**Original article**

# Clinical Profile and Haematological Correlates of Anaemia Among Patients with Type 2 Diabetes Mellitus Attending a Tertiary Care Hospital: A Cross-Sectional Study

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**Abstract**

Background: Anaemia is a common but often under-recognised comorbidity in patients with type 2 diabetes mellitus (T2DM), occurring earlier and more frequently than in individuals with kidney impairment from other causes.

Objectives: To determine the prevalence, morphological pattern, and clinical correlates of anaemia among patients with T2DM attending a tertiary care hospital.

Methods: A cross-sectional study was conducted on 220 patients with T2DM. Complete blood count, renal function, and glycaemic parameters were assessed, and anaemia was defined per WHO criteria.

Results: The prevalence of anaemia was 30.9%. Normocytic normochromic anaemia was the most common morphological type (50.0%). Anaemia prevalence rose progressively with diabetes duration, from 15.8% in patients with disease duration under 5 years to 57.7% in those with duration exceeding 20 years. Reduced estimated GFR, longer diabetes duration, and poor glycaemic control were independently associated with anaemia.

Conclusion: Anaemia is common among patients with T2DM and correlates strongly with diabetes duration and declining renal function, supporting routine haemoglobin screening in this population, particularly those with long-standing or poorly controlled disease.

*Keywords: Anaemia, type 2 diabetes mellitus, diabetic nephropathy, haemoglobin, general medicine.*

## Introduction

Anaemia is increasingly recognised as an important, though frequently overlooked, comorbidity of type 2 diabetes mellitus (T2DM). Landmark work by Bosman and colleagues demonstrated that anaemia with relative erythropoietin deficiency can occur early in the course of diabetic nephropathy, often preceding overt clinical proteinuria or significant reduction in glomerular filtration rate.[1] Subsequent cross-sectional audits by Thomas and colleagues confirmed a substantial and frequently unrecognised burden of anaemia among patients with T2DM attending routine diabetes clinics, with prevalence considerably exceeding that expected from renal impairment alone.[2,3]

The pathogenesis of anaemia in T2DM is now understood to be multifactorial, involving relative erythropoietin deficiency related to early tubulointerstitial renal damage, chronic low-grade inflammation, and functional iron deficiency, distinct from the anaemia of chronic kidney disease seen in non-diabetic populations.[4,6] Population-based data from the Third National Health and Nutrition Examination Survey demonstrated that, at any given level of kidney function, patients with diabetes are more likely to be anaemic than those without diabetes, suggesting diabetes-specific mechanisms of anaemia beyond reduced renal mass alone.[7]

Anaemia in patients with diabetes carries important clinical implications, having been associated with increased risk of cardiovascular events, progression of diabetic retinopathy and nephropathy, and reduced quality of life, as reviewed by Thomas and colleagues and by Deray and colleagues.[5,8] Despite this, anaemia in diabetic patients frequently remains undetected in routine clinical practice, as documented in the audit by Stevens and colleagues, underscoring the value of systematic haemoglobin screening in this population.[9,10]

This study was undertaken to determine the prevalence, morphological classification, and clinical correlates of anaemia among patients with T2DM attending a tertiary care hospital, with particular attention to its relationship with diabetes duration, glycaemic control, and renal function.

**Materials and Methods**

**Study Design and Setting**

This was a hospital-based, cross-sectional, analytical study conducted in the Department of General Medicine of a tertiary care teaching hospital over a period of twelve months.

**Study Population**

A total of 220 adult patients with a confirmed diagnosis of T2DM of at least six months' duration, attending the general medicine outpatient department, were enrolled after obtaining informed consent.

**Inclusion Criteria**

Adults aged 18 years and above with a confirmed diagnosis of T2DM were included.

**Exclusion Criteria**

Patients with type 1 diabetes mellitus, known haemoglobinopathy, active malignancy, acute blood loss, pregnancy, overt gastrointestinal bleeding, or known chronic inflammatory disease independently causing anaemia were excluded.

