

Dental Caries Experience in Cambodia: Findings from the 2011 Cambodia National Oral Health Survey

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Abstract:

Objectives: To report the results of the 2011 National Oral Health Survey which was conducted to assess the dental caries, sequelae, and selected risk indicators in the population.

Methods: A sample of 2028 participants aged 6, 12-13, 15-17 and 35-44 was recruited from Phnom Penh and four provinces to represent age, sex, and urban/rural locations. Examinations were conducted using ambient light and mouth mirrors by standardized examiners. Tooth-specific data were obtained to calculate the number of decayed, missing and filled teeth (dmft) and number of teeth with pulp, ulcer, fistula, and abscess sequelae (PUFA index). Interviews were carried out to collect socio-demographic and behavioral information. *T* and χ^2 tests were used to assess statistical differences ($\alpha < 0.05$).

Results: The prevalence of dental caries was 93% at age 6 years, and 80% at age 12-13, and 35-44 years. At age 6 years, the mean dmft was 9.0 (standard deviation [SD] 4.9) and the mean PUFA 2.7 (SD 2.8); at age 12-13 years the mean DMFT was 3.8 (SD 3.6) and the mean PUFA 0.9 (SD 1.6); at age 35-44 years the mean DMFT was 5.6 (SD 5.8) and the mean PUFA 1.9 (SD 3.1). There was a high frequency of cariogenic foods consumption by children and adolescents, and prolonged nocturnal breastfeeding was common. Around 62% of children aged 6 years had not started tooth brushing yet.

Conclusion: The Cambodian population experiences a high burden of dental caries requiring immediate public health interventions.

Key Words: Cambodia, dental caries, epidemiology

Introduction

The Cambodian population is known to have a high burden of dental caries, although most of the recent reports relate to children.¹⁻³ Since 1994, publications have highlighted the high prevalence and severity of early childhood caries and have linked this with certain risk behaviors.^{4,5} Changes in dietary habits have been implicated.¹⁻⁵ One report stated that as many as one in five 12 years old from rural Cambodia had never brushed their teeth,¹ and another linked the high caries rate with the lack of access to oral hygiene aids.³

For public health planning purposes, it is important to have a periodic assessment of the oral disease status of the population to develop appropriate interventions and guide public health policy.⁶ This is especially important in societies experiencing rapid economic and social changes which can directly affect oral health.⁷ In recent years, Cambodia has been experiencing these changes which have created an increasing divide in income levels and increasing access to western lifestyles. The last national oral health study in Cambodia was conducted in 1990,⁸ and more recent studies have been conducted in non-representative samples. The World Health Organization (WHO) recognizes that oral diseases have a significant impact on individuals and are a major burden on communities, especially those with scarce resources to address prevalent oral health problems.⁸ Thus, the need to update our understanding of the oral health status in Cambodia to plan appropriate preventive and curative interventions, including allocation of public health resources.⁹

The aim of this paper is to report on the findings of the 2011 National Oral Health Survey (OHS) with regards to dental caries experience and some of its risk factors and indicators.

Methods

This study was a cross-sectional epidemiological survey to investigate the oral health status of the Cambodian population. The survey was planned and implemented by the staff of the Oral Health Bureau of the Ministry of Health with ethical approval from the Preventive Medicine Department to conduct routine surveillance of oral health in Cambodia. Figure 1 depicts the sample selection process which used a modified version of the recommendations included in the fourth edition of the WHO-OHS Basic Methods (WHO-OHS)⁷ to improve representation. In the first stage of

selection, five provinces (Pursat, Stung Treng, Kampot, Kampong Cham) were randomly selected from 24 provinces in the country, and Phnom Penh, the capital, was selected with certainty. In each of the four provinces, two sites, one urban, and one rural were selected. The town with the largest population was selected with certainty to represent the urban part of the province. All other districts within the province were used as a sampling frame from which one district was randomly selected to represent the rural area. In Phnom Penh, two districts (out of eight) were randomly selected. Within each district for all sites (Provinces and Phnom Penh) two schools were selected using probability proportional to size. We used population proportional to size at the district level to eliminate the need for sample weights. In the final sample, “urban areas” are represented by Phnom Penh and the largest population aggregates, while “rural areas” are represented by rural districts in Cambodia with the exception of Phnom Penh.

