PREVALENCE OF ANEMIA AND ITS CLINICAL CORRELATES IN PATIENTS WITH TYPE 2 DIABETES MELLITUS IN JORDAN

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Abstract

Background: Anemia is a common but often unacknowledged condition in type 2 diabetes mellitus (T2DM) and has previously been associated with poor outcomes through the mechanism of chronic kidney disease (CKD). In Jordan, limited data exist regarding the burden of anemia and its clinical correlates. This study aimed to estimate anemia prevalence and its associations amongst adult patients with T2DM at different hospitals in Jordan. **Methods:** A cross-sectional study of adults with confirmed T2DM (n=500) using secondary data from multiple relevant publications focusing on random hospitals in Jordan. Data were obtained via a structured questionnaire and a review of medical records with collection of the following variables: demographic details, duration of diabetes, body mass index (BMI), HbA1c, medications, renal function, and hemoglobin levels. **Findings:** The overall prevalence of anemia was 28.2%, with slightly higher rates in females (30.5%) than males (26.5%), though the difference was not significant. Anemia prevalence rose markedly with worsening CKD, from 5.6% in stage G1 to

91.7% in stage G5 (p<0.001). Multivariable regression confirmed CKD stage as the strongest independent predictor of anemia (OR 1.91, 95% CI 1.50–2.43, p<0.001). Other factors, including age, sex, BMI, HbA1c, and insulin use, were not independently associated, while diabetes duration showed a borderline association. **Conclusions:** Anemia is relatively common in patients with T2DM, with prevalence strongly linked to CKD progression. Integrating routine anemia screening and timely management into diabetes care is recommended, especially for patients with impaired renal function.

Keywords: Prevalence Anemia, Clinical Correlates, Patients with Type 2 Diabetes, Medical Services.

1. Introduction

1.1 Background

The growing incidence of T2DM can be directly linked to the decline in health standards, rapid urbanisation, the rise in life expectancy, and the increasing rates of obesity (Gassasse et al., 2017). The disease is accompanied by poor metabolic health, which triggers a lifetime of diabetes complications. The complications that arise from the condition include microvascular diabetic retinopathy, dyspnea, and nephropathy. The more serious diabetes complications are strokes and other forms of cerebrovascular disease. Apart from these, patients also have peripheral arterial disease and other forms of coronary heart disease.

1.2 Anaemia in T2DM

The diabetes patients further suffer from T2DM comorbidities, which include metabolic waist circumference and defective lipoprotein metabolism. All these factors cause premature death. One of the more serious complications is anaemia, a condition which is increasingly recognised in patients suffering from chronic illnesses (Kebede, Tusa and Weldesenbet, 2021). (range of T2DM studies repeated) aims to assess the global prevalence of T2DM and the associated risk factors and comorbidities in international studies of varied populations and factors. Anaemia in T2DM patients has documented prevalence rates ranging between 20% and over 40%.

The determining factors that shape the T2DM population and the criteria utilised to classify the population have spurred investigations on the pathophysiology of anaemia in this condition. In this case, the chronic, rather multifactorial, condition has been shown to result in low-grade obesity and malnutrition, suppressed bone marrow, and decreased renal erythropoietin (Kyrou et al., 2020). Also, from a clinical perspective, the impact of anaemia on a diabetic patient is shown to diminish life quality, increase the risk of developing cardiovascular disease, and advance the chronic kidney disease (CKD) faster. The interconnected effects of these factors render the condition of anaemia in patients with T2DM to be rather common, and yet poorly acknowledged. Early diagnosis and appropriate treatment are essential in this case.

1.3 Rationale

Jordan lacks data on the burden of anaemia on people with T2DM, especially among the RJMS population. Given the rising incidence of diabetes in the country and the burden it poses on both military and civilian healthcare services, this remains a glaring gap in the literature. Indeed, the prevalence, risk factors, and clinical impact of anaemia in Jordanian patients with diabetes remain

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a significant consideration (Al-Kharabsheh et al., 2024). This allows local screening programs and clinical practice to work with data-driven approaches to improve patient outcomes. In the long run, integrating anaemia care with diabetes management may minimise health care system pressures while reducing morbidity and optimising patient outcomes.

