Nutritional status and dental caries of vulnerable Cambodian children and adolescents living in Phnom Penh

Estado nutricional e cáries dentárias em crianças e adolescentes cambojanas vulneráveis que vivem em Phnom Penh

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Abstract During childhood, malnutrition is associated with dental caries, being the most prevalent oral disease in Cambodian. Therefore, this cross-sectional study investigated the nutritional status and the prevalence of dental caries in 344 vulnerable Cambodian children and adolescents aged 6 to 18 years old. Nutritional status (body weight, height and body mass index-for-age and sex) and the DMFT index (decayed-missing-filled teeth) were measured and calculated. Results showed that most participants presented normal weight (56.7%), 36.6% were underweight, 6.7% were overweight and 45.1% were stunted. Dental caries prevalence was remarkably high (94.9%) with children aged 6–11y-old presenting a significantly higher DMFT index (6.7 ± 4.0) than adolescents

Resumo Durante a infância, a malnutrição está relacionada com a cárie dentária, doença mais prevalente no Camboja. Assim, este estudo transversal avaliou o estado nutricional e a prevalência de cárie dentária em 344 crianças e adolescentes vulneráveis cambojanos com idades entre os 6 e os 18 anos. O estado nutricional (peso corporal, estatura e índice de massa corporal para idade e sexo) e o índice CPOD (dentes cariados-perdidos-obturados) foram medidos e calculados. Os resultados mostraram que a maioria dos participantes apresentava peso normal (56,7%), 36,6% baixo peso, 6,7% excesso de peso e 45,1% baixa estatura para a idade e sexo. A prevalência de cárie dentária foi notavelmente alta (94,9%) com as crianças de 6–11 anos a apresentar um índice CPOD significativamente maior (6,7 ± 4,0)

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(4.0 ± 2.9 for 12–14y and 4.1 ± 1.6 for 15–18y, $P < 0.01$). Children suffering from underweight showed the highest DMFT index (6.6 ± 3.8). In conclusion, vulnerable and at-risk children aged 6–11y-old and underweight were the most affected; therefore, prevention is urgent, especially nowadays. Nutritional and oral health literacy should be encouraged.

Keywords: Nutritional status; dental caries; children; adolescents; Cambodia.

do que os adolescentes (4,0 ± 2,9 para 12–14 anos e 4,1 ± 1,6 para 15–18 anos, $P < 0,01$). As crianças com baixo peso apresentaram o maior índice CPOD (6,6 ± 3,8). Em conclusão, as crianças vulneráveis e em situação de risco, na faixa etária dos 6 aos 11 anos e com baixo peso foram as mais afetadas, pelo que a prevenção é urgente, principalmente nos dias de hoje. A literacia em alimentação e em saúde oral deve ser incentivada.

Palavras-chave: Estado nutricional; cáries dentárias; crianças; adolescentes; Camboja.

Introduction

The Global Nutrition Report (2020) estimated Cambodian children under 5 years old suffer from moderate or severe stunting (32.4%) and wasting (9.7%), which are higher than the average for Asia (21.8% and 9.1%), respectively; overweight is 2.2%. Also, great inequality access to dental care has been shown by the World Health Organization – WHO (2012). Yet, there is a lack of epidemiological data about dental caries in Cambodia children (Turton et al. 2019).

Nutrition and eating habits can enable the caries' incidence by the consumption of carbohydrates high-rich food, which can be quickly fermented; the increased meals frequency; the masticatory function, which influences the dental activity and; the capacity to ensure a natural cleaning of the oral cavity (Moynihan and Kelly, 2014; Kassebaum et al., 2017). Furthermore, it is well-known the nutrition great influence on children's growth and nutritional status (Machado-Rodrigues et al., 2018; Nogueira et al., 2020); therefore, it is relevant to understand the possible relation of children and adolescents' nutritional status with dental caries according to sex and age.

In fact, dental caries is the most prevalent oral disease in the Cambodian population (Chher et al., 2016) and among the most severe oral diseases worldwide (Khitdee, 2017; Turton et al., 2019). They can not only impair individuals' general and oral health, but also their eating habits and sleep (Turton et al., 2019), especially during childhood (Kubota et al., 2020; Zahid et al., 2020). In addition, children and adolescents from lower socioeconomic status are the most vulnerable and affected by unequal

access to health, outdated or non-existent sanitation systems, lack of drinking-water and food insecurity, which can make them more susceptible to dental caries (Kubota et al., 2020; Turton et al., 2020).