The sample selection process generated approximately 200 participants from each selected province (equal allocation). This comprised 40 per age group, including approximately 20 female and 20 male participants over five age groups: 6, 12-13, 15-17, 35-44, and 60+ years. The minimum age was 6 and the maximum was 68 years.

Questionnaire

Three different questionnaires were developed and tested to be administered by trained interviewers; one for the parents of the 6-year-old children, one for the 12-13 and 15-17-year-old children, and one for the two adult groups (35-44 years, and 60 years and older). The face-to-face interviews were conducted before the intra-oral examination and after consent were gained. Parents gave consent for their 6-year-old children to participate.

Clinical examination

Tooth-specific data were collected on the number of teeth present, the number of decayed, missing and filled teeth (DMFT index) and the number of teeth with pulp infection, ulcers, fistulae, and abscesses (PUFA index).¹⁰ Examiners used a dental mirror with the participant seated in a chair (adults) or lying on a table (children). The examination was visual, and untreated decay lesions (D component of the DMFT index) were detected at the cavitation level. Probes were not used.

All intra-oral examinations were conducted by three trained dentists using the techniques recommended in the WHO-OHS protocol.⁶ All examiners participated in a 3 days training and standardization exercise, and replicate examinations were performed on around 3% of participants during the field work phase. Cohen’s Kappa statistic was applied at tooth level to generate an inter-examiner reliability score of 0.85 for dental caries and 0.75 for PUFA status. The intra-examiner reliability score was 0.95 for dental caries and 0.95 for PUFA status.

Data transformation and analysis

Data were entered into IBM SPSS (version 19) where indices and transformation for dental caries variables were computed. This report included statistical tests for means (*t*-test) and rates and proportions (χ^2) using $\alpha = 0.05$. We included published data from the 1990 national survey for assessment of change between both surveys.

Results

Table 1 shows the distribution of the sample by age group, location, and sex. As designed, the sample was approximately half male and female, half urban and half rural and approximately equal in size by age group.

Table 2 presents data on the socioeconomic characteristics of adult participants. Overall, participants in the urban locations (or their parents in the case of 6-year-old children) had higher levels of education and income, while participants in the rural areas tended to report farming as their main occupation.

