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RESEARCH ARTICLE

Evaluation of patient satisfaction following oral glucose tolerance test

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ABSTRACT

Aim: Diabetes mellitus (DM) is a common metabolic disease. Early diagnosis of diabetes prevents the increase in mortality and morbidity due to complications. The oral glucose tolerance test (OGTT) is a test used in the diagnosis of DM and in the determination of impaired glucose tolerance (IGT). In our study, it was aimed to evaluate the satisfaction of patients who underwent OGTT.

Methods: A 25-question questionnaire was applied to 300 patients who underwent OGTT, aiming to evaluate their satisfaction. The physical and psychological status of the patients was examined before, during, and after the test.

Results: Patients who were informed about the test before the test experienced less nausea during fluid intake (p=0.005). Approximately 58.7% of the participants agreed to repeat the test. Those who felt nauseous or hungry during the test were statistically less likely to accept retesting. The retest acceptance rates were statistically higher (p<0.05) among individuals who did not feel uncomfortable with the blood draw and inactivity and who did not vomit or feel uneasy during the test. 70% of the participants answered 'yes' to the suggestion of using an alternative diagnostic method.

Conclusion: OGTT is the gold standard for the diagnosis of IGT and DM, despite tests such as HbA1c and fasting plasma glucose, which are more easily performed and practical. It would be beneficial to develop another method that is easy to apply, better tolerated by patients, easy to repeat, and can be standardized instead of OGTT.

Keywords: diabetes mellitus, oral glucose tolerance test, satisfaction

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INTRODUCTION

According to the International Diabetes Federation, the prevalence of diabetes mellitus (DM) is projected to increase from 463 million in 2019 to an estimated 578 million by 2030 and 700 million by 2045 (1). Simultaneously, the prevalence of individuals with prediabetes is also expected to rise. This substantial increase in the number of prediabetic patients is evolving into a significant public health problem of the 21st century (2). Diabetes mellitus, a chronic disease characterized by irregular glycemic states, leads to both microvascular and macrovascular complications and is associated with high morbidity and mortality (3).

Prediabetes is a risk factor for progression to both diabetes and cardiovascular disease. The term 'prediabetes' is used to describe individuals whose glucose levels do not meet the criteria for diabetes, but who have abnormal carbohydrate metabolism. Prediabetes is typically characterized by impaired fasting glucose (IFG) and/or impaired glucose tolerance (IGT) and/or the presence of an A1C level ranging between 5.7–6.4% (39–47 mmol/mol). IFG is defined as fasting plasma glucose (FPG), levels falling between 100 and 125 mg/dL, while IGT is indicated by 2-hour post-meal glucose (2-h PG) levels during the 75-gram OGTT ranging from 140 to 199 mg/dL (4). Studies have revealed that approximately 70% of individuals with IGT or IFG are at risk of developing type 2 diabetes, with 20-30% of them progressing to diabetes within 5-10 years (1). Prediabetes is often associated with obesity, particularly abdominal or visceral obesity, dyslipidemia characterized by high triglycerides and/or low HDL cholesterol, as well as hypertension (4).

Identifying IGT is crucial for implementing type 2 DM prevention strategies in high-risk individuals. The oral glucose tolerance test (OGTT) has been widely utilized in clinical settings to diagnose impaired glucose tolerance (IGT) and/or type 2 diabetes mellitus (5). In addition to the OGTT, diabetes diagnosis also involves fasting plasma glucose and A1C measurements (4). The prevalence of DM calculated according to plasma fasting glucose was found to be 40% lower than that calculated according to the oral glucose tolerance test. Measuring fasting plasma glucose level alone causes the person with 70-80% impaired glucose tolerance to be overlooked (6,7). Similarly, relying solely on A1C measurements results in overlooking more than half of the diabetes cases detected by OGTT. Despite its effectiveness, OGTT has limitations; it is challenging to repeat, time-consuming, laboratory-dependent, laborious, and difficult for patients to tolerate. Patients often report discomforts such as nausea and vomiting during the test (8-11). Nevertheless, due to its higher sensitivity and specificity compared to other methods, OGTT remains the most appropriate diagnostic tool for diabetes (5).

Our study aimed to assess the satisfaction of patients who underwent OGTT.

