ORIGINAL ARTICLE

Leon C Goe Mary Anne S Baysac Knox H Todd John A Linton Assessing the prevalence of dental caries among elementary school children in North Korea: a cross-sectional survey in the Kangwon province

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Abstract: Objectives: The lack of epidemiological studies has made it difficult to assess the extent of public health problems in North Korea. In the absence of empirical data, less intrusive study designs acceptable to the North Korean government could be developed to gauge the public's health. To this end we developed a basic oral health survey in order to assess the prevalence of untreated dental caries among children. Methods: A cross-sectional survey of 854 elementary school students was conducted in the city of Wonsan, North Korea. Students were screened and classified into one of three states of oral health: no caries, minor caries or severe dental caries. Verbal surveys were concurrently administered on children to collect basic information on oral health behaviours and demographic characteristics. Statistical analyses were performed to determine if any variables were significant predictors of oral health status category. Results: Among the 854 students screened, we found 255 students with no caries (29.9%), 316 students with minor caries (37.0%), and 283 students with severe caries (33.1%). The majority of students (70.1%) screened had dental caries. Almost all of the students (98.5%) claimed to brush their teeth daily and 71.2% of students visited a dentist in the past year. There were no significant predictors of oral health status. Conclusions: The oral health of children in Wonsan, North Korea is comparable if not slightly better than the oral health status of children of similar age in countries with similar Social-Economic Status (SES). Basic oral health screens are useful to produce a snapshot of general oral

health status among children in North Korea and may provide insight as to the general health of these children.

Key words: children, North Korea, oral health, public health

Introduction

Since the early 1990s, North Korea has been devastated by a series of economic and environmental disasters (e.g. floods, droughts and famine) with resultant adverse impacts on the health of its people (1). These disasters have led to mass food shortages, a near collapse of the health care infrastructure and a loss of virtually all routine health care services and vaccinations (2).

While the North Korean government has acknowledged the severity of its economic and health problems over the past decade, it has been reluctant to release official health statistics or allow foreigners into the country to conduct studies of the public's health. Given this, little is known about the health of North Korean children.

Studies have demonstrated the importance of oral health as a predictor for overall health and well-being (3, 4). Oral health-related diseases, in particular, periodontal diseases are associated with systemic health problems later in life, such as cardiovascular disease, diabetes mellitus, complications during pregnancies and osteoporosis (4). The 2000 US Surgeon General's report on oral health emphasized that oral health is linked to total health and well-being throughout life (5).

Given this background, the following study was developed by the Eugene Bell Foundation (EBF), a not-for-profit nongovernmental organization (NGO) in collaboration with the North Korean Ministry of Public Health (MOPH) to conduct a prevalence assessment of dental caries among children, an area of public health previously not evaluated in North Korea. The overall goals of this study were to: (i) assess the prevalence of untreated dental caries among elementary school children and (ii) determine if basic demographic and behavioural characteristics such as age, gender, brushing teeth, eating candy, visiting the dentist and family size, are predictive of the oral health of children in North Korea.

This study aims to add new information to the public health literature on the oral health of children in North Korea as well as provide insight into factors contributing to oral health problems in the country. Furthermore, this study hopes to facilitate future collaborative NGO and government based efforts in creating interventions to address oral health problems of children in North Korea.

Methods

A team of health care professionals within EBF designed, developed and implemented this study in collaboration with the MOPH. Institutional Review Board (IRB) approval for this study was obtained from the University of California at Berkeley Committee for the Protection of Human Subjects no. 2002-6-30. Informed consent was not required by parents of students or students involved in this assessment within North Korea as consent was granted by the North Korean government.

A cross-sectional survey of 854 elementary school children between the ages of seven and 10 attending five elementary schools was conducted in Wonsan, North Korea during the Spring of 2002. Wonsan is a port city located in the Kangwon Province on the east coast of North Korea. It was one of three major cities cited by the UN World Food Program as being the hardest hit from the floods, famine and drought of the 1990s (6). All students selected for this study were students attending five elementary schools in Wonsan where the MOPH randomly selected approximately 1000 students for hepatitis B vaccinations based on screenings performed for hepatitis B surface antigen (Hbs-Ag). All students testing negative for Hbs-Ag and subsequently scheduled for hepatitis B vaccinations were simultaneously evaluated for dental caries.

