



# Difficulty with Dental Caries among Adolescents Who Are Underweight: A Nationwide Study

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This study highlights a unique association between weight status and difficulty with dental caries among US adolescents. Being underweight was significantly associated with dental caries in adolescents aged 10-17. (*J Pediatr* 2024;14:200136).

Previous literature shows a strong association between obesity or being overweight and dental caries experience among children and adolescents.<sup>1-4</sup> This association has been further strengthened by the biological, genetic, cultural, dietary, environmental, and lifestyle risk factors common to both diseases.<sup>5,6</sup> With studies showing a positive association and the many risk factors common to both diseases, some evidence shows the opposite.<sup>7-10</sup>

Understanding oral health issues in children and adolescents who are underweight is equally essential because being underweight has been linked with a myriad of adverse health consequences, including compromised immunity, malnutrition, reproductive dysfunction, cancer, impaired wound healing, and cardiovascular diseases.<sup>11</sup> A few studies found that children who were underweight had a significantly higher prevalence of dental caries than healthy children.<sup>12-14</sup> Using nationally representative data (2016-2021) from the National Survey of Children's Health (NSCH), we assessed if there was any association between being underweight and experiencing difficulty due to dental caries in the previous year in adolescents aged 10-17 years.

## Methods

This study was exempt from ethical approval. We used the STROBE guidelines to develop this manuscript. The NSCH comprises a nationally representative sample of noninstitutionalized children ages 0-17 years. The data are collected in 2 phases. First, adult participants answered an initial screener survey and later answered a topical and more detailed survey if they have children. These adults could be either parents or caregivers (called parents, hereafter).

## Population of Interest

We restricted the data analyses to a subpopulation of adolescents 10-17 ( $n = 111\,910$ ). Parents usually underestimate the weight and overestimate the height of children <10 years of

age.<sup>15</sup> Therefore, the NSCH did not collect this data for this age group. We used NSCH data from 2016 through 2021.

## Outcome Variable

Parents were asked to answer the following question with a yes/no response: "During the past 12 months, has this child had frequent or chronic difficulty with any of the following?" One of the options among the conditions listed for this question was decayed teeth or cavities.

## Primary Independent Variable

The NSCH derived the child's weight status by estimating the body mass index (BMI) using the parent-reported height, weight, and age of the child. For this estimation, all children were assumed to be at the midpoint of their age year because NSCH reports age only in years. The weight status of the child was broadly categorized into three categories based on BMI: underweight (<5th percentile), healthy (or normal) weight (5th-84th percentile), and overweight or obese ( $\geq 85$ th percentile).

## Covariates

The following sociodemographics were included: child's age, gender, race/ethnicity, type of health insurance coverage, parent's education level, and federal poverty level (FPL). We included having had a dental visit in the past 12 months (yes/no) as a covariate because experiencing difficulty with dental caries may be associated with visiting a dental office and receiving treatment. We also included having access to a medical home (yes/no) as another covariate because a previous study found that not having access to a medical home was associated with lower preventive dental visits and more unmet dental needs.<sup>16</sup>

## Statistical Analyses

Descriptive statistics were conducted to estimate frequencies and weighted percentages for all variables. An adjusted multivariate logistic regression model was run to test the association

NSCH	National Survey of Children's Health
BMI	Body mass index
FPL	Federal poverty level

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**Table I.** Adolescent characteristics stratified by difficulty with dental caries in the past 12 months

	Overall (%) (n = 111 910)	Experienced difficulty (%)	Did not experience difficulty (%)
Age, years			
10-13	50	12	88
14-17	50	11	89
Sex			
Male	51	12	88
Female	49	11	89
Race/ethnicity			
Hispanic	26	13	87
Non-Hispanic White	51	10	90
Non-Hispanic Black	14	13	87
Other	9	11	89
Highest Education level in household			
Less than high school education	11	18	82
High school or GED	20	13	87
Some college or technical school	22	13	87
College degree or higher	47	8	92
FPL			
0%-99%	16	17	83
100%-199%	18	14	86
200%-399%	24	10	90
≥400%	42	9	91
Type of insurance coverage			
Public only	28	16	84
Private only	60	8	92
Private and public	4.6	15	85
Insurance type not specified	0.3	16	84
Not insured	7.1	19	81
Access to medical home			
Yes	46	9	91
No	54	13	87
Dental visit in the past 12 months			
Yes	89	11	89
No	11	14	86
Weight status			
Underweight	6	14	86
Normal weight	62	10	90
Overweight/obese	32	12	88
Difficulty experienced with dental caries in past 12 months			
Yes	11		
No	89		

Values are percent.

between being underweight and experiencing difficulty with dental caries. All covariates were included in the model. Analyses were conducted using Stata Version 18.5 (StataCorp, College Station, TX), with the sampling plan and weights provided to account for the NSCH's complex sampling design and to generate nationwide population estimates.