MATERIAL AND METHOD

In our study, we included 300 patients who presented to the general internal medicine and endocrinology outpatient clinics at our hospital and were given OGTT indications. Exclusion criteria encompassed factors such as drug use, presence of infection, and prolonged sedentary lifestyle, which could potentially influence the test result before the OGTT. The study protocol adhered to the guidelines outlined by the American Diabetes Association (ADA) for the 75-g OGTT. Prior to the OGTT, patients were instructed to maintain a diet containing at least 150 grams of carbohydrates for a minimum of 3 days. Additionally, they were advised to consume an evening meal containing 30-50 grams of carbohydrates and to engage in regular physical activity during this period. At the beginning of the test, a catheter was inserted into the subjects' forearm vein to facilitate frequent blood sampling. Following a fasting period of at least 8 hours, a 7 ml blood sample was drawn through this catheter into a tube containing fluoride oxalate. Subsequently, participants were administered a 300 cc glucose solution containing 75 grams of anhydrous glucose. Blood samples were obtained from the patients again at the end of the second hour for glucose level measurement. Importantly, patients were instructed not to smoke or engage in physical activity before or during the test to ensure the accuracy and reliability of the results (4,12,13).

After the final blood sample was taken, satisfaction with the test was assessed using visual analog scales

(12,14). A questionnaire consisting of 25 questions in 4 parts was applied to the patients, and their physical and psychological conditions were assessed before, during, and after the test. The first part consisted of 4 questions describing the socio-demographic characteristics of the patients. In the second part of the questionnaire, there were 7 'yes/no' questions (if yes, mild-moderate-severe) evaluating the physical and psychological conditions of the patients before the test. Physical factors included nausea, vomiting, cold sweats, tremors in the hands, palpitations, and feeling faint, which may be related to hypoglycemia during the fasting period, the complaints they may experience, and compliance with the appointment time. The psychological factors section provides information about the anxiety experienced before the test, the situations that may be experienced by the patient before the test, and the questioning of the discomfort, and degree of hunger that may be caused by the test. The third part of the questionnaire consists of yes/no questions that evaluate the physical and psychological state during the test. The physical factors included difficulty in drinking the given liquid, experiencing nausea and vomiting during drinking, immobilization during the test, and discomfort from two blood draws. The psychological factors included the feeling of distress experienced during the test or the ease of access to health personnel in case of any distress encountered, and the analytical approach of the personnel. The fourth part aimed to ask about post-test information, confirmation of acceptance in case of re-testing, and a request for another diagnostic method.

The average time required to complete the questionnaire was 30 minutes. Illiterate participants were provided with assistance from their relatives and filled out the questionnaire under the supervision of nurses. This support was explicitly mentioned at the bottom of the questionnaire to ensure transparency and accuracy in the data collection process.

Statistical analysis

The data were presented as numerical values, percentages, means, and standard deviations. Statistical analysis was performed using the SPSS 18 computer statistics program. The questionnaire data were analyzed using the chi-square test. A p-value of less than 0.05 was considered significant, indicating a statistically significant difference between the groups.

RESULTS

This study analyzed data from 300 patients who underwent OGTT. Table 1 presents the demographic characteristics of the patients. The analysis revealed no statistically significant differences between pre-test fasting times and complaints such as nausea, vomiting, sweating, and palpitation ($p>0.05$). Patients with symptoms did not experience hypoglycemia. The impact of pre-test information on the complaints experienced during the test is analyzed in Table 2. According to the chi-square analysis, patients who were informed before the test reported significantly lower complaints of nausea ($p=0.005$). The variables and their influence on the acceptance of a repeat OGTT are shown in Table 3. Approximately 58.7% of the participants agreed to repeat the test. The statistical analysis revealed that individuals who accepted the test-retest reported higher levels of staff courtesy and ease of access. Additionally, acceptance of repeating the test was significantly higher among individuals who did not feel discomfort during the blood draw, inactivity, or hunger, those who did not experience vomiting, and those who did not feel uneasy ($p<0.05$). Patients who experienced nausea and discomfort due to hunger were statistically less likely to accept the test

Table 1. Demographic characteristics.

	Variables
Gender	
Woman (n)	142 (%58.6)
Man (n)	176 (%41.4)
Age	
Average (years)	44.5 ±12.6
Median	47
Education status	10 (%3.3)
Illiterate (n) Primary school (n)	83 (%27.7)
Middle school (n)	54 (%18)
High school (n)	94 (%31.3)
University (n)	59 (%19.7)

Table 2. Pre-test information and the complaints encountered during the test.

