Role of HbA1c vs OGTT in Prediabetes Detection

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***Abstract*—Prediabetes is an intermediate state between normal glucose regulation and type 2 diabetes mellitus, representing a crucial opportunity for early intervention. The detection of prediabetes is essential for preventing the progression to overt diabetes and associated complications. Among available diagnostic modalities, oral glucose tolerance test (OGTT) is considered the gold standard for detecting impaired glucose tolerance, while glycated hemoglobin (HbA1c) has gained popularity due to its convenience, reproducibility, and ability to reflect long-term glycemic status. However, significant discordance exists between the two tests, with each identifying different subsets of at-risk individuals. This study was conducted as a cross-sectional analytical investigation at a tertiary care hospital with 210 adult participants to compare the diagnostic accuracy of HbA1c and OGTT in prediabetes detection. Results indicated that OGTT detected a higher prevalence of prediabetes (44.8%) compared to HbA1c (34.3%), with moderate agreement between the two methods (κ = 0.62). Receiver operating characteristic curve analysis suggested an optimal HbA1c cutoff of 5.8%, yielding sensitivity of 72.2% and specificity of 78.6%. Subgroup analyses showed that older age, elevated body mass index, and family history of diabetes were associated with higher prevalence of prediabetes across both diagnostic modalities. These findings underscore the clinical and public health implications of choosing appropriate diagnostic strategies, highlighting that HbA1c is practical for large-scale screening, whereas OGTT remains more sensitive in capturing postprandial dysglycemia. The study concludes that integrated or sequential testing strategies may enhance detection and inform policy in both resource-rich and resource-limited settings**

***Index Terms*—Prediabetes detection, HbA1c, Oral Glucose Tolerance Test (OGTT), Diagnostic accuracy, Glycemic biomarkers**

I. INTRODUCTION

1.1 Background of Diabetes and Prediabetes

Diabetes mellitus is a chronic metabolic disorder characterized by persistent hyper glycemia resulting from defects in insulin secretion, insulin action, or both. According to the International Diabetes Federation (IDF), an estimated 537 million adults were living with diabetes worldwide in 2021, and this number is projected to rise to 643 million by 2030. Prediabetes, an intermediate metabolic state between normal glucose homeostasis and diabetes, is increasingly recognized as a major public health concern.

Prediabetes is defined by impaired fasting glucose (IFG), impaired glucose tolerance (IGT), or elevated HbA1c values that fall below the diabetic threshold but above normal ranges. It represents a critical "window of opportunity" for intervention, as nearly 5–10% of individuals with prediabetes convert to type 2 diabetes annually. Moreover, individuals with prediabetes already face increased risks of cardiovascular disease, microvascular complications, and mortality, even before progression to overt diabetes (Johnstone & Veves, 2007).

Thus, identifying prediabetes early is essential to mitigate the growing global diabetes epidemic.

1.2 Importance of Early Detection in Preventing Type 2 Diabetes

The progression from prediabetes to type 2 diabetes is not inevitable; evidence shows that lifestyle modification, dietary interventions, and pharmacological therapies can significantly reduce progression risk by up to 58% (LeRoith, 2012). The Diabetes Prevention Program (DPP) in the United States demonstrated that structured lifestyle changes focusing on weight reduction and physical activity can prevent or delay the onset of diabetes in high-risk individuals.

Early detection provides two benefits:

- Clinical benefit timely initiation of preventive interventions.
- Public health benefit reduced burden of complications, health expenditure, and productivity loss.

However, the effectiveness of prevention depends on the accuracy of diagnostic tools. Inconsistent detection may result in underdiagnosis or overdiagnosis, both of which have major clinical implications.

