

# Barriers To Oral Health Among U.S. Children with Developmental Disorders: A Population-Based Study

Raghad Obeidat (✉ [obeidatr85@gmail.com](mailto:obeidatr85@gmail.com))

Texas A&M Health Science Center

**Amal Noureldin**

Texas A&M Health Science Center

**Anneta Bitouni**

Texas A&M Health Science Center

**Hoda Abdellatif**

Texas A&M Health Science Center

**Shirley Lewis-Miranda**

Texas A&M Health Science Center

**Shuling Liu**

Texas A&M Health Science Center

**Victor Badner**

Albert Einstein College of Medicine

**Peggy Timothé**

Texas A&M Health Science Center

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## Research Article

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# Abstract

## Background

Children with developmental disorders (DD) have higher rates of oral diseases and tooth decay compared to the general population. Despite that, they often face more barriers to access the needed health care, especially dental care. This study aims to describe the oral health needs (OHN), utilization of dental services, and unmet dental needs of children with developmental disorders (DD) compared to children without developmental disorders (DD); and to assess the impact of access to healthcare factors on the oral health of children with DD.

## Methods

This cross-sectional study utilized a sample of 30,530 noninstitutionalized children from the 2018 National Survey of Children's Health (NSCH). Descriptive and inferential statistics were used to compare and analyze healthcare barriers in children with and without OHN.

## Results

Overall, there were 6,501 children with DD compared to 24,029 children without DD. A significantly higher proportion of children with DD relative to children without DD were found with OHN (20.3% vs. 12.2%, respectively), unmet dental needs (3.5% vs 1.2%), and utilization of any dental visits (86.1% vs 76.1%), (P-value < .001). The adjusted logistic model found that poverty (< 100% of the Federal Poverty Level (AOR = 2.27, CI: 1.46–3.51), being uninsured (AOR = 2.12, 95% CI: 1.14–3.95), a great deal of disability (AOR = 1.89, CI: 1.23–2.78), and living in the West (AOR = 1.61, CI: 1.09–2.37) contributed to the largest odds of OHN among children with DD.

## Conclusion

Despite the high utilization of dental services, children with DD had poor oral health and more unmet dental needs compared to children without DD. Advocacy efforts and policy changes are needed for the development of an integrated model of care that addresses health insurance, poverty and considers children's levels of disability.

## Background

Children with developmental disorders/disabilities (DD) are a subgroup of Children with Special Health Care Need (CSHCN) who have various physical, behavioral, and cognitive limitations that affect their abilities to perform daily living activities, including maintaining their oral health (1). Research has indicated that children with DD have higher rates of oral diseases and tooth decay compared to the

general population (2–4). Despite that, they often face more barriers to access the needed health care, especially dental care, and end up having a higher rate of unmet dental needs (3, 5, 6). In fact, the burden of oral disease among children with DD and their families is significant (2, 3, 7). High caries risk and caries burden were reported in a recent study conducted in North Carolina measuring caries risk among different groups of CSHCN (8). In another study that described the oral health status and access barriers to dental care among CSHCN in Massachusetts, Nelson et al. found that the oral health status of 20% of the study's sample was reported as fair or poor (4).

Moreover, several studies have concluded that those with DD had higher unmet dental needs than their counterparts (4, 9, 10). For example, Lida et al. found higher unmet dental care needs for CSHCN compared to their counterparts, especially teenagers, children in poverty, uninsured or with insurance gaps, and those who have been severely affected by their conditions. Their study indicated that poor CSHCN and those who have been severely affected by their conditions had 13.4 times the odds of unmet dental needs (9).

Given the increasing prevalence of DD in children (11) and higher unmet dental needs among children with DD, a lot of studies have been conducted to examine factors impacting the oral health among children with DD (4, 12–15). Individual-level factors for oral diseases, such as a diet high in sugar, dependence on caregivers for oral hygiene, and sugary medications or medications that impair saliva's excretion, have been found to play an important role in poor oral health among CSCHN (2, 4, 15).

Access to healthcare and its related factors are also reported to influence the oral health of CSHCN. According to the National Academy of Medicine (NAM), access to healthcare is an umbrella term that refers to factors centering on the degree to which individuals and populations can obtain the needed health services from the healthcare system. Access to healthcare is measured by three indicators: barriers (structural, financial, and personal), utilization (visits and procedures), and outcomes (health outcomes and equity) (16). Utilization of health services is often reported among healthcare-related factors that influence oral health among CSHCN (3, 15, 17). Craig et al. found that CSHCN enrolled in Medicaid were less likely to use preventive dental care than children without SHCN (18).

Sarkar et al found that CSHCN with Medicaid had more unmet dental needs and were less likely to have excellent oral health than CSHCN with private insurance (19). Sannicandro et al (10) found that CSHCN had barriers to obtain dental care and ended up having unmet dental needs. CSCHN who had moderate (OR = 1.74,  $p < 0.001$ ) and consistent disability (OR = 2.30,  $p < 0.001$ ) were more likely to have unmet dental needs. CSHCN were more likely to have unmet dental needs if they live with one biological and one stepparent (OR = 1.42,  $p < 0.01$ ), live in a single-parent household (OR = 1.29,  $p < 0.01$ ), or with no health insurance (OR = 3.74,  $p < 0.001$ ). Unmet dental needs were also associated with poverty. CSHCN were less likely to have unmet dental needs if they live in families between 200 and 399 % of the federal poverty level (OR = 0.68,  $p < 0.001$ ) or above 400 % of the federal poverty level (OR = 0.33,  $p < 0.001$ ).