## Results

The sample was distributed evenly by age and sex (Table I). Most adolescents were non-Hispanic White (51%), from a household where the highest level of education was a

**Table II.** Multivariable logistic regression model of experiencing difficulty with dental caries in the past 12 months in adolescents aged 10-17 years

	Difficulty with dental caries in the past 12 months	
	aOR (95% CI)	P value
Weight status		
Underweight	1.37 (1.12-1.66)	<b>.002</b>
Overweight/obese	1.01 (0.89-1.15)	.83
Normal weight	[Reference]	
Age, years		
10-13	1.21 (1.08-1.35)	<b>.001</b>
14-17	[Reference]	
Sex		
Female	0.94 (0.84-1.06)	.31
Male	[Reference]	
Race/ethnicity		
Hispanic	0.92 (0.79-1.07)	.29
Non-Hispanic Black	0.98 (0.82-1.18)	.87
Other	0.99 (0.86-1.16)	.99
Non-Hispanic White	[Reference]	
Highest education level in household		
Less than high school education	1.54 (1.21-1.97)	<b>&lt;.0001</b>
High school or Graduation Education Diploma	1.22 (1.05-1.43)	<b>.01</b>
Some college or technical school	1.31 (1.15-1.50)	<b>&lt;.0001</b>
College degree or higher	[Reference]	
FPL		
0%-99%	1.23 (0.99-1.51)	.06
100%-199%	1.09 (0.91-1.31)	.35
200%-399%	1.08 (0.94-1.25)	.27
≥400%	[Reference]	
Type of insurance coverage		
Public only	1.69 (1.46-1.97)	<b>&lt;.0001</b>
Private and public	1.87 (1.43-2.44)	<b>&lt;.0001</b>
Insurance type not specified	1.99 (0.57-6.98)	.28
Not insured	1.97 (1.56-2.50)	<b>&lt;.0001</b>
Private only	[Reference]	
Dental visits in the past 12 months		
Yes	1.01 (0.83-1.24)	.96
No	[Reference]	
Access to medical home		
No access to a medical home	1.19 (1.06-1.34)	<b>.003</b>
Yes	[Reference]	

Bold indicates significant associations.

college degree and higher (47%), and with ≥400% FPL (42%). Almost 60% had private insurance, with nearly 90% having had a dental visit the past year and 46% having had access to a medical home. Most adolescents had a healthy (normal) weight (62%); 32% were overweight/obese, and 6% were underweight. Only 11% had chronic difficulty with dental caries in the past 12 months.

Only 10% of adolescents with normal weight experienced difficulty due to dental caries. In comparison, 12% of adolescents who were overweight or obese and 14% who were underweight experienced difficulty due to dental caries (Table I). The prevalence of experiencing difficulty due to dental caries ranged from 8% to 19%. The lowest was observed in adolescents with private health insurance (8%) and from households where the level of education was a college degree or higher (8%). The highest was observed among those with no insurance (19%).

After adjusting for other covariates (age, gender, race/ethnicity, type of health insurance coverage, parent's education level, FPL, dental visit, and access to medical home), the regression model showed that being underweight was significantly associated with experiencing difficulty due to dental caries in the previous year (aOR, 1.37; 95% CI, 1.12-1.66;  $P = .002$ ) (Table II). No significant associations between being overweight or obese and experiencing difficulty due to dental caries in the previous year were observed.

