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Original Article

Fast food consumption and its relationship with oral health among US adults: A cross-sectional NHANES-based study

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ABSTRACT

This study aimed to assess the link between fast-food consumption and oral health outcomes as measured by the mean number of decayed, missing due to dental disease, or filled permanent teeth (DMFT) and teeth with untreated dental caries. This study utilized data obtained from the National Health and Nutritional Examination Survey (NHANES). The data used was collected from 11,288 participants aged 20 and above from 2015 to 2018. The frequency of fast-food consumption was divided into two groups: “less than two meals over the past seven days” and “two meals or more over the past seven days.” The mean number of DMFT and teeth with untreated dental caries were used to assess the participants’ oral health. The link between fast-food consumption and these mean values was explored using Poisson regression analysis, in which confounding variables such as income, race, age, and sex were adjusted for. After adjusting for these variables, the results revealed that individuals who reported consuming two or more fast-food meals during the preceding seven days had higher mean numbers of DMFT and teeth with untreated dental caries compared to those who consumed less than two fast-food meals during the same period (adjusted mean ratio = 1.05; 95 % confidence interval [CI] 1.01–1.10 and mean ratio = 1.22; 95 % CI 1.01–1.47, respectively). Conclusion: This study revealed a link between poor oral health outcomes and fast-food consumption. Consequently, public health officials must focus on fast-food settings and availability of high-sugar-content items. Interventions that target fast-food outlets and what they offer may have a positive impact on oral health.

1. Background

Food and drink consumption have a profound impact on an individual’s overall health (NHS, 2022). Maintaining a healthy diet composed of nutritious foods is a crucial factor for the well-being of the US population (Centres for Disease Control and Prevention (CDC), 2022). A balanced diet contributes to normal development and promotes healthy living (Centres for Disease Control and Prevention (CDC), 2022). The act of eating can be viewed from several aspects, including time, location, and the company of others (Warde, 2016). The location where food and meals are consumed, is essential for understanding food consumption, and key differences have been noted between eating at home and eating out (Warde, 2016). The practice of consuming meals prepared outside the home is prevalent among the US population (Economic Research Service, U.S. Department of Agriculture, 2022). The

literature in this area focuses on fast-food as a commonly consumed, non-homemade food.

Frequent articles have discussed the prevalence of fast-food consumption (Fryar et al., 2018; Kant et al., 2015; AlTamimi et al., 2022; Alhashemi et al., 2022). Research shows that in the US between 2013 and 2016, over 36 % of adults consumed fast-food on a given day (Fryar et al., 2018).

Fast-food consumption has been linked to adverse nutritional outcomes (Paeratakul et al., 2003; Barnes et al., 2016; Mumena et al., 2022; Bowman and Vinyard, 2004; An, 2016). Additionally, several studies have discussed the poor health outcomes associated with fast-food consumption (Bhutani et al., 2018; Bodicoat et al., 2015; Burgoine et al., 2018; Pereira et al., 2005). Few studies have examined the association between fast-food consumption and dental caries (Punitha et al., 2015; Schroth et al., 2013; Tsang et al., 2019). A study by Punitha et al.

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(2015) examined the association between various dietary habits, including a fast-food-heavy diet, and the development of caries among participants aged 13–19. Their results showed a statistically insignificant association between the rate at which fast food is consumed and the occurrence of dental caries. However, Schroth et al. (2013) conducted a study among children and found that severe childhood caries is associated with multiple factors, including fast-food consumption.

Existing research on fast-food consumption primarily focuses on nutritional intake or various health outcomes, with limited attention to its impact on oral health. Few studies have explored the correlation between fast-food intake and dental caries. Therefore, this large sample-based study utilized data from the National Health and Nutritional Examination Survey (NHANES) (2015–2016, 2017–2018) to examine the relationship between fast-food consumption and oral health among the US adult population. Oral health was assessed using the mean numbers of decayed, missed due to dental disease, filled permanent teeth (DMFT), and teeth with untreated dental caries.

2. Methods

2.1. Research design

This study employed pooled NHANES data from 2015 to 2018 (NHANES, 2015–2016 and 2017–2018). The Centers for Disease Control and Prevention (CDC) conducted this national, non-institutionalized, cross-sectional survey of the US population. Clinical examinations, laboratory evaluations, and self-reported questionnaires were used to gather data. A total of 11,288 participants participated in this study. Inclusion criteria included adults aged 20 years or older who underwent a dental examination and had at least one tooth present.

