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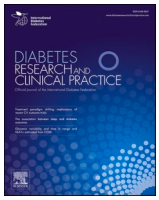

# Implications of the use of 1-hour post-load plasma glucose value during an oral glucose tolerance test (OGTT) for the diagnosis of dysglycemia among a cohort of high-risk Thai people

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ABSTRACT

Implications of the use of 1-hour post-load plasma glucose value during an oral glucose tolerance test (OGTT) for the diagnosis of dysglycemia among a cohort of high-risk Thai people.

*Aims:* The recent International Diabetes Federation (IDF) statement recommended using the 1-hour plasma glucose (1-h PG) during oral glucose tolerance test (OGTT) for diagnosing dysglycemia. This study aimed to examine the prevalence of dysglycemia among high-risk Thai people.

*Methods:* An 18-year retrospective study of Thai people who underwent OGTT procedures in routine clinical setting was analyzed.

*Results:* A total of 1,203 subjects (age 50.3 ± 13.0 years, BMI of 26.3 ± 4.9 kg/m$^2$, $HbA_{1c}$ 5.7 ± 0.5 %) were reviewed. Based on traditional OGTT criteria, impaired glucose tolerance (IGT) was found in 36.6 %, and diabetes (DM) in 16.8 % of the subjects. An elevated 1-h PG was found in 40.6 % of normal glucose tolerance (NGT) people, and 3.4 % of them would be classified as DM based on the IDF OGTT criteria. Among IGT people, 40.9 % would be classified as DM per the IDF criteria. The prevalence of DM was more than two times higher with the IDF OGTT criteria When the proposed 1-hr OGTT criteria was used as a reference standard, the optimal $HbA_{1c}$ cut-off point to diagnose diabetes was at 5.9 % which was much lower than the current $HbA_{1c}$-based criteria of diabetes.

*Conclusions:* Diabetes prevalence is more than 2 times higher when diagnosed with the IDF OGTT criteria in high-risk Thai people. Overt DM by the IDF OGTT would be missed for almost 5 times by using the $HbA_{1c}$ level alone.

## 1. Introduction

The incidence of type 2 diabetes (T2D) continues to increase globally and is associated with increased morbidity and mortality especially in young-onset diabetes [1]. Early detection and early intervention are keys to tackle diabetes epidemic. The diagnosis of diabetes mellitus (DM) is typically based on the level of fasting plasma glucose (FPG), 2-hour plasma glucose (2-h PG) during an oral glucose tolerance test (OGTT), or glycated hemoglobin ($HbA_{1c}$) [2–4]. The progression from normal glucose tolerance to T2D involves the intermediate stage of prediabetes, indicated by impaired fasting glucose (IFG) (fasting plasma glucose 100–126 mg/dL) (5.6–6.9 mmol/L) and/or impaired glucose tolerance (IGT) (plasma glucose 140–199 mg/dL) (7.8–11.0 mmol/L) 2-h after OGTT). The American Diabetes Association (ADA) also defines prediabetes with $HbA_{1c}$ level between 5.7 % (39 mmol/mol) and 6.4 % (46 mmol/mol) [4]. Prediabetes provides a critical window for interventions to prevent progression to diabetes and achieve regression to normoglycemia [5]. Even though OGTT had been perceived as an inconvenience screening test for T2D, a 75-gram OGTT with assessment of both fasting and 2-h PG level is the only way to diagnose both IFG and IGT and is currently recommended by various organizations [2–4].

In the past decades, there is growing interest in identifying intermediate hyperglycemia (IH) and overt T2D by the elevated plasma glucose levels at 1 h (1-h PG) during an OGTT [6–9]. Several cohort studies including our previous study in Thai people supported that 1-h PG had higher predicted accuracy of future T2D and was more closely associated with cardiovascular disease than 2-h PG after OGTT [10–13]. Recently, the International Diabetes Federation (IDF) has recommended

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determination of 1-h PG during OGTT to diagnose IH (prediabetes) and T2D in people at risk [14]. The Statement recommends the use of 1-h PG with the validated cut points of 155 mg/dL (8.6 mmol/L) for IH and 209 mg/dL (11.6 mmol/L) for T2D. Furthermore, several experts have proposed a staging schema of glucose tolerance (from stage 0 to stage 3) based on the pathophysiological progression from normal glucose tolerance (NGT) to overt T2D to alert both the individuals and healthcare providers of the potentially progressive nature of prediabetes [15]. Although the 1-h PG has been found to be a more sensitive test for the earlier identification of dysglycemia, there are challenges inherent in implementing the 1-h OGTT and more studies in diverse racial/ethnic groups are required to understand the rates of dysglycemia from these proposed IDF criteria compared with the traditional criteria. Therefore, the aim of this study is to evaluate the prevalence of IH and diabetes according to the proposed IDF criteria for elevated 1-h PG and examine the diagnostic accuracy of $HbA_{1c}$, using both traditional and the proposed IDF OGTT criteria as a reference standard among cohort of high-risk Thai people who underwent 75-g OGTT.

