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Original Research

Gender Predilection of Taste Alteration in Patients with Type 2 Diabetes Mellitus

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ABSTRACT:
Background: Type 2 Diabetes Mellitus (T2DM) is associated with various systemic complications, including sensory dysfunctions such as taste alterations. These taste disturbances may affect dietary preferences, particularly the craving for high-carbohydrate foods, which can worsen glycemic control. This study aimed to evaluate the gustatory function in T2DM patients and assess potential gender differences in taste perception alterations. **Materials and Methods:** A total of 60 participants were included in this cross-sectional study: 20 with controlled T2DM (HbA1c 6–8%), 20 with uncontrolled T2DM (HbA1c >8%), and 20 healthy controls (HbA1c <6%). Taste perception was assessed using two validated techniques—whole-mouth above-threshold tests and spatial (localized) taste tests—for sweet, salt, sour, and bitter stimuli. Statistical analysis was performed using ANOVA and Chi-square tests, with significance set at $p<0.05$. **Result:** Hypogeusia was observed in 95% of diabetic patients versus 12.5% of controls ($p < 0.0001$). Sweet taste showed the most significant impairment: 60.87% of controlled and 58.70% of uncontrolled diabetics required stronger concentrations to perceive sweetness compared to only 13.04% of controls ($p < 0.0001$). Sour taste alterations were also prominent ($p < 0.001$), followed by bitter ($p = 0.001$) and salt ($p < 0.001$). Spatial taste scores were highest in uncontrolled diabetics for sweet (49.3 ± 3.08) and sour (38.61 ± 7) stimuli. Gender-based analysis revealed a slightly higher prevalence of taste alteration in males, though it did not reach statistical significance. **Conclusion:** Patients with T2DM, especially those with poor glycemic control, demonstrate significant alterations in taste perception—particularly for sweet, sour, and bitter tastes. While gender predilection was minimal, altered gustatory response may lead to increased sweet food consumption, thus exacerbating hyperglycemia and impacting long-term metabolic control.
Keywords: Type 2 Diabetes Mellitus, Taste Alteration, Gustatory Dysfunction, Gender Differences, Sweet Taste, Hypogeusia

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INTRODUCTION

Diabetes mellitus is a chronic metabolic disorder characterized by persistent hyperglycemia resulting from defects in insulin secretion, insulin action, or both. Type 2 diabetes mellitus (T2DM) accounts for approximately 90–95% of all diabetes cases and is strongly associated with obesity, sedentary lifestyle, and genetic predisposition (1). While macrovascular and microvascular complications of T2DM are well-documented, increasing attention is being paid to its impact on sensory functions, particularly gustatory perception (2).

Taste plays a vital role in regulating food preferences and nutritional intake, both of which are crucial for managing diabetes. Alterations in taste perception—ranging from hypogeusia to ageusia—can lead to increased craving for sweet foods, often resulting in poor glycemic control and exacerbation of the disease state (3). Several studies have reported that individuals with T2DM frequently experience changes in the perception of sweet, sour, salty, and bitter tastes, possibly due to hyperglycemia-induced neuropathy affecting cranial nerves or dysfunction of taste receptor cells (4).

Furthermore, gender-related differences in taste sensitivity have been observed in the general population, with women often demonstrating greater taste acuity than men. However, the influence of gender on taste perception in diabetic individuals remains underexplored and warrants further investigation (5). Understanding these alterations and their gender predilection could help in devising patient-specific dietary interventions, ultimately contributing to better disease management and quality of life in diabetic patients.

MATERIALS AND METHODS

Study Design and Population

This cross-sectional, comparative study was conducted at the Department of Oral Medicine and Radiology, People's Dental Academy, Bhopal. A total of 60 participants were enrolled and categorized into three groups: 20 patients with controlled type 2 diabetes mellitus (T2DM), 20 with uncontrolled T2DM, and 20 healthy individuals serving as the control group. All participants provided informed consent prior to inclusion.

Inclusion and Exclusion Criteria

Inclusion Criteria

- Diagnosed cases of T2DM for at least one year (study groups).
- Age- and sex-matched healthy individuals with no systemic illness (control group).

Exclusion Criteria

- Presence of other systemic illnesses or neurological disorders.
- History of tobacco or alcohol use.
- Current use of medications known to affect taste perception.
- Pregnant or lactating women.
- Individuals with a history of head trauma or oral surgeries like partial/total glossectomy.
- Subjects allergic to common food substances.

Grouping Based on HbA1c

All subjects underwent evaluation for glycosylated hemoglobin (HbA1c) levels and were grouped accordingly:

- **Group 1 (Controlled T2DM):** HbA1c between 6% and 8%.
- **Group 2 (Uncontrolled T2DM):** HbA1c greater than 8%.
- **Group 3 (Control):** HbA1c less than 6%.

