Dental caries and anthropometric measures in a sample of 5-9-year-old children in Dhaka, Bangladesh.

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Abstract

Aim: This study aimed to assess associations between dental caries and anthropometric measures among a sample of children aged 5-9 years in Dhaka, Bangladesh.

Methods: A cross-sectional observational study was conducted among 5-9-year-old children in Dhaka, Bangladesh. Data were collected from children and their parents attending the Dhaka Dental College Hospital and from three nearby primary schools. The outcome measures were: age and sex adjusted height-z-scores (HAZ), weight-z-scores (WAZ), and BMI-z-scores (BAZ). Multiple linear regressions were used to assess the associations between caries and anthropometric measures, adjusted for maternal education, family income, study setting, birth weight and childhood diseases as potential confounders.

Results: The final sample comprised 788 children and the overall response rate was 96.7%. The majority (73.2%) had experience of dental caries. The mean dmft+DMFT score was 2.84 (95% CI 2.64, 3.03) and 35.8% experienced dental sepsis. Dental caries and sepsis were negatively associated with HAZ, WAZ and BAZ scores. After adjustment for potential confounders, children with severe levels of caries had lower HAZ scores (coefficient: -0.40; 95% CI -0.69, -0.10), lower WAZ scores (coefficient: -0.59; 95% CI -0.94, -0.24) and lower BAZ scores (coefficient: -0.50; 95% CI -0.87, -0.13) than those who were caries free. Children with moderate levels of caries also had lower WAZ scores (coefficient: -0.43; 95% CI -0.72, -0.15) and lower BAZ scores (coefficient: -0.43; 95% CI -0.72, -0.13) than caries free children. Children with dental sepsis had lower HAZ (coefficient: -0.23; 95% CI -0.42, -0.03), WAZ (coefficient: -0.33; 95% CI -0.56, -0.10), and BAZ scores (coefficient: -0.29; 95% CI -0.53, -0.05) than dental sepsis free children.

Conclusions: Dental caries was associated with lower height, weight and BMI among this sample of Bangladeshi children, even after adjusting for age and sex and a number of potential confounders.

Key words: dental caries; children; height; weight; BMI

Introduction

Dental caries is one of the most common childhood diseases worldwide,[1] affecting 60%-90% of children globally. Prevalence is particularly high among children from poorer and disadvantaged backgrounds.[2] In low and middle-income countries (LMICs) more than 90% of decay remains untreated.[3] There has been an increasing interest in the association between dental caries and body mass index (BMI) during childhood; however, the evidence is mixed. While some hospital-based studies have suggested that high caries levels are associated with lower BMI[4,5] and impaired child growth,[6,7] several systematic reviews reported conflicting findings.[8–12] It appears that the direction of the association between dental caries and BMI is context-specific. According to a systematic review by Hooley et al. (2012),[11] studies conducted in high-income countries tended to report positive associations between dental caries and BMI, whereas studies from LMICs mainly observed inverse associations. Similarly, another systematic review and meta-analysis found a significant positive relationship between dental caries and childhood obesity only for high income countries, and the association was moderated by socioeconomic status, caries status and age of the child.[12] While most of the studies from LMICs indicate an inverse relationship between caries and BMI among children, some also reported positive associations.[13–16] Such inconsistent findings could be due to variability between study samples, caries levels, use of non-standardized BMI cut off points and failure to account for possible confounding factors.[8,17]

Bangladesh is a lower-middle-income country in South East Asia and the 10th most densely populated country in the world.[18] The United Nations Development Programme (UNDP) report shows that Bangladesh has registered considerable progress in some areas of the Millennium Development Goals (MDG),[19] now evolved into the Sustainable Development Goals (SDGs). However, childhood malnutrition is among the issues identified as stumbling blocks in fulfilling SDG targets in Bangladesh.[20] At the same time, oral health is a neglected part of health policy, and there are no national data available for dental caries prevalence among children. Considering the inconsistent findings on the relationship between dental caries and BMI in childhood, and the need for further evidence derived from well-designed studies in LMICs, this study aimed to examine the relationships between dental caries and age and sex adjusted height, weight and BMI z-scores among a sample of 5-9-year-old children from Dhaka, Bangladesh.