## 2. Materials and methods

### Study design and participants

This single-center, cross-sectional study with a retrospective analysis was conducted at Theptarin Diabetes, Thyroid and Endocrine Center, Vimut-Theptarin Hospital, Bangkok, Thailand in the cohort of high-risk Thai people who underwent 75-g OGTT and had an $HbA_{1c}$ value measured within 3 months of OGTT procedure during the study period of 2007–2024. Most subjects underwent OGTT because of high risk for diabetes such as having a body mass index (BMI) $\geq$ 25 kg/m$^2$, abdominal obesity, a history of IFG, or a family history of diabetes. Subjects were excluded from this study if they had a history of diagnosed diabetes, had hematologic or endocrinologic disorders or on medications that would interfere with glucose metabolism and, $HbA_{1c}$ level, pregnant participants, and subjects with other nationalities. Examples of medications affecting $HbA_{1c}$ levels including erythropoietin, iron supplement, dapsone, ribavirin, etc. Only the results of the first OGTT in the study period were used for the analysis.

All participants underwent a three-point 75 g OGTT after at least 8 h overnight fasting. Venous blood samples were collected at 0, 60, 120 min during OGTT. Plasma glucose was measured by enzymatic hexokinase method (Roche Diagnostics Cobas analyzer). Measurement of $HbA_{1c}$ level was done by electrochemiluminescence immunoassay using Abbott Diagnostics core laboratory (from 2007 to 2008) and Roche Diagnostics Cobas Analyzer (from 2009 to 2024). The $HbA_{1c}$ test was Diabetes Control and Complications Trial (DCCT)-aligned assay and was accredited by the National Glycohemoglobin Standardization Program (NGSP).

Data were collected on baseline characteristics including age, sex, blood pressure, BMI, history of diabetes in first-degree relatives, previously documented cardiovascular diseases, history of smoking, and hypertension. This study was approved by the Institutional Review Board of the Vimut-Theptarin Hospital Ethics Committee (EC No.04/2024).

### Glucose tolerance categories

Glucose tolerance state was defined according to both traditional and proposed IDF OGTT criteria as a reference standard to identify dysglycemic status. Based on traditional OGTT criteria, diabetes status was defined as subjects with 2-h PG level from OGTT $\geq$ 200 mg/dL and FPG $\geq$ 126 mg/dL. IGT status was defined for those with 2-h PG level from OGTT 140–199 mg/dL. Isolated IFG status was defined as subjects with FPG from OGTT 100–125 mg/dL but 2-h PG level from OGTT $<$ 140 mg/dL.

Based on the IDF 2024 criteria [14], diabetes status was defined as subjects with 1-h PG level from OGTT $\geq$ 209 mg/dL and IH status was defined for those with 1-h PG level from OGTT 155–208 mg/dL. The proposed staging schema for early diagnosis of prediabetes and diabetes was also evaluated in the present study [15]. Individuals are at stage 0 if OGTT results revealed NGT with 1-h PG $<$ 155 mg/dL and $HbA_{1c}$ $<$ 5.7 %; stage 1 if OGTT results revealed NGT with 1-h PG $\geq$ 155 mg/dL and $HbA_{1c}$ $<$ 5.7 %; stage 2 if 1-h PG $\geq$ 155 mg/dL with prediabetes by any criteria; stage 3 if overt T2D by any criteria. Unclassified stage was classified if prediabetes by any traditional criteria but 1-h PG $<$ 155 mg/dL or NGT people with prediabetes from other criteria.

## 3. Statistical analyses

Data were presented as mean (standard deviation), median (Q1, Q3) or frequency (percentage). The comparisons between the groups were tested using the *t-test*, chi-square test, or Wilcoxon rank sum test, as appropriate. The consistency of the two OGTT criteria was assessed by the Kendall's Tau-b coefficient. The accuracy for $HbA_{1c}$ for diabetes diagnosis when OGTT was used as the reference standard was evaluated. The Youden's index which combines sensitivity and specificity into a single measure (sensitivity + specificity − 1) was calculated at selected $HbA_{1c}$ thresholds to define diabetes from OGTT. All the statistical analyses were performed via the Statistical Package for the Social Sciences (version 26.0; SPSS, Chicago, IL, USA) software, and *P-value* $<$ *0.05* was considered statistically significant.

