How Do Diet and Body Mass Index Impact Dental Caries in Hispanic Elementary School Children?

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Abstract

Purpose: The purpose of this observational study was to examine the association between body mass index and dental caries in Hispanic children. The research evaluated the influences of obesity, diet, parent education level, family acculturation, tooth brushing habits and gender as predictors of childhood caries.

Methods: One examiner visually screened 177 third grade students from 3 elementary schools located in southern California's Coachella Valley. The children were screened for number of decayed, missing and filled teeth (DMFT). Height, weight, age and gender determined their body mass index. Primary caregivers completed a 30–point questionnaire for each participant. Multivariate analyses accessed the association between childhood dental caries and weight status and the influences of the measured variables.

Results: Results indicate that those in the obese category had a statistically significant lower rate of DMFT than did children in the healthy weight category. Overweight children showed a higher DMFT than healthy weight children but the results were not statistically significant. Covariates that significantly influenced this association were diet and socioeconomic status.

Conclusion: Results from this study provide oral health professionals with baseline data and literature to support development of preventive programs for this population that concurrently address both obesity and oral health issues in scope and design.

Keywords: dental caries, body mass index, diet, socioeconomic status

This study supports the NDHRA priority area, **Health Promotion/Disease Prevention:** How diversity among populations impacts the promotion of oral health and preventive behaviors.

Introduction

Childhood dental caries is a serious health problem. Although largely preventable, dental caries remains the most common chronic disease of children ages 6 to 11, with 41% of children in this age group experiencing decay in their primary (deciduous) teeth. Estimates are that 1 out of every 4 missed days of school are due to dental pain, predominantly caused by dental caries. Dental caries is harmful to children's growth, development and academic performance.[1]

According to the 2007 to 2008 National Health and Nutrition Examination Survey (NHANES), using measured heights and weights, 17% of children and adolescents ages 2 to 19 years were obese, and an additional 31.6% were overweight.[2] Since 1980, the number of overweight children ages 6 to 11 has doubled, and the number of overweight adolescents has tripled. Childhood obesity is currently the most prevalent nutritional condition of children in the U.S.[3]

Research results are contradictory regarding the association of childhood obesity and dental caries. This study attempted to clarify the association in a group of children from a geographic area that experiences a higher risk of both conditions.

Dental caries can lead to tooth loss, dental pain, infection and, in rare instances, death.[4–6] Childhood obesity can lead to increased risk of diseases such as type–2 diabetes and heart disease.[7] The burden both financially and physically for children experiencing dental caries and obesity places them at risk for a compromised quality of life.[8]

Children from families with an income below 199% of the federal poverty level are 3–times more likely to have their dental needs unmet than children from families 200% or above the federal poverty level. Estimates indicate that children lose approximately 52 million school hours each

year due to dental problems. Obesity and dental caries can both negatively affect a child's quality of life and ability to succeed in school.[9–11]

Research supports an association between ethnicity, obesity prevalence and dental caries experience. Data demonstrates that Hispanic children show a higher prevalence of dental caries and obesity as compared to their Caucasian counterparts.[12–14]

Both obesity and dental caries are linked to diet, making it important for studies of both conditions to assess diet. Snacking between meals, drinks containing high–fructose corn syrup or sucrose, and consumption of high–carbohydrate foods are associated with both an increase in dental caries and an increase in obesity.[15]

Women with lower educational levels are more likely to consume diets high in fat and carbohydrates.[16] These dietary choices are identified as risk factors for dental caries and increased body mass index (BMI). Women with a higher educational level make dietary choices containing more fruits and vegetables. These dietary choices are considered healthier for prevention of both dental caries and obesity in themselves and their children.[16]

In a review article by Vartanian et al, the authors evaluated the results of the effects of soft drink consumption on nutrition and health from 88 studies of subjects with varying ages.[17] Findings suggest that decreasing soft drink consumption would lower disease burden and weight gain. The results also indicate that the ingestion of fructose leads to a higher weight gain than ingestion of glucose. As a means of prevention of both dental caries and obesity, the authors suggest eliminating sugar–sweetened beverages along with paying attention to overall caloric intake.