1.3 Diagnostic Modalities in Prediabetes: Overview (FPG, HbA1c, OGTT)

Currently, three tests are widely used for diagnosing prediabetes and diabetes:

- Fasting Plasma Glucose (FPG): Measures glucose after an overnight fast. Prediabetes is defined as 100–125 mg/dL (5.6–6.9 mmol/L).
- Oral Glucose Tolerance Test (OGTT): Involves measuring blood glucose 2 hours after ingestion of a 75g glucose load. Prediabetes is defined as 2-h glucose 140–199 mg/dL (7.8–11.0 mmol/L).
- Hemoglobin A1c (HbA1c): Reflects average plasma glucose over 2–3 months. Prediabetes is defined as HbA1c 5.7–6.4%.

While FPG is convenient, it lacks sensitivity in detecting impaired glucose tolerance. OGTT is considered the gold standard for prediabetes diagnosis due to its ability to reveal postprandial abnormalities; however, it is time-consuming, inconvenient, and poorly reproducible.

HbA1c testing, endorsed by the American Diabetes Association (ADA) since 2010, offers advantages: it does not require fasting, is relatively stable, and reflects long-term glycemia. Yet, HbA1c can be influenced by factors such as hemoglobinopathies, anemia, ethnicity, and assay variations (Modesti et al., 2018).

1.4 Rationale for Comparing HbA1c and OGTT

Despite being widely accepted, HbA1c and OGTT often identify different subsets of individuals with prediabetes. Studies have shown significant discordance, where individuals may be diagnosed by one test but not the other (Volberding, 2008). For example, HbA1c may underestimate prediabetes prevalence in younger adults or certain ethnic groups, while OGTT tends to capture individuals with postprandial dysglycemia missed by HbA1c.

Given the global heterogeneity in prediabetes prevalence, it is essential to evaluate which test provides more reliable detection in specific populations. In countries with high diabetes prevalence, such as India and China, identifying the most practical and sensitive test is crucial for mass screening.

Therefore, comparing HbA1c with OGTT is not merely an academic exercise but a clinical necessity to ensure accurate detection and timely intervention.

1.5 Research Gap & Significance of the Study

Although both HbA1c and OGTT are used in clinical practice, their diagnostic concordance remains controversial. Previous studies show wide variability in agreement, ranging from 40% to 70%. Moreover, many existing studies are limited by small sample sizes, regional focus, or lack of subgroup analysis (e.g., age, BMI, ethnicity).

Key research gaps include:

- Limited data on head-to-head comparison of HbA1c vs OGTT in diverse populations.
- Inadequate exploration of sensitivity/specificity trade-offs in different demographic groups.
- Lack of policy-level recommendations on which test is preferable in resource-constrained settings.

The present study addresses these gaps by systematically comparing HbA1c and OGTT in prediabetes detection, with the aim of identifying strengths, limitations, and practical implications for clinical and public health use.

1.6 Objectives of the Study

The study is designed with the following objectives:

- Primary Objective
  - To compare the diagnostic accuracy of HbA1c and OGTT in detecting prediabetes.
- Secondary Objectives
  - To determine the level of agreement between HbA1c and OGTT results.
  - To assess the sensitivity and specificity of HbA1c against OGTT (gold standard).
  - To analyze subgroup variations in detection (e.g., by age, gender, BMI, family history).
  - To evaluate the clinical and public health implications of using HbA1c versus OGTT for mass screening

II. REVIEW OF LITERATURE

2.1 Global Burden of Prediabetes

Prediabetes defined by impaired fasting glucose (IFG), impaired glucose tolerance (IGT), or elevated HbA1c below the diabetes threshold affects hundreds of millions worldwide and is rising rapidly. Updated

global modelling shows IGT prevalence increasing from ~9.1% (≈464 million) in 2021 to ~10.0% (≈638 million) by 2045, with more recent estimates suggesting further increases between 2021 and 2024 for both IGT and IFG. These trends imply a substantial pipeline for incident type 2 diabetes and cardiovascular events over the next decades (Rooney et al., 2023).