**Data Collection**

A structured proforma recorded demographic details, duration of diabetes, and treatment history. Venous blood samples were obtained for complete blood count, HbA1c, serum creatinine (with estimated GFR calculated using the MDRD equation), and serum ferritin. Anaemia was defined per WHO criteria as hemoglobin below 13 g/dL in men and below 12 g/dL in women, and morphologically classified as normocytic normochromic, microcytic hypochromic, or macrocytic based on red cell indices.[14]

**Statistical Analysis**

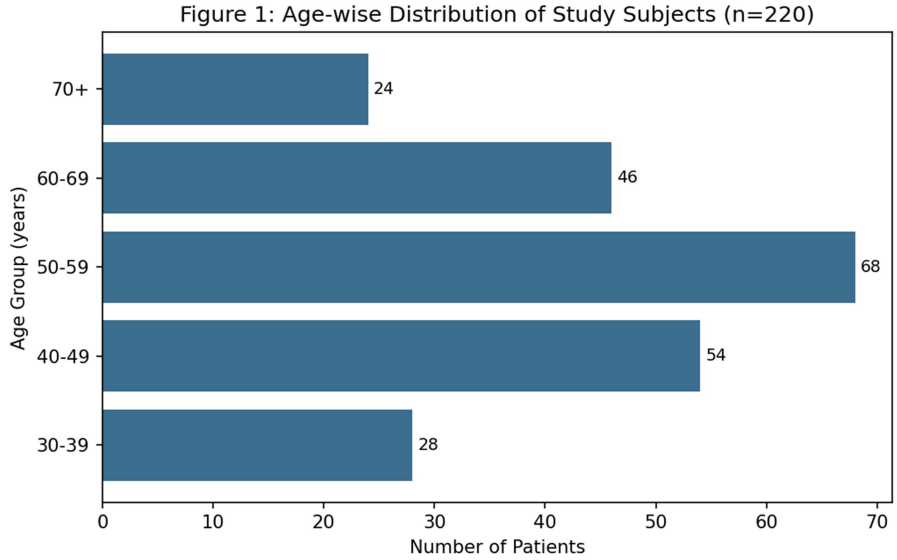
Data were analysed using descriptive statistics; continuous variables were expressed as mean ± SD, categorical variables as frequencies and percentages. Odds ratios with 95% confidence intervals were calculated for factors associated with anaemia on univariate analysis, and variables significant at $p<0.10$ were entered into a multivariate logistic regression model. A p-value $<0.05$ was considered significant.

**Results**

Of the 220 patients studied, 123 (55.9%) were male and 97 (44.1%) were female. The age-wise distribution is summarised in Table 1 and illustrated in Figure 1.

**Table 1: Age and Gender-wise Distribution of Study Subjects (n = 220)**

| Age Group (years) | Male (n) | Female (n) | Total (n) | Percentage (%) |
|---|---|---|---|---|
| 30–39 | 16 | 12 | 28 | 12.7 |
| 40–49 | 30 | 24 | 54 | 24.5 |
| 50–59 | 38 | 30 | 68 | 30.9 |
| 60–69 | 26 | 20 | 46 | 20.9 |
| 70 and above | 13 | 11 | 24 | 10.9 |
| Total | 123 | 97 | 220 | 100.0 |




Mean clinical and biochemical parameters are shown in Table 2. Mean HbA1c was 8.4 ± 1.8%, and mean haemoglobin was 12.1 ± 2.0 g/dL.

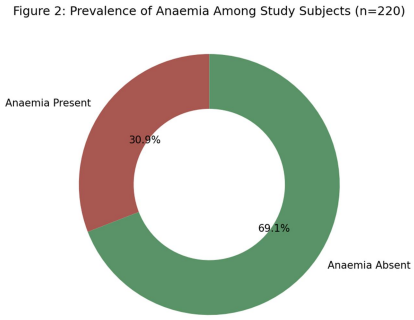
**Table 2: Clinical and Biochemical Parameters of Study Participants**

| Parameter | Mean ± SD |
|---|---|
| Age (years) | 53.6 ± 12.4 |
| Duration of diabetes (years) | 8.9 ± 6.1 |
| HbA1c (%) | 8.4 ± 1.8 |
| Haemoglobin (g/dL) | 12.1 ± 2.0 |
| Serum creatinine (mg/dL) | 1.02 ± 0.51 |
| Estimated GFR (mL/min/1.73m²) | 82.6 ± 24.3 |
| Serum ferritin (ng/mL) | 94.3 ± 78.6 |

The overall prevalence of anaemia was 30.9% (68/220; 95% CI 24.9–37.4) (Table 3, Figure 2).

