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Original Article

Association Between Food Groups, Diet Quality, and Dental Anxiety: A Survey-Based Study

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ABSTRACT

While the link between diet and mental health has been widely established, the specific association between diet and dental anxiety has not been previously explored. This study aimed to address this gap by investigating how diet quality and mental distress relate to dental anxiety. Data were gathered through an anonymous Google Forms questionnaire, which included an adapted Food–Mood Questionnaire and the Modified Dental Anxiety Scale, along with demographic and oral health items. Data collection occurred over seven months, from April to October 2021. Statistical analyses were conducted using Pearson's correlation coefficient in SPSS version 25.0 and STATA 17 for sample size estimation, data handling, and regression modeling. In total, 506 valid responses were analyzed. Findings demonstrated that diet quality influences dental anxiety. Women showed stronger associations with dental anxiety than men ($p < 0.01$). High intake of sugary foods was significantly linked to various aspects of dental anxiety ($p < 0.01$). Diets rich in low-quality, energy-dense foods and dairy correlated positively with dental anxiety, while caffeine, meat, nuts, and leafy greens were negatively correlated. This cross-sectional research supports the hypothesis that dietary habits may be associated with dental anxiety.

Keywords: Dental anxiety, Mental health, Age, Nutrition, Western diet, Mediterranean diet

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Introduction

Dental anxiety, oral health, and mental health

Dental anxiety refers to intense fear or apprehension associated with dental procedures, often stemming from prior negative experiences at dental clinics [1]. Such anxiety may persist beyond dental visits. Physiological symptoms such as rapid heartbeat and accelerated breathing may accompany dental fear [2]. Severe and irrational fear can escalate into dental phobia [1], leading to avoidance of care and worsening oral health conditions, thereby increasing susceptibility to oral infections [3]. These issues disproportionately affect underprivileged groups lacking adequate dental and medical access. Populations most at risk include ethnic minorities, the elderly, and individuals with low socio-economic status or residing in rural regions [4]. Poor diet quality also adversely influences oral health, as sugar-rich, cariogenic diets heighten the risk of oral diseases [5]. Several studies have documented links between mental health issues and dental anxiety [3, 4, 6, 7]. Individuals with mental disorders tend to have poorer oral health and lower engagement with dental care services [4].

Nutrition, mental health, and dental anxiety

Evidence increasingly supports a strong connection between diet and mental health. Nutrient-dense diets

sustain brain structure and neurochemical balance [8], while foods high in refined carbohydrates often lack essential nutrients. In contrast, complex carbohydrates—rich in fiber and micronutrients—contribute to emotional stability. Low-glycemic, high-fiber foods improve mood by stabilizing blood glucose levels [9]. Caffeine, found in beverages like coffee, tea, and energy drinks, acts as a central nervous stimulant but can also trigger mood fluctuations when combined with simple sugars [6, 9, 10]. Deficiencies in amino acids and omega-3 fatty acids can severely affect brain function, while vitamins B, D, and C, and minerals like magnesium, play critical roles in mood regulation. Thus, nutrient deficiencies caused by poor diets may disrupt emotional balance.

Individuals with dental problems, particularly missing teeth, may avoid nutrient-rich foods like fruits, vegetables, or meats that require more chewing effort [6]. This limitation can shift dietary preferences toward fast or processed foods, worsening both mental and oral health over time. Caffeine exerts dual effects: while it enhances cognitive alertness and dopamine-driven motivation, excessive intake activates the hypothalamic-pituitary-adrenal (HPA) axis, potentially raising stress and anxiety levels. Its connection to dental anxiety, however, remains unexamined. Verster *et al*. report that adults aged 35–49 consume the most caffeine (around 170 mg/day), with men typically consuming more than women [11], primarily from coffee.

The interplay between diet, oral health, and mental wellness may influence dental anxiety. Individuals adhering to high-quality diets tend to experience fewer mood swings and reduced dental-related fears or phobias [6]. Although prior research highlights nutritional effects on oral health, the direct link between dietary habits and dental anxiety remains unexplored. Considering this, the present study sought to investigate whether diet quality influences dental anxiety. The null hypothesis proposed that no association exists between diet quality and dental anxiety. Additionally, this research aimed to examine how specific food groups relate to anxiety regarding dental visits and procedures.

