Original Research Article

Prevalence of anaemia and associated factors in patients with type 2 diabetes mellitus at a tertiary care centre in Sri Lanka

Abstract

Anaemia encountered frequently with Type-2 Diabetes Mellitus (T2DM) leads to development of micro and macro-vascular complications. Although many studies describe prevalence of anemia among diabetics in other countries no studies in this area for Sri Lanka. The aim was to determine prevalence and associated causes of anaemia among patients with T2DM attending the Family Practice Centre, University of Sri Jayewardenepura and describe relationship between anaemia and associated factors.

Full Blood Counts, S. Ferritin were performed and T2DM patients with haemoglobin<12g/dl (females) and <13g/dl (males) were identified, red cell indices analysed. Mean haemoglobin was 11.98±1.79 g/dl (12.92±2.49 g/dl in males, 11.60 ± 1.24 g/dl in females). 35.29% (36/102) of patients were anaemic with female preponderance. Iron deficiency anaemia was present in 11.11 % (4/36), heemoglobinopathy in 11.11% (4/36) and anaemia of chronic disorder in 77.78% (28/36)

Anaemia significantly related to increasing age (p=0.036), female gender(p=0.01),duration of diabetes mellitus (> 5 years) (p=0.002) .Presence of Chronic-Kidney-Disease(p=0.001).Retinopathy(p=0.05) and treatment modality had no association with prevalence of anaemia(p=0.322).

Prevalence of anaemia among T2DM patients in Sri Lanka is high specially with increasing age , female gender , duration of disease and corresponds to regional countries. As treatment of anaemia of chronic disorder is treatment of underlying disease management of diabetes will reduce prevalence of anaemia.

Key Words

Anemia in Type 2 Diabetes mellitus, associations of anemia in Type 2 Diabetes mellitus, Causes for anemia in diabetics

Introduction

Diabetes Mellitus is a chronic metabolic disease characterized by hyperglycemia caused by insufficient insulin secretion or diminished insulin action or both. It is associated with the risk of micro vascular complications (diabetic retinopathy, neuropathy and nephropathy) and this risk increases with the duration of the disease. [1] Types of Diabetes Mellitus include Type 1, Type 2 and Gestational Diabetes Mellitus.

Type 2/Non- Insulin dependent Diabetes/Adult-onset diabetes is the most common type of DM . [2]

According to Global report on diabetes, WHO, Geneva, 2016 there were 422 million of diabetic patients worldwide in 2014 in comparison to the 108 million cases in 1980. Thus the prevalence of diabetes has risen to 8.5% from 4.7% during 1980-2014.International Diabetes Federation (2015) estimates, there will be 642 million diabetes patients by the year 2040 [3,4]

According to International Diabetes Federation South-East Asia (IDF SEA) there were 1.16 million patients with diabetic Mellitus in Sri Lanka.[5]

Anaemiais defined by the World Health Organization (WHO) as hemoglobin values <13 g/dL in men and <12 g/dL in women. [6]

Anaemia ofchronic disorder is a common cause of anaemia. The pathophysiology is multifactorial and involves an inability to use the available iron for red cell production.

Diseases that can lead to Anaemia chronic disorder include, Autoimmune disorders such as systemic lupus erythematosus, crohndiseaseandrheumatoid arthritis ,malignancies , long-term infections, such as HIV/AIDS, hepatitis B or hepatitis C, bacterial endocarditis and osteomyelitis ,Chronic diseases such as kidney failure and diabetes mellitus. [7]

Treatment for anaemia of chronic disorder involves proper management of the underlying disease .This type of anaemia is generally mild. So usually transfusions are not required.

Anaemia is a frequent condition in patients with T2DM and almost a quarter of diabetic patients are reported as anaemic.[8]

Anaemia in diabetes has complex and multifactorial aetiology including reduced erythrocyte half-life, impaired production of erythropoietin, renal denervation, certain drugs and nutritional deficiencies.[9,10]

Also anaemia can contribute to development and progression of diabetes-related micro and macro vascular complication in diabetes patients.[8]

Serum ferritin level can be used to identify iron deficiency anemia from other types of anemia. Normally, ferritin in plasma is present in small quantities and is directly proportional to the stored iron concentration in the body Low concentration of ferritin is specific for iron deficiency anemia while normal or high values may present in Anemia chronic disorder. [11]

There are no studies indicating the prevalence of anaemia in T2DM patients in Sri Lanka. Hence we are not aware of the magnitude of the problem. Our study is designed to achieve an insight into the current situation in Sri Lanka.