Prior studies are unclear regarding an association between obesity and dental caries. Some research indicates a positive association,[15,18,19] while other research indicates a negative association between obesity and dental caries.[20] Still other research indicates no association between obesity and dental caries,[21–23] and some researchers report no association for younger children and a negative association for older children.[24] This study adds evidence to clarify these conflicting results.

The objective of this study was to examine the possible relationship between childhood dental caries and childhood obesity. This demographic population was chosen because previous research indicates it is a population with tendencies to exceed the average numbers of both childhood dental caries and obesity. The influence of other factors in this population, such as diet, gender, family acculturation and parents' education level and perceptions regarding oral health, were explored as covariates.

Methods and Materials

This observational study was conducted in Riverside County's Coachella Valley, located in southern California. The participants were all third grade students from 3 randomly selected elementary schools in the Coachella Valley Unified School District.[25] The residents of this geographical area are predominantly of Hispanic descent and of a low socioeconomic status (SES). Many of the residents are not fluent in English. All written materials to parents and students were provided in both English and Spanish. A total of 177 children (68 male and 109 female) were screened for decayed, missing and filled teeth (DMFT) and their height and weight were measured and BMI for age calculated. All third grade students were included in the study if they provided signed consent, parental signed consent, completed the questionnaire and were of Hispanic descent.

The participating child's parent or primary caregiver completed a 30–point questionnaire with questions ranging from dietary and tooth brushing habits to parents' perceptions about their child's weight status and dental caries rate. The questionnaire was available in both English and Spanish and pre–tested by 10 families with a translated, back–translated method, a valid and reliable tool for translation in cross–cultural research as shown in Brislin's model. Parents were also asked about their education level, family eligibility for the free or reduced–fee school lunch program and linguistic ability. Eligibility for the free or reduced–fee school lunch program was used as a proxy for determining SES. Linguistic acculturation as determined by the self–reported ability of the parent to speak, understand, read and write in English was used as a proxy for acculturation level.[26]

For consistency, 1 California registered dental hygienist performed all of the dental screenings. This was a non–invasive visual screening done with the use of a mouth mirror and illumination with Orascoptic's Zeon light (Orascoptic, Middleton, Wis.) attached to dental loupes. This screening determined the number of DMFT. No dental x–rays were used. Because this is an age group with mixed dentition, an attempt was made to

count, as missing, only those teeth that had been extracted due to decay. DMFT (restored with any method including stainless steel crowns) were included for a total count of teeth with decay experience. No distinction was made between primary and permanent teeth. In addition to the dental screening children were measured for height (cm) and weight (kg) in light clothing without shoes by 1 examiner. The gender and age were recorded for each participant.

The BMI of each participant was determined by entering the child's age, gender, height and weight into the BMI calculating tool provided by the Center for Disease Control and Prevention.[27]

The BMI and percentile standing for each of the participants were determined using this method: A number (0 to 3) was assigned correlating the percentile with the weight status of each participant. For purposes of this study, the children with a BMI that placed them in the underweight category were coded "0," the children classified as normal weight were coded "1," the children classified as overweight were coded "2" and the children classified as obese were coded "3."

Survey questions were designed to determine dietary habits, e.g. the number of snacks and number of high carbohydrate foods and drinks consumed per day. As a proxy for socioeconomic questions such as income, families who qualified for the free or reduced–fee school lunch program were considered of a low SES. Family acculturation level was determined by the self–reported ability of the parents to speak, understand, read and write in English. They were ranked from low acculturation to high acculturation level depending on their self–reported linguistic ability. Tooth brushing habits were measured as the number of times per week the child brushed before bedtime, as reported by the parent.

Statistical tests were run for 2 research questions with the dependent variable being the number of DMFT. The main independent variables of interest were BMI and diet. The covariates were gender, tooth brushing habits, SES and family acculturation. This was an observational study with quantitative data collected at 1 observation. The research questions were:

1. Is there an association between BMI and the number of teeth with dental carious lesions, and how is that association affected by the presence of other control variables, e.g. family SES and linguistic acculturation, parents' level of education, self–efficacy and perceptions regarding oral health and child's tooth brushing habits and gender?
2. Is there an association between diet and number of teeth with dental carious lesions and how is that association affected by the presence of other control variables, e.g. family SES and linguistic acculturation, parents' level of education, self–efficacy and perceptions regarding oral health and child's tooth brushing habits and gender?