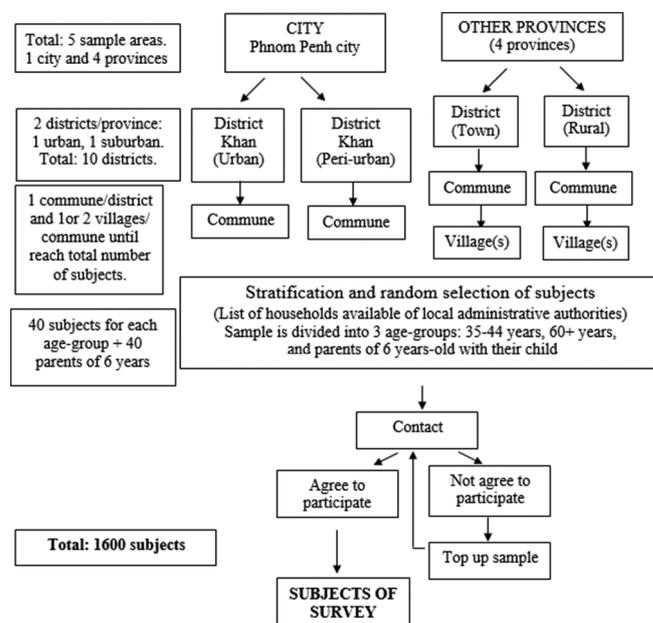


Figure 1: Sample selection process

Characteristics	n (%)		
	Male	Female	Combined
Children (years)			
6	197 (48.9)	206 (51.1)	403 (32.9)
12-13	208 (50.4)	205 (49.6)	413 (33.8)
15-17	207 (50.9)	200 (49.1)	407 (33.3)
Total	612 (49.9)	611 (50.1)	1223 (100)
Adults (years)			
35-44	200 (49.0)	208 (51.0)	408 (50.7)
60-86	193 (48.6)	204 (51.4)	397 (49.3)
Total	393 (48.8)	412 (51.2)	805 (100)
Location			
Urban	493 (48.9)	515 (51.1)	1008 (49.7)
Rural	512 (50.2)	508 (49.8)	1020 (50.3)
Total	1005 (49.6)	1023 (50.4)	2028 (100)

Table 2: Parent- or self-reported social and demographic characteristics of study participants, by age group and location.

Characteristics	Parents of 6 years n (%)		P-value	35-44 year n (%)		P-value	60-87 year n (%)		P-value
	Urban	Rural		Urban	Rural		Urban	Rural	
	Education				0.0368				
No schooling	24 (12.2)	48 (23.3)		18 (8.8)	18 (8.8)		54 (26.7)	69 (35.4)	
Primary school	90 (45.9)	86 (41.8)		65 (31.9)	78 (38.2)		101 (50.0)	104 (53.3)	
Secondary school	75 (38.3)	66 (32.0)		100 (49.0)	94 (46.1)		44 (21.8)	21 (10.8)	
Tertiary	7 (3.6)	6 (2.9)		21 (10.3)	14 (6.9)		3 (1.5)	1 (0.5)	
Occupation			<0.0001			<0.0001			<0.0001
Home duties	71 (36.2)	53 (25.7)		38 (18.6)	37 (18.1)		16 (7.9)	18 (9.2)	
Seller (small business)	58 (29.6)	48 (23.3)		53 (26.0)	35 (17.2)		37 (18.3)	13 (6.7)	
Farmer	13 (6.6)	57 (27.7)		21 (10.3)	59 (28.9)		16 (7.9)	57 (29.2)	
Government staff	22 (11.2)	15 (7.3)		43 (21.1)	39 (19.1)		16 (7.9)	2 (1.0)	
Laborer	16 (8.2)	20 (9.7)		38 (18.6)	18 (8.8)		12 (5.9)	7 (3.6)	
Private business	7 (3.6)	3 (1.5)		11 (5.4)	16 (7.8)		4 (2.0)	1 (0.5)	
Others	9 (4.6)	10 (4.9)		0 (0.0)	0 (0.0)		101 (50.0)	97 (49.7)	
Income			<0.0001			<0.0001			0.0002
<\$50	46 (23.6)	92 (44.7)		33 (16.2)	74 (36.3)		97 (48.0)	126 (64.6)	
\$50-<\$100	80 (41.0)	86 (41.8)		92 (45.1)	65 (31.9)		59 (29.2)	37 (19.0)	
\$100-<\$250	52 (26.7)	24 (11.7)		53 (26.0)	43 (21.1)		21 (10.4)	21 (10.8)	
\$250-<\$500	6 (3.1)	3 (1.5)		9 (4.4)	14 (6.9)		14 (6.9)	1 (0.5)	
\$500+	1 (0.5)	1 (0.5)		17 (8.3)	7 (3.4)		4 (2.0)	0 (0.0)	
Depend on their children	-	-		-	1 (0.5)		7 (3.5)	10 (5.13)	

Adults aged 35-44 years reported the highest proportion of the secondary and tertiary education, even among those living in rural areas. The most frequent reported occupations were “seller or small business,” “home duties,” and “farmer.” Most of the participants in this study came from households that earned <US\$100 per month. Among the 6-year-old children, three in four belong to families reporting earnings of <US\$100 per month. On the other hand, one in five older adults earned more than US\$250 per month.