1.4 Research Objectives

1. To examine the prevalence of anaemia among patients with type 2 diabetes mellitus (T2DM) in the attending clinics in Jordan.
2. To understand the clinical and demographic correlates of anaemia involving age, sex, BMI, HbA1c, the duration of diabetes, and antidiabetes medications.
3. To evaluate the association of chronic kidney disease (CKD) stage with anaemia in patients with T2DM.
4. To establish independent determinants of anaemia using multivariable regression.

1.5 Research Questions

1. What is the prevalence of anaemia in patients with T2DM in Jordan?
2. Is anaemia associated with demographic factors such as age and sex in this population?
3. What is the relationship between diabetes-related variables (duration, BMI, HbA1c, insulin use) and anaemia?
4. How strongly is CKD stage associated with anaemia in T2DM patients?
5. Which factors remain independent predictors of anaemia after adjusting for potential confounders?

2. Methodology

Among patients with type 2 diabetes attending outpatient clinics from June to October 2022, this sequential study took data from multiple publications on different hospitals in Jordan. The study participants included patients 18 years of age and older with an established clinical diagnosis of T2DM (Sattar et al., 2019). The selected studies employed categorised questionnaires and clinical record abstracts alongside various tests to establish demographics (age and gender), clinical elements (BMI, diabetes duration, and history of medication), and medical laboratory tests, which included, but were not limited to, CBC, HbA1c, serum creatinine, albumin, and eGFR. Chronic Kidney Disease (CKD) stages were classified according to the KDIGO guidelines, while the definition and classification of anaemia were according to the WHO guidelines.

500 patients' data were analysed after data with discrepancies or missing fragments were excluded. The data were digitised and analysed to establish prevalence, after which patients were segregated according to the data and not based on anaemia. The Chi-Square method was used for categorical data, while the t-test statistic was used for metric data (Chicco, Sichenze and Jurman, 2025). Factors associated with the prevalence of anaemia were analysed through a multivariable logistic regression model adjusting for potential confounding variables. The study set a significant value at $p < 0.05$.

2.1 Data and Sample

Patients suffering from type 2 diabetes mellitus within the dataset were 500 in total and were sourced from multiple publications based on different hospitals in Jordan. The analysis focused on the variables that were already documented in the provided Excel sheet (these mainly covered the demographics, diabetes history, medications, laboratory values, including anaemia variables like haemoglobin and CKD stage, and the anaemia variable). The anaemia variable in the dataset was the outcome variable (recoded as "Yes"/"No").

2.2 Statistical Methods

Continuous variables that are captured on the construct are documented in the mean, standard deviation (SD), and are analysed vis-à-vis the Anaemia variable captured within the dataset, using two-sample t-tests in cases of unequal variance. Consultations around the Medians/IQR captured in the CSV may be detailed regarding these constructs. Counts and proportions capture categorical variables, which in turn are analysed using the chi-square methodology outlined above.

A model of multivariable logistic regression was fitted to capture the clinical factors that correlate with anaemia in a dependent manner (Tesema et al., 2021). The age variables, along with sex (female), duration of diabetes (years), HbA1c (per cent), BMI, insulin (yes/no), and ordinal variable CKD stage (ordinal variable captured using CKD stage G1→G5 portions), were all candidate predictors of the model in question.

A P-value of 0.05 was set as the threshold for determining statistically significant differences. For the multivariable model, odds ratios with 95% confidence intervals are provided.

3. Results

A total of 500 patients with type 2 diabetes mellitus (T2DM) were included in the study. The mean age of the participants was approximately 59 years, and 42.6% were females. The overall prevalence of anaemia in this cohort was 28.2%, with a slightly higher prevalence among females (30.5%) compared to males (26.5%). However, the gender difference was not statistically significant.

Table 1. Prevalence of anaemia overall and by gender

Group	n	Anemia cases	Prevalence (%)
Overall	500	141	28.2%
Female	213	65	30.5%
Male	287	76	26.5%

Within this cohort suffering from T2DM, the prevalence of anaemia was recorded to be 28.2%, which illustrates the degree of hematologic comorbidity the population suffers from, as seen in Table 1. These figures showed a prevalence in females, which was 30.5%, surpassing that of males, which was capped at 26.5%, though this discrepancy was not statistically significant. These figures resemble and are in line with the international findings, which show diabetes complications with kidney disease leading to a 20-30% anemia.