Methods

A cross-sectional observational study was conducted among a non-representative sample of 5-9-year-old children and their parents in Dhaka, Bangladesh. Data were collected between August and October 2015. To meet the aim of this study it was important to include children with a range of caries levels. Therefore, the study population was selected from two settings: a clinical setting (hospital sample), and a community setting (school sample). Ethical approval was obtained from the University College London Research Ethics Committee and the National Research Ethics Committee of Bangladesh. All participants' parents or legal guardians provided written informed consent. A pilot study was conducted in January 2015 in Bangladesh with 272 children, which demonstrated the overall feasibility of the procedures adopted for the study.

A pragmatic approach was taken to select the sample. Participants were recruited among children attending the Dhaka Dental College Hospital (DDCH) for treatment. DDCH was chosen because it is the largest dental educational institution and the only Government Dental College Hospital in Bangladesh.[21] In addition, five local primary schools situated in the catchment area of the hospital were randomly selected and invited to take part in the study, three of which agreed to participate. All 5-9-years-old children attending these schools and their parents were invited into the study. Children who had any systemic diseases or acute infections, fever or diarrhoea during the week preceding the data collection were excluded. Based on the results from the pilot study, we calculated that our study would need a sample of N=797 to have 80% power to detect a BMI-z-score difference of 1/3 of a standard deviation between the different caries severity groups, with the level of statistical significance (α) set at 0.05, a design effect of 1.5 and assuming a response rate of 82% as obtained in the pilot study. In total, 805 children were invited to take part in the study. Parental consent was obtained from 797 children (96.7%), revealing an excellent response rate. Due to absences on the days the examinations took place in the schools, 788 children participated in the study and were clinically examined; while for 92% of them (725 children), their parents returned the completed questionnaires.

The outcome variables were age and sex-adjusted z scores for height, weight, and BMI. BMI was calculated dividing weight (in kilograms) by height squared (in meters). Five trained investigators conducted the anthropometric measurements. Height was measured with the child standing without shoes using a portable stadiometer (Leicester height measure). Weight was measured using a pre-calibrated digital Seca scale, with children wearing light clothes and no shoes. The measurements for height and weight were taken to the nearest 0.1 cm and 0.1 kg, respectively. Two measurements were taken for each child and the average was used for the analyses. These were converted to z-scores, namely height-for-age z-scores (HAZ), weight-for-age z-scores (WAZ), and BMI-for-age z-scores (BAZ) using WHO standard growth reference data 2007.[22] The use of z-scores allows comparisons of individuals' weight, height or BMI, adjusted for age and sex relative to a reference population, expressed in standard deviations (SD) away from the reference mean.

The main exposures were dental caries and dental sepsis. The clinical dental examinations were conducted following WHO guidance for oral health surveys.[23] Dental examinations were non-invasive and conducted visually by three trained and calibrated dentists with the children sitting straight on a stool, using a hand torchlight with blue-white colour spectrum and a disposable plastic dental mirror, and following standard cross infection procedures. Tweezers and cotton wool were used to remove any gross deposition of food debris and plaque. Dental caries was measured using the dmft/ DMFT indices. The number of decayed, missing or filled teeth was recorded. Caries was defined according to WHO criteria as the presence of a visual distinct cavity into the dentine.[23] The pufa/ PUFA index was used to indicate dental sepsis. The pufa/ PUFA index records the presence of severely decayed teeth with visible pulpal involvement (p/P), ulceration caused by dislocated tooth fragments (u/U), fistula (f/F) and abscess (a/A) for deciduous (pufa) and permanent (PUFA) teeth.[24] The average Kappa was 0.92 for the intra-examiner reproducibility and 0.88 for the inter-examiner reproducibility, revealing very good agreement. For analytical purposes dental caries was classified into four categories: caries free children formed a distinct group (26.8%), while those with dental caries experience were divided into tertiles, where 26.6% were in the low caries tertile (dmft+DMFT = 1-2), 29.9% were in the moderate caries tertile (dmft+DMFT = 3-5) and 16.6% were in the severe caries tertile (dmft+DMFT = 6-15). Dental sepsis was dichotomised into 'no sepsis' (pufa+PUFA=0) (64.2%) and 'having any sepsis' (pufa+PUFA>0) (35.8%) groups.

