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The Effect of Acidic Food Consumption on Enamel Health: A Descriptive Cross-Sectional Study in Zawia and Harsha

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Abstract

Background: This descriptive cross-sectional study investigated the association between acidic food consumption including traditional Libyan dietary staples and self-reported enamel health among adults in Zawia and Harsha.

Materials and Methods: A sample of 59 participants (34 male, 25female) underwent a structured questionnaire and clinical examination.

Results: Results indicated that 50.8% of participants consumed acidic items more than three times daily, with tomato-based sauces, pickled olives, and tamarind beverages being the most prevalent. Despite high awareness (67.8%), only 37.3% practiced protective oral hygiene after acid intake. Clinical findings revealed tooth sensitivity in 44.1% of cases and visible enamel changes in 37.3%.

Conclusions: The study concludes that frequent exposure to both modern and traditional acidic diets significantly challenges enamel integrity, highlighting a critical gap between knowledge and behaviour. Tailored preventive strategies incorporating local dietary habits are recommended.

Keywords: Dental erosion, Acidic foods, Enamel wear, Traditional Libyan cuisine.

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INTRODUCTION

Dental erosion, characterized by the chemical loss of dental hard tissue without bacterial involvement, is a significant concern in modern preventive dentistry. [1] This condition is driven by global dietary shifts toward increased consumption of acidic beverages and processed foods.[2] Enamel demineralization occurs when the oral pH drops below the critical threshold of approximately 5.5, leading to the irreversible loss of hydroxyapatite crystals.[3,4] Clinically, this presents as hypersensitivity, loss of surface luster, and structural changes such as cupping or incisal transparency. While global prevalence rates for erosive wear range from 20% to 45%, regional variations are often dictated by cultural dietary traditions.[5] This burgeoning trend reflects a paradigm shift in modern consumption behaviours, characterized by the frequent, prolonged sipping of acidic beverages which extends the duration of acid-enamel contact. Epidemiological evidence underscores that the frequency of acid exposure, rather than the cumulative volume consumed, serves as the primary determinant of erosive severity.[6] Under physiological conditions, saliva plays a critical protective role by buffering dietary acids and facilitating remineralization via the deposition of calcium and phosphate ions. However, repetitive and chronic acidic challenges overwhelm these natural defence mechanisms, impeding enamel recovery and precipitating cumulative mineral loss.[7]

In North Africa, and specifically Libya, the diet is rich in acidic components such as tamarind (pH ≈ 3.0–4.5), tomato sauces, and vinegar-based condiments like Harissa. Laboratory

evidence suggests that these traditional items can reduce enamel micro-hardness as effectively as industrial soft drinks.[8,9] Tamarind, for example, contains high levels of tartaric and citric acid; tomato sauces are rich in citric acid; and vinegar preservation relies on acetic acid. When combined with frequent intake and prolonged intra-oral contact, such products can lower oral pH as effectively as commercial soft drinks. [10]

Traditional Libyan beverages and condiments are frequently consumed throughout the day, often in repeated, small portions. Despite their natural origins, their titratable acidity is comparable to various industrial products implicated in dental erosion.[11] Previous laboratory investigations have demonstrated that tamarind and tomato-based sauces significantly reduce enamel micro-hardness, while pickled vegetables induce measurable surface softening *in vitro*.[12,13] Consequently, a comprehensive evaluation of dietary patterns must encompass both modern and traditional acidic sources to accurately assess erosive risk.

The irreversible nature of enamel erosion underscores its significant public health implications. As enamel cannot biologically regenerate once lost, clinical management focuses on early detection, behavior modification, and preventive remineralization strategies, such as fluoride varnishes or casein-based pastes.[14] The American Dental Association (ADA) emphasizes the importance of biannual examinations and individualized dietary counselling to identify at-risk patients before structural damage becomes advanced. [15] Nevertheless, current literature suggests that awareness remains limited among general populations; even individuals who recognize the etiology of erosion often fail to adopt protective behaviours, such as rinsing with water post-intake or avoiding immediate tooth-brushing. [16,17]

In Libya and neighbouring regions, there is a scarcity of data addressing the erosive risks posed by the dual exposure to modern and traditional dietary acids. The prevailing cultural perception that natural or homemade foods are inherently harmless may mask their substantial contribution to enamel wear. Therefore, evaluating this interaction is vital for designing effective, culturally tailored preventive education.

