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The relationship between lifestyle and self-reported oral health among American adults

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Objectives: Whereas an unhealthy lifestyle is a risk factor for chronic disease, its relationship to self-reported oral health is unclear. This paper studies this relationship among American adults using two dimensions of self-reported oral health, namely: (1) the extent to which a person's teeth are in poor condition, simply called 'bad teeth'; (2) the occurrences of negative consequences of poor oral health, simply called 'bad experience'. The main purpose of this study is to describe and assess their relationship to four markers of lifestyles and to use the results to make recommendations on improving oral health. **Methods:** Data were obtained from National Health and Nutrition Examination Survey (NHANES) 2005–2006. A series of logistic regression models quantified the associations between lifestyle markers with self-reported oral health. **Results:** Our major findings are that: (1) individuals who smoked every day were significantly more likely to have bad teeth and a bad oral experience than non-smokers, with risk ratios of 1.61 (95% CI 1.36, 1.92) and 1.50 (95% CI 1.24, 1.8), respectively; (2) individuals who had poor diets were more likely to report bad teeth and have bad oral experiences than those who had excellent diets, with risk ratios of 4.22 (95% CI 2.8, 6.28) and 2.88 (95% CI 1.83, 4.55), respectively, both comparisons adjusted for other demographic variables. **Conclusions:** These results suggest that self-reported indicators of oral health could be used to guide people in making improvements in their life style that could result in better oral health, especially for disadvantaged individuals.

Key words: *Lifestyle markers, teeth condition, bad oral experience*

INTRODUCTION

Recent studies have indicated that unhealthy lifestyles can not only lead to a number of major health problems but can also adversely affect the effectiveness of medical treatments. According to World Health Organisation (WHO) estimates in 2003, up to 80% of cases of coronary heart disease, 90% of type 2 diabetes cases and one-third of cancers are potentially avoidable through adopting healthier lifestyles[1]. Low levels of physical activity, use of tobacco and alcohol, poor daily hygiene habits and diet are major risk factors for poor general health[1,2]. Some dental studies have also found that behaviours such as smoking and diet are markedly related to dental caries and periodontal disease[3,4].

The status of an individual's oral health can be measured using widely accepted clinical standards as well as subjective assessments. Clinical standards, which are generally reliable and useful methods, are important for assessing the condition of teeth and the need for treatment. However, they have some limitations[5]. Self-reported oral health questionnaires were recently developed to complement objective clinical indicators of oral disease and aimed at providing a comprehensive measure of self-reported dysfunction, discomfort and disability caused by oral conditions.

A literature search revealed that some dental studies have investigated self-reported oral health in adolescents and seniors[5–7]. However, only a few self-reported oral health studies of Americans using a nationwide survey have been conducted, possibly because self-reported oral health was only recently collected in NHANES2003-04. One study examined the self-reported oral health status of Americans and Australians and found similar oral health profiles in both countries[8]. Another two studies investigated the disparities in self-reported oral health categorised by sociodemographics, perception of dental needs, etc., and found that those individuals having dental needs had the poorest self-reported oral health[9] and that the ability to pay for care is linked to self-reported oral

health status[10]. None of these previous studies asked the question 'How would you describe the condition of your teeth?', and only a few studies investigated the independent effect of lifestyle markers on self-reported oral health.

While it has been suggested that lifestyle has a marked impact on general health[1], no study before this one has examined the joint role of multiple lifestyle markers in relation to self-reported oral health status, including the condition of teeth and bad experiences caused by oral health problems. To fill this gap, the objectives of this study were to (1) describe and summarise the prevalence of bad teeth and the extent of bad oral experiences; and (2) test the relationship between four markers of lifestyle, namely smoking, alcohol use, diet and physical activity, and self-reported oral health in a national representative sample of USA adults.

MATERIALS AND METHODS

Data for this study were taken from the NHANES 2005–2006 survey, which were based on a stratified, multistage design implemented to monitor five 'Healthy People 2010' oral health objectives. Only subjects who were ≥20 years old and had completed both behaviour and oral health questionnaire interviews were included.