Research also found that unmet needs were higher in regions with greater health professional shortage areas and in regions with greater poverty (12). Paschal et al in a study to assess regional differences for

unmet dental needs among CSHCN found that CSHCN live in the West region were more likely to have more unmet needs for preventive and specialized dental care than the reference region (Northeast). The South region followed the West region (12).

Research identified barriers of access to dental care among children with DD (20–22). However, to what extent these barriers impact oral health of children with DD remains unknown. Most of the literature only addresses the oral health of children with individual disorders such as Autism Spectrum Disorders (ASD) and Down Syndrome (DS) or as a broad group of CSHCN with its heterogeneity of health conditions. Because of the broad variety of disorders covered by the term CSHCN, it is challenging to provide guidelines and recommendations regarding dental care for CSHCN. Thus, clinical and comprehensive public health research on the oral health of children with DD is still scarce (5). This study attempts to investigate the impact of access to healthcare-related factors on the OHN of children with DD at the national level in the U.S. This study has the following objectives: 1) To describe the OHN, utilization of dental health services, and unmet dental needs of children with DD compared to children without DD; and 2) To investigate the impact of access to healthcare-related factors on the oral health of children with DD.

## Methods

This study was conducted between December 2019 to June 2020. The National Survey of Children's Health (NSCH) data were employed. NSCH is a screening for various developmental disorders that provides data on different, intersecting aspects of children's lives including physical and mental health, parental health, access to health care, and the family, and social environment (23). NSCH included completed interviews of a representative national sample of non-institutionalized children aged 0–17 years and an average of 520–796 participants per individual state (23). The survey was conducted as a mail and web-based survey administered by the Data Research Center (DRC) with a partnership of Maternal and Child Health Bureau and Census Bureau. The 2018 NSCH data are publicly available on the Census Bureau's NSCH page. Further information on sample methodology and selection is on the DRC website ([childhealthdata.org](http://childhealthdata.org)).

Institutional Review Board of Texas A&M University examined the proposal of this study and deemed this project is not research involving human subjects as defined by the Department of Health and Human Services (DHHS) and Food and Drug Administration (FDA) regulations. A representative sample of 30,530 noninstitutionalized children aged 0–17 years from the 2018 NSCH was included in this study. Children with DD were identified based on the DD definition described by the American Academy of Pediatrics (AAP) (1, 24, 25). The child was included in the DD group if he/she had any or a combination of the following: Autism Spectrum Disorders (ASD), Down Syndrome (DS), Attention Deficit Disorders (ADD/ADHD), Cerebral Palsy (CP), Intellectual Disability (ID), epilepsy, Tourette syndrome, developmental delay, learning disability, behavioral and conduct disorders, and speech disorder.

**Study Variables:** To investigate access to healthcare-related factors on the oral health of children with DD, we utilized the model of access to healthcare by the NAM (16). Thus, we included the following indicators

in our theoretical framework: Utilization of dental services, barriers of access to healthcare (personal, financial, and structural), and outcomes variables (OHN and unmet dental needs). Specifically, the utilization of dental services was analyzed using questions regarding annual dental provider visits and annual preventive visits in the NSCH. Any annual dental provider visit was further collapsed into two groups: “Yes, saw a dental provider” and “No, did not see a dental provider during the past 12 months”. For annual preventive visit, we used the survey’s question: “during the past 12 months, if a child saw a dental provider for preventive dental services such as check-ups, cleaning, sealants, and fluoride treatment?” We classified the children into two groups: “No, did not see a dental provider for a preventive visit” and “yes, saw a dental provider once or twice within the past 12 months”.

As to access to healthcare barriers, for the personal barriers, we measured the extent of disability which was developed from parents’ responses to two questions in the NSCH: “Health condition affected ability-How often” and “Health condition affected ability -Extent”. Ability was defined as the child’s ability to do things other children his or her age do. If parents responded that their child’s health condition had no impact on his/her ability, the child was categorized as “never” for the extent of the disability. If they responded as “yes” the health condition affected their child’s ability somehow, they were asked to describe the extent into three categories: Very little, somewhat and a great deal. Accordingly, the extent of the disability variables included four groups: Never, very little, somewhat, and a great deal.

For the financial barriers, since no question was asked about dental insurance, “health insurance coverage within the past 12 months” was used as a proxy and includes two categories: Insured all 12 months and uninsured all 12 months. The health insurance types were further divided into four categories: Public, private, public and private, and uninsured. Four categories for the Federal Poverty Level (FPL) were used to indicate income/poverty level: 0–99%, 100–299%, 300–399%, and 400% and above. In terms of structural barriers, two variables were used for geographic location: residence (metropolitan and non-metropolitan) and Census Bureau regions. Standard Metropolitan statistical area is defined as a core with a population of at least

50,000. In the NSCH, since child’s state of residence was collected as Federal Information Processing Standard State Code “FIPS”, using the Census Bureau Regions Classification, we created four categories for the Census Bureau regions: Northeast (e.g. NY, PA, NJ), Midwest (e.g. OH, MN, MI), South (e.g. TX, FL, MS), and West (e.g. CA, OR, WA).

