https://doi.org/10.46389/rjd-2021-1005
www.rjdnmd.org

Rom J Diabetes Nutr Metab Dis
2021; volume 28, issue 1, pages 27-37

Original Research

1-Hour post-load glycemic value in risk population: a better tool for type 2 diabetes screening?

Sorina-Alina Chelaru*[1,2], Doina Catrinoiu[1,2], Ileana Ion[2]

[1] **Emergency Clinical County Hospital, Diabetes Mellitus, Nutrition and Metabolic Diseases Unit, Constanţa, Romania**
[2] **Ovidius University, Faculty of Medicine, Constanţa, Romania**

*Correspondence to: Sorina-Alina Chelaru, Diabetes Mellitus, Nutrition and Metabolic Diseases Unit, Emergency Clinical County Hospital, Constanta, Romania, E-mail: cristeasorinaalina@yahoo.com, Phone:+40723369221

Received: 11 January 2021 / Accepted: 8 March 2021

Abstract

Background and Aims: Type 2 diabetes mellitus (T2DM) is a chronic disease with a negative impact by decreasing the life quality and expectancy of patients. The PREDATORR study, which started in 2013 in our country showed double prevalence to previous data. In 2000, the World Health Organization drew attention to the fact that it is the first time that a non-infectious disease has become epidemic, replacing the major health problems of the last century. The study evaluates the usefulness of measuring one hour post-load blood glucose during an oral glucose tolerance test in T2DM risk population. **Material and Method:** The subjects included in the study were selected over a period of two years from the patients' families of the Diabetes, Nutrition, and Metabolic Diseases Outpatient Unit of the "St. Andrew" Emergency Clinical County Hospital of Constanta. The assessment was made based on the risk score for diabetes (FIND RISC), anthropometric indices, and glucose metabolism parameters. The statistical analysis was performed in SPSS 27.0, STATA and Microsoft Excel. **Results:** The studied population consisted of 112 subjects, 38.4% being included in the control group and 61.6% in the study group. In the analysis of risk factors present in the study group, pre-diabetes was identified in 36.2% of patients, exclusively characterized by impaired fasting glucose. The values of FIND RISC score were much higher in the study group than in the control group. The BMI was higher in the study group compared to the control group. In 65.8% of patients regarding basal glycemia and 80% regarding glycated hemoglobin, the values did not exceed the pathological threshold. In the study group, 1-hour post-load blood glucose identified more patients at risk for T2DM than 2-hour post-load glycemic value. **Conclusions:** Evaluation of glucose metabolism parameters through the oral glucose tolerance test may be useful in screening for T2DM and the measurement of 1-hour post-load blood glucose can be used successfully among patients at risk.

Keywords: screening, type 2 diabetes, 1-hour post-load glycemia.

Background and Aims

Type 2 diabetes mellitus (T2DM) is defined by chronic hyperglycemia in the background of insulin deficiency itself or associated insulin resistance with negative effect on carbohydrate, protein, and lipid metabolism [1].

In recent years, many studies identified various clinical conditions associated with insulin resistance and compensatory hyperinsulinemia such as pre-diabetes, metabolic syndrome, obesity, dyslipidemia, primary arterial hypertension, polycystic ovary syndrome, atherosclerosis, hepatic steatosis or even the family history of T2DM [2].

Over time, International Diabetes Federation (IDF) tried to draw attention to the potential burden of diabetes, but even their prediction did not estimate the real impact. Nowadays, there is a dramatic trend of diabetes globalization in the background of obesity, another worldwide health problem [3, 4]. The major environmental changes after 2nd World War were directly involved in creating an obesogenic environment through poor

quality food supply and decrease of daily physical activity [5].

In 2019, IDF declared 463 million patients diagnosed with diabetes and estimated for 2045 an increase of 51% [6]. The recent study conducted in our country, PREDATORR, showed doubled prevalence of 11.6% compared to previous local data [7, 8].

In 2000, the World Health Organization drew attention to the fact that it is the first time that a non-infectious disease has become epidemic, replacing the major health problems of the last century.

T2DM is a chronic disease with a negative impact by decreasing the life quality and expectancy of patients [9, 10].

The study evaluates the usefulness of measuring one-hour post-load blood glucose during a oral glucose tolerance test in T2DM risk population.

Material and Method

Being a case control study, it consisted of two groups selected over a period of two years from the family patients of the Diabetes, Nutrition and Metabolic Diseases Outpatient Unit of the "St. Andrew" Emergency Clinical County Hospital of Constanta. The inclusion and exclusion criteria are presented in table 1.

Table 1: Inclusion and exclusion criteria for the studied groups.