2.2. Clinical examinations

All clinical examinations of NHANES participants were performed by calibrated dental examiners. The authors then reviewed the data to identify participants with untreated dental caries in one or more teeth and/or one or more decayed, missed due to dental disease, or filled permanent teeth (DMFT). Both outcome variables, dental caries in one or more teeth, and DMFT were categorized as discrete outcomes.

2.3. Covariates

The independent variables applied in this study were age (20–39, 40–64, and 65 and above), household income relative to the federal poverty level (<1.38, 1.38–3.99, and > 3.99), and ethnicity (non-Hispanic (NH) white, NH black, Hispanic, Asian, and other). Additionally, the frequency of fast-food consumption was included based on the participants' responses to the question, "How many of those meals {did you/did the SP} get from a fast-food or pizza place?" Participants were categorized into two groups based on their responses, resulting in binary variables of 0 (less than two fast-food meals over the past seven days) and one (two fast-food meals or more over the past seven days), as per Nagao-Sato and Reicks (Nagao-Sato and Reicks, 2022).

2.4. Data analysis

Sociodemographic characteristics of individuals with varying levels of fast-food consumption over the past week were analyzed using weighted descriptive statistics. The chi-square test was used to assess the association between fast-food consumption and sociodemographic factors. Additionally, the average fast-food consumption, categorized as less than or more than two meals per week, was calculated for each sociodemographic group, stratified by DMFT and untreated dental caries.

Weighted logistic regression models were applied to analyze the association between fast-food consumption frequency (less than two

meals or two or more meals per week) and various sociodemographic factors. Adjusted odds ratios (OR) were calculated at a 95 % confidence interval (CI). The mean number of teeth with untreated dental caries and DMFT were subjected to Poisson regression models to estimate the adjusted measures of the link between fast-food consumption and oral health. The adjusted mean ratios (AMR) of the results were also calculated at a 95 % confidence interval (CI), with independent confounding variables controlled for in the multivariable regression models used to produce adjusted estimates. Statistical significance was determined at $p < 0.05$. All statistical analyses were performed using Stata/MP V.15.1 (StataCorp).

This research was approved by the Institutional Review Board (IRB) of the Harvard Medical School Faculty of Medicine (IRB23-0862).

The manuscript adheres to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklists (Von Elm et al., 2014).

3. Results

Table 1 presents descriptive statistics illustrating the prevalence of fast-food consumption considering sociodemographic factors, of those who consumed two or more fast-food meals during the past seven days. This analytical cross-sectional study included a total of 11,288 adults from the United States. Participants aged 20–39 account for 36.16 %, 40–64 formed 43.45 %, and 65 and above constituted 20.39 % of the study participants. Females constituted 51.9 % of the participants, while males made up 48.1 %. The results shown in Table 1 reveal that the number of participants who consumed two or more fast-food meals during the past seven days differed according to sociodemographic variables. A total of 52.17 % of respondents aged 20–39 reported consuming two or more fast-food meals during the past seven days, 42.8 % of those aged 40–64 reported the same, and 27.49 % of respondents aged 65 years and above reported consuming two or more fast-food meals during the past seven days.

Table 2 presents the mean number of teeth with untreated dental caries among the study participants, stratified by fast-food consumption

Table 1
Demographics and prevalence of eating two meals or more of fast food among adults aged ≥ 20 years in the National Health and Nutrition and Examination Survey; 2015–2018.

Characteristics	Total population (11,288)		Two meals or more fast food over the past seven days (6,303)		P-value
	Mean %	95 % CI	Mean %	95 % CI	
Age					
20–39	36.16	(34.33–38.03)	52.17	(49.66–54.67)	<0.001
40–64	43.45	(41.84–45.07)	42.8	(39.23–46.45)	
65+	20.39	(18.69–22.21)	27.49	(24.15–31.11)	
Sex					
Male	48.1	(47.05–49.16)	49.13	(46.14–52.12)	<0.001
Female	51.9	(50.84–52.95)	38.19	(35.75–40.68)	
Race/ Ethnicity					
NH-White	63.04	(58.18–67.65)	41.19	(38.07–443.7)	<0.001
NH-Black	11.4	(8.92–14.46)	59.09	(56.53–61.6)	
Hispanic	15.52	(12.47–19.16)	47.95	(44.49–514.3)	
Asian & Other	10.03	(8.32–12.05)	35.2	(30.74–39.93)	
Ratio of family income to poverty					
<1.38	19.78	(18.07–21.61)	48.6	(56.3–51.57)	<0.001
1.38–3.99	36.69	(34.1–39.36)	46.24	(43.0–49.52)	
>3.99	43.53	(40.08–47.04)	39.44	(35.83–431.6)	

Weighted percentages.