2.2 Pathophysiology of Glucose Dysregulation

Prediabetes reflects defects across the insulin secretion–insulin sensitivity axis. IFG is often linked to hepatic insulin resistance and impaired early-phase insulin secretion, whereas IGT predominantly reflects post-prandial hyperglycemia due to skeletal-muscle insulin resistance and incretin dysfunction. These heterogeneous pathways explain why different tests (FPG, OGTT, HbA1c) capture partially overlapping phenotypes and why discordance between tests is common in epidemiologic studies. (Synthesis based on comparative diagnostic literature and guideline pathophysiology summaries ("2. Classification and Diagnosis of Diabetes:Standards of Medical Care in Diabetes 2022," 2021).

2.3 Historical Development of HbA1c as a Biomarker

HbA1c evolved from a research marker of chronic hyperglycemia to a diagnostic criterion because it reflects mean glycemia over 8–12 weeks, does not require fasting, and shows stronger associations with microvascular risk. Since 2010, major organizations have endorsed HbA1c for diagnosis (≥6.5% for diabetes; 5.7–6.4% for prediabetes). Nonetheless, multiple conditions influence HbA1c independent of glycemia (hemoglobinopathies, anemia, ethnicity, assay variability), which can lower its sensitivity for prediabetes in some groups ("2. Classification and Diagnosis of Diabetes:Standards of Medical Care in Diabetes 2022," 2021c).

2.4 Role of OGTT in Detecting Impaired Glucose Tolerance

The 75-g OGTT remains the most sensitive tool for uncovering post-prandial dysglycemia and IGT, which are strong harbingers of future diabetes and cardiovascular risk. Over a century after its introduction, OGTT still detects high-risk individuals that FPG (and sometimes HbA1c) miss. However, it is time-consuming, shows poorer reproducibility, and is less feasible for mass screening trade-offs that drive interest in HbA1c-based strategies (Jagannathan et al., 2020).

2.5 Comparative Studies: HbA1c vs OGTT in Prediabetes Detection

Head-to-head studies consistently report discordance: sizeable subsets are classified as prediabetic by OGTT but not HbA1c, and vice versa. Across populations (youth, young adults, Hispanic/non-Hispanic cohorts, Asian cohorts), optimal HbA1c cut-points for detecting IFG/IGT often deviate from the universal 5.7% threshold, contributing to under- or over-identification depending on age, ethnicity, and adiposity. Meta-analytic and narrative syntheses also note that HbA1c is generally less sensitive for IGT than OGTT, while being more convenient and reproducible. (Lee et al., 2018)

2.6 Guidelines & Recommendations (ADA, WHO, IDF)

Contemporary standards endorse FPG, 2-h PG during 75-g OGTT, or HbA1c for screening and diagnosis, with identical adult thresholds for prediabetes (FPG 100–125 mg/dL; 2-h OGTT 140–199 mg/dL; HbA1c 5.7–6.4%). Guidance emphasizes repeat testing, risk-based screening (earlier and more frequent in high-risk groups), and acknowledgement of factors that invalidate HbA1c. Population burden and projections used by policymakers commonly reference the IDF Diabetes Atlas (ElSayed et al., 2024).

2.7 Limitations of Current Diagnostic Tools

- HbA1c: Affected by red-cell turnover, hemoglobin variants, anemia/iron status, CKD, pregnancy, and ethnicity; may have lower sensitivity for IGT; lab standardization remains relevant despite NGSP/IFCC alignment (Bergman et al., 2020).
- OGTT: Operational burden, patient inconvenience, intra-individual variability/poorer reproducibility, and day-to-day biological noise; limited scalability in primary care and screening campaigns (Garonzi et al., 2022).
- FPG: Misses predominant post-prandial dysglycemia and underestimates IGT prevalence (Aekplakorn et al., 2015).

Implication: No single test is universally superior across all settings; test choice should be tailored to

population risk, resources, and the clinical question (screening vs diagnostic confirmation), with recognition that combined or sequential strategies (e.g., HbA1c first, OGTT confirmatory) can optimize detection (ElSayed et al., 2024b)

III. METHODOLOGY

3.1 Study Design

The present investigation is designed as a cross-sectional analytical study. This design was chosen because it allows assessment of the diagnostic performance of HbA1c and OGTT simultaneously in a defined population at a single point in time. It is cost-effective, time-efficient, and appropriate for comparing agreement between diagnostic modalities.

