Comparison of Haemoglobin, RDW, RBC Values among Diabetes Mellitus and Normal Individuals

Sharwini Baskar a≡, R. Priyadharshini b★* and Palati Sinduja b★

≡ Department of Pathology, Saveetha Dental College, Saveetha Institute of Medical and Technical Sciences, Chennai, Tamil Nadu, India.
★ Department of Pathology, Saveetha Dental College, Saveetha Institute of Medical and Technical Sciences (SIMATS), Saveetha University, Chennai - 77, Tamil Nadu, India.

Authors’ contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

ABSTRACT

Introduction: Diabetes mellitus is a disorder characterized by hyperglycemia. It has been reported that 75% of the primary cause for mortality in diabetes mellitus patients is cardiovascular disease which is caused by hyperglycemia. Erythrocytes of diabetes mellitus patients have a shorter life span than normal. Red cell distribution width (RDW) is a measure of the heterogeneity of the volume of red blood cells (Red Blood Cells). High RDW has various adverse outcomes. The study aims to compare Haemoglobin, RDW and RBC values among diabetes mellitus and normal individuals.

Materials and Methods: Blood samples of 20 patients with and without diabetes were collected from outpatients visiting Saveetha dental college and hospitals. The results of the following parameters Haemoglobin, RDW, RBC were analyzed using Independent t Test in SPSS software. The statistical significance (P value) was set at 0.05.

Results: It is evident that there is a higher incidence of diabetes among the male population compared to females which result in higher RBC and Haemoglobin values. The RDW value is also reported to be higher in diabetic patients than non-diabetic patients. For Haemoglobin p value was 0.984 (>0.05), RDW p value was 0.180 (>0.05), RBC p value was 0.680 (>0.05). The p values were >0.05 which is statistically not significant.
Conclusion: The Hemoglobin, RBC and RDW values are higher for diabetic patients than non-diabetic. Higher RDW has various adverse effects such as cardiovascular disease which may cause mortality in diabetes mellitus patients.

Keywords: Diabetes mellitus; RDW; RBC; Innovative technique; Haemoglobin.

1. INTRODUCTION

Hyperglycemia is the key factor in the diagnosis of Diabetes Mellitus. It has been reported that 75% of the primary cause for mortality in diabetes mellitus patients is cardiovascular disease which is caused by hyperglycemia [1]. The red cell distribution width (RDW) is a measure of variation in size and volume of red blood cells (RBC) [2]. RDW value is frequently used in clinical practice. RDW is provided in most of the hematological examinations. Red cell distribution width (RDW) is associated with morbidity and mortality in coronary artery disease. Red cell distribution width (RDW) is associated with morbidity and mortality in coronary artery disease [3]. Previous studies have demonstrated the associations between high RDW values and various adverse health outcomes [4]. The adverse outcomes of high RDW values are as follows: increased mortality, increased incidence of atrial fibrillation, heart failure, and adverse prognosis in patients with heart failure or coronary heart disease [5]. A correlation was demonstrated between RDW and low heart rate variability.

The National Health and Nutrition Examination Study (NHANES), reported that high RDW values were associated with increased odds of cardiovascular disease and nephropathy [6]. RDW values may be a useful clinical marker of vascular complications in DM. The mechanism by which RDW predicts mortality and other adverse outcomes remains unclear [7-9]. The authors of the previous study suggested that chronic hyperglycemia mediates the association between high RDW and cardiovascular disease [10]. It has been shown that hyperglycemia has multiple effects on RBC. In diabetes mellitus (DM) patients the lifespan of erythrocytes is shorter than normal [11]. In addition to that, it has been reported that RBC counts have increased in pre-diabetic states and decreased in established DM, compared to normal glucose homeostasis [12]. The effects of hyperglycemia include glycation of hemoglobin, reduced deformability of RBCs, and reduced RBC lifespan [13]. Our team has extensive knowledge and research experience that has translate into high quality publications [14,15-28,29-33]. This study was conducted to observe the variation between RDW, RBC, and Hemoglobin values among DM and healthy individuals.