Ethics statement

National Health and Nutrition Examination Survey data is freely available on the web and the NCHS Research Ethics Review Board (ERB) approved the study (NCHS IRB/ERB Protocol #2005-06) and for further ethical approval use. This research has been conducted in full accordance with the World Medical Association Declaration of Helsinki.

Self-reported oral health variables

The Oral Health questionnaire in NHANES2005-06 was filled out at home, before the physical examination, using the computer-assisted personal interviewing (CAPI) system. Two dimensional subjective aspects were used (1) the condition of a participant's teeth, calibrated on a Likert scale as being excellent, very good, good, fair and poor (in the data analysis performed here, the first three categories were collapsed and referred to as 'good condition', the others denoting 'bad condition'); (2) an individual's oral experience was based on seven questions, namely, how often in the last year have you (1) had an aching pain in your mouth? (2) felt bad because of the condition of your mouth? (3) had difficulty in doing usual jobs or attending school because of problems with teeth, mouth or dentures? (4) found that the condition of your mouth affected your sense of taste? (5) avoided some foods because of your mouth? (6) could not eat because of your mouth? (7) been embarrassed because of your mouth. Each of the above seven questions had five ordinal levels: very often, fairly often, occasionally, hardly ever and never. 'Oral experience', a dichotomous variable, was created to indicate whether the participants had a bad experience or not, so that the term 'bad oral experience' indicates that at least one of the above seven conditions was reported as having occurred very often, fairly often or occasionally.

Behavioural variables

Four variables indicating daily behaviour were used: (1) smoking status, (2) how often alcohol had been consumed, (3) physical activity as measured by the metabolic equivalent (MET) intensity level and (4) diet. These four markers have been repeatedly used in medical[2,11] and oral health studies[10,12,13]. 'Smoking status' consisted of three levels indicating how often cigarettes were smoked: never, some days and every day. Alcohol assumption was categorised into tertiles and diet had five ordinal levels. Physical activity was categorised into three levels, based on the MET score, as being light, moderate or vigorous[2]; this variable was only included in NHANES2005-06 among recent surveys.

Demographic variables

These included age, gender and race. Family income status is the ratio of family income to the federal poverty threshold (FTP), adjusted for family size and composition, and has three levels: poor (PIR < 1), near poor (1 ≤ PIR 3) and non-poor (PIR ≥ 3). Education reflects the highest grade or level of school completed by the participant, described as <12 years, 12 years and >12 years.

Statistical analysis

The distribution of all explanatory variables, categorised by the self-reported oral health variables, was used to assess the characteristics of the population. As other studies have indicated that males are more active than females[14,15], we tested the interaction between lifestyle markers and gender. We also tested the interaction between lifestyle markers and age, education and family poverty status. In order to investigate the direct and indirect effect of behaviour markers, a series of logistic regression models were employed using both self-reported oral health variables as responses, alternatively adjusting for other variables.

RESULTS

The analysis was based on the responses of 3,552 adults aged 20 years and older who had completed the oral health and behaviour questionnaire in NHANES200-06. The mean age of participants was 44.7 years and standard error was 0.27. Among the participants, 31.92% self-reported having bad teeth and 20.38% having had a bad oral experience because of their oral health in the past year (*Table 1*). Individuals who had participated in vigorous activity had a lower prevalence of bad teeth (25.87%) than those with moderate (29.63%) and light activity (44.94%) profiles. Similarly, non-smokers had the lowest prevalence of bad teeth (25.03%) compared with the other groups (*Table 1*).

Table 1 Bad tooth condition and bad oral experiences within groups of explanatory variables

