International Journal of Research in Medical Sciences
Ramasamy J et al. Int J Res Med Sci. 2016 Jul;4(7):2569-2575
www.msjonline.org
pISSN 2320-6071 | eISSN 2320-6012
DOI: http://dx.doi.org/10.18203/2320-6012.ijrms20161850

Research Article

Prevalence of undiagnosed diabetes and prediabetes among voluntary blood donors in a tertiary health care setting

Jawahar Ramasamy*, Umadevi Komarla Parthasarathy

Department of Pathology, Aarupadai Veedu Medical College and Hospital, Pondicherry, India

Received: 25 May 2016
Accepted: 28 May 2016

***Correspondence:**
Dr. Jawahar Ramasamy,
E-mail: jawahar84@gmail.com

ABSTRACT

Background: Finnish diabetes risk score (FINDRISC) questionnaire is a screening tool to estimate risk of type 2 diabetes. This study was conducted to find the prevalence rate of diabetes and prediabetes among voluntary blood donors using FINDRISC score as screening tool in large population.
Methods: A total of 210 eligible blood donors were included in this study. After obtaining the consent, subjects will be assessed with FINDRISC questionnaire. The patients with score ≥12 points, blood samples were taken and HbA1c test will be done by particle enhance immunoturbidimetric test to detect diabetes and prediabetes.
Results: Out of 210 donors, 93 had a score of ≥12 points among which the prevalence rate of prediabetes 43 (46.24%) and diabetes 14 (15.05%) was noted. Subjects with BMI in overweight category had diagnosed diabetes 4 (5.8%), prediabetes 20 (28.99%) and subjects in obese category had diagnosed diabetes 10 (31.25%) and prediabetes 19 (59.38%). It shows that BMI was significant indicator of undiagnosed diabetes.
Conclusions: In this study we found that the prevalence rate of diabetes 14 (15.05%) and prediabetes 43 (46.24%) among voluntary blood donors. The FINDRISC questionnaire used was a reliable and valuable screening tool for detecting undiagnosed type 2 diabetes and prediabetes in large population. Person diagnosed early has a chance to delay disease progression and limit secondary damage caused by undiagnosed diabetes.

Keywords: Diabetes, Prediabetes, FINDRISC questionnaire

INTRODUCTION

The prevalence of diabetes is rapidly rising all over the world.[1] Current estimates are that there are at least 150 million people living with diabetes worldwide of which two-thirds are in developing countries.[2] According to the international diabetic federation more than 70.3 million people in Southeast Asian region have diabetes and by 2030 this will rise to 120.9 million. In India alone total of 63.0 million cases of diagnosed diabetes among which Pondicherry has 48,876 cases of diagnosed diabetes.[3]

Diabetes mellitus is a clinical syndrome characterized by hyperglycemia due to absolute or relative deficiency of insulin. It is classified into two types: type 1 and type 2, where type 1 is most commonly due to autoimmune cause that leads to lack of insulin, whereas type 2 diabetes is a multi-factorial disorder involving both impaired insulin release leading to relative insulin deficiency and end-organ insufficiency.[4]

Glycosylated hemoglobin (HbA1C) is a biomarker in blood which indicates a persistently elevated blood glucose levels. It is an important measure of how effectively diabetes is being managed. Usually HbA1c levels of >6.5% used to diagnose diabetes and values between 5.7%-6.4% identifies prediabetic individual. Despite the cloud controversy regarding the limitations of HbA1C for making a diagnosis of diabetes mellitus, International committee members selected by American

Diabetes Association (ADA) recently suggested that glycosylated hemoglobin (HbA1c) could be used as an alternative for making a diagnosis of diabetes.[5]

In order to detect type 2 diabetes and prediabetes among voluntary blood donors, a cost effective, convenient and sensitive screening tool need to be developed in the tertiary health care setting.

Review of literature

Diabetes

The term 'Diabetes' was coined by Artaeus Cappadocia (81-133A.D) which literally siphon-to pass through and Thomas Willis, a Britain doctor coined the term 'Mellitus' in 1675, from the latin meaning 'Honey', reference to sweet taste of urine. Later Dopson in 1776 confirmed the presence of excess sugar in urine and blood as a cause of their sweetness. At the end of 1889 a German scientist Oskar Minkowski and German physician Joseph Vommering were successful in describing the relation between the pancreas and diabetes. Later Banting and Best in 1921 discovered insulin isolation and clinical use in diabetes.