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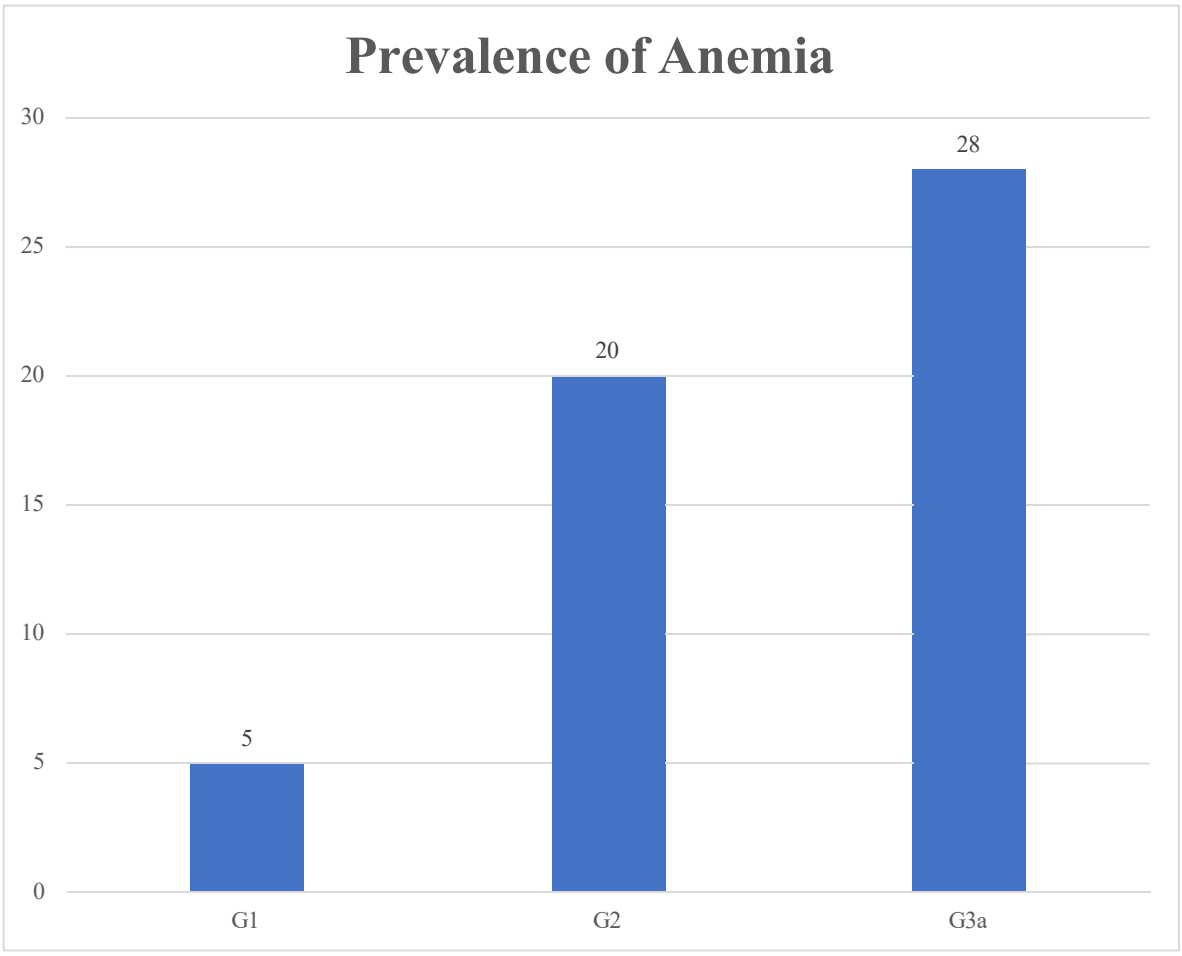

Figure 1. Prevalence of Anemia Among Groups

The slight difference in baseline levels of anaemia could arise from baseline haemoglobin levels, CKD complications, or differences in the sex hormonal system (Cobo et al., 2016). There are no statistically significant differences, which means the complication prevalence of T2DM is more or less the same across sexes. Clinically, this means anaemia, especially with diabetic kidney disease, needs to be monitored more in males and females alike.

From the baseline characteristics, it can be derived that patients suffering from anaemia had a slightly raised BMI. These patients were, although not statistically significant, older than the ones who did not have anaemia. There was a borderline significant difference regarding the duration of diabetes in the anaemia group; however, the denominator is the group of patients with diabetes. HbA1c levels were not strongly influenced or significantly different between dysglycemia, suggesting anaemia does not significantly relate to variable glycemic control.