Our dependent variable is the perceived OHN, which is a dichotomous variable that we developed from parents’ responses to the questions regarding if their child had any of the following oral conditions during the past 12 months: cavities, bleeding gum, and/or toothache. If the parents’ response was “yes” to any of these conditions, the child was classified as having OHN. The other outcome variable is unmet dental needs through the question: “During the past 12 months, was there any time when this child needed healthcare, but it was not received?”. If parents’ response was “yes”, parents asked to choose from a list of health care services (medical, dental, mental, hearing, and vision) that a child needed but not received.

Additionally, covariates such as age, race/ethnicity, family structure, guardian education, and household language were developed from items present in the NSCH. Age was developed from a continuous variable (0–17) into three categories based on a phase of dentition: <6 years old (primary), 6–12 years old (transitional), and 13–17 years old (permanent). Race/Ethnicity was developed from two variables race and ethnicity to provide 5 racial/ethnic categories: Whites, African Americans or Blacks, Hispanics, Asians, and Others. Family structure was collapsed into three categories: Two parents, single mother, and others. Guardian education included two categories: Less than high school or high school and some college or higher. Household language was classified into 2 groups: English and non-English.

## **Statistical Analysis**

Data were analyzed with IBM SPSS software, version 26. Descriptive statistics and bivariate analysis (Chi-square test) were used to compare oral health status, unmet dental needs, and utilization of dental services between children with and without DD. Additionally, frequency tables were used to summarize sociodemographic factors and factors related to access to health care for our sample of children with DD stratified by OHN status. Multi-variable logistic regression analysis was conducted to examine the association between OHN and each variable related to access to healthcare.

To ensure proper variance estimation, statistical estimates were calculated for the complex sample design (to adjust clustering, stratification, and non-response). For the analysis, all variables were weighted to represent the population of non-institutionalized children 0–17 nationally. The child's weight was composed of a base sampling weight, adjustments for both screener and topical nonresponse, an adjustment for the selection of a single child within the sample household, and adjustments used to control to population counts for various demographics obtained from the 2017 American Community Survey (ACS) one-year data. All percentages, confidence intervals (CI), and p values reflect the sampling weights and are thus generalizable to nationally representative estimates. Adjusted Odds Ratio (OR) and 95% CI were reported.

## **Results**

From the 30,530 completed interviews for all children in the 2018 NSCH, we identified 6,501 children with DD. In terms of the characteristics of the children with DD, there were more likely to be: males (64.1%), school-age children (66.3%), Whites (53.1%), live with guardians who had some college or more education (69.5%), English speaking (91.8%), two-parent family (74.0%), with income above 200% FPL (55.3%), live in metropolitan areas (73.7%) and resided in the South region (40.4%). More than half of them (58.5%) had not been affected by their condition.

## **Oral Health Status and Unmet Needs**

In terms of oral health status, dental cavities are the most prevalent oral diseases among our sample. The prevalence of cavities is 16.7% among children with DD compared to 9.9% for children without DD. For children with bleeding gums, the prevalence of children with DD and those without are 3.5% and 1.5%,

respectively. Moreover, the prevalence of toothache among children with DD and those without are 7.2% and 4.1%, respectively. A significantly higher proportion of children with DD relative to children without DD were found for OHN (20.3% vs. 12.2%, respectively,  $P < .000$ ; Fig. 1). Furthermore, 3.5% of children with DD compared to 1.2% of children without DD reported having needed health care that was not received (unmet dental need) (Fig. 1). Although the rate of unmet dental needs is relatively low, it is more than twice that for children with DD compared to children without DD.

A higher proportion of children with DD relative to children without DD was found to utilize any dental services in the past 12 months (86.1% vs 76.1%  $P < 0.000$ ) (Fig. 1). However, there was no difference for preventive dental preventive visits between those with and without developmental disorders (96.8% vs. 96.5%,  $P = .639$ ).

For our sample of children with DD, our bivariate analysis shows no association between OHN and any dental provider visit (86.9.1% vs 85.9.1%,  $P = .643$ ) nor preventive dental visit (96.9% vs 96.7%,  $P = .866$ ) (Table 1).