	Study group	**Control group**
Inclusion criteria	✓ Age between 18–75 years old; ✓ Romanian ethnicity; ✓ risk groups association: • Family history of T2DM; • Personal history of prediabetes (impaired fasting glucose - IFG and/ or impaired glucose tolerance - IGT); • Overweight or obesity; • Gestational diabetes (GD); • Polycystic ovary syndrome (PCOS); • Arterial hypertension/ Myocardial infarction; • dyslipidemia; • hepatic steatosis;	✓ Age between 18–75 years old; ✓ Romanian ethnicity; ✓ BMI <25 kg/m^2);
Exclusion criteria	✓ Age under 18 years or over 75 years old; ✓ Personal diagnosis of T2DM; ✓ BMI<25 kg/M^2; ✓ Women during pregnancy or breastfeeding period; ✓ Recent surgical procedures; ✓ Other known chronic diseases (chronic pancreatitis, chronic hepatitis, liver cirrhosis, cancers, hemochromatosis, HIV infection); ✓ Chronic consumption of alcohol (>40 g/ daily on men and 20 g/daily on woman).	✓ Age under 18 years or over 75 years old; ✓ Personal diagnosis of T2DM; ✓ risk groups association: • Family history of T2DM; • Personal history of prediabetes (IFG glucose and/or IGT); • Overweight or obesity; • GD; • PCOS; • Arterial hypertension/ myocardial infarction; • dyslipidemia; • hepatic steatosis; ✓ Women during pregnancy or breastfeeding period; ✓ Recent surgical procedures; ✓ Other known chronic diseases (chronic pancreatitis, chronic hepatitis, liver cirrhosis, cancers, hemochromatosis, HIV infection); ✓ Chronic consumption of alcohol (>40 g/ daily on men and 20 g/daily on woman).

https://doi.org/10.46389/rjd-2021-1005

After inclusion in the study, the subjects of both groups were evaluated taking into account demographic data, family and personal pathological history, FIND RISC diabetes risk score, anthropometric indices (weight, height, BMI) and glucose metabolism parameters (fasting glycemia, 1-hour post-load and 2-hour post-load glycemia measured during the oral glucose tolerance test, glycated hemoglobin, after a nocturnal fasting for at least 8 hours, respectively after ingestion of 75 g of glucose dissolved in 200 ml of water). The statistical analysis was performed in SPSS 27.0, STATA and Microsoft Excel.

Results

The studied population consisted of 112 patients, divided in two groups: the control group, represented by 43 subjects (38.4%) and the study group consisting of 69 patients with risk for T2DM (61.6%). There is a balanced gender distribution (table 2), the investigated subjects belonging to adulthood with a mean value of 44.25 ± 13,348 years (table 3).

In the study group, T2DM was reported in first and second-degree relatives in 31.9% of cases. Those who had a history of first-degree relatives, accounted for 23.2%. A history of T2DM only to second degree relatives has been identified in 14.5% of patients. (table 4).

Following the risk factors analysis in the study group, pre-diabetes was the most frequently identified (36.2%), characterized exclusively by impaired fasting glucose (table 5).

We have counted the FIND RISC score for both groups, and we have identified that its values are much higher in the study group (13.90 ± 5,145) compared to the control group (5.35 ± 2,608), the differences being statistically significant (table 6). All patients of the control group had a low to moderate FIND score. In the study group, low to moderate risk was present in 58% of subjects, while the remaining 42% were at high and very high risk. One third of patients (31.9%) had a high FIND score and 10.1% had a very high FIND score (table 7). The patients' risk of diabetes varies in the same way: in 74.1% of patients (control group) and 58.0% of the others (study group), the risk is between 1–17%, meanwhile in 31.9% of patients of the control group there is a 33% risk of diabetes and in 10.1% of the same ones there is a 50% risk of diabetes (table 7).

We measured the anthropometric parameters (weight, height) and counted the body mass index (BMI) to identify the presence or absence of obesity. The recorded values are presented in detail, compared by gender and groups in table 8. In the control group, there were no overweight or obese patients, over 90% of them having BMI <25 kg/m^2. In the study group, the percentage of patients with normal weight decreased

Table 2: Gender distribution of both groups.

		Group						Pearson Chi-square	P
		Study		Control		Total			
		n	%	n	%	n	%		
Gender	Male	28	40.6%	17	39.5%	45	40.2%		
	Female	41	59.4%	26	60.5%	67	59.8%		
Total		69	100.0%	43	100.0%	112	100.0%	.012	.913

Table 3: Age - descriptive statistic parameters of both groups.

Group	N	Mean	Standard error	Standard deviation	Minimum	Maximum
Study	69	42.86	1.652	13.724	27	74
Control	43	46.49	1.914	12.553	25	61
Total	112	44.25	1.261	13.348	25	74

Table 4: Distribution according to family history of the study group.

Family history	Group				Total		Pearson Chi-square	p
	Study		Control					
	n	%	n	%	n	%		
without	21	30.4%	43	100.0%	64	57.1%		
1st degree	16	23.2%			16	14.3%	35.842	.000*
2nd degree	10	14.5%			10	8.9%	27.919	.000*
1st and 2nd degree	22	31.9%			22	19.6%		
Total	69	100.0%	43	100.0%	112	100.0%	52.348	.000*

Table 5: Distribution of other T2DM risk factors of the study group.

