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Can we rely solely on fasting parameters instead of oral glucose tolerance test for gestational diabetes mellitus screening?

Gebelikte diyabet taramasında oral glukoz tolerans testi yerine sadece açlık parametreleri kullanılabilir mi?

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ABSTRACT

Aim: Gestational diabetes mellitus (GDM) poses significant risks during pregnancy. While the oral glucose tolerance test (OGTT) remains the diagnostic standard, its complexity and poor patient compliance highlight the need for simpler alternatives. This study evaluates whether fasting glucose and other metabolic parameters can effectively replace the OGTT for GDM screening in Turkish pregnant women, offering a more practical and efficient diagnostic approach tai-lored to this population.

Materials and Methods: This retrospective observational study was conducted between January 2020 and August 2022 in two maternity hospitals in the same region. A total of 192 women diagnosed with GDM and 384 healthy pregnant women were included in the study. A receiver operating characteristic (ROC) analysis was performed to determine the association between the biochemical blood parameters tested in the second trimester fasting plasma glucose, fasting insulin, and HbA1c and the diagnosis of GDM.

Results: The study included 576 pregnant women. The GDM group showed a higher pre-pregnancy BMI compared with the healthy controls ($p < 0.01$). There were statistical differences in the fasting plasma glucose (FPG), fasting insulin, and hemoglobin A1c (HbA1c) between the groups ($p = 0.001$, 0.001, and 0.01, respectively). In the ROC analysis, FPG demonstrated the highest area under the curve (AUC) value (0.920).

Conclusions: Although fasting plasma glucose and fasting insulin can detect a significant proportion of GDM cases, they are insuf-ficient as standalone tools, and the OGTT remains the diagnostic gold standard.

Keywords: Gestational diabetes; glucose tolerance test; fasting blood glucose; pregnancy; diagnostic screening

ÖZ

Amaç: Gestasyonel diabetes mellitus (GDM) gebelik sırasında önemli riskler oluşturmaktadır. Oral glukoz tolerans testi (OGTT) tanısal standart olmaya devam ederken, karmaşıklığı ve hasta uyumunun zayıf olması daha basit alternatiflere olan ihtiyacı vurgulamaktadır. Bu çalışma, açlık glukozu ve diğer metabolik para-metrelerin Türk gebe kadınlarda GDM taraması için OGTT'nin yerini alıp ala-mayacağını ve bu popülasyona özel daha pratik ve etkili bir tanı yaklaşımı sunup sunamayacağını değerlendirmektedir.

Gereç ve Yöntemler: Bu retrospektif gözlemsel çalışma, Ocak 2020 ile Ağustos 2022 tarihleri arasında aynı bölgede bulunan iki kadın doğum hastanesinde yürütülmüştür. Çalışmaya, GDM tanısı alan 192 kadın ile 384 sağlıklı gebe dahil edilmiştir. İkinci trimesterde ölçülen biyokimyasal kan parametreleri (açlık kan glukozu, açlık insülini ve HbA1c) ile GDM tanısı arasındaki ilişkiyi belirlemek için alıcı işletim karakteristik (ROC) analizi yapılmıştır.

Bulgular: Çalışmaya 576 gebe kadın dahil edilmiştir. GDM grubunda gebelik öncesi vücut kitle indeksi (VKİ) sağlıklı kontrollere kıyasla daha yüksekti ($p < 0.01$). Gruplar arasında açlık kan şekeri (AKŞ), açlık insülini ve hemoglobin A1c (HbA1c) açısından istatistiksel farklılıklar vardı (sırasıyla $p = 0.001$, 0.001 ve 0.01). ROC analizi sonucunda, AKŞ en yüksek eğri altında kalan alan (AUC) değerine sahipti (0.920).

Sonuçlar: AKŞ ve açlık insülini parametreleri GDM olgularının önemli bir kısmını belirleyebilse de tek başına yeterli değildir; OGTT'nin tanısal değeri korunmalıdır.