2. MATERIALS AND METHODS

Blood samples from 20 patients with and without Diabetes mellitus visiting Saveetha Dental College were collected. This Retrospective study was undertaken with the approval of the Institutional Human ethical committee of Saveetha Dental College, SIMATS. Institutional Human Ethical Clearance number obtained was IHEC/SDC/UG-OPATH/21/01. Out of 20, 10 were patients with Diabetes Mellitus and 10 were healthy individuals. Patients were selected randomly with Type I diabetes and age (35-50 years) as dependant variable. From the blood samples, the following required parameters such as Haemoglobin, RDW, RBC were evaluated and collected and recorded in the google sheet. The data collected were exported and analyzed using statistical software SPSS version 23. The test done was an independent sample t-test and the p values were noted and the results were discussed.

3. RESULTS

In our study, the female participants in non-diabetic group were higher of about 60% than male participants at 40%. Among the diabetic group male participants were 80% and the female participants were 20% (Fig. 1). The mean RDW of nondiabetic group is 12.9 and mean RDW of diabetic group is 12.31. Independent t test transpired with the p value of 0.18 (>0.05) which is statistically insignificant (Fig. 2).

The mean Hemoglobin value of Nondiabetic group was 12.83 and mean Hemoglobin value of diabetic group was 14.02. Independent t test transpired with the p value of 0.984 (>0.05) which is statistically insignificant (Fig. 3). Mean RBC values of Nondiabetic group was 4.573 and mean RBC values of diabetic group was 5.03. Independent t test transpired with the p value of 0.680 (>0.05) which is statistically insignificant.
Fig. 1. The bar graph represents the gender in which blue denotes the Nondiabetic group, whereas green denotes the diabetic group. The X-axis represents gender, Y-axis represents the percentage of the population. 60% of female population are non-diabetic and 20% of female population were diabetic. 40% of male population were non-diabetic and 80% of male population were diabetic.

Fig. 2. The bar graph represents the mean value for RDW in which Purple denotes the Nondiabetic group, whereas yellow denotes the diabetic group. The X-axis represents the group, the Y-axis represents the mean of RDW. The mean RDW of nondiabetic group was 12.9 and mean RDW of diabetic group was 12.31. Independent t-test transpired with the p-value of 0.180 (>0.05) which is statistically insignificant.
Fig. 3. The above bar graph represents the mean value of Hemoglobin of nondiabetic group (Purple) and diabetic group (Yellow). The X-axis represents the group, the Y-axis represents the mean of Hemoglobin. The mean Hemoglobin value of Nondiabetic group was 12.83 and mean Hemoglobin value of diabetic group was 14.02. Independent t test transpired with the p value of 0.984 (>0.05) which is statistically insignificant.

Fig. 4. The above bar graph represents the mean value of RBC in nondiabetic group (Purple) and diabetic group (Yellow). The X-axis represents the group, the Y-axis represents the mean of RBC. Mean RBC values of Nondiabetic group was 4.573 and mean RBC values of diabetic group was 5.03. Independent t test transpired with the p value of 0.680 (>0.05) which is statistically insignificant.
4. DISCUSSION

In our present study, in non-diabetic group, 60% were female participants and 40% were male participants. Among the diabetic group male participants were 80% and female participants were 20%. This finding correlate with the previous studies, that the males are more commonly affected by Diabetes Mellitus than females [34,35].

Mean value of RDW was higher in the non-diabetic group than the diabetic group. In a previous study increased red blood cell distribution width (RDW) has been associated with adverse outcomes in heart failure and stable coronary disease in diabetes mellitus [36]. It was found that the RDW is an indicator of the major complications of diabetes mellitus.

Mean value of Hemoglobin in diabetic group were elevated when compared to the non-diabetic group [37]. A previous study reported that the erythrocyte membrane of diabetic patients contains increased amounts of cholesterol [38], saturated fatty acids, and lipid peroxidation products (LPP) like malondialdehyde (MDA) 7-oxo cholesterol, and 7-keto-cholestasis [39-41]. Also decreased amounts of phospholipids and polyunsaturated fatty acids have been reported.