		Group				Total		Pearson Chi-square	p
		Study		Control					
		n	%	n	%	n	%		
Prediabetes	yes	25	36.2%	0	0.0%	25	22.3%	20.057	.000*
	no	44	63.8%	43	100.0%	87	77.7%		
IFG	yes	25	36.2%	0	0.0%	25	22.3%	20.057	.000*
	no	44	63.8%	43	100.0%	87	77.7%		
IGT	yes	0	0.0%	0	0.0%	0	0.0%	–	–
	no	69	100.0%	43	100.0%	112	100.0%		
GD	yes	10	24.4%	0	0.0%	10	14.9%	7.454	.006*
	no	31	75.6%	26	100.0%	57	85.1%		
Dyslipidemia	yes	10	14.5%	0	0.0%	10	8.9%	6.843	.007*
	no	59	85.5%	43	100.0%	102	91.1%		
Arterial hypertension	yes	17	24.6%	0	0.0%	17	15.2%	12.490	.000*
	no	52	75.4%	43	100.0%	95	84.8%		
Myocardial Infarction	yes	2	2.9%	0	0.0%	2	1.8%	1.269	.523
	no	67	97.1%	43	100.0%	110	98.2%		
Hepatic Steatosis	yes	7	10.1%	0	0.0%	7	6.3%	4.653	.042*
	no	62	89.9%	43	100.0%	105	93.8%		
PCOS	yes	6	14.6%	3	11.5%	9	13.4%	.131	1.000
	no	35	85.4%	23	88.5%	58	86.6%		
Total		69	100.0%	43	100.0%	112	100.0%		

significantly (26.1%), most of them being overweight (21.7%), 1st stage obesity (31.9%) or even with 2nd stage obesity (14.5%) (table 9, figure 1).

We also analyzed the glucose metabolism parameters by determining fasting glucose (FG), 1-hour (1-hG) and 2-hour (2-hG) post-load glycemic value during the oral glucose tolerance test (OGTT) and glycated hemoglobin (HbA1c).

The mean value of fasting glucose was higher in the study group (93.91 ± 14,961) compared to the control group (89.21 ± 5,734) (table 10). All patients in the control group had

https://doi.org/10.46389/rjd-2021-1005

Table 6: FIND score - descriptive statistic parameters in both groups.

Group	N	Mean	Standard error	Standard deviation	Minimum	Maximum
Study	69	13.90	.619	5.145	5	25
Control	43	5.35	.398	2.608	0	8
Total	112	10.62	.569	6.020	0	25

Table 7: Category distribution of the FIND RISC score in both groups.

Risk category – FIND score	Group						Pearson Chi-square	p
	Study		Control		Total			
	n	%	n	%	n	%		
Low to moderate	40	58.0%	43	100.0%	83	74.1%		
High	22	31.9%	0	0.0%	22	19.6%		
Very high	7	10.1%	0	0.0%	7	6.3%		
Total	69	100.0%	43	100.0%	112	100.0%	24.387	.000*

Table 8: BMI - descriptive statistic parameters, comparative by gender, in both groups.

Group	Gender	N	Mean	Standard error	Standard deviation	Minimum	Maximum
Study	Male	28	30.8746	.50654	2.68037	25.64	35.06
	Female	41	25.8551	.91248	5.84271	18.14	36.92
	Total	69	27.8920	.64939	5.39426	18.14	36.92
Control	Male	17	23.6412	.26378	1.08761	22.09	24.87
	Female	26	22.1481	.42841	2.18449	17.83	24.34
	Total	43	22.7384	.29871	1.95875	17.83	24.87
Total	Male	45	28.1420	.62214	4.17342	22.09	35.06
	Female	67	24.4166	.62066	5.08031	17.83	36.92
	Total	112	25.9134	.47824	5.06126	17.83	36.92

Table 9: Obesity distribution in both groups (according to BMI).

BMI category	Group						Pearson Chi-square	P
	Study		Control		Total			
	n	%	n	%	n	%		
underweight	4	5.8%	3	7.0%	7	6.3%		
normal weight	18	26.1%	40	93.0%	58	51.8%		
overweight	15	21.7%	0	0.0%	15	13.4%		
1st stage obesity	22	31.9%	0	0.0%	22	19.6%		
2nd stage obesity	10	14.5%	0	0.0%	10	8.9%		
Total	69	100.0%	43	100.0%	112	100.0%	52.269	.000*