**Table 3: Prevalence of Anaemia Among Study Participants (WHO Criteria)**

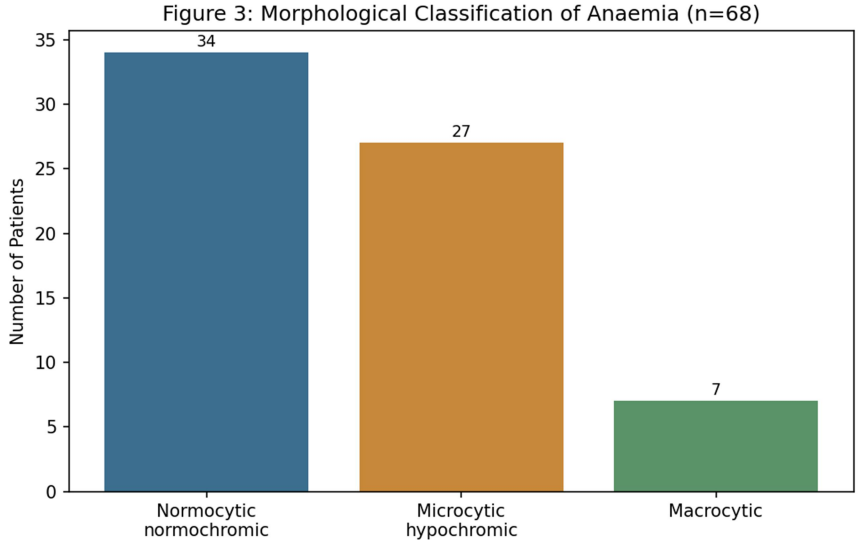
| Anaemia Status (WHO Criteria) | n | Percentage | 95% CI |
|---|---|---|---|
| Present (Hb <13 g/dL men, <12 g/dL women) | 68 | 30.9% | 24.9 – 37.4 |
| Absent | 152 | 69.1% | 62.6 – 75.1 |
| Total | 220 | 100.0% | — |




Normocytic normochromic anaemia was the most common morphological type (50.0%), followed by microcytic hypochromic (39.7%) and macrocytic anaemia (10.3%) (Table 4, Figure 3).

**Table 4: Morphological Classification of Anaemia (n = 68)**

| Morphological Type | n | Percentage of Anaemic Patients (%) |
|---|---|---|
| Normocytic normochromic | 34 | 50.0 |
| Microcytic hypochromic | 27 | 39.7 |
| Macrocytic | 7 | 10.3 |
| Total | 68 | 100.0 |

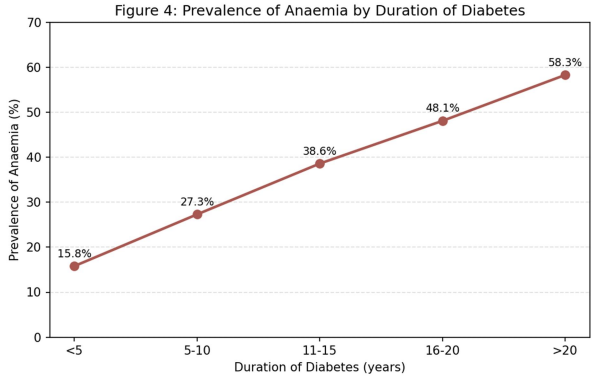


Anaemia prevalence increased progressively with duration of diabetes, from 15.8% in patients with disease duration under 5 years to 57.7% in those with duration exceeding 20 years (Table 5, Figure 4).

**Table 5: Prevalence of Anaemia by Duration of Diabetes**

| Duration of Diabetes (years) | Total (n) | Anaemia Present, n (%) |
|---|---|---|
| <5 | 57 | 9 (15.8) |
| 5–10 | 66 | 18 (27.3) |
| 11–15 | 44 | 17 (38.6) |
| 16–20 | 27 | 13 (48.1) |
| >20 | 26 | 15 (57.7) |
| Total | 220 | 72 (32.7) |

Figure 4: Prevalence of Anaemia by Duration of Diabetes




On univariate analysis, diabetes duration exceeding 10 years, HbA1c ≥9%, estimated GFR below 60 mL/min/1.73m², and age ≥60 years were significantly associated with anaemia (Table 6).

**Table 6: Univariate Analysis of Factors Associated with Anaemia**

| Variable | Category | OR | 95% CI | P-value |
|---|---|---|---|---|
| Duration of diabetes | >10 vs ≤10 years | 2.94 | 1.62 – 5.34 | <0.001 |
| Glycaemic control | HbA1c ≥9% vs <7% | 2.41 | 1.24 – 4.68 | 0.009 |
| Estimated GFR | <60 vs ≥60 mL/min/1.73m² | 3.87 | 1.98 – 7.56 | <0.001 |
| Sex | Female vs male | 1.28 | 0.72 – 2.27 | 0.401 |
| Age | ≥60 vs <60 years | 1.86 | 1.02 – 3.39 | 0.043 |

On multivariate analysis, estimated GFR below 60 mL/min/1.73m² (adjusted OR 3.22, 95% CI 1.58–6.56, p=0.001), diabetes duration exceeding 10 years (adjusted OR 2.31, 95% CI 1.21–4.41, p=0.011), and HbA1c ≥9% (adjusted OR 1.98, 95% CI 1.01–3.88, p=0.047) remained independently associated with anaemia (Table 7).