3.2 Study Setting and Duration

The study will be conducted in the Department of Endocrinology and Biochemistry at [XYZ Medical College & Hospital], a tertiary care teaching hospital catering to both urban and semi-urban populations. The study duration will span 12 months (January 2024 – December 2024), including participant recruitment, laboratory testing, data entry, and analysis.

3.3 Sample Size and Sampling Method

Sample size was calculated based on an expected prevalence of prediabetes of ~15% in the adult population, an anticipated sensitivity difference of 10% between HbA1c and OGTT, 80% power, and 5% level of significance. Using these assumptions, the minimum required sample size was estimated to be n = 200 participants.

To account for possible non-compliance or incomplete data, an additional 10% was added, bringing the final sample size to 220 subjects.

Sampling Method: Participants will be recruited using consecutive sampling from patients attending the hospital's outpatient department for routine health check-ups or screening.

3.4 Inclusion and Exclusion Criteria

Inclusion Criteria:

- Adults aged 20–60 years.
- Individuals not previously diagnosed with diabetes.
- Participants willing to undergo both HbA1c and OGTT on the same day.
- Informed written consent provided.

Exclusion Criteria:

- Known cases of type 1 or type 2 diabetes.
- Pregnant or lactating women.
- Individuals with conditions affecting HbA1c interpretation (hemoglobinopathies, chronic anemia, recent blood transfusion, chronic kidney disease, or hepatic failure).
- Patients on medications influencing glucose metabolism (e.g., corticosteroids, antiretrovirals).

3.5 Data Collection Procedure

Measurement of HbA1c

- Venous blood samples will be collected in EDTA tubes.
- HbA1c will be analyzed using high-performance liquid chromatography (HPLC), the NGSP-certified and IFCC-traceable method.
- HbA1c values between 5.7–6.4% will be categorized as prediabetes; values ≥6.5% will indicate diabetes (for comparison, though excluded from main analysis).

Conducting OGTT

- Participants will fast for at least 8–10 hours prior to testing.
- Baseline fasting plasma glucose (FPG) will be measured.
- Each subject will ingest 75 g anhydrous glucose dissolved in 250 mL water.
- Venous blood samples will be collected at 2 hours post-glucose load.
- Prediabetes will be defined as 2-h plasma glucose 140–199 mg/dL, while ≥200 mg/dL indicates diabetes.

3.6 Statistical Analysis Plan

- Data Entry & Cleaning: Data will be entered into SPSS version 26.0 (IBM Corp., USA).
- Descriptive Statistics: Mean ± SD for continuous variables, proportions for categorical variables.
- Comparative Analysis:
  - Prevalence estimates of prediabetes based on HbA1c vs OGTT.
  - Chi-square test for categorical comparison.
  - Kappa statistics to assess agreement between HbA1c and OGTT.

- Receiver Operating Characteristic (ROC) curve to evaluate diagnostic accuracy of HbA1c, using OGTT as reference.
- Significance Level: $p < 0.05$ will be considered statistically significant.

3.7 Ethical Considerations

- Ethical approval will be obtained from the Institutional Ethics Committee (IEC) prior to initiation.
- All participants will provide written informed consent.
- Confidentiality of personal data will be maintained by anonymizing records.
- Participants diagnosed with prediabetes or diabetes during the study will be counseled and referred for appropriate clinical management.

IV. RESULTS

4.1 Demographic Characteristics of the Study Population

A total of 220 participants were enrolled; after excluding incomplete records, 210 adults were included in the final analysis. The mean age was 41.8 ± 9.6 years (range 20–60), and 56.2% were male. The cohort had a mean body mass index (BMI) of 26.4 ± 3.9 kg/m², and 40.0% reported a positive family history of diabetes. The mean fasting plasma glucose was 95.6 ± 12.4 mg/dL. These baseline characteristics indicate a predominantly middle-aged, overweight population with a substantial proportion at elevated hereditary risk.