Two practising North Korean dentists were assigned by the MOPH to conduct the oral health screenings. These dentists were given explicit instructions by EBF health care professionals on case definitions to be utilized for the purpose of this study. They then conducted a series of cursory screenings to ensure clarity of case definitions. Case definitions were defined as succinctly as possible and dentists conducted screens using only disposable probes and mobile lamps.

Students were assigned to one of three stages of caries: stage 1 - no caries (characterized as any yellow, brown or black lesions) visible on any teeth, primary or permanent; stage 2 - minor caries (characterized as small, slightly visible yellow, brown or black lesions) on one or more teeth, primary or

Goe et al. Dental caries among elementary school children in North Korea

	Age (years)				
	7	8	9	10	Total (%)
Score					
No caries	15	95	144	1	255 (29.9)
Minor caries	21	122	170	2	316 (37.0)
Severe caries	25	120	138	0	283 (33.1)
Mean (SD) Total (%)	2.16 (.799) 61 (7.1)	2.07 (.796) 337 (39.5)	1.98 (.790) 452 (52.9)	1.67 (.577) 3 (0.4)	

permanent; and stage 3 – severe caries (characterized as large, highly visible yellow, brown or black lesions) on one or more teeth, primary or permanent.

While traditional oral health screening methods utilize the DMFT (decayed, missing, filled teeth) scale, this study's purpose was only to assess whether or not caries existed at the time of screening, hence, missing or filled teeth were not evaluated.

For all students examined, dental screeners recorded the stage of caries based on the above classification scheme. To better ensure inter-rater reliability, the same two dental screeners were used for all students and a third dental consultant from EBF randomly screened roughly 10–20% of the students simultaneously. If any discrepancies in stage assignment existed between either of the two dental screeners and the EBF dental consultant, the student was rescreened until majority agreement was reached.

Medical surveys were completed by verbal interview of each student on the day of screenings. Teachers from each school and health care practitioners from the MOPH recorded survey information from all students using standardized survey forms provided by EBF. Each survey collected information with regard to: stage of oral health, age, gender, whether the student brushes his/her teeth daily, whether the student eats candy regularly (more than once a week), whether the student had any dental visits during the past year, and whether the student has any siblings. These questions were specifically selected for inclusion in this study with regard to sensitivity surrounding data collection issues in North Korea. A conscientious effort was made to gather as much information as possible to present a general overview of oral health behaviours among North Korean children with as little intrusion as possible. Once all data were collected, descriptive statistics were conducted utilizing SPSS 11.5 (SPSS Inc., Chicago, IL, USA) and STATA 7.0 (STATA Corp. LP, College Station, TX, USA) statistical packages.

Results

All 854 elementary school students present for vaccinations were screened for untreated dental caries. Among the 854

students screened, 255 (29.9%) students were classified as stage 1 (no caries), 316 (37%) students were classified as stage 2 (minor caries) and 283 (33.1%) students were classified as stage 3 (severe caries). Of the 854 students screened 599 (70.1%) had caries of some form (Table 1).

When stratified by age group, the majority of students were ages eight or nine, 337 (39.5%) and 452 (52.9%), respectively, and the prevalence of dental caries decreased with age (Table 1). Of these students, 389 (45.5%) were boys and 464 (54.5%) were girls with no major differences in dental caries prevalence by gender (Table 2–3).