Table 1  
 Characteristics of Children with DD Stratified by Parent's Reported Oral Health Needs Status, n = 6501

	All % (weighted)	With oral health needs (18.3) (weighted%) (weighted)	Without oral health needs (81.5 %)	P- value
Characteristics of child				
Sex of child				.229
Male	64.1	67.1	63.4	
Female	35.9	32.9	36.6	
Age of Child				.000
< 6 years old (primary dentition)	16.4	11.3	17.7	
6–12 years old (transitional dentition)	49.9	60.6	47.2	
13–17 years old (permanent dentition)	33.7	28.1	35.2	
Race of child				.603
White	53.1	50.9	53.7	
African American or Black	14.7	14.3	14.8	
Hispanics	23.3	26.5	22.5	
Asian	2.3	2.6	2.3	
Other	6.5	5.8	6.7	
Primary language				.122
English	91.8	88.6	92.6	
Non-English	8.2	11.4	7.4	
Family/ Household Characteristics				
Guardian education				.000
Less than high school or high school	30.5	39.5	28.2	
Some college or more	69.5	60.5	71.8	
Family Structure				.151
*All percentages are weighted				

	All % (weighted)	With oral health needs (18.3) (weighted%) (weighted)	Without oral health needs (81.5 %)	P- value
Two parents	74.0	70.0	75.0	
Single mother	22.7	26.4	21.7	
Other	3.3	3.6	3.3	
Federal Poverty/income level				.000
0–99% federal poverty level	20.9	31.0	18.4	
100–199% federal poverty level	23.7	26.8	22.9	
200–399% federal poverty level	26.5	23.1	27.4	
400% federal poverty level or above	28.8	19.1	31.3	
Residence				.008
Metro	73.7	70.2	74.6	
Non-Metro	11.5	15.6	10.5	
Non-disclosed	14.8	14.2	14.9	
Census Bureau Regions				.389
Northeast	16.0	14.4	16.5	
Midwest	20.7	19.0	21.1	
South	40.4	40.5	40.4	
West	22.8	26.1	22.0	
Any Dental Visit	86.1	86.9	85.9	.643
Preventive dental visit	96.8	96.9	96.7	.866
Disability extent				.001
Never	58.5	48.9	61.0	
Very little	11.8	13.6	11.3	
<b>Table 1 Continued</b>				
Somewhat	21.2	25.0	20.2	

\*All percentages are weighted

	All % (weighted)	With oral health needs (18.3) (weighted%) (weighted)	Without oral health needs (81.5 %)	P- value
A great deal	8.5	12.5	7.4	
Health Insurance Coverage (Past 12 months)				.001
Insured	91.4	86.6	92.7	
Uninsured	8.6	13.4	7.3	
Health insurance Type				.000
Private	51.0	38.1	54.3	
Public	36.8	46.3	34.4	
Public and private	6.5	8.0	6.1	
Not insured	5.6	7.6	5.2	
*All percentages are weighted				

## Barriers to Oral Health by Children with DD

For the **financial barriers**, a statistically significant difference was found for health insurance coverage between DD children with and without OHN. For DD children with OHN, 86.6% were insured the entire past 12 months compared to 92.7% for DD children without OHN ( $P < .001$ ). Children who were uninsured the entire past 12 months were more likely to have OHN. The type of health insurance was also significantly associated with OHN ( $P < .001$ ). DD children with private insurance had a lower proportion of OHN compared to children with public insurance (38.1% vs 46.3%). Furthermore, DD children with both private and public health insurance were more likely to have OHN (8.0% vs 6.1% for with and without OHN, respectively). A significant difference was also found for poverty levels between DD children with and without OHN ( $p < .001$ ). Among DD children with OHN, 80.9% of them were below the 400% FPL compared to 68.7% for DD children without OHN.

For the **structural barriers**, differences existed in OHN among children with DD by residence location: 70.2% of DD children with OHN lived in metropolitan areas whereas 74.6% without OHN and for non-metro areas: 15.6% with OHN compared to 10.5% without OHN ( $P < .008$ ). The residence by Census Bureau regions was not significantly associated with OHN ( $P = .389$ ). Overall, the highest percentage of DD children with OHN lived in the South, and the

lowest lived in the Northeast (40.5% vs to 14.4%). However, DD children who live in the West had a higher proportion of OHN (26.1% for OHN vs. 22.0% without OHN). In contrast, fewer DD children with OHN live in the Midwest (19.0% for OHN vs 21.1% for without OHN).

For **personal barriers**, we found that DD children whose condition affected their ability somewhat or a great deal to do things than normal children usually do have higher proportions of OHN compared to children without OHN (25.0% vs. 20.2% for somewhat and 12.5% vs. 7.4% for a great deal,  $P < .001$ ). However, a higher proportion of DD children without OHN was found among children whose condition did not affect their ability (61.0% vs 48.9% for without OHN and with OHN respectively,  $p < .000$ ).

When we examined the association between OHN among children with DD and various potential predictive variables including sociodemographic variables and access to healthcare barriers through multivariable regression analysis (Table 2), we found that elementary school children (aged 6–12 years) had higher adjusted odds of OHN (AOR: 1.88, 95% CI: 1.21–2.93). We also found that children living in the West region had a statistically significant higher odds of OHN compared to those living in the Midwest (AOR: 1.61, 95% CI: 1.09–2.37).