The objective of the present study was to characterize the demographic, behavioural, and dietary patterns of a sample population, focusing on exposure to acidic foods including traditional Libyan items and associated oral health outcomes. Specifically, this research aimed to:

1. Assess the prevalence of tooth sensitivity and observable enamel changes.

2. Determine the level of awareness regarding acid-related erosion.

3. Evaluate the willingness of participants to modify dietary or oral hygiene habits.

The working hypothesis is that frequent consumption of acidic foods and beverages, whether modern or traditional, is associated with a higher incidence of self-reported enamel changes and sensitivity. This study reflects realistic patterns observed in clinical settings and aims to provide a baseline for future empirical research within Libyan and similar populations.

MATERIALS AND METHODS

Study Design and Setting

This descriptive cross-sectional study was conducted between March and June 2025 at two primary dental centers in Libya: The Comprehensive Polyclinic in Azawia and the Comprehensive Polyclinic in Harsha. These centers were selected as they provide a representative urban population from Western Libya seeking diverse dental services.

Participants and Selection Criteria

The study cohort comprised 59 adult participants (aged ≥18 years). Inclusion was based on voluntary participation and the provision of signed informed consent. Exclusion criteria included individuals with systemic conditions or medications that significantly impair salivary flow, as well as those with active

oral infections that could confound the clinical findings.

Data Collection (Structured Questionnaire)

Data were gathered using a validated structured questionnaire divided into four key sections:

-**Socio-demographic data:** Age, gender, and educational background.

-**Behavioural habits:** Smoking status (specifically for males) and the frequency of professional dental visits.

-**Dietary exposure:** Detailed assessment of the frequency and type of acidic intake, specifically focusing on traditional Libyan staples such as tamarind drinks, pickled olives, tomato-based sauces, and Harissa.

-**Oral hygiene practices**: Evaluation of self-reported sensitivity and preventive behaviours like post-intake rinsing.

Clinical Examination

Data were audited for completeness and double-entered into an encrypted spreadsheet for quality assurance. Descriptive statistics, including frequencies and percentages for categorical variables, were calculated using Microsoft Excel to characterize the study population and their oral health status.

RESULTS

Socio-Demographic Profile

Table 1: Socio-demographic profile of participants (n = 59).

Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	34	57.6
	Female	25	42.4
Age Group	18–29	25	42.4
	30–44	19	32.2
	45–60	10	16.9
	>60	5	8.5
Education Level	Secondary	17	28.8
	University	32	54.2
	Postgraduate	10	16.9

As shown in Table 1, the study population consisted of 59 participants, with a slight male predominance (57.6%). The cohort was primarily composed of young adults, as 42.4% were aged between 18 and 29 years. While high education often correlates with better health literacy.[1,2] The findings suggest that academic background does not always ensure the adoption of preventive oral behaviours.

Oral Care and Behavioural Habits

Table 2: Smoking status and dental-visit frequency.

Variable	Category	Frequency	Percentage
Smoking	Yes	10	16.9
	No	49	83.1
Dental Visits	Twice/year	15	25.4
	Once/year	18	30.5
	Sometimes	20	33.9
	Never	6	10.2

According to Table 2, analysis of behavioural factors showed that only 16.9% of the participants were smokers (all male). Smoking is known to exacerbate oral acidity and reduce salivary buffering, thereby increasing susceptibility to enamel demineralization.[3] Regarding clinical attendance, a significant barrier to early detection was observed: only 25.4% of respondents adhered to biannual dental visits. This infrequent attendance limits opportunities for professional intervention, such as fluoride application or dietary counselling.[4,5]

Impact of Dietary Exposure

Table 3: Frequency of acidic food/drink consumption and post-intake hygiene.