## 4. Results

### Baseline characteristics

Of the 1,325 subjects without prior history of diabetes who underwent OGTT from 2007 to 2024, 1,203 subjects met the inclusion criteria for analysis as shown in Fig. 1. The subjects' clinical characteristics (females 62.9 %, mean age of 50.3 ± 13.0 years, BMI of 26.3 ± 4.9 kg/m$^2$, $HbA_{1c}$ 5.7 ± 0.5 %) are presented in Table 1. Out of 1,203 individuals, 320 (26.6 %) were categorized as NGT, 240 (20.0 %) were categorized as IFG, 440 (36.6 %) individuals as having IGT, and 203 (16.8 %) subjects were classified as newly diagnosed type 2 diabetes according to the traditional OGTT criteria. Compared to the NGT group, the IFG, IGT and DM groups were significantly older (*p-value* $<$ *0.001*) and having higher BMI (*p-value* = *0.001*). As shown in Table 1, there were significant differences in $HbA_{1c}$ in each glycemic spectrum ($HbA_{1c}$ 5.4 ± 0.4 % in NGT, $HbA_{1c}$ 5.7 ± 0.4 % in IFG, 5.8 ± 0.4 % in IGT, 6.2 ± 0.5 % in DM, *p-value* $<$ *0.001*). More than 90 % of subjects with IGT and DM had a higher prevalence of 1-h PG $\geq$ 155 mg/dL compared to those with NGT which had a prevalence of 1-h PG $\geq$ 155 mg/dL at 40.6 %. The distributions of 1-h PG $\geq$ 155 mg/dL and 1-h PG $\geq$ 209 mg/dL among subjects with different glucose tolerance status are illustrated in Fig. 2. The highest proportion of 1-h PG $\geq$ 155 mg/dL was observed in people with overt DM by the traditional OGTT criteria.

### Implications of the proposed IDF criteria for elevated 1-h PG

As shown in Fig. 3, diabetes prevalence is more than 2 times higher when diagnosed with the proposed OGTT criteria in high-risk people compared with the traditional OGTT criteria (35.1 % vs 16.8 %). Among NGT people, only 3.4 % of these people would be classified as overt DM based on the proposed IDF criteria. Among IFG people, 21.3 % of these people would be classified as overt DM based on the proposed IDF criteria. Among IGT people, 40.9 % would be classified as DM per the IDF OGTT criteria but 9.8 % would be re-classified as normal glycemic status (1-hour PG $<$ 155 mg/dL). Clinical characteristics of individuals with overt DM by the traditional OGTT criteria compared with the proposed IDF criteria were demonstrated in Table 2. Individuals with overt DM by the proposed IDF criteria were more likely to be men when compared with individuals with overt DM by the traditional OGTT criteria. Notably, the mean $HbA_{1c}$ level was lower in these newly diagnosed DM group ($HbA_{1c}$ 6.0 % vs 6.2 %, *p-value* $<$ *0.001*).

When the proposed staging schema for early diagnosis of prediabetes and diabetes was applied, 12.8 % were classified as stage 0, 6.5 % were classified as stage 1, 29.8 % were classified as stage 2, 38.2 % were classified as stage 3, and 12.7 % were unclassifiable as illustrated in Fig. 3. The overall agreement rate for both OGTT criteria showed a