The causes for anemia in Diabetes include Anemia of chronic disorder , anemia of renal origin, nutritional anemias including iron deficiency and Vit B12/Folate deficiency and haemoglobinopathy.No studies are available in Sri Lanka describing the causes of anemia in diabetes.

Data from studies around the world show varied prevalence of Anaemia in Patients with T2DM.

Anaemia was present in varying prevalence in studies in India from 12.3% [12], 18% [13] ,18.09%. [14] 37% [15]. Although one study showed similar occurrence between women (18.60%) and men (17.54%) [13] most showed a female preponderance11% of males and 16% of females [14, 16].

Other prevalence studies showed 22% in China with a female preponderance (male 19.1% , female 25.8%) [8],63% (females-36%, males-27%) in Pakistan [17] ,22.8% in Hong Kong [18] ,39.4% in Malaysia [19] ,23% in Australia [20] ,34.4% in Tehran [21] ,55.5% in Saudi Arabia [22] ,19.6% in Iran with higher female prevalence [23] and 59% in the United Kingdom.[24]

Most had normocytic normochromic anaemia [21,19]. Duration of diabetes and older age had significant correlation with anaemia.[24] and there was a significant association among micro vascular complications and prevalence of anaemia.[21]

Methods and material

Descriptive cross sectional study carried out at the Diabetic clinic in Family Medicine Center, University of Sri Jayewardenepura.

All Patients with T2DM who attended the Diabetic clinic at the Family Medicine Center, University of Sri Jayewardenepura were included in the study due to travel and financial restrictions. The aim was to corelate presence of anaemia in T2 DM.

The sample size was limited to 102 as it was restricted to the T2DM patients receiving care at the Family Practice Centre.

Sampling and data collection:

Patients with T2DM were identified from the medical records. Volunteers were consented and a K_3EDTA anticoagulated blood sample for Full Blood Count was collected from each participant.

An interviewer administered questionnaire was filled and medical records perused of each participant to gather demographic information ,data pertaining to the disease (duration, complications , treatment) ,laboratory results of tests used to monitor disease (FBS, S. creatinine, HbA1C)

Blood samples were analyzed by using an automated cell analyzer. The Full Blood Count reports were analyzed and hemoglobin values, MCV, MCH and MCHC values were tabulated for each patient. Quality control samples for the analyzer were run with the samples ensuring reliable reproducible results.

Patients with low hemoglobin value were selected and a non anticoagulated blood sample was collected for serum Ferritin.

Patients with red cell indices suggestive of haemoglobinopathy were reviewed by Blood picture and HPLCwas done for confirmation.

Data analysis:

Socio demographic data and laboratory results were recorded and data analysis using **SPSS**(Statistical Package for Social Science) to detect the proportion and percentages. A p value < 0.05 was considered statistically significant.

Ethical consideration

Ethical clearance was obtained from the Ethical Review Committee of Faculty of Medical Sciences, University of Sri Jayewardenepura. Voluntary informed written consent was obtained from all participants .De identified data was used for study analysis

Results and analysis

A total of 102, T2DM patients were analyzed . 30 (29.4%) were males and 72 (70.6%) were females. (Figure 1) The mean age was 62.68 ± 12.26 years. The majority of the population was Sinhalese (99.0 %) and living in urban areas.

The recent mean fasting glucose level of the study population was 151.89 ± 71.29 mg/dL. The percentage of patients who had diabetes < 5 years was 43.1% and > 5 years was 56.9% and mean duration of diabetes was 9.57 ± 7.49 years.

90.2% of patients were on oral hypoglycemic agents (Mainly Biguanides and Sulphonylureas) , 1% was on insulin and 8.8% were on combined insulin and oral agent treatment .

7 patients (6.9%) had chronic kidney diseases 2(2%) had retinopathy and 2(2%) had diabetes related foot ulcers. The clinical characteristics of the total study population were analyzed and are presented in Table 1.