Table 2  
Adjusted Odds Ratios and 95% Confidence Intervals Predicting Likelihood of  
OHN Among Children with DD

<b>Variable</b>	<b>Point Estimate</b>	<b>95% CI</b>
Disability severity		
Never	Referent	
Very little	1.48	.99–2.21
Somewhat	<b>1.43</b>	<b>1.06–1.94</b>
A great deal	<b>1.89</b>	<b>1.23–2.78</b>
Health Insurance Coverage (past 12 months)		
Insured	Referent	
Uninsured	<b>2.12</b>	<b>1.14– 3.95</b>
Health insurance Type		
Private	Referent	
Public	1.16	.82–1.62
Public and private	1.33	.86–2.05
Not insured	.66	.23–1.51
Poverty income level		
0–99% federal poverty level	<b>2.27</b>	<b>1.46–3.51</b>
100–199% federal poverty level	<b>1.58</b>	<b>1.07– 2.33</b>
200–399% federal poverty level	<b>1.44</b>	<b>1.01–2.04</b>
400% federal poverty level or above	Referent	
Census Bureau Regions		
Northeast	1.18	.77–1.81
Midwest	Referent	
South	1.11	.83– 1.50
West	<b>1.61</b>	<b>1.09–2.37</b>
Residence		

\* Other include single father, grandparent household, and other relation

**Bold indicates significance.**

<b>Variable</b>	<b>Point Estimate</b>	<b>95% CI</b>
Metro	Referent	
Non-Metro	<b>1.42</b>	<b>1.02–1.99</b>
Non-Disclosed	.96	.71–1.29
Characteristics of the child/Parents		
Table 2 <b>continued</b>		
Age		
< 6 years old	Referent	
6–12 years old	<b>1.88</b>	<b>1.21– 2.93</b>
13–17 years old	1.22	.78– 1.90
Race/Ethnicity		
White	Referent	
African American or Black	.68	.45–1.06
Hispanics	.84	.55–1.26
Asian	1.19	.59–2.41
Other	.66	.47 – .95
Guardian Education		
Less than high school or high school	1.18	.87– 1.61
Some college or more	Referent	
Household language		
English	Referent	
Non-English	1.21	.61–2.42
Family structure		
Two parents	Referent	
Single mother	1.10	.82– 1.48
Other*	1.14	.63–2.08
* Other include single father, grandparent household, and other relation		
<b>Bold indicates significance.</b>		

Children who lived in families with income less than or equal to 400% FPL had higher adjusted odds of OHN than those who lived in families with income greater than 400% FPL. A statistically significant trend was found for higher adjusted odds of OHN with an increasing level of poverty ( $P < .000$ ). DD children who were uninsured had higher odds of OHN than DD children who were insured the entire past 12 months (AOR = 2.12, 95% CI: 1.14–3.95). However, for DD children who had public health insurance or both public and private health insurance, the results were not statistically significant. Lastly, DD children who had been affected by their conditions a great deal had higher adjusted odds of OHN than those who had been affected somewhat by their condition (AOR = 1.89, 95% CI: 1.23–2.78 and AOR = 1.43, 95% CI: 1.06–1.94, respectively).

## Discussion

This study is the first to investigate the impact of barriers to access to dental healthcare on the OHN of a representative sample of U.S. children with DD at the national level. Overall, we found that children with DD had higher OHN and unmet dental needs compared to children without DD. Further, use of dental services as measured by dental visits was found not associated with OHN among children with DD. Poverty, health insurance coverage, urbanicity, residence by census regions, and the level of disability are barriers found to be associated with OHN and access to healthcare. Our adjusted logistic model found that being uninsured, poor ( $< 100\%$  FPL), and having great disability had the greatest impact on the OHN among children with DD.

Dental caries and periodontal diseases are prevalent oral diseases among U.S. children with DD (4, 8, 26–28). Our results of a higher prevalence of oral diseases among children with DD compared to children without DD are consistent with most of the studies in the literature that investigated oral health status among children with DD.

## Utilization of Dental Health Services and Unmet Dental Needs:

Our results of the high use of any dental services among children with DD are consistent with the finding of Lida et al. who found that CSCHN used more dental care services and were more likely to receive only nonpreventive care than their counterparts(29). This is also confirmed by our finding of a non-significant difference for the use of preventive dental care between children with DD compared to children without DD. In the present study, although children with DD had higher OHN than their counterparts, utilization of dental services was not the culprit. There was no significant association between OHN and either any dental visit use and preventive dental visit use among our sample of DD children. This finding is consistent with the results of Nelson et al and Lida et al. regarding utilization of dental services for the CSCHN (4, 9).

The rate of unmet dental needs among children with DD is three times that among children without DD. It was also found that the rate of unmet needs among children with DD at the national level (2.4%) was

lower than the rate of unmet needs (20%) of the study conducted by Nelson et al. in Massachusetts (4). Moreover, our unmet needs rate among children with DD (2.4%) was also lower than the rate of unmet dental needs among CSHCN (8.9%) that was reported by Lewis et al. (15) using the 2006 NSCH. The discrepancies could be explained by the improvement made in meeting the needs of CSHCN such as services offered through Title V Maternal and Child Health Services Block Grant Program for CSHCN (30).

### **Access to healthcare barriers**

In the present study financial, structural, and personal barriers were investigated in their association with OHN among children with DD.