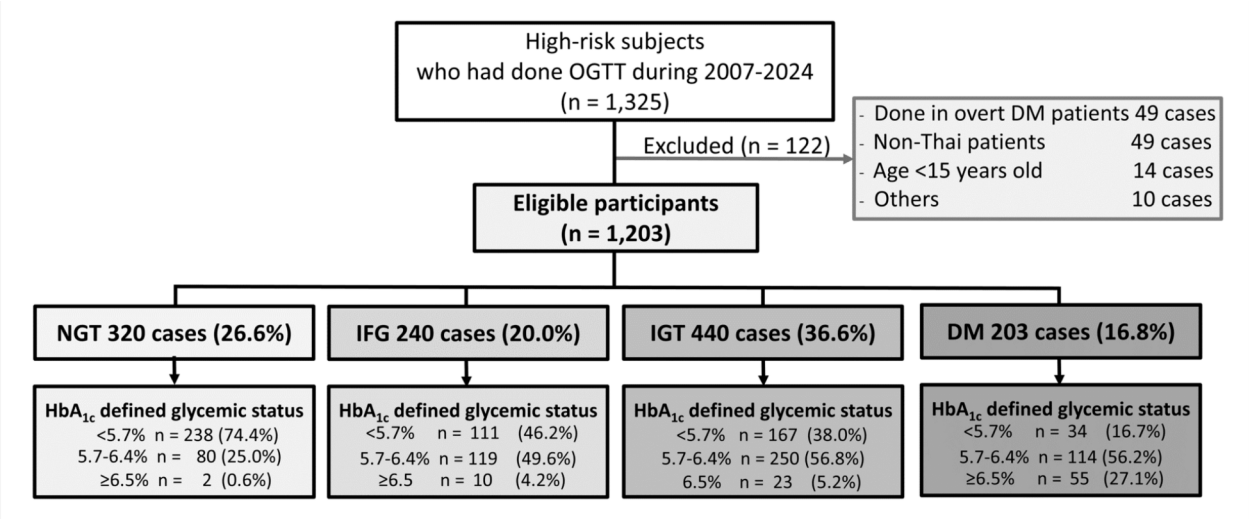


**Fig. 1.** Flow diagram of the studied participants.

**Table 1**
Clinical characteristics and laboratory data of participants stratified by the traditional OGTT criteria.

| | Total (N = 1,203) | NGT (N = 320, 26.6 %) | IFG (N = 240, 20.0 %) | IGT (N = 440, 36.6 %) | DM (N = 203, 16.8 %) | *P-value* |
|---|---|---|---|---|---|---|
| **Age (years)** | 50.3 ± 13.0 | 45.5 ± 12.5 | 51.4 ± 12.3 | 51.6 ± 12.6 | 53.8 ± 13.5 | <0.001 |
| **Female (%)** | 62.9 | 72.2 | 50.8 | 60.5 | 68.0 | <0.001 |
| **Body weight (kgs)** | 69.7 ± 14.9 | 66.9 ± 14.7 | 71.8 ± 14.4 | 70.1 ± 14.7 | 70.6 ± 15.6 | 0.001 |
| **BMI (kg/m$^2$)** | 26.3 ± 4.9 | 25.5 ± 4.8 | 26.4 ± 4.5 | 26.4 ± 4.7 | 27.2 ± 5.8 | 0.001 |
| **Hypertension (%)** | 27.3 | 20.0 | 25.4 | 31.1 | 32.5 | 0.002 |
| **Active Smoking (%)** | 6.0 | 3.8 | 6.3 | 8.4 | 3.9 | 0.032 |
| **Family History of DM (%)** | 53.6 | 52.8 | 55.0 | 52.3 | 56.2 | 0.774 |
| **Fasting plasma glucose (mg/dL)** | 102.4 ± 12.0 | 91.9 ± 5.2 | 105.9 ± 5.3 | 103.0 ± 10.5 | 113.4 ± 15.4 | <0.001 |
| **1-hour plasma glucose (mg/dL)** | 190.3 ± 49.2 | 148.6 ± 33.6 | 176.7 ± 41.3 | 201.4 ± 36.1 | 248.4 ± 33.6 | <0.001 |
| **2-hour plasma glucose (mg/dL)** | 152.5 ± 49.1 | 109.9 ± 17.3 | 114.2 ± 17.7 | 165.0 ± 17.1 | 236.6 ± 29.8 | <0.001 |
| **Elevated 1-hour plasma glucose ≥ 155 mg/dL (%)** | 74.4 | 40.6 | 69.2 | 90.2 | 99.5 | <0.001 |
| **Elevated 1-hour plasma glucose ≥ 209 mg/dL (%)** | 35.1 | 3.4 | 21.3 | 40.9 | 88.7 | <0.001 |
| **HbA$_{1c}$ (%)** | 5.7 ± 0.5 | 5.4 ± 0.4 | 5.7 ± 0.4 | 5.8 ± 0.4 | 6.2 ± 0.5 | <0.001 |

NGT: Normal Glucose Tolerance; IFG: Impaired Fasting Glucose; IGT: Impaired Glucose Tolerance; DM, Diabetes Mellitus; BMI: Body Mass Index; HbA$_{1c}$: Glycated Hemoglobin

strong agreement with a Kendall's Tau-b coefficient of 0.59 (95 % CI 0.55–0.62) as shown in Table 3.