Materials and Methods

Participants and study design

This project (protocol ID: STUDY00002931) was granted ethical clearance by the Institutional Review Board of Binghamton University on 8 April 2021. Before participation, each respondent reviewed a digital consent form outlining the study's intent, methodology, potential risks and advantages, and the contact information of the lead investigator. Eligible participants included English-literate adults aged 18 years or older. Participation was completely voluntary, with no monetary or material reward.

The anonymous questionnaire was made available online, via social media, and in dental clinics to capture a broader demographic. Clinics from various locations were chosen to ensure geographic and social diversity. Combining digital and in-person collection methods aimed to strengthen data validity by increasing respondent variety.

QR codes placed in several dental offices allowed individuals to access the form directly through their mobile devices. No personal or medical records were reviewed prior to survey completion. The data collection phase extended over seven months (April–October 2021).

Sample size calculations

Sample size estimations were carried out using the Powerlog module in STATA 17.0 (StataCorp LLC, Lakeway Drive, College Station, TX, USA) to guarantee sufficient statistical power. This function determines the minimum sample needed for logistic regression analysis based on effect size and alpha values. For one-tailed testing, alpha was fixed at 0.05, and for two-tailed testing, at 0.025.

In STATA terms, p1 represents the probability that the dependent variable equals 1 when the predictor is at its mean, while p2 indicates that probability when the predictor is one standard deviation above the mean.

Powerlog results indicated that at 0.80 power, at least 154 responses were required, and at 0.90 power, 260 were necessary for a one-tailed test. For a two-tailed test, 196 and 260 observations were needed for the same power levels. Since the present study included 506 valid participants, the dataset comfortably surpassed the required thresholds for both power levels.

Data collection and surveys

Nutritional and psychological data were obtained using a revised Food–Mood Questionnaire (FMQ), a validated instrument measuring the frequency and type of food intake. It covered groups such as whole grains, poultry, fish, leafy greens, fruits, dairy, caffeine, beans, seafood, nuts, fast foods, and high-glycemic foods, as well as supplement use (e.g., multivitamins, fish oil) [12]. The survey also tracked the frequency of sugary, prepackaged, and fast food consumption **(Table 1)**. Participants identified their general dietary pattern (e.g., Western, Mediterranean, Asian, Korean, Eastern, Hindu, South American, or Other).

Mental distress was evaluated using the Kessler Psychological Distress Scale (K-6), assessing six emotional states: nervousness, hopelessness, depression, restlessness, worthlessness, and feeling that "everything is an effort" [13]. Each item offered five responses: "None," "A little," "Some," "Most," and "All of the time." Scores ranged from 0 to 24, with higher totals reflecting greater psychological strain. Demographic data included gender, age group, race, ZIP code, education, and employment.

Table 1. Components of the Modified Dental Anxiety Scale (MDAS), FMQ, and Kessler-6.

Dental Anxiety Survey (DAS)
How would you feel while waiting in a dental office waiting room?
How would you feel just before a tooth is drilled?
How would you feel prior to having your teeth cleaned and polished?
How would you feel before receiving a local anesthetic injection in your gums?
Modified Food and Mood Questionnaire (FMQ)
In a typical week, how many times do you drink coffee or consume other caffeinated products?
In a typical week, how many times do you eat fruits?
In a typical week, how many times do you eat nuts, such as flaxseed?
In a typical week, how many times do you eat rice and/or pasta?
In a typical week, how many times do you eat red meat, chicken, turkey, or fish?
In a typical week, how many times do you eat dark green leafy vegetables?
In a typical week, how many times do you eat fast food and/or pre-packaged or processed foods?
In a typical week, how many times do you eat sugary foods (such as candy, chocolate, or sweets)?
In a typical week, how many times do you take dietary supplements (like multivitamins, fish oil, etc.)?
Kessler-6 Psychological Distress Scale
Over the past 30 days, how often did you feel hopeless?
Over the past 30 days, how often did you feel restless or unable to sit still?
Over the past 30 days, how often did you feel so sad that nothing could lift your spirits?
Over the past 30 days, how often did you feel that everything required significant effort?
Over the past 30 days, how often did you feel worthless?

