## **Original Research Article**

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# Study of the effect of prior calorie intake on results of random blood sugar measurement for screening of diabetes mellitus

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## **ABSTRACT**

**Background:** Random blood sugar (RBS) is a commonly performed screening test for type 2 diabetes in both programmatic as well as clinical settings. Previous calorie intake is known to affect the results of RBS. So, present study was conducted to assess the effect of previous calorie intake on sensitivity, specificity, positive and negative predictive values (NPV) and accuracy of RBS.

**Methods:** A cross sectional study was done in 317 patients of 30 years or more using systematic random sampling in a general outpatient department of a district hospital. All the patients underwent RBS measurement. History of calorie intake in past 1-2 hours before undergoing RBS was taken. Screening test parameters of RBS was evaluated using oral glucose tolerance test as clinical reference.

**Results:** This study found that calorie consumption of 200 kcal or more significantly affected the screening test result of RBS. When patient had consumed 200 kcal or more in last 1-2 hours, the sensitivity of RBS is 90.0%, specificity is 57.4%, positive predictive value (PPV) is 26.9% and NPV is 97.1%. Whereas, these parameters are 63.3%. 78.5%, 43.6% and 88.9% respectively when patient had consumed less than 200 kcal in last 1-2 hours before RBS.

**Conclusions:** Sensitivity and NPV of RBS is higher if patient had consumed more than 200 kcal 1-2 hours prior to RBS whereas specificity and PPV is higher if patient had consumed less than 200 kcal. Taking history of quantity and time of last meal would be helpful to better interpret the screening test results of RBS.

Keywords: RBS, Screening test, Type 2 diabetes, Sensitivity, Specificity

## INTRODUCTION

Diabetes and other non-communicable diseases (NCD) are a growing challenge in world as well as in India. India is home to 62 million diabetics, with estimated 8.7% diabetic population in the age group of 20 and 70 years. To address the raising trend of NCDs, Government of India has initiated National Program for Prevention and Control of Cancer, Diabetes, Cardiovascular Diseases and Stroke (NPCDCDS) in October 2010 towards the end of

the  $11^{th}$  Plan.<sup>3,4</sup> One of the strategy of NPCDCS is early diagnosis of chronic NCD which consist of opportunistic screening of persons above the age of 30 years at the point of primary contact with any health care facility. Under this program, opportunistic screening for diabetes is recommended by random capillary blood glucose testing; random blood sugar (RBS). The cut-off decided for this screening test is 140 mg/dl. Those who are having RBS  $\geq 140 \text{ mg/dl}$  are further tested for fasting blood sugar and post prandial blood sugar.

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Moreover, RBS is a commonly performed test in suspected cases of diabetes in any clinical setting. Previous calorie intake is known to affect the results of blood glucose measurement.<sup>5</sup> So, present study was conducted to assess the effect of previous calorie intake on sensitivity, specificity, positive and NPV and accuracy of RBS.

## **METHODS**

We conducted a cross-sectional study during February 2017 to August 2017 at a district hospital of Suarashtra, Gujarat. As a part of NPCDCS program, all the patients of 30 years or more coming to general outpatient department (OPD) of this hospital are screened by RBS testing for detection of type 2 diabetes.

#### Sampling technique and sample size

We used systematic random sampling to select every third patient from the general OPD attendees of 30 years or more coming to this district hospital. We excluded the patients who were a known case of diabetes mellitus or those requiring urgent medical attention. During stipulated time, we enrolled total 317 patients. All the selected patients underwent RBS measurement using SD CodeFree<sup>TM</sup> blood glucose meter and SD CodeFree<sup>TM</sup> blood glucose test strip, manufactured by SD BIOSENSOR, (Republic of Korea).<sup>6</sup>

All the enrolled patients were asked the details about time and content of food items consumed within last 1-2 hours just before undergoing RBS. The amount of food consumed was converted into calorie value using standard Indian Council of Medical Research manual.<sup>7</sup>

Oral glucose tolerance test (OGTT) was done for all the enrolled patients using 75 gm glucose dissolved in 200 ml of water. The time of completion of 75 gm glucose was noted for each patient and venous blood was collected in fluoride bulb 2 hours after complete ingestion of 75 gm glucose. The blood sugar of the collected samples was measured at the Biochemistry laboratory of P.D.U. Medical College Hospital which is a National Accrediting Board for Laboratories certified laboratory.

## Data analysis

The data was entered in MS Excel and the data analysis was done using Epi Info v7.2 and MS Excel. Sensitivity, specificity, positive predictive value (PPV), negative

predictive value (NPV) and accuracy of RBS were calculated taking result of OGTT as clinical reference.

#### Ethical considerations

The study was approved by institutional ethics committee of P. D. U. Medical College, Rajkot. Informed written consent was taken from all patients prior to enrolment in the study and confidentiality was assured.

#### RESULTS

In this study, 317 study participants underwent RBS measurement where RBS <140 mg/dl was considered as screened 'negative' and ≥140 mg/dl was considered as screened 'positive'. Out of total 317 study participants, 38.5% (n=122) patients were screened positive while 61.5% (n=195) were screened negative for type 2 diabetes by RBS measurement. The screening test results showed that the sensitivity of RBS is 72.4%, specificity is 69.1%, PPV is 34.4%, NPV is 91.8% and accuracy is 69.7% (Table 1).

To see the least amount of calorie consumption that would maximally affect the result of RBS, various cutoffs of calorie consumption was used to cross tabulated it with the screening test results of RBS.

