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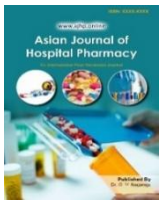

PREVALENCE OF ANEMIA IN TYPE 2 DIABETES AND ITS ASSOCIATED RISK

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Abstract

This cross-sectional study aimed to assess the prevalence of anemia in type 2 diabetes mellitus (T2DM) patients and its associated risks. Conducted at SVS Medical College and Hospital, Mahbubnagar, over six months, the study enrolled 210 patients, categorized into two groups: those with T2DM alone and those with T2DM and anemia. Data collection included demographic details, clinical parameters such as HbA1c and renal function, and Framingham risk scores. Results revealed that 66.67% of T2DM patients were anemic, with moderate anemia being the most prevalent type (89%). The study identified a significant association between anemia and increased risks of cardiovascular complications, neuropathy, nephropathy, and retinopathy. Furthermore, Framingham risk scores indicated a higher prevalence of severe cardiovascular risks in anemic patients (77%) compared to non-anemic individuals. Rural residence (51%) and female gender (53%) were associated with higher anemia prevalence. The study concluded that anemia exacerbates the complications of T2DM and highlights the need for early detection and management to improve patient outcomes. Statistical significance was tested at $P < 0.05$, and findings suggest targeted interventions to mitigate risks.

Keywords:Type 2 Diabetes Mellitus, Anemia, Cardiovascular Risk, Prevalence, Framingham Risk Score.

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Introduction

Anemia is a common but often overlooked comorbidity in patients with type 2 diabetes mellitus (T2DM), significantly contributing to the disease's overall burden[1]. T2DM is a chronic metabolic disorder characterized by persistent hyperglycemia, insulin resistance, and associated vascular complications [2]. Emerging evidence highlights a strong association between T2DM and anemia, primarily driven by mechanisms such as inflammation, renal dysfunction, and nutritional deficiencies [3]. Chronic hyperglycemia and insulin resistance can impair erythropoiesis, leading to reduced production of red blood cells, while diabetic kidney disease, a prevalent complication of T2DM, further exacerbates anemia by decreasing erythropoietin synthesis [4]. This interrelation not only impacts the progression of diabetes-related complications but also contributes to a decline in patients' quality of life and increased healthcare costs [5-7].

The prevalence of anemia in T2DM is reported to be higher than in the general population, varying across regions and populations due to differences in genetic, environmental, and healthcare factors [8]. Anemia in T2DM patients is associated with an increased risk of cardiovascular disease, diabetic retinopathy, neuropathy, and nephropathy, thereby worsening clinical outcomes [9,10]. Additionally, anemia contributes to fatigue, exercise intolerance, and diminished functional capacity, further complicating diabetes management. Early detection and management of anemia in T2DM are therefore critical to mitigating these risks and improving overall disease outcomes [11]. This study aims to explore the prevalence of anemia in T2DM patients and its associated risk factors, providing a foundation for targeted interventions and improved patient care strategies.

Materials and Methods

Study Design

This study is a cross-sectional observational study conducted over a period of six months to assess the prevalence of anemia in type 2 diabetes mellitus (T2DM) patients and its associated risks.

Source of Data and Materials

The data collection utilized a structured Patient Consent Form and Patient Questionnaire Form to obtain patient demographic and clinical information.

Inclusion Criteria

The study included:

- Patients visiting the Department of General Medicine.
- Individuals aged above 30 years.
- Patients willing to provide informed consent and participate in the study.
- Patients with a history of anemia, T2DM, cardiovascular disorders, or chronic kidney disease (CKD) related to diabetes mellitus.

Exclusion Criteria

The study excluded [13,14]:

- Pregnant women.
- Patients with a history of blood transfusion.
- Individuals with CKD causes unrelated to diabetes mellitus.
- Patients with type 1 diabetes mellitus.
- Patients with malignancies, auto-immune disorders, or those at high risk.

Tools of Study

- Laboratory Tests (HbA1c, Renal Function Tests).
- Framingham Risk Score for assessing cardiovascular risks[15,16].

Method of Data Collection

Data was collected through structured Patient Questionnaire Forms and clinical investigations.

Study Procedure

The study was conducted at SVS Medical College and Hospital, Mahbubnagar. A sample of 210 patients was categorized into two groups: one group with only T2DM and another with T2DM and anemia. Data was collected on various clinical parameters such as HbA1c, renal function, and cardiovascular risks using the Framingham risk score. Statistical analysis was performed using chi-square tests to determine the association between variables, prevalence, and incidence rates. Descriptive statistics, including mean ± SD, were calculated, and the level of significance was tested at $P < 0.05$ with a 98% confidence interval [17-22].