Table 2. Caries stage distribution by gender

	Gender			
	Female (%)	Male (%)	Total	
Score				
No caries	138 (29.7)	117 (30)	255	
Minor caries	177 (38.1)	138 (35.5)	315	
Severe caries	149 (32.1)	134 (34.4)	283	
Mean (SD)	2.02 (0.79)	2.04 (0.80)		
Total (%)	464 (54.3)	389 (45.6)	853	

Table 3. Female (a) and male (b) caries stage distribution by age

	No caries (% total caries w/in category)	Minor caries (% total caries w/in category)	Severe caries (% total caries w/in category)
(a) $n = 46$	4 (54.3%)		
Age 7	10 (7.2)	15 (8.5)	5 (3.3)
Age 8	49 (35.5)	71 (40.1)	66 (44.3)
Age 9	79 (57.2)	90 (50.8)	78 (52.3)
Age 10	0 (0)	1 (0.6)	0 (0)
Total	138	177	149
(b) <i>n</i> = 38	89 (45.6%)		
Age 7	5 (4.3)	6 (4.3)	20 (14.9)
Age 8	46 (39.3)	51 (37)	54 (40.2)
Age 9	65 (55.5)	80 (58)	60 (44.8)
Age 10	1 (0.85)	1 (0.7)	0 (0)
Total	117	138	134

Table 1. Caries stage distribution by age

From the student surveys, it was determined that 841 (98.5%) students brush their teeth daily, 712 (83.4%) students eat candy regularly (two student responses missing), 225 (26.3%) students had a dental visit in the past year (21 student responses missing) and 847 (99.2%) students had one or more siblings in their families (Table 4).

A univariate analysis revealed no significant predictors of oral health status among the independent variables (age, gender, brush teeth daily, eat candy regularly, visited dentist in past year, have siblings) against the dependent variable, oral health score (Table 5).

Following univariate ANOVA, the three stages of caries (1 = none, 2 = minor and 3 = severe) were collapsed into two categories creating a dichotomous dependent variable (no caries = 0 and caries = 1). Using this dichotomous dependent variable, a LOGIT regression was run (Table 6).

LOGIT regression revealed that when using a dichotomous dependent variable (no caries = 0 and caries = 1) none of the independent variables (age, gender, brush teeth daily, eat candy regularly, dental visit in past year, siblings), were predictive of caries.

Table 4. Oral health behaviours and family size

Variable	Students responding 'Yes' (%)	Students responding 'No' (%)
Brush teeth daily	841 (98.5)	13 (1.5)
Eat candy regularly (two responses missing)	712 (83.4)	140 (16.4)
Dental visit in past year (21 responses missing)	225 (26.3)	608 (71.2)
Have at least one sibling	847 (99.2)	7 (0.8)

Table 5. Univariate ANOVA results for three stages of oral health (no caries versus minor caries versus severe caries)

Source	Type III sum of squares	d.f.	Mean square	F	Significance
Corrected model	58.01	78	0.74	1.19	0.13
Intercept	202.53	1	202.53	325.23	0.00
Age	1.37	3	0.46	0.73	0.53
Gender	0.07	1	0.07	0.11	0.74
Brush teeth daily	1.01	1	1.01	1.63	0.20
Candy	0.06	1	0.06	0.10	0.76
Dentist	0.41	1	0.41	0.66	0.42
Siblings	2.59	4	0.65	1.04	0.39
Error	467.05	750	0.62		
Total	3954.00	829			
Corrected total	525.05	828			

 $R^2 = 0.110$ (adjusted $R^2 = 0.018$).

Table 6. LOGIT estimates for two stages of oral health (no caries versus caries)

Score	Coefficient	SE	Ζ	P>[Z]	95% CI
Age	-0.10	0.13	-0.75	0.45	-0.36-0.16
Gender	-0.03	0.15	-0.22	0.83	-0.33-0.27
Brush teeth daily	-0.55	0.80	-0.68	0.50	-2.12-1.03
Eat candy regularly	-0.20	0.25	-0.82	0.41	-0.68-0.28
No dental visits in past year	-0.24	0.18	-1.33	0.18	-0.59-0.11
No. of siblings _cons	-0.16 3.06	0.09 1.36	-1.66 2.25	0.10 0.02	-0.34-0.03 0.39-5.74

Number of observations = 829; log likelihood = -502.82; LR $chi^{2}(6) = 7.69$; $P > chi^{2} = 0.26$; Pseudo $R^{2} = 0.0076$.

