history of delivery within three months of the data collection period, pregnant women, critically ill patients, and patients who had a history of acute or chronic blood loss and blood transfusion within three months of enrollment were excluded. Patients were also excluded if they had known chronic liver disease (CLD), HIV infection, or cancer, including haematological malignancies.
The sample size was estimated using a single population proportion formula, with p = 29.8 percent (expected proportion of anaemia in T2DM), a tolerable margin of error of 35% (d=0.05), and a confidence interval (CI) of 95% (Z a/2 =1.96). The resulting minimum sample size was 321 people. A correction formula was used, and the result was 226. The study comprised 249 T2DM patients after adjusting for a 10% non-response rate. A systematic random selection procedure (i.e., every third patient) was employed to choose study participants.

A semi-structured questionnaire was used to collect data. The data was collected by three data collectors (one nurse and two laboratory personnel). Socio-demographic parameters, clinical characteristics, anthropometric measurements, and laboratory analysis are among the data gathered. Socio-demographic data and clinical characteristics such as DM duration were collected using an interview guide, whereas the presence of diabetes-related complications such as retinopathy, neuropathy, nephropathy, and other complications, as well as a history of hypertension and current diabetic medications, were obtained by reviewing patients' medical records. Four consecutive fasting blood glucose measures, including one taken during the data collecting period, were also obtained from the patient's medical records and used to calculate the mean blood glucose level.

Weight (kg), height (m), and waist circumference were all measured in accordance with WHO standards. The body mass index (BMI) was calculated by dividing the weight in kilogrammes by the square of the height in metres (kg/m2). The participants' BMI was classified as underweight (less than 18.5 kg/m^2), normal (18.5–24.9 kg/m^2), overweight (25–29.9 kg/m^2), or obese (more than ≥ 30 kg/m^2).Central obesity is defined as a waist circumference of more than >102 cm in men and more than >88 cm in women. After 10 minutes of rest in a sitting position, blood pressure (BP) was measured with an aneroid sphygmomanometer. Hypertension was defined as having a Systolic Blood Pressure (SBP) of ≥130 mmHg and/or a Diastolic Blood Pressure (DBP) of ≥80 mmHg or being on antihypertensive medication.

Six mL of venous blood was collected from each participant under aseptic conditions by venous puncture from the vein using a disposable syringe as follows: 3 mL into an ethylene diamine tetraacetate (EDTA) tube for haemoglobin and red blood cell (RBC) indices determination, and the remaining 3 mL into a plain tube for serum creatinine analysis. The ABX Micros 60 Hematology Analyzer was used to calculate haemoglobin (Hgb) readings and RBC indices. The remaining 3 mL of blood was collected in a clot activator with a gel test tube for serum creatinine assay and allowed to clot at room temperature for 30 minutes.The cells were isolated from the serum after full coagulation by centrifugation at 3000 RPM for 5 minutes. The serum creatinine level was then measured as mg/dl using an ECHO XPC automated chemistry analyzer.

The following equation was used to assess kidney function: 186 × SCr (mg/dl) −1.154 ×age (years) −0.203 × 0.742 (if female) × 1.210. It was characterised as having a normal or enhanced estimated glomerular filtration rate (eGFR ≥ 90 mL/min/1.73 m2), mild renal impairment (eGFR 60–89.9 mL/min/1.73 m2), moderate and severe renal impairments (eGFR <60 mL/min/1.73 m2).

Data were imported into Epi-data manager version 4.4.1.0 and exported to the statistical software SPSS version 22 for analysis. The data was then analysed using descriptive analytic techniques such as frequency distribution, crosstabulation, and summary measures. The selected variables with p-value <0.25 in the bivariate logistic regression analysis were subjected to multivariate logistic regression analysis (backward stepwise), and the corresponding adjusted odds ratios (AOR) with 95 percent confidence intervals (CI) were used to identify factors independently associated with anaemia. P-values less than 0.05 were considered statistically significant.

