

DETERMINING THE RATE AND OVERLAP OF THE CRITERIA OF FASTING BLOOD GLUCOSE, 2-HOUR BLOOD GLUCOSE AFTER ORAL GLUCOSE TOLERANCE TEST AND HbA1C IN THE DIAGNOSTIC OF PREDIABETES IN PEOPLE AT RISK IN VIETNAM

Tran Thua Nguyen^{1,2}, Tran Quang Nhat^{1,2}, Tran Bui Hoai Vong^{1,2}, Tran Huu Dang^{2,3}, Do Dinh Thuc^{1,2}

¹General Internal Medicine and Geriatrics Department, Hue Central Hospital, Hue, Viet Nam

²Vietnam Association of Diabetes and Endocrinology, Viet Nam

³Hue University of Medicine and Pharmacy, Hue, Viet Nam

ABSTRACT

Objectives: Determine the rate of prediabetes based on fasting blood glucose concentration (G0), blood glucose concentration 2 hours after oral glucose tolerance test (G2) and HbA1c value and evaluate the overlap when using criteria in diagnosing prediabetes in the study group.

Methods: A cross-sectional descriptive study on 1899 patients ≥ 18 years old with risk factors of prediabetes or diabetes according to criteria of Vietnam Ministry of Health at 05 hospitals in Vietnam: Hanoi Heart Hospital, National Hospital of Endocrinology, Nghe An Endocrinology Hospital, Ho Chi Minh City Heart Institute and Hue Central Hospital from April 2020 to August 2023. Include in the study the cases satisfying the selection criteria. Perform an oral glucose tolerance test: determine blood glucose at two times G0, G2 and test HbA1c. Data processing using SPSS 26.0 software.

Results: The rate of prediabetes in the study group was 83.92%. Of which, the diagnosis of prediabetes based on HbA1C criteria had the highest rate (48.64%), followed by meeting G2 criteria (48.07%) and the lowest was meeting G0 criteria (47.59%). When using additional G2 or HbA1C criteria to determine prediabetes compared to the group using only 1 G0 criterion, the rate increased by 0.48% or 1.05%, respectively. When using the combined criteria of G0 or G2 and G2 or HbA1C to determine prediabetes compared to the group using the combined criteria of G0 or HbA1C, the rate decreased by 1.53% and 0.8%, respectively.

Conclusion: People at risk are at high risk of developing prediabetes. It should be paid attention to the managing and treating people at risk.

Key words: Prediabetes, oral glucose tolerance test, HbA1c, Vietnam.

I. INTRODUCTION

Prediabetes is a condition in which individuals have blood glucose levels higher than normal but not high enough to be classified as diabetes. Prediabetes is an intermediate stage between normal glycemia and type 2 diabetes. Observational evidence shows associations of prediabetes with early forms of nephropathy, chronic kidney disease, small fibre

neuropathy, diabetic retinopathy, and increased risk of macrovascular disease [1].

Diabetes is a major health issue that has reached alarming levels. The International Diabetes Federation (IDF) has published a comprehensive picture of current and future trends in the prevalence of prediabetes based on impaired glucose tolerance (IGT), impaired fasting glucose (IFG) in people

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Corresponding author: Tran Thua Nguyen. Email: tranthuanguyen23@gmail.com. Phone: +84 903597695

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aged 20 - 79 years. In 2021, it is estimated that 541 million adults, or 10.6% of adults worldwide, have impaired glucose tolerance. By 2045, this number is projected to increase to 730 million adults (11.4%). In 2021, it is estimated 319 million adults (6.2%) have impaired fasting glucose, and by 2045, this number is projected to increase to 441 million (6.9%) [2].

There is limited overlap between impaired glucose tolerance (IGT) and impaired fasting glucose (IFG); only 20 - 25% of people with IGT have IFG and 30 - 45% of people with IFG have IGT [1].

That is the reason why we conducted the topic "Determining the rate and overlap of fasting blood glucose, 2 hours post-glucose load glycemia of oral glucose tolerance test and HbA1c criteria in diagnosing prediabetes in people at risk in Vietnam" with the following objectives: To determine the rate of prediabetes based on fasting blood glucose concentration (G0), 2-hour post-glucose load glycemia from the oral glucose tolerance test (G2), and HbA1c values, and to assess the overlap when using these criteria in diagnosing prediabetes in the study group.

II. MATERIALS AND METHODS

2.1. Research subjects

The study was conducted on 1899 subjects $\geq$ 18 years old with risk factors for prediabetes at 05 hospitals in Vietnam: Hanoi Heart Hospital, National Hospital of Endocrinology, Nghe An Endocrinology Hospital, Ho Chi Minh City Heart Institute and Hue Central Hospital from April 2020 to August 2023.