Diabetes is a group of metabolic diseases characterized by relative insulin deficiency/action or both leading to hyperglycemia. A study by Shaw et al showed that by 2030, the world wide prevalence of adult diabetes mellitus is expected to rise by 7.7%, which roughly translates to 439,000,000 individuals.[6] Gupta et al studied on prevalence of diabetes and its risk factors in urban Pondicherry. In 616 respondents about 51 (8.27%) were diabetics.[7]

Based on recommendations by American Association of Diabetes, a diagnosis of DM requires the presence of a fasting plasma glucose concentration of ≥126 mg/dL, or a 2 hour plasma glucose level of ≥200 mg/dL on an oral glucose tolerance test (OGTT). But later an international committee members selected by the American Diabetes Association (ADA) and the Alliance for European Diabetes Research (EURADIA) suggested that glycosylated hemoglobin (HbA1c) could be used as an alternative for making a diagnosis.[8]

The validated finnish diabetes risk score (FINDRISC) has traditionally been used as a predictor of type 2 diabetes. It takes into account the usual clinical characteristics, such as age, body mass index (BMI), waist circumference (WC), physical activity, dietary consumption of fruits, vegetables, and berries, use of antihypertensive, medication, history of high blood glucose, and family history of diabetes. FINDRISC has been successfully implemented as a practical screening instrument to assess diabetes risk and to detect undiagnosed type 2 diabetes in European populations.[9]

Screening of diabetes

1. *Urine examination*

Cheap and convenient but the diagnosis cannot be based on urine testing since there may be false positive and false negative.

Glucosuria: Benedict's qualitative test for glucose can be done. But benedicts test can give false positive results for other reducing sugars such as lactose, fructose and maltose.

Ketonuria: Rothera's test, Strip test.

Ketone bodies such as acetone and acetoacetic acid can be identified in urine but not the beta hydroxybutric acid.

Reagent strip test can give false positive results or false negative results too.[10]

2. *Blood examination*

More than a decade diabetes is being detected by the criteria formulated by American Association of Diabetes (ADA) by using plasma glucose levels either by fasting plasma glucose levels or 75 g oral glucose tolerance test (OGTT). The diagnostic criteria for diabetes by American Diabetes Association (ADA) are:

- Fasting plasma glucose >126 mg/dl (or)
- 2 hour plasma glucose level >200 mg /dl.[10]

But recently international committee members selected by ADA suggested that glycosylated hemoglobin can be used as an alternative test for diagnosing diabetes.

- HbA1c >6.5%.
- In patient with classic symptoms of hyperglycemia or hyperglycemic crisis, a random plasma glucose >200 mg/dl is required.[11]

3. *Glycosylated hemoglobin (HbA1c)*

Glycosylated hemoglobin (HbA1c) is minor components of hemoglobin.[11] HbA1c is formed when a aldehyde group of glucose and other hexoses combine irreversibly, post translationally and non-enzymatically with the amino-terminal valine of the β -chain of hemoglobin, and this process is substrate-concentration dependent.[12] Then between 1958 and 1961, Allen, Schroeder and colleagues chromatographically separated several fast moving minor Hb components in red cell haemolysates from healthy adults.[13-16] They were called minor hemoglobins or fast hemoglobins because of their fast migration in electrophoretic field. They were described as HbA1a, HbA1b, HbA1c, in the order in which they were eluted.[17] The definitive structure of HbA1c was finally elucidated by Bunn et al.[18] Samuel Rahbar recognized that HbA1c is elevated in people with diabetics.[19] Then Trivelli in the

year 1971 suggested that the relationship between mean blood glucose, long-term diabetic complications and fast hemoglobins.[20] Finally, it was Anthony Cerami, Ronald Koenig and co-workers, who in 1976 proposed the role of HbA1c for monitoring the degree of control of glucose metabolism in diabetic patients.[21]

HbA1c has now become more advantageous than measuring plasma glucose levels, since HbA1c is biologically more stable, not affected by nutritional status, stress or other disorder and does not require fasting, and more suitable reflection of chronic glycemic state.[22]

Objectives

The purpose of the study is to find the prevalence rate of undiagnosed diabetics and pre diabetics among voluntary blood donors using FINDRISC as a screening tool in a tertiary health care setting.