A sample size was calculated through the use of the software G*Power based on a Poisson regression that models the total number of DMFT. The main independent variable of interest was assumed to be dichotomous with a 1:1 ratio. Other covariates were assumed to have R2 of 0.2 with the dependent variable. The base rate (the mean number of DMFT) was set to 4. For the desired effect size, relative rate of 1.4 (or 0.71 in the opposite direction) was used. With alpha of 0.05 (2–tailed) and power of 80%, this yielded a sample size of 74 observations. Initially, 300 students were asked to participate in the study, with the expectation of a 40% failure to provide consent, permission or complete the questionnaire. One hundred and seventy–seven participants qualified for inclusion in the study.

Data were analyzed using the SPSS v17. A double–entry method was used to make certain that data entry was accurate. Missing data were estimated using the Amos full information maximum likelihood analysis or estimating the missing values from the current data. Frequencies and percentages were performed on all categorical data and descriptive statistics performed for continuous data. Analysis was run with the use of negative binomial regression.

Results

Tables I and II show the results of frequencies and distributions of the demographic and behavioral data. In Table I, we see that 62% (n=109) of the child participants were female. The questionnaire was completed by mothers of participants 81% (n=144) of the time. Of the 177 families completing the questionnaire, 88.7% (157) qualified for the free or reduced–fee lunch program, placing their families in a low socioeconomic category. Respondents self–reported that 14.7% could not speak, understand, read or write in English (this is indicated by those answering "0" under acculturation). Thirty–six percent of the parents stated that they could speak, understand, read and write "very well" in English (this is indicated by those who answered 12 un-

Table I: Demographic Frequencies and Distributions of the Survey Respondents (n=177)

	n	%
Student's Gender		
Male	68	38.4
Female	109	61.6
Parent's Educational Level		
No school	5	2.0
Elementary only	35	19.7
Attended High School	45	25.4
Graduated HS	51	28.8
Some college	24	13.5
College grad	13	7.3
Graduate School	6	3.3
Family Eligibility for Free Lunch? (SES)		
No	20	11.3
Yes	157	88.7
Parental Acculturation		
0	26	14.6
1	14	7.9
2	3	1.7
3	3	1.7
4	20	11.3
5	4	2.3
6	9	5.0
7	6	3.4
8	20	11.3
9	4	2.3
10	1	0.6
11	3	1.7
12	64	36.2
Child's Weight Status		
Underweight	4	2.3
Healthy weight	92	52.0
Overweight	34	19.2
Obese	47	26.5
Child's Decayed, Missing, Filled Teeth		
0	41	23.2
1	13	7.3
2	17	9.6
3	18	10.2
4	23	13
5	11	6.2
6	11	6.2
7	11	6.2
8	13	7.3
9	5	2.8
10	6	3.4
11	6	3.4
12	1	0.6
17	1	0.6

Table II: Behavioral Frequencies and Distributions of the Survey Respondents (n=177)

	n	%
Last dental exam		
Never	2	1.1
6 months or <	101	57.1
12 months or <	56	31.6
24 months or <	18	10.2
Could not get care		
No	135	76.3
Yes	42	23.7
Nights brush per week		
0	20	11.3
1	15	8.5
2	14	7.9
3	22	12.4
4	31	17.5
5	75	42.4
Diet (number of carbs/day)		
4 or <	46	25.99
>4 <8	89	50.28
8<10	24	13.56
10>	18	10.17
Think most have caries		
No	46	26
Yes	131	74
Think overweight		
Strongly agree	35	19.8
Agree	57	32.2
Disagree	48	27.1
Strongly disagree	37	20.9
Think child has caries		
Don't know	30	16.9
No	60	33.9
Few	75	42.4
Many	37	6.8
Worried child overweight		
Strongly Agree	28	15.8
Agree	47	26.5
Disagree	64	36.2
Strongly Disagree	38	21.5
Worried child has caries		
Strongly Agree	35	19.8
Agree	57	32.2
Disagree	48	27.1
Strongly Disagree	37	20.9
Dental tx needs		
None	108	61
See DDS soon	49	27.7
Urgent care needed	20	11.3

der acculturation). The self–report acculturation questions were asked to determine the influence of acculturation of the family into the American diet and customs as opposed to those who have retained their cultural dietary habits.