Explanatory variables	Bad teeth% (95% CI)	Bad experience% (95% CI)
Overall	31.92 (30.16, 33.68)	20.38 (18.83, 21.93)
Age (years)		
20–39	30.36 (27.65, 33.06)	24.23 (21.66, 26.80)
40–59	34.36 (31.26, 37.46)	19.83 (17.26, 22.4)
60 and over	30.53 (37.16, 33.9)	13 (10.51, 15.49)
Gender		
Male	33.08 (30.77, 35.39)	17.7 (15.83, 19.6)
Female	30.34 (27.6, 33.08)	24.44 (21.83, 27.05)
Race/ethnicity		
Mexican American	48.77 (43.75, 53.79)	18.86 (14.98, 22.74)
Other Hispanic	44.74 (32.37, 57.11)	6.98 (2.06, 11.90)
Non-Hispanic white	28.78 (26.78, 30.78)	19.34 (17.60, 21.08)
Non-Hispanic black	46.73 (42.46, 51.0)	25.02 (21.27, 28.76)
Other Race	46.12 (36.2, 56.04)	40.55 (30.65, 50.45)
Education (years)		
<12	55.33 (50.17, 60.49)	29.97 (25.28, 34.65)
12	40.39 (37.27, 43.51)	26.06 (23.24, 28.88)
>12	23.08 (20.81, 25.35)	15.45 (13.47, 17.43)
Poverty income ratio		
Poor	57.9 (35.27, 62.53)	32.86 (28.17, 37.54)
Near poor	37.96 (34.18, 41.74)	31.59 (18.43, 24.74)
Non-poor	24.25 (22.13, 26.37)	17.34 (15.45, 19.22)
Smoking		
Every day	42.18 (37.55, 46.81)	26.35 (23.61, 29.09)
Some days	27.53 (23.75, 31.31)	14.71 (10.55, 18.65)
No smoking	25.03 (22.91, 27.15)	16.83 (14.83, 18.83)
Alcohol		
No alcohol	39.72 (36.62, 42.82)	24.08 (19.87, 28.29)
Moderate	30.15 (24.72, 35.58)	21.25 (19.21, 23.29)
Heavy	32.06 (29.84, 34.27)	15.6 (12.78, 18.42)
Physical activity		
Light	44.94 (40.29, 49.58)	21.57 (18.32, 24.82)
Moderate	29.63 (27.38, 31.88)	20.32 (18.09, 22.55)
Vigorous	25.87 (22.2, 29.53)	19.59 (16.69, 22.49)
Healthy diet		
Excellent	24.34 (18.91, 29.77)	15.27 (10.41, 20.12)
Very good	19.75 (15.95, 23.55)	17.61 (14.32, 20.90)
Good	32.64 (29.86, 35.42)	19.85 (17.46, 22.24)
Fair	40.24 (35.97, 44.51)	22.12 (18.63, 25.61)
Poor	59.65 (52.12, 67.18)	37.05 (29.56, 44.54)

A strong relationship was found between bad teeth and bad oral experience using a chi-square test ($P < 0.0001$). Generally, the rate of reporting bad teeth increased as the number of different types of bad oral experiences increased. Among those not having had a bad oral experience, only 23.35% reported having bad teeth. However, around 97% of individuals reported bad teeth if they had six different types of bad oral experiences (*Table 2*). The types of bad experiences occurring most frequently were: avoiding some food (11.03%), difficulty eating (9.5%) and mouth pain (8.4%). At the lowest occurrence rate, only 1.5% of participants had difficulty doing their usual jobs or attending school.

Smoking every day, heavy alcohol use and vigorous physical activity were higher in males than their female counterparts by 4%, 7% and 3%, respectively. Smoking every day was highest among individuals with <12 years of education (55.96%) followed by 50% among those with only high-school diplomas and 31.50% among those having more than 12 years of education. Similarly, 41.14% of participants who did not earn a high-school diploma participated only in light-intensity physical activity, compared with 15.43% who participated only in light-intensity physical activity among participants having more than 12 years of education.

Table 3 shows the association between the four markers of lifestyle (smoking, alcohol use, diet and physical activity) with the self-reported indicators 'bad teeth' and 'bad oral experience'. The 'every day' smokers had a higher prevalence of bad teeth and oral experiences than non-smokers, with risk ratios of 1.74 (95%CI 1.49, 2.04) and 1.78 (95% CI 1.49, 2.13), respectively. This relationship remained significant after adjusting for socioeconomic and behavioural variables. The individuals who only engaged in vigorous activity were significantly less likely to have bad teeth than those with light physical activity (risk ratio 1.76; 95% CI 1.44, 2.15). This relationship remained statistically significant even after adjusting for both other lifestyle markers and demographics. Both alcohol use and physical activity did not demonstrate a

Table 2 The prevalence of bad experiences and bad teeth based on number of types of bad experiences