METHODS

The present study was a descriptive study in which a total of 223 donors who came to donate blood in our Aarupadai Veedu Medical College and Hospital Blood bank, India were included in the study.

Table 1: Find risk assessment form.

Circle the right alternative and add up your points	
1. Age 0p. Under 45 years 2p. 45-54 years 3p. 55-64 years 4p. Over 64 years	5. How often do you eat vegetables, fruits or berries? 0p. Every day 1p. Not every day
2. Height: cm Weight: Kg Body mass index: _____ 0 p. Lower than 25Kg/m^2 1 p. 25-30Kg/m^2 3 p. Higher than 30 Kg/m^2	6. Have you ever taken anti-hypertensive medication regularly? 0p. No 2p. Yes
3. Waist circumference measured below the ribs (Usually the level of the navel) MEN / WOMEN 0 p. Lesser than 94cm / Less than 80cm 3p. 94-102 cm / 80-88 cm 4p. More than 102cm / More than 88cm	7. Have you ever been found to have high blood glucose (e.g., in a health examination during an illness, during Pregnancy)? 0p. No 5p. Yes
4. Do you usually have daily at least 30 minutes of physical activity at work and/or during leisure time (including normal daily activity)? 0p.Yes 2p.No	8. Have any of the members of your immediate family or Other relative been diagnosed with diabetes (type1 Or type2)? 0p. No 3p. Yes grandparent, aunt, uncle or first cousin (but no own parent, brother, sister or child) 5p. Yes: parent, brother, sister or own child
Total risk score ☐ The risk of developing type 2 Diabetes within 10 years is Lower than 7: Low estimated 1 in100 will develop disease 7-11: Slightly elevated estimated 1 in 25 will develop disease 12-14: Moderate estimate 1 in 6 will develop disease 15-20: High estimated 1 in 3 will develop disease > 20: Very high estimated 1 in 2 will develop disease	

Institutional ethical clearance was obtained prior to the study. Among 223 donors, 13 donors were excluded by applying the exclusion criteria such as vaccination for hepatitis (5), already diagnosed diabetes (4), and had alcohol within 24 hrs (4) before donation. All subjects (210) who are eligible as blood donors after taking proper medical history and preliminary health checkup; they are recruited into this study after obtaining written informed consent. An information sheet explaining about the purpose of the study will be provided to each subject. After obtaining the consent, subjects will be assessed with FINDRISC questionnaire (Table 1). The patients with score ≥12 points, blood samples were taken and HbA1c test will be done by particle enhance

immunoturbidimetric test to detect diabetes and prediabetes.

RESULTS

A total of 210 voluntary blood donors were included in the study of which 195 (92.86%) were male and 15 (7.14%) were female (Figure 1).

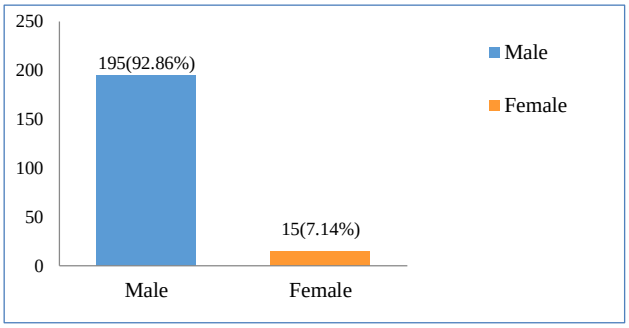

Figure 1: Sex ratio.

Subjects included in the study ranging from 18-50 years. Group 1 (18-28 years) comprising of 112 (53.33%) subjects, group 2 (29-39 years) comprising of 75 (35.71%) subjects, group 3 (40-50 years) comprising of 23(10.96%) subjects (Figure 2).