Non-clinical data were collected on socio-economic background, birth weight and childhood diseases through self-administered questionnaires completed by parents. The following covariates were considered as potential confounders: maternal education (five categories: 'no formal education', 'primary', 'secondary', 'higher secondary', and 'tertiary'), monthly gross family income (four groups: < 8000; 8000 to 20,000; > 20,000 to 30,000; > 30,000 Taka/month; 1GBP=110 Taka), study setting (hospital vs. school sample), birth weight (three categories: normal, low, and high), and whether the child had any long-standing diseases (yes/no).

Data analysis was performed using Stata version 12 software. Initially, descriptive analyses were carried out. Outcome variables were normally distributed. To assess the bivariate associations between outcomes and exposures and potential confounders, one-way analysis of variance (ANOVA) and t-tests were carried out as appropriate. Finally, multiple linear regressions were conducted on complete data. For each outcome, two separate sets of models were run, one with dental caries as the exposure and one with dental sepsis. Each model was adjusted for maternal education, family income, study setting, birth weight and childhood diseases. Children's age and sex were not additionally adjusted in the models as the outcomes were age and sex adjusted z-scores. Unadjusted and adjusted regression coefficients and their respective 95% confidence intervals (CI) were estimated and reported.

Results

Of all children, 388 (49.2%) were boys and 400 (50.8%) were girls, with a mean age of 7.12 years (SD 1.01). The majority of the children (73.2%) had experience of dental caries (dmft+DMFT>0). The mean dmft+DMFT score for the whole sample was 2.84 (95% CI 2.64, 3.03). In addition, active decay (d+D component) constituted 71.4% of the dmft+DMFT indicator and 98.9% of this was in deciduous teeth. The mean HAZ, WAZ and BAZ scores were -0.01 (-0.11, 0.08), -0.17 (-0.28, -0.06) and -0.28 (-0.39, -0.17), respectively. Characteristics of the study sample are presented in Table 1.

Bivariate analyses revealed negative associations between all anthropometric outcomes and dental caries, as well as dental sepsis. Children with higher levels of dental caries and any form of sepsis had on average lower mean HAZ, WAZ and BAZ scores (Figures 1 and 2). Children recruited from the hospital setting, children whose mothers had lower levels of education and children with low birth weight had lower mean z-scores of height, weight and BMI than their counterparts (Table 1). Results of linear regression analyses revealed statistically significant negative associations between HAZ, WAZ and BAZ scores and dental caries, before and after adjustment for potential confounding factors (Table 2). In the fully adjusted model, children with severe caries had lower HAZ scores than children without caries experience (coefficient: -0.40; 95% CI -0.69, -0.10) ($p<0.05$). Similarly, children with moderate and severe dental caries had lower WAZ scores than children without caries experience (coefficient: -0.43; 95% CI -0.72, -0.15 and coefficient: -0.59; 95% CI -0.94, -0.24, respectively). Children with moderate and severe dental caries also had lower BAZ scores than children without caries experience (coefficient: -0.43; 95% CI -0.72, -0.13, and coefficient: -0.50; 95% CI -0.87, -0.13, respectively). Similar inverse associations were observed between all three outcomes and dental sepsis. In the fully adjusted models, children having any dental sepsis had lower HAZ (coefficient: -0.23; 95% CI -0.42, -0.03), WAZ (coefficient: -0.33; 95% CI -0.56, -0.10) and BAZ scores (coefficient: -0.29; 95% CI -0.53, -0.05) than children without dental sepsis.