Anahtar Kelimeler: Gestasyonel diyabet, glukoz tolerans testi, açlık kan şekeri, gebelik, tanısal tarama

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INTRODUCTION

Gestational diabetes mellitus (GDM), defined as glucose intolerance first identified after 15 weeks of gestation (1), is a significant global health concern affecting approximately 17% of pregnancies worldwide, with prevalence varying by population and diagnostic criteria (2-4). Despite reported gestational diabetes mellitus (GDM) rates as high as 27.9% in Turkey, adherence to the gold-standard oral glucose tolerance test (OGTT) for diagnosis remains alarmingly low. Studies indicate that only 30–50% of eligible pregnant women in Turkey undergo OGTT, even in high-risk populations (5, 6). This contrasts sharply with higher adherence rates in countries like Australia (85–90%) (7) and the United Kingdom (75–80%) (8), where standardized screening protocols and robust healthcare systems facilitate implementation. Globally, adherence varies widely, with low- and middle-income countries reporting rates as low as 20–40% due to logistical, financial, or cultural barriers (9). The gap between Turkey's high GDM burden and low OGTT utilization underscores urgent needs for improved screening strategies and healthcare provider education (10-15).

GDM is associated with both short- and long-term fetomaternal complications, including cesarean delivery, birth trauma, neonatal intensive care admissions, and stillbirths (16-18). While screening and treatment mitigate acute morbidity, evidence of long-term benefits (e.g., reduced risks of diabetes, obesity, and metabolic disorders) remains inconclusive. Nevertheless, consensus guidelines emphasize postpartum glucose monitoring and lifestyle interventions for all GDM patients to curb future metabolic risks (19) .

In Turkey, the OGTT, though nationally recommended (12), faces declining uptake due to patient misconceptions (e.g., media-fueled fears of fetal harm) and practical barriers (17). The 2 h duration and fasting requirements represent major limitations that further deter compliance in the 75 g OGTT; however, although fasting is not required for the 50 g glucose tolerance test, it is a screening test and additional testing is required to diagnose. Although alternatives such as hemoglobin A1c (HbA1c) have been explored (20, 21), their diagnostic validity remains unestablished (21). Consequently, some clinicians resort to ad hoc monitoring of FPG, postprandial glucose, or fasting insulin, despite lacking robust evidence.

This study aims to evaluate the diagnostic utility of fasting parameters (FPG and fasting insulin) at 24–28 weeks' gestation as potential alternatives to the OGTT in Turkish pregnant women, addressing critical gaps in screening accessibility and reliability.

MATERIALS AND METHODS

The study protocol was approved by the Ethics Committee of Giresun Training and Research Hospital (approval date: 14.05.2025 / number: 18) and was conducted in accordance with the ethical principles of the Declaration of Helsinki. Written informed consent was obtained from all participants

Study Design, Patient Selection, and Diagnosis

This retrospective observational study was conducted between January 2020 and August 2022 at two maternity hospitals in Northeast Turkey: Trabzon Kanuni Training and Research Hospital and Giresun University Maternity and Children's Hospital. The study population comprised pregnant women aged 18–40 years who attended the antenatal clinic and underwent a 75 g OGTT during the late second trimester of pregnancy (24–28 weeks gestation), gestational age was initially calculated based on the last menstrual period and was verified using first-trimester ultrasound crown-rump length measurements for accuracy. Women with pre-existing medical conditions that could affect study participation, such as chronic hypertension, pre-gestational diabetes, thyroid disorders, and other endocrine abnormalities, were excluded. Additional exclusion criteria included high-risk pregnancies, such as those complicated by preeclampsia or multiple gestation, as well as known metabolic disorders. Women with incomplete clinical data or missing laboratory results were also excluded from the study.

Recorded maternal characteristics included age, gravidity, parity, pre-pregnancy BMI, and BMI at the time of OGTT evaluation. The gestational week at the time of OGTT was recorded instead of the date of the last menstrual period. In addition, family history of diabetes was noted for all participants.

Venous blood samples were collected from all participants after an overnight fast. Samples for FPG, fasting insulin, and HbA1c analyses were drawn into sterile, standardized 4 mL dipotassium EDTA tubes (Vacutainer® BD, USA). This volume ensured sufficient material for all planned assays while adhering to standard clinical protocols.