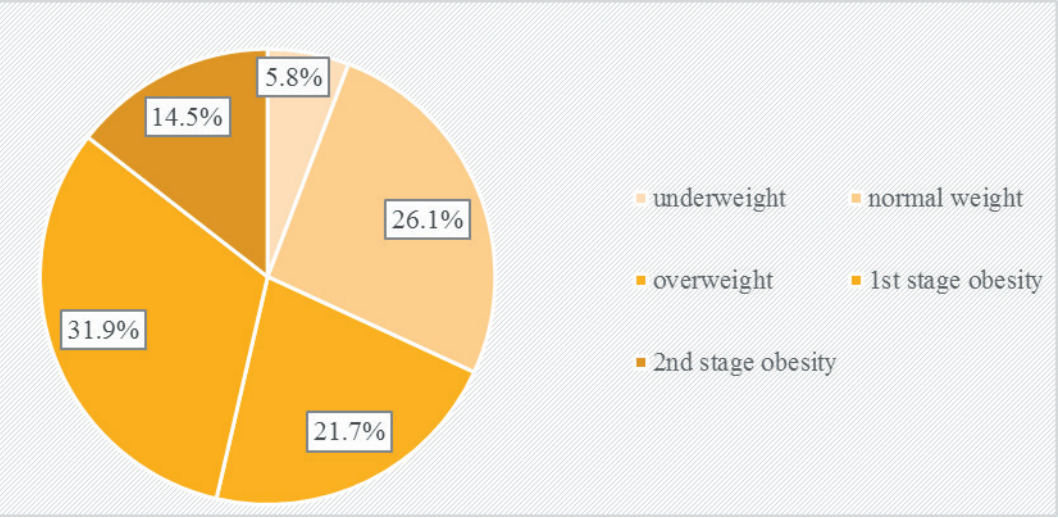


Figure 1: Weight category distribution in the study group (according to BMI).

Table 10: Fasting glycemia - descriptive statistic parameters in both groups.

Group	N	Mean	Standard error	Standard deviation	Minimum	Maximum
Study	69	93.91	1.801	14.961	74	134
Control	43	89.21	.874	5.734	78	99
Total	112	92.11	1.176	12.444	74	134

normal blood glucose values. In the study group, normal values of this parameter were recorded only in 65.2% of patients, 26.1% being with impaired fasting glucose and 8.7% with baseline values for T2DM. Consequently, the differences between the two groups are statistically significant (table 11, figure 2).

The mean value of 1-hour post-load glycemia was higher in the study group (156.39 ± 47,862) compared to the control group (126.51 ± 37,095), the differences being statistically significant (table 12). In the control group, over 80% of patients had values below 155 mg/dl. In the study group, 43.5% had 1-hG less than 155 mg/dl, 31.9% had a value between 155 and 200 mg/dl and 24.6% with a value over 200 mg/dl (table 13, figure.3).

The 2-hour post-load blood glucose (2-hG) had a higher mean value in the study group (116.42 ± 38,706) compared to the control group (98.16 ± 15,964) (table 14). All patients in the control group had normal values (NGT) for 2-hG, while in the study group the percentage of patients with NGT was reduced to 81.2%, impaired glucose tolerance (IGT) being identified in 15.9% of cases and T2DM in 2.9% of patients (table 15, figure 4).

The mean value of glycosylated hemoglobin (HbA1c) was higher in the study group

Table 11: Fasting glycemia - categories distribution of both groups.

FG	Group				Total		Pearson Chi-square	P
	Study		Control					
	n	%	n	%	n	%		
Normal	45	65.2%	43	100.0%	88	78.6%		
IFG	18	26.1%	0	0.0%	18	16.1%		
T2DM	6	8.7%	0	0.0%	6	5.4%		
Total	69	100.0%	43	100.0%	112	100.0%	19.036	.000*

https://doi.org/10.46389/rjd-2021-1005

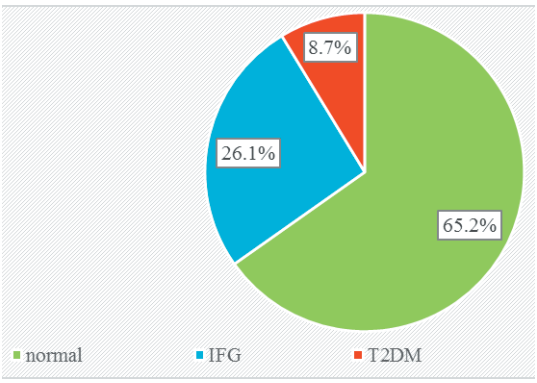


Figure 2: Fasting glycemia - categories distribution of the study group.

(5.44493 ± 0.334108) compared to the control group (5.39302 ± 0.222961), this time without statistically significant differences between groups (table 16). Over 80% had normal values for this parameter, pre-diabetes being thus identified only in 18.8% of them (table 17, figure 5). This suggests that HbA1c was not effective in identifying all patients at risk for diabetes.