There was a high prevalence and severity of dental caries across all age groups and few statistical differences by sex and location (Table 3). Over 90% of 6-year-old children and over 80% of 12-13, 15-17 and 35-44 years old had dental caries (dmft or DMFT>0). 6-year-old children had on average 9.0 dmft and 2.7 of those teeth had advanced caries involving the pulp or surrounding tissues (PUFA). Adolescents aged 12-13 years and 15-17 years had 3.8 and 4.5 DMFT, respectively. Adolescents had on average about 1 permanent tooth with pulpal or surrounding tissue involvement (PUFA). Adults aged 35-44 years had on average 5.6 DMFT and 2.6 teeth with pulpal or surrounding tissue involvement (PUFA). Most of the carious lesions across all age groups were untreated; even in the oldest age group, <1 in 10 participants had restorations present (data not shown).

There were differences in the severity of dental caries between provinces. For example, among 6-year-old children the mean dmft (from highest to lowest) was 10.2 (standard deviation [SD] 5.0) for Kampot, 9.5 (SD 3.9) for Phnom Penh, 9.0 (SD 5.2) for Pursat, 8.8 (SD 4.7) for Kampong Cham, and 7.4 for Stung Treng among 12-13-year-old children, the

mean DMFT was 5.8 (SD 4.0) for Kampot, 4.1 (SD 3.6) for Stung Treng, 3.6 (SD 3.4) for Kampong Cham, 3.5 (SD 3.6) for Pursat, 3.2 (SD 2.9) for Phnom Penh.

Table 4 presents the nursing habits for 6-year-old children as reported by their parents. Most of the 6-year-old children (94%) had been breastfed, however, the practice was more common in the rural areas ($P = 0.0005$). More than 90% of children were breastfed at least 6 months, and this was more common in rural (93%) than in urban (89%) areas. However, most parents in urban locations reported breastfeeding for 19-24 months (27.7%) followed by 13-18 months (27.1%) while in the rural locations most parents reported 13-18 months (34%) followed by 7-12 months (8.7%). Differences in breastfeeding patterns were not statistically different between urban and rural children ($P = 0.0575$). A statistically significantly greater proportion of parents in rural locations (89%) breastfed at night compared with parents in urban locations (75.6%, $P = 0.003$).

Less than 1/3 of parents reported bottle feeding (29%), and this behavior was more common among parents from urban (36.5%) than rural locations (22.3%) ($P = 0.0035$). There were no statistically significant differences in the duration of bottle feeding between urban and rural areas ($P = 0.6882$); however, urban parents reported bottle feeding for a mean of 8 months compared with 4.6 months for rural parents (data not shown). Furthermore, a higher proportion of parents in urban compared with rural areas provided a bottle to their 6-year-old children at night (58% vs. 42%, $P = 0.0346$).

Among the bottle-fed children, the most common liquid put in the bottle was milk formula (99%) followed by water (59%)

Table 3: Prevalence and severity of dental caries and sequelae by age-group, sex, and location.