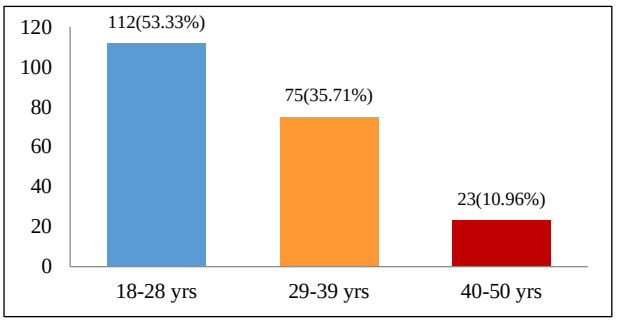

Figure 2: Age group.

Samples of donors who had ≥12 points from FINDRISC questionnaire are tested for HbA1c levels and HbA1c between 5.7-6.4% was diagnostic of pre-diabetes and values of ≥6.5% was diagnostic of diabetes.

From the FINDRISC questionnaire it was found that 117 (55.71%) donors had a score of <12 points, and 93 (44.29%) donors had a score of >12 points. Blood samples from these 93 donors were tested for HbA1c levels for diagnosing diabetes/prediabetes. The results showed that 36 (38.71%) donors had normal HbA1c level, 43 (46.24%) donors were prediabetic and 14 (15.05%) donors were diabetic among these 93 donors (Figure 3).

Body mass index (BMI) was recorded for all the donors. Out of 210 donors, 109 (51.9%) had normal BMI, 69 (32.86%) donors were in overweight (BMI 25-29 Kg/m^2) category and 32 (15.24%) were under obese (BMI >30kg/m^2) category. Among 69 overweight individuals 21 (30.43%) were in prediabetic stage and 4 (5.8%) were diabetics. In 32 obese individuals 22 (68.75%) were prediabetics and 10 (31.25%) were diagnosed as diabetics (Figure 4).

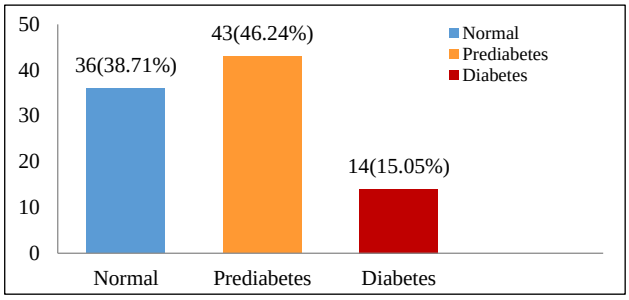

Figure 3: FINDRISC score versus diabetes/prediabetes.

Among 210 voluntary donors 89 (42.38%) had family history of diabetes and 121 (57.62%) did not have any family history of diabetes. Among donors with positive family history prediabetics were 33 (37.08%) and diabetics was 11 (12.36%) but with negative family history they were 10 (8.26%) donors who are in prediabetic stage and 3 (2.48%) were diabetics (Figure 5).

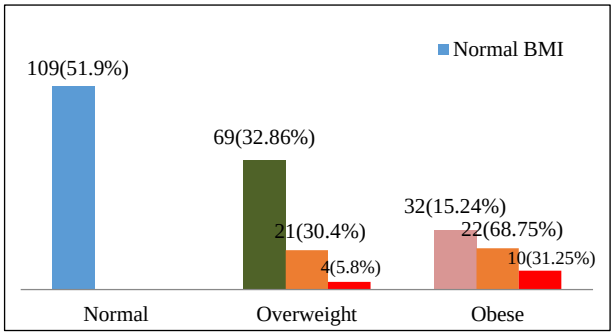

Figure 4: Body mass index.

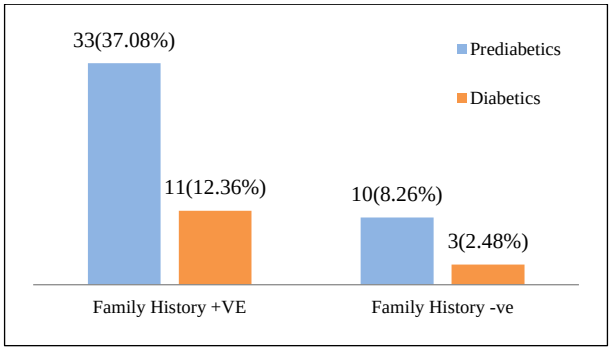

Figure 5: Family history of diabetes.