RESULTS

DEMOGRAPHIC CHARACTERISTICS OF THE PARTICIPANTS

The study included 249 T2DM patients, 128 (51.4 percent) of whom were females. Their ages varied from 36 to 80 years, with a mean (standard deviation) of 53.71 ± 10.41 years. More over half of the participants, 132 (53 percent), were between the ages of 45 and 60. From the total number of respondents, 172 (69.1 percent) were married, 31 (12.4%) were

single, and 46 (18.4%) were divorced or widowed. One hundred seventy-two (69.1%) of those who took part were from cities. Approximately 71 (28.5 percent) of those polled had a higher level of education. In terms of employment, 104 (41.8 percent) of the participants worked for the government, while 45 (18.1 percent) worked for a private company (Table 1).

CLINICAL CHARACTERISTICS OF THE PARTICIPANTS

The duration of diabetes ranged from 8 months to 24 years, with a mean (standard deviation) of 7.49 ± 4.6 years. From the total number of responders, 102 (41%) had DM for less than five years, followed by 84 (33.7%) with DM for five to ten years. The BMI of the patients at the time of the investigation revealed that 162 (65.1 percent) had normal BMI (18.5–24.9 kg/m2) and 76 (30.5 percent) had higher BMI (≥ 25 kg/m2). Seventy-eight (31.3%) of the individuals had documented histories of at least one of the diabetes-related microvascular problems.

Retinopathy was the most common complication, accounting for 33 (13.3 percent), followed by diabetic nephropathy 15 (6 percent), diabetes-related foot ulcers 14 (5.6 percent), neuropathy 6 (2.4 percent), and patients with multiple problems 10 (4 percent). Eighty-three (33.3 percent) of the participants were hypertensive, DBPs of ≥ 80 mmHg in 63 (25.3 percent), with SBPs of ≥130 mmHg in 77 (30.9 percent) of the participants. The average of four consecutive fasting blood glucose levels (FBG), including FBG during study periods, varied from 101.25 to 264.25 mg/dl, with a mean (±SD) of 147.90 ± 35.21 mg/dl.More than half of the participants (54.2 percent) had a low level of glycemic control. The majority of subjects (85.1 percent) had normal serum creatinine levels. 95.63± 26.2 mL/min/1.73 m2 was the mean estimated GFR. One hundred fifty-seven (63.1 percent) of research participants had eGFRs greater than 90 mL/min/1.73 m2, while 43 (17.3 percent) had eGFRs less than 60 mL/min/1.73 m2 (Table 1).

Table 1: Socio-Demographic Characteristics and Clinical Characteristics of the Study Participants

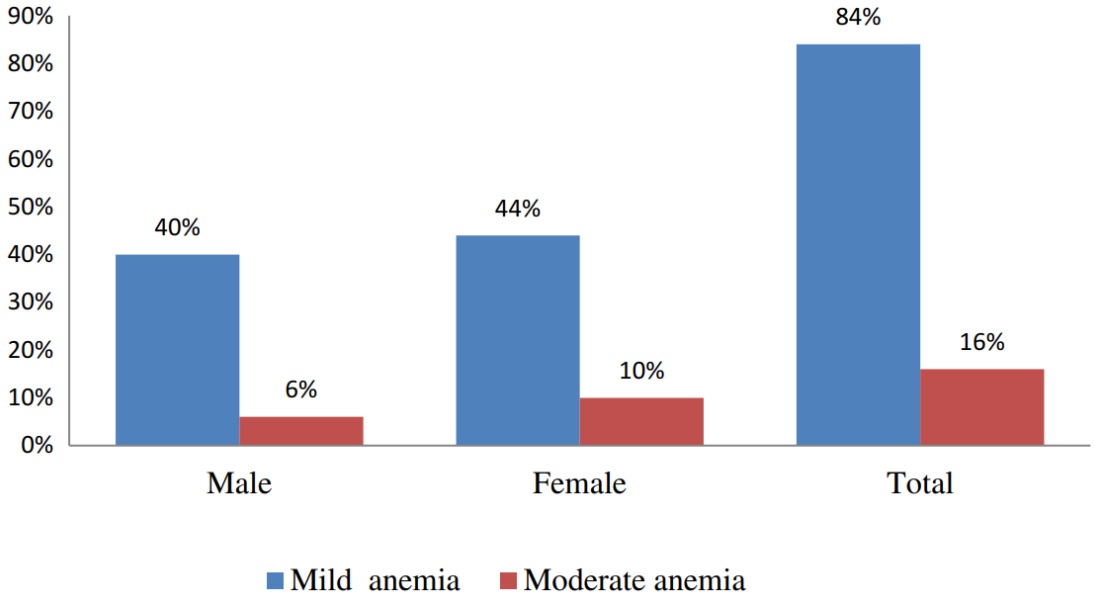
Variable		Frequency (n = 249)	Percentage (%)
Sex	Male	121	48.6
	Female	128	51.4
Age (years)	< 45	58	23.3
	45-60	132	53.0
	>60	59	23.7
Duration of DM (years)	<5	102	41.0
	5-10	84	33.7
	>10	63	25.3
BMI (Kg/m^2)	Below 18.5	11	4.4
	18.5-24.9	162	65.1
	25 and above	76	30.5
Central obesity	Yes	45	18.1
	No	204	81.9
Hypertension	Yes	83	33.3
	No	166	66.7
SBP (mmHg)	≥ 130	77	30.9
	< 130	172	69.1
DBP (mmHg)	≥ 80	63	25.3
	< 80	186	74.7
Serum creatinine level	High	37	14.9