Ethical Considerations

Ethical clearance was obtained from the Institutional Ethical Committee of SVS Medical College and Hospital before initiating the study.

Results

Prevalence of Anemia-Based Distribution of Cases

Table 1 and Figure 1 representthe Prevalence of Anemia in Type 2 Diabetes patients. A significant difference was observed, with anemia being more prevalent in patients with Type 2 diabetes mellitus.

Table 1: Prevalence of Anemia Based Distribution of Cases

Grading	No. Of Patients
Mild	9 (6%)
Moderate	124 (89%)
Severe	7 (5%)

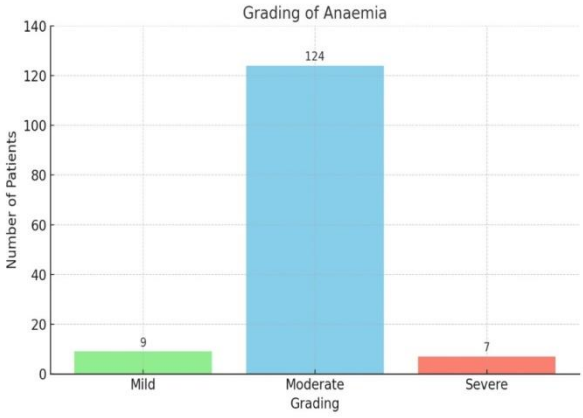

Fig.2: Grading of Anemia Based On Distribution of Cases

Age Wise Case Distribution

Table 3 and figure 4 shows age distribution of Type 2 Diabetic patients, in which among 210 participant's maximum number of patients were found to be between 41-50 years of age followed by 51-60 years, 61-70 years, and 30-40 years and 71-80 years respectively in Descending order, and the mean age was reported to be 42. There was no significant difference with respect to age distribution between the groups.

Table 3: Age Wise Case Distribution

Age(Yrs.)	No. Of Patients
30-40 Years	37 (18%)
41-50 Years	48 (23%)
51-60 Years	45 (21%)
61-70 Years	45 (21%)

71-80 Years	35 (17%)
MeanAge	**42**

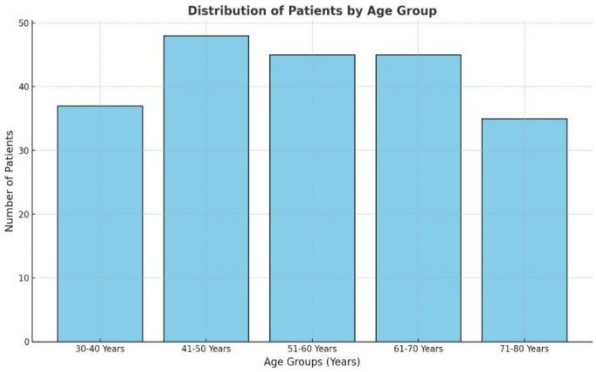

Fig.3: Age Wise Case Distribution

Gender Wise Distribution of Cases

Table 4 and figure 4 shows the total number of Patients who got admitted in the general ward at SVS Medical College and Hospital during the duration of study. Female Patients [111 (53%)] were found to be higher in the entire sample size followed by Male Patients [99 (47%)]. A significant difference was observed in female patients with respect to gender based distribution.

Table.4:Gender Wise Distribution of Cases

Gender	No. Of Patients
Male	99 (47%)
Female	111 (53%)

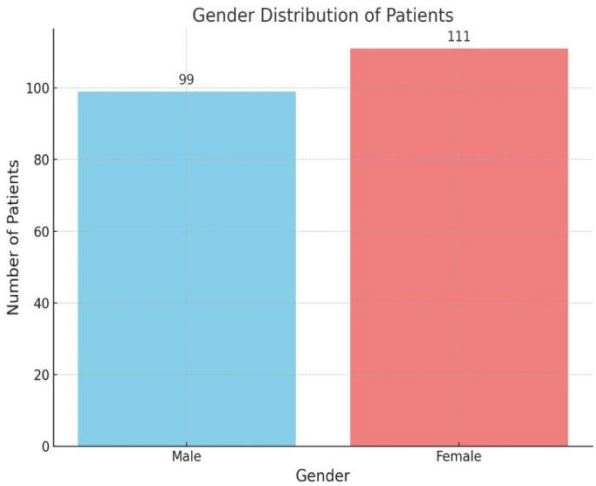

Fig .4:Gender Wise Distribution of Cases

Residence Based Distribution of Cases

Table and figure 5 shows that Type 2 Diabetic Patients were found to be highest in Rural Areas, compared to Urban Area. The number of patients from Rural Areas were found to be 107(51%), followed by patients from Urban Areas 103(49%). A significant difference was observed in patients from Rural Areas with respect to residence based distribution between the groups.