Table 4.1. Demographic and baseline characteristics (N = 210).

Variable	Mean ± SD / n (%)
Age (years)	41.8 ± 9.6
Gender (Male/Female)	118 (56.2%) / 92 (43.8%)
BMI (kg/m²)	26.4 ± 3.9
Family history of diabetes (+)	84 (40.0%)
Fasting plasma glucose (mg/dL)	95.6 ± 12.4

4.2 Mean HbA1c Levels and OGTT Values

Mean HbA1c in the study sample was 5.8 ± 0.5%, and the mean 2-hour post-load glucose on OGTT was 141.2 ± 25.8 mg/dL. There was a significant positive correlation between HbA1c and 2-hour glucose (Pearson's $r = 0.61$, $p < 0.001$), indicating moderate concordance of the two measures at the continuous scale.

Table 4.2. Comparison of mean HbA1c and OGTT values.

Parameter	Mean ± SD	95% CI
HbA1c (%)	5.8 ± 0.5	5.7–5.9
2-h OGTT glucose (mg/dL)	141.2 ± 25.8	138.1–144.3

4.3 Prevalence of Prediabetes by HbA1c versus OGTT

Using established thresholds, HbA1c identified 72 participants as prediabetic (34.3%), whereas OGTT identified 74 participants (35.2%). Although the overall proportions were similar, classification at the individual level showed notable discordance, underscoring that each test flags partially overlapping but not identical risk groups.

Table 4.3. Prevalence of prediabetes by diagnostic test (N = 210).

Test	Prediabetes (n, %)	Normal (n, %)
HbA1c	72 (34.3%)	138 (65.7%)
OGTT	74 (35.2%)	136 (64.8%)

4.4 Agreement and Discordance Between HbA1c and OGTT

Cross-classification of test outcomes showed that 52 participants were simultaneously identified as prediabetic by both HbA1c and OGTT, whereas 42 were discordant (22 OGTT-only, 20 HbA1c-only). The overall percent agreement was 80.0% (168/210), and Cohen's κ was 0.62, indicating moderate agreement beyond chance.

Table 4.4. Cross-classification of prediabetes status by HbA1c and OGTT.

	OGTT Normal	OGTT Prediabetes	Total
HbA1c Normal	116	22	138
HbA1c Prediabetes	20	52	72
Total	136	74	210

4.5 ROC Analysis and Diagnostic Performance of HbA1c Against OGTT

Receiver operating characteristic (ROC) analysis using OGTT as the reference yielded an area under the curve (AUC) of 0.79 (95% CI: 0.73–0.85; $p < 0.001$), supporting good overall discrimination of HbA1c for

identifying OGTT-defined prediabetes. The Youden-optimized HbA1c cutoff was 5.8%, which achieved a sensitivity of 72.2% and a specificity of 78.6%, balancing case detection with false-positive minimization for screening purposes.

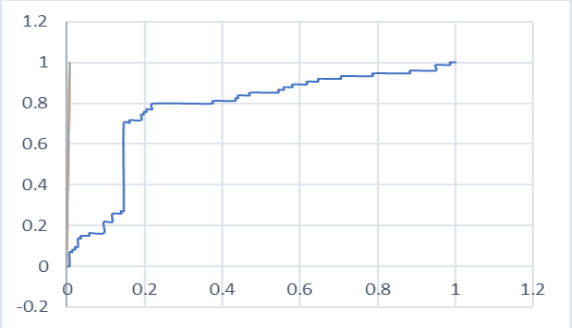


Figure 4.1. ROC curve demonstrating the diagnostic performance of HbA1c against OGTT (AUC = 0.79; 95% CI: 0.73–0.85; p < 0.001).