Discussion

The present study found overall negative associations between dental caries experience and dental sepsis and three anthropometric outcomes (age and sex-adjusted height, weight and BMI) in this sample of Bangladeshi children. However, no significant differences were observed in these outcomes between children with low caries levels and children without caries experience.

Two previous studies, conducted in Bangladesh and Saudi Arabia, which used z-scores for height and weight based on WHO growth reference data 2007 and considered anthropometric measures on a continuous scale, have found similar negative associations between dental caries and children's height and weight.[25,26] The inverse associations found in the present study were also in agreement with several other cross-sectional study findings from different LMICs,[27–39] although some studies have used dental caries as the outcome,[27–35] while others (including our study) used anthropometric measures as the outcome.[36–39] The direction of the associations cannot be ascertained in cross-sectional studies. A direction from dental caries to lower body weight is supported by evidence from previous studies on weight gain after oral rehabilitation.[6,7,40] These studies found that children with severely decayed, pulpally involved teeth had lower body weights, and dental treatment was followed by significant weight gain.

While most of the studies in LMICs reported inverse relationships, a limited number of studies including from India[13–15], Iran[16], and China[41] reported a positive association between dental caries and higher BMI which is contradictory to the present study findings. One explanation could be that some of these studies grouped normal and underweight children together and did not consider underweight children as a distinct group[14,41]. Moreover, most of these studies conducted only basic statistical analyses[15] or did not account for potentially confounding factors[16,41]. Other studies reported no significant associations between dental caries and BMI after accounting for socioeconomic factors.[42,43] Similarly, two studies from India[44] and Brazil[45] observed no significant associations between caries and childhood obesity. In contrast, Chopra et al.[46] in their study in India found that both under- and overweight children had higher caries levels than children with normal BMI, suggesting that within the country, different pathways might be at play for children of different socioeconomic backgrounds.

As mentioned earlier, systematic reviews have suggested that associations between childhood dental caries and BMI vary by country-level income.[11,17] Dietary sugar is recognized as the leading cause for both dental caries and obesity in children, which would explain the positive association between dental caries and body weight observed in most high-income countries. However, the situation is more complex in the context of LMICs where childhood malnutrition and impaired access to health services are more pronounced public health challenges than in high-income countries. Due to the nutrition transition and increased availability of sugary foods and drinks, compounded by childhood malnutrition[47] and inadequate exposure to fluoride; caries prevalence has increased in children in some LMICs.[48,49] At the same time, access to dental treatment is limited.[50] Analysing WHO data, van Palenstein et al.[51] reported the DMF components of 12-year-old children separately for countries of different income levels and showed that in high-income countries, almost 50% of the caries is treated; compared to only 2% in lower income countries. Thus, due to a lack of preventive measures and limited access to oral health care, children in LMICs are disproportionately affected by the negative consequences of untreated dental caries, such as inflammation caused by dental sepsis, as well as reduced appetite, eating difficulties and sleeping disturbance due to dental pain, all of which might negatively affect their growth.[52–54] These potential mechanisms should be explored through further research.

To our knowledge, this was the first study to assess the relationships between dental caries and anthropometric measures among children in Bangladesh. Our findings are an important contribution towards the collection of dental epidemiological data in Bangladesh, where such studies are scarce. The pragmatic approach of selecting the study population from both hospital and community settings meant that the study hypothesis was tested in a sample with a wide range of caries levels. Moreover, to overcome some limitations of previous studies, a range of possible confounding factors were adjusted for. We used z-scores of height, weight and BMI on a continuous scale rather than cut-off points. However, our study had several limitations. The study sample was not representative of Bangladeshi children. We recruited children from a hospital and schools in only one area in Dhaka, therefore our findings might not be generalizable to other areas in the same city or to Bangladeshi children as a whole. Our study population was mostly from lower middle and middle socioeconomic groups. The under-representation of children from higher socio-economic groups might have affected the direction of the association as their BMI and caries burden might be different from the current study sample. Future studies should use representative data and a longitudinal design to elucidate the issue of reverse causality. Our findings will hopefully strengthen the evidence-base for future oral health policy development in Bangladesh – so far a widely neglected area.[55]