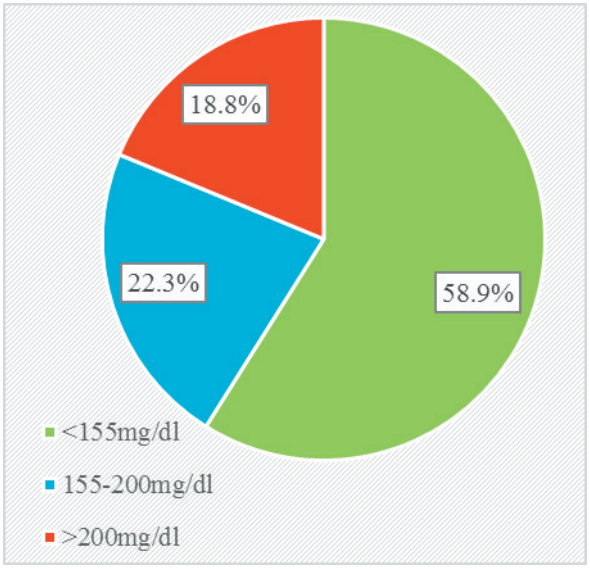
We used the receiver operating characteristic (ROC) analysis and area under the curve (AUC) to identify the cutt-off values of blood tests used for diabetes predisposition, respectively the

Table 12: 1-hour post-load glycemia - descriptive statistic parameters in both groups.

Group	N	Mean	Standard error	Standard deviation	Minimum	Maximum
Study	69	156.39	5.762	47.862	62	253
Control	43	126.51	5.657	37.095	68	205
Total	112	144.92	4.368	46.229	62	253

Table 13: 1-hour post-load glycemia - categories distribution of both groups.

1 hG	Group						Pearson Chi-square	P
	Study		Control		Total			
	n	%	n	%	n	%		
<155 mg/dl	30	43.5%	36	83.7%	66	58.9%		
155–200 mg/dl	22	31.9%	3	7.0%	25	22.3%		
200 mg/dl	17	24.6%	4	9.3%	21	18.8%		
Total	69	100.0%	43	100.0%	112	100.0%	17.966	.000*



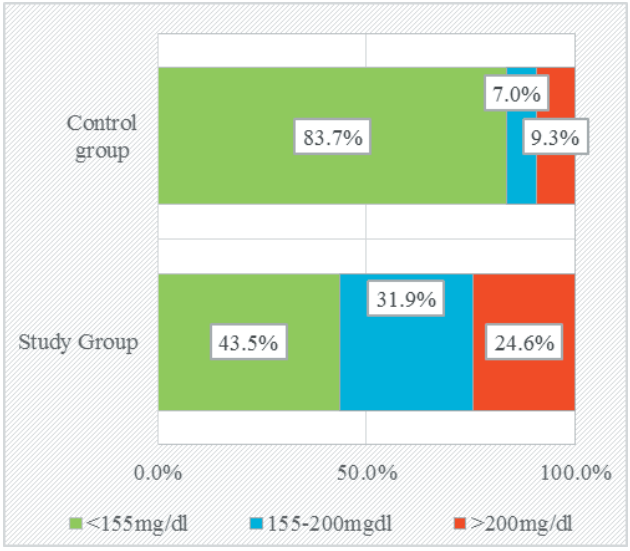


Figure 3: 1-hour post-load glycemia – categories distribution of both groups.

Table 14: 2-hour post-load glycemia - descriptive statistic parameters in both groups.

Group	N	Mean	Standard Error	Standard Deviation	Minimum	Maximum
Study	69	116.42	4.660	38.706	61	247
Control	43	98.16	2.435	15.964	68	117
Total	112	109.41	3.125	33.072	61	247

Table 15: 2-hour post-load glycemia - categories distribution of both groups.

2hG	Group						Pearson Chi-square	p
	Study		Control		Total			
	n	%	n	%	n	%		
NGT	56	81.2%	43	100.0%	99	88.4%		
IGT	11	15.9%	0	0.0%	11	9.8%		
T2DM	2	2.9%	0	0.0%	2	1.8%		
Total	69	100.0%	43	100.0%	112	100.0%	9.165	.010*