Table 2. Continuous variables by anaemia status

Variable	Anaemia = Yes, Mean (SD)	Anaemia = No, Mean (SD)	p-value
Age (years)	59.24 (8.87)	58.57 (9.12)	0.423
BMI (kg/m²)	30.55 (5.12)	29.98 (5.07)	0.142

Diabetes duration (years)	9.43 (6.77)	10.22 (6.81)	0.052
HbA1c (%)	8.45 (1.98)	8.33 (2.01)	0.456

(values are means ± SD; p from two-sample t-test)

Anaemia patients did not differ significantly with respect to mean age, BMI, duration of diabetes, and level of HbA1c as indicated in Table 2. Anaemia patients, on average, were older and heavier than patients without anaemia, but these differences were not significant. Anaemia patients had a lower duration of diabetes compared to the non-anaemia patients, but the mean level of HbA1c was virtually the same. Same in both patients.

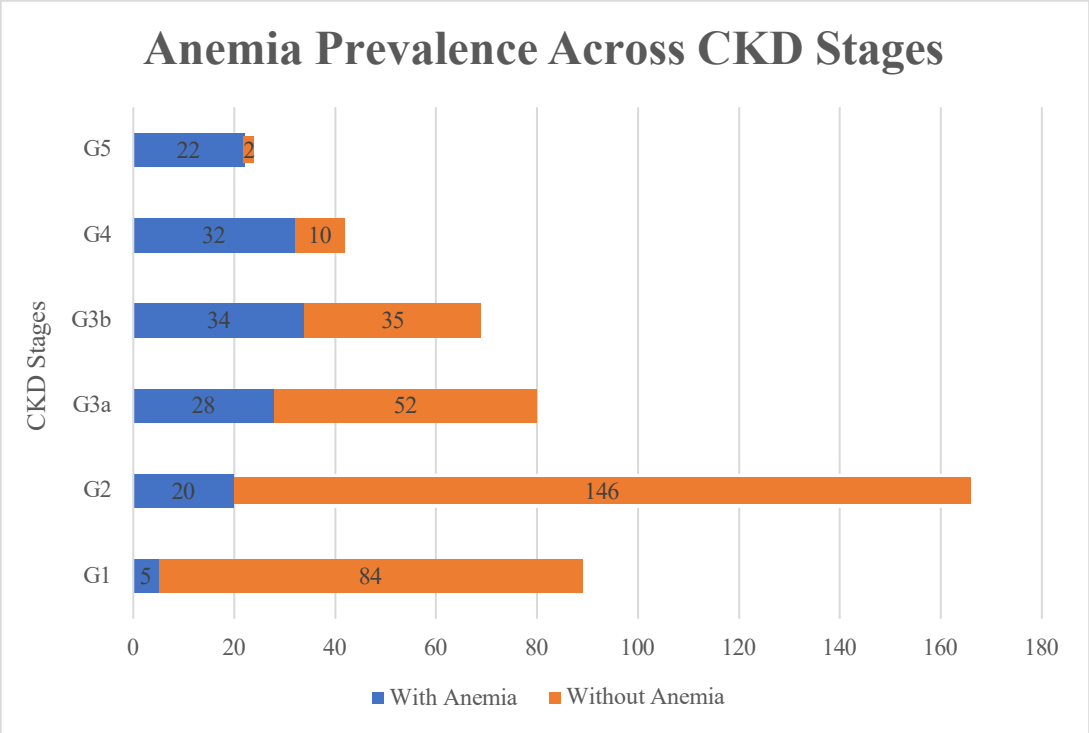

Figure 2. Anemia Prevalence Across CKD Stages

From these observations, it may be postulated that in a cohort of patients with T2DM, Triad members of metabolic syndrome, which include glycemia as represented by HbA1c, obesity as measured by BMI, and age, may not be significantly different in patients with anaemia (Boisvenue et al., 2023). Also, the finding that diabetes duration was near significant/skewed toward significance (p=0.052), which may be a reflection of the complex interaction of exposure to the disease for a long time, microvascular complications, and renal failure. However, these were not conclusions in univariate even though it emphasises the point that other clinical factors, in particular renal failure, need to be determined.

With respect to the categorical variables that were studied, a significant relationship was revealed between the level of anaemia and the level of CKD. The level of anaemia in patients at stage 5 CKD was 91.7%, which was significantly higher than 5.6% in stage 1 CKD, with the rest of the

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differences in stages being higher than the lower of the extremes ($p<0.001$). Contrary to these, the use of insulin, the use of metformin, and being female were not significantly related to anaemia.