	Normal	212	85.1
Complications of DM	Yes	78	31.3
	No	171	68.7
Glycaemic control	Poor	135	54.2
	Good	114	45.8
Types of treatment	Oral hypoglycemic agents	191	76.7
	Combined	58	23.3
eGFR (mL/min/1.73 m^2)	> 90	157	63.1
	60-89.9	49	19.7
	< 60	43	17.2

PREVALENCE OF ANAEMIA AMONG T2DM PATIENTS

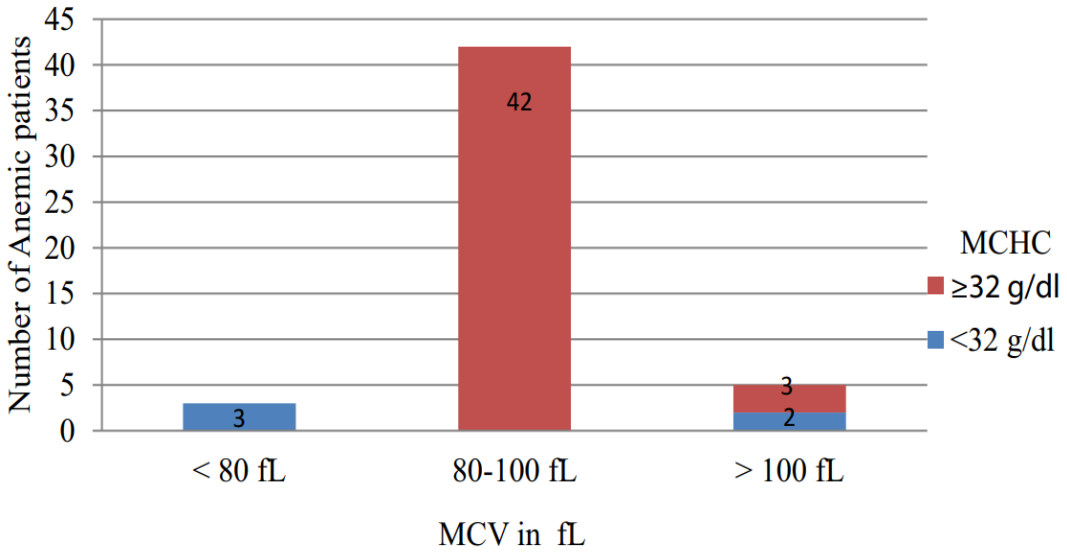
The subjects' haemoglobin levels ranged from 9.4 g/dl to 17.5 g/dl, with a mean (± SD) of 14.32 ± 1.68 g/dl. In male and female participants, the mean (± SD) haemoglobin levels were 14.73 ± 1.53 g/dl and 13.93 ± 1.73 g/dl, respectively. The overall prevalence of anaemia in study participants was found to be 20.1 percent (95 percent CI = 15.3–-25.3 percent), with males accounting for 23 (19.01 percent) and females accounting for 27 (21.1 percent).Hb values in male and female anaemic patients were 12.2 ± 0.73 g/dl and 11.4 ± 0.58 g/dl, respectively. 42 (84 percent) of anaemic T2DM patients had mild anaemia, whereas 8 (16 percent) had significant anaemia. This study found no evidence of severe anaemia. None of these anaemic patients were ever tested for anaemia (Figure 1).