CI: Confidence Interval.

NH: Non-Hispanic.

Table 2

Mean DMFT and mean number of teeth with untreated caries among adults aged ≥ 20 years by the number of fast-food meals and the demographic variables in the National Health and Nutrition and Examination Survey; 2015–2018.

Characteristics	Untreated dental caries				DMFT			
	Less than two meals fast food		Two meals or more fast food		Less than two meals fast food		Two meals or more fast food	
Overall	Mean	CI	Mean	CI	Mean	CI	Mean	CI
Age	0.53	(0.45-0.61)	0.77	(0.63-0.88)	8.4	(8.0–8.8)	7.6	(7.3–7.9)
20–39	0.79	(0.63-0.96)	0.99	(0.80–1.20)	5.48	(4.95–6.01)	5.98	(5.56–6.38)
40–64	0.62	(0.49-0.74)	0.92	(0.71–1.14)	10.60	(10.07–11.14)	10.99	(10.68–11.31)
65+	0.38	(0.28-0.48)	0.60	(0.41-0.79)	15.98	(15.43–16.52)	16.69	(16.12–17.26)
Sex								
Male	0.75	(0.62-0.89)	1.01	(0.83–1.20)	9.36	(8.74–9.99)	9.05	(8.57–9.53)
Female	0.52	(0.41-0.62)	0.82	(0.62–1.01)	10.61	(10.13–11.08)	9.37	(8.84–9.91)
Race/ ethnicity								
NH-White	0.55	(0.43-0.68)	0.88	(0.67–1.08)	10.59	(10.00–11.18)	9.84	(9.41–10.28)
NH-Black	1.06	(0.78–1.34)	1.40	(1.17–1.63)	9.33	(8.75–9.90)	8.67	(8.10–9.23)
Hispanic	0.74	(0.59-0.90)	0.76	(0.62-0.90)	8.81	(8.22–9.39)	7.46	(6.90–8.02)
Asian & Other	0.60	(0.43–1.06)	0.75	(0.43–1.06)	8.66	(7.78–9.53)	8.74	(7.72–9.76)
Ratio of family income to poverty								
<1.38	1.42	(1.14–1.71)	1.66	(1.34–1.98)	9.86	(8.98–10.73)	8.70	(7.85–9.56)
1.38–3.99	0.77	(0.61-0.94)	1.10	(0.89–1.30)	10.22	(9.52–10.92)	9.42	(8.96–9.89)
>3.99	0.27	(0.19-0.34)	0.43	(0.33–0.52)	9.99	(9.49–10.50)	9.21	(8.73–9.68)

Weighted means.

CI: Confidence Interval.

NH: Non-Hispanic.

frequency and demographic variables. The highest mean number of untreated dental caries was observed among participants who consumed two or more fast-food meals and were male (mean = 1.01), aged 20–39 (Mean = 0.9) years, black (mean = 1.40), and whose family income to poverty ratio was < 1.38 (Mean = 1.66).

Table 3 presents the results following the use of a logistic regression model to illustrate the link between the frequency of fast-food consumption and sociodemographic variables among the study participants. The table shows that adults aged 40–64 and 65 years and above were less likely to consume two or more of fast-food meals during the past week compared to those aged 20–39 years (AOR = 0.71; 95 % CI = 0.61–0.83; P < 0.001 and AOR = 0.37; 95 % CI = 0.30–0.45; P < 0.001, respectively). Moreover, women are less likely to consume two or more fast-food meals during the past week compared to men (AOR = 0.63; 95 % CI = 0.57–0.70; P ≤ 0.001).

Table 4 illustrates the results of the Poisson regression analysis examining the association between fast-food consumption and the mean number of DMFT scores and teeth with untreated caries among the study participants. The table indicates that individuals who reported

Table 3

Logistic regression models of associations between number of fast food meals and sociodemographic characteristics among adults aged ≥ 20 years in the National Health and Nutrition and Examination Survey; 2015–2018.