All pregnant women were screened at 24-28 weeks' gestation using the 75g OGTT test. Patients were diagnosed with GDM according to the International Association of Diabetes and Pregnancy Study Groups criteria: FPG ≥92 mg/dL (5.1 mmol/L) and/or 1-hour blood glucose ≥180 mg/dL (10.0 mmol/L) and/or 2-hour blood glucose ≥153 mg/dL (8.5 mmol/L) (if they met any of the conditions). In addition, patients with FPG ≥126 mg/dL (7 mmol/L) and/or 2-hour plasma glucose ≥200 mg/dL (11.1 mmol/L) were diagnosed with overt diabetes (2). Patients who met the criteria were referred to as the GDM group. The optimum cut-off point for fasting insulin was 15.7 µU/mL (20) and for HbA1c ≥ 5.7 (22). Two groups were made

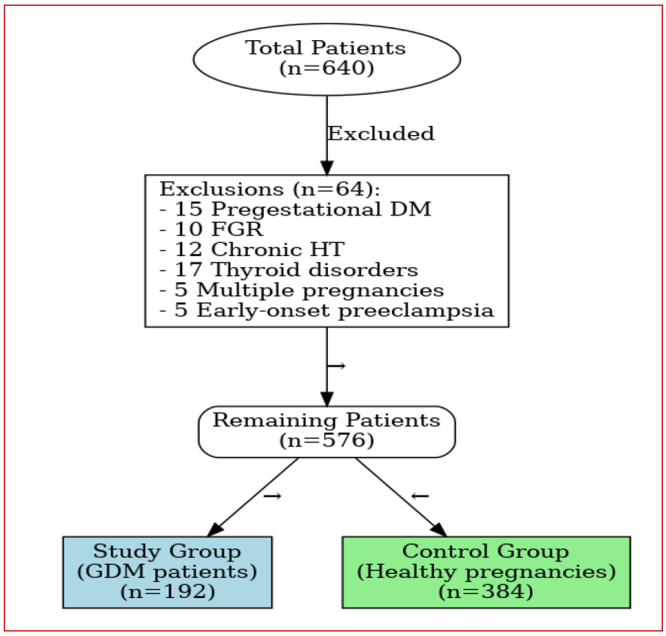

Figure 1. Patient Flow Diagram

according to their pre-pregnancy BMI. BMI 25 ≤ BMI <30 kg/m^2 was considered overweight and BMI ≥ 30 kg/m^2 was considered obese (23).

From an initial cohort of 640 patients, 64 were excluded based on the predefined exclusion criteria. Specifically, 15 patients had pregestational diabetes, 10 had fetal growth restriction, 12 had chronic hypertension, 5 had early-onset preeclampsia, 17 presented with thyroid disorders, and 5 had multiple pregnancies. Consequently, 576 pregnant women were included in the final analysis, comprising 192 diagnosed with GDM and 384 healthy controls (Figure 1).

Statistical Analysis

Statistical analysis was performed using SPSS version 25.0 (IBM Corp., Chicago, IL, USA). Continuous variables with normal distribution were presented as mean ± standard deviation, while non-normally distributed variables were expressed as median with interquartile range. Categorical variables were reported as frequencies and percentages. The normality of distribution was assessed using the Kolmogorov–Smirnov test.

For comparative analyses, independent samples t-tests were used for normally distributed continuous variables, while the Mann–Whitney U test was employed for non-normally distributed data. Categorical variables were analyzed using Fisher's exact test or Pearson's chi-square test, as appropriate.

Diagnostic performance was evaluated through receiver operating characteristic (ROC) curve analysis, which assessed fasting insulin, OGTT glucose values, and HbA1c as predictors of GDM. The analysis provided area under the curve (AUC) measurements with 95% confidence intervals, along with optimal cut-off values, sensitivity, specificity, positive predictive values (PPV), and negative predictive values (NPV).

A two-tailed p-value of ≤0.05 was considered statistically significant for all analyses. The sample size calculation was based on an effect size of 0.2, alpha error of 0.05, and power of 0.80, indicating that a minimum of 190 participants per group was required to achieve adequate statistical power.

RESULTS

The study involved 576 pregnant women, 192 with GDM and 384 with normal results. Table 1 shows the general characteristics and laboratory parameters between the groups. Pre-pregnancy BMI was higher in the GDM group than in the controls (31.4 ± 6.9 vs. 27.9 ± 4.6, p = 0.001).

Table 1. Comparison of demographic characteristics and laboratory parameters between GDM and non-GDM groups.