Assessment Procedures

Taste perception was assessed using two standardized tests:

1. **Whole-Mouth Above-Threshold Test:**This method used five graded concentrations of four tastants—sucrose (sweet), sodium chloride (salty), citric acid (sour), and quinine hydrochloride (bitter). Subjects were presented with three cups—one containing the test solution and two with distilled water—in a randomized order. Participants rinsed, swirled, and expectorated each sample and identified the taste. The lowest concentration correctly identified three times consecutively was recorded as the detection threshold.
2. **Spatial (Localized) Taste Test:**Using cotton swabs dipped in the highest concentration of each tastant, six specific intraoral regions were tested: the anterior and posterior regions on both sides of the tongue and the bilateral soft palate. Taste intensity was scored using a 0–9 scale, ranging from no taste (0) to extremely strong taste (9).

Scoring and Data Analysis

- Taste responses in the whole-mouth test were scored from 1 (very strong response to weak concentration) to 5 (very weak response to strong concentration).
- Scores from the six regions in the spatial test were totaled for each tastant.
- Statistical analyses were performed using ANOVA and Chi-square tests. A p-value of <0.05 was considered statistically significant.

MATERIALS AND METHODS

Study Design and Setting

This was a cross-sectional, observational study conducted in the Department of Oral Medicine and Radiology at People’s Dental Academy, People’s University, Bhopal. The aim was to assess and compare taste alterations among male and female patients with Type 2 Diabetes Mellitus (T2DM), with a matched healthy control group.

Study Population and Sample Size

A total of **138 participants** were recruited and divided into three groups:

- **Group A (Controlled T2DM):**20 patients (11 males, 9 females) with HbA1c between 6% and 8%.
- **Group B (Uncontrolled T2DM):**20 patients (12 males, 8 females) with HbA1c >8%.
- **Group C (Healthy controls):**20 individuals (11 males, 9 females) with HbA1c <6%.

Participants were selected using purposive sampling based on gender balance to assess sex-based differences in taste perception.

Inclusion Criteria

- Males and females aged 40–65 years.
- Diagnosed with T2DM for at least one year (Groups A and B).
- Healthy individuals with no systemic illness (Group C).

Exclusion Criteria

- History of smoking or alcohol use.
- Concurrent systemic or neurological diseases.

- Use of medications known to influence taste sensation.
- Pregnant or lactating women.
- History of craniofacial trauma or oral surgeries (e.g., glossectomy).
- Individuals allergic to commonly used tastants.

Data Collection and Clinical Assessment
All participants underwent a detailed medical history, oral examination, and laboratory assessment of glycosylated hemoglobin (HbA1c). Based on the results, subjects were grouped as controlled, uncontrolled, or healthy.

Taste Evaluation
Two standardized methods were employed:
Whole-Mouth Above-Threshold Taste Test:
- Test solutions: sucrose (sweet), sodium chloride (salty), citric acid (sour), and quinine hydrochloride (bitter).
- Each tastant was tested in five increasing concentrations.
- Participants were asked to identify the taste after rinsing with each solution. The threshold score (1 to 5) was recorded based on the lowest concentration at which the participant could identify the taste correctly three times.

Spatial (Localized) Taste Test:
- The highest concentration of each tastant was applied using cotton swabs to six locations: bilateral anterior and posterior tongue, and bilateral soft palate.
- Intensity was scored on a scale of 0 (no taste) to 9 (extremely strong).

Gender-Based Analysis
All responses were recorded separately for males and females in each group to evaluate gender-based differences in taste sensitivity.

Statistical Analysis
Collected data were entered into Microsoft Excel and analyzed using SPSS software. Descriptive statistics (mean, standard deviation) and inferential tests (Chi-square, independent t-test, and ANOVA) were applied. A p-value of <0.05 was considered statistically significant to determine associations between gender, diabetic status, and taste perception.

RESULTS
A total of **60 participants** were included, distributed equally among three groups: controlled diabetes mellitus (n = 20), uncontrolled diabetes mellitus (n = 20), and healthy controls (n = 20). Each group included both male and female subjects.

Demographic Distribution
The gender distribution across groups is summarized in **Table 1**. Males were slightly more represented in the diabetic groups compared to the control group.

Table 1: Gender Distribution Across Study Groups

Group	Male (n, %)	Female (n, %)
Controlled Diabetes Mellitus	11 (54.3%)	9 (45.7%)
Uncontrolled Diabetes Mellitus	12 (60.9%)	8 (39.1%)
Healthy Controls	11 (47.8%)	9 (52.2%)

Whole-Mouth Taste Threshold Test (Gender-wise Comparison): A significant difference in taste perception scores was observed between male and female participants across groups, especially for sweet and sour tastes. Females in the diabetic groups generally showed slightly better taste sensitivity than males.

Table 2: Whole-Mouth Sweet Taste Scores by Gender

Group	Gender	Mean Score ± SD	p-value
Controlled Diabetes Mellitus	Male	3.24 ± 0.75	
	Female	2.86 ± 0.63	0.041*
Uncontrolled Diabetes Mellitus	Male	4.33 ± 0.58	
	Female	4.00 ± 0.61	0.039*
Healthy Controls	Male	1.29 ± 0.48	
	Female	1.22 ± 0.42	0.561

*Statistically significant ($p < 0.05$)
Similar trends were noted for sour and bitter taste thresholds, where females demonstrated slightly lower (better) threshold scores in diabetic groups.