**Diagnostic accuracy of HbA$_{1c}$ and OGTT**

The agreement of HbA$_{1c}$ ≥ 6.5 % according to American Diabetes Association (ADA) clinical guidance in identifying diabetes status compared with both traditional and proposed IDF OGTT criteria were demonstrated in Fig. 4. Almost 20 % of all subjects had been diagnosed with overt DM based on only the IDF OGTT criteria and only 4.2 % of all subjects had been diagnosed with overt DM consistently from any criteria. Sensitivity, specificity, positive predictive value, and negative predictive value for detecting type 2 diabetes mellitus based on the proposed IDF OGTT criteria at different HbA1c thresholds were displayed in Table 4. The sensitivity of recommended cut-off HbA$_{1c}$ level (HbA$_{1c}$ ≥ 6.5 %) is only 17.1 % (95 % CI 15.0–19.2 %) but with high specificity of 97.7 % (95 % CI 96.9–98.6 %) by using the proposed OGTT as the reference diagnosis. The optimal cut-off HbA$_{1c}$ threshold to diagnose diabetes per the proposed IDF OGTT criteria was found at HbA$_{1c}$ level of 5.9 % (Youden's index 0.369) as shown in Table 4. The agreement between HbA$_{1c}$-defined diabetes and OGTT criteria, represented by kappa value showed the higher value of 0.305 from the traditional OGTT criteria when compared with the proposed IDF OGTT criteria (kappa value of 0.180).

## 5. Discussion

Our present study found that diabetes prevalence is more than 2 times higher when diagnosed with the proposed IDF OGTT criteria in high-risk Thai people. Individuals with overt DM diagnosed according to the proposed IDF criteria displayed a lower HbA$_{1c}$ value when compared with individuals with overt DM by the traditional OGTT criteria. Compared to OGTT, HbA$_{1c}$ level had lower sensitivity but higher specificity in diagnosing DM. When the proposed 1-hr OGTT criteria was used as a reference standard, the optimal HbA$_{1c}$ cut-off point to diagnose diabetes was at 5.9 % which was much lower than the current HbA$_{1c}$-based criteria of diabetes. To the best of our knowledge, this is the first study to address the implications of the proposed IDF OGTT criteria among high-risk Southeast Asia subjects in the outside clinical research setting.

One-hour post-load plasma glucose diagnostic criteria recommended by IDF were derived from a *meta*-analysis of clinical cohorts in the past decades which demonstrated stronger correlation with the risk in progression of diabetes, development of microvascular disease, cardiovascular events and total mortality [13,16]. Mid-OGTT plasma glucose time points (30, 60, or 90 min) could inform the dynamic of insulin resistance, beta-cells dysfunction as well as defects in incretin action [17–19]. The proposed IDF OGTT criteria and the recently proposed staging schema for early diagnosis of prediabetes and diabetes emphasized the role of 1-hr OGTT to identify people with higher risk for progression to T2D, complications and mortality. Identification of people