Dental anxiety and oral health data were gathered using a modified version of the MDAS [14], covering anxiety in various dental scenarios—anticipating an appointment, sitting in the waiting area, tooth drilling, scaling, polishing, or receiving a local anesthetic injection **(Table 1)**. Additional questions addressed self-rated oral health, insurance coverage, time since the last dental visit, and fear of tooth extraction.

Data analysis

For the regression models, dental anxiety served as the dependent variable. The original measure, drawn from a five-point Likert question, was transformed from a multinomial categorical scale into a binary variable, where 0 represented participants who indicated "not anxious," and 1 represented any reported level of anxiety ("slightly," "fairly," "very," or "extremely anxious"). The question prompting this variable asked: "How would you feel if you had a dental appointment tomorrow?" This transformation was performed to enhance the logistic regression model's fit by aligning it with the data's distribution pattern.

The key independent variable was dietary pattern, while gender, age, race, and education were included as control variables. Gender was coded as binary (0 = female; 1 = male). Education was treated as a categorical factor indicating the highest educational level attained. Race was recorded as a nominal variable with seven groups: American Indian or Alaska Native, Asian, African American, Hispanic, Native Hawaiian or Pacific Islander, White, and Other. Age was classified into four brackets: 18–29, 30–39, 40–49, and 50 or older. Since the distribution of dental anxiety **(Figure 1)** showed skewness, converting it to a binary form helped reduce potential bias and yielded a more precise estimate.

All statistical computations were conducted using STATA version 17 for regression modeling, data processing, and power calculations, and SPSS version 25.0 (IBM, SPSS Inc., Chicago, IL, USA) for Pearson's correlation tests.

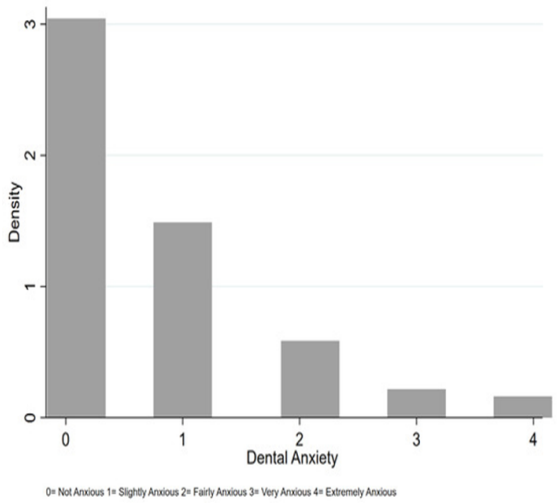

Figure 1. Distribution of dental anxiety levels in the sample.

Results and Discussion

Demographics

A total of 506 responses were collected. Among them, 66.4% were female, and 41.6% were aged 18–29 years. The racial distribution showed 54% White, and 35.6% of respondents reported having completed two or four years of college. Additionally, 63.8% were employed. Regarding self-assessed oral health, 43.1% rated it as good, 28.3% as excellent, 23.7% as average, and 4.9% as poor. About 83% reported having dental insurance, while 17.3% did not. Concerning recent dental visits, 44% had seen a dentist within the past six months, 29.6% within 6–12 months, 19.4% within 1–2 years, and 7.3% had not visited for over two years **(Table 2)**.

Table 2. Participant demographics and oral health characteristics.

Independent Variables	Category 1	Category 2	Category 3	Category 4
Gender	**Female**	**Male**		
	336	170		
Age Group	18–29	50–59		
	210	72		
	30–39	60–69		
	94	46		
	40–49	70+		
	62	21		
Ethnicity	White	Native Hawaiian/Pacific Islander		
	273	2		
	Black/African-American	Hispanic/Latino		
	29	30		
	Asian	Other		
	124	44		
Education Level	Less than High School	Master's Degree		
	5	61		
	High School	Doctoral Degree		
	176	29		
	Associate/Bachelor's Degree	Professional Degree		
	180	55		
Work Status	Employed	Other (e.g., Homemaker, Student, Retiree)		
	323	131		
	Unemployed			
	52			
Self-Reported Oral Health	Excellent	Good	Average	Poor
	143	218	120	25
Dental Insurance	Covered	Not Covered		
	417	87		
Time Since Last Dental Visit	Within 6 Months	6–12 Months	1–2 Years	Over 2 Years
	220	149	98	37

Two logistic regression models were developed to assess the connection between diet quality and dental anxiety. Results are displayed in **Table 3**.

