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Correlations of Glycated Hemoglobin with Systolic and Diastolic Blood Pressure Levels in Non-Diabetics Adults

Ibrahim A. Ali
Department of Physiology, Faculty of Medicine, The National Ribat University, Khartoum, Sudan

Key words: HbA_{1c}, Systolic BP, Diastolic BP, diabetes

Abstract: Glycated Hemoglobin (HbA_{1c}) is now used largely for DM control. Hb A_{1c} is influenced by many risk factors; these include Body Mass Index (BMI), physical activity, age, ethnicity, diet, smoking and Blood Pressure (BP). Previous studies showed that that the levels of HbA_{1C} a showed continuous relationship with cardiovascular disease and hypertension. The objective of this study is to investigate the correlation between the blood pressure levels as determinants of glycated hemoglobin in non-diabetic Sudanese population. A cross sectional study was conducted during 2016-2018 in Sudan covering Khartoum state, Northern state, Gezira state, Red Sea state and North Darfur state, on adults of ages between 20-60 years and not known to be diabetic or suffering from any chronic illness. The 1096 participants were assessed by a questionnaire covering age, gender and other demographic and social characteristics. BMI and BP was calculated by standard scales. A sample of 5 mL venous blood was taken for FBG to exclude DM and measurement of HbA_{1c} using a modified ELISA reader known as Cobas Integra 800 (Roch) machine. Correlations between the variables were estimated and $p<0.05$ was considered statistically significant. The overall mean value of HbA_{1c} was 4.6%±0.9 with a minimum value of 1.2% and maximums of 6.3. At 95% confidence interval the lower bound Mean was 4.5% and the upper bound mean was 4.7%. The mean of systolic and diastolic blood pressure levels was found to be 114.7%±11.9 and 75.8%±8.5, respectively. There was no correlation was observed between HbA_{1c} with age and BMI (r) = 0.009, -0.032 and the p = 0.7, 0.33, respectively. There was no correlation between HbA_{1c} with DBP. There was significant negative correlation between HbA_{1c} with pulse rate and systolic blood pressure (r) = -0.160 and -0.063 with

Corresponding Author:
Ibrahim A. Ali
Department of Physiology, Faculty of Medicine, The National Ribat University, Khartoum, Sudan

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significant p = 0.00 and 0.049, respectively. In conclusion HbA_{1c} can be utilized as a prognostic factor for heart failure, cardiac muscles disorders, coronary artery disease, stroke and death before the diagnosis of diabetes.

INTRODUCTION

HbA_{1c} is formed over a period of two to three months and reflects the glycemic status of a patient over the past two to three months, for this reasons HbA_{1c} test has been used for diabetics follow-up and diagnosis[1].

According to a report published in 2009 by an international expert committee on the role of Hb A_{1c} in the diagnosis of diabetes, HbA_{1c} can be used to diagnose diabetes and that the diagnosis can be made if the Hb A_{1c} level is 6.5% or more and Hb A_{1c} level below 6% is considered normal.

HbA_{1c} results in the UK have usually been aligned to the assay used in the Diabetes Control and Complications Trial (DCCT), expressed as a percentage (DCCT-HbA_{1c})-non-diabetic 'normal' range being 4-6% [2].

Diagnostic criteria for diabetes that made by WHO.[3] determined that HbA_{1c} of 6.5% was considered as the cut-off point for diagnosing diabetes. A value <6.5% does not exclude diabetes diagnosed using glucose tests[4].

Different studies have shown variations in the normal ranges of Glycated Hemoglobin (HbA_{1c}) according to theeffect of age, gender, Body Mass Index (BMI), physical activity, ethnicity, diet and smoking [5-9].

According to a lot of previous studies it has been documntated that Hemoglobin A_{1C} is highly correlated with long-termmorbidity associated with DM including nephropathy and retinopathy [10-14].

The 2003 American Diabetes Association (ADA) Standards of Medical Care position statement recommends maintaining a virtually (HbA_{1c}) of 7.0% for all persons with diabetes [10].

Bennett *et al*.[15] and Peters *et al*.[16] conducted two studies and stated that the Glycatedhemoglobin acquiresimportance as a test for glycaemia because it has less intraindividualvariation and is a better predictor of cardiovascularcomplications compared to Fasting Plasma Glucose (FPG) and Oral Glucose Tolerance Test (OGTT). In addition, it is used forglucose monitoring of diabetic patients.