Selection criteria

Age $\geq$ 18 years; overweight or obese (BMI $\geq$ 23 kg/m²) and have one of the following risk factors: First-degree relative with diabetes (parent, sibling, biological child). History of cardiovascular disease due to atherosclerosis. Hypertension (BP $\geq$ 140/90 mmHg, or being treated for hypertension) - HDL cholesterol $<$ 35 mg/dL (0.9 mmol/l) and/or triglyceride $>$ 250 mg/dL (2.8 mmol/l). Women with polycystic ovary syndrome. Physical inactivity. Other clinical conditions associated with insulin resistance (such as severe obesity, acanthosis nigricans); women who have been diagnosed with gestational diabetes.

Exclusion criteria

Diagnosed with diabetes or currently being treated for diabetes. Using drugs that increase

blood glucose, such as: corticosteroids, thiazides, contraceptives containing estrogen and progesterone, androgens, β -blockers, ACE inhibitors, calcium channel blockers. Having acute illnesses that are being treated or having serious illnesses. Anemia, hemoglobin disorders, bleeding. The diseases that cause blood glucose disorders: Diabetes mellitus, Cushing's syndrome, hyperthyroidism, pheochromocytoma, acromegaly, polycystic ovary syndrome... Individuals who are unable to stand on their own, have scoliosis, or liposuction; are pregnant; do not agree to participate in the study; and are not cooperating with the study.

2.2. Research method

Across-sectional descriptive research, convenient sampling.

Conduct interviews about: age, gender, history of cardiovascular disease, hypertension, physical activity, history of gestational diabetes and polycystic ovary syndrome (female), history of first-degree relatives with diabetes. Collect parameters on blood pressure, height, weight, BMI, waist circumference.

Perform an oral glucose tolerance test; determine glucose at 2 times G0, G2. Test HbA1c, Biland lipid.

Diagnostic criteria for prediabetes according to ADA (2019) [2, 3]

HbA1c from 5.7 to 6.4% and/or fasting glucose (IFG): Blood glucose after fasting for at least 8 hours from 5.6 - 6.9 mmol/l (100 mg/dl - 125 mg/dl) and/or glucose tolerance (IGT): 2 hours post-glucose load glycemia of oral glucose tolerance test (WHO) from 7.8 - 11 mmol/l (140 - 199 mg/dl).

Diagnostic criteria for diabetes according to ADA (2019) [2, 3]

Fasting blood glucose $\geq$ 7 mmol/l (126 mg/dl). Fasting is defined as no calorie intake for at least 8 hours and/or blood glucose after 2 hours of glucose tolerance test $\geq$ 11.1 mmol/l (200 mg/dl). The test is performed according to WHO guidelines, using an amount of glucose equivalent to 75 g of anhydrous glucose dissolved in water and/or HbA1c $\geq$ 6.5% (48 mmol/l). The test must be performed in a laboratory standardized according to international standards and/or the patient has classic symptoms of hyperglycemia. Random blood glucose $\geq$ 11.1 mmol/l (200 mg/dl) (Table 1).

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Table 1: Diagnostic criteria for overweight and obesity based on BMI and waist circumference applied to Asian adults [4]

Classification	BMI	Risk of comorbidities	
		Waist circumference	
		Male < 90cm Female < 80cm	Male ≥ 90cm Female ≥ 80cm
Underweight	< 18.5	Low (but increases risk of other diseases)	Medium
Normal	18.5 - 22.9	Medium	Increased
Obesity	≥ 23	Increased	Moderate
Overweight	23 - 24.9	Moderate	Severe
Obese class I	25 - 29.9	Severe	Very Severe
Obese class II	≥ 30		

Data processing using SPSS 26.0 statistical software: Measurement data for normally distributed continuous variables are expressed as mean ± standard deviation the Student's t-test method is used for comparison between groups. Data for other continuous variables are expressed as median and comparisons between groups are performed using non-parametric methods.

III. RESULTS

3.1. Participants'22 characteristics

Our study recruited the most subjects from Hue Central Hospital (26.7%). (Table 2). Based on the analysis of G0, G2 and HbA1c results, we recorded that prediabetes accounted for 54.98%; suspected diabetes accounted for 34.49% and normal accounted for 10.53%. (Table 3). In our study, the highest proportion of diabetic patients (22.6%) came from the National Hospital of Endocrinology, while the highest rate of prediabetes was from Hue Central Hospital (31.61%). (Table 4).