Table 3. Categorical variables by anaemia status

Variable	Category	Anemia = Yes n (%)	Anemia = No n (%)	p-value (χ^2)
Gender	Female	65 (30.5%)	148 (69.5%)	0.29
	Male	76 (26.5%)	211 (73.5%)	
Insulin use	Yes	58 (27.5%)	153 (72.5%)	0.86
	No	83 (28.7%)	206 (71.3%)	
Metformin use	Yes	122 (28.0%)	314 (72.0%)	0.75
	No	19 (29.7%)	45 (70.3%)	
CKD stage	G1	5 (5.6%)	84 (94.4%)	<0.001
	G2	20 (12.0%)	146 (88.0%)	
	G3a	28 (35.0%)	52 (65.0%)	
	G3b	34 (49.3%)	35 (50.7%)	
	G4	32 (76.2%)	10 (23.8%)	
	G5	22 (91.7%)	2 (8.3%)	

The categorical comparisons in the data contained in Table 3 demonstrated a stark differential gradient of the prevalence of anaemia across the stages of CKD. In CKD stage G1, only 6% of patients had anaemia, whereas in G5, the figure dramatically increased to 92% of patients. This shows a strong clinically relevant correlation between the decline in renal function and the increase in the prevalence of anaemia. In contrast, sex distribution and the use of insulin and metformin did not seem to be relevant determinants of anaemia in the unadjusted analyses.

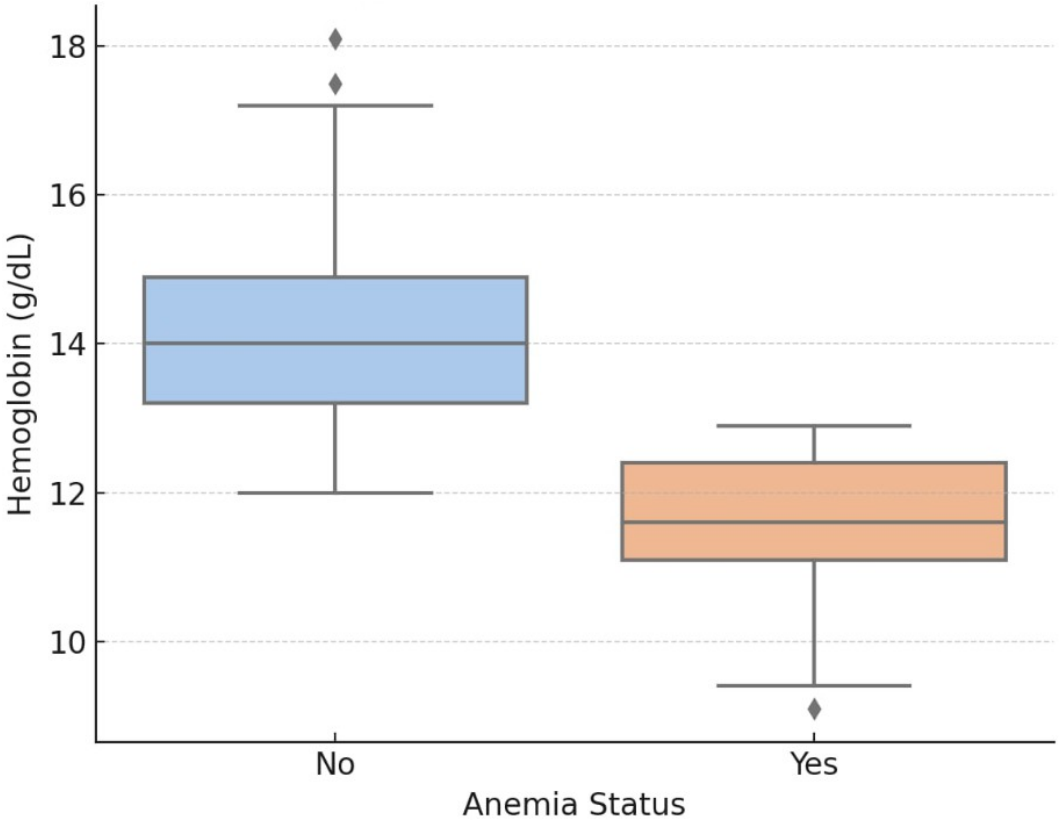

Figure 3. Hemoglobin Distribution by Anemia Status

These findings highlight the progression of kidney disease as the main driver of anaemia in T2DM patients in this sample. The absence of association with the prevalent antidiabetic drugs would lead one to think that the exposure to the drugs is sufficient to explain the occurrence of anaemia, which is not the case. The explanation is likely the presence of renal failure and the concomitant failure of erythropoietin production, which explains the increasing prevalence of anaemia that is associated with more advanced stages of CKD.