In another study performed by Jesudason *et al*.[17] HbA_{1C} and fasting blood glucose (FPG) showed continuous relationship with cardiovascular disease.

The aim of this study was to investigate the correlations between the systolic and diastolic blood pressurelevels in relation with glycaemic control of non-diabetic Sudanese Adults.

MATERIALS AND METHODS

A cross sectional study was conducted during 2016-2018 on Healthy Sudanese subjects of both sexes with age group 20-60 years. The 1163 Healthy Sudanese adult volunteers were included and the study covered Khartoum state, Northern state, Gezira state, Red Nile state and North Darfur state. The exclusion criteria of this study included: Pregnant ladies, abnormal Fasting Blood Glucose (FBG), Diabetes mellitus, Hypertension , Renal failure, Liver disease , Cancer, Chronic diseases (cardiac diseases, TB, asthma, thyroid disorders), Hematological disorders, Recent acute diseases (Malaria, typhoid fever), Lactation., History of recent surgery or splencetomy, History of schistosomiasis, hemoglobinopathies, blood disorders and Subjects not consenting. Written consents were obtained from all participants after fully explaining to them the project.

A questionnaire was filled by all volunteers to obtain the data about name, age, address, medical history, drug use and lifestyle. Weight, height and blood pressure were measured with standard techniques. Complete clinical examination was performed. Blood pressure was taken by trained personnel using a mercury sphygmomanometer and a stethoscope. Participants were asked to sit on a chair for 5 min. Measurements taken from the upper arm, different cuff sizes were used for different body sizes and placed to cover the left arm at the heart level. Systolic and diastolic blood pressure was taken three times with at least five minutes interval, using a digital sphygmomanometer. The average of the three readings was used for the analysis.Weight, height, Body mass index (weight (kg)/height $(m)^2$) and blood pressure (Systolic and diastolic) were measured and recorded in the data collection sheet.

After informed consent; 5 mL of venous blood was collected by a standard procedure from each participant under complete aseptic conditions in the morning and after an overnight fasting. The 2.5 mL was placed in fluoride oxalate containers and then used for FBG measurement with auto analyzer A 15. The remaining 2.5 mL was placed in EDTA container and used for HbA_{1c} analysis. (Icteric, lipemic, hemolyzed or bacterially contaminated samples were not used).

HbA_{1c} was measured using modified ELISA reader known as COPAS Integra 800 using commercial reagent kits from Roche Company. All techniques and equipment were standardized. All data collected in this study was analyzed using the SPSS computer programs.

Correlation coefficient (r) was used for continuous numerical variables and Student t-test and (ANOVA) statistics was used for categorical variables. The $p \leq 0.05$ was considered significant.

Ethical consideration: Ethical approval of this study was obtained from the Federal Ministry of Health in Sudan (FMOH) and The National Ribat University (NRU). The objectives of the study were explained to all individuals participating in the study. An informed consent was obtained from each participant in the study.

RESULTS

A total of 1096 volunteers were identified as eligible; according to the inclusion criteria and approved to be enrolled after filling the consent, questionnaire and were fit on the physical examination. The 67 subjects (5.7%) were excluded due to high fasting blood glucose (FBG) and they were not known to be diabetics. The 808 (73.7%) of the study sample were females and 288 (24.8%) were males (Table 1). The mean age of the participants was found to be 25.1±9.2 years with a range of 20-60 years. The mean of BMI was found to be 22.8±4.8 with a minimum of 18.5 and maximum of 51.4 (Table 2). The 196 (17.9%) of the participants have a BMI less than 19, 630 (57.7) have a normal BMI between 19-24.9, 189 (17.2%) are overweight with BMI between 25-30 and 81 (7.4%) are obese with BMI more than 30 (Fig. 1).

The overall mean value of HbA_{1c} was 4.6% ±0.9 with a minimum value of 1.2% and maximums of 6.3. At 95% confidence interval the lower bound Mean was 4.5% and the upper bound mean was 4.7% as shown in Table 2. The mean of systolic and diastolic blood pressure levels was found to be 114.7%±11.9 and 75.8%±8.5, respectively.

Table 3 shows the correlations of HbA_{1c} with other neumerical variables and the test that carried out was Pearson correlation coefficient (bivariate analyses); correlations coefficient of determination (r) values were calculated at level of ($p \leq 0.05$).