- Model 1 evaluated demographic predictors of dental anxiety.
- Model 2 incorporated both demographics and dietary patterns.

Findings from both models revealed that diet maintained a positive and statistically significant association with dental anxiety at $p < 0.05$. Gender also demonstrated significance at $p < 0.01$, showing a negative relationship—indicating that females were more likely to experience dental anxiety compared to males after adjusting for confounders.

Table 3. Logistic regression outcomes for diet and dental anxiety.

	Model 1	Model 2
Variables	**Dental Fear**	**Dental Fear**
Diet		0.0382 **
		(0.0186)
Gender	−0.790 ***	−0.775 ***
	(0.206)	(0.214)
Education	−0.0861	−0.0567
	(0.0579)	(0.0603)
Race	−0.0199	−0.0700
	(0.0432)	(0.0534)
Age 18 to 29	−0.558 *	−0.609 *
	(0.297)	(0.312)
Age 30 to 39	0.355	0.208
	(0.332)	(0.352)
Age 40 to 49	−0.499	−0.473
	(0.369)	(0.389)
Age 50 to 59	−0.623 *	−0.470
	(0.357)	(0.384)
Constant	1.495 ***	1.164 **
	(0.509)	(0.545)
Observations	505	462

(Standard errors in parentheses; ***p < 0.01, *p < 0.05, p < 0.1)

After controlling for dietary and demographic factors, education and race did not show any statistically meaningful effects. When only demographics were considered (Model 1), those aged 18–29 and 50–59 were less likely to experience dental anxiety. However, upon including dietary variables (Model 2), only the 18–29 age group retained a significant inverse relationship with dental anxiety. These findings reinforce that dietary patterns exert an independent influence on dental anxiety levels.

To further assess model performance, a Receiver Operating Characteristic (ROC) test compared Models 1 and 2 **(Figure 2)**. The ROC curve evaluates how well the model distinguishes between individuals with and without dental anxiety by plotting true positives against false positives. Model 2 showed a greater area under the curve (AUC = 0.633) compared to Model 1 (AUC = 0.600), indicating a better model fit when dietary factors were included. Consequently, the null hypothesis—that both models have identical AUCs—was rejected.

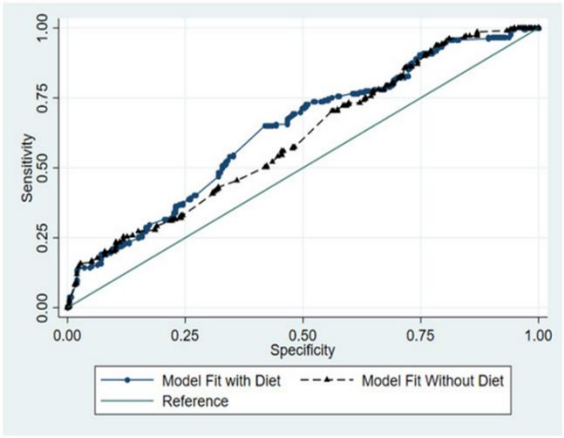

Figure 2. ROC curves for Models 1 and 2 comparing dietary and demographic predictors of dental anxiety.

Together, **Table 3 and Figure 2** confirm that diet quality has a significant and measurable impact on dental anxiety. Adding dietary information clearly enhances model accuracy and explanatory power.

Subsequently, additional regression models were developed to identify which specific dietary patterns most strongly relate to dental anxiety. Four extra models were tested to evaluate the Western, Mediterranean, and Asian dietary styles. This multi-model approach ensured robustness and examined how distinct diet types might influence anxiety levels differently. To prevent multicollinearity, the composite diet variable was removed from these models.