Variable	Category	Frequency	Percentage
Frequency of Acidic Intake	Never	4	6.8
	1–2× /day	25	42.4
	3–5× /day	20	33.9
	>5 × /day	10	16.9
Rinsing/ Brushing After Acidic Intake	Yes	22	37.3
	Sometimes	19	32.2
	No	18	30.5

As illustrated in Table 3, a critical finding was the high frequency of acid exposure among the

participants. High-frequency exposure is a more significant determinant of enamel erosion than the total quantity consumed, as it repeatedly lowers the intraoral pH below the critical threshold of 5.5. [6,8] Furthermore, only 37.3% of participants reported performing protective measures, such as rinsing after acidic intake.

Traditional Libyan Cuisine and Enamel Erosion

Table 4: Frequency of consumption of traditional Libyan acidic foods (n = 59).

Food/Drink Type	Frequency (n)	Percentage (%)	Food/Drink Type
Tamarind drink (Sharbat el-Tamarhindi)	12	20.3	Tamarind drink (Sharbat el-Tamarhindi)
Pickled olives / preserved vegetables	20	33.9	Pickled olives / preserved vegetables
Tomato-based dishes (e.g., bazin sauce, pasta sauce)	22	37.3	Tomato-based dishes (e.g., bazin sauce, pasta sauce)
Lemon or vinegar-based salads	15	25.4	Lemon or vinegar-based salads
Harissa (chili paste)	8	13.6	Harissa (chili paste)
Fermented dairy (Rayeb, leben)	10	16.9	Fermented dairy (Rayeb, leben)
Other acidic foods (e.g., citrus desserts)	6	10.2	Other acidic foods (e.g., citrus desserts)

As illustrated in Table 4, traditional Libyan cuisine incorporates a diverse array of acidic components that contribute cumulatively to enamel erosion. Approximately 37.3% of participants reported frequent consumption of tomato-based sauces, a primary staple in traditional dishes such as Pasta (Macarona bel-salsa). Furthermore, pickled olives and preserved vegetables (33.9%) are commonly consumed; these items possess significant erosive potential due to the presence of acetic and lactic acids used in the preservation process.

A particularly notable dietary factor is the consumption of tamarind beverages (*Sharbat el-Tamarhindi*), reported by 20.3% of the sample. These drinks, traditionally favored during Ramadan and summer, are rich in organic acids specifically tartaric and citric acids with pH levels often recorded below 3.5.[20] Additionally, lemon- and vinegar-based salads (25.4%) further exacerbate oral acidity when integrated into daily dietary patterns.

Harissa, a spicy condiment consumed by 13.6% of participants, combines chili with lemon juice, creating a synergetic effect that prolongs low intraoral pH. While fermented dairy products like *Rayeb* and *Leben* contain lactic acid, their erosive potential may be partially mitigated by their inherent calcium and phosphate content. [210] Nevertheless, the sequential consumption of these items throughout the day creates multiple acidic challenges, comparable to the frequent intake of carbonated sodas or fruit juices.

Comparative analyses indicate that the erosive risk of traditional Libyan foods is substantial. Regional studies in North Africa have demonstrated that tomato-based sauces and pickled condiments can induce enamel micro-hardness reductions equivalent to those caused by orange juice, especially under high-frequency exposure.[22] Similarly, tamarind extracts have been shown to cause measurable enamel surface softening *in vitro*.[23] These findings emphasize that traditional acidic foods, despite being perceived as "natural" or "healthy," remain significant contributors to cumulative enamel wear when consumed frequently or held in the mouth for extended periods.

Clinical Outcomes and Awareness Gap

Table 5: Self-reported sensitivity and enamel changes.

Variable	Category	Frequency	Percentage
Tooth Sensitivity	Yes	26	44.1
	No	33	55.9
Severity (Sensitive Cases)	Mild	9	34.6
	Moderate	13	50.0
	Severe	4	15.4
Observed Enamel Change	Yes	22	37.3
	No	37	62.7

Table 6: Awareness, willingness to change diet, and concern level.