Out of 210 voluntary donors 163 (77.62%) were non-alcoholics and 47 (22.38%) donors were alcoholics among which 13 (27.66%) donors were prediabetics and 4 (8.5%) were diabetics. In 163 (77.62%) non-alcoholics,

30 (18.4%) were prediabetics and 10 (6.13%) was diabetics (Figure 6).

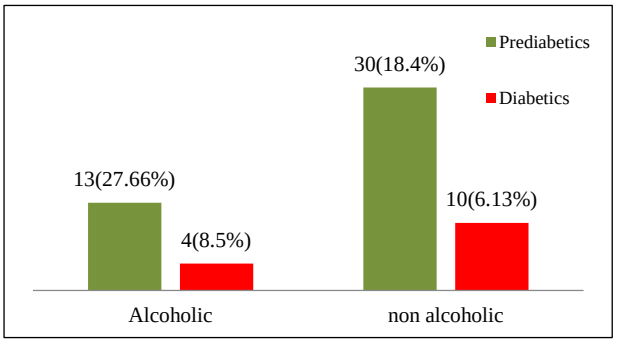

Figure 6: Non-alcoholic versus alcoholic subjects.

DISCUSSION

In India the nationwide study was performed by the Indian Council of Medical Research task force on diabetes in which, 34194 subjects were screened and the prevalence of diabetes was shown to be 2.1% in urban subjects and 1.5% in the rural population. There has been a rapid increase in diabetes epidemiology studies in India in the past 20 years.[23]

In large Indian cities like Chennai, Trivandrum, Mumbai, Delhi, as well as in a national study in large metropolises and industrial populations, diabetes prevalence among adults (≥ 20 years) has ranged from 8 to 15 %.[3]

In our study a total of 210 subjects were included among which 195 (92.86%) males and 15 (7.14%) females. Our study revealed that among 210 voluntary blood donors, using FINDRISC questionnaire with HbA1c as screening cum diagnostic tool for undiagnosed diabetics and prediabetics, found that 93 donors had a score of ≥12 points, out of which 43 (46.24%) were prediabetics and 14 (15.05%) were diabetics and 36 (38.71%) had normal HbA1c levels. Similar study has been done by Martin et al in Germany. He showed that among 671 donors, 27 were diagnosed to have diabetes and 322 donors were diagnosed with prediabetes using FINDRISC score and followed by HbA1c testing. They have concluded that FINDRISC score in combination with HbA1c testing can be applied as screening strategy to detect undiagnosed diabetes in large population.[24] Our study also proved that FINDRISC score along with HbA1c testing can help in mass screening of undiagnosed diabetes and prediabetes.

Recently ADA has recommended that HbA1c can be used for diagnosis of diabetes mellitus. Since the precision and accuracy has been improved greatly in recent years with widespread availability of international standardization. HbA1c is expected to overtake the OGTT as the test of choice for diabetes mellitus.[11] Since HbA1c is biologically more stable and not affected by nutritional status, medication, posture, exercise, stress or other disorders. On the other hand OGTT can be influenced by active infection, venous stasis, physical activity and diet.[22]

In current scenario there are at least 150 million people were diagnosed to have diabetes worldwide of which two thirds in developing nations. It was also noted that rise in diabetic population seems to be in the most economically productive age group. But whether young adults should be screened for type 2 diabetes remains controversial? Our study showed that young adults between 18-28 years of age were 112 (53.33%) donors, of which 8 (7.14%) were prediabetics and 2 (1.79%) was diabetic. In age group of 29-39 years were 75 (35.71%) donors of which 23 (30.67%) was prediabetics and 4 (5.33%) was diabetics. In the age group between 40-50 years were 23 (10.96%) among which 12 (52.17%) was prediabetics and 8 (34.78%) was diabetics. Similarly a study done by Purty et al on prevalence of diabetes mellitus in urban population showed that in the total population of 11,835 there are about 684 (5.8%) persons with diabetes. In the age group of >20 years the prevalence rate was 8.2% of diabetes and was more than 20% after the age of 50 years.[3]