	GDM (n: 192) [a]	Non-GDM (n: 384)	*p*-Value
Maternal age	29.6 ± 5	28 ± 5	0.59
Pre-pregnancy BMI, kg/m^2	31.4 ± 6.9	27.9 ± 4.6	0.001
BMI at the time of OGTT	31.9 ± 15	28.3 ± 13	0.001
Gravida	2.2 ± 1.2	1.8 ± 1	0.001
Parity	1.1 ± 1.2	0.6 ± 0.8	0.001
OGTT fasting, mg/dL	96.9 ± 10	82.1 ± 5	0.001
OGTT 1 h, mg/dL	153 ± 41	124 ± 26	0.001
OGTT 2 h, mg/dL	134 ± 28	106 ± 19	0.001
Fasting insulin	21.6 ± 12	12.9 ± 5.6	0.001
HbA1c	4.8 ± 0.4	4.6 ± 0.3	0.01
Gestational age	25.2±4	26.3±2	0.56

Abbreviations: [a] Parameters with a normal distribution are presented as mean ± standard deviation; GDM, gestational diabetes mellitus; BMI, body mass index; OGTT, oral glucose tolerance test; $p < 0.05$ values were considered significant.

Table 2. General characteristics of the participants.

	GDM (n: 192)	Non-GDM (n: 384)	*p*-Value
Maternal age			
≥35 y (n, (%))	36 (18.75)	22 (5.8)	0.04
Pre-pregnancy BMI, kg/m²			
≥25 n, (%)	75 (39.5)	153 (39.9)	0.06
≥30 n, (%)	99 (52)	115 (30.5)	0.001
Insulin			
≥15.7 mikroU/mL (n, %)	104 (54)	81 (21.1)	0.001
HbA1c			
≥5.7 (n, %)	24 (12.7)	15 (4)	0.001
OGTT fasting			
≥92 n, (%)	128 (66.6)	0	0.001
OGTT 1 h			
≥180 n, (%)	30 (15.6)	0	0.001
OGTT 2 h			
≥153 n, (%)	28 (14.5)	0	0.001

Abbreviations: **GDM:** gestational diabetes mellitus; **BMI**: body mass index; **OGTT**: oral glucose tolerance test; $p < 0.05$ values were considered significant

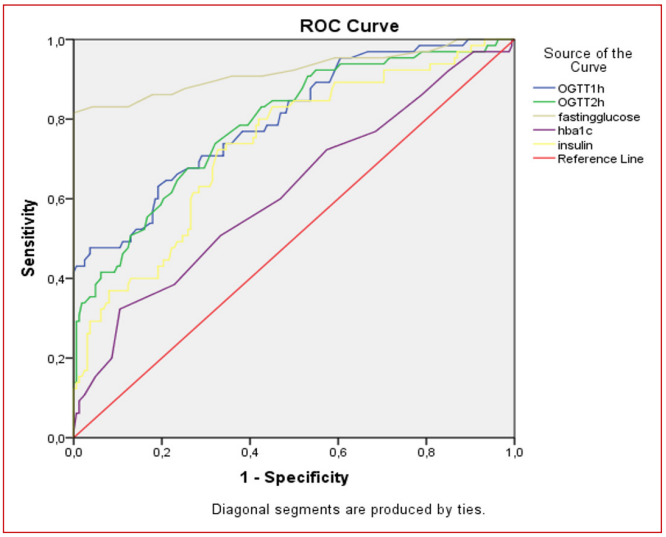

Figure 2. Comparison of Diagnostic Performances of Various Biomarkers Using ROC Curve Analysis

Abbreviations: ROC: receiver operating characteristic, OGTT: oral glucose tolerance test, OGTT1h: 1-hour glucose value from the Oral Glucose Tolerance Test, OGTT2h: 2-hour glucose value from the Oral Glucose Tolerance Test, HbA1c: Glycated hemoglobin

The GDM group exhibited significantly higher concentrations of fasting insulin, FPG, HbA1c, and glucose values at both the first and second hours of the OGTT, relative to the control group.

Table 2 shows categorized general characteristics of the participants. In the GDM group, 18.7% of the pregnant women were ≥ 35 years old and 52% had a BMI >30 (p = 0.04 and p = 0.001, respectively). In the GDM group, 54% had insulin ≥ 15.7 µU/mL and 12.7% had HbA1c ≥ 5.7, which were significantly higher than in the control group (p = 0.001 and p = 0.001, respectively). In the GDM group, 66.6% of cases were diagnosed based solely on FPG ≥92 mg/dL, without requiring OGTT values. An additional 15.6% were diagnosed through elevated 1-hour glucose levels (≥180 mg/dL), and 14.5% through elevated 2-hour glucose levels (≥153 mg/dL), according to the IADPSG diagnostic criteria.