Number of types of bad experiences	Bad experience (%)	Bad teeth given bad experience (%)
0	79.62	23.35
1	8.79	54.55
2	4.3	75.52
3	2.74	55.57
4	2.04	84.55
5	1.73	85.85
6	0.54	96.86
7	0.48	75.37

Table 3 Association between lifestyle markers and two dimensions of self-reported oral health

	Model 1	Model 2	Model 3
Bad tooth condition			
Smoking (reference: no smoking)			
Some days	1.51 (1.17, 1.96)**	1.36 (1.03, 1.78)*	1.42 (1.07, 1.88)*
Every day	1.74 (1.49, 2.04)***	1.92 (1.63, 2.27)***	1.61 (1.36, 1.92)***
Alcohol use (reference: no alcohol)			
Moderate	0.67 (0.55, 0.81)***	0.8 (0.65, 0.98)*	0.98 (0.79, 1.21)^{NS}
Heavy	0.73 (0.58, 0.91)**	0.88 (0.69, 1.12)^{NS}	1.09 (0.85, 1.38)^{NS}
Physical activity (reference: vigorous)			
Light	1.76 (1.44, 2.15)***	1.56 (1.27, 1.92)***	1.27 (1.03, 1.58)*
Moderate	1.13 (0.94, 1.35)^{NS}	1.11 (0.93, 1.33)^{NS}	1.05 (0.87, 1.27)^{NS}
Diet (reference: excellent)			
Very good	0.83 (0.62, 1.12)^{NS}	0.95 (0.7, 1.29)^{NS}	1.01 (0.74, 1.37)^{NS}
Good	1.56 (1.19, 2.05)*	1.82 (1.38, 2.42)***	1.82 (1.37, 2.42)***
Fair	2.21 (1.65, 2.97)***	2.53 (1.87, 3.43)***	2.34 (1.72, 3.2)***
Poor	3.56 (2.45, 5.2)***	4.52 (3.06, 6.67)***	4.22 (2.8, 6.28)***
Bad oral experience			
Smoking (reference: no smoking)			
Some day	1.08 (0.79, 1.48)^{NS}	1.03 (0.75, 1.43)^{NS}	1.08 (0.78, 1.50)^{NS}
Every day	1.78 (1.49, 2.13)***	1.69 (1.4, 2.03)***	1.50 (1.24, 1.8)**
Alcohol use (reference: no alcohol)			
Moderate	0.93 (0.74, 1.18)^{NS}	0.89 (0.7, 1.23)^{NS}	1.0 (0.79, 1.28)^{NS}
Heavy	0.82 (0.63, 1.08)^{NS}	0.83 (0.63, 1.09)^{NS}	0.93 (0.7, 1.23)^{NS}
Physical activity (reference: vigorous)			
Light	0.97 (0.77, 1.22)^{NS}	1.01 (0.79, 1.29)^{NS}	0.89 (0.7, 1.14)^{NS}
Moderate	1.05 (0.86, 1.29)^{NS}	1.07 (0.88, 1.32)^{NS}	1.02 (0.83, 1.26)^{NS}
Diet (reference: excellent)			
Very good	1.48 (1.01, 2.17)*	1.42 (1.07, 2.10)*	1.53 (1.03, 2.25)*
Good	1.89 (1.32, 2.71)***	1.84 (1.28, 2.65)*	1.83 (1.27, 2.65)*
Fair	2.31 (1.58, 3.38)***	2.13 (1.45, 3.15)***	2.04 (1.38, 3.02)**
Poor	3.23 (2.07, 5.05)***	3.05 (1.95, 4.8)***	2.88 (1.83, 4.55)***

Model 1: only included four markers of lifestyle.
Model 2: adjusted for age, gender and race/ethnicity, in addition to the social network and support variables.
Model 3: additionally adjusted for family poverty status and education.
*$P < 0.05$, **$P < 0.001$, ***$P < 0.0001$.
NS, not significant.

statistically significant association with bad oral experience (*Table 3*). Individuals with poor diets were more likely to report bad teeth and have bad oral experience than those eating excellent diets, with risk ratios of 4.22 (95% CI 2.8, 6.28) and 2.88 (95% CI 1.83, 4.55), after adjusting for other demographic variables.