Table 1: Summary of clinical characteristics

Variable	Frequency (n=102)	Percentage (n=102)
Duration of DM		
1-5 years	44	43.1%
>5 years	58	56.9%
Type of medication		
Oral hypoglycemic agents	91	89.21%
Insulin	02	1.96%
Combined insulin and Hypoglycemic agents	09	8.82%
Presence of Chronic kidney disease	07	6.86%
Presence of diabetes retinopathy	02	1.96%
Presence of diabetes related foot ulcers	02	1.96%

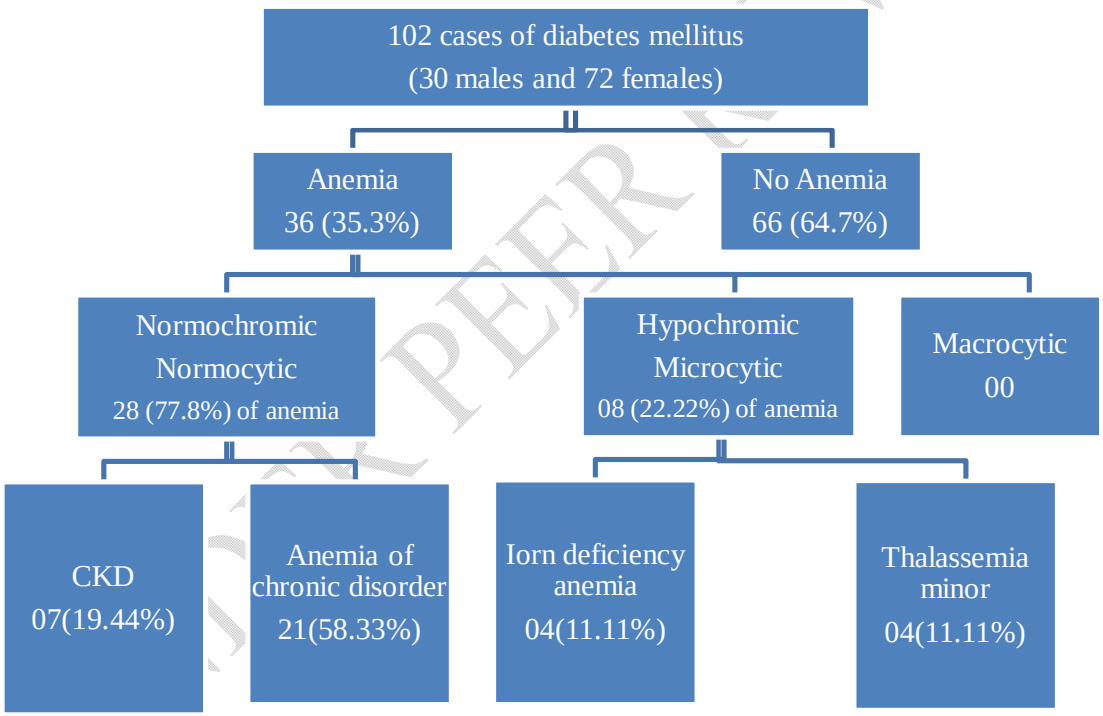
Mean Hb of the study population was 11.98 ± 1.79 g/dl (12.92 ± 2.49 g/dl in males and 11.60 ± 1.24 g/dl in females). The minimum Hb value was 6.3 g/dl and maximum Hb value was 17.5 g/dl in the study population. The patients were divided into non-anemic and anemic groups using normal ranges for males (12.5g/l) and females (11.5g/l).

The overall prevalence of anemia was 35.3% (36/102). This included 5 males (16.67% of male patients) and 31 females (43.05% of the female patients).

Serum ferritin level was assayed for all anemic patients and 04 anemic patients had low serum ferritin level. (Normal serum ferritin level was taken as 18-270 ng/ml for male and 18-160 ng/ml for female)

Among anemic patients, normocytic anemia was present in 77.88% (28/36) of anemia; 07of them had evidence of CKD and majority (21) was anemia of chronic disorder. Microcytic anemia was found in 22.22% (08/36); 04 of them had iron deficiency and 04 had thalassemia minor. There was no Macrocytic anemia found.