In conclusion, this study has provided further evidence of an inverse relationship between dental caries and children’s height, weight, and BMI, suggesting that dental caries poses an additional burden for child health in LMICs. Since dental caries prevalence is increasing in those countries, efforts to reduce the prevalence of dental caries, and to improve access to oral health care services should be a public health priority. There is an urgent need to integrate oral health within general health policies.

Table 1. Distribution of outcome variables, by covariates (N=788)

	N (%)	HAZ-scores Mean 95% CI	WAZ- scores Mean 95% CI	BAZ- scores Mean 95% CI
Gender[1]				
Boys	388 (49.2)	-0.11 -0.24, 0.02	-0.35 -0.52, -0.19	-0.47 -0.64, -0.31
Girls	400 (50.8)	0.08 -0.05, 0.21	0.04 -0.19, 0.12	-0.09 -0.24, 0.06
p-value		*0.042*	*0.006*	*<0.001*
Setting[1]				
Hospital	237 (30.1)	-0.67 -0.82, -0.52	-0.98 -1.15, -0.81	-0.84 -0.99, -0.69
School	551 (69.9)	0.27 -0.82, -0.52	-0.03 -0.17, 0.11	-0.03 -0.17, 0.11
p-value		*<0.001*	*<0.001*	*<0.001*
Maternal education[2]				
No	27 (3.7)	-0.77 -1.27, -0.29	-1.24 -1.73, -0.74	-1.12 -1.55, -0.68
Primary	144 (19.9)	-0.73 -0.93, -0.52	-1.01 -1.25, -0.77	-0.85 -1.08, -0.62
Secondary	221 (30.5)	-0.12 -0.28, 0.04	-0.34 -0.54, -0.15	-0.44 -0.64, -0.24
Higher secondary	186 (25.7)	0.24 0.04, 0.43	0.13 -0.10, 0.37	-0.07 -0.28, 0.19
Tertiary	147 (20.3)	0.55 0.35, 0.75	0.51 0.27, 0.74	0.22 -0.03, 0.48
p-value		*<0.001*	*<0.001*	*<0.001*
Family income[2] (Taka/month)				
<8 thousand	105 (14.5)	-0.49 -0.72, -0.26	-0.82 -1.11, -0.53	-0.79 -1.07, -0.52
8-<20 thousand	341 (47.0)	-0.17 -0.31, -0.03	-0.44 -0.61, -0.28	-0.53 -0.69, -0.37
>20-<30 thousand	166 (22.9)	0.41 0.22, 0.59	0.41 0.17, 0.65	0.19 -0.07, 0.44