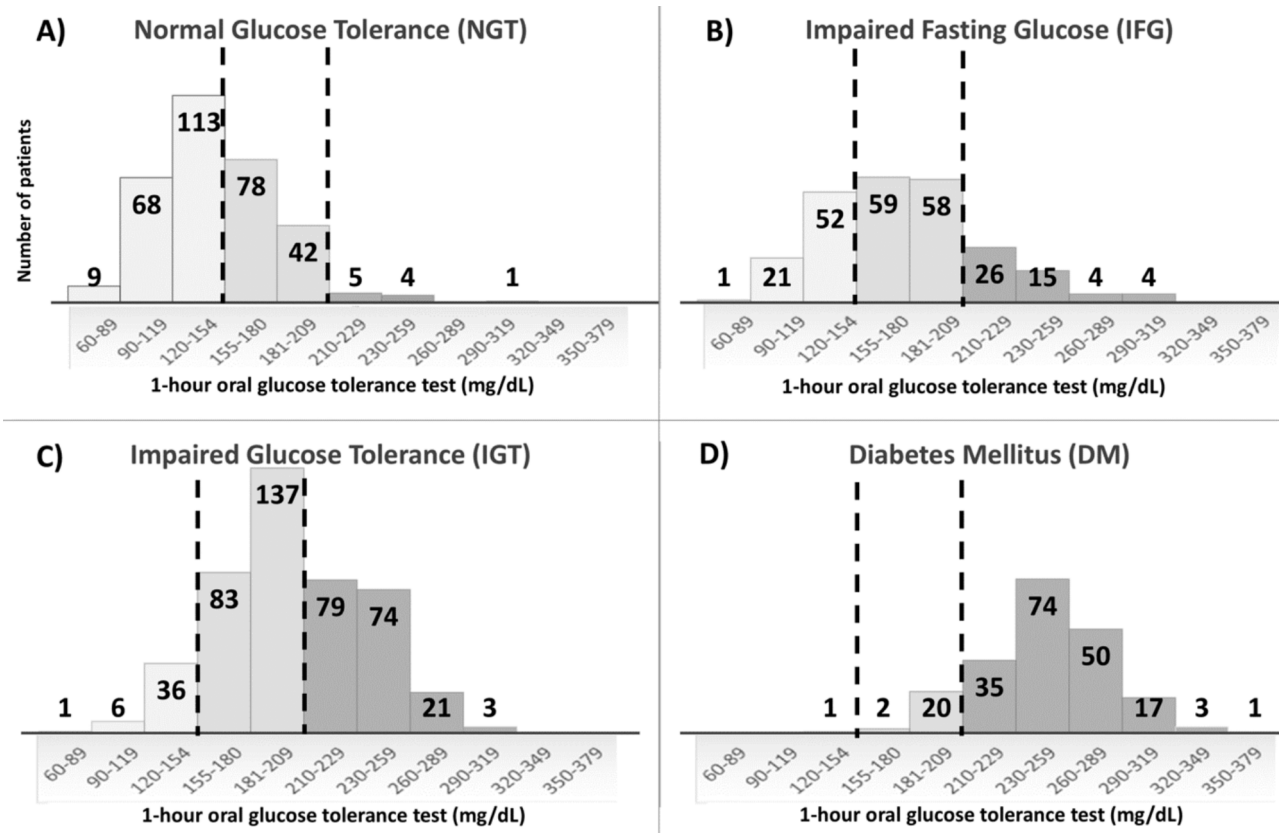


**Fig. 2.** The distributions of 1-h PG ≥ 155 mg/dL and 1-h PG ≥ 209 mg/dL among subjects with the traditional criteria of oral glucose tolerance test **A)** normal glucose tolerance **B)** impaired fasting glucose **C)** impaired glucose tolerance **D)** overt diabetes.

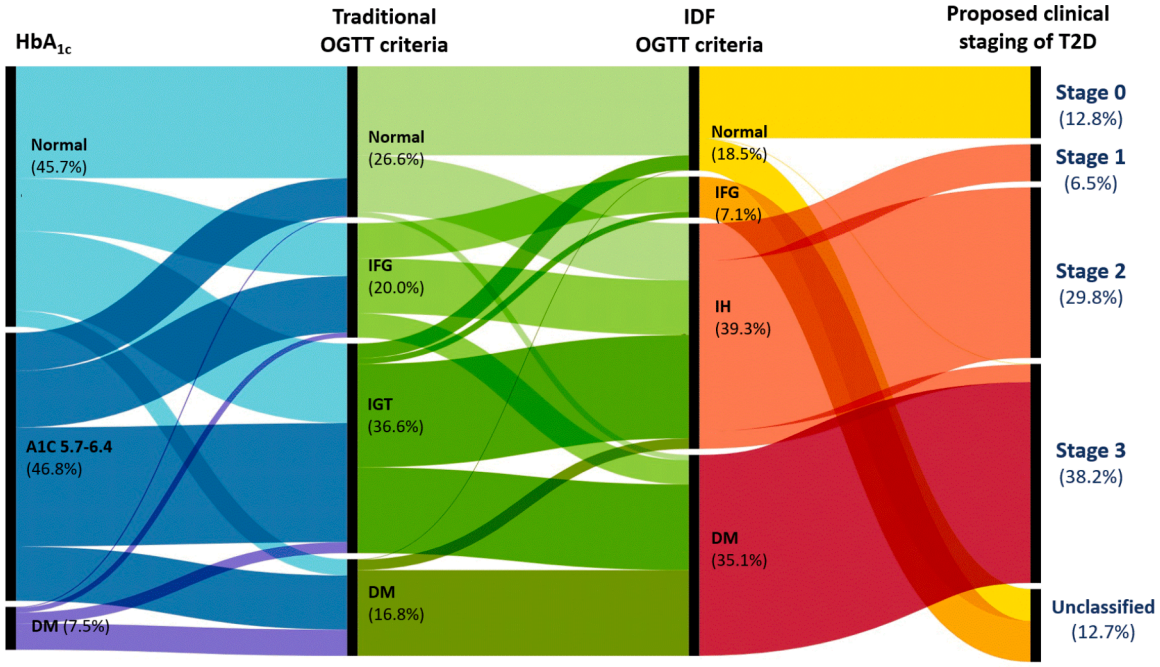


**Fig. 3.** Changes from glycated hemoglobin categories to glucose tolerance categories to the proposed staging schema for early diagnosis of prediabetes and diabetes.

with IGT can be considered by performing a 2-h OGTT but people at high risk even based only with a 1-h PG level, independent of having IGT, should be referred for lifestyle intervention. In our hospital, 1-hr PG during OGTT has been routinely practiced for a few decades so the present study could provide supporting evidence to understand the rates of dysglycemia from the proposed IDF OGTT criteria compared with the traditional OGTT criteria. The FPG and 2-h PG thresholds for diagnosing diabetes were determined based upon the incidence of diabetic retinopathy. A previous study from the Pima Indian data reported the incidence of retinopathy in relation to 1-h PG [20] and found that 1-h PG

