Original Article

Screening of Young Adults Using HbA1c for Evaluating Pre-Diabetic Status

Huma Ahsan, Moin Ud Din Ahmed and Tooba Khan

ABSTRACT

Objective: HbA1c is usually used a useful biomarker for monitoring glycemic control but also in predicting and identifying diabetic patients. The objective of this study is to determine the incidence of diabetes in pre-diabetic adults by using HbA1c.

Study Design: Cross Sectional Observational Study

Place and Duration of Study: This study was conducted at the Naz Memorial Hospital Karachi Sindh Pakistan from June, 2019 to December, 2020.

Materials and Methods: After ethical approval, patients attending the medicine clinic of the hospital between 18 and 50 years of age, previously undiagnosed with diabetes, having HbA1c in between 5.4-6.4 and agreed to participate were included. Diabetic patients or with an HbA1c below 5 and above 7 were excluded. SPSS version 23.0 was used for analysis of data. Chi-square and independent t tests were applied between qualitative and quantitative variables keeping p-value of <0.05.

Results: In 100 patients with mean age 33.59 ± 6.68 years, 38 males and 62 females. Mean weight and height was 77.2 ± 12.17 kg and 1.62 ± 0.09 m respectively. 28 patients were between 18.5-24.5 kg/m^2 of BMI while 26 between 24.5-30 kg/m^2 and 46 were above 30 kg/m^2. Mean fasting blood glucose was 110.52 ± 5.63 mg/dl, mean HbA1c 5.87 ± 0.35 %. 54 patients had HbA1c below 6.5 while 46 had above 6.5 but less than 7%.

Conclusion: Significant differences between nationalities, weight, BMI, smoking, family history of diabetes and fasting blood sugar levels were reported in patients having an HbA1c greater than 6.5 %.

Key Words: Pre-diabetes, Glycosylated hemoglobin, Screening

Citation of article: Ahsan H, Ahmed M, Khan T. Screening of Young Adults Using HbA1c for Evaluating Pre-Diabetic Status. Med Forum 2021;32(7):53-57.

INTRODUCTION

Diabetes is a chronic endocrine disorder that becomes a serious problem in developing world. It occurs when either pancreas does not produce enough insulin in body or body does not use insulin actively to regulate blood glucose which is produce by pancreas [(1)]. Non-insulin dependent or adult onset diabetes also known as diabetes type II in which body fails to secrete ample amount of insulin to fulfill body requirements, the risk of diabetes include, family history, metabolic factors, ethnicity and a sedentary lifestyle[(2,3)].

On the global health care system, a large economic burden imposes due to increase cases of diabetes, in future low-middle income nations will carry larger population effected with diabetes[(4)]. The eight most common reason behind mortality in either gender and fifth most commonly observed reason of death amongst women was diabetes[(5)]. Prevalence of diabetes has risen in the past few decades throughout the world among all socio-economic status especially in low and middle income population. Such populations have also reported an increased number overweight or obese people[(6,7)]. Recent researches show that obesity's prevalence amongst children as well as adolescents is rising at alarming rates. Most of adult diagnosed with diabetes are found to be overweight, with positive history of diabetes in family, demonstrating insulin resistance [(8)]. Diabetes is increasingly being reported among females as well as specific ethnicities. Detecting diabetes in the early phase might help in reduction of disease's impact especially in-between young adults. Therefore, analyzing aspects attributed with impairment of glucose metabolism may result in improved understanding of present increase in diabetes in young adults [(9)]. HbA1c (Glycosylated hemoglobin) has recently been advocated as standard approach in confirming diabetes. HbA1c is utilized as screening tool in detection of diabetes [(10)]. First isolation of HbA1c was accomplished by Huisman. Characteristics were noted by Bookchin and Gallop, regarding HbA1c under glycoproteins. It is used as biomarker in monitoring blood glucose levels, initially being proposed by Koenig et al [(11)].

Naz Memorial Hospital Karachi, Sindh.