	Information		p
	Yes n (%)	No n (%)	
Uneasiness			
No (n)	124 (57.6)	39 (45.8)	0.262
Yes (n)	91 (42.3)	46 (54.1)	
Discomfort from the feeling of hunger			
No (n)	97 (45.2)	35 (41.1)	0.536
Yes (n)	118 (54.8)	50 (58.8)	
Difficulty drinking liquid			
No (n)	79 (36.7)	29 (34.1)	0.669
Yes (n)	136 (63.2)	56 (65.8)	
Nause during the test			
No (n)	120 (55.8)	32 (37.6)	0.005
Yes (n)	95 (44.1)	53 (62.3)	
Vomiting during the test			
No (n)	176 (81.8)	70 (82.3)	0.920
Yes (n)	39 (18.2)	15 (17.6)	
Feeling of boredom			
No (n)	86 (40)	27 (31.8)	0.185
Yes (n)	129 (60)	58 (68.2)	
Discomfort due to the blood draw			
No (n)	164 (76.3)	63 (74.2)	0.694
Yes (n)	51(23.7)	22 (25.8)	

again. The impact of these variables on the request for an alternative diagnostic method is shown in Table 4. 70% of the participants answered "yes" to the request for another method. Patients who had difficulty drinking fluids, felt nauseated during the test, and were uncomfortable with inactivity were statistically more likely to request another method. Conversely, among those who did not seek an alternative method, there were statistically more individuals who did not feel discomfort during blood draws and did not vomit during the test ($p<0.05$). Additionally, a statistically significant difference was found when examining the relationship between the desire for an alternative method and educational status (Table 5), with a p-value of less than 0.05.

Table 3. Accepting the OGTT repetition and the variables.

Variables	Accepting a repeat test		p
	Yes n (%)	No n (%)	
Gender			
Woman (n)	87 (54.1)	74 (45.9)	
Man (n)	89 (64)	50 (36)	
Access to staff			
Yes (n)	150 (93.2)	115 (83.5)	0.013
No (n)	11 (6.8)	23 (16.5)	
Discomfort due to the blood draw			
Yes (n)	20 (12.5)	53 (38.2)	0.00
No (n)	141 (87.5)	86 (61.8)	
Difficulty drinking liquid			
Yes (n)	152 (94)	114 (82)	0.001
No (n)	9 (6)	25 (18)	
Nausea during the test			
Yes (n)	65 (40.3)	83 (59.8)	0.00
No (n)	96 (59.7)	56 (40.2)	
Vomiting during the test			
Yes (n)	19 (11.8)	35 (25.2)	0.014
No (n)	142 (88.2)	104 (74.8)	
Discomfort from the feeling of hunger			
Yes (n)	78 (48.4)	90 (64.7)	0.01
No (n)	83 (51.6)	49 (35.3)	
Uneasiness			
Yes (n)	54 (33.5)	83 (59.7)	0.00
No (n)	107 (66.5)	56 (40.3)	
Discomfort due to inactivity			
Yes (n)	68 (42.3)	86 (61.8)	0.00
No (n)	93 (57.7)	53 (38.1)	
Information			
Yes (n)	142 (88.2)	118 (84.9)	0.501
No (n)	19 (11.8)	21 (15.1)	
Staff courtesy			
Yes (n)	156 (96.9)	125 (90)	0.013
No (n)	5 (3.1)	14 (10)	

Table 4. Request for another diagnostic method and the variables.

Variables	Request for Another Method		p
	Yes n (%)	No n (%)	
Gender			
Woman (n)	126 (60)	50 (55.6)	
Man (n)	84 (40)	40 (44.4)	
Access to staff			
Yes (n)	187 (89.6)	78 (86.7)	0.630
No (n)	22 (10.4)	12 (13.3)	
Discomfort due to the blood draw			
Yes (n)	59 (28.1)	14 (15.6)	0.017
No (n)	151 (71.9)	76 (84.4)	
Difficulty drinking liquid			
Yes (n)	180 (85.5)	86 (95.6)	0.014
No (n)	30 (14.2)	4 (4.4)	
Nausea during the test			
Yes (n)	115 (71.4)	33 (23.7)	0.004
No (n)	95 (28.6)	57 (76.3)	
Vomiting during the test			
Yes (n)	19 (9)	35 (38.8)	0.003
No (n)	142 (91)	104 (61.2)	
Uneasiness			
Yes (n)	102 (48.5)	35 (38.8)	0.123
No (n)	108 (51.5)	55 (61.2)	
Discomfort due to inactivity			
Yes (n)	126 (60)	28 (31.2)	0.00
No (n)	84 (40)	62 (68.8)	
Information			
Yes (n)	147 (60.9)	68 (84.2)	0.328
No (n)	63 (39.1)	22 (15.8)	

Table 5. Requesting for another diagnostic method depending on the education level.