Figure 1: Prevalence and degree of anaemia among type 2 DM patients



In anaemic and non-anemic patients, the mean (SD) MCV was 92.5 ± 5.2 fL and 91.6 ± 4.9 fL, respectively. Similarly, the mean MCHC (SD) in anaemic and non-anemic patients was 33.9 ± 1.6 g/dl and 34.2 ± 1.6 g/dl, respectively. The differences in MCV and MCHC distribution between non-anemic and anaemic individuals were not statistically significant ($p>0.05$). The majority of anaemic individuals, 42 (84%) had MCV between 80–100 fL and 45 (90%) had MCHC greater than 32 g/dl. Overall, 42 (84%) of patients had normocytic normochromic anaemia, 3 (6%) had microcytic hypochromic anaemia, and 5 (10%) had macrocytic anaemia (Figure 2).

Figure 2: Distribution of MCV and MCHC of anemic type 2 DM patients



DISCUSSION

The prevalence of anaemia and its related variables among T2DM patients at a designated tertiary centre in _____, India, was examined in this institutional-based cross-sectional study. Anaemia was discovered in one out of every five T2DM patients. It was also discovered that the incidence of anaemia was substantially correlated with the various stages of renal function as evidenced by eGFR, patient age, length of DM, level of glycemic control, and presence of diabetes-related comorbidities.

This study differs from another conducted in India, which found a greater rate of microcytic hypochromic anaemia [18]. This study's low prevalence of microcytic hypochromic anaemia could be explained by their location and access to health care providers. Nearly three-fifths of the participants in this study were from urban regions with access to health care services related to adequate nutrition and a variety of nutrition. Although the study did not measure food status, it is doubtful that the anaemia was caused by nutritional deficits because the majority (84 percent) of patients had normocytic normochromic anaemia.In terms of anaemic state, the majority of respondents (84 percent) had moderate anaemia, which is particularly frequent in anaemia caused by chronic conditions such as diabetes. This study's findings are comparable to those found in Malaysia [19].

One of the parameters connected with the existence of anaemia in this study is the duration of diabetes. It was shown that there is a positive association between the length of diabetes and anaemia, with a higher likelihood in individuals with more than ten years. When compared to people with DM for ≤10 years, the chances ratio of getting anaemia was roughly three times higher in those with DM for 10 years. This finding is consistent with earlier research from Australia, Korea, and Malaysia [20, 21]. The persistent effects of hyperglycemia may be to blame for the increased risk of anaemia development with increasing duration of DM.

According to this study, respondents with poor glycemic control were three times more likely to develop anaemia than those with adequate glycemic control. This corresponds to findings in Nigeria, Pakistan, and Kuwait [22, 23, 24, 25]. Because erythropoietin synthesis and release are influenced in part by the autonomic nervous system, and diabetic autonomic neuropathy is common in individuals with poor glycemic control, the findings suggest that erythropoietin synthesis may be prematurely curtailed in these patients [26, 27, 28]. Furthermore, in people with poorly controlled diabetes, erythrocyte precursors in the bone

marrow may be subjected to extended direct glucose toxic effects, or mature red blood cells may be damaged by oxidative stress, producing disruptions in RBC function.

CONCLUSION

Anaemia was seen in one out of every five T2DM patients, even those with good renal function as measured by eGFR. The majority of the anaemic individuals had a mild form of anaemia. Morphologically, normocytic normochromic anaemia was the most common kind of anaemia. Poor glycemic control, reduced eGFR, diabetes-related comorbidities, DM duration >10 years, and age >60 years were all associated with poor glycemic control. The findings point to the importance of incorporating regular anaemia screening in all T2DM patients, particularly those with these identified risk factors, in order to facilitate early detection and management of anaemia among T2DM patients and, as a result, improve the overall care of these patients.

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