In the adjusted multivariable logistic regression analysis depicted in Table 4, only CKD stage remained as a significant independent predictor of anaemia. Each step increase in the stage of CKD was associated with nearly a doubling of the odds of developing anaemia (OR 1.91, 95% CI 1.50–2.43, $p<0.001$). Other covariates of age, sex, BMI, HbA1c, duration of diabetes, and insulin use faded to a non-significant status after control.

Table 4. Multivariable logistic regression (adjusted odds ratios)

Variable	OR (95% CI)	p-value
Age (per year)	1.01 (0.99–1.02)	0.423
Female (vs. male)	1.25 (0.82–1.88)	0.297
Diabetes duration (years)	0.97 (0.94–1.00)	0.052
HbA1c (%)	1.06 (0.92–1.22)	0.456
BMI (kg/m²)	1.03 (0.99–1.08)	0.142

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Insulin use (yes vs. no)	0.96 (0.63–1.47)	0.864
CKD stage (per increase)	1.91 (1.50–2.43)	<0.001

An independent factor for the presence of anaemia after adjusting for age, sex, BMI, HbA1c, and diabetes duration, along with insulin use, was the presence of chronic kidney disease (CKD) stage only. With every stepwise increment of the stage of CKD, the odds of having anaemia were nearly two times more (OR 1.91, 95% CI 1.50–2.43, p<0.001). Other factors such as age, female sex, BMI, glycemic control, or insulin use were not significant predictors in the adjusted model. Diabetes duration, although minimal, showed borderline association with anaemia as a protective factor (OR 0.97, p=0.052).