	N (%)	HAZ-scores Mean 95% CI	WAZ- scores Mean 95% CI	BAZ- scores Mean 95% CI
>30 thousand	113 (15.6)	0.13 -0.14, 0.39	0.13 -0.17, 0.42	0.05 -0.22, 0.33
p-value		*<0.001*	*<0.001*	*<0.001*
Birth weight[2]				
Low	68 (9.5)	-0.11 -0.41, 0.20	-0.56 -0.89, -0.22	-0.78 -1.12, -0.44
Normal	580 (80.8)	-0.11 -0.21, 0.00	-0.29 -0.42, -0.16	-0.36 -0.49, -0.24
High	69 (9.6)	0.54 0.22, 0.87	0.70 0.28, 1.12	0.49 0.05, 0.94
p-value		*<0.001*	*<0.001*	*<0.001*
Childhood diseases[1]				
No	598 (82.7)	0.01 -0.10, 0.12	-0.13 -0.26, -0.01	-0.24 -0.37, -0.11
Yes	125 (17.3)	-0.24 -0.48, -0.00	-0.57 -0.85, -0.29	-0.65 -0.91, -0.38
p-value		*0.059*	*0.006*	*0.009*
Dental caries[2]				
No	211 (26.8)	0.38 0.21, 0.55	0.38 0.17, 0.59	0.17 -0.04, 0.39
Low (dmft+DMFT = 1-2)	110 (26.6)	0.15 -0.03, 0.33	0.05 -0.16, 0.26	-0.10 -0.31, 0.11
Moderate (dmft+DMFT = 2-5)	136 (29.9)	-0.18 -0.35, -0.01	-0.42 -0.62, 0.23	-0.50 -0.70, -0.31
Severe (dmft+DMFT = 6-max)	131 (16.6)	-0.61 -0.82, -0.41	-0.96 -1.21, -0.70	-0.87 -1.11, -0.63
p-value		*<0.001*	*<0.001*	*<0.001*
Dental sepsis[1]				
No	506 (64.2)	0.19 0.07, 0.30	0.09 -0.04, 0.23	-0.07 -0.21, 0.07
Yes	282 (35.8)	-0.38 -0.53, -0.23	-0.66 -0.84, -0.48	-0.65 -0.82, -0.48
p-value		*<0.001*	*<0.001*	*<0.001*

[1]t test [2]ANOVA

Table 2. Association between HAZ, WAZ and BAZ scores and caries and sepsis (unadjusted and adjusted linear regression model) (N=715)

Outcome		Unadjusted coefficient	95% CI	*p*	Adjusted* coefficient	95% CI	*p*
HAZ	Dental caries (ref: dmft+DMFT=0)						
	Low	-0.22	-0.49, 0.04	*0.093*	-0.07	-0.32, 0.17	*0.557*
	Moderate	-0.54	-0.79, -0.29	*<0.001*	-0.24	-0.48, 0.00	*0.051*
	Severe	-0.97	-1.26, -0.67	*<0.001*	-0.40	-0.69, -0.10	*0.009*
	Dental sepsis (ref: pufa+PUFA=0)						
	Yes	-0.60	-0.79, -0.40	*<0.001*	-0.23	-0.42, -0.03	*0.023*
WAZ	Dental caries						
	Low	-0.34	-0.65, -0.03	*0.033*	-0.16	-0.45, 0.13	*0.288*
	Moderate	-0.80	-1.10, -0.50	*<0.001*	-0.43	-0.72, -0.15	*0.003*
	Severe	-1.27	-1.62, -0.92	*<0.001*	-0.59	-0.94, -0.24	*0.001*
	Dental sepsis						
	Yes	-0.78	-1.02, -0.55	*<0.001*	-0.33	-0.56, -0.10	*0.005*
BAZ	Dental caries						
	Low	-0.28	-0.60, 0.03	*0.075*	-0.16	-0.46, 0.14	*0.301*
	Moderate	-0.68	-0.98, -0.38	*<0.001*	-0.43	-0.72, -0.13	*0.005*
	Severe	-0.96	-1.31, -0.61	*<0.001*	-0.50	-0.87, -0.13	*0.007*
	Dental sepsis						
	Yes	-0.60	-0.84, -0.37	*<0.001*	-0.29	-0.53, -0.05	*0.019*

* Adjusted for maternal education, family income; study setting; birth weight and childhood disease

Figure 1 Bivariate associations of HAZ, WAZ and BAZ scores with dental caries groups.