Dental caries represents one of the most common threat for a good childhood's oral health and are the leading cause of absence from school. They are a multifactorial disease caused by the interaction between the tooth surface, sugars from food and the bacterial biofilm causing the deterioration of tooth enamel over time through sugars' metabolism and acids' production (World Dental Federation, 2015).

A systematic review conducted by Kassebaum et al. (2017) reported that oral health has not been improving in the last 25 years due to population growth and aging, and 48% of the world population is still suffering from insufficient oral conditions, such as, untreated caries in permanent teeth (affecting 2.4 billion people worldwide in 2010) and untreated caries in deciduous teeth (the 10th most prevalent condition affecting 621 million children worldwide). Several studies have already investigated this, but results were inconsistent. For example, a systematic review showed that 48% of studies did not find any association between body mass index (BMI) and dental caries; 35% found a positive association, while 19% found an inverse association (Hooley et al., 2012).

Since children's nutritional status and general and oral health are influenced by several economic, social, and cultural factors, Cambodia is not an exception.

Exactly, the country is one of the poorest ones in Asia as it has been experiencing great instability due to wars in the last century (United Nations Development Programme, 2020). The World Bank (2017) formally reclassified Cambodia as a lower middle-income country as the result of a continued rapid economic growth over the past several years due to tourism growth, but still 14% of the population in 2014 was living on less than $1.90 per day (poverty line in the world). In July 2017, from the 16.204.486 Cambodians, 50% were under 25 years old; the life expectancy at birth was 64.9 years old, which was the lowest from Asia (except Laos); the infant mortality rate was of 47.4 deaths/1.000 live births (35th country in the world); 75.5% had access to drinking water and; only 42.4% had sanitation facility access.

In 2017, the Cambodia's Human Development Index (HDI) value was 0.582 and, in the last estimation in 2019, it was 0.594, classifying the country in the medium human development category, and positioning it at 144 out of 189 countries and territories (United Nations Development Programme, 2020). However, this HDI decreases to 0.475 when considering the inequality in the distribution of the HDI dimension indices (Cambodia's Human inequality coefficient is equal to 19.9%).

In order to help Cambodian people recover from this situation, more than thousands Non-Governmental

Organizations (NGO) grew up, such as, "Pour un sourire d'enfant" (PSE), one of the biggest, and "Poids Plume Asie" (PPA).

Therefore, the main purpose of this study was to evaluate the nutritional status and the incidence of dental caries of Cambodian children and adolescents living in Phnom Penh and studying in these two NGO.

Materials and methods

Study design and participants

Three hundred and forty-four Cambodian children and adolescents aged 6 to 18 years old studying in the two NGO (PSE and PPA) were evaluated through a cross-sectional epidemiological survey in relation to their nutritional status and dental caries. This study took place on the entire month of June 2017 in Phnom Penh, Cambodia. Vulnerable and at-risk children and adolescents integrated these NGO, such as: orphans, victims of abuse and/or abandoned. Thirty-three participants were observed in the dental clinic of the NGO and 311 participants were observed in rural schools. Due to growth and BMI-for age stratification, participants were subdivided in three subgroups: from 6–11 years, 12–14 years to 15–18 years (Dye et al., 2010).

Ethical approval of human subjects and consent

All procedures performed were in accordance with the ethical standards of the Hospital La Calmette (Cambodia), the Ethical Committee of the University Fernando Pessoa, Oporto, Portugal (CE-UFP26-09-2017) and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Written informed consent was obtained from all participants or participants' guardians included in the study.

Anthropometric measurement

The participants' weight was measured by a digital scale (SECA-872, Hamburg, Germany) to the nearest 0.01kg and height was determined with a portable stadiometer (SECA-213, Hamburg, Germany) to the nearest 0.1cm. Measures were made with participants lightly dressed and without shoes. Procedures were conducted as recommended by the International Society for the Advancement of Kinanthropometry (Marfell-Jones, 2006). Measurements were obtained in duplicate, and the average of two measurements was reported. Body mass index was calculated as weight/height^2 (kg/m^2).

Weight and height data were subsequently converted to BMI-for-age z-scores and height-for-age z-scores with the WHO AnthroPlus software, which uses the WHO Growth reference 2007 (De Onis, 2015). Z-scores allow comparison of an individual's weight, height or BMI, adjusted for age and sex relative to a reference population, expressed in standard deviations (SDS)

from the reference mean. For school aged children, cut-offs for BMI-for-age z-scores were used to categorize children's weight status into underweight (< – 2 (SDS), normal weight (≥ -2SDS & ≤ 2SDS) and overweight (> 2SDS). Stunting was defined as a height-for-age z-score < -2SDS; scores ≥ -2SDs were classified as 'not stunted' (WHO, 2017a).