**Table 2**
Clinical characteristics of individuals with overt DM by the traditional OGTT criteria compared with the proposed IDF criteria.

| | Overt DM by the traditional OGTT criteria (N = 203, 16.8 %) | Overt DM by the proposed IDF criteria (N = 422, 35.1 %) | *P-value* |
|---|---|---|---|
| **Age (years)** | 53.8 ± 13.5 | 52.8 ± 12.8 | 0.402 |
| **Female (%)** | 68.0 | 58.1 | 0.017 |
| **Body weight (kgs)** | 70.6 ± 15.6 | 72.2 ± 15.6 | 0.209 |
| **BMI (kg/m$^2$)** | 27.2 ± 5.8 | 27.2 ± 5.2 | 0.963 |
| **Hypertension (%)** | 32.5 | 34.1 | 0.690 |
| **Active Smoking (%)** | 3.9 | 7.3 | 0.099 |
| **Family History of DM (%)** | 56.2 | 57.1 | 0.822 |
| **Fasting plasma glucose (mg/dL)** | 113.4 ± 15.4 | 110.3 ± 12.8 | 0.013 |
| **1-hour plasma glucose (mg/dL)** | 248.4 ± 33.6 | 244.1 ± 26.7 | 0.107 |
| **2-hour plasma glucose (mg/dL)** | 236.6 ± 29.8 | 191.9 ± 50.1 | <0.001 |
| **HbA$_{1c}$ (%)** | 6.2 ± 0.5 | 6.0 ± 0.5 | <0.001 |

DM, Diabetes Mellitus; IDF: International Diabetes Federation; BMI: Body Mass Index; HbA$_{1c}$: Glycated Hemoglobin

**Table 3**
Agreement between the traditional OGTT criteria and the proposed IDF OGTT criteria in diagnosing intermediate hyperglycemia and overt diabetes mellitus.

| | | Traditional OGTT criteria | | | | Total | Kendall's Tau-b (95 % CI) |
|---|---|---|---|---|---|---|---|
| | | NGT | IFG | IGT | DM | | |
| **IDF OGTT criteria** | **NGT** | 190 | 0 | 31 | 1 | 222 | 0.59 (0.55–0.62) |
| | **IFG** | 0 | 74 | 12 | 0 | 86 | |
| | **IH** | 119 | 115 | 217 | 22 | 473 | |
| | **DM** | 11 | 51 | 180 | 180 | 422 | |
| **Total** | | **320** | **240** | **440** | **203** | **1203** | |

NGT: Normal Glucose Tolerance; IFG: Impaired Fasting Glucose; IGT: Impaired Glucose Tolerance; DM, Diabetes Mellitus; IH: Intermediate Hyperglycemia.

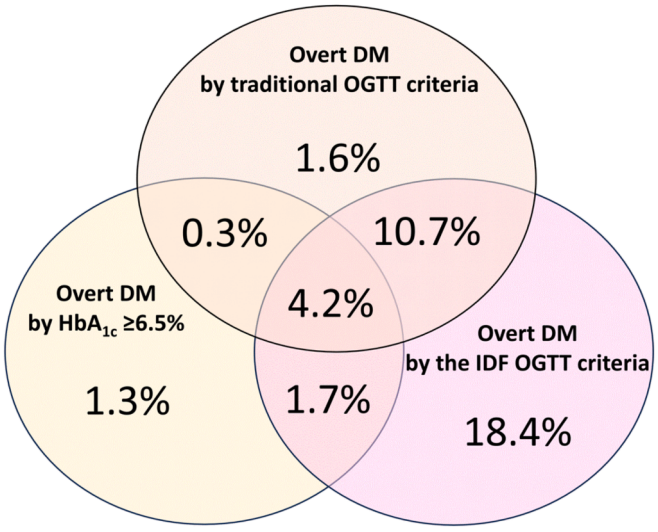


**Fig. 4.** Venn diagram showing overlap of subjected diagnosed as overt diabetes by different criteria based on the overall studied subjects who underwent OGTT (N = 1,203 cases).

cut points of 230 mg/dL was optimal for the incidence of diabetic retinopathy. We also analyzed this threshold with our present cohort. Our data revealed that overt DM from Pima Indian OGTT criteria was in between the traditional OGTT and IDF OGTT criteria (22.5 % vs. 16.8 % vs. 35.1 %) as shown in Supplement Fig. 1. Therefore, different cut-off threshold for 1-h PG following OGTT should be further investigated in diverse population.