Figure 1: The etiological subtypes of anemia seen among T2DM in this study



Presence of anemia was significantly related to Age, Gender, Duration of DM and presence of CKD.

Among the male patients of study population, 16.67% (5/30) were anemic, and 43.06% (31/72) of the female patients were anemic. Significant association was found between gender and anemia in diabetics (p=0.01).

Prevalence of anemia was 19.35% among adults who aged 50 -59 years, 41.6% for those aged 60-69 years, and 55.55% for those aged 70 years and older.

The presence of anemia was significantly related to increasing age (p=0.036)

There was a significant relationship between duration of DM and presence of anemia. Out of the 36 patients of anemia with DM, 28(77.8%) patients had DM for more than 5 years duration and 08 (22.2%) patients had DM for less than 5 years duration (p=0.002).

86.1% of anemic patients were used oral hypoglycemic agents while 13.9% anemic patients were used combined oral hypoglycemic agents with insulin therapy. There was no significant association of mode of treatment with anemia (p=0.322).

The correlation between the duration of oral metformin usage and the presence of anemia among diabetes was not statistically significant (p=0.092)

In this study 19.4% of the anemic patients had evidence of CKD. There was a significant association with anemia and CKD. (p =0.000). Retinopathy was found in 5.6% anemic patients. However ,retinopathy does not having a significant association with anemia (p=0.05).

Table 2: Frequency of various variables and their association with anemia

Variables	Anemic n=36 (35.3%)	Non Anemic n=66 (64.7%)	P value
Gender			

Male	5 (16.67%)	25 (83.33%)	
Female	31(43.06%)	41 (56.9%)	0.01
Age			
30-39 years	0 (0%)	1(100%)	
40-49 years	0 (0%)	4(100%)	
50-59 years	6 (19.4%)	25 (69.4%)	
60-69 years	20 (41.6%)	28(58.3%)	
>69 years	10 (55.6%)	8 (44.4%)	0.036
Duration of DM			
1-5 years	8 (18.1%)	36(81.8%)	
>5 years	28 (48.3%)	30(51.7%)	0.002
Type of medication			
Oral hypoglycemic agents	31(33.7%)	61(66.3%)	
Insulin	0 (0%)	1(100%)	0.322
Combined insulin and Hypoglycemic agents	5 (55.6%)	4(44.4%)	
Presence of diabetes retinopathy	2 (100%)	0(0%)	0.05
Absence of diabetes retinopathy	34(34%)	66(66%)	
Presence of Chronic kidney disease	7 (100%)	0(0%)	0.000

Absence of Chronic kidney disease	29(30.52%)	66(69.47%)	

Discussion

Anaemia frequently complicates T2DM and contributes to progression of micro and macrovascular complications .[25] Although many studies have been done worldwide to ascertain the prevalence of anaemia in T2DM there are no published data available in Sri Lanka .In this study, we aimed to detect prevalence of anaemia, types of anaemia among patients with DM and describe any association to factors such as age, gender, duration of DM, medications and complications.

102 patients confirmed as T2DM were enrolled and the prevalence of anaemia was 35.29% (36 out of 102). Our study results correlate with the findings of Makadiya R. et al found who reported that 37 of 100 patients (37%) with diabetes had anaemia in India.[26] However it was significantly higher than the prevalence reported in two other studies which reported prevalence of 18% [27] and 12.3% [12] . This could be due to the vast differences in population demographics over India. Our percentages are matched to that of prevalence found in studies in other countries such as Bagdad 39% [35] ,Malaysia 39.4% [19] , Tehran 34.4% [21] and Nothern California 34.7% [36]. But higher than Australia 23% [20] , Iran 19.6% [23] China ,22% [24] and Hong Kong 22.8% [18] .