Demographics	DMFT ¹		PUFA teeth ²	
	DMFT>0 n (%)	DMFT Mean (SD)	PUFA>0 n (%)	PUFA Mean (SD)
6 years				
Gender				
Male	183 (92.9)	8.9 (5.0)	127 (64.5)	2.5 (2.7)
Female	192 (93.2)	9.0 (4.8)	134 (65.0)	2.8 (2.9)
Location				
Urban	186 (94.4)	9.5 (4.9) ³	135 (68.5)	2.9 (2.9)
Rural	189 (91.7)	8.5 (4.9)	126 (61.2)	2.5 (2.7)
Combined	375 (93.1)	9.0 (4.9)	261 (64.8)	2.7 (2.8)
12-13 years				
Gender				
Male	157 (75.5) ⁴	3.5 (3.4)	83 (39.9)	0.9 (1.4)
Female	175 (85.4)	4.0 (3.7)	90 (43.9)	1.0 (1.8)
Location				
Urban	162 (79.0)	3.8 (3.9)	91 (44.4)	1.1 (1.9)
Rural	170 (81.7)	3.7 (3.3)	82 (39.4)	0.8 (1.3)
Combined	332 (80.4)	3.8 (3.6)	173 (41.9)	0.9 (1.6)
15-17 years				
Gender				
Male	175 (84.5)	4.4 (3.6)	98 (47.3)	1.0 (1.5)
Female	169 (84.5)	4.7 (3.8)	91 (45.5)	1.1 (1.6)
Location				
Urban	166 (83.0)	4.0 (3.6) ³	87 (43.5)	1.0 (1.5)
Rural	178 (86.0)	5.0 (3.8)	102 (49.3)	1.2 (1.6)
Combined	344 (84.5)	4.5 (3.7)	189 (46.4)	1.1 (1.6)
35-44 years				
Gender				
Male	143 (71.5) ⁴	4.0 (4.8) ³	103 (51.5)	1.2 (1.8) ³
Female	185 (88.9)	7.2 (6.3)	121 (58.2)	2.6 (3.8)
Location				
Urban	165 (80.9)	5.9 (5.9)	108 (52.9)	1.9 (2.9)
Rural	163 (79.9)	5.4 (5.8)	116 (56.9)	1.9 (3.3)
Combined	328 (80.4)	5.6 (5.8)	224 (54.9)	1.9 (3.1)
60-years				
Gender				
Male	150 (77.7)	8.1 (8.7)	115 (59.6)	2.7 (4.0)
Female	151 (74.0)	8.1 (8.4)	117 (57.4)	2.6 (4.0)
Location				
Urban	163 (80.7) ⁴	8.6 (8.2)	119 (58.9)	2.6 (3.9)
Rural	138 (70.8)	7.5 (8.9)	113 (57.9)	2.7 (4.2)
Combined	301 (75.8)	8.1 (8.6)	232 (58.4)	2.6 (4.0)

¹Number of decayed (cavitated), missing and filled teeth. Restricted to primary teeth among 6-year-old. ²Number of teeth with pulp, ulcer, fistula and abscess sequelae. Restricted to primary teeth among 6-year-old. ³Differences between means were statistically significant at $P<0.05$ using Satterthwaite correction for unequal variances. ⁴Differences between proportions were statistically significant at $P<0.05$ using Pearson's Chi-square statistics. DMFT: Decayed missing and filled teeth, PUFA: Pulp, ulcer, fistula and abscessed, SD: Standard deviation

and rice water (52%). 18% reported using condensed milk and 8% soft-drinks. Although more urban than rural mothers reported using milk formula (58% vs. 42%, respectively), these differences were not statistically significant ($P = 0.2247$).

Table 5 reports dietary habits among children and adolescents. More than 80% of 6-year-old children consumed sweets, biscuits and soft drinks and a large proportion consumed these products every day or several times a week. For example, 74% of children consumed sweets and candy every day or several

Table 4: Parent-reported nursing habits of 6-year-old participants.

Nursing Habit	Urban	Rural	Combined	P-value
Breastfeeding	177 (89.8)	202 (98.1)	379 (94.0)	0.0005
Duration breastfeeding (months)				0.0575
1-6	20 (11.3)	13 (6.4)	33 (8.7)	
7-12	38 (21.5)	58 (28.7)	96 (25.3)	
13-18	48 (27.1)	68 (34.0)	116 (30.8)	
19-24	49 (27.7)	46 (23.0)	95 (25.2)	
25-48	22 (12.4)	15 (7.5)	37 (9.8)	
Night time breastfeeding	149 (75.6)	184 (89.3)	333 (82.6)	0.0003
Bottle feeding	72 (36.5)	46 (22.3)	118 (29.3)	0.0035
Duration bottle feeding (months)				
1-6	5 (7.0)	5 (10.4)	10 (8.4)	0.6882
7-12	17 (23.9)	15 (31.3)	32 (26.9)	
13-18	11 (15.5)	7 (14.6)	18 (15.1)	
19-24	19 (26.8)	13 (27.1)	32 (26.9)	
25-48	19 (26.8)	8 (16.7)	27 (22.7)	
Night time bottle feeding	57 (58.2)	41 (41.8)	98 (24.3)	0.0346
Materials in bottle				
Milk formula	58 (58.2)	39 (41.8)	97 (98.9)	0.2247
Rice water (porridge)	21 (41.2)	30 (58.8)	51 (52.0)	0.0956
Condensed milk	10 (55.6)	8 (44.4)	18 (18.4)	0.4743
Juice	3 (33.3)	6 (66.6)	9 (9.2)	0.3105
Soft drink	4 (50.0)	4 (50.0)	8 (8.2)	1.0000
Water	34 (68.6)	24 (41.4)	58 (59.2)	0.5135