## **Financial barriers**

### **Health Insurance and Poverty**

Children with DD living in poverty and being uninsured were more likely to have OHN, and this is consistent with the literature (4, 10, 15, 17, 31, 32). A trend of increased OHN with an increased level of poverty was found in our study. Our results of higher odds of OHN with increasing levels of poverty are consistent with Nelson et al. (4), Lewis et al (15), and Sannicandro et al (10) results regarding poor oral health and greater unmet needs for CSHCN from low-income families. We also found public health insurance covers a large segment of children with DD (36.8%), nevertheless, the type of health insurance was not associated with increased odds of OHN. Our finding is consistent with Lewis et al. (15) who found public insurance such as Medicaid and CHIP was not associated with unmet dental needs after adjusting for other confounding factors. That is also confirmed in McManus et al. study (14) where no association between public health insurance eligibility and unmet preventive care needs was reported.

### **Structural Barriers**

Geographic location by Census regions also contributes to the higher odds of OHN among children with DD. Although a higher number of children with DD was found in the South, children living in the West had the highest OHN (1.61 higher odds of OHN compared to the Midwest). This finding is consistent with the results of a study conducted by Paschal et al. (2016) (12), in which the outcome variable was unmet preventive dental needs.

Urbanicity also plays a role in OHN among children with DD in our study. Higher odds of OHN was found among DD children live in non-metropolitan areas (1.42, 95% CI: 1.02–1.99). This is consistent with what Skinner et al. (2006) found in a study that investigated the effect of rural residence on dental unmet need among CSHCN using 2005 NSCH (33). They found that CSHCN who lived in rural areas were more likely to have unmet dental needs compared to their urban counterparts.

### **Personal Barriers**

Higher odds of OHN were found among children who have been considerably affected by their condition. These results confirmed what has been reported in the literature regarding the association of condition

severity/degree of the disability and OHN or unmet needs among CSHCN (9, 13, 15). Our result is consistent with Sannicandro et al finding that CSHCN who had a moderate or consistent disability were more likely to have unmet dental needs (10). It is important to intervene early and prevent the burden of oral diseases among children with DD, particularly children whose conditions impacted their abilities. Future research to identify conditions by a medical diagnosis that adversely affect the functional ability of children with DD is essential.

The study has several limitations. First, this cross-sectional study allowed us to examine associations but not causation and temporal association was not determined. However, our findings illustrate valuable direction toward future research and targeted public health efforts toward prevention and intervention strategies for the severely affected subgroup of CSHCN. Second, our outcome variable "OHN" was collected through parents' self-reported data, which is subjected to various bias such as recall, reporting, and social desirability bias. No verification of oral health by professional providers was conducted. Another limitation is we used health insurance as a proxy for dental health insurance since there was no question in the survey about dental insurance. Generally, the percentage of children without dental insurance is twice of children without medical insurance (34, 35). Thus, using health insurance is a suboptimal substitute. Last, there was no verification of the parents' reported diagnosis of the developmental disorders among respondents to the survey. However, there is a notable consistency of the prevalence of individual DDs between the results of the NSCH and other nationally representative surveys, such as the National Health Interview Survey (NHIS) (11).

Our study had multiple strengths, too. To our knowledge, this is the first study to measure the OHN of children with DD using a nationwide sample. Most studies investigated an individual disorder or at a broader group of CSHCN that included other medical conditions such as asthma, diabetes, blood disorders, and cancers. Although these conditions put children under the umbrella of special health care needs, they do not share a common risk of developmentally affected/delayed growth status. Second, our study also looked at the OHN of children with DD by geographic regions. Additionally, the NSCH included a large sample size of representative participants of children with DD from each state which allowed us to perform robust analysis. Our findings could help policymakers focus efforts or target populations with the highest OHN by regions or to investigate factors related to the high OHN among these populations.

## **Conclusion**

Oral health diseases are prevalent in children with DD. Despite the high utilization rate of dental care services, children with DD had poor oral health and more unmet dental needs compared to children without DD. Children with DD usually present with multiple co-morbid conditions which leads to worse oral health outcomes. The more a child was affected by his/her condition, the higher his/her oral needs. Dental treatments for these children are challenging due to multiple factors including communication and ability to behave in a way that is conducive to effective dental care. Improving the oral health and meeting the needs of children with DD is important to improve the quality of life of these vulnerable populations and reduce the burden on their families and the society. Advocacy efforts and policy changes

related to access to healthcare are needed to develop an integrated model of care with affordable access that addresses regional differences, health insurance, payment structure, and considers children's levels of disability and poverty.

## Declarations

### Ethics approval and consent to participate

Ethics approval by Institutional Review Board of Texas A&M University was not necessary according to Department of Health and Human Services (DHHS) and Food and Drug Administration (FDA) regulations. Human subjects were not directly involved in this study; only data coming from the 2018 National Survey of Children's Health were used which did not imply any additional approval requirements. Ethics approval for this study was waived by the Institutional Review Board of Texas A&M University (letter number: IRB2020-1004. Dated 14th September, 2020). All methods were carried out in accordance with relevant guidelines and regulations.

### Consent for publication

Not Applicable

### Availability of data and materials

The 2018 NSCH data are publicly available on the Census Bureau's NSCH page (<https://www.census.gov/data/datasets/2018/demo/nSCH/nSCH2018.html>).