DISCUSSION

This study, based on a nationally representative sample and using subjective measures of both oral health and indicators of lifestyle, namely alcohol consumption, physical activity, smoking and diet, found that smoking and diet status were statistically significantly associated with self-reported conditions of having bad teeth and bad oral experiences among adults in the USA, regardless of whether adjusting for sociodemographics or not, which is consistent with other findings that smoking and bad diet were inversely related to dental disease. In contrast, alcohol consumption did not have a significant relationship with the occurrence of bad teeth after adjusting for education and family poverty status. Both alcohol consumption and physical activity did not show statistically significant relationships with bad oral experiences.

A significant relationship between the occurrence of bad teeth and bad oral experiences was found. Participants with a greater number of types of bad oral experience were more likely to describe their teeth as being in bad condition. For example, only 23.35% of individuals reported bad teeth without having had any bad oral experiences. About 97% of individuals reported having bad teeth if they had experienced six types of bad oral experiences. However, only 75% of those reporting having had seven types of bad oral experiences had bad teeth. Possible explanations of this inconsistency are: (1) the duration and severity of bad experiences might influence the result; (2) the subjective results varied among individuals and were unavoidably affected by other factors such as age, gender and other psychological factors.

The self-reported status of oral health assessed the influences of subjective factors on oral health and assessed how many dental problems had an adverse impact on the ability to function normally in ordinary daily life. Compared with clinical indicators, self-reported oral health is a non-invasive, convenient and

a cost-effective method of obtaining information on oral health needs and outcomes. Therefore, it is an ideal method for quickly evaluating the oral health status of large populations and monitoring progress toward a series of 'Healthy People' targets for the improvement of the quality of life. Moreover, unlike the clinically determined standards, self-reported results can assist investigators in determining the impact of various factors such as religion, behaviour, home income, etc., on oral health, which is affected not only by oral diseases, but also by many other factors, such as psychosocial variables[6,16–18].

Self-assessed oral health, an essential and effective approach for measuring oral health status, complements clinical oral examination and is related to real oral and/or dental conditions such as periodontal disease, oral dryness and tooth decay[19,20]. Two self-reported oral health dimensions in the present study, just like the results of clinical oral examination, revealed disparities among American adults. Individuals with low incomes and low levels of education are more likely to report bad teeth and bad oral experience than others. Given that a high level of healthy lifestyle is inversely related to bad teeth and bad oral experience, we speculate that disadvantaged people can reduce their types of bad oral experiences through adopting healthier lifestyles, such as by quitting smoking and reducing alcohol consumption.

It is, of course, widely accepted that oral health is an essential component of general health. Having bad oral experiences in terms of pain and suffering and impairment of function clearly affect the quality of life and must be taken into consideration. The results of this study indicate that both self-reported oral health dimensions, bad teeth and bad experience, have common risk factors related to lifestyle. The significant correlation existing between oral health and general health can be explained by their common risk factors[21]. Lack of physical activity, unhealthy diet, tobacco use and excessive alcohol consumption are responsible for chronic disease and are positively related to the risk of mortality[22,23]. Therefore, we can speculate that an intervention programme of healthy behaviour would produce favourable results in both general and oral health and the reduction of mortality.

We cannot definitively conclude that an unhealthy lifestyle such as smoking and eating an unhealthy diet are causally linked to bad teeth and having bad oral experiences on the basis of the observational survey data used here. The nature of cross-sectional studies limits their ability to identify underlying causes. Further study using longitudinal data will be needed to confirm a causal relationship between lifestyle and self-reported oral health. Exposure to fluoride and good oral hygiene are effective protective factors for oral health but they were not included in the national survey used here. Further study linking the attainment of optimal oral health by maximising lifestyle indicators, including oral hygiene habits, is needed. A strength of this study is that its findings can be generalised to the entire US population. Previous studies have investigated the independent effect of these lifestyle markers on oral disease and/or self-reported oral health. To the best of our knowledge, this is the first study to examine the relationship between self-reported oral health and multiple lifestyle markers among US adults. The joint effect of multiple lifestyle markers on self-reported oral health hopefully provides insights leading to the improvement of oral health and consequently a better overall quality of life.

Conflict of interest

None declared.

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