Socio-demographic Characteristics	Reference	Fast food		
		AOR	P> t	95 % CI
Age				
40–64	20–39	0.71	<0.001*	(0.61–0.83)
65+	20–39	0.37	<0.001*	(0.30–0.45)
Sex				
Female	Male	0.63	<0.001*	(0.57–0.70)
Race/ethnicity				
NH-Black	NH-White	1.85	<0.001*	(0.58–2.16)
Hispanic	NH-White	1.07	0.488	(0.88–1.30)
Asian & Other	NH-White	0.68	0.001*	(0.56–0.84)
Ratio of family income to poverty				
1.38–3.99	<1.38	1.01	0.871	(0.86–1.19)
>3.99	<1.38	0.79	0.008*	(0.66–0.93)

AOR: Adjusted Odds Ratio; CI: Confidence Interval; NH: Non-Hispanic; *P < 0.05.

consuming two or more fast-food meals during the past week had a higher mean number of DMFT (adjusted mean ratio = 1.05; 95 % CI 1.01–1.10) and teeth with untreated dental caries (adjusted mean ratio = 1.22; 95 % CI 1.01–1.47) compared to those consuming less than two fast-food meals. The mean number of DMFT was higher among individuals aged 40–64 and 65 or above compared to individuals aged 20–39, (adjusted mean ratio = 1.91; 95 % CI 1.79–2.05 and 2.87; 95 % CI 2.65–3.11, respectively). Females had a higher mean DMFT than males (adjusted mean ratio = 1.07; 95 % CI 1.04–1.11) while Hispanics had a lower mean DMFT compared to NH-Whites (adjusted mean ratio = 0.92; 95 % CI 0.87–0.98). The mean number of teeth with untreated dental caries was lower among individuals aged 65 years or older than among individuals aged 20–39, (adjusted mean ratio = 0.64; 95 % CI 0.48–0.86). Females had a lower mean number of teeth with untreated dental caries compared to males (adjusted mean ratio = 0.69; 95 % CI 0.59–0.82).

4. Discussion

This study used the most recent NHANES data to examine the relationship between fast-food consumption and oral health outcomes in a representative sample of US adults. After adjusting for income, race, age, and sex, it was found that individuals who reported consuming two or more fast-food meals during the past seven days exhibited higher mean DMFT scores and a greater number of teeth with untreated dental caries compared to those who consumed less than two fast-food meals during the same period (adjusted mean ratio = 1.05; 95 % CI 1.01–1.10 and mean ratio = 1.22; 95 % CI 1.01–1.47, respectively). These findings suggest that fast-food consumption negatively affects oral health, and also implies that fast-food meals are likely to have a high sugar content.

Currently, there is limited literature on the correlation between dental caries and fast-food consumption, and the literature that does exist is contradictory (Punitha et al. 2015, Schroth et al., 2013; Tsang et al., 2019). For instance, this study aligns with Schroth et al. (2013) and Tsang et al. (2019) in demonstrating a positive correlation, while contradicting Punitha et al. (2015), who found no statistically significant link. Importantly, it is difficult to make direct comparisons between the findings of this study and those of existing studies, as this research differs from the aforementioned studies (Punitha et al., 2015; Schroth et al., 2013; Tsang et al., 2019) in several respects. In particular, this study was only concerned with adults aged 20 years and above, whereas

Table 4

Poisson regression analysis of the associations of eating fast food with mean number of DMFT and mean number of teeth with untreated caries among adults aged ≥ 20 years in the National Health and Nutrition and Examination Survey; 2015–2018.

Socio-demographic Characteristics		DMFT			Untreated dental caries		
Variable	Reference	AMR	P> t	95 % CI	AMR	P> t	95 % CI
Fast food							
Two meals or more	< two meals	1.05	0.013*	(1.01–1.10)	1.22	0.035*	(1.01–1.47)
Age							
40–64	20–39	1.91	<0.001*	(1.79–2.05)	1.03	0.761	(0.86–1.23)
65+	20–39	2.87	<0.001*	(2.65–3.11)	0.64	0.004*	(0.48–0.86)
Sex							
Female	Male	1.07	<0.001*	(1.04–1.11)	0.69	<0.001*	(0.59–0.82)
Race/ ethnicity							
NH-Black	NH-White	0.96	0.138	(0.90–1.01)	1.31	0.001*	(1.13–1.52)
Hispanic	NH-White	0.92	0.009*	(0.87–0.98)	0.77	0.018*	(0.62–0.95)
Asian & Other	NH-White	0.95	0.196	(0.87–1.03)	0.81	0.079	(0.64–1.03)
Ratio of family income to poverty							
1.38–3.99	<1.38	0.92	0.005*	(0.88–0.97)	0.61	<0.001*	(0.50–0.75)
>3.99	<1.38	0.85	<0.001*	(0.80–0.91)	0.22	<0.001*	(0.17–0.28)

DMFT: Decayed, Missed, Filled, Teeth; AMR: Adjusted Mean Ratio; CI: Confidence Interval; NH: Non-Hispanic; *P < 0.05.

the other above-mentioned studies focused on children and teenagers. This distinction in the ages of the study participants may explain some of the variations in the findings.