### Competing interests

The authors declare that they have no competing interests.

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This research was not supported by any source of funding.

### Authors' contributions

RO and PT were responsible for the study design. RO was responsible for the data analysis and writing the manuscript. RO, AN, AB, HA, SM, SL, VB, PT contributed to the protocol, reviewed, and approved the final manuscript.

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## References

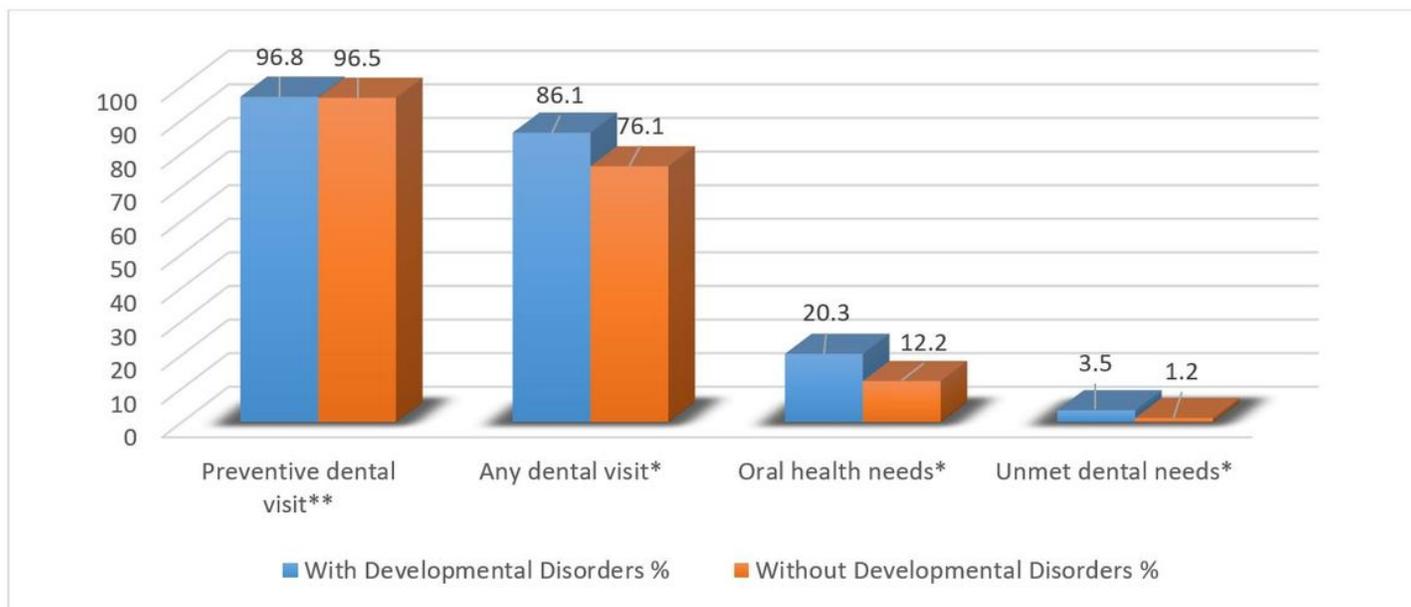
1. Centers for Disease Control and Prevention C. Facts About Developmental Disabilities 2019 [Available from: <https://www.cdc.gov/ncbddd/developmentaldisabilities/facts.html>].
2. Fisher K. Is There Anything to Smile about? A Review of Oral Care for Individuals with Intellectual and Developmental Disabilities. *Nurs Res Pract*. 2012;2012:860692.
3. Norwood KW, Jr., Slayton RL. Oral health care for children with developmental disabilities. *Pediatrics*. 2013;131(3):614–9.
4. Nelson LP, Getzin A, Graham D, Zhou J, Wagle EM, McQuiston J, et al. Unmet dental needs and barriers to care for children with significant special health care needs. *Pediatr Dent*. 2011;33(1):29–36.
5. Chi DL. Oral Health for US Children with Special Health Care Needs. *Pediatr Clin North Am*. 2018;65(5):981–93.
6. Cheak-Zamora NC, Thullen M. Disparities in Quality and Access to Care for Children with Developmental Disabilities and Multiple Health Conditions. *Matern Child Health J*. 2017;21(1):36–44.
7. Chi DL, McManus BM, Carle AC. Caregiver burden and preventive dental care use for US children with special health care needs: a stratified analysis based on functional limitation. *Matern Child Health J*. 2014;18(4):882–90.
8. Frank M, Keels MA, Quinonez R, Roberts M, Divaris K. Dental Caries Risk Varies Among Subgroups of Children with Special Health Care Needs. *Pediatr Dent*. 2019;41(5):378–84.
9. Iida H, Lewis C, Zhou C, Novak L, Grembowski D. Dental care needs, use and expenditures among U.S. children with and without special health care needs. *J Am Dent Assoc*. 2010;141(1):79–88.
10. Sannicandro T, Parish SL, Son E, Powell RM. Health care changes for children with special health care needs, 2005–2011. *Maternal and child health journal*. 2017;21(3):524–30.
11. Zablotzky B, Black LI, Maenner MJ, Schieve LA, Danielson ML, Bitsko RH, et al. Prevalence and Trends of Developmental Disabilities among Children in the United States: 2009–2017. *Pediatrics*. 2019;144(4).
12. Paschal AM, Wilroy JD, Hawley SR. Unmet needs for dental care in children with special health care needs. *Prev Med Rep*. 2016;3:62–7.
13. McKinney CM, Nelson T, Scott JM, Heaton LJ, Vaughn MG, Lewis CW. Predictors of unmet dental need in children with autism spectrum disorder: results from a national sample. *Acad Pediatr*. 2014;14(6):624–31.
14. McManus BM, Chi D, Carle A. State Medicaid Eligibility Criteria and Unmet Preventive Dental Care Need for CSHCN. *Matern Child Health J*. 2016;20(2):456–65.
15. Lewis CW. Dental care and children with special health care needs: a population-based perspective. *Acad Pediatr*. 2009;9(6):420–6.
16. Institute of Medicine (US) Committee on Monitoring Access to Personal Health Care Services; Millman M e. *Access to health care in America*: Washington (DC): National Academies Press (US);