Dental caries status assessment

Participants were examined in a supine position with a plane mouth mirror number 4, a dental probe (Arinstrumed 102–127) and illumination from a hand-held torch. Appropriate infection control procedures were performed.

Data were collected on dental caries experience using the decayed-missing-filled teeth index (DMFT), which has been used to describe the prevalence of dental caries in an individual by teeth (T): Decayed (D), Missing (M), Filled (F). This index is used to get an estimation of how much the dentition until the day of examination has become affected by dental caries (WHO, 2013). If a tooth had both caries lesion and filling, it was calculated as D only. All intra-oral examinations were performed by one trained assistant using the techniques suggested in the WHO-Oral Health Surveys protocol (WHO, 2013). The dental team included one calibrated examiner and one trained assistant. Calibration training was conducted until both achieved a kappa score above 0.9 for the DMFT index indicating near perfect agreement.

Statistical analysis

Descriptive statistics were calculated (frequencies and means) to characterize the participants. Differences in means between groups were tested using the Kruskal-Wallis test for non-parametric data and t-test for parametric data; differences in proportions among groups were tested using the Chi-squared test. The level of statistical significance was set at a P-value < 0.05. Statistical analysis was performed using the software SPSS version 25.0.

Results

In table 1 are shown the results regarding sociodemographic characteristics, nutritional status, malnutrition and oral health status of 344 participants, 178 were females (51.7%) and 166 were males (48.3%,). Participants' mean age was 10.5 ± 2.5 years old with the majority (67.7%) being children from 6 to 11 years old, and with an average of 27.2 ± 9.4kg, 1.31 ± 0.14m and 15.5 ± 2.7kg/m^2 for body weight, height and BMI, respectively.

Although most of the participants presented normal body weight (56.7%), 36.6% were underweight, 6.7% were overweight and 45.1% were stunted. Significant differences were observed for sex with most underweight children being females (67%, $P < 0.01$; data not shown).

The mean DMFT was 5.8 ± 3.8 with 94.9% of children and adolescents being affected by caries (Table 1). Children aged 6–11y-old presented a significantly higher DMFT index (6.7 ± 4.0) than adolescents (4.0 ± 2.9 for 12–14y-old and 4.1 ± 1.6 for 15–18y-old, $P < 0.01$). There were significant differences for the DMFT index by BMI with participants suffering from underweight showing the highest DMFT score (6.6 ± 3.8, Table 2). No significant differences were observed for DMFT by sex (5.9 ± 3.8 for females and 5.8 ± 3.9 for males, $P > 0.05$) or local of evaluation (5.3 ± 3.8 for NGOs' clinic and 5.9 ± 3.9 for rural schools, $P > 0.05$, Table 2).

Table 3 presents the nutritional status between age-strata. There were significant differences in dental caries status by age-groups. Surprisingly, children aged 6–11y-old demonstrated more decayed teeth than the oldest group and, as expected, less missing and filled teeth.

In table 4 are shown the results of the prevalence of dental caries and oral health status of participants (n = 344) according to BMI-for-age.

Discussion

This is one of the few studies evaluating the nutritional status and the presence of dental caries among Cambodian children and adolescents, since epidemiological data on the subject is lacking (Turton et al. 2019, 2020) and previous studies were mostly conducted in young children (under 5 years old) or adults. Furthermore, these participants were vulnerable and at-risk children and adolescents (orphans, victims of abuse and/or abandoned).

The participants' nutritional status is of concern as 36.6% children were underweight; from those, 67% were mainly female children; and 451.1% were stunted. Children, especially females might be more vulnerable to undernutrition with negative consequences for their growth, physical and mental development and, obviously, oral health. This can be confirmed by our results that showed 94.9% of the participants affected by caries, and were mostly underweight. Furthermore, the DMFT index was also significantly higher in these latter and in the youngest children (aged 6–11y-old).

These findings may be affected by poor environmental conditions and primary health care and/or long-term restriction of a healthy nutrition, since children and adolescents with opposite nutritional status, i.e., underweight or overweight, demonstrated a higher mean of missing teeth than others, which may be indicative of poor oral health hygiene, eating and/or drinking habits (probably by sugary drinks) (Chher et al., 2016). On the other hand, filled teeth were significantly greater in participants with normal body weight, which can indicate a possible greater nutrition and oral health response to infection than those with a more vulnerable immune system.