Table 5: Residence Based Distribution of Cases

Residence	No. of Patients
Urban	103 (49%)
Rural	107 (51%)

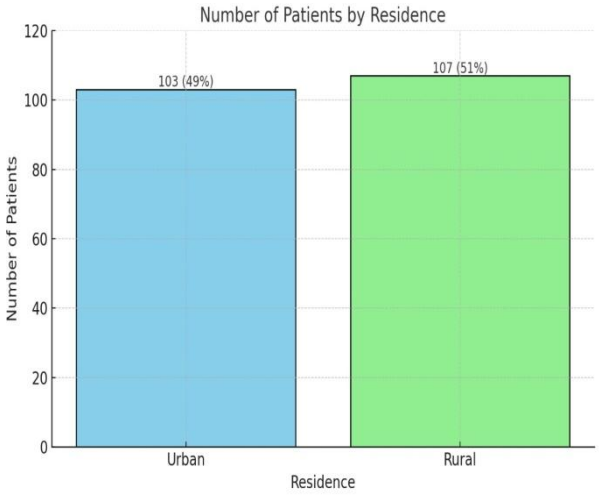

Fig.5: Residence-Based Distribution of Cases

Religion Based Distribution of Cases

Table 6 shows that the distribution of patients based on religion. The study observed a religion-based distribution of patients, where the majority were Hindus (46%), followed by Muslims (42%) and Christians (12%), with no representation from other religions. The mean number of patients across the groups was 52.50, indicating a relatively balanced distribution among the primary religious demographics.

Table.6: Religion Based Distribution of Cases

Religions	No. Of patients
Muslims	88 (42%)
Hindus	97 (46%)
Christians	25 (12%)
Others	0 (0%)
Mean	**52.50**

Literacy Based Distribution of Cases

Table 7 and figure 6 indicate the literacy-based distribution of Type 2 Diabetic patients. In this group, among 210 more than 118 patients were found to be literate followed by 92 patients being those of illiterate.

Table 7: Literacy Based Distribution of Cases

Literacy	No. Of Patients
Literate	82 (59%)
Illiterate	58 (41%)

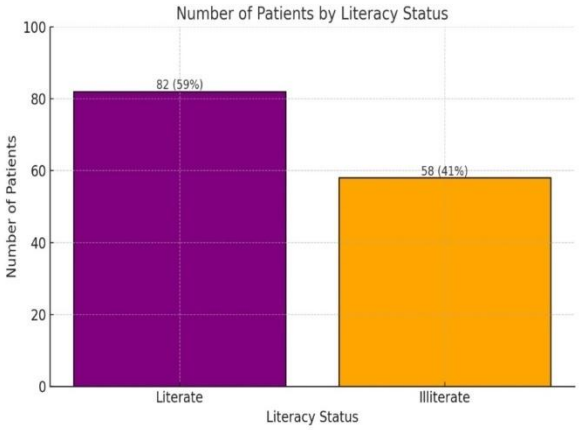

Fig.6: Literacy Based Distribution of Cases

Associated Complications

Table 8 and Figure 7, represents the associated complications in both anaemic and non-anaemic patients with type 2 diabetes mellitus and it suggests who are anaemic reported to have more complications than compared to non - anaemic. Most of the complication reported were Macro-Vascular and Multiple Complications. The chi square value obtained is 4.99 with P value of <0.05, All the data tabulated below are significant.