Parents were allowed to answer more than one answer. Thus, the percentages for the urban and rural locations were calculated from the total number of parents reporting such material. On the other hand, the percentages in the combined column correspond to percentages among all parents reporting nighttime bottle feeding

times a week. A similar pattern was observed in the 12-13 and 15-17 years old groups with a trend toward consuming more soft drinks every day, with increasing age. (28% and 34%, respectively). Less than one in three children reported eating fruit on a daily basis.

The tooth brushing habits of 6-year-old children were generally unfavorable (data not shown). Only 119 (32.0%) brushed their teeth 2 times a day; 61.7% had not started brushing by the age of 5 years. In the 12-13 and 15-17 years old age groups, 96.9% and 98.7% brushed one or more times per day. Almost all those who reported tooth brushing said that they used toothpaste; 276 (96.5%) of 6-years-olds who brushed, 379 (95.3%) of 12-13 years old who brushed, and 388 (98.5%) of the 15-17 years old who brushed.

Discussion

This study seeks to describe the caries experience of the Cambodian population and some of the associated risk factors and risk indicators. It found that the disease burden of dental caries in children has worsened over the past two decades, and some unfavorable dietary and oral hygiene habits may have contributed to this, particularly in the younger age groups.

Caries experience

Dental caries is by far the most prominent oral disease experienced by the Cambodian population. With almost half

Table 5: Number and frequency of selected dietary foods as reported by the parent (6-year-old) or the study participant.

Age (years)	Every day	Several times/week	Once per week	Several times/months	Never
6					
Fresh fruit	62 (17.9)	68 (19.6)	28 (8.1)	108 (31.1)	81 (23.3)
Sweets/candy	191 (54.9)	68 (19.5)	20 (5.8)	32 (9.2)	37 (10.6)
Biscuits/cakes	121 (35.3)	64 (18.7)	37 (10.8)	66 (19.2)	55 (16.0)
Soft drinks	43 (12.7)	66 (19.5)	33 (9.7)	126 (37.2)	71 (20.9)
12-13					
Fresh fruit	95 (23.0)	139 (33.7)	86 (20.8)	87 (21.1)	6 (1.5)
Sweets/candy	89 (21.5)	82 (19.8)	74 (17.9)	84 (20.3)	84 (20.3)
Biscuits/cakes	86 (20.9)	67 (16.2)	63 (15.3)	107 (25.9)	90 (21.8)
Soft drinks	114 (27.6)	82 (19.8)	73 (17.7)	101 (24.5)	43 (10.4)
15-17					
Fresh fruit	125 (30.7)	143 (35.1)	56 (13.8)	73 (17.9)	10 (2.5)
Sweets/candy	96 (23.6)	91 (22.4)	63 (15.5)	78 (19.2)	79 (19.4)
Biscuits/cakes	100 (24.6)	72 (17.7)	43 (10.6)	110 (27.0)	82 (20.2)
Soft drinks	139 (34.2)	71 (17.4)	51 (12.5)	105 (25.8)	41 (10.1)

56, 55, 60, and 64 parents with missing information on these dietary products, respectively

Table 6: Comparison of dental caries status in two National Surveys in Cambodia, 1990 and 2011 for specific age groups.