Table 2: Distribution of study subjects by hospital

Unit	n	%
Hanoi Heart Hospital	350	18.43
National Hospital of Endocrinology	384	20.22
Nghe An Endocrinology Hospital	355	18.69
Ho Chi Minh City Heart Institute	303	15.96
Hue Central Hospital	507	26.70
Total	1899	100.00

Table 3: Distribution of blood glucose tolerance status

Distribution of blood glucose tolerance status	n	%
Normal	200	10.53
Prediabetes	1044	54.98
Diabetes	655	34.49
Total	1899	100.00

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Table 4: Distribution of study subjects by hospital and blood glucose tolerance status

Unit	Normal		Prediabetes		Diabetes	
	n = 200	%	n = 1044	%	n = 655	%
Hanoi Heart Hospital	51	25.50	185	17.72	114	17.40
National Hospital of Endocrinology	30	15.00	206	19.73	148	22.60
Nghe An Endocrinology Hospital	52	26.00	171	16.38	132	20.15
Ho Chi Minh City Heart Institute	22	11.00	152	14.56	129	19.69
Hue Central Hospital	45	22.50	330	31.61	132	20.15
Total	200	100.00	1044	100.00	655	100.0

3.2. Assessment of prediabetes status based on G0, G2 and HbA1c criteria in people with risk factors

In this review, we analyzed only 1244 subjects, excluding 655 people who were diagnosed with diabetes or suspected of having diabetes. The highest rate of prediabetes diagnosis was achieved by HbA1C criteria (48.64%), followed by G2 criteria (48.07%) and the lowest rate was G0 criteria (47.59%). (Table 5).

Table 5: Distribution of prediabetes status based on 1 diagnostic criterion (n = 1244)

Diagnosis	G0		G2		HbA1C	
	n	%	n	%	n	%
No prediabetes	652	52.41	646	51.93	639	51.37
Prediabetes	592	47.59	598	48.07	605	48.64

Analysis of cases diagnosed with prediabetes shows that: Subjects diagnosed with prediabetes meeting one of the two criteria G0 or HbA1C accounted for the highest proportion (72.59%), followed by meeting two criteria G0 or G2 (71.3%) and the lowest was meeting two criteria G2 or HbA1C (70.18%). (Table 6). In our study, when subjects satisfy at least 1 of the 3 criteria G0, G2 and HbA1C, they are identified as having prediabetes, this rate is 83.92% in people with risk factors. (Table 7).

Table 6: Distribution of prediabetes status based on the combination of 2 diagnostic criteria (n = 1244)

Diagnosis	G0 or G2		G0 or HbA1C		G2 or HbA1C	
	n	%	n	%	n	%
No prediabetes	357	28.7	341	27.41	371	29.82
Prediabetes	887	71.3	903	72.59	893	70.18

Table 7: Distribution of prediabetes status based on 3 diagnostic criteria (n = 1244)

Diagnosis	G0 or G2 or HbA1C	
	n	%
No prediabetes	200	16.08
Prediabetes	1044	83.92

3.3. Analysis of overlap when using criteria in diagnosing prediabetes in the study population

In our study, when using additional criteria G2 or HbA1C to determine prediabetes status compared to the group using only criteria G0, the rate increased by 0.48% or 1.05%, respectively. (Table 8).

Table 8: Overlap analysis when using G0 criteria in diagnosing prediabetes compared with G2 criteria and HbA1C

Content	n	%
Use only 01 G0 criterion in determining prediabetes	592	47.59
Prediabetes patients using G2 criteria compared with G0 criteria only	+ 6	+ 0.48
Prediabetes patients using HbA1C criteria compared with G0 criteria only	+ 13	+ 1.05

In our study, when using the combined criteria of G0 or G2 and G2 or HbA1C to determine prediabetes status compared with the group using the combined criteria of G0 or HbA1C, the reduction rates were 1.53% and 0.8%, respectively. (Table 9).

Table 9: Overlap analysis when using the combined criteria of G0 or HbA1C in diagnosing prediabetes compared with the remaining combined criteria

Content	n	%
Use only one combined criterion G0 or HbA1C in determining pre-diabetes	903	72.59
Prediabetes patients using combined criteria G0 or G2 compared with using combined criteria G0 or HbA1C	- 16	- 1.53
Prediabetes patients using combined criteria G2 or HbA1C compared with using combined criteria G0 or HbA1C	- 10	- 0.8

IV. DISCUSSION

4.1. Assessment of prediabetes status based on G0, G2 and HbA1c criteria in people with risk factors

Based on the ADA (2019), when surveying 1899 subjects with risk factors for prediabetes, we excluded 655 people who were diagnosed with diabetes or suspected of having diabetes, so the number of samples for the survey was 1244 subjects

According to the results of table 7, analyzing the results of G0, G2 and HbA1C, we recorded that prediabetes accounted for 83.92%. This result is higher than the research of some authors in Vietnam and around the world: author Che Thi Nga when evaluating on the group of subjects with risk factors determined the rate of prediabetes was 68.2% [5]; author Tran Quang Nhat, when studying overweight and obese patients with high blood pressure, determined the rate of prediabetes to be 69.5% [6].