In our study, among 210 voluntary donors, BMI was normal in 109 (51.9%) donors and overweight in 69 (32.86%) and obese in 32 (15.24%) donors. Among the obese category subjects 19 (59.38%) were prediabetics and 10 (31.25%) were diabetics. Among overweight individuals 20 (28.99%) donors were in prediabetics and 4 (5.8%) donors were diabetics. This shows that BMI was associated with elevated risk of diabetes and prediabetes. Study done by David Edelman et al studied on the utility of HbA1c in predicting diabetes risk. He showed that HbA1c and BMI was significant predictor of undiagnosed type 2 diabetes.[25] Another study by Gupta SK et al also showed that the chances of high diabetic score increases with increase in BMI. They also got a prevalence of 5.99% diabetes in their studied population where 56% cases of diabetes had high score.[7]

In the present study 89 (42.38%) had family history of diabetes, in which 33 (37.08%) were diagnosed to be prediabetics and 11 (12.36%) were diabetics, and 121 (57.62%) did not have family history of diagnosed diabetics, among them 10 (8.26%) were diagnosed to be in prediabetic stage and 3 (2.48%) were diagnosed to be diabetics. A study conducted by Ramachandran et al on high prevalence of diabetes in an urban population in South India showed that 47% of the people who had diabetes had a positive family history, and the other study done by Gupta SK et al also showed that 31.50% had positive family history in diagnosed Type 2 Diabetes in urban population.[26,7] These differences possibly may be due to difference in socio-economic status and varying life style of the respondents.

In our study, 163 (77.62%) were non-alcoholics and 47 (22.38%) donors were alcoholics among which

13 (27.66%) donors were prediabetics and 4 (8.5%) were diabetics, in 163 (77.62%) non-alcoholics, 30 (18.4%) were prediabetics and 10 (6.13%) was diabetics. We had not found any correlation between alcohol and diabetes. The probable reason for this is that we included patients who had any history of alcohol intake, since the time of starting alcohol intake and the amount may be an important factor as Ming Wei et al. in his study he showed that each 100 g/week of alcohol in-take (8 drinks) for average of 6 years was associated with a 10% higher incidence of type 2 diabetes.[28]

After completing the study, all voluntary donors included in the study are called for a meeting. The findings were discussed and a session was conducted to motivate them to take necessary precaution and advised to adopt a healthy lifestyle.