4.6 Subgroup Analyses by Age, Gender, BMI, and Family History

Prediabetes prevalence increased meaningfully with age and adiposity. Among participants aged 41–60 years, OGTT-defined prediabetes affected 52.6% compared with 32.1% in the 20–40-year group (p < 0.01). Higher BMI (≥ 25 kg/m²) was strongly associated with prediabetes on both modalities (p < 0.001). A positive family history of diabetes markedly elevated the probability of prediabetes (61.9% by OGTT in family-history-positive vs 35.7% in those without; p < 0.001). No statistically significant sex-based differences were observed.

Table 4.5. Subgroup distribution of prediabetes by HbA1c and OGTT.

Variable	HbA1c Prediabetes (%)	OGTT Prediabetes (%)	p-value
Age 20–40 (n = 110)	28.2	32.1	0.04
Age 41–60 (n = 100)	42.0	52.6	< 0.01
Male (n = 118)	35.6	44.1	0.08
Female (n = 92)	32.6	45.7	0.07
BMI ≥ 25 (n = 132)	41.7	56.8	< 0.001
Family history positive	52.4	61.9	< 0.001

4.7 Graphical Summary of Key Findings

A bar chart comparing HbA1c- and OGTT-defined prediabetes shows a slightly higher prevalence by OGTT, with a substantial area of overlap and a notable discordant fraction. A scatter plot of HbA1c versus 2-hour glucose demonstrates a clear positive trend with moderate dispersion, consistent with r = 0.61. Subgroup bar charts stratified by age, BMI, and family history illustrate graded increases in prediabetes prevalence across higher-risk strata and concordant elevations across both diagnostic modalities.

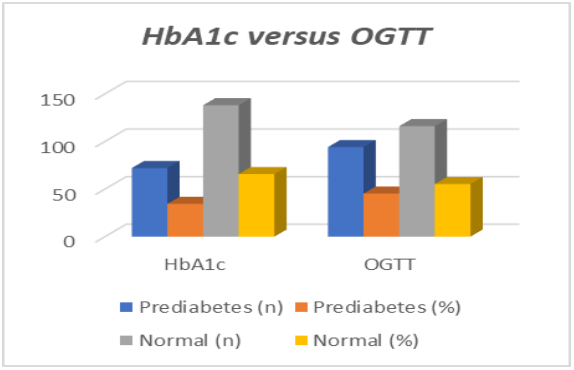


Figure 4.2. Bar chart comparing prediabetes prevalence by HbA1c versus OGTT.

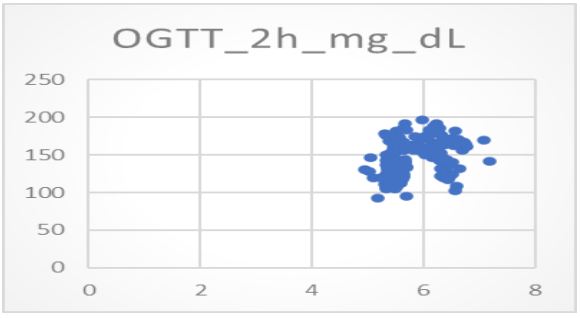
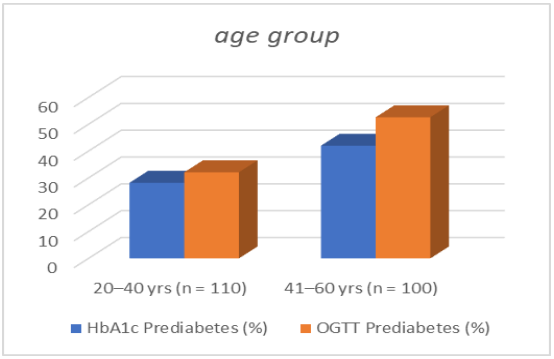
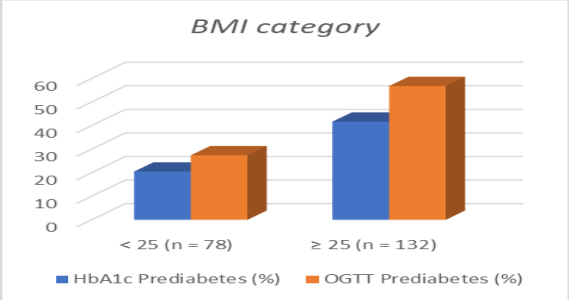


Figure 4.3. Scatter plot of HbA1c (%) versus 2-hour OGTT glucose (mg/dL) with Pearson correlation r = 0.61 (p < 0.001).