Age (years)	Year	n	Prevalence %	Mean			
				DT	MT	FT	DMFT
6 ^a	1990	-	-	-	-	-	-
	2011	403	93.1	8.9	0.1	0.0	9.0
12	1990	288	79.5	1.5	0.1	0.0	1.6
	2011	272	78.3	3.4	0.1	0.1	3.5
15	1990	265	69.1	1.6	0.1	0.0	1.7
	2011	230	80.4	3.9	0.1	0.3	4.2
35-44	1990	270	89.5	3.4	2.5	0.5	6.4
	2011	408	80.4	3.8	1.3	0.5	5.6
65-74	1990	253	93.3	3.3	13.0	0.1	16.4
60-84	2011	397	75.8	3.8	4.1	0.1	8.1

Estimates for specific single ages in 2011 were recalculated to make them comparable to the 1990 age indicators. Data for 6-year-old participants correspond to primary teeth only. DMFT: Decayed, missing and filled teeth, DT: Decayed Teeth, MT: Missing Teeth, FT: Filled Teeth

of the primary teeth affected by dental caries and most of it being untreated decay, this is an indication of the poor oral health and lack to dental care for children in Cambodia. The severity of dental caries was explored by the use of the PUFA index. One in three of the carious lesions in 5-year-old children was pulpally involved. This indicates a pattern of widespread untreated dental caries. Consistent with the dmft/DMFT results, the most severe PUFA scores were in the youngest and the oldest age groups, in females, and in the provinces of Phnom Penh and Kampot.

Comparison of disease experience with other countries

The dental caries experience in Cambodia appears to be among the most severe in the world, particularly in the younger age groups, although there are some similarities to epidemiological samples taken from certain neighboring countries. The most comparable in terms of caries experience is the Philippines, which completed a national OHS in 2006. They found that

the prevalence of pulpally involved teeth (PUFA index) was similar to Cambodia; 85% of 6-year-old and 56% of 12-year-old Filipino children had one or more pulpally involved teeth. It is interesting to note that although the dmft of 6-year-olds in the Philippines was similar to Cambodia (mean dmft in Philippines 8.4; mean dmft in Cambodia, 9.0) the mean PUFA score was the higher in the Philippines (PUFA: 3.4) than in Cambodia (PUFA: 2.6).⁹

The 1999 Vietnam National OHS showed a lower prevalence (83.7%) and severity (dmft 6.2) of dental caries in 6 years old compared with Cambodia. However, it is possible that both of these indicators may have worsened over the following decade to mirror the caries experience of Cambodia.¹⁰

Although the Philippines and Vietnam also have a high caries experience it appears that this is not uniform across South East Asia. An epidemiological sample taken from Vientiane, Laos in 2008 found that the 12 years old had a mean DMFT of 1.8.¹¹ Other examples from around the region as reported by FDI are: 12 years old DMFT of 1.0 in Singapore in 2002, 1.6 in Thailand in 1999, 1.6 in Malaysia in 1997, and 0.5 in Nepal in 2004 (http://www.fdiworldental.org/media/11443/atlas_table.pdf). Laos and Singapore have much lower caries experiences than Cambodia, Vietnam, and Philippines perhaps for different reasons; Laos is less developed and possibly people have less access to processed foods and drinks, whereas Singapore is highly industrialized with a high socio-economic status population, a fluoridated water supply, and an effective school dental service.

The dental caries experience in Cambodia differs greatly from that in developed countries as evidenced by recent surveys in the United States of America (USA), the United Kingdom (UK) and New Zealand (NZ). The 2004 national OHS in the USA reported a caries prevalence of 51% among 6-11 years old and a mean DMFT OF 0.4.¹² The 2003 survey in the UK reported a caries prevalence of 34% and DMFT of 0.5 among 12 years old.¹³ The 2009 NZ survey reported that 5-11 years old had a prevalence of 17.3% for untreated decay and a mean DMFT of 0.3.¹⁴ After taking into account the variances in the way the data were presented, it is clear that there is a wide gap in the prevalence and severity of dental caries experience between these industrialized countries and Cambodia. This supports the argument that there is a growing gap in disease experience between the developed and the developing world¹⁵ and that Cambodia, along with many other developing countries, is disproportionately affected by dental caries.