Correspondence: Dr. Huma Ahsan, Consultant Internal Medicine, Naz Memorial Hospital Karachi Sindh.
Contact No: +966502214917
Email: drhumaahsan@yahoo.com

Received: February, 2021
Accepted: May, 2021
Printed: July, 2021

The expression of HbA1c is done in percentage. More percentage mean greater blood glucose levels in previous 2-3 months. HbA1c levels in-between 5.7-6.5%, denote pre-diabetes status wherein levels 6.5% or higher, means a patient is diabetic[12]. HbA1c was directly associated to diabetes risk progression in glucose intolerant individuals. HbA1c percentages are measured at the same time as oral glucose tolerance tests to evaluate if HbA1c should be utilized to diagnose diabetes instead of oral glucose tolerance test [13]. It is found that the oral glucose tolerance test could identify approximately 90% patients having HbA1c greater than 7 percent as being diabetic. Race / ethnicity amongst diabetic people with "borderline diabetes," and people with no diabetes have been shown to be substantially co-related to HbA1c[14]. A growing number of countries have rapidly embraced the use of HbA1c as a screening marker in clinical practice where it can provide an excellent cost-effective approach to diabetic mellitus screening, provided it is demonstrated to have adequate sensitivity and specificity. The aim of this study is to evaluate incidence of diabetes in pre-diabetic adults by using HA1c. People with family history of diabetes or other predisposing risk factors will benefit. Early diagnosis or prediction helps them to change their lifestyle or pharmacological intervention to prevent or delay onset of diabetes.

MATERIALS AND METHODS

This cross sectional observational study was done using non-probability convenient sampling technique from June 2019 to December 2020 at the Naz Memorial Hospital Karachi Sindh Pakistan. After ethical approval, patients attending the medicine clinic of the hospital between 18 and 50 years of age who were previously undiagnosed with diabetes mellitus, having an HbA1c between 5 -7 and agreed to participate in the study were included. Diabetic patients or patients with an HbA1c below 5 and above 7 were excluded from the study.

HbA1c cut off values for pre-diabetes were used as recommended by the American Diabetes Association (ADA) were patients having HbA1c above 5.4 and below 6.5 were treated as pre-diabetes if checked for the first time, while HbA1c above 6.5 was check again and if still found above 6.5, were excluded been diagnosed with diabetes. Demographic characteristics of the patients included their age, gender, nationality, weight, height, BMI, history of hypertension, asthma, thyroid disorder, family history of diabetes in family, fasting blood sugar, HbA1c, lipid profile including total cholesterol, triglycerides, high density lipoprotein and low density lipoprotein. For laboratory investigation, a fasting blood sample of five ml venous blood was taken using aseptic technique and fasting for about 12 hours.

SPSS version 23.0 was used for analysis of data. For qualitative variables, frequency and percentages were reported and for quantitative variables, mean and standard deviation were reported. Patients were divided into two groups, one group being those having HbA1c levels below 6.5 % and another group having HbA1c levels above 6.5 %. To test for significance between groups, chi-square and independent t tests were applied between qualitative and quantitative variables. A p-value of <0.05 was considered as statistically significant.

RESULTS

From the total of 100 patients in the study, the mean age was 33.59 ± 6.68 years. 38 were male and 62 females 80 percent patients were Sindhi. Mean weight and height of patients was 77.2 ± 12.17 kg and 1.62 ± 0.09 m respectively. 28 patients were between 18.5-24.5 kg/m^2 of BMI while 26 between 24.5-30 kg/m^2 and 46 were above 30 kg/m^2. 38 patients gave a history of hypertension while 20 of asthma and 38 of a thyroid disorder. 12 patients reported positive history of smoking. Mean fasting blood glucose was 110.52 ± 5.63 mg/dl, mean HbA1c 5.87 ± 0.35 %, mean total cholesterol 200.1 ± 23.15, mean triglycerides 170.9 ± 13.73 mg/dl, mean HDL 48.16 ± 7.25 mg/dl while mean LDL was 92.1 ± 19.23 mg/dl [Table I].