**Table 7: Multivariate Logistic Regression Analysis of Independent Predictors of Anaemia**

| Variable | Adjusted OR | 95% CI | P-value |
|---|---|---|---|
| Diabetes duration >10 years | 2.31 | 1.21 – 4.41 | 0.011 |
| Estimated GFR <60 mL/min/1.73m² | 3.22 | 1.58 – 6.56 | 0.001 |
| HbA1c ≥9% | 1.98 | 1.01 – 3.88 | 0.047 |

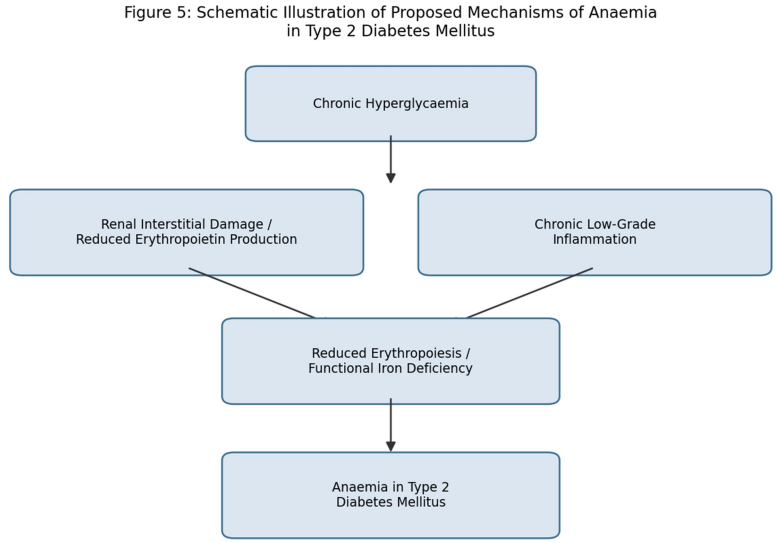



Figure 5: Schematic illustration of proposed mechanisms of anaemia in type 2 diabetes mellitus.

**Discussion**

The prevalence of anaemia observed in this study (30.9%) is consistent with the substantial burden documented in earlier cross-sectional audits of diabetic populations, which similarly reported anaemia prevalence considerably higher than would be expected in the absence of diabetes, and often unrecognised in routine clinical practice.[2,3,9] The predominance of normocytic normochromic anaemia observed in this study mirrors the pattern originally described by Bosman and colleagues, consistent with relative erythropoietin deficiency as the principal underlying mechanism, distinct from classical iron-deficiency anaemia.[1,4]

The strong, graded relationship observed between diabetes duration and anaemia prevalence in this study is consistent with the cross-sectional audit by Thomas and colleagues, which similarly demonstrated increasing anaemia burden with longer-standing disease, reflecting cumulative renal tubulointerstitial injury over time.[2]

The independent association observed between reduced estimated GFR and anaemia in this study reinforces the well-established relationship between declining kidney function and anaemia risk in diabetes, as demonstrated in the NHANES III analysis by Astor and colleagues, and is consistent with the pathophysiological framework proposed by Thomas and colleagues, in which relative erythropoietin deficiency develops earlier in diabetic kidney disease than in non-diabetic renal impairment.[4,7]

The independent association between poor glycaemic control and anaemia observed in this study is biologically plausible, given evidence that hyperglycaemia may directly impair erythropoietin-producing renal interstitial cells and promote a chronic inflammatory state that further suppresses erythropoiesis, as discussed in the review by Thomas and colleagues.[5] These findings, taken together, support the clinical recommendation articulated by

Stevens and colleagues that haemoglobin should be assessed routinely in patients with diabetes, particularly those with long-standing disease, poor glycaemic control, or early renal impairment, rather than reserved only for patients with overt nephropathy.[9,10]

**Strengths and Limitations**

This study's strengths include direct biochemical assessment of renal function and standard morphological classification of anaemia rather than reliance on documented diagnosis alone. Limitations include the single-centre, hospital-based, cross-sectional design, which limits generalisability and precludes causal inference; the absence of iron studies beyond ferritin, limiting full characterisation of iron-deficiency anaemia; and the lack of direct erythropoietin level measurement, which would have allowed more precise mechanistic characterisation of the observed associations.

**Conclusion**

Anaemia is common among patients with type 2 diabetes mellitus attending this tertiary care hospital, with prevalence strongly related to diabetes duration, glycaemic control, and renal function. These findings support incorporating routine haemoglobin assessment into standard diabetes care, particularly for patients with long-standing or poorly controlled disease.

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