Changes in caries experience in Cambodia since the year 1990

The changes seen in caries experience across time (Table 6) could reflect the differences in lifestyle habits and life experiences across generations (cohort effects). Those who are in the current 60-87 years old cohort would have been between their early 20s and early 50s during the rule of the Khmer

Rouge. During that time, sugar was scarce and the caries rate would have been low. This contrasts with the 65-to 74 years old in the 1990 sample that would have been between their early 50 s and early 60 s over the same period. This may help to explain the difference in the oral health of the two groups. In addition, in the survey in 1990 the numbers of elderly in the survey were relatively low since many in this age-group would have lost their lives during the Khmer Rouge period.

Caries risk indicators

The oral health behaviors examined in this survey focused on known risk factors for dental caries, for example, those related to diet, oral hygiene and dental care seeking behaviors. This survey enquired about nursing and snacking habits among children and adolescents. Among the preschool children, there was evidence of: a high prevalence of nighttime breastfeeding in infants and preschoolers, frequent consumption of cariogenic foods, and unfavorable oral hygiene habits, especially the delayed introduction of tooth brushing until after the age of five.

Breast- or bottle-feeding on-demand or at night and bottle feeding with sweetened liquids are risk factors for early childhood caries.¹⁵⁻²⁰ Night time on-demand breastfeeding (often for several years) is widely practiced in the Cambodian population. The most common snack foods consumed had low nutritional value, high cariogenic potential and could also have contributed to the severe dental caries experience found in the younger age groups. Finally, it has long been known that brushing twice per day with a fluoride toothpaste will help to prevent dental caries;²¹ the low prevalence of tooth brushing in the youngest age group points to a potential area for intervention. It is likely that an improvement in tooth brushing habits with fluoride-containing toothpaste could impact on the levels of dental caries²⁴ in Cambodia. Improving tooth brushing behaviors and improving access to fluoride toothpaste is in line with the basic package of oral care²² recommended by the WHO. Water fluoridation should also be considered for Phnom Penh and perhaps other urban centers.

Strengths and limitations

Due to limitations in budget, resources, and more importantly, a reliable sampling frame for all schools and for adults, we could not implement a full probability sample of the population. However, we inserted random selection elements in the different sampling stages. The data represents well each of the primary provinces and Phnom Penh, as well as estimates for urban and rural areas in the aggregate. However, because of the variability in the data by provinces, there may be some bias in the overall (population) estimates. In these cases, using a full range would be a less bias approach, for example, instead of assigning 9.0 as the overall estimates for Cambodia, it would be more prudent to indicate that this may vary between 7.4 and 10.2. On the other hand, because we have introduced

some randomization processes in our sampling our data may be less biased than national data had we followed the WHO sampling method.

Another issue in aggregating data would be in the urban and rural composition (geographical bias). Four in five Cambodians live in rural areas according to national figures (<http://www.nis.gov.kh/index.php/nss/official-statistics> accessed on 10/8/13). We designed the sample to have equal representation of each of these locations to allow comparisons. Thus, aggregates at the provincial levels could be biased if disease levels differ by location. Our data, however, show few differences in disease levels by location and sex (Table 3), suggesting that provincial estimates should not be affected by geographical bias.

The main strengths of the study were the use of the standardized protocol with good inter-examiner reliability, and the use of some of the same methods and criteria as were used in the 1990 National OHS, thereby allowing for comparisons between the two surveys over a 21-year period.

Conclusion

The prevalence and severity of dental caries in Cambodia is very high, especially among children. This may be related to early childhood feeding practices, a high sugar diet, late adoption of daily brushing, and a lack of fluoride exposure. To address these problems public health preventive interventions are recommended, focusing primarily on pregnant women, preschool children and their mothers, and children at school.

Recommendations to Ministry of Health

In light of the findings of the 2011 Cambodian National OHS, the following recommendations have been made by the Ministry of Health, Cambodia: (1) Ensure that that Cambodian people have access to the WHO Basic Package of Oral Care, including Oral Urgent Treatment; (2) ensure that Cambodian people have access to fluorides, including fluoride toothpaste and fluoridated water supplies; (3) implement "healthy schools" policies to enhance oral health in children using a preventive approach; and (4) focus on preventing dental caries from birth, by targeting mothers and children for education and topical fluoride applications, for example, fluoride varnishes applied by primary health care providers.

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