Table No.1: Baseline demographics of study participants

Variables		Mean ± SD / Frequency (%) n=100
Age (years)		33.59 ± 6.68
Gender	Male	38 (38%)
	Female	62 (62%)
ethnicity	Sindhi	80 (80%)
	Balochi	10 (10%)
	Pathan	04 (4%)
	Punjabi	04 (4%)
	Siraiki	02 (2%)
Weight (kg)		77.2 ± 12.17
Height (m)		1.62 ± 0.09
BMI (kg/m^2)	<18.5	0
	18.5-24.5	28 (28%)
	24.5-30	26 (26%)
	>30	46 (46%)
Hypertension		38 (38%)
Asthma		20 (20%)
Thyroid disorder		38 (38%)
Smoking		12 (12%)
Family History of Diabetes with relation	Father	18 (18%)
	Mother	32 (32%)
Fasting Blood Sugar (mg/dl)		110.52 ± 5.63
HbA1c (%)		5.87 ± 0.35
Total Cholesterol (mg/dl)		200.1 ± 23.15
Triglycerides (mg/dl)		170.9 ± 13.73
High Density Lipoprotein (mg/dl)		48.16 ± 7.25
Low Density Lipoprotein (mg/dl)		92.1 ± 19.23

With regards to the demographics of patients according to HbA1c, a significant difference of 0.04 was observed between different ethnicities. A substantially higher mean weight was observed among patients having an HbA1c greater than 5.5. A higher BMI was reported among patients with higher HbA1c. Patients with a family history of diabetes were observed to be more prone to diabetes as well as reported higher HbA1c levels [Table 2].

Table No.2: Demographics of study participants according to HbA1c

Variables		HbA1c <6.5 n=54	HbA1c >6.5 n=46	p-value
Gender	Male	20	18	0.83
	Female	34	28	
Nationality	Sindhi	42	38	0.04
	Balochi	06	04	
	Pathan	0	04	
	Punjabi	04	0	
	Siraiki	02	0	
Weight (kg)		75.44 ± 14.33	79.26 ± 8.73	0.04
Height (m)		1.63 ± 0.09	1.61 ± 0.08	0.34
BMI	<18.5	0	0	<0.001
	18.5-24.5	24	04	
	24.5-30	6	20	
	>30	24	22	
Hypertension		18	20	0.3
Asthma		12	08	0.55
Thyroid disorder		16	22	0.06
Smoking		02	10	0.006
Family History of Diabetes with relation	Father	06	12	0.001
	Mother	12	20	
Fasting Blood Sugar (mg/dl)		98.3 ± 6.06	103.13 ± 3.69	0.003
Total Cholesterol (mg/dl)		198.63 ± 25.16	201.83 ± 20.68	0.78
Triglycerides (mg/dl)		169.26 ± 15.03	172.74 ± 11.92	0.66
High Density Lipoprotein (mg/dl)		48 ± 6.73	48.35 ± 7.89	0.34
Low Density Lipoprotein (mg/dl)		91.89 ± 19.12	92.3 ± 19.57	0.62

DISCUSSION

HbA1c is usually used a useful biomarker for monitoring glycemic control but also in predicting and identifying diabetic patients which were either previously undiagnosed or prone to become diabetic, being at a greater risk of diabetic complication if left undiagnosed. Therefore, a single HbA1c test can provide vital information about a patient which can be used to prevent, manage and treat chronic disorders [(15)]. A study not only evaluated HbA1c for predicting glycemic index of patients previously undiagnosed with diabetes, however in addition the study also evaluated HbA1c in terms of lipid profile (including total cholesterol, triglycerides, high density lipoprotein and low density lipoprotein) and BMI of patients. The study concluded that total cholesterol and triglycerides were significantly higher while HDL substantially lower in patients with a higher HbA1c level [(16)]. Similarly, in our study as well we evaluated the levels of HbA1c in terms of patient demographic and also included lipid profiles and anthropometric features such as weight, height and BMI.