It was lower than that reported than 55.5% in Saudi Arabia [22] 59% in the United Kingdom, and 63% in Pakistan [17]

On classification according to MCV and MCH, Normochromic normocytic type is the most common type (77.78%) among anaemic patients while 22.22% were hypochromic microcytic. This corresponds to any studies where Normochromic normocytic anaemia was the most prevalent when classified morphologically.[19, 21, 35]

Serum ferritin was done on all of the patients with anaemia and was normal in 32 patients. Thus a majority of patients have anaemia of chronic disorder , which is expected to be the most frequent cause for anaemia in T2DM . 04 patients had low Serum ferritin and hypochromic microcytic indices and were diagnosed as iron deficiency anaemia. Samples of blood of 04 (11.11%) with red cell indices suggestive of thalassemia trait were subjected to HPLC and a diagnosis of Beta Thalassemia Trait was made.

Our results indicate, that the presence of anaemia was significantly related to age, gender and duration of DM and presence of CKD. But the correlation between anaemia and the duration of oral metformin usage is not statistically significant.

In the present study anaemia was observed in 05 male and 31 female patients suggesting that risk the of anaemia in patients with T2DM is significantly affected by gender ($p < 0.05$).This correlates well with findings of Makadiya R. et al who showed that 26 % of male diabetic patients and 62% of females were classified as anaemic and the difference was significant.[26] Shams N. et al also found that Females were more prone to be anaemic than male patients, but the difference was not significant ($P = 0.154$). [25]

ArtzA. S. has stated that Hb drops slightly and anaemia prevalence increases in males and females with advancing age.[28] The present study also proves the above finding.

($p= 0.036$).The prevalence of anaemia was 19.35% among adults aged 50 -59 years, 41.6% for those aged 60-69 years, and 55.55% for those aged 70 years and older. This correlates with other studies done to establish the presence of anaemia with age in DM patients.Abate A. et al have showed that there is a significant correlation with increased age and association of anaemia among T2DM patients.[29] Fayed H. M. et al found the prevalence of anaemia was

87.3% among T2DM patients with >45 years age and 12.7% among T2DM patients with <45 years, while 94.6 % T2DM patients were non-anaemic with age >45 years and 5.4% with age <45 years.[30]

As expected, there was a significant correlation between anaemia and the duration of DM. 44 patients in this study had DM for less than 5 years (48.3%). Among those, 8 patients had anaemia (18.2%). Out of the patients who had DM for more than 5 years, 28 were anaemic (48.3%). Based on data in the current study, there is a 2.65 times higher risk of getting anaemia after 5 years of onset of diabetes. According to the study by RathodG. et al, a 1.56 times higher risk of anemia in diabetes after 5 years is reported. .[27]

In the current study,86.1% of anemic patients used oral hypoglycemic agents while 13.9% anemic patients were treated with combined oral hypoglycemic agents and insulin therapy. However there was no significant correlation between mode of treatment and prevalence of anemia among patients with DM (p=0.322). This correlates with the finding of Shams N. et al who also has stated that there was no significant correlation between mode of treatment and anemia (p=0.382).[31]

Metformin is the most widely used treatment for people with T2DM. In this population it was 94.12%. This medication is known to cause malabsorption of vitamin B_{12}, which causes vitamin B_{12} deficiency and it can be lead to macrocytic anemia.[32] ThambiahS.C. et al found 3.1% of patients who using metformin had macrocytic anemia.[19] But in the current study, there were no patients with macrocytic anemia. This result may be due to the fact that most diabetics are supplemented with vitamin B_{12}.

Reduced Hb values may be caused by the presence of CKD due to diminution of erythropoietin. Thomas M. et al said that anaemia could be used as an early predictor for reduction of renal function in diabetes.[33] According to shams N. et al, prevalence of anaemia

in diabetic patients with CKD was 50%.[31] In the present study, 7 patients had diabetes related kidney disease and all of them were diagnosed as anaemic. Al salmon said that, 64.7% with impaired renal function had anaemia among DM patients in their study.[34] In this study, we used only available clinical data to identify CKD but most patients were not screened for CKD previously. Our results might be changed if GFR, Serum Creatinine, Albumin urea, EPO level & other related tests were performed.

According to Shams N. et al there was a significant correlation between anaemia and diabetic retinopathy.[31] In present study, 5.5% of anaemic patients had diabetes related retinopathy. However the association between anaemia and diabetic retinopathy was not significant. This may be due to the small number of subjects analyzed.