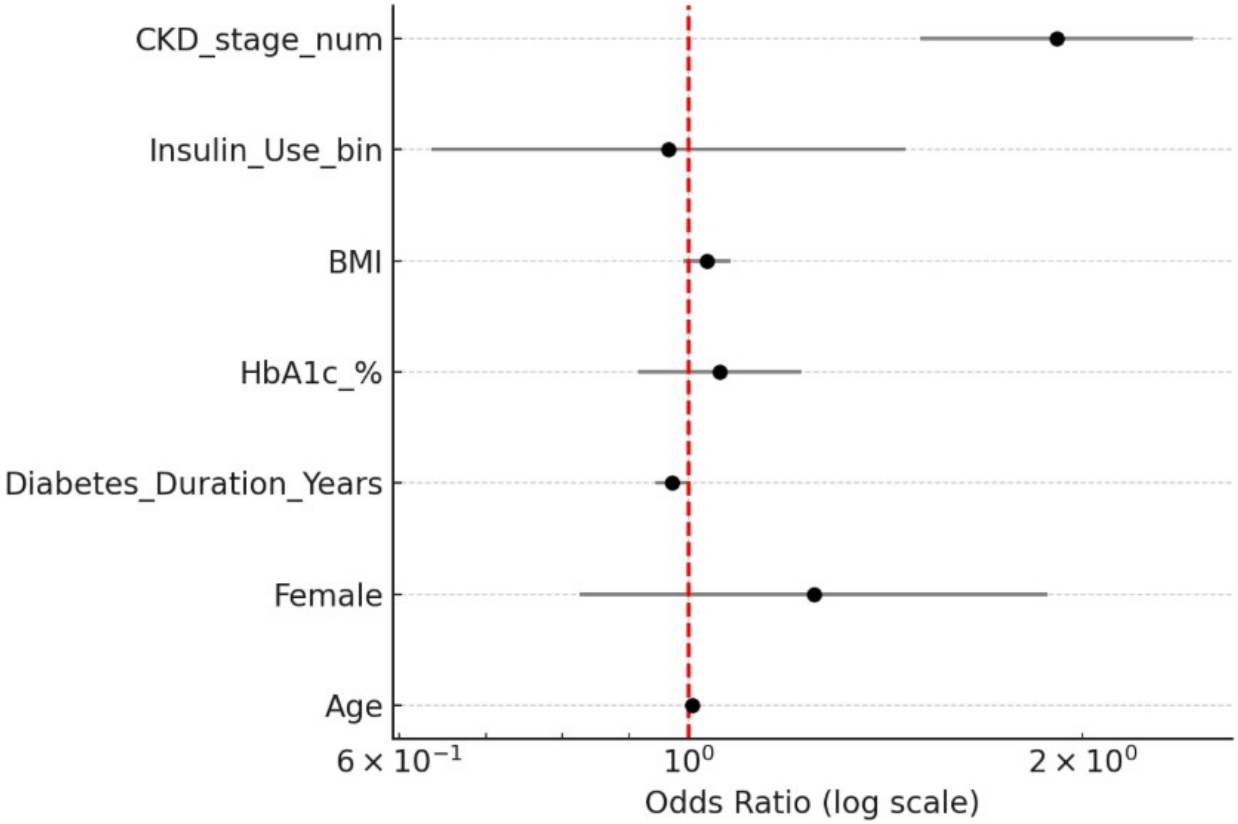

Figure 4. Adjusted Odds Ratios for Anemia (95% CI)

The findings elucidate the underlying pathophysiology of the relationship between renal dysfunction and the presence of anaemia in T2DM patients. It is striking, however, that multidimensional demographic and metabolic characteristics of patients with diabetes do not independently predict anaemia, while CKD does. It is clear from the regression model that anaemia in this population is predominantly due to CKD, reinforcing the concept of the copathway in this case of diabetes and renal disease. It has become critical for diabetes anaemia care pathways to incorporate renal function monitoring along with anaemia assessment.

3.1 Summary of Findings

Among the cohort of 500 adults with type 2 diabetes mellitus (T2DM), the prevalence of diabetes-associated anaemia was 28.2%, which is substantially lower than other studies have found

(Sawandika Rupasinghe and Inoka Kumudini Jayasinghe, 2024). These findings were consistent with other studies in which the prevalence of anaemia was higher among patients with diabetes. Females were found to have a higher prevalence (30.5%) of diabetes-associated anaemia than males (26.5%), but this was not statistically significant. Females with diabetes and anaemia were found to have a poorer metabolic profile than their male counterparts.

The findings from the current study found a significant and consistent association of poor diabetes control and the subsequent development of Chronic Kidney Disease (CKD). The prevalence of anaemia of poor diabetes control and the subsequent increase in the numerical CKD stages also increased in a stepwise process. This was found to be consistent with other studies showing a higher than 90% prevalence of anaemia in Stage 5 CKD. Multivariate logistic regression with Stage of CKD showed that all other stages were significantly lower than that of Stage 5 and are independent predictors of lower prevalence. This demonstrates the primary role of poorly controlled diabetes and its associated erythropoietin deficiency on the development of CKD and subsequent renal anaemia in this population.

After adjustment, the other demographic and diabetes related variables like age, sex, BMI, HbA1c, and insulin use were not independently associated with anaemia (Jitraknatee, Ruengorn and Nochaiwong, 2020). Diabetes duration had a borderline association, which indicates that the longer the exposure to hyperglycemia and associated vascular damage, the greater the risk of developing anaemia. However, this association was not as strong as that of renal impairment. Taken together, these results highlight the importance of timely screening and management of anaemia in patients with T2DM and CKD, which is not generally available, and, in this cohort, the rest of the demographic and metabolic variables seem to be unhelpful predictors.

4. Discussion

The study results reported in this paper show that among patients with type 2 diabetes mellitus (T2DM), the condition of anaemia as a comorbidity is not that rare, with a prevalence of 28.2%. This is in keeping with the 20-30% prevalence of anaemia in T2DM patients, particularly those with chronic kidney disease (CKD), as reported in the literature (Harb et al., 2025). The cohort of women in this study had a 30.5% prevalence, which is higher than that of men, it is a 26.5%; this difference is not statistically significant. This is in accordance with the literature that has reported inconsistent gender related differences in the risk of anaemia, which is conjectured to arise from physiological differences in the baseline levels of haemoglobin.