## Discussion

Using nationally representative data, we specifically tested if there was a significant association between being underweight and dental caries experience in the past 12 months. Our research found that being underweight was significantly associated with dental caries among adolescents. We specifically explored underweight status and its association with dental issues because previous studies have primarily focused on overweight and obesity.<sup>17</sup> As the prevalence of overweight and obesity increased in the US among children and adolescents, low body mass or underweight has been overlooked.<sup>17,18</sup> Second, previous studies unintentionally used combined BMI classes to characterize body weight status. For instance, several studies have used either a dichotomous variable (obesity/overweight vs no obesity/overweight) or combined the healthy weight (5th-85th percentile) and underweight (<5th percentile) subcategories into 1 category, but not the obese and overweight subcategories to study the association between BMI status and dental caries experience, thereby missing the opportunity to study the risk of dental caries in children and adolescents who were underweight.<sup>19-21</sup> One study of 127 children in Alabama found that when a model-compatible 4-level BMI variable was used, children with underweight were 4 times more likely to have dental caries than children who were of normal weight, but yielded no associations when a dichotomous categorization of BMI or continuous BMI variable were used.<sup>22</sup>

We used a 3-level NSCH-approved BMI variable (overweight/obesity, normal weight, underweight) to understand the association between underweight and dental caries experience among adolescents aged 10-17 years using nationally representative data. We believed identifying the relationship between underweight and dental caries experience, if any, was essential. Children and adolescents who are underweight experience a myriad of health problems, some of which may also be related to poor oral health, such as malnutrition. Untreated dental caries in these children cause tooth pain, further leading to poor eating habits and sleep quality, in turn hampering proper growth and development.<sup>23</sup>

We chose adolescents 10-17 years old and not children <10 for a few reasons. The prevalence of underweight is highest in adolescents 12-19 years old (4.7%), followed by 6-11 years old (3.6%), and 2-5 years old (3.4%).<sup>24</sup> National data also show that adolescents aged 12-19 years experience the highest prevalence of dental caries (56.8%) compared with children

aged 6-11 years (17.4%) or 2-5 years (23.3%).<sup>25</sup> Coincidentally, NSCH collected BMI data only for adolescents aged 10-17 and not for children 0-9 years.

Similar to a prior study, we found that adolescents who did not have access to a medical home were at significantly higher odds of experiencing difficulty with dental caries than those with access to a medical home.<sup>16</sup> However, the mechanism by which how accessing a medical home decreases the likelihood of experiencing dental caries is unknown and must be investigated further. The US Preventative Services Task Force's preventive care recommendations for preventing caries are based on primary care recommendations and the presence of a primary care home.<sup>26</sup>

Age, parental education, and insurance type were associated with dental caries experience. These findings were expected. However, FPL and dental visits in the past year were not predictors of dental caries experience. In a previous NSCH study, authors reported similar findings about FPL and dental caries experience.<sup>27</sup> Although dental visits did not impact dental caries experience, a greater proportion of the sample had a dental visit the previous year. Dental professionals are uniquely positioned and, therefore, must take the opportunity to assess nutritional risk, estimate BMI, provide nutritional counseling, and refer adolescents who are at-risk, overweight, or underweight to an appropriate healthcare specialist.<sup>28</sup>

Evidence shows that enamel hypoplasia or defects in the permanent teeth of adolescents are highly associated with malnutrition-related exposures in early childhood,<sup>29</sup> and permanent teeth with enamel defects are prone to dental caries development.<sup>30</sup> Although this makes malnutrition a distal risk factor for dental caries experience, we recommend further investigating the relationship between being underweight and dental caries.

Despite the robust sample size and rigorous analysis accounting for many possible confounders, several limitations must be considered. Recall bias and under-reporting could exist because data collection relies on proxy reports from parents. Parents' perceptions of dental health may vary, which could impact the accuracy of the findings. The question that assessed difficulty owing to dental caries experience could have missed capturing children with dental caries but without difficulty inadvertently, leading to an underestimation of dental caries prevalence. Because of the cross-sectional nature of the study data, we cannot establish causality between BMI and dental caries.

In summary, we found that underweight status was associated with dental caries in this sample of adolescents. The results of our study highlight the relevance of the American Dental Association recommendation that dental professionals be knowledgeable in nutritional science and skilled in performing motivational counseling to empower their patients to adopt healthy dietary patterns and eat a balanced diet.<sup>31</sup> ■

## CRedit authorship contribution statement

**Vinodh Bhoopathi:** Writing – original draft, Validation, Supervision, Project administration, Methodology,

Investigation, Conceptualization. **Paula Ortega-Verdugo:** Writing – review & editing, Validation, Methodology, Investigation. **Christine Wells:** Writing – review & editing, Software, Methodology, Formal analysis, Data curation. **Honghu Liu:** Writing – review & editing, Validation, Supervision, Project administration, Methodology, Investigation.

## Declaration of Competing Interest

The authors declare no conflicts of interest.

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