- Model 3: The Western diet showed a positive and statistically significant relationship with dental anxiety at $p < 0.1$, implying higher anxiety likelihood among individuals following this diet, even after adjusting for demographics.
- Model 4: The Mediterranean diet exhibited a negative and significant effect at $p < 0.1$, suggesting that adherence to this diet correlates with lower dental anxiety.

- Model 5: The Asian diet did not show any statistically significant association once demographic variables were included.
- Model 6: When the three diet types were analyzed together, no combined significant effect was detected, indicating that mixed dietary habits did not predict dental anxiety levels **(Table 4)**.

Table 4. Logistic regression outcomes for diet and dental anxiety.

	Model 3	**Model 4**	**Model 5**	**Model 6**
Variables	**Dental Fear**	**Dental Fear**	**Dental Fear**	**Dental Fear**
Gender	−0.787 ***	−0.788 ***	−0.759 ***	−0.783 ***
	(0.214)	(0.214)	(0.213)	(0.215)
Education	−0.0576	−0.0608	−0.0743	−0.0658
	(0.0603)	(0.0601)	(0.0600)	(0.0609)
Race	−0.0584	−0.0109	−0.0377	−0.0547
	(0.0522)	(0.0442)	(0.0479)	(0.0546)
Age 18–29	−0.584 *	−0.545 *	−0.585 *	−0.580 *
	(0.312)	(0.311)	(0.311)	(0.313)
Age 30–39	0.249	0.349	0.235	0.263
	(0.351)	(0.351)	(0.352)	(0.356)
Age 40–49	−0.433	−0.352	−0.503	−0.410
	(0.388)	(0.392)	(0.390)	(0.395)
Age 50–59	−0.428	−0.371	−0.477	−0.419
	(0.383)	(0.385)	(0.384)	(0.387)
Western Diet	0.423 *			0.114
	(0.236)			(0.288)
Mediterranean Diet		−0.601 *		−0.591
		(0.327)		(0.385)
Asian Diet			−0.530	−0.561
			(0.351)	(0.381)
Constant	1.386 ***	1.414 ***	1.613 ***	1.680 ***
	(0.537)	(0.538)	(0.561)	(0.570)
Observations	462	462	462	462

Standard errors appear in parentheses.*p < 0.01, and p < 0.1.

The next objective was to analyze how distinct categories of food influence dental anxiety in order to gain deeper insight into the role of dietary quality. Each food variable was coded as binary, representing either consumption or non-consumption. As demonstrated in **Table 5**, the intake of sugary foods shows a positive and statistically significant relationship with dental anxiety across multiple model frameworks, indicating that consuming sugary foods heightens the probability of experiencing dental anxiety. These associations remained consistent across all model types.

Table 5. Effects of Various Food Categories on Dental Anxiety.

	Model 7	**Model 8**	**Model 9**	**Model 10**
Variables	Dental Fear	Dental Fear	Dental Fear	Dental Fear
Sugary food	1.072 ***	1.121 ***	1.200 ***	1.207 ***
	(0.413)	(0.429)	(0.436)	(0.455)
Dairy		1.532 **	1.486 **	1.477 **
		(0.728)	(0.726)	(0.729)

Coffee (caffeine)		−0.633 *	−0.632 *	−0.649 *
		(0.381)	(0.380)	(0.382)
Meat		−0.930 **	−0.876 *	−0.872 *
		(0.470)	(0.477)	(0.479)
Rice & pasta			−0.579	−0.561
			(0.387)	(0.396)
Fruit				−0.286
				(0.669)
Nuts				0.0399
				(0.205)
Vegetables				0.590
				(0.788)
Fast food				0.0139
				(0.268)
Constant	−1.216 ***	−1.281	−0.820	−1.165
	(0.403)	(0.814)	(0.865)	(1.178)
Observations	507	507	507	507

Standard errors in parentheses ***p < 0.01, **p < 0.05, and p < 0.1.

Similarly, dairy consumption displayed a positive and statistically meaningful correlation with dental anxiety. Conversely, coffee and both red and white meats were inversely associated with dental anxiety, implying that these foods may help reduce its likelihood. The outcomes held steady under multiple modeling scenarios. Lastly, the data in **Table 5** show that foods with a high glycemic index—such as rice, pasta, fruits, nuts, vegetables, and fast food—did not exhibit any statistically significant effect on dental anxiety.