Table 1:Distribution of studied population according to gender in the study

Gender	Frequencies	Percentage
Male	272	24.80
Female	808	73.70
Missing	16	1.500
Total	1096	100.0

Table 2: Descriptive statistics of Age, BMI, Pulse rate, SBP, DBP, FBG and HbA_{1c} of the studied population (n = 1096)

Test	Mean	SD	SE of Mean	Median	Minimum	Maximum
Age	25.1	9.2	0.27	21.0	20	60.0
BMI	22.8	4.8	0.15	22.0	0.24	51.4
Pulse	76.2	7.3	0.29	76.0	45	104.0
SBP	114.7	11.9	0.37	115.0	12	135.0
DBP	75.8	8.5	0.26	75.0	55	87.0
FBG	74.3	13.8	0.68	75.00	52	111.0
HbA_{1c}	4.6	0.98	0.03	4.75	1.2	6.3

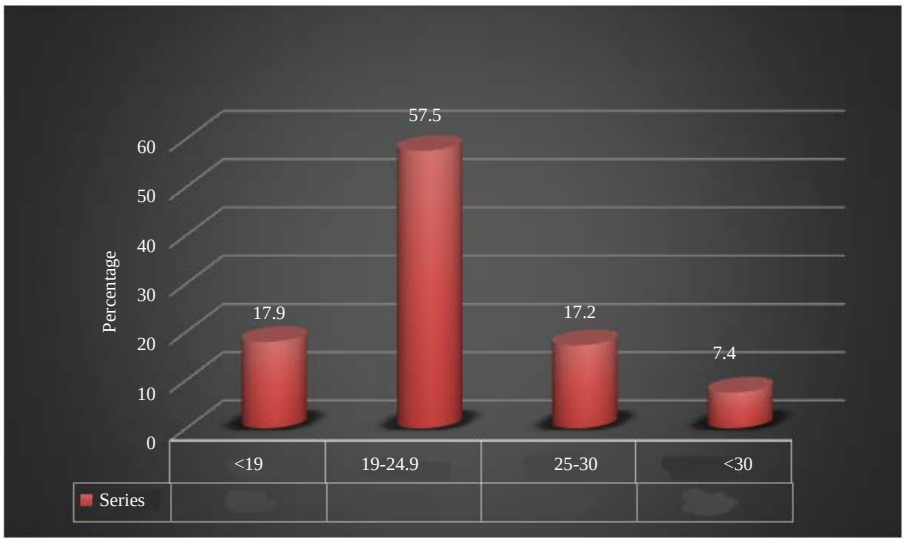

Fig. 1: Distribution of studied population according to BMI groups in the study

Table 3: HbA_{1c} Correlations with age, BMI Pulse rate, SBP and DBP in Sudanese population

HbA_{1c}	Age	BMI	Pulse	SBP	DBP
Pearson correlation	0.009	-0.032	-0.160**	-0.063*	-0.015
Sig. (2-tailed)	0.772	0.335	0.000	0.049	0.633

**. Correlation is significant at the 0.01 level (2-tailed); *Correlation is significant at the 0.05 level (2-tailed)

There was no correlation between HbA_{1c} with age and BMI (r) = 0.009, -0.032 and the p = 0.7, 0.33, respectively. There was no correlation between HbA_{1c} with DBP.

There was intermediate negative correlation between HbA_{1c} with pulse rate and systolic blood pressure (r) = -0.160 and -0.063 with significant p = 0.00 and 0.049, respectively.

DISCUSSION

HbA_{1c} measurement is one of the diagnostic tests used in the diagnosis of diabetes and monitoring hyperglycemia in uncontrolled diabetic patients. HbA_{1c} is a relevant predictor of diabetes related complications and of mortality[18].

Some retrospective studies have affirmed the relation between increased glycosylated hemoglobin and increased events and mortality rates from cardio-vascular diseases among diabetic patients[15-17].

But recently the relation between glycosylated hemoglobin and increased danger of cardio-vascular diseases in non-diabetics has been reported. There was no correlation was observed between HbA_{1c} and diastolic blood pressure.In this study significant negative correlation was observed between HbA_{1c}, Pulse rate and Systolic blood pressure (r = -0.160, p = 0.00) (r = -0.063, p = 0.49), respectively.

CONCLUSION

In conclusion HbA_{1c} can be utilized as a prognostic factor for heart failure, cardiac muscles disorders, coronary artery disease, stroke and death before the diagnosis of diabetes.