1993.

17. Sarkar M, Earley ER, Asti L, Chisolm DJ. Differences in Health Care Needs, Health Care Utilization, and Health Care Outcomes Among Children With Special Health Care Needs in Ohio: A Comparative Analysis Between Medicaid and Private Insurance. *J Public Health Manag Pract*. 2017;23(1):e1-e9.
18. Craig MH, Scott JM, Slayton RL, Walker AL, Chi DL. Preventive dental care use for children with special health care needs in Washington's Access to Baby and Child Dentistry program. *The Journal of the American Dental Association*. 2019;150(1):42–8.
19. Sarkar M, Earley ER, Asti L, Chisolm DJ. Differences in health care needs, health care utilization, and health care outcomes among children with special health care needs in Ohio: a comparative analysis between Medicaid and private insurance. *Journal of Public Health Management and Practice*. 2017;23(1):e1-e9.
20. Ummer-Christian R, Iacono T, Grills N, Pradhan A, Hughes N, Gussy M. Access to dental services for children with intellectual and developmental disabilities - A scoping review. *Res Dev Disabil*. 2018;74:1–13.
21. Owens J, Dyer T, Mistry K. People with learning disabilities and specialist services. *British Dental Journal*. 2010;208(5):203.
22. Dougall A, Fiske J. Access to special care dentistry, part 1. Access. *British dental journal*. 2008;204(11):605.
23. Data Resource Center (DRC). About the National Survey of Children's Health [Available from: <https://www.childhealthdata.org/learn-about-the-nsch>].
24. Lipkin PH, Macias MM. Promoting Optimal Development: Identifying Infants and Young Children With Developmental Disorders Through Developmental Surveillance and Screening. *Pediatrics*. 2020;145(1).
25. Identifying infants and young children with developmental disorders in the medical home: an algorithm for developmental surveillance and screening. *Pediatrics*. 2006;118(1):405–20.
26. Jaber MA. Dental caries experience, oral health status and treatment needs of dental patients with autism. *J Appl Oral Sci*. 2011;19(3):212–7.
27. Moreira RN, Alcântara CEP, Mota-Veloso I, Marinho SA, Ramos-Jorge ML, Oliveira-Ferreira F. Does intellectual disability affect the development of dental caries in patients with cerebral palsy? *Research in developmental disabilities*. 2012;33(5):1503–7.
28. Shyama M, Al-Mutawa SA, Morris RE, Sugathan T. Dental caries experience of disabled children and young adults. *Community dental health*. 2001;18:181–6.
29. Iida H, Lewis C, Zhou C, Novak L, Grembowski D. Dental care needs, use and expenditures among US children with and without special health care needs. *The Journal of the American Dental Association*. 2010;141(1):79–88.
30. U.S. Department of Health and Human Services. Title V maternal and child health services block grant program. Retrieved April. 2017;7.

31. Berdahl T, Hudson J, Simpson L, McCormick MC. Annual Report on Children's Health Care: Dental and Orthodontic Utilization and Expenditures for Children, 2010–2012. *Acad Pediatr.* 2016;16(4):314–26.
32. Lee JN, Scott JM, Chi DL. Oral health behaviors and dental caries in low-income children with special health care needs: an observational prospective study. *Int J Paediatr Dent.* 2020.
33. Skinner AC, Slifkin RT, Mayer ML. The effect of rural residence on dental unmet need for children with special health care needs. *J Rural Health.* 2006;22(1):36–42.
34. Nasseh K, Vujcic M. Dental benefits coverage rates increased for children and young adults in 2013. Health Policy Institute Research Brief American Dental Association. 2015.
35. Vujcic M, Buchmueller T, Klein R. Dental care presents the highest level of financial barriers, compared to other types of health care services. *Health Affairs.* 2016;35(12):2176–82.

## Figures



**Figure 1**

Children's utilization of dental services, OHN, and unmet dental needs, stratified by developmental disorders status. \*P < .000 each comparison between children with and without DD: any dental visit, oral health needs, and unmet dental needs. \*\*P = .639 for preventive dental visit