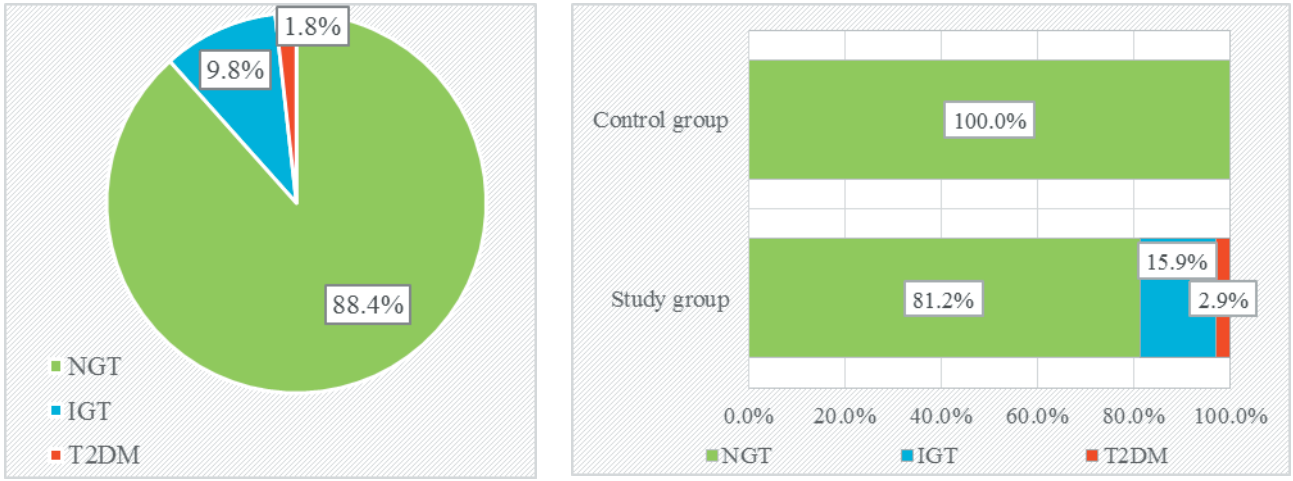


Figure 4: 2-hour post-load glycemia – categories distribution of both groups.

patients' affiliation to the study group compared to the control group. To choose the appropriate cut-off value, we took into consideration the sensitivity, specificity, and maximum of these two (Youden's coefficient). The obtained results are presented in table 18..

We noticed that both fasting glycemia and HbA1c did not identify all patients with risk factors for diabetes, much more useful being the 1-hour post-load and 2-hour post-load glycemic values. Statistical analysis showed that 1-hG is more predictive with a cutt-off value of 142.5 (table 18, figure 6) in comparison with the value of 155 mg/dl mentioned in the literature [11].

Discussions

From the T2DM family history point of view, there are statistically significant differences between the two investigated groups, which showed that its presence can be systematically associated with the risk of diabetes, a fact also stated by the literature data.

https://doi.org/10.46389/rjd-2021-1005

Table 16: HbA1c - descriptive statistic parameters in both groups.

Group	N	Mean	Standard Error	Standard Deviation	Minimum	Maximum
Study	69	5.44493	.040222	.334108	4.700	6.000
Control	43	5.39302	.034001	.222962	4.900	5.800
Total	112	5.42500	.028005	.296374	4.700	6.000

Table 17: HbA1c - categories distribution of both groups.

HbA1c	Group						Pearson Chi-square	p
	Study		Control		Total			
	n	%	n	%	n	%		
Normal	54	78.3%	37	86.0%	91	81.3%		
Prediabetes	15	21.7%	6	14.0%	21	18.8%		
Total	69	100.0%	43	100.0%	112	100.0%	1.054	.305

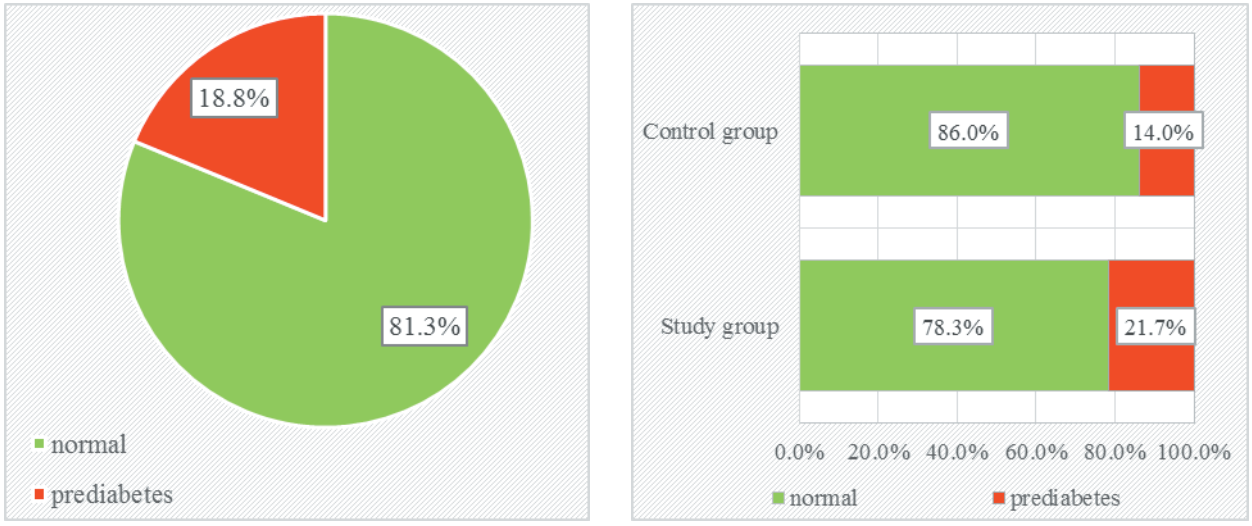


Figure 5: HbA1c - categories distribution of both groups.