Limitations

The sample size was limited as the study was restricted to the Diabetic clinic of Family Medicine Center, Faculty of Medical Sciences, University of Sri Jayewardenepura and therefore we could not collect the expected. The study population only represented the suburbs of the University of Sri Jayewardenepura. If more patients from other diabetic clinics were enrolled in the study the sample size could have been increased.

Conclusion

Findings from current the study suggest that anemia is present in a significant proportion of T2DM (35.29%) . Anemia of chronic disorder(inclusive of anaemia of renal disease) is the most frequent type of anemia (77.78%) with a smaller percentage diagnosed as iron deficiency(11.11%) and haemoglobinopathy (11.11%).The presence of anemia is significantly associated with increasing age, female gender, duration of diabetes mellitus and

presence of CKD. Therefore anemia detection should be included in to tests done for routine management of T2DM. As the treatment of anemia of chronic disorder is treatment for the underlying disease proper management of diabetes will reduce the prevalence of anemia in this group. It will also help to minimize the risk of microvascular and macrovascular complications and enhance the life quality of T2DM patients.

Declarations

- **Availability of data and materials** patient de identified raw data are with the researchers can be made available.
- **Competing interests** No competing interest
- **Funding** Not applicable
- **Authors' Contribution**

BF: conceptualization of the research, editing of the research proposal through all stages, writing up the manuscript, editing and formatting manuscript to journal specifications. **SS**: Supervising data collection, editing final version of manuscript **MWND, HTNB**: Writing the project proposal, data collection and analysis, writing the project report. All authors have read and approved the final manuscript.

References

1. World Health Organization. diabetes world immunization week 2016. 2016;2–7.

2. Boada CA., Mereno JM. *Pathophysiology of diabetes mellitus type 2 : beyond the duo " insulin resistance-secretion deficit* ." 2013;28:78–87.

3. World Health Organization. GLOBAL REPORT ON DIABETES. 2016;88.

4. Tucker ME. Medscape Medical News > Conference News IDF Atlas : About 415 Million Adults Worldwide Have Diabetes. 2015;6–8.

5. Sri Lanka | International Diabetes federation. Sri lanka. 2016;1–2.

6. World Health Organization. Haemoglobin concentrations for the diagnosis of anaemia and assessment of severity. Geneva, Switz World Heal Organ [Internet]. 2011;1–6. A

7. Mayo Clinic. Symptoms and Causes of anemia. Tens Headache [Internet]. 2016;1–4.

8. He B Bin, Xu M, Wei L, Gu YJ, Han JF, Liu YX, et al. Relationship between anemia and chronic complications in Chinese patients with type 2 diabetes mellitus. *Arch Iran Med*. 2015;18(5):277–83.

9. Shams N, Osmani MH. Newly Diagnosed Anemia in Admitted Diabetics , Frequency , *J Coll Physicians Surg Pak*. 2015;25(4):242–6.

10. Pape J. Anemia Diagnosing anemia. 2016;3–7.

11. Wang W, Knovich MA, Coffman LG, Torti FM, Torti S V. Serum Ferratin: Past, Present, Future.*Biochim Biophys Acta*2011;1800(8):760–9.

12. A. SinhaBabu, Chakrabarti A, RN Karmakar. Anemia and neuropathy in type- 2 diabetes mellitus : A case control study. *IJRRMS*. 2013;3(3).

13. Rathod GB, Parmar P, Rathod S, Parikh A. Prevalence of anemia in patients with Type 2 Diabetes Mellitus at Gandhinagar , *IAIM*. 2016;3(3):12–6.

14. Gulati M , AgrawalN.Study of Prevalence of Anaemia in Patients with Type 2 Diabetes Mellitus.F Sch J *App Med Sci* 2016; 4 (5) : 1826-1829;

15. Makadiya R, Bhanvadia V, Bhavsar M, Shah RM. Association of anemia in Type 2

DM in patients of Dhiraj General Hospital. *Int J Biomed Adv Res* [Internet]. 2014;5(1):79–80.

16. A. SinhaBabu, Chakrabarti A, RN Karmakar. Anemia and neuropathy in type- 2 diabetes mellitus : A case control study *IJRRMS*. 2013;3(3).

17. Sharif A, Younus S, Baig K, Ali NH. Prevalence and Risk of Anemia in Type-2 Diabetic Patients. *Health* 2014;(June):1415–9.