Elevated levels of HbA1c especially among undiagnosed diabetics can be more harmful than known diabetics owing to the fact that in undiagnosed patients, the status of not only diabetic but also cardiovascular, neurological and ophthalmic complication status remains unknown [(17)]. Especially among young adults, HbA1c predicting diabetic status can help in preventing diabetic among those having high or pre-diabetic levels of HbA1c. Another important aspect of pre-diabetic control among young adults is that their metabolic status can easily be altered as compared with older adults [(18)]. In addition, individuals with higher BMI are also reported to be prone to diabetes, as reported in studies [(19)]. Likewise, in our study as well, individuals with higher HbA1c were found to have higher BMI values. Nonetheless, lipid profile of patients with high or optimum HbA1c levels were not reported to be significantly different, however they were slightly higher among group having HbA1c above 6.5 %.

HbA1c, a test which can reflect the levels of blood glucose for about 120 days, stands in itself a standardized and valuable test in assessment of glycemic control. On the contrary, it is debated that if for every individual, HbA1c levels are optimal biomarker for observing glycemic index, control and assess level of complications associated with diabetes[(20)]. The only factor postulated in observing discordance between HbA1c among different populations is because of inter-individual variations in red blood cells life span differing among different races and populations [(21)].

In our study, individuals having an HbA1c level above 6.5 % were observed to have higher weight and BMI than individuals with normal HbA1c or below 6.5 %. Similarly, individuals with a family history of diabetes in either parent were observed to have higher levels of HbA1c. Other researchers have also reported similar results where individuals having pre-diabetic status [(22)]. They have observed that a wide range of possible levels exist for mean glucose levels for a given HbA1c value which means that for some individuals, HbA1c might not be as a reliable for glycemic control. Additionally, HbA1c only denotes information about hyperglycemia

and not hypoglycemia, glycemic variability or daily pattern of glucose levels [23]. The benefits of HbA1c include an accurate and easily administered test having on-the-spot availability of results and help not diagnosing, managing and maintaining diabetic control especially in low and middle income countries and in hard to reach populations.

CONCLUSION

According to the results of the study, a significant difference of nationality, weight, BMI, smoking, family history of diabetes and fasting blood sugar levels were reported in patients having an HbA1c greater than 6.5%. Additionally, values of lipid profile were not significant in patients with HbA1c above 6.5 % or below 6.5 %.

Author's Contribution:

Concept & Design of Study:	Huma Ahsan
Drafting:	Moin Ud Din Ahmed, Tooba Khan
Data Analysis:	Tooba Khan , Moin Ud Din Ahmed
Revisiting Critically:	Huma Ahsan, Moin Ud Din Ahmed
Final Approval of version:	Huma Ahsan

Conflict of Interest: The study has no conflict of interest to declare by any author.