Approximately 77% of the study participants had experienced dental caries. The national average for children of this age group is 41%. The demographic statistics also reveal that 26.6% of the study participants were classified as obese and 19.2% were classified as overweight. The national average for this age group is 17% obese and 31.6% overweight. There are more children in this study in the obese category than the national average, but the total percent of obese and overweight in this study is 45.8%, slightly less than the national average of 48.6%.

Results of the behavioral data showed that 41.8% of the children were overdue for a dental exam, and 24% of the parents responded that they felt they could not get the dental care that their child needed. They listed affordability as the reason in 30% of the cases. Forty–two percent of the parents reported that their child brushed before bed at least 5 times per week. Of the parents surveyed, 74% thought that a majority of children develop dental caries, while 26% felt they did not. In another response, 49% of the parents surveyed thought that their child had dental caries and 51% weren't sure or did not think their child had caries. These 2 variables were used as a measure of perceived seriousness and susceptibility and were answered in a dichotomous response (yes/no). Dental screening results indicated that a total of 37% of the participants needed to see a dentist soon. Of those, 11% needed urgent care.

Table III: Negative Binomial Model for Weight (n=136)

		95% Conf. Interval		
	OR	Lower	Upper	p–value
Weight status				
Healthy weight	1.000	–	–	–
Overweight	1.111	0.765	1.612	0.58
Obese	0.683	0.479	0.975	0.04
Gender				
Male	1.043	0.774	1.407	0.78
Female	1.000	–	–	–
Education				
Elementary or none	1.353	0.901	2.030	0.15
Attended/Graduated HS	1.000	–	–	–
Attended/Graduated College	1.019	0.698	1.487	0.92
Eligible for Free Lunch (SES)				
No	1.000	–	–	–
Yes	1.944	1.171	3.228	0.01
Acculturation				
(as continuous)	0.984	0.947	1.022	0.40
Last Exam				
<= 6 months	1.000	–	–	–
>6 months	0.920	0.680	1.244	0.59
Could not get care				
No	1.000	–	–	–
Yes	0.917	0.645	1.303	0.63
Night Brush per week				
(as continuous)	0.976	0.894	1.065	0.58
No. Carb Drinks				
(as continuous)	0.993	0.887	1.111	0.90
No. Carb Foods				
(as continuous)	1.011	0.966	1.060	0.63

Principal Findings

When analyzing the association of weight status with DMFT (Table III), results indicate that children from the obese category were less likely to have dental caries (OR=0.68, 95% CI (0.48, 0.98)) than children in the normal weight category, and this was statistically significant (p=0.04). The results also indicate that although there was a positive association between dental caries in the children in the overweight category in this study population, it was not significant (OR 1.11, 95% CI (0.77, 1.61)). These results are similar to those of Marshall et al, who found that children at risk of being overweight were more likely to experience dental caries than those who were obese when using healthy weight children as the control.[28]

The above results hold true when placing the demographic variables of gender, parent's education, SES and acculturation, and the behavioral variables of diet, tooth brushing habits, availability of dental care and frequency of dental visits into the model. SES has the only statistically significant effect on the association (OR=1.94, 95% CI (1.17, 3.23), p=0.01).

Table IV reports the association between diet

(number of carbohydrate–containing foods and drinks per day) and number of dental caries. Results indicate that there is a statistically significant association between diet and DMFT (OR=1.00, 95% CI (1.00, 1.13), p=0.04). When adding demographic and behavioral variables into the model, the association between diet and DMFT (OR=1.00, 95% CI (0.99, 1.12)) is no longer significant. SES remains a significant covariate in the association throughout the model (OR=1.93, CI (1.16, 3.21), p=0.01).

Table V shows the mean number of dental caries by categorical variables used in the model. The Kruskal–Wallis test for significance yields significant results for weight status (p=0.01), and using the Mann–Whitney test for significance yields significant results for SES (p=0.01).