Table 8: Diabetic Complication Based Distribution

Complications	ObservedValues		Chi - Square	Inference
	Anaemic	Non-Anaemic		
Neuropathy	24	13	4.99	Significant
Nephropathy	24	13		
Retinopathy	25	8		
Macro-Vascular	27	9		
Multiple Complications	27	15		
No Complications	13	12		

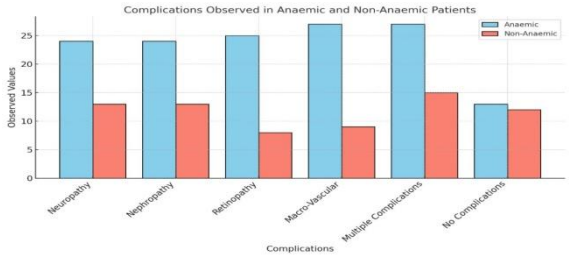

Fig.7.: Diabetic Complication Based Distribution

Framingham Risk Score

Table 9 and Figure 8, represents Framingham risk score in both anaemic and non anaemic patients. The score represents high risk (77%) in anaemic patients than compare to non anaemic (14%) with the chi - square value 0.62 and p value 0.05. All the data tabulated below are significant.

Table.9: Framingham Risk Score Based Distribution

Risk Score	Observed Values		Chi – Square	Inference
	Anaemic	Non Anaemic		
Low Risk	16	7	0.62	Significant
Moderate Risk	15	10		
Severe Risk	109	53		

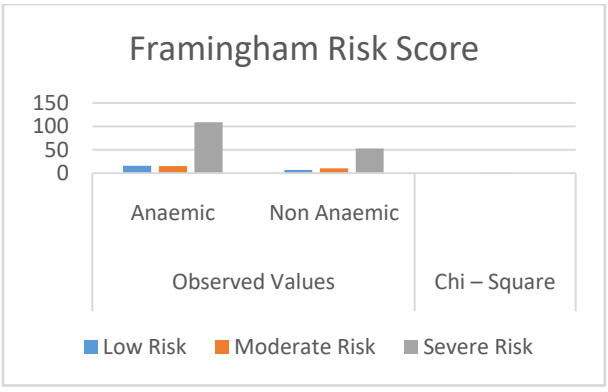

Fig.8.: Framingham Risk Score Based Distribution

Glomerular Filtration Rate (GFR)

Table 10, represents Distribution based on Glomerular Filtration Rate (GFR) in both anaemic and non-anaemic patients. The Data suggests high risk of renal failure (46%) in anaemic patients than compared to non-anaemic patients (38%) with the chi – square value 2.26 and p value 0.05. All the data tabulated below are significant.

Table 10:Glomerular Filtration Rate (GFR) Based Distribution

Parameter	Observed Values		Chi - Square	Inference
	Anaemic	Non Anaemic		
Normal	47	30	2.26	SIGNIFICANT
Early Stage Renal Disease	27	13		
Renal Failure	65	27		
Failure	1	0		

Uric Acid

Table 11 and Figure 9, represents serum uric acid levels in both anaemic and non-anaemic patients. The data represents high risk of renal and cardiovascular diseases (21%) in anaemic patients than compare to non-anaemic patients with chi square value 1.95 and p value 0.05. All the data tabulated below are significant.

Table 11: Uric Acid Based Distribution

Parameter	ObservedValues		Chi - Square	Inference
	Anaemic	Non Anaemic		
Safe	49	29	1.95	Significant
Good	38	20		
Warning	23	7		
Danger	30	14		

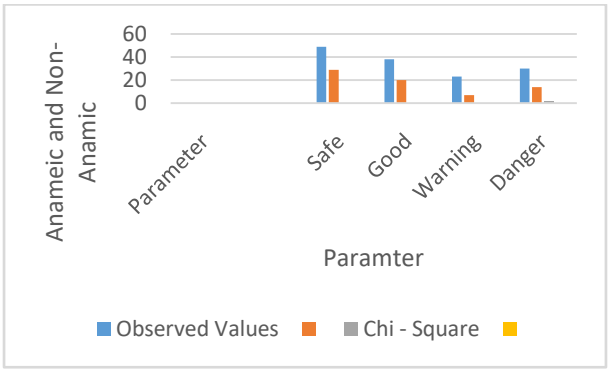

Fig-.9: Uric Acid Based Distribution

Distribution of Diabetic Drug Therapy

Table 12, and Figure 10 represents Distribution of Diabetic Drugs Therapy, most the patients were given the combination therapy which consist of metformin, glimepiride, Sitagliptin, teneligliptin, voglibose, pioglitazone in combination.