Limitations of HbA$_{1c}$ to capture dysglycemia in high-risk people had been explored in many studies [21] but the present study found that the optimal HbA$_{1c}$ cut-off point when the proposed 1-hr OGTT criteria is used as a reference standard to diagnose diabetes was at 5.9 % which is much lower than the current HbA$_{1c}$ −based criteria of diabetes. In clinical practice, those subjects with slightly elevated HbA$_{1c}$ levels should be closely monitored and OGTT which incorporated 1-h PG should be offered for early diagnosis of dysglycemia. Recent publications from various population also explored the discrepancy between existing diagnostic criteria of DM and the recent IDF criteria [22–24] but the issue of optimal cut-off point for HbA$_{1c}$ as a screening tool before performing OGTT is lacking.

The importance of primary prevention efforts to prevent the onset of diabetes led many experts to propose staging schema for early diagnosis of prediabetes and diabetes aimed to identify and address diabetes risk earlier [15]. There are many limitations to this proposed framework as the stages combine a very heterogeneous group of individuals and assumed that T2D progress linearly from stage 1 to stage 2 and subsequently stage 3 might not be straightforward. Based on this study, unclassifiable subjects which mainly composed of NGT people with prediabetes from other criteria and IH or overt DM without elevated 1-hr PG had been found up to more than 10 % of people. In resource-constrained settings, the use of 1-h PG rather 2-h PG following OGTT could simplify screening dysglycemia process and to limit cost and imposition.

Several limitations of this study should be considered when interpreting the results. First, the OGTT had been performed only once in a routine clinical setting. Day-to-day variability in 1-h and 2-h post-load PG concentrations might misclassify glucose tolerance categories. Second, the present study was based on high-risks individuals in outpatients setting only. Thus, the prevalence of dysglycemia would be much higher from that of the general healthy population. Finally, the retrospective design of the study precluded long-term clinical outcomes (progression from NGT to T2D, DM complications, and mortality). A recent research study from Singapore also underscored the importance of not assuming a one-size-fits-all approach of IDF to recommend the elevated 1-h PG at ≥ 155 mg/dL and proposed a higher cut-off of 193 mg/dL in Asian population [25]. Therefore, the optimal threshold of 1-h PG for identifying those at high risk is still debatable in Asian population.

In conclusion, the prevalence of DM was more than two times higher when the OGTT criteria from IDF was applied while the mean HbA$_{1c}$ was lower in these newly diagnosed DM subjects. Overt DM by the IDF OGTT criteria would be missed for almost 5 times by using the HbA$_{1c}$ level alone. Our present study supported the earlier identification of high-risk people for dysglycemia by using 1-h PG following OGTT in a routine clinical setting and may be considered as an alternative glucose time point during an OGTT. More than 50 % of people with NGT had elevated 1-h PG and one-tenth of them would be classified as DM based on the IDF OGTT criteria. Further prospective follow-up study should be conducted to evaluate the impact and effects of lifestyle interventions of this IDF recommendation in diverse population and settings.

Authors Contributions

T.Y., C.W. and N.S. designed the study. B.S., P.H., and N.S. contributed to the specification of the analyses data. C.W., W.E., K.S., and H.T. contributed to interpretation of data. T.Y. and C.W. wrote the initial draft of manuscript. W.E., K.S., and H.T. contributed with a critical revision of the first and subsequent manuscript versions. T.Y., C.W., W. E., B.S., P.H., N.S., K.S., and T.H. approved the final manuscript. T.Y. and C.W. are the guarantors of this work and, as such, had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

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**Table 4**
Sensitivity, specificity, positive likelihood ratio, and negative likelihood ratio for detecting selected diabetes mellitus at different $HbA_{1c}$ thresholds by using the IDF OGTT as the reference diagnosis.

| $HbA_{1c}$ (%) | Sensitivity (%) | Specificity (%) | Positive likelihood ratio | Negative likelihood ratio | Youden's index |
|---|---|---|---|---|---|
| 5.7 | 76.1 | 57.5 | 1.79 | 0.42 | 0.336 |
| 5.8 | 68.7 | 67.6 | 2.12 | 0.46 | 0.363 |
| **5.9** | **61.1** | **75.8** | **2.53** | **0.51** | **0.369** |
| 6.0 | 51.9 | 81.4 | 2.80 | 0.59 | 0.333 |
| 6.1 | 42.4 | 88.2 | 3.60 | 0.65 | 0.306 |
| 6.2 | 35.5 | 93.0 | 5.05 | 0.69 | 0.285 |
| 6.3 | 27.0 | 94.8 | 5.15 | 0.77 | 0.218 |
| 6.4 | 22.3 | 96.8 | 6.96 | 0.80 | 0.191 |
| 6.5 | 17.1 | 97.7 | 7.40 | 0.85 | 0.148 |

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## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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## Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.diabres.2025.112056.

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