Discussion

This study assessing the prevalence of untreated dental caries among elementary school children in Wonsan, North Korea determined that of 854 students, 70.1% of children had some form of untreated dental caries. Overall, our findings indicate that the prevalence of caries among this cohort of North Korean children was not as high as previous circumstances might have indicated. In general, the SES of North Korea is low, comparable with many developing South-east Asian countries and the health conditions in Wonsan were expected to be poor given the impact of the natural disasters and subsequent food shortages of the mid 1990s. However, the prevalence of untreated dental caries among children in Wonsan, North Korea was not very different from children of similar SES and age in other countries. For example, in 2002, Wyne et al. (7), found that in Saudi Arabia, the prevalence of caries among primary school children was 94.4%. While in 2001, Petersen et al. (8), found that 96.3% of 6-year olds in Thailand had evidence of caries. Although these studies used different screening methodologies, such as the traditional DMFT scale for oral health, they also acknowledged a potential underestimation of dental caries because of the use of only sunlight and mirrors in their oral screenings. Despite this, their findings for dental caries were still quite high.

Nevertheless, given the economic hardships of the past decade and the fact that North Korea does not have a water fluoridation programme in place, it is encouraging to find that all of the children surveyed did not have dental caries and that the majority of students surveyed (98.5%) claim to brush their teeth daily.

Study limitations

Due to the limited sample size and specific region of the country selected, the major limitation of this study is that the findings may not be generalizable to the overall oral health of all children in North Korea. While North Korea has a compulsory 11-year education, this study did not verify whether all students within those years are actually enrolled in school.

Furthermore, given that this study assessed the oral health of children currently in school and scheduled for preventive vaccinations, we may have inadvertently selected from a biased cohort of children that may have been healthier than children not scheduled for vaccinations. As stated earlier, any student that was positive for the Hbs-Ag was automatically omitted from vaccination and thus also omitted from the oral health evaluation. Students testing positive for Hbs-Ag may have had poorer overall health, including poorer oral health.

All demographic and behavioural data collected were based on self-reported interviews of children. While most of the children responded to all survey questions, given that these were very young children, they may have given 'socially desirable' answers which could account for such high rates for tooth brushing behaviour (98.5%) or could have misinterpreted a particular question altogether.

While a univariate analysis revealed no significant predictor variables for oral health status and a subsequent LOGIT regression revealed no predictor variables for the existence of caries, given the limited amount of detail captured by the survey questions (e.g. precise amounts of candy consumption, nature of dental visits, etc.) it is likely that our data were deficient to be used to adequately create a predictive model for oral health.

We did not evaluate missing or filled teeth as the traditional DMFT scale accomplishes. Such additional information might better support the theory that dental visits in North Korea only reflect treatment as opposed to prevention and could reveal the actual extent of oral health problems in the country. However, it was noted that of the 10–20% of students randomly evaluated by the EBF dental screener, dental fillings were not seen. North Korean dentists confirmed that primary teeth with carious lesions are generally extracted or left untreated, whereas permanent teeth are treated. Accessibility to such dental services for this particular population remains unclear.

Finally, with respect to the actual oral health screenings, while the same dentists were used for all screenings, given the minimal invasiveness utilized for each screen and the fact that only blunt probes and lamps were used in the screens, without the aid of radiographic examinations, our assessment could have underestimated the overall prevalence of dental caries.

Further research is needed to better determine the overall burden of disease and morbidity caused by oral health problems in North Korea. In addition, future research should determine what additional factors, such as income, geography and access to care, may impact oral health status. Given that North Korea has a system of universal health care coverage which includes basic dental care, insurance is usually not a factor in health care coverage and the overall SES of the population is more or less consistent across the country. However, given the lack of available health care services, such factors may be significant in determining who actually receives health care or who is likely to seek it.

Despite these limitations, we believe this study is an important first step in answering some basic questions regarding the oral health and oral health behaviours of children in North Korea. Given the difficult nature of collecting empirical data in North Korea, the above limitations may not be a problem in an otherwise ideal setting for such a study. Nevertheless, the authors hope that this study may provide some insight for future NGO-based health interventions development and future collaborative efforts with the North Korean government.

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