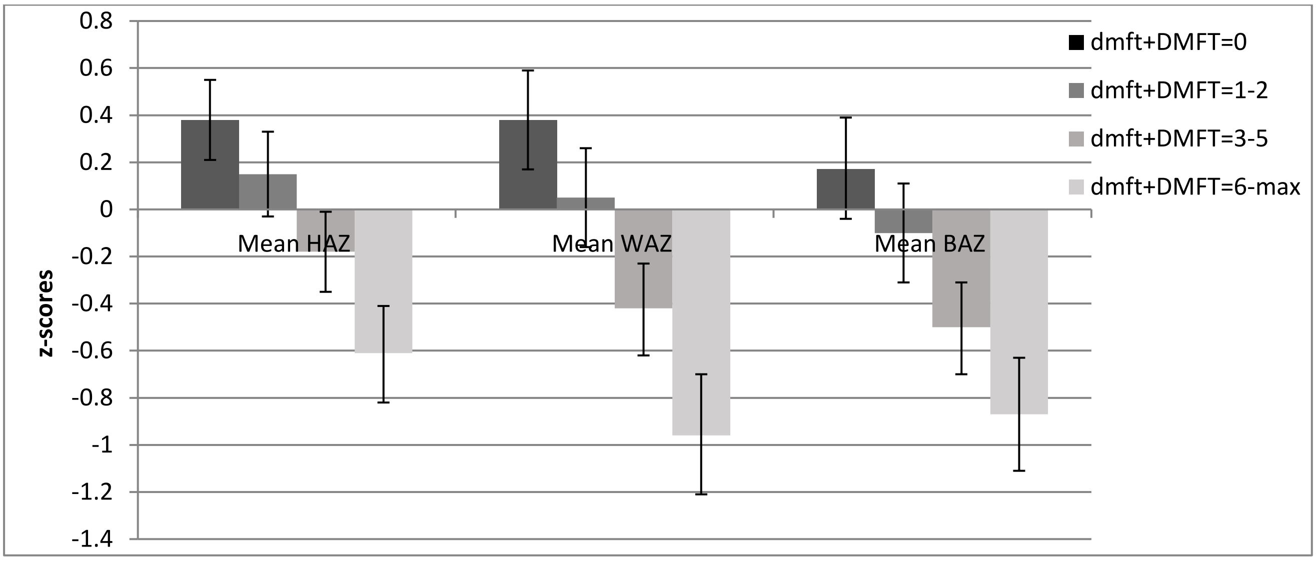
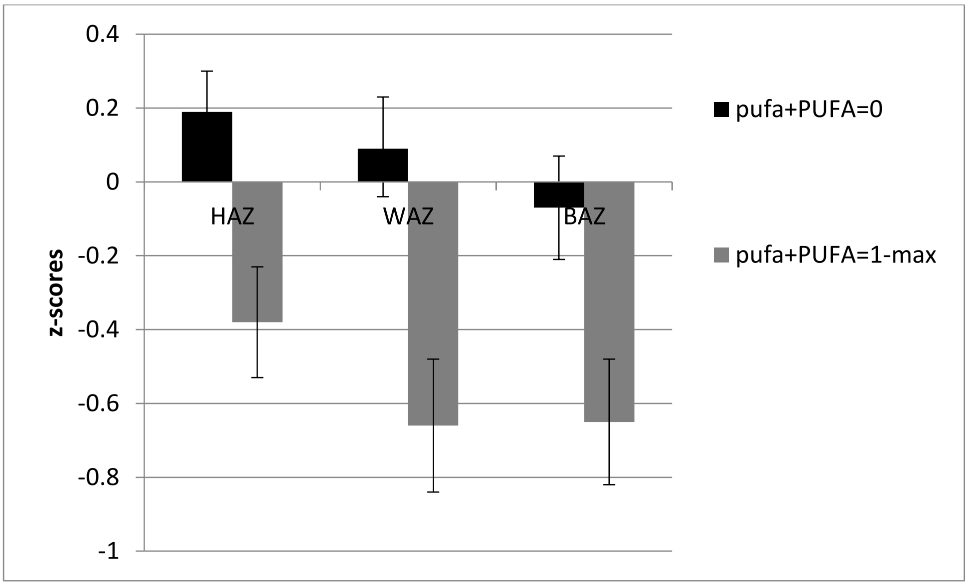


Figure 2 Bivariate associations of HAZ, WAZ and BAZ scores with dental sepsis.



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