	Other method requests		p
	Yes n (%)	No n (%)	
Primary school	45 (21.4)	38 (42.2)	p<0.036
Middle school	42 (20)	12 (13.3)	
High school	71 (33.8)	23 (25.5)	
University	46 (21.9)	13 (14.4)	
Illiterate	6 (2.8)	4 (1.9)	

DISCUSSION

The 75-g OGTT is widely recognized as the "gold standard" diagnostic test for diabetes and prediabetes (15). Previous studies have highlighted the limitations encountered during OGTT administration. To the best of our knowledge, our study is the first to assess not only the physical side effects but also the psychological impact of the OGTT on patients. It explores how these effects influence patients' decisions regarding retesting or recommendations for new diagnostic tests when necessary.

In our study, nausea was reported by 42% of the patients before the OGTT. Interestingly, no correlation was found between the severity of nausea and the duration of fasting. This observation suggests that despite the extension of the fasting period, there might not be a significant change in the intensity of nausea due to the sensitivity of the gastrointestinal system. Nausea may discourage individuals from initiating the test. Additionally, 25% of the patients experienced sweating and palpitations before the test. However, these symptoms were not associated with hypoglycemia. It was hypothesized that the test procedure itself, along with the anxiety and anticipation of the test results, might lead to increased sympathetic activity, potentially causing these symptoms.

Tolerating the fluid consumed during the OGTT can prove to be challenging. Among the participants, 49.3% experienced nausea, and 18% reported vomiting during liquid intake. Another study involving 36 participants found that drinking 75 grams of OGTT liquid led to gastric discomfort in 14%, belching in 19%, hunger in 24%, and nausea in 6% of the participants

(14). Similarly, in a study conducted by Harano et al., in which a 75-gram OGTT was administered to 19 patients, mild hypoglycemia was observed in 5 individuals, and discomfort such as nausea, vomiting, and heartburn was reported by 4 patients (16). These findings underscore the challenges associated with the tolerance for the liquid consumed during OGTT. The higher incidence of nausea in our study compared to similar studies in the literature can be attributed to our larger sample size of 300 participants, which significantly surpasses the numbers in other research. The fact that nearly half of our patients experienced nausea raises concerns about the OGTT, a commonly used diagnostic test that could adversely affect a significant portion of the population in larger studies. When accompanied by vomiting, it could lead to misinterpretation of the test results. Notably, 31.7 % of patients who were informed about the challenging nature of the liquid beforehand still experienced nausea. Despite psychological support and sufficient information, the taste of the liquid proved to be intense and unpleasant, making it difficult to tolerate and causing complaints among patients. This highlights the importance of reevaluating the methods and solutions used during OGTT to enhance patient comfort and minimize adverse effects.

Numerous studies have explored the possibility of using alternative fluids during OGTT, aiming to find a more tolerable option for patients than the standard 75-gram glucose solution. For instance, Harano et al. conducted a study involving 83 participants, where OGTT was performed using a standardized meal stimulation test. Interestingly, they found no metabolic differences in the results compared to the traditional 75-gram glucose test, and the patients found the alternative test more tolerable (16). In another study, the OGTT was performed using a standardized meal test containing 50 grams of glucose. The discomfort reported in this test was minimal, with stomach discomfort at 6%, belching at 7%, hunger at 14%, and no instances of nausea. Moreover, the 2nd-hour blood glucose results were comparable to those obtained from the standard 75-gram OGTT13. In a study involving 232 participants, OGTT was carried out using glucose and maltose solutions. The nausea rates were 2.3% for 50 grams of maltose, 4.2% for 100 grams of maltose, and 21% for 100 grams of glucose load (17). These studies suggest that using alternative substances or modifying the OGTT procedure might reduce the discomfort experienced by patients, making the test more tolerable while maintaining the accuracy of the diagnostic results.