In fact, an estimated 45% of deaths of children under the age of 5-years

Table 1. Sociodemographic characteristics, nutritional status, malnutrition and oral health status of participants (n = 344).

Variable	Category	Statistics	Values
Sex	Female	n (%)	178 (51.7%)
	Male	n (%)	166 (48.3%)
Age		Mean ± sd	10.5±2.5
		Min-Max	6-18
	6-11 y-old	n (%)	233 (67.7%)
	12-14 y-old	n (%)	92 (26.7%)
	15-18 y-old	n (%)	19 (5.5%)
Local	NGOs' clinic	n (%)	33 (9.6%)
	Rural schools	n (%)	311 (90.4%)
Weight (kg)		Mean ± sd	27.2±9.4
		Min-Max	10-72
Height (m)		Mean ± sd	1.31±0.14
		Min-Max	1.02-1.72
BMI-for-age (kg/m^2)		Mean ± sd	15.5±2.7
		Min-Max	7.8-27.6
	Underweight	n (%)	126 (36.6%)[a,b]
	Normal weight	n (%)	195 (56.7%)[a,c]
	Overweight	n (%)	23 (6.7%)[b,c]
Stunting	No	n (%)	189 (54.9%)
	Yes	n (%)	155 (45.1%)
Oral health status	Total teeth examined	n	2004
	Dental caries prevalence	n (%)	1902 (94.9%)
	Decayed teeth	Mean ± sd	5.5±3.9
		Min-Max	0-19
		n (%)	1901 (94.9%)
	Missing teeth	Mean ± sd	0.1±0.4
		Min-Max	0-4
		n (%)	28 (1.4%)
	Filled teeth	Mean ± sd	0.2±0.6
		Min-Max	0-4
		n (%)	75 (3.7%)
	DMFT index	Mean ± sd	5.8±3.8
		Min-Max	0-19

DMFT: decayed-missing-filled teeth index, sd: standard deviation, NGO: non-governmental organizations.
[a,b,c] Significant differences ($P < 0.01$) were observed using the Kruskall Wallis test.

Table 2. DMFT index by sex, local and BMI-for-age of participants (n = 344).

DMFT index	Category	Mean±sd	Min-Max	*P*
DMFT by sex				0.870
	Female (n=178)	5.9±3.8	0-19	
	Male (n=166)	5.8±3.9	0-17	
DMFT by age-group				0.001*
	6-11y-old (n=233)[a]	6.7±4.0	0-19	
	12-14y-old (n=92)	4.0±2.9	0-13	
	15-18y-old (n=19)	4.1±1.6	0-7	
DMFT by local				0.462
	NGOs' clinic (n=33)	5.3±3.8	1-16	
	Rural schools (n=311)	5.9±3.9	0-19	
DMFT by BMI-for-age				0.032*
	Underweight (n=126)	6.6±3.8	0-19	
	Normal weight (n=195)	5.8±3.9	0-16	
	Overweight (n=23)	4.5±4.0	0-12	

BMI: body mass index. DMFT: Decayed, missing and filled teeth, NGO: non-governmental organizations, sd: standard deviation.
[a] indicates dmft: decayed, missing, and filled teeth with reference to primary dentition.
*$P < 0.05$.

Table 3. Age, nutritional status and dental caries of participants (n = 344) according to age-strata.

Variables	**6-11y-old** (n=233)	**12-14y-old** (n= 92)	**15-18y-old** (n= 19)
	Mean ± sd (min-max)	*Mean ± sd (min-max)*	*Mean ± sd (min-max)*
Age (years)	9.1±1.6 (6-11)*	12.7±0.7 (12-14)*	16.2±1.1 (15-18)*
Weight (kg)	23.1±5.2 (10.0-40.0)*	33.5±9.2 (18-64)*	46.9±8.8 (33-72)*
Height (m)	1.24±0.85 (1.02-1.47)*	1.42±0.88 (1.23-1.65)*	1.59±0.80 (1.40-1.72)*
BMI (kg/m^2)	14.8±2.2 (7.8-23.0)*	16.4±3.2 (11.2-27.6)*	18.6±3.2 (15.2-26.4)*
Prevalence of DC (%)	65.9	29.1	5.0
DT	6.5±4.0 (0-19)[a,b]	3.5±2.9 (0-13)[b,c]	3.1±1.8 (0-7)[b,c]
MT	0.0±0.2 (0-1)[b]	0.2±0.7 (0-4)	0.3±0.6 (0-2)[b]
FT	0.2±0.5 (0-3)[b]	0.3±0.7 (0-4)[c]	0.7±1.3 (0-4)[b,c]

DC: dental caries, DT: Decayed Teeth, MT: Missing Teeth, FT: Filled Teeth, sd: standard deviation.
[a] indicates dmft: decayed, missing, and filled teeth with reference to primary dentition.
[b,c] Means that in groups within the same row with a common super script letter have a statistically significant difference ($P < 0.05$ or $P < 0.01$).
* $P < 0.01$.