Dietary habits associated with general anxiety

The subsequent phase explored the relationship between specific food groups, general psychological distress, and dental anxiety. A significant positive correlation was observed between sugary food consumption and feelings of restlessness, nervousness, hopelessness, worthlessness, and depression ($p < 0.01$). Likewise, consumption of fast or pre-prepared meals showed a similar positive correlation with the same psychological indicators ($p < 0.01$). Interestingly, no significant relationship was detected between pre-made/fast food intake and dental-specific anxieties **(Table 6)**.

Table 6. Dietary Factors and General Anxiety Symptoms.

Food Categories	Symptoms	Correlation
Sugary Food	Agitated and Restless	0.192 **
Sugary Food	Anxious	0.229 **
Sugary Food	Despairing	0.162 **
Sugary Food	Unable to Feel Cheered Up	0.125 **
Sugary Food	Everything Felt Effortful	0.186 **
Sugary Food	Feeling Worthless	0.174 **
Fast Food	Agitated and Restless	0.116 **
Fast Food	Anxious	0.105 **
Fast Food	Despairing	0.167 **
Fast Food	Unable to Feel Cheered Up	0.161 **
Fast Food	Everything Felt Effortful	0.116 **
Fast Food	Feeling Worthless	0.141 **

$p < 0.05$.

Dental anxiety, gender, and the role of sugary and caffeinated foods

Females were more prone to report dental anxiety in situations such as anticipating a dental visit the following day, waiting for treatment, or undergoing procedures including tooth drilling, scaling and polishing, local anesthesia injections, and tooth extractions. Significant positive correlations were also identified between sugary food intake and these various dental anxiety scenarios ($p < 0.01$) as shown in **Table 7**.

Table 7. Associations Between Dental Anxiety Levels and Sugary Food Consumption.

Dental Fear Scenario	Female	Sugary Food Intake
Visiting the dentist tomorrow	−0.171 **	0.178 **
Waiting in the dental office	−0.195 **	0.220 **

Having a tooth drilled	−0.259 **	0.175 **
Having a tooth extracted	−0.118 **	0.175 **
Receiving a numbing shot in the gum	−0.239 **	0.225 **

$p < 0.05$.

Dietary patterns and anxiety related to dental treatments

Strong positive correlations emerged between frequent fruit consumption and intake of nuts/flaxseed, leafy green vegetables, and dietary supplements ($p < 0.01$), indicating the presence of an overall healthy eating pattern. Negative correlations were identified between frequent fruit intake and high-glycemic-index or pre-packaged foods ($p < 0.01$), implying that individuals adhering to healthy diets tend to avoid unhealthy foods. Notably, dental anxiety regarding tooth extraction showed significant negative correlations with consumption of nuts/flaxseed ($p < 0.01$) and high-quality proteins such as red meat, poultry, and fish ($p < 0.01$). Anxiety associated with tooth scaling and polishing also demonstrated a negative correlation with regular intake of green leafy vegetables ($p < 0.05$). Additionally, a statistically significant negative link was found between adherence to a Western diet and anxiety about tooth drilling ($p < 0.01$), as well as a negative association with anxiety over scaling and polishing ($p < 0.05$) **(Table 8)**.

Table 8. Correlations Between Food Categories and Dental-Related Anxiety Indicators.

Category	Variable	Correlation
Food Categories	**Food Categories**	
Fruits	Nuts	0.322 **
Fruits	High-Glycemic-Index Food	−0.138 **
Fruits	Dark Green Leafy Vegetables	0.415 **
Fruits	Fast Food	−0.272 **
Fruits	Multivitamin Supplements	0.223 **
Dietary Patterns	**Dental-Related Fear**	
Fruits	Tooth Extraction	−0.115 **
Dark Green Leafy Vegetables	Tooth Extraction	−0.106 *
Meat	Tooth Extraction	−0.102 *
Western Diet	Tooth Extraction	−0.146 **
Western Diet	Tooth Scaling and Polishing	−0.111 *

*$p < 0.05$ and $p < 0.1$.