An ROC analysis was performed to evaluate the diagnostic performance of the blood parameters used for identifying GDM. The AUC value for FPG was 0.920 when applying the standard

Table 3. ROC analysis of fasting insulin, fasting glucose, OGTT 1 h, OGTT 2 h, and HbA1c for the prediction of GDM.

	Cut-off Value	AUC (95% CI)	Sensitivity %	Specificity %	PPV%	NPV%
Fasting glucose	≥ 92	0.92 (0.871–0.971)	69%	100%	100	78.6
OGTT 1 h	≥ 180	0.79 (0.735–0.864)	32.5	100	100	78.6
OGTT 2 h,	≥ 153	0.78 (0.722–0.854)	32.5	100	100	78.4
Fasting insulin	≥15.7	0.73 (0.660–0.805)	50.7	75.4	45.2	79.4
HbA1c	>5.7	0.61 (0.534–0.701)	25	78	47	60

Abbreviations: AUC Area Under the Curve, **PPV**: Positive Predictive Value, **NPV**: Negative Predictive Value, **GDM**: Gestational Diabetes Mellitus, **OGTT**: Oral Glucose Tolerance Test, **HbA1c**: Glycated Hemoglobin

diagnostic cut-off of ≥92 mg/dL. At this threshold, the sensitivity and NPV of FPG were 69% and 78.6%, respectively. For fasting insulin, when a cut-off value of ≥15.7 µIU/mL was applied, the AUC was 0.730, with a specificity of 75.4%, sensitivity of 50.7%, PPV of 45.2%, and NPV of 79.4%. The results of the ROC analysis are shown in Figure 2, Table 3.

DISCUSSION

This retrospective observational study is one of the first clinical trials focus-ing on a GDM screening strategy based on fasting insulin and fasting blood glucose levels in second-trimester pregnant women in Turkey. Our findings showed that 54% of GDM patients could be diagnosed with fasting insulin and 66% with fasting blood glucose based on the cut-off values recommended in the literature.

Gestational diabetes mellitus (GDM) is defined as carbohydrate intolerance of variable severity with onset or first recognition during pregnancy. This condition arises from progressive insulin resistance that develops during the second trimester, peaking in the late gestational period. When pancreatic β-cell function proves insufficient to compensate for this physiological insulin resistance, re-sultant hyperglycemia manifests, necessitating systematic screening between 24 and 28 weeks of gestation, as recommended by current clinical guidelines (1, 11, 15). Although simple ratios derived from fasting insulin and glucose have been widely used in epidemiological studies, none are recommended for routine assessment of insulin resistance in the clinical setting (24, 25). Serum fasting insulin concentration, triglyceride concentration, and the ratio of triglyceride to high-density lipoprotein (HDL) cholesterol concentrations are useful markers for identifying individuals with insulin resistance. The optimum cut-off point for insulin was determined as 15.7 µU/mL (21). In our study, fasting insulin levels were significantly higher in the GDM group compared to the controls. Moreover, more than half of the women with GDM had fasting insulin levels above the cut-off value, which was statistically significant compared with the control group.

National and international organizations recommend universal GDM screening instead of selective screening since 20% of individuals with GDM have no risk factors (1, 2, 12) . However, publications in the literature suggest that cost savings can be achieved by using the FPG at 24 to 28 weeks to screen pregnant women in low-income regions where universal screening cannot be applied. A study conducted in China showed that 38% of pregnant women with FPG between 79 mg/dL and 90 mg/dL had undiagnosed GDM, and 12% of patients with GDM were not detected(24). In the HAPO study, 50% to 75% of patients with GDM had FPG ≥ 92 mg/dL on the OGTT (25). Consistent with these findings, our study demonstrated that approximately two-thirds of GDM cases could be identified using FPG ≥ 92 mg/dL, while additional cases were detected with the 1-hour and 2-hour OGTT values. Based on the FPG alone, 34.6% of GDM patients could not be diagnosed. In a systematic review, when the FPG threshold used was 95.5 mg/dL, specificity was reported as 98% and sensitivity as 58%. In our study, the sensitivity and predictive values of FPG supported its diagnostic utility, although a proportion of cases would still remain undetected if used as the sole screening tool.