REFERENCES

1. Zhao C, Yang C, Wai ST, Zhang Y, P. Portillo M, Paoli P, et al. Regulation of glucose metabolism by bioactive phytochemicals for the management of type 2 diabetes mellitus. Critical reviews in food science and nutrition 2019;59(6):830-47.
2. Silver B, Ramaiya K, Andrew SB, Fredrick O, Bajaj S, Kalra S, et al. EADSG guidelines: insulin therapy in diabetes. Diabetes therapy 2018; 9(2):449-92.
3. DeFronzo RA. Pathogenesis of type 2 (non-insulin dependent) diabetes mellitus: a balanced overview. Diabetologia 1992;35(4):389-97.
4. Seuring T, Archangelidi O, Suhrcke M. The economic costs of type 2 diabetes: a global systematic review. Pharmacoeconomics 2015; 33(8):811-31.
5. Hastings KG, Jose PO, Kapphahn KI, Frank AT, Goldstein BA, Thompson CA, et al. Leading causes of death among Asian American subgroups (2003–2011). PLoS One 2015;10(4):0124341-59.
6. Magliano DJ, Sacre JW, Harding JL, Gregg EW, Zimmet PZ, Shaw JE. Young-onset type 2 diabetes mellitus—implications for morbidity and mortality. Nature Reviews Endocrinol 2020;1-1.
7. Harding JL, Pavkov ME, Magliano DJ, Shaw JE, Gregg EW. Global trends in diabetes complications: a review of current evidence. Diabetologia 2019;62(1):3-16.
8. Ehtisham S, Barrett TG, Shaw NJ. Type 2 diabetes mellitus in UK children–an emerging problem. Diabetic Med 2000;17(12):867-71.
9. Cornelis MC, Qi L, Zhang C, Kraft P, Manson J, Cai T, et al. Joint effects of common genetic variants on the risk for type 2 diabetes in US men and women of European ancestry. Annals of Internal Medicine 2009;150(8):541-50.
10. Nam HK, Cho WK, Kim JH, Rhie YJ, Chung S, Lee KH, et al. HbA1c cutoff for prediabetes and diabetes based on oral glucose tolerance test in obese children and adolescents. J Korean Med Sci 2018;33(12).
11. Florkowski C. HbA1c as a diagnostic test for diabetes mellitus–reviewing the evidence. The Clinical Biochemist Reviews 2013;34(2):75.
12. Bachmann MO, Lewis G, John WG, Turner J, Dhatariya K, Clark A, et al. Norfolk Diabetes Prevention Study. Determinants of diagnostic discordance for non-diabetic hyperglycaemia and Type 2 diabetes using paired glycated haemoglobin measurements in a large English primary care population: cross-sectional study. Diabetic Med 2019;36(11):1478-86.
13. Liu AY, Silvestre MP, Poppitt SD. Prevention of type 2 diabetes through lifestyle modification: is there a role for higher-protein diets? Advances in nutrition 2015 Nov;6(6):665-73.
14. American Diabetes Association. Standards of medical care in diabetes--2014. Diabetes care 2014;37:14-80.
15. Sherwani SI, Khan HA, Ekhzaimy A, Masood A, Sakharkar MK. Significance of HbA1c test in diagnosis and prognosis of diabetic patients. Biomarker insights 2016;11:38440-50.
16. Khan HA, Sobki SH, Khan SA. Association between glycaemic control and serum lipids profile in type 2 diabetic patients: HbA 1c predicts dyslipidaemia. Clin Experimental Med 2007;7(1): 24-9.
17. Xu L, Chan WM, Hui YF, Lam TH. Association between HbA1c and cardiovascular disease mortality in older Hong Kong Chinese with diabetes. Diabetic Med 2012;29(3):393-8.
18. Ghazanfari Z, Haghdoost AA, Alizadeh SM, Atapour J, Zolala F. A comparison of HbA1c and fasting blood sugar tests in general population. Int J Preventive Med 2010;1(3):187-94.
19. Alzahrani SH, Baig M, Aashi MM, Al-shaibi FK, Alqarni DA, Bakhamees WH. Association between glycated hemoglobin (HbA1c) and the lipid profile

in patients with type 2 diabetes mellitus at a tertiary care hospital: a retrospective study. Diabetes, metabolic syndrome and obesity: targets and therapy 2019;12:1639-44

20. Rodríguez-Segade S, Rodríguez J, Lopez JM, Casanueva FF, Camiña F. Estimation of the glycation gap in diabetic patients with stable glycemic control. Diabetes Care 2012;35(12): 2447-50.
21. Cohen RM, Franco RS, Khera PK, Smith EP, Lindsell CJ, Ciraolo PJ, et al. Red cell life span heterogeneity in hematologically normal people is sufficient to alter HbA1c. Blood, The J Am Society of Hematol 2008;112(10):4284-91.
22. Beck RW, Connor CG, Mullen DM, Wesley DM, Bergenstal RM. The fallacy of average: how using HbA1c alone to assess glycemic control can be misleading. Diabetes Care 2017;40(8):994-9.
23. Weykamp C. HbA1c: a review of analytical and clinical aspects. Annals of Laboratory Med 2013;33(6):393-400.