Table 18: ROC analysis for blood glucose and HbA1c.

	AUC	p	95% AUC Confidence Interval		Cut-off Value	Sensitivity	Specificity
			Inf.L.	Sup.L.			
FG	.559	.291	.454	.665			
1-hG	.682	.001*	.582	.782	142.5	0.652	0.767
2-hG	.643	.011*	.541	.745	109.0	0.565	0.837
HbA1c	.538	.495	.432	.645			

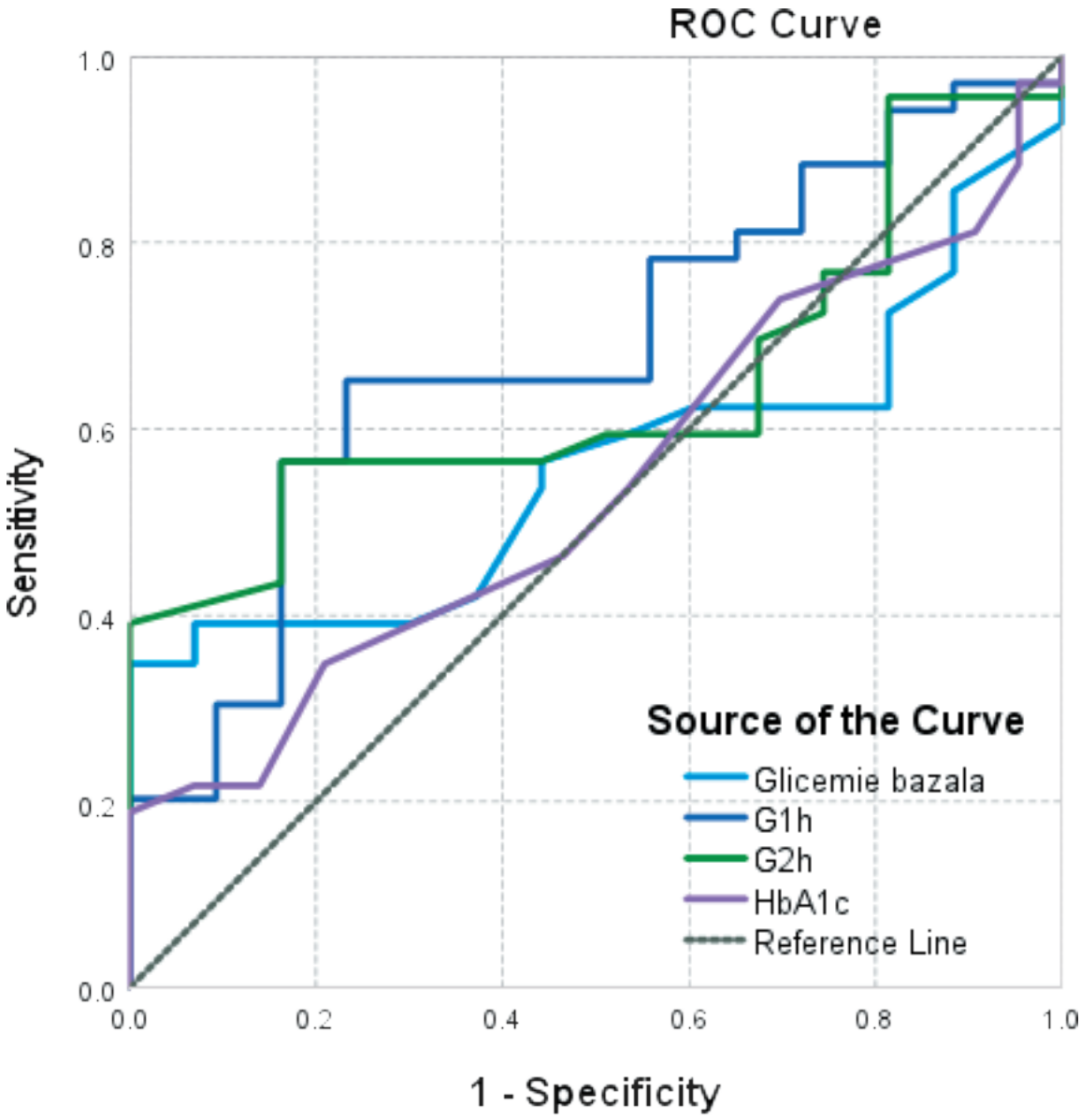


Figure 6: ROC curves for blood glucose and HbA1c.

The FIND RISC score proves once again its usefulness in assessing the risk of diabetes as showed in many studies [12, 13].

Overweight and obesity were identified in the study group in a percentage similar to the one reported in the PREDATORR study (>60%) [8].