HbA1c, which is used to diagnose diabetes and monitor the efficacy of treatment (26, 27) , may be a helpful test for evaluating glycemic management during pregnancy (28, 29). There are no standardized values according to trimesters. Levels are lower in pregnant women due to physiologic changes during pregnancy (30). A study involving 607 Indian women found an AUC of 0.683 (95% CI: 0.601–0.765) for HbA1c in diagnosing GDM in the late second trimester of gestation (31). Similarly, a Turkish study including 339 women found an AUC of 0.697 (95% CI: 0.645–0.745) (32). In this study, a threshold of HbA1c ≥ 5.7% was used, although this value is conventionally applied to define prediabetes rather than overt diabetes (≥ 6.5%). The rationale for using this lower threshold was to evaluate its potential utility as an early marker for gestational diabetes mellitus (GDM), given that even mild elevations in HbA1c during pregnancy may indicate impaired glucose metabolism. Previous studies have also explored HbA1c cut-off values below the diagnostic threshold for diabetes to assess their predictive value for GDM (22), and our study aimed to contribute to this growing body of evidence. In our study, the AUC was 0.61 (95% CI: 0.534–0.701), which is consistent with other studies. When HbA1c ≥ 5.7% was used, the proportion of GDM patients identified was limited, although this finding remained statistically significant compared with controls. This reduced sensitivity may be attributed to physiological changes in pregnancy, such as shortened erythrocyte lifespan and altered hemoglobin glycation rates. While the specificity for GDM increased with higher HbA1c cut-off values, the sensitivity improved at lower cut-offs, though neither approach provided sufficient diagnostic accuracy.

The study's strengths include its retrospective design, multicenter nature, relatively large sample size, and potential clinical utility in settings with low patient compliance.

This study has several limitations. First, the findings may not be generalizable to all Turkish populations, as important factors such as socioeconomic status and lifestyle were not assessed. Second, clinical outcomes including birth weight, cesarean delivery rates, and neonatal hypoglycemia were not evaluated. Third, the fasting

insulin cut-off value was not population-specific, and pregnancy-related anemia may have influenced HbA1c measurements. Finally, the analysis was restricted to the 24–28 weeks' gestational window, without considering earlier or later time points.

CONCLUSIONS

This retrospective study demonstrates that while FPG and fasting insulin levels show reasonable diagnostic accuracy for GDM, they remain insufficient as standalone screening tools, missing approximately one-third of GDM cases. Our findings reinforce that the OGTT remains the gold standard for GDM diagnosis, particularly given the limitations of alternative biomarkers such as HbA1c, which exhibited poor sensitivity in our cohort.

The clinical implications are twofold: First, in resource-limited settings or for patients refusing the OGTT, FPG-based screening may identify a majority of GDM cases, though with significant false negative rates requiring careful patient counseling. Second, our results highlight the need for population-specific cut-off optimization and further research into composite screening algorithms combining fasting parameters with clinical risk factors.

Institutional Review Board Statement: The Ethics Committee of Giresun Training and Research Hospital approved the study protocol, which complied with the requirements of the Declaration of Helsinki (approval date 14.05.2025/ number 18)

Informed Consent Statement: The need for written informed consent was exempted because of the study's retrospective design.

Data Availability Statement: The datasets used and/or analyzed in this study are accessible from the corresponding author upon reasonable request.

Conflicts of Interest: The authors declare no conflicts of interest.

Author Contributions: Conceptualization, S.B.Y.; methodology, S.BY.; validation, S.BY.; formal analysis, S.BY. and N.B.A.; investigation, S.B.Y. and N.B.A.; resources, S.B.Y and N.B.A.; data curation, S.B.Y and N.B.A.; writing—S.B.Y.; writing—review and editing, S.B.Y. and N.B.A.; visualization, S.B.Y. and N.B.A.; supervision, S.B.Y. and N.B.A.; project administration, S.B.Y. and N.B.A.; funding acquisition, S.B.Y. and N.B.A. All authors have read and agreed to the published version of the manuscript.

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