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REFERENCES

01. Sacks, D.B., D.E. Bruns, D.E. Goldstein, N.K. Maclaren, J.M. McDonald and M. Parrott, 2020. Guidelines and recommendations for laboratory analysis in the diagnosis and management of diabetes mellitus. Clin. Chem., 48: 436-472.
02. Weykamp, C., W.G. John and A. Mosca, 2014. A review of the challenge in measuring hemoglobin A1c. J. Diabetes Sci. Technol., 3: 439-445.
03. WHO., 2011. Use of glycated haemoglobin (HbA1c) in diagnosis of diabetes mellitus: Abbreviated report of a WHO consultation. No. WHO/NMH/ CHP/CPM/11.1, World Health Organization, Geneva, Switzerland.
04. Ali, I.A., M.S. Abdalla and O.A. Musa, 2017. Normal values of Hemoglobin A1c (Hb A1c) in non-diabetic adults. Int. J. Sci. Res. Publ., 7: 131-133.
05. Ali, I.A., H.M. Abdelrhim, F.A. Fadul and O.A. Musa, 2016. Reference values for hemoglobin A1c in males living in Khartoum State: Pilot study 2016. Sudan Med. Monit., 11: 91-96.
06. Ai, I.A., H.M.A. Rahim, B. Almobasher, R.M. Badi and A. Alborai *et al*., 2018. Reference range of hemoglobin A1c in Khartoum state. Anatomy Physiol. Biochem. Int. J., Vol. 4, No. 4.
07. Ai, I.A., H.M.A. Rahim, E.H. Taha, A.A. Abeadalla and A. Hussein *et al*., 2018. Distribution of glycated hemoglobin according to gender, age and body mass index in sudanese adults without diabetes. Sch. Int. J. Anat. Physiol., 1: 68-71.
08. Fadul, F.A., H.M. Abdelrhim, I.A. Ali and O.A. Musa, 2016. Normal values of hemoglobin A1c among women in Khartoum State: (A pilot study, 2016). M.Sc. Thesis, National Ribat University, Khartoum, Sudan.
09. Anonymous, 2003. Standards of medical care for patients with diabetes mellitus. Am. Diabetes Asso. Diabetes Care, 26: S33-50.
10. Stratton, I.M., A.I. Adler, H.A. Neil, D.R. Matthews and S.E. Manley *et al*., 2003. American diabetes association: Standards of medical care for patients with diabetes mellitus. Diabetes Care, 26: S33-S50.
11. UKPDS., 1998. Intensive blood-glucose control with sulphonylureas or insulin compared with conventional treatment and risk of complications in patients with type 2 diabetes (UKPDS 33). Lancet, 352: 837-853.
12. UKPDS Group, 1998. Effect of intensive blood-glucose control with metformin on complications in overweight patients with type 2 diabetes (UKPDS 34). Lancet, 352: 854-865.
13. Lawson, M.L., H.C. Gerstein, E. Tsui and B. Zinman, 1999. Effect of intensive therapy on early macrovascular disease in young individuals with type 1 diabetes. Diabetes Care, 22`: B35-B39.

14. Adler, A.I., I.M. Stratton, H.A.W. Neil, J.S. Yudkin and D.R. Matthews *et al*., 2000. Association of systolic blood pressure with macrovascular and microvascular complications of type 2 diabetes (UKPDS 36): Prospective observational study Br. Med. J., 321: 412-419.
15. Bennett, C.M., M. Guo and S.C. Dharmage, 2007. HbA_{1c} as a screening tool for detection of type 2 diabetes: A systematic review. Diabetic Med., 24: 333-343.
16. Peters, A.L., M.B. Davidson, D.L. Schriger and V. Hasselblad, 1996. Clinical approach for the diagnosis of diabetes mellitus: An analysis using glycosylated haemoglobin levels. Metaanalysis research group on the diagnosis of diabetes using glycated haemoglobin levels. J. Am. Med. Assoc., 276: 1246-1252.
17. Jesudason, D.R., K. Dunstan, D. Leong and G.A. Wittert, 2007. Macrovascular risk and diagnostic criteria for type 2 diabetes: Implications for the use of FPG and HbA1c for cost-effective screening. Diabetes Care 26: 485-490.
18. Koga, M., H. Saito, M. Mukai, M. Otsuki and S. Kasayama, 2008. Serum glycated albumin levels are influenced by smoking status, independent of plasma glucose levels. Acta Diabetologica, 46: 141-144.