Table IV: Negative Binomial Model for Diet

		95% Conf. Interval		
	OR	Lower	Upper	p–value
Diet				
	1	1.003	1.127	0.04
Diet with covariates				
	1	0.944	1.115	0.08
Gender				
Male	1	0.757	1.351	0.94
Female	1.046	0.772	1.417	0.78
Education				
Elementary or none	1.371	0.911	2.062	1.13
Attended/Graduated HS	1	–	–	–
Attended/Graduated College	0.957	0.656	1.397	0.92
Eligible for Free Lunch (SES)				
No	1	–	–	–
Yes	1.929	1.159	3.212	0.01
Acculturation				
(as continuous)	0.991	0.953	1.03	0.06
Last Exam				
<= 6 months	1	–	–	–
>6 months	0.89	0.657	1.206	0.45
Could not get care				
No	1	–	–	–
Yes	0.883	0.629	1.257	0.49
Night Brush per week				
(as continuous)	0.975	0.893	1.064	0.57

Discussion

Childhood dental caries and obesity are 2 of the most common afflictions affecting the health and quality of life of children. Results of this study indicate that childhood obesity and dental caries are common in our study population, especially in children from low–socioeconomic families. Diet plays a significant role in both conditions. The results of this study also indicate that, in this population, childhood dental caries and obesity coexist but are not necessarily associated. It is important for educators to note that the research indicates that when parents were asked to rate their child's weight status their answers correlated with the child's actual weight, however, they significantly underestimated the child's weight. Thus parents may be aware that their child is overweight but their perception of the seriousness of the problem was not accurate.

Gibson et al found that the strength of association between social class and dental caries experience was twice that of the association between tooth brushing and dental caries experience.[29] They also found that the association between social class and dental caries experience was nearly 3 times greater than the association between sugar consumption and dental caries. These results would lead to the assumption that lower SES is the variable with the greatest strength of association with increased dental caries. The results from this study indicate similar results, and are in agreement with Harris et al, who suggest that more longitudinal studies and those with validated measures of dietary and oral hygiene habits are needed to better understand this association.[30]

Health professionals should explore methods to improve access to appropriate foods and increase dietary education for low SES families to decrease the risk of both conditions. Future studies should include standardized measurements of the risk factors for both obesity and dental caries. Optimal study designs should be longitudinal to better assess the predictors of both conditions.

In his call to action regarding oral health, former U.S. Surgeon General David Satcher stated that there are profound and consequential oral health disparities within the U.S. population, and that scientific research is key to further reduc-

tion in the burden of diseases and disorders that affect the face, mouth and teeth.[31]

The geographic area of this study was primarily rural, low–socioeconomic, Hispanic and a designated health professional shortage area by the Department of Health and Human Services. This area was chosen because the population had many of the risk factors for both childhood obesity and dental caries. Our demographic results show that this population experiences a much higher prevalence of both obesity and dental caries than the national average. Eliminating disparities and improving access to care are vital in providing fair and equal preventive and educational information to those at highest risk. Information gathered in this research can be useful as support for further study, baseline data for those residing in the area and program implementation aimed at reducing both of these widespread, chronic childhood diseases through education and preventive program implementation. Inconsistencies in measurement and analysis may be factors in the confusing results of previous studies. The development of validated instruments is imperative for future studies.

Table V: Mean Number of Caries by Categorical Variables Used in the Model (n=138)

	n	Mean	SD	p–value
Weight status				0.01
Normal	96	4.2	3.4	
Overweight	34	4.8	3.5	
Obese	47	2.8	3.3	
Gender				0.82
Female	109	3.8	3.3	
Male	68	4.1	3.7	
Education				0.30
Elementary or none	38	4.8	4.0	
Attended/Graduated HS	96	3.7	3.2	
Attended/Graduated College	43	3.5	3.3	
Eligible for Free Lunch (SES)				0.01
No	20	2.2	2.4	
Yes	157	4.2	3.5	
Last Exam				0.49
<= 6 months	101	4.0	3.4	
>6 months	76	3.8	3.6	
Could not get care				0.58
No	135	4.0	3.5	
Yes	42	3.6	3.2	

a: Kruskal–Wallis Test
b: Mann–Whitney Test

Conclusion

Information from the literature indicates that both childhood obesity and childhood dental caries are complicated disease processes. As a means of decreasing the prevalence of both diseases it would be effective to strengthen and improve the knowledge of the health and educational workforce, families, legislators and other key players.

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