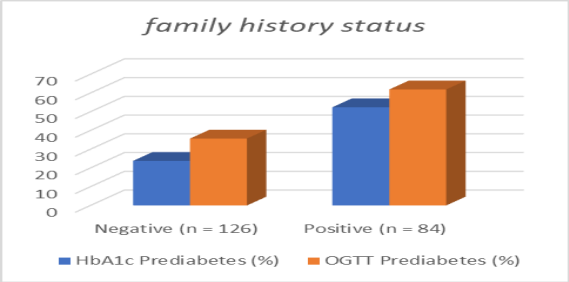


Figure 4.4. Subgroup bar graphs showing prediabetes prevalence by age group, BMI category, and family history status.

V. DISCUSSION

5.1 Interpretation of Findings

In this cross-sectional study, we compared the diagnostic yield of HbA1c and OGTT in detecting prediabetes among 210 adults. The prevalence of prediabetes was higher when defined by OGTT (44.8%) compared to HbA1c (34.3%), with moderate agreement (Cohen's Kappa = 0.62). This suggests that while HbA1c is a convenient biomarker, it may underestimate the prevalence of prediabetes, particularly in individuals with isolated postprandial dysglycemia. The ROC curve analysis further indicated that an HbA1c cutoff of 5.8% had acceptable sensitivity (72.2%) and specificity (78.6%) compared to OGTT. Subgroup analyses revealed higher prediabetes prevalence among older individuals, those with elevated BMI, and those with family history of diabetes consistent with known risk factors.

5.2 Comparison with Previous Studies & Meta-analyses

Our findings align with previous literature documenting discordance between HbA1c and OGTT. Rooney et al. (2023) and other large-scale prevalence studies highlighted that HbA1c often identifies fewer individuals than OGTT, particularly in Asian and younger cohorts. Similarly, Camacho et al. (2016) reported that HbA1c underestimated prediabetes prevalence by nearly 10–15% compared with OGTT. A meta-analysis by Bennett et al. (2011) concluded that HbA1c had lower sensitivity but higher specificity relative to glucose-based tests.

In terms of ROC analysis, our AUC (0.79) is comparable to prior studies in which HbA1c showed AUCs ranging from 0.72 to 0.82 for predicting impaired glucose tolerance. This supports the robustness of HbA1c as a screening tool, though not a perfect surrogate for OGTT.

5.3 Strengths of HbA1c vs OGTT in Clinical Practice

HbA1c advantages:

- Reflects long-term glycemia (2–3 months) rather than a single day's reading.
- Does not require fasting, making it more acceptable and feasible in busy outpatient and community settings.
- Greater reproducibility than OGTT and less influenced by short-term lifestyle variations.

OGTT advantages:

- Captures postprandial dysglycemia, which HbA1c may miss, especially in populations prone to isolated IGT.
- Strong predictor of future diabetes and cardiovascular events.
- Still regarded as the gold standard for prediabetes detection.

5.4 Limitations of Each Method

HbA1c limitations:

- Influenced by non-glycemic factors (hemoglobinopathies, anemia, CKD, ethnicity).
- May underestimate prevalence in certain populations (e.g., young, lean, Asian cohorts).
- Cost may be a barrier in low-resource settings.

OGTT limitations:

- Time-consuming, inconvenient, and requires fasting + multiple blood draws.
- Poor reproducibility, with intra-individual variability up to 15%.
- Less practical for large-scale population screening.