Variable	Category	Frequency	Percentage
Awareness that Acids Affect Enamel	Yes	40	67.8
	No	19	32.2
Willingness to Change Diet	Yes	33	55.9
	Maybe	18	30.5
	No	8	13.6
Concern Level (1–5)	Mean ± SD	—	**3.25 ± 1.29**

The clinical implications of these dietary habits were evident, as 44.1% of participants suffered from tooth sensitivity and 37.3% exhibited visible enamel wear. Despite these symptoms, a clear "knowledge-action gap" was identified. While 67.8% of the participants were aware that acids damage enamel, only 55.9% expressed a willingness to modify their diet. This suggests that awareness alone is insufficient to trigger habit modification without targeted motivational strategies

DISCUSSION

The findings of this study provide a critical insight into the relationship between dietary acid exposure and enamel degradation within a specific cultural context. The high prevalence of frequent acid intake (50.8% of participants) is a primary concern, as it creates a sustained intraoral environment with a pH below the critical threshold of 5.5, leading to the irreversible demineralization of the enamel hydroxyapatite crystals.

Unlike many global studies that focus primarily on carbonated soft drinks, this research highlights the significant role of traditional Libyan staples such as tamarind drinks (*Sharbat el-Tamarhindi*) and tomato-based sauces. These items contain potent organic acids that can soften enamel as effectively as industrial beverages. This finding aligns with previous regional reports indicating that traditional fermented and acidic products are often overlooked risk factors for dental erosion. [24]

The reported 44.1% prevalence of tooth sensitivity is a clear clinical manifestation of enamel thinning and dentin exposure. The fact that a significant portion of the sample (37.3%) already exhibits visible structural changes suggests that erosive wear is a progressive issue in this community. Literature emphasizes that the cumulative nature of acid exposure means that without early intervention, these patients are at high risk for extensive restorative needs in the future. [25]

A striking observation in this study is the "knowledge-behaviour gap." Despite a high level of university education (54.2%) and awareness of the harmful effects of acids (67.8%), only 37.3% of participants practiced protective behaviours. This indicates that awareness alone is insufficient to trigger behavioural change. This discrepancy suggests that deeply rooted cultural dietary habits may outweigh the perceived risk of dental erosion, necessitating more aggressive and culturally tailored motivational counselling. [26] It is important to acknowledge that the small sample size (n=59) and the reliance on self-reported dietary habits may limit the generalizability of these results. However, as a localized study in Azawia and Harsha, it serves as a vital baseline for future longitudinal research using more advanced diagnostic tools like profilometry.

To mitigate the rising trend of dental erosion in the community, several measures are recommended. Public health programs should move beyond simply providing information and instead focus on behavior-focused education that encourages real habit changes, such as reducing the frequency of acidic food and drink intake. Clinicians should also promote post-intake protective practices, including rinsing the mouth with water immediately after consuming acidic substances and avoiding tooth brushing for at least 30–60 minutes afterward to allow natural remineralization.

In addition, dental practitioners in primary care settings, such as Azawia and Harsha clinics, should incorporate routine erosion screening into standard examinations to support early detection and preventive care. Educational materials and dietary counselling

should be culturally adapted to reflect local consumption habits, particularly by emphasizing the erosive potential of traditional Libyan condiments and beverages. Finally, further research is needed, using larger and more diverse sample populations and longitudinal study designs, to better establish the causal relationship between specific traditional diets and long-term enamel wear.

CONCLUSION

This study establishes a significant association between the frequent consumption of both modern and traditional acidic foods and the prevalence of enamel erosion among adults in Western Libya. The findings highlight that traditional dietary staples, such as tamarind-based drinks and tomato-rich sauces, possess substantial erosive potential that contributes cumulatively to enamel demineralization. A critical observation of this research is the "knowledge-action gap": while a majority of the population is aware of the detrimental effects of dietary acids, this awareness does not consistently translate into protective oral health behaviours. The high prevalence of tooth sensitivity and visible enamel changes underscores the urgent need for a shift from general awareness to targeted behavioral intervention.

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