Fasting glycemia and HbA1c have not been effective in identifying patients at risk, the 1-hour post-load and 2-hour post-load glycemia measured during 75 g OGTT being more useful in this regard.

Recent studies suggested that a 1-hG cut off value above 155 mg/dl represents a risk for developing T2DM and places it as an intermediate risk category between impaired fasting glucose and impaired glucose tolerance [11, 14]. Hisayama Study suggested that a 30 min post-load glycemia is also helpful to predict T2DM and stated a cut off value of 173mg/dl for detecting the high-risk population [15].

In our study, it seems that 1-hour post-load plasma glucose is more accurate in assessing the risk of diabetes, 50% of patients having a value above 155 mg/dl. 1-hG demonstrated its superiority also by identifying its risk values in over 50% of patients in the study group, 2-hG achieving this in only 30% of cases for a risk value above 140 mg/dl.

https://doi.org/10.46389/rjd-2021-1005

Furthermore, a prospective population-based cohort study suggested that 1-hG gives us information regarding the risk for diabetes complications [11]. Recent evidence showed similar ability between 1-h and 2-h post-load glucose level to predict diabetic retinopathy [16]. However, it seems that 1-h post-load glycemia is an independent risk factor for cardiovascular disease also [17].

Long term studies on larger populations will better confirm our results regarding 1-hour post-load glycemic value being a better tool for type 2 diabetes screening.

Conclusion

Evaluation of glucose metabolism parameters through the 75 g oral glucose tolerance test may be useful in screening the type 2 diabetes risk population, evaluation of 1-hour post-load glycemia being more predictive for diagnosis.

Conflict of Interest

The authors declare no conflict of interest.

References

1. Serban V. (2010). Tratat român de boli metabolice 1, Brumar, Timisoara.
2. Chelaru Sorina-Alina, Catrinoiu Doina, Ion Ileana, (2019). Diabesity: were we are wrong and what is the cost?, *ARS Medica Tomitana*, 25(1):40–43.
3. Etu-Seppala L. (2001). Long Way but real hope. *Diabetes Voice*, 46:5.
4. Frank B. (2011). Globalization of diabetes. *Diabetes care*, 34:1249–1257
5. Hâncu N., Roman Gabriela, Vereşiu I.A. (2010). Diabetul zaharat, nutriţia şi bolile metabolice. vol. 2, Echinox, Cluj Napoca.
6. https://diabetesatlas.org/, IDF Diabetes Atlas 9th edition 2019.
7. Cheta D. (2014). Diabetes complications: new explanations and solutions, AGIR, Bucuresti.
8. Mota Maria, Popa Simona Georgiana, Mota E. et.al, (2016). Prevalence of diabetes mellitus and prediabetes in the adult Romanian population: PREDATORR study: *Journal of diabetes*, 8: 336–344.
9. Members of the management taskforce of the EASO (2004). Management of obesity in adults: project for European primary care. *Int J Obes Relat Metab Disord*, 28:S226–S31.
10. World Health Organization (2003). Food and Agriculture Organization of the United Nations. Diet, Nutrition and the prevention og chronic diseases. Report of a joint WHO/FAO expert consultation (WHO Technical Report Series 916). Geneva.
11. 11.Manan Pareek, Deepak L.Bhatt, Mette L.Nielsen et.al.(2018). Enhanced predictive capability of a 1-hour oral glucose tolerance test: a prospective population-based cohort study, *Diabetes Care*, 41:171–177.
12. 12.Makrilakis K., Liatis S., Grammatikou S. et.al.(2011). Validation of the Finnish diabetes risk score (FINDRISC) questionnaire for screening for undiagnosed type 2 diabetes, dysglycaemia and the metabolic syndrome in Greece. Diabetes Metab. 37(2):144–51.
13. 13. Nnamudi, A.C., Orhue, N.E.J. & Ijeh, I.I.(2020). Assessment of the FINDRISC tool in predicting the risk of developing type 2 diabetes mellitus in a young adult Nigerian population. *Bull Natl Res Cent* 44, 186.
14. Melania Manco, Andrea Mari, John Petrie et.al, 2019. One hour post-load plasma glucose and 3 year risk of worsening fasting and 2 hour glucose tolerance in the RISC cohort. *Diabetologia* 62:544–548.
15. Hirakawa Y., Hata J., Yoshinari M. et. al, (2020). 30-minute post-load plasma glucose levels during an oral glucose tolerance test predict the risk for future type 2 diabetes: the Hisayama Study. *BMJ Open Diab Res Care*, 8:e001156.
16. Ethan Paddock, Helen C. Looker, Paolo Piaggi et. al, (2018). One-hour plasma glucose compared with two-hourr plasma glucose in relation to diabetic retinophaty in american indians. *Diabetes care*, 41:1212–1217.
17. Ceriello A. (2017). Targeting one-hour postmeal glucose: is it time for a paradigm switch in diabetes management?, *Diabetes Technol Ther*, 19(9):493–497.