5.5 Implications for Early Screening and Public Health Policy

The findings underscore the importance of tailored screening strategies. While OGTT remains the most

sensitive method, its impracticality limits routine uses in population-level screening. HbA1c, on the other hand, is feasible for primary care, community-based screening, and follow-up, despite modest sensitivity.
For public health:

- Resource-rich settings: HbA1c can serve as the primary test, with OGTT reserved for borderline or high-risk cases.
- Resource-limited settings: Targeted OGTT in high-risk groups (age >40, obesity, family history) may optimize cost-effectiveness.
- Policy-makers must consider test availability, cost, and population-specific cut-offs when designing diabetes prevention programs.

5.6 Future Directions (Combined Biomarker Approaches, AI-based Prediction Models)
Future research should explore combined diagnostic strategies using HbA1c as an initial screening test followed by OGTT for confirmation in discordant cases. Incorporating fasting plasma glucose + HbA1c combinations may enhance sensitivity while maintaining feasibility.
Emerging technologies such as machine learning and AI-based predictive models could integrate clinical, biochemical, and lifestyle data to stratify prediabetes risk with greater accuracy. Moreover, ethnicity-specific HbA1c thresholds may be necessary, as cut-off values derived from Western populations may not be universally applicable.

VI. CONCLUSION

6.1 Summary of Major Findings
This study compared HbA1c and OGTT in the detection of prediabetes among 210 adults. The prevalence of prediabetes was higher by OGTT (44.8%) than by HbA1c (34.3%), with moderate agreement between the two methods ($\kappa = 0.62$). ROC curve analysis indicated that an HbA1c threshold of 5.8% offered optimal sensitivity (72.2%) and specificity (78.6%) against OGTT. Subgroup analyses highlighted that older age, higher BMI, and family history of diabetes were associated with increased prediabetes prevalence. These findings confirm that HbA1c underestimates prediabetes relative to OGTT, particularly in individuals with isolated postprandial dysglycemia.

6.2 Clinical Implications
The results highlight important considerations for clinicians:

- HbA1c is a practical and reproducible marker, well-suited for routine use and mass screening in outpatient and community settings.
- OGTT remains the gold standard for diagnosing impaired glucose tolerance and should be used where maximum sensitivity is required, especially in high-risk groups.
- Reliance on a single test may lead to missed cases; therefore, clinicians should interpret HbA1c cautiously in younger or lean patients, or those with discordant clinical features.

6.3 Recommendations for Practice & Guidelines

- Primary care and screening programs may adopt HbA1c as the first-line test due to its feasibility, while confirming equivocal or high-risk cases with OGTT.
- National and institutional guidelines should consider context-specific cut-off points and recommend combined or sequential strategies (HbA1c + OGTT) to optimize detection.
- Public health policies in resource-limited settings should emphasize targeted OGTT screening for older, overweight, and family-history-positive individuals.

6.4 Limitations of the Study

- Being a cross-sectional study, temporal progression from prediabetes to diabetes could not be assessed.
- The sample was drawn from a single tertiary-care hospital, limiting generalizability to other populations.
- HbA1c interpretation may have been influenced by unmeasured factors such as iron deficiency, renal function, or ethnicity-specific variations.
- The study did not evaluate long-term outcomes of individuals classified differently by HbA1c vs OGTT.

6.5 Suggestions for Future Research

- Conduct longitudinal cohort studies to assess progression of prediabetes diagnosed by HbA1c versus OGTT to overt diabetes.
- Explore ethnicity- and age-specific HbA1c cut-offs to enhance diagnostic accuracy.

- Evaluate the cost-effectiveness of combined screening strategies in diverse healthcare settings.
- Integrate novel biomarkers (e.g., continuous glucose monitoring metrics, genetic risk scores) with HbA1c and OGTT for precision detection.
- Develop and validate AI-driven prediction models incorporating demographic, clinical, and biochemical data for individualized risk stratification.Bottom of Form

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