Mean value of RBC, of diabetic patients are higher than a non-diabetic. When the results were compared and analysed statistically by using the independent sample t-test, the parameters Haemoglobin, RDW, RBC were showed that there is no significant difference between the control and test groups as the p-values for Haemoglobin is 0.98(p >0.05), RDW is 0.18 (p >0.05), RBC is 0.68 >0.05 statistically not significant. The findings obtained in our study were correlated with the previous studies by khalid et al and Auzannaeeau et al. in different countries [42,43].

The limitations of this study were, the demographic details of the study population were not matching each other. As the male population in the diabetes mellitus group were higher than the females. This led to biased results that the hemoglobin and RBC values of the diabetes mellitus (Test) group were higher than the normal healthy (control) population. The sample size of the study population is also small to obtain proper results. In future, further studies may be done to overcome these limitations and to obtain unbiased results.

5. CONCLUSION

From the study even though it is not statistically significant, since the male population was higher the values of RBC, Haemoglobin, and RDW values were also higher in the diabetes mellitus individuals. RDW is a measurable biomarker that could improve risk assessment for individuals at risk of developing DM. Further studies have to be conducted to obtain unbiased results.

CONSENT

As per international standard or university standard, patients’ written consent has been collected and preserved by the author(s).

ETHICAL APPROVAL

This Retrospective study was undertaken with the approval of the Institutional Human ethical committee of Saveetha Dental College, SIMATS. Institutional Human Ethical Clearance number obtained was IHEC/SDC/UG-OPATH/21/01.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Virtue MA, Furne JK, Nuttall FQ, Levitt MD. Relationship between GHb concentration and erythrocyte survival
determined from breath carbon monoxide concentration. Diabetes Care. 2004;27(4):931–5.
2. Montagnana M, Cervellin G, Meschi T, Lippi G. The role of red blood cell distribution width in cardiovascular and thrombotic disorders. Clin Chem Lab Med. 2011;50(4):635–41.
3. Perlstein TS, Weuve J, Pfeffer MA, Beckman JA. Red Blood Cell Distribution Width and Mortality Risk in a Community-Based Prospective Cohort [Internet]. Archives of Internal Medicine. 2009;169:588. Available: http://dx.doi.org/10.1001/archinte rm.ed.2009.55
4. Lappé JM, Horne BD, Shah SH, May HT, Muhlestein JB, Lappé DL, et al. Red cell distribution width, C-reactive protein, the complete blood count, and mortality in patients with coronary disease and a normal comparison population [Internet]. Clinica Chimica Acta. 2011;412:2094–9. Available: http://dx.doi.org/10.1016/j.cca.2011.07.018
5. Borné Y, Gustav Smith J, Melander O, Hedblad B, Engström G. Red cell distribution width and risk for first hospitalization due to heart failure: a population-based cohort study [Internet]. European Journal of Heart Failure. 2011;13:1355–61. Available: http://dx.doi.org/10.1093/eurjhf/h fr127
6. Malandrino N, Wu WC, Taveira TH, Whittal HB, Smith RJ. Association between red blood cell distribution width and macrovascular and microvascular complications in diabetes. Diabetologia. 2012;55(1):226–35.
7. Horne BD. A Changing Focus on the Red Cell Distribution Width: Why Does It Predict Mortality and Other Adverse Medical Outcomes? [Internet]. Cardiology. 2012;122:213–5. Available: http://dx.doi.org/10.1159/000341 244
8. Preethikaa S, Brundha MP. Awareness of diabetes mellitus among general population. Research Journal of Pharmacy and Technology. 2018;11(5):1825–9.
9. Timothy CN, Samyuktha PS, Brundha MP. Dental pulp stem cells in regenerative medicine--A literature review. Research Journal of Pharmacy and Technology. 2019;12(8):4052–6.
10. Veeranna V, Zalawadiya SK, Panaich SS, Ramesh K, Afonso L. The association of red cell distribution width with glycated hemoglobin among healthy adults without diabetes mellitus. Cardiology. 2012;122(2):129–32.
11. Koenig RJ, Peterson CM, Jones RL, Saudek C, Lehrman M, Cerami A. Correlation of glucose regulation and hemoglobin acin diabetes mellitus [Internet]. Vol. 295, New England Journal of Medicine. 1976;417–20. Available: http://dx.doi.org/10.1056/nejm19 7608192950804
12. Simmons D. Increased red cell count in diabetes and pre-diabetes. Diabetes Res Clin Pract. 2010 Dec;90(3):e50–3.
13. Vabushana VJ, Sinduja P, Priyadharshini R. Comparison of hemoglobin (Hb) and Hematocrit (HCT) value in normal and cancer patients- An in-vitro study. Journal of Pharmaceutical Research International. 2021;33(59B):113-119. DOI: 10.9734/jpri/2021/v33i59B34359.
14. Anita R, Paramasivam A, Priyadharshini JV, Chitra S. The m6A readers YTHDF1 and YTHDF3 aberrations associated with metastasis and predict poor prognosis in breast cancer patients. Am J Cancer Res. 2020;10(8):2546–54.
15. Jayaseelan VP, Paramasivam A. Emerging role of NET inhibitors in cardiovascular diseases. Hypertens Res. 2020;43(12):1459–61.
16. Sivakumar S, Smiline Girija AS, Vijayashree Priyadharshini J. Evaluation of the inhibitory effect of caffeic acid and gallic acid on tetR and tetM efflux pumps mediating tetracycline resistance in Streptococcus sp., using computational approach. Journal of King Saud University - Science. 2020;32(1):904–9.
17. Smiline Girija AS. Delineating the immunodominant antigenic vaccine peptides against gacS-sensor kinase in Acinetobacter baumannii: An in silico Investigational Approach. Front Microbiol. 2020;11:2078.
18. Iswarya Jaisankar A, Smiline Girija AS, Gunasekaran S, Vijayashree Priyadharshini J. Molecular characterisation of csgA gene among ESBL strains of A. baumannii and targeting with essential oil compounds from Azadirachta indica. Journal of King Saud University - Science. 2020;32(8):3380–7.
19. Girija ASS. Fox3+ CD25+ CD4+ T-regulatory cells may transform the nCoV's final destiny to CNS! J Med Virol [Internet]; 2020. Available: http://dx.doi.org/10.1002/jmv.26482