The present research aimed to evaluate the hypothesis that the quality of diet is linked to dental anxiety, addressing an existing gap in academic literature. Another goal was to explore how nutrition influences mental health, with a special emphasis on dental anxiety.

Initially, we assessed how different dietary patterns affect the probability of experiencing dental anxiety. The analysis produced several notable outcomes: factors such as gender, age, nutrition, education, and employment status were significantly related to dental anxiety. The majority of participants reported some degree of dental anxiety, with higher prevalence among females and younger adults.

The elevated anxiety levels observed in women may be influenced by hormonal mechanisms involving corticosterone, estrogen, and corticotropin-releasing factor—all of which heighten anxiety-related responses [15]. The limbic system, particularly the amygdala and hippocampus, plays a central role in modulating emotions, and females exhibit stronger activation of the left central amygdala (CE), which is associated with anxiety regulation [16]. Another finding was that individuals with lower employment or educational attainment were more likely to exhibit both general and dental-related anxiety disorders. Younger participants also showed elevated anxiety levels, confirming prior studies [17, 18]. This may be attributed to the incomplete maturation of the prefrontal cortex—the brain region responsible for reasoning and emotional control.

Dental anxiety and dietary quality

Participants whose eating habits were dominated by low-nutrient foods—such as sugary snacks, processed items, and fast food—displayed greater levels of anxiety and depressive symptoms. These food types generally lack essential nutrients that sustain normal brain chemistry and function. Furthermore, they promote oxidative stress and inflammation, both of which can damage neural tissues. Insufficient intake of antioxidant-rich foods like fruits and vegetables compromises neural communication and disrupts the efficiency of brain signaling. The regression analyses in this study confirmed these outcomes, consistent with earlier findings that linked poor diet quality, minimal fruit and vegetable consumption, and depressive tendencies—particularly among adult women [19].

Additionally, the Western diet, known for its reliance on low-quality foods, has been associated with decreased levels of brain-derived neurotrophic factor (BDNF), a critical element for neurogenesis and neuroplasticity [10]. Neurogenesis supports brain

volume maintenance, while neuroplasticity ensures strong neural connectivity.

Vegetable consumption, on the other hand, can help reduce symptoms of anxiety and depression by supplying vital vitamins, minerals, fibers, and bioactive antioxidants that promote neural stability and health [20]. Many of these phytonutrients play a regulatory role in maintaining brain homeostasis through gene expression control.

Moreover, adherence to the Western diet is often linked to gut dysbiosis, another biological factor that triggers anxiety and depression [21]. This condition disturbs immune function and disrupts neuronal signaling, leading to inflammation and impaired brain region communication. Consequently, our findings reinforce prior studies indicating that low-quality food intake increases vulnerability to mental health disorders, likely through such physiological mechanisms.

In contrast, individuals consuming leafy green vegetables, nuts or flaxseeds, and high-quality proteins (including red meat, poultry, and fish) exhibited lower levels of dental anxiety as well as fewer anxiety and depression symptoms. Fruit intake was not directly tied to anxiety, but it showed significant positive associations with nutrient-rich foods like nuts, green vegetables, and supplements. The Mediterranean diet, abundant in whole grains, fruits, and vegetables, has been correlated with mental resilience and psychological balance [22, 23]. It is postulated that the combined effects of these nutrients enhance brain performance at the molecular level by regulating genes related to neural health and chemical balance.

Dental anxiety and caffeine intake

Across all regression models, caffeine showed an inverse relationship with dental anxiety. Specifically, individuals who consumed caffeine more frequently (four or more times per week) tended to experience lower dental anxiety. This inverse relationship suggests that the frequency of caffeine use warrants deeper investigation.

Caffeine functions as a double-edged agent: in small amounts, it elevates mood, but in excessive doses, it can intensify stress reactions [24]. Physiological side effects of high caffeine levels include heart palpitations, restlessness, trembling, and nausea [25]. Nonetheless, caffeine also enhances dopamine release, promoting alertness, pleasure, and mental stimulation [24, 26]. Our analysis showed that consuming caffeine between 0 and 3 times weekly correlated with higher dental anxiety, while consuming it 4 or more times weekly was linked to lower anxiety levels. Though these observations contrast several published studies on caffeine and psychological distress [25, 27, 28], they can be interpreted through established neurobiological mechanisms.