Reconciling findings from different studies is hindered by the absence of a standardized definition for “fast-food.” Additionally, the current study differs from the aforementioned studies in terms of how fast-food consumption is classified and the measures used to assess oral health outcomes.

Moreover, the reviewed literature (Punitha et al., 2015; Schroth et al., 2013; Tsang et al., 2019) did not clarify whether the authors adjusted for age, race, income, sex, or any other potential confounding variables in their research. Finally, the sample sizes varied across the studies reviewed and the present study, potentially affecting the comparability of the results.

The link between dental caries and fast-food consumption identified in this study invites us to reflect on the types of beverages and food items available at fast-food outlets. According to Lewis et al. (2020) and Mackay et al. (2021), fast-food outlets offer a variety of options, such as desserts, burgers, condiments, sandwiches, breakfast sandwiches, and beverages ranging from sugary soft drinks to sugar-free soft drinks and hot drinks. Of the abovementioned items, the high sugar content of desserts and soft drinks is likely to contribute most significantly to the association between the development of dental caries and fast-food consumption. This is especially the case given the ready availability of these items in fast-food outlets, as repeated research has shown that the availability of products in particular contexts can increase their consumption (Wiecha et al., 2006; Grimm et al., 2004; Hattersley et al., 2009; Neumark-Sztainer et al., 2005).

The findings of this study have several implications for public health. Targeting fast-food outlets and what they offer is beneficial, as it may help to reduce the negative health consequences of oral health on the population. This strategy aligns with the Ottawa Charter’s recommendations for environmental interventions (World Health Organization et al., 1986), particularly those aimed at creating an environment that supports good health.

This study had several limitations. The use of the NHANES data from 2015 to 2018 excluded more recent data that were unavailable and potentially affected by the COVID-19 pandemic. Therefore, generalizing these results may be problematic. Furthermore, this was a cross-sectional study; thus, causality between fast-food consumption and oral health cannot be established. Additionally, as the NHANES data were gathered using self-reported questionnaires, recall bias and social desirability bias may have impacted the accuracy of the data collected.

This study provided a limited explanation for the link between dental caries and fast-food consumption, focusing on the availability of high-sugar-content items in fast-food outlets. Other explanations such as

the convenience and accessibility of these items have not been discussed. Finally, there are some unmeasured confounders that might distort the link between fast-food consumption and dental caries, such as oral hygiene practices, other dietary factors, and the number of dental visits.

Therefore, further research in this area is required. The current lack of rigorous research necessitates additional confirmatory studies, particularly those employing a consistent definition of fast-food to facilitate future comparisons in the literature. Studies that broaden our understanding of the availability of sugary items in fast-food restaurants and their correlation with oral health outcomes are required.

5. Conclusion

This study examined the association between fast-food consumption and oral health. The findings revealed a significant link between fast-food consumption and the mean number of DMFT and teeth with untreated dental caries. This study also offers insights into possible interpretations of this correlation by highlighting that the availability of high-sugar-content items at fast-food restaurants, in particular, soft drinks and desserts, could contribute to this association. Finally, this paper concludes by suggesting that creating interventions that target fast-food settings and what they offer may have a positive impact on oral health.

Ethical statement

The study was conducted in accordance with the Declaration of Helsinki, and approved by the Institutional Review Board (IRB) of the Harvard Medical School Faculty of Medicine (IRB23-0862/August 15, 2023).

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CRediT authorship contribution statement

Mohammed M. Sarhan: Conceptualization, Writing – original draft, Writing – review & editing, Visualization, Investigation, Validation, Methodology, Resources. **Hesham A. Alhazmi:** Conceptualization, Data curation, Writing – original draft, Writing – review & editing, Visualization, Investigation, Validation, Formal analysis, Methodology, Resources.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability statement

Data is available on Centers for Disease Control and Prevention website.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.sdentj.2024.02.021>.

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