Author Indah Budiastutik and colleagues studied 512 people aged 30 and over in Pontianak, West Kalimantan province, Indonesia: the rate of prediabetes was 76.4%, of which: the rate of overweight-obese patients was 65.5%; the rate of

sedentary people was 79.3% and prediabetes status had a multivariate correlation with age and BMI [7].

Zihui Yan and colleagues conducted a survey of 3540 people who had not been diagnosed with diabetes or prediabetes in Shanghai city in 2019: the rate of prediabetes was 52.3%, in the prediabetes group: the rate of overweight-obese patients was 55.5%, hypertension was 38.9% [8].

Author Camila Maciel De Oliveira et al. (2020) recorded the rate of prediabetes as 12.8% [9], author Robinson Ramirez-Velez et al. (2019) recorded the rate of prediabetes as 25.3% [10].

Authors abroad all have lower rates of prediabetes than us because these studies were conducted in the community, while we conducted them on groups of subjects with risk factors.

According to Table 3.4, we recorded the highest rate of prediabetes detection based on HbA1C criteria (48.64%), followed by G2 criteria (48.07%) and the lowest rate of G0 criteria (47.59%).

Meanwhile, author Che Thi Nga recorded the highest rate of prediabetes detection based on HbA1C at 63.6% while the rate of prediabetes based

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on G0 and G2 was lower at 36.4% and 39.5% [5]. Author Tran Quang Nhat: the rate of prediabetes based on G0, G2, HbA1c was 31.7%; 43.9%; 62.2% respectively [6].

We have similarities with the two authors above: the diagnosis of prediabetes based on HbA1C criteria is the highest when compared with using G0 or G2 criteria. In our study, when analyzing cases diagnosed with prediabetes, it showed that: Subjects diagnosed with prediabetes meeting one of the two criteria G0 or HbA1C accounted for the highest proportion (72.59%), followed by meeting two criteria G0 or G2 (71.3%) and the lowest was meeting two criteria G2 or HbA1C (70.18%).

4.2. Evaluation of overlap when using criteria in diagnosing pre-diabetes in the study group

According to the results in Table 8, when using additional criteria G2 or HbA1C to determine prediabetes status compared to the group using only criteria G0, the rate increased by 0.48% or 1.05%, respectively.

Our results are much lower than those of author Mary R. Rooney et al. (2023): in the group of prediabetes patients, 30 - 45% of people with impaired fasting glucose (using G0 concentration for assessment) had impaired glucose tolerance (using G2 concentration for assessment) [1]. Meanwhile, according to the results of Table 3.8, in our study: when using the combined criteria of G0 or G2 and G2 or HbA1C to determine prediabetes compared to the group using the combined criteria of G0 or HbA1C, the reduction rate was 1.53% and 0.8%, respectively. This demonstrates the effectiveness of using G0 and HbA1C to diagnose prediabetes when using the criteria combined with G2.

While impaired fasting glucose (IGT) and impaired glucose tolerance (IFG) may reflect different but overlapping underlying disease processes, people with impaired fasting glucose or impaired glucose tolerance are at high risk of developing diabetes, with up to 50% progressing to diabetes within 5 years. People with impaired fasting glucose

or impaired glucose tolerance are also at high risk of chronic kidney disease, cardiovascular disease, and mortality. Intensive lifestyle interventions (e.g., dietary changes and increased physical activity) and pharmacological interventions (e.g., metformin) can significantly reduce the risk of progression to diabetes in people with impaired glucose tolerance or impaired fasting glucose [1].

V. CONCLUSION

The rate of prediabetes in the study group was 83.92%. Of which, the diagnosis of prediabetes based on HbA1C criteria accounted for the highest rate (48.64%), followed by G2 criteria (48.07%) and the lowest was G0 criteria (47.59%). When using additional criteria G2 or HbA1C to determine prediabetes status compared to the group using only criteria G0, the rate increased by 0.48% or 1.05%, respectively. When using combined criteria G0 or G2 and G2 or HbA1C to determine prediabetes status compared to the group using combined criteria G0 or HbA1C, the rate decreased by 1.53% and 0.8%, respectively.

Disclosure

The authors report no other conflicts of interest in this work.

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