20. Jayaseelan VP, Ramesh A, Arumugam P. Breast cancer and DDT: putative interactions, associated gene alterations, and molecular pathways. Environ Sci Pollut Res Int. 2021;28(21):27162–73.

21. Arumugam P, George R, Jayaseelan VP. Aberrations of m6A regulators are associated with tumorigenesis and metastasis in head and neck squamous cell carcinoma. Arch Oral Biol. 2021;122:105030.

22. Kumar SP, Girija ASS, Priyadharsini JV. Targeting NM23-H1-mediated inhibition of tumour metastasis in viral hepatitis with bioactive compounds from Ganoderma lucidum: A computational study. Pharmaceutical-sciences [Internet]. 2020;82(2). Available: https://www.ijpsonline.com/articles/targeting-nm23h1-mediated-inhibition-of-tumour-metastasis-in-viral-hepatitis-with-bioactive-compounds-from-ganoderma-lucidum-a-comp-3883.html

23. Girija SA, Priyadharsini JV, Paramasivam A. Prevalence of carbapenem-hydrolyzing OXA-type β-lactamases among Acinetobacter baumannii in patients with severe urinary tract infection. Acta Microbiol Immunol Hung. 2019;67(1):49–55.

24. Priyadharsini JV, Paramasivam A. RNA editors: key regulators of viral response in cancer patients. Epigenomics. 2021;13(3):165–7.

25. Mathivadani V, Smiline AS, Priyadharsini JV. Targeting epstein-barr virus nuclear antigen 1 (EBNA-1) with Murrayakoengii bio-compounds: An in-silico approach. Acta Virol. 2020;64(1):93–9.

26. Girija AS, Priyadharsini JV, A P. Prevalence of Acb and non-Acb complex in elderly population with urinary tract infection (UTI). Acta Clin Belg. 2021;76(2):106–12.

27. Anchana SR, Girija SAS, Gunasekaran S, Priyadharsini VJ. Detection of csgA gene in carbapenem-resistant Acinetobacter baumannii strains and targeting with Ocimum sanctum biocompounds. Iran J Basic Med Sci. 2021;24(5):690–8.