Several studies have investigated different methods to improve the tolerability and acceptability of OGTT. In a study with 35 participants, the OGTT solution was diluted to 300 cc, 600 cc, and 900 cc. Surprisingly, the 600 cc solution was found to have the best taste and acceptability scores, while the 900 cc solution resulted in the fewest side effects (12). A recent study involving 399 pregnant women experimented with various glucose solutions for the 75g OGTT. Cold glucose solution and any-temperature glucose solution containing a tea bag resulted in slightly higher taste scores and lower degrees of nausea compared to the room-temperature water-based glucose solution (18). Another study with 30 participants tested a novel lemon-lime flavored beverage was tested during the OGTT. This alternative solution yielded similar biochemical results to the traditional OGTT, but significantly increased taste satisfaction and compliance rates among the participants (19). These studies demonstrate the ongoing efforts to enhance the OGTT experience for patients. Exploring different solutions, temperatures, and flavors not only improves patient comfort, but also ensures accurate test results, enhancing the overall effectiveness and acceptability of OGTT in various populations.

The provision of pre-test information did not alleviate the discomfort experienced by patients due to the double blood draw and inactivity during the test. Surprisingly, there is a lack of data in the existing literature concerning inactivity, which was a significant concern for half of the patients in our study. The high rates of easy access to personnel and their courteous approach might have contributed to the patients feeling safer. This sense of security may prevent glucose increases triggered by stress and anxiety. In our study, the primary metrics assessing patient satisfaction were their willingness to undergo the test again and their inclination toward alternative diagnostic methods. These aspects are pivotal in understanding the patient experience and can inform future improvements in the OGTT procedure to enhance patient comfort and

overall satisfaction. A significant correlation was observed between the decision to repeat the test and several factors, including feelings of hunger before the test, the occurrence of nausea and vomiting during the test, the accessibility and politeness of healthcare personnel, inactivity during the test, and discomfort or uneasiness related to the blood draws. Patients who experienced vomiting might fear a recurrence of the same or even more severe problems if the test were to be repeated. Remarkably, 70% of the participants expressed a preference for an alternative diagnostic method other than OGTT. Among those who wanted another method, 85.7% had difficulty drinking the liquid, indicating a substantial impact on their preference. Other factors influencing the demand for an alternative method included nausea, vomiting, discomfort of remaining still during the test, and discomfort associated with the blood draws. Interestingly, even positive interactions with healthcare professionals did not fully alleviate dissatisfaction stemming from OGTT. Furthermore, the increase in the educational level of the patients appeared to be associated with a preference for alternative diagnostic methods. This increased awareness might lead them to question whether there are other methods that are easier to tolerate, emphasizing the need for more patient-friendly testing approaches.

In clinical practice, A1c testing is often favored over OGTT to diagnose diabetes. A1c testing offers several advantages, such as not requiring fasting, the ingestion of a glucose solution, or prolonged waiting times for blood to be drawn. Additionally, A1c levels remain stable under stress and can be used to monitor individuals undergoing antihyperglycemic treatment. However, it's important to note that A1c testing can be relatively more expensive than other diagnostic tests, and its standardization is still an area of concern within the medical community (4).

CONCLUSION

Despite the availability of alternative tests such as HbA1c and fasting plasma glucose, the 75g OGTT remains the gold standard for the diagnosis of impaired glucose tolerance (IGT) and diabetes mellitus (DM). However, the findings of our study suggest the need for the development of a new diagnostic method. Ideally, this method should be cost-effective, easy to administer, repeatable, well-tolerated by patients, and standardized. Such an approach could significantly improve the diagnostic experience for patients while ensuring accurate results, marking a potential breakthrough in diabetes diagnosis.

Ethical approval

This study has been approved by the Atatürk University Faculty of Medicine Ethics Committee (approval date 15/02/2011). Written informed consent was obtained from the participants.

Author contribution

Concept: PG, HB; Design: PG, HB, EMA; Data Collection or Processing: PG, ÇÖ, VG; Analysis or Interpretation: PG, EMA, GK; Literature Search: PG, VG, GK; Writing: PG, HB, GK. All authors reviewed the results and approved the final version of the article.

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Conflict of interest

The authors declare that there is no conflict of interest.