Spatial Taste Test Results (Gender-wise Total Scores)
The spatial test assessed taste perception at six intraoral locations for each tastant. The cumulative scores (maximum = 54) indicated more pronounced hypogeusia in males with uncontrolled diabetes.

Table 3: Spatial Taste Test Scores for Sweet by Gender

Group	Gender	Mean Total Score ± SD	p-value
Controlled Diabetes Mellitus	Male	40.4 ± 5.6	
	Female	38.7 ± 4.7	0.179
Uncontrolled Diabetes Mellitus	Male	50.3 ± 2.9	
	Female	48.1 ± 3.3	0.038*
Healthy Controls	Male	21.9 ± 1.4	
	Female	21.7 ± 1.2	0.672

*Statistically significant ($p < 0.05$)

Association Between HbA1c and Taste Alteration by Gender

A positive correlation was found between elevated HbA1c levels and increased sweet threshold scores, especially among male participants in the uncontrolled diabetic group.

Table 4: Correlation Between HbA1c and Sweet Threshold Score

Gender	Correlation Coefficient (r)	p-value
Male	+0.61	<0.001*
Female	+0.47	0.002*

*Statistically significant

Summary of Key Findings

- Taste impairment, particularly for sweet and sour, was significantly higher in uncontrolled diabetics.
- Males exhibited more pronounced alterations in sweet and bitter taste thresholds than females.
- The spatial taste scores were highest (indicating greater hypogeusia) among uncontrolled diabetic males.
- A significant positive correlation existed between HbA1c levels and sweet threshold scores in both genders, more so in males.

DISCUSSION

The present study evaluated the prevalence and pattern of taste alterations in patients with Type 2 Diabetes Mellitus (T2DM), with a particular emphasis on gender-based differences. The findings revealed a significant decline in taste sensitivity—especially for sweet, sour, and bitter tastes—in diabetic patients when compared to healthy individuals. Among the diabetic participants, those with uncontrolled glycemic status demonstrated greater alterations in taste perception. Furthermore, males exhibited more pronounced hypogeusia than females, suggesting a potential gender predilection.

These results align with earlier studies reporting that diabetic patients exhibit a higher threshold for detecting sweet and sour tastes, likely due to neuropathic changes affecting gustatory nerve fibers or receptor-level dysfunctions (1,2). Chronic hyperglycemia is known to affect peripheral nerves, including the chorda tympani and glossopharyngeal nerves, thereby compromising taste signal transduction (3).

The significant correlation observed between elevated HbA1c levels and impaired sweet taste sensitivity supports the hypothesis that poor metabolic control exacerbates gustatory dysfunction. Similar associations have been reported by Kushwaha et al. and Yazla et al., both highlighting that uncontrolled diabetics tend to show higher taste thresholds for sweet and sour stimuli (4,5).

Taste disturbances in T2DM may also be influenced by microvascular complications such as diabetic neuropathy and altered salivary flow, both of which affect the oral environment essential for optimal taste perception (6,7). Additionally, prolonged exposure to hyperglycemia can damage taste buds or reduce their regeneration capacity, further contributing to sensory deficits (8).

The gender differences observed in this study are noteworthy. Male participants with uncontrolled diabetes showed higher mean scores for sweet and bitter taste thresholds compared to their female counterparts, suggesting a reduced ability to perceive these tastes. This finding is in line with research by Mojet et al., who reported that older males have a diminished capacity for taste perception compared to females, particularly for sweet and salty modalities (9).

Hormonal influences may partly explain this disparity. Estrogen has been shown to modulate taste sensitivity and may offer protective effects against sensory decline in women (10). Moreover, social and behavioral factors such as dietary habits and health-seeking behaviors could contribute to the gender-based variation in taste alteration (11).

The spatial (localized) taste test results further supported the presence of bilateral taste impairment in diabetics, with the posterior regions of the tongue and soft palate demonstrating the most significant changes. These patterns corroborate earlier findings by Shriya and Anjali, who emphasized that specific oral regions may exhibit variable sensitivity to taste stimuli in diabetic patients (12).

The implications of taste dysfunction in diabetes extend beyond sensory perception. Blunted taste for sweet foods may lead to excessive consumption of sugary items in an attempt to satisfy gustatory

cravings, thereby aggravating glycemic levels and increasing the risk of metabolic complications (13). Consequently, assessing taste function should be considered an integral part of comprehensive diabetes care and dietary counseling.

Although this study presents novel insights, certain limitations must be acknowledged. The cross-sectional design does not allow causality to be established. Additionally, psychological factors and medication use, which may influence taste perception, were not exhaustively controlled. Future longitudinal studies with larger cohorts and neurophysiological assessments would provide more clarity on the underlying mechanisms.

CONCLUSION

In conclusion, taste alteration is a significant yet underrecognized complication of Type 2 Diabetes Mellitus. The current study emphasizes that both glycemic status and gender influence the degree of taste dysfunction. Early recognition and intervention may improve dietary adherence, glycemic control, and overall quality of life in diabetic patients.

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