18. Chen CXR, Li YC, Chan SL, Chan KH. Anaemia and type 2 diabetes: Implications from a retrospectively studied primary care case series. *Hong Kong Med J*. 2013;19(3):214–21.

19. Thambiah SC, Samsudin IN, George E, et al. Anaemia in Type 2 Diabetes Mellitus (T2DM) Patients in Hospital Putrajaya. *Malaysian Journal of Medicine and Health Sciences* 2015;11(January):49–61.

20. Thomas M, Maclsaac R, Tsalamandris C. Unrecognized Anemia in Patients With Diabets. *Diabetes Care*. 2003;26(4).

21. Hosseini MS, Rostami Z, Saadat A, Saadatmand SM, Naeimi E. Anemia and microvascular complications in patients with type 2 diabetes mellitus. *Nephrourol* Mon. 2014;6(4).

22. Al-Salman.M. Anemia in Patients with Diabetes Mellitus : Prevalence and Progression. *Gen Med*. 2015;3(1):10–3.

23. Bonakdaran S, Gharebaghi M, Vahedian M. Prevalence of anemia in Type 2 Diabetes and role of Renal Involvement. *Saudi J Kidney Dis Transpl* 2011;124(15):2260–8.

24. Trevest K, Treadway H, Hawkins-van der Cingel G, Bailey C, Abdelhafiz AH. Prevalence and determinants of anemia in older people with diabetes attending an outpatient clinic: a cross-sectional audit. *Clin Diabetes.* 2014;32(4):158-162. doi:10.2337/diaclin.32.4.158

25. Shams N, Osmani MH. Newly diagnosed anemia in admitted diabetics, frequency, etiology and associated factors. *J Coll Physicians Surg Pak.* 2015;25(4):242–6.

26. Makadiya R, Bhanvadia V, Bhavsar M, Shah RM. Association of anemia in Type 2 DM in patients of Dhiraj General Hospital. *Int J Biomed Adv Res* [Internet]. 2014;5(1):79–80.

27. Rathod GB, Parmar P, Rathod S, Parikh A. Prevalence of anemia in patients with Type 2 Diabetes Mellitus at Gandhinagar . *IAIM,*. 2016;3(3):12–6.

28. Artz AS. Anemia in Elderly Persons. Medscape [Internet]. 2013;1–16.

29. Abate A, Birhan W, Alemu A. Association of anemia and renal function test among diabetes mellitus patients attending Fenote Selam Hospital, West Gojam, Northwest Ethiopia: a cross sectional study. *BMC Hematol [*Internet]. 2013;13(1):6.

30. Fayed HM, Elsaied ARA, Alsenbesy MA, Moubark IA. Proportion of Anemia in Type 2 Diabetic Patients in Qena Governorate Case – Control Study : Clinical Correlates and Prognostic Significance. *International Journal of Diabet es Resear ch* 2013, 2(4): 64-75 DOI: 10.5923/j.

31. Shams N, Osmani MH. Newly diagnosed anemia in admitted diabetics, frequency, etiology and associated factors. *J Coll Physicians Surg Pak.* 2015;25(4):242–6.

32. Kibirige D, Mwebaze R. Vitamin B12 deficiency among patients with diabetes mellitus: is routine screening and supplementation justified? *J Diabetes Metab Disord*

[Internet]. 2013;12(1):17.

33. Thomas M, Maclsaac R, Tsalamandris C. Unrecognized Anemia in Patients With Diabets. *Diabetes Care*. 2003;26(4).

34. Al-Salman.M. Anemia in Patients with Diabetes Mellitus : Prevalence and Progression. *Gen Med.* 2015;3(1):10–3.

35. AA Salih, MA Sadiq. Anaemia profile in a sample of Iraqi type 2 diabetic patients without renal impairment. *Age* ,2010; 51, 10.49383

36. Ahmed AT, Go AS, Warton EM, Parker MM, Karter AJ. Ethnic differences in anaemia among patients with diabetes mellitus: the Diabetes Study of Northern California (DISTANCE). *Am J Hematol*. 2010;85(1):57-61. doi:10.1002/ajh.21577