REFERENCES

1. Jiang Q, Li JT, Sun P, Wang LL, Sun LZ, Pang SG. Effects of lifestyle interventions on glucose regulation and diabetes risk in adults with impaired glucose tolerance or prediabetes: a meta-analysis. Arch Endocrinol Metab. 2022; 66(2): 157-67. [Crossref]
2. Meijnikman AS, De Block CEM, Dirinck E, et al. Not performing an OGTT results in significant underdiagnosis of (pre)diabetes in a high risk adult Caucasian population. Int J Obes (Lond). 2017; 41(11): 1615-20. [Crossref]
3. Soltani S, Mansouri K, Parvaneh S, Thakor AS, Pociot F, Yarani R. Diabetes complications and extracellular vesicle therapy. Rev Endocr Metab Disord. 2022; 23(3): 357-85. [Crossref]
4. ElSayed NA, Aleppo G, Aroda VR, et al. 2. Classification and Diagnosis of Diabetes: Standards of Care in Diabetes-2023. Diabetes Care. 2023; 46(Suppl 1): S19-40. [Crossref]

5. Kuo FY, Cheng KC, Li Y, Cheng JT. Oral glucose tolerance test in diabetes, the old method revisited. World J Diabetes. 2021; 12(6): 786-93. [Crossref]

6. Gimeno SG, Ferreira SR, Franco LJ, Iunes M. Comparison of glucose tolerance categories according to World Health Organization and American Diabetes Association diagnostic criteria in a population-based study in Brazil. The Japanese-Brazilian Diabetes Study Group. Diabetes Care. 1998; 21(11): 1889-92. [Crossref]

7. Gómez-Pérez FJ, Aguilar-Salinas CA, López-Alvarenga JC, Perez-Jauregui J, Guillen-Pineda LE, Rull JA. Lack of agreement between the World Health Organization Category of impaired glucose tolerance and the American Diabetes Association category of impaired fasting glucose. Diabetes Care. 1998; 21(11): 1886-8. [Crossref]

8. Stolk RP, Orchard TJ, Grobbee DE. Why use the oral glucose tolerance test? Diabetes Care. 1995; 18(7): 1045-9. [Crossref]

9. Ko GT, Chan JC, Woo J, et al. The reproducibility and usefulness of the oral glucose tolerance test in screening for diabetes and other cardiovascular risk factors. Ann Clin Biochem. 1998; 35(Pt 1): 62-7. [Crossref]

10. Mooy JM, Grootenhuis PA, de Vries H, et al. Intra-individual variation of glucose, specific insulin and proinsulin concentrations measured by two oral glucose tolerance tests in a general Caucasian population: the Hoorn Study. Diabetologia. 1996; 39(3): 298-305. [Crossref]

11. Feskens EJ, Bowles CH, Kromhout D. Intra- and interindividual variability of glucose tolerance in an elderly population. J Clin Epidemiol. 1991; 44(9): 947-53. [Crossref]

12. Sievenpiper JL, Jenkins DJ, Josse RG, Vuksan V. Dilution of the 75-g oral glucose tolerance test improves overall tolerability but not reproducibility in subjects with different body compositions. Diabetes Res Clin Pract. 2001; 51(2): 87-95. [Crossref]

13. Sievenpiper JL, Jenkins DJ, Josse RG, Vuksan V. Dilution of the 75-g oral glucose tolerance test increases postprandial glycemia: implications for diagnostic criteria. CMAJ. 2000; 162(7): 993-6.

14. Wolever TM, Chiasson JL, Csima A, et al. Variation of postprandial plasma glucose, palatability, and symptoms associated with a standardized mixed test meal versus 75 g oral glucose. Diabetes Care. 1998; 21(3): 336-40. [Crossref]

15. Duan D, Kengne AP, Echouffo-Tcheugui JB. Screening for Diabetes and Prediabetes. Endocrinol Metab Clin North Am. 2021; 50(3): 369-85. [Crossref]

16. Harano Y, Miyawaki T, Nabiki J, et al. Development of cookie test for the simultaneous determination of glucose intolerance, hyperinsulinemia, insulin resistance and postprandial dyslipidemia. Endocr J. 2006; 53(2): 173-80. [Crossref]

17. Harano Y, Sakamoto A, Izumi K, Shimizu Y, Hoshi M. Usefulness of maltose for testing glucose tolerance. Am J Clin Nutr. 1977; 30(6): 924-31. [Crossref]

18. Wang P, Chang PC, Wang CY, Wang LC, Shih CL. Comparing the effects of water temperature and additives in glucose solution on pregnant women's taste, side effects, and glycemic levels during an oral glucose tolerance test: a randomized controlled trial. Am J Obstet Gynecol MFM. 2023; 5(4): 100870. [Crossref]

19. Chotwanvirat P, Thewjitcharoen Y, Parksook W, et al. Development of New Lemon-Lime Flavored Beverage for OGTT: Acceptability and Reproducibility. J Med Assoc Thai. 2016; 99(5): 497-504.