Out of 122 study participants having positive screening result, 54.9% (n=67) consumed calorie equivalent to 200 kcal or more whereas 45.1% (n=55) consumed calorie less than 200 kcal. Out of 195 study participants having negative screening result, 34.9% (n=68) consumed calorie equivalent to 200 Kcal or more whereas 65.1% (n=127) consumed calorie less than 200 kcal. It was found that calorie consumption equivalent to 200 Kcal or more was significantly associated with 'positive' screening result by RBS. This association was found significant at p<0.001 (Table 2).

To know the effect calorie intake on screening by RBS, screening test parameters of RBS was analysed in two groups of patients as those who consumed 200 kcal or more and those who consumed less than 200 kcal before undergoing RBS testing.

In present study, total 135 patients reported to consume 200 kcal or more within past 1-2 hours of undergoing RBS whereas total 182 patients reported to consume less than 200 kcal. The screening test result of RBS in these two groups is shown in Table 3 and 4.

**Table 1: Screening results of RBS.** 

Screening by RBS	OGTT result		Total
	Diabetic	Non-diabetic	
	N (%)	N (%)	N (%)
Positive (≥140 mg/dl)	42 (72.4)	80 (30.9)	122 (38.5)
Negative (<140 mg/dl)	16 (27.6)	179 (69.1)	195 (61.5)
Total	58 (100)	259 (100)	317 (100)

Table 2: Association between history calorie consumption and screening result of RBS.

Calorie consumption equivalent to	Screening result of RBS		Total
	Positive	Negative	<b>Total</b>
	N (%)	N (%)	N (%)
200 kcal or more	67 (54.9)	68 (34.9)	135 (42.6)
Less than 200 kcal	55 (45.1)	127 (65.1)	182 (57.4)
Total	122 (100)	195 (100)	317 (100)

 $\chi^2$ =12.334, df=1, p<0.001.

Table 3: Screening test results of RBS in those who consumed 200 kcal or more.

RBS measurement	OGTT result		Total
	Diabetic	Non-diabetic	Total
	N (%)	N (%)	N (%)
Positive	18 (90.0)	49 (42.6)	67 (49.6)
Negative	2 (10.0)	66 (57.4)	68 (50.4)
Total	20 (100)	115 (100)	135 (100)

Table 4: Screening test results of RBS in those who consumed less than 200 kcal.

RBS measurement	OGTT result		Total
	Diabetic	Non-diabetic	Total
	N (%)	N (%)	N (%)
Positive	24 (63.3)	31 (21.5)	55 (30.2)
Negative	14 (36.7)	113 (78.5)	127 (69.8)
Total	38 (100)	144 (100)	182 (100)

Table 5: Screening test parameters of RBS for two groups according to calorie consumption.

Screening test parameters	Group 1 (patient who consumed 200 kcal or more)	Group 2 (patient who consumed less than 200 kcal)	Overall screening test result of RBS
	N (%)	N (%)	N (%)
Sensitivity	90.0	63.3	72.4
Specificity	57.4	78.5	69.1
PPV	26.9	43.6	34.4
NPV	97.1	88.9	91.8
Accuracy	62.2	75.3	69.7

Table 5 shows screening test parameters for two groups according to calorie consumption and its comparison with overall screening test results of RBS. As shown in the table, in group 1, the sensitivity of RBS is 90.0%, specificity is 57.4%, PPV is 26.9% and NPV is 97.1%. Whereas in group 2, these parameters are 63.3%. 78.5%, 43.6% and 88.9% respectively. Overall accuracy of RBS is 62.2% if patient has consumed more than 200 kcal whereas it is 75.3% when patient has consumed less than 200 kcal (Table 5).

## **DISCUSSION**

Our study found that screening test results of RBS is significantly affected by consumption of calorie in last 1-2 hours just before RBS. As seen in Table 5, consumption of more than 200 kcal increases the sensitivity and NPV of screening by RBS, although specificity and PPV

decreases. If the screening is done by RBS when patient has consumed less than 200 kcal, sensitivity and NPV is lesser than group 1, but there is increase in specificity and PPV. Overall accuracy of RBS is better when patient has consumed less than 200 kcal. There are various studied which have evaluated screening properties of random capillary blood glucose measurement, although very few studies have evaluated effect of previous calorie intake on the results of RBS measurement.

In a study carried out by Simmons et al, it was found that sensitivity of RBS is higher at 83.9% when done within 2 hours of a meal in south Asian population as compared to 54.9% when done at more than or equal to 2 hours after a meal. This finding is similar to the findings of present study.

In a study carried out by Engelgau et al, it was found that for noninsulin-dependent diabetes mellitus, screening by RBS performed better when subjects had eaten shortly before the test. It was found in this study that, for a postprandial period of 1 hour, cut-off points of 115 mg/dl for individuals 30 years of age and 140 mg/dl for those 75 years of age yielded similar performance characteristics (sensitivity 82% and specificity 78% for those 30 years old; sensitivity 81% and specificity 80% for those 75 years old). The study concluded that screening by random capillary blood glucose measurement was significantly affected by postprandial period. Present study has also found similar results.

#### CONCLUSION

It was found in present study that consumption of calorie in last 1-2 hours significantly affects the screening test results of RBS. Sensitivity and NPV of RBS are higher if patient had consumed more than 200 kcal just prior to RBS whereas specificity and PPV are higher if patient had consumed less than 200 kcal. When more number of true positives are required to be identified, sensitivity should be high. So, it is better to apply screening by RBS when patient had consumed more than 200 kcal, as this would detect 90% of true positives. From a clinician's perspective, who is more interested in PPV, it is better to screen patient when he is empty stomach or consumed less than 200 kcal, because PPV is better in this state. History of quantity and time of last meal should always be taken as this would be helpful to better interpret the screening test result of RBS.

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