The prevalence of anaemia reached over 90% in patients in the G5 stage of CKD. This is in line with the fact that progressive renal impairment is associated with a decrease in erythropoietin production, a decrease in red blood cell lifespan, and the presence of uremic toxins and chronic inflammation. The regression analysis showed that CKD stage was the strongest predictor of anaemia, and that the odds of developing anaemia doubled with each stage of CKD. These findings reconfirm that diabetic kidney disease is a major driver of anaemia risk in different populations. Other demographic and diabetes-related factors, such as age, sex, and the use of insulin, did not have any significant association with the presence of anaemia. The protective association from

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diabetes duration is likely sample-specific or a result of survival bias because patients with diabetes and advanced complications are usually absent in outpatient settings (Alzahrani et al., 2023). There is also the absence of association with HbA1c, the level of glycemic control, which implies that anaemia in this case is unconditionally associated with the structural complications of the kidneys, specifically nephropathy, more than the metabolic control.

Several clinical applications can be derived from the results. Considering the increased prevalence of anaemia, particularly in patients with CKD, prophylactic anaemia screening needs to be part of the management plan for T2DM, especially in patients with renal decline. Prevention and early treatment of anaemia can enhance patient outcomes and quality of life while mitigating cardiovascular risk. More robust research is necessary to elucidate the inflammation, malnutrition, and treatment factors (particularly with renin-angiotensin system blockers) associated with the pathogenesis of anaemia in diabetic patients in Jordan. There is a need for longitudinal studies to clarify the temporal sequence of events and the outcomes associated with administering fostered circulation of erythropoietin-stimulating agents, in addition to iron therapy.

5. Conclusion

The study marks that the comorbidity of anaemia among the Type 2 Diabetes Mellitus (T2DM) patients attending the hospitals in Jordan is poorly understood, even though there is widespread awareness of the prevalence of anaemia in T2DM cases. We must seek to understand anaemia in its broader clinical context and appreciate its pivotal role in the progression and complications of diabetes. The study is particularly important because it addresses the gap of evidence on the diabetes- anemia link and its specific expression in the Jordanian setting.

Among the malady's many determinants, progression of Chronic Kidney Disease (CKD) was the most significant. The steady progression of the risk of anaemia that accompanies declining renal function, particularly in the context of diabetes, underscores the triad relationship of diabetic nephropathy, reduced erythropoietin (EPO), and resultant anaemia. Lacking also were the presence of other characteristics, including advanced age, female sex, overweight and obesity (MO), poorly controlled diabetes (as measured by HbA1c), and even insulin therapy, which were equally unhelpful in ameliorating the link between diabetes and anaemia, reinforcing the notion that renal function is the most important determinant of anaemia in this population.

These results have essential clinical meanings as they demonstrate the importance of considering the anaemic status of patients with diabetes and obtaining routine anaemic screening as part of the diabetes care plan. This is especially true for patients with advanced CKD or patients with a higher likelihood of developing renal complications. Improving quality of life, decreasing CV risk, controlling the progression of CKD, and even managing CKD's comorbid conditions may all be achievable by the timely detection and efficient treatment of anaemia. Screening frameworks' tailored approaches can improve the outcome, while hernia screening pathways would help lessen the healthcare burden. These approaches would improve the diabetes and anaemia care systems as well.

4.1 Recommendations

In order to enhance outcomes, a regular assessment for anaemia should be incorporated into the care of all patients with T2DM, especially for those with CKD. Building capacity for multidisciplinary pathways between endocrinologists, nephrologists, and haematologists will enable comprehensive care. It is important to provide healthcare practitioners with a solid grounding in early identification and specific treatment pathways, including the provision of iron supplements and referral for erythropoietin treatment, when appropriate. Patient education about the symptoms and risks of anaemia also has a potential role in early reporting and identification.

4.2 Limitations

This study has some limitations. Its cross-sectional design does not allow conclusions about the causal nature of the findings, and data from a single centre may limit the generalisability of findings. Important confounders such as nutritional deficiencies, iron studies, and inflammatory markers were not examined. The use of questionnaires and medical information also introduces recall bias and incomplete data. Additionally, anaemia classification relied only on WHO definitions, without specific regard to severity and treatment history.

4.3 Future Scope

In the future, research should conduct longitudinal studies across multiple centers to support these findings, which are worth doing, and to apply them more generally. We need to examine the etiological mechanisms of anaemia in T2DM, including inflammation, nutrition, and medications. Studies should assess how treating anaemia may change patients' quality of life, kidney outcomes, and cardiovascular risk. Studies are also needed to study gender, comorbidity, and socioeconomics as potential influences on rates of anaemia. Finally, validated risk prediction models should be developed so that screening could be just for higher-risk diabetic populations and/or demographic groups.

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