CONCLUSION

The prevalence rate of diabetes is 14 (15.05%) and pre diabetes is 43 (46.24%) respectively. The FINDRISC questionnaire was perceived a reliable, valuable and easy to use screening tool for large number of people at risk of undiagnosed diabetes and prediabetes. Nevertheless, further investigation on a large population is needed in order to determine the best cut-off value of the FINDRISC questionnaire to be used for diagnostic evaluation of diabetes. By interventional life style modification, persons detected as diabetics and prediabetics have a chance to delay disease progression and limit secondary damage caused by undiagnosed diabetes. Since this is the first study on non-communicable diseases like diabetes on voluntary blood donors which has not been reported in our country, hence more such studies are needed.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Huizinga MM, Rothman RL. Addressing the diabetes pandemic: a comprehensive approach. Indian J Med Res. 2006;124:481-4.
2. Wild S, Roglic G, Green A, Sicree R, King H. Global prevalence of diabetes: Estimates for the year 2000 and projections for 2030. Diabetes Care. 2004;27:1047-53.
3. Purty AJ, Vedapriya, Bazroy J, Gupta S. Prevalence of diabetes in an urban area of Puducherry, India: time for preventive action. Int J Diab Dev Ctries. 2009;29:6-11.
4. American Diabetes Association. Clinical Practice Recommendations. Standards of medical care for patients with DM. January 2012;35:S11-S63.
5. International Expert Committee report on the role of the A1C assay in the diagnosis of diabetes. Diabetes Care 2009;32:1327-34.
6. Shaw JE, Sicree RA, Zimmet PZ. Global estimates of the prevalence of diabetes for 2010 and 2030. Diabetes Res Clin Pract. 2010;87:4-14.
7. Gupta SK, Singh Z, Purty AJ, Vedapriya DR. Diabetes prevalence and its risk factors in rural areas of Tamilnadu. Indian J Comm Med. 2010;35:396-9.
8. Ginis Z, Ozturk G, Sirmali R, Yalcindag A. The role of HbA1c as a screening and diagnostic test for diabetes mellitus in Ankara. Turk J Med Sci. 2012;42(2):1430-6.
9. Janghorbani M, Adinesh H, Amini M. Evaluation of the finnish diabetes risk score (FINDRISC) as a screening Tool for the metabolic syndrome. The Rev Diabetic Stud. 2013;10:283-92.
10. American diabetes association. diagnosis and classification of diabetes mellitus. Diabetic Care. 2012;35:S67-71.
11. International expert committee report on the role of the A1C assay in the diagnosis of diabetes. Diabetes Care. 2009;32:1327-34.
12. Rahbar S. The discovery of glycated hemoglobin: a major event in the study of nonenzymatic chemistry in biological systems. Ann NY Acad Sci. 2005;1043:9-19.
13. Chandalia HB, Krishnaswamy PR. Glycated haemoglobin. Current Science. 2002;83(12):1522-32.
14. Allen DW, Schroeder WA, Balog J. Oberservations on the chromatographic heterogeneity of normal adult and fetal human hemoglobin: a study on the effectstallization and chromatography on the heterogeneity and isoleucine content. J Am Chem Soc.1958;80:1628-34.
15. Clegg MD, Schroeder WA. A chromatographic study of the minor components of normal adult haemoglobin including a comparison of haemoglobin from normal and phenylketamine individuals. J Am Chem Soc. 1959;81:6065-9.
16. Schneck AG, Schroeder WA. The relation between the minor components of normal adult haemoglobin as isolated by chromatography and starch block electrophoresis. J Am Chem Soc. 1961;83:1472-8.
17. Huisman THJ, Dozy AM. Studies on the heterogeneity of haemoglobin. V. Binding of haemoglobin with oxidised glutathione. J Lab Clin Med. 1962;60:302-5.
18. Bunn HF, Haney DN, Gabbay KH, Gallop PM. Further identification of the nature and linkage of the carbohydrate in hemoglobin Al Biochem Biophys Res Commun. 1975;67:103-9.
19. Rahbar S. An abnormal hemoglobin in red cells of diabetics. Clin Chim Acta. 1968;22:296.
20. Trivelli LA, Ranney HM, Lai HT. Haemoglobin components in patients with diabetes mellitus. N Eng J Med. 1971;284:353-7.

21. Koenig RJ, Peterson CM, Jones RL, Saudek C, Lehrman M, Cerami A. Correlation of glucose regulation and hemoglobin AIC in diabetes mellitus. N Engl J Med. 1976;295(8):417-20.
22. Kumar PR, Bhansali A, Ravikiran M, Bhansali S, Dutta P. Utility of glycated hemoglobin in diagnosing type 2 diabetes mellitus: a community-based study. J Clin Endocrinol Metab. 2010;95:2832-5.
23. Sridhar GR, Rao PV, Ahuja MM. Epidemiology of diabetes and its complications. In: Ahuja MM, Tripathy BB, Moses SG, editors. RSSDI textbook of diabetes mellitus. Hyderabad: RSSDI;2002:95-112.
24. Martin E, Ruf E, Landgraf R. FINDRISK questionnaire combine with HbA1c testing as a potential screening strategy for undiagnosed diabetes in a healthy population. Horm Metab Res. 2011;43(11):782-7.
25. Edelman D, Olsen MK, Dudley TK. Utility of hemoglobinA1c in Predicting Diabetes Risk. J Gen Intern Med. 2004;19:1175-80.
26. Ramachandran A. High prevalence of diabetes and impaired glucose tolerance in India: national urban diabetes survey. Diabetologia. 2001;44(9):1094-101.
27. Ming W, Gibbons L, Mitchell T, Kampert J. Alcohol intake and incidence of type 2 diabetes in men. Diabetes Care. 2000;23:18-22.

Cite this article as: Ramasamy J, Parthasarathy UK. Prevalence of undiagnosed diabetes and prediabetes among voluntary blood donors in a tertiary health care setting. Int J Res Med Sci 2016;4:2569-75.