Caffeine serves as an adenosine receptor (A1 and A2a) antagonist, preventing receptor activation that usually promotes glutamate release during chronic stress [29]. The adenosine receptor genes (A1R, A2aR, or ADORA2a) play a role in mood regulation [30]. As explained by Kaster *et al*., regular caffeine intake may counteract maladaptive responses to chronic stress, a condition known to cause biochemical and structural brain alterations [31]. Under chronic unpredictable stress (CUS), caffeine's antagonistic action on adenosine receptors appears to provide neuroprotective effects, shielding against stress-related impairments in neuroplasticity. This mechanism could clarify why frequent caffeine users exhibit reduced dental anxiety—they may have developed beneficial neuroadaptive responses.

Moreover, genetic polymorphisms of the A2a receptor have been linked to heightened anxiety and panic attacks [24]. Individuals carrying these variants tend to react more strongly to caffeine and consume it less often. Consequently, habitual caffeine consumers are less likely to experience caffeine-induced anxiety, while occasional users may feel heightened anxiety responses due to lower physiological adaptation.

Rogers and colleagues examined the anxiety-inducing (anxiogenic) influence of caffeine on both regular and occasional caffeine users [30]. Individuals who rarely consume caffeine are more likely to possess the TT genotype, whereas those who consume it frequently generally carry CC or CT genotypes. Consequently, infrequent users with TT genotypes tend to exhibit higher anxiety levels, while habitual users with CC or CT genotypes report minimal or no increase in anxiety following caffeine intake. When regular caffeine consumers were deprived of caffeine and later re-exposed, their anxiety levels rose sharply. Conversely, those who consistently maintained their usual caffeine intake did not experience significant changes in anxiety.

While genetic differences offer one explanation for the caffeine–anxiety relationship, additional studies have explored tolerance development patterns. Lower consumption frequency typically implies irregular intake, while higher frequency denotes steady and habitual use. Individuals with low caffeine intake (less than 500 mg per week) demonstrated stronger anxiety responses when administered caffeine, whereas high caffeine consumers (400 mg or more daily) showed reduced anxiogenic effects [23]. These results indicate that habitual caffeine users develop tolerance to the

anxiety-provoking impact of caffeine, unlike those who consume it occasionally.

Taken together, the combined influence of adenosine receptor blockade and adaptive neurochemical changes resulting from regular caffeine use may help alleviate anxiety symptoms related to dental procedures—such as tooth extraction, cleaning, or drilling [32, 33]. However, this theoretical link requires further empirical investigation to be substantiated.

Limitations and future directions

This research offers several strengths along with a few limitations. Among its strengths are the large sample size and its contribution to addressing a notable gap in current literature. The use of multiple regression models and the testing of their robustness further enhance its credibility. However, the cross-sectional design limits the ability to establish causal relationships, and the results should therefore be interpreted carefully.

One limitation is the absence of data on physical activity, a factor known to influence mental well-being. Studies have shown that engaging in at least 20 minutes of exercise three to four times weekly can have a significant positive effect on psychological health [34]. Another shortcoming is that the study did not account for breakfast habits. Previous research has identified a clear association between skipping breakfast and increased risk of anxiety and depressive disorders in adults [35].

For future research, it is recommended to assess the type and duration of physical activity in relation to dental anxiety. Moreover, caffeine intake should be examined more comprehensively—taking into account not just weekly frequency, but also the actual caffeine content across different beverages.

Conclusion

The findings from this study suggest that diet quality, gender, and age play a key role in shaping dental anxiety. Consumption of sugary and fast foods was positively correlated with dental anxiety, whereas nutrient-rich diets were associated with better mental health outcomes. The intricate, two-way relationship between nutrition, oral health, and psychological well-being warrants further exploration to confirm these observations.

Future studies should also explore how exercise and breakfast consumption influence dental anxiety. Although the connection between nutrition and dentistry has been largely overlooked in existing research, the present study serves as a foundation linking dietary habits with dental anxiety, opening new pathways for interdisciplinary research.

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