Table 12: Distribution of Diabetic Drug Therapy

Drugs	No. Of Patients
Insulin Therapy	
HumanActrapid	25
HumanMixtard	32
InsulinLanctus	5
Non – Insulin Therapy	
Metformin	28
Glimepiride	20
Dapagliflozin	10
Sitagliptin	8
Teneligliptin	4
CombinationTherapy	
Metformin+Glimepiride	30
Metformin+ Sitagliptin	5
Metformin+ Teneligliptin	5
Glimepiride+Metformin + Voglibose	20
Glimepiride+Metformin + Pioglitazone	18

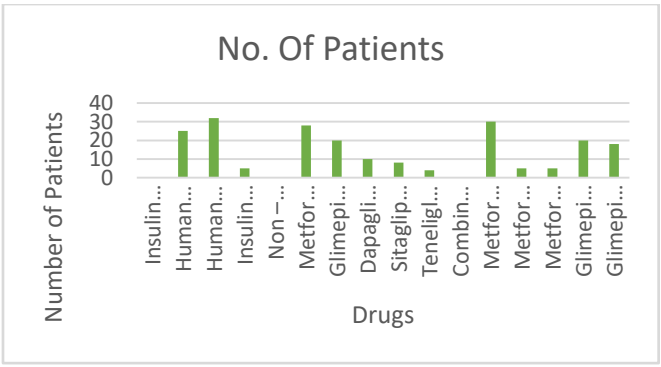

Fig.10: Distribution of Diabetic Drug Therapy

Distribution of Anaemic Supplements

Table 13, and Figure 11represents Distribution of Anaemic Supplements, most the patients were given the combination therapy which consist of metformin, glimepiride, Sitagliptin, teneligliptin, voglibose, pioglitazone in combination.

Table 13:Distribution ofAnaemic Supplements

Supplements	No. Of Patients
AscorbicAcid	38
Vitamin D3	33
VitaminB2ComplexWith B12	28

NoTreatment	41

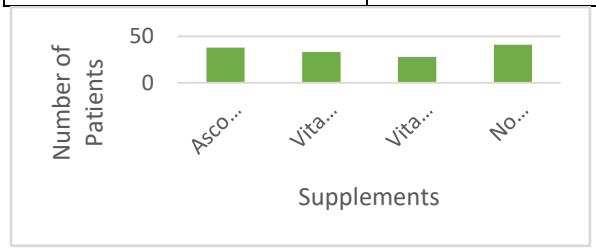

Fig.11: Distribution of Anaemic Supplements

Discussion

The study highlights a significant correlation between anemia and the severity of complications in patients with type 2 diabetes mellitus (T2DM). Among the 210 participants, 66.67% were found to be anaemic, with moderate anemia being the most prevalent form. Anaemic patients exhibited higher rates of complications, such as neuropathy, nephropathy, retinopathy, and macrovascular conditions, compared to their non-anaemic counterparts. This aligns with the finding that anemia exacerbates diabetes-related cardiovascular and renal risks, as evidenced by elevated Framingham risk scores and decreased glomerular filtration rates in the anaemic group. The data emphasize the compounded vulnerability of rural residents and females to anemia, underscoring the multifactorial nature of these risks.

Furthermore, the study identified that anemia management remains a critical yet under addressed aspect of T2DM care. The provision of supplements like ascorbic acid and vitamins D3 and B12 varied across the sample, indicating a need for more systematic approaches to anemia treatment. The association between anemia and reduced renal function, coupled with its contribution to cardiovascular risks, highlights the importance of integrating anemia screening and management into routine diabetes care. Addressing these gaps through early interventions and personalized therapeutic strategies may improve long-term outcomes for T2DM patients.

Conclusion

This study underscores the high prevalence of anemia in T2DM patients and its significant association with cardiovascular and renal complications. Moderate anemia was the most frequently observed type, with female patients and rural residents being disproportionately affected. Anemic patients demonstrated higher Framingham risk scores and greater susceptibility to complications such as neuropathy, nephropathy, and retinopathy. These findings emphasize the critical role of early screening and management of anemia in T2DM patients to mitigate disease progression and associated risks. Future research should explore targeted therapeutic approaches and the impact of anemia correction on long-term outcomes in diabetic populations.

Limitations and Recommendations

Limitations

- The study was limited to a single institution, potentially restricting the generalizability of results to broader populations.
- The cross-sectional design limits the ability to establish causality between anemia and T2DM complications.
- The sample size, though adequate, may not represent all demographic and clinical variations.

Recommendations:

- Expand the study to multiple centers and diverse populations to validate findings.
- Conduct longitudinal studies to assess the causal relationships and long-term effects of anemia correction in T2DM.
- Investigate the role of nutritional interventions and personalized therapies in managing anemia in diabetic patients.
- Integrate anemia screening into routine diabetes care for early identification and prevention of complications.

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