28. Girija ASS, Shoba G, Priyadharsini JV. Accessing the T-Cell and B-Cell Immuno-Dominant Peptides from A. baumannii Biofilm Associated Protein (bap) as Vaccine Candidates: A Computational Approach. Int J Pept Res Ther. 2021;27(1):37–45.

29. Arvind P TR, Jain RK. Skeletally anchored forus fatigue resistant device for correction of Class II malocclusions-A systematic review and meta-analysis. Orthod Craniofac Res. 2021;24(1):52–61.

30. Venugopal A, Vaid N, Bowman SJ. Outstanding, yet redundant? After all, you may be another Choluteca Bridge! Semin Orthod. 2021;27(1):53–6.

31. Ramadurai N, Gurunathan D, Samuel AV, Subramanian E, Rodrigues SJL. Effectiveness of 2% Articaine as an anesthetic agent in children: randomized controlled trial. Clin Oral Investig. 2019;23(9):3543–50.

32. Varghese SS, Ramesh A, Veeraiyann DN. Blended module-based teaching in biostatistics and research methodology: A retrospective study with postgraduate dental students. J Dent Educ. 2019;83(4):445–50.

33. Mathew MG, Samuel SR, Soni AJ, Roopa KB. Evaluation of adhesion of Streptococcus mutans, plaque accumulation on zirconia and stainless steel crowns, and surrounding gingival inflammation in primary molars: randomized controlled trial [Internet]. Clinical Oral Investigations. 2020;24:3275–80. Available: http://dx.doi.org/10.1007/s00784-020-03204-9

34. Kumar A, Hejmady DI, Unnikrishnan B, Thapar R, Kumar N, Holla R, et al. Are our diabetic patients’ adherent to the treatment? Curr Diabetes Rev [Internet]; 2021. Available: http://dx.doi.org/10.2174/157339017666210223114010

35. Mirazi N, Hosseini A. Attenuating properties of L. on oxidative damage and inflammatory response following streptozotocin-induced diabetes in the male Wistar rats. J Diabetes MetabDisord. 2020;19(2):131–6.

36. Eryd SA, Adamsson Eryd S, Borné Y, Melander O, Persson M, Smith JG, et al. Red blood cell distribution width is associated with incidence of atrial
37. Bansod A, Anjankar A. “An Association between COVID-19 and Diabetes Mellitus”. Journal of Pharmaceutical Research International. 2021;33(60A):103-111. DOI: 10.9734/jpri/2021/v33i60A34461

38. Lijnen P, Fenyesi A, Bex M, Bouillon R, Amery A. Erythrocyte cation transport systems in insulin-dependent diabetics: correlation with prorenin and albuminuria. J Hum Hypertens. 1994;8(4):251–6.

39. Inouye M, Mio T, Sumino K. Link between glycation and lipoxidation in red blood cells in diabetes. Clin Chim Acta. 1999;285(1-2):35–44.

40. Brundha MP, Pathmashri VP, Sundari S. Quantitative changes of red blood cells in cancer patients under palliative radiotherapy-A retrospective study.

41. Hannah R, Ramani P, Brundha MP, Sherlin HJ, Ranjith G, Ramasubramanian A, et al. Liquid paraffin as a rehydrant for air dried buccal smear. Research Journal of Pharmacy and Technology. 2019;12(2):687–92.

42. Khalid SH, Liaqat I, Mallhi TH, Khan AH, Ahmad J, Khan YH. Impact of diabetes mellitus on clinico-laboratory characteristics and in-hospital clinical outcomes among patients with myocardial infarction. J Pak Med Assoc. 2020;70(12(B):2376–82.

43. Auzanneau M, Fritsche A, Icks A, Siegel E, Kilian R, Karges W, et al. Diabetes in the hospital—a nationwide analysis of all hospitalized cases in Germany with and without diabetes, 2015-2017. Dtsch Arztebl Int [Internet]. 2021;118 (Forthcoming). Available:http://dx.doi.org/10.3238/arztebl.m2021.0151

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