Table 4. Prevalence of dental caries and oral health status of participants (n = 344) according to BMI-for-age.

	Prevalence of DC (%)	DT	MT	FT
		Mean ± sd (min-max)	Mean ± sd (min-max)	Mean ± sd (min-max)
BMI-for-age				
Underweight (n=126)	38.7	6.7±4.0[a,b,c] (0-19)	0.2±.06 (0-4)	0.2±0.2[a] (0-2)
Normal weight (n=195)	25.8	5.6±3.8[d,a,e] (0-16)	0.0±0.3[d,f] (0-1)	0.7±1.2[d,a] (0-4)
Overweight (n=23)	7.4	4.5±4.1[f,b,g] (0-12)	0.3±0.8[f] (0-4)	0.4±0.5 (0-3)

DC: dental caries, DT: Decayed Teeth, MT: Missing Teeth, FT: Filled Teeth, sd: standard deviation.
[a-g] Means that in groups within the same column with a common super script letter have a statistically significant difference ($P < 0.01$).

old are linked to malnutrition (Black et al, 2013). Malnutrition and diet are now the largest risk factors responsible for this global burden of dental caries (Forouzanfar et al., 2016; Kubota et al., 2020; Zahid et al., 2020). Contrarily to Shivakumar et al. (2018), dental caries was associated to BMI, since children aged from 6 to 11years old and those with underweight presented significantly higher levels of DMFT (6.7 ± 4.0 and 6.6 ± 3.8, respectively, $P < 0.01$) than their counterparts. These results are consistent with a previous study conducted in Cambodia with 23.9% of children under 5 years old being underweight (Black et al., 2013). In addition, the incidence of stunting was also high (45.1%) in our study. A systematic review showed that primary dentition caries has been associated with underweight and early childhood malnutrition (Psoter et al., 2005). In fact, malnutrition may influence enamel hypoplasia, salivary glandular hypofunction and saliva compositional changes which can impair teeth structure. In a recent systematic review, Chen et al. (2018) found a significant high prevalence of dental caries among overweight and obese children from high-income countries in both primary and permanent teeth, but not in those from low- and middle-income countries, as is the case of Cambodia, and that dental caries were associated to an increased consumption of sugar. They also observed that dental enamel is weaker in children than in adolescents or young adults (Chen et al., 2018).

In a study with 3985 participants, from which 1126 (28.3%) children (under 4 years old) were from the province Phnom Penh, as our participants, a high consumption (around 80%) of sugary

drinks was observed (Sheiham, 2009). In another study with Cambodian children (7, 10 and 13 years old), sugar intake was 28.42 ±2 5.28g from which 46% were from commercial beverages and snacks (Shikanai et al., 2014); however, no associations were found between body weight and sugar intake. Also, a more recent study conducted in 121 mother-child pairs (from 18 to 36 months-old children living in a rural area of Cambodia) found that early childhood caries and maternal caries prevalence were 54.5% and 84.3%, respectively, and that breast-feeding after 18 months, sugary food and beverage intake for the child and late introduction of toothbrushing for the child (among others) were indicators for early childhood caries (Kubota et al., 2020).

As previously mentioned, the high level of dental caries in our participants might be linked to the poor oral health hygiene, but the recent trend of high sugar consumption in Cambodia should also be considered, despite participants' characteristics. Although eating and drinking habits were not evaluated in this study, during data collection children were often eating sweets and had easy access to various types of sweet foods or drinks from street sellers, which may affect their oral health and nutritional status. Furthermore, they were vulnerable children living in a low-income environment with possible low food availability, contrarily to medium- or higher-incomes environments as cited in the literature, which impair their eating habits and nutritional status.

When comparing decayed, missing and filled teeth across age-strata from findings of Cambodian National Oral Health Surveys from 1990 (Petersen, 2003) and 2011 (Chher et al., 2016), our study confirms the tendency of 2011 with children showing worse results than adolescents.

Despite no significant differences were found for DMFT according to sex, as observed by Kassebaum et al. (2017), or local of the study, our participants aged 6–11 years old presented a lower mean DMFT (6.7 ± 4.0) than children of same age and province (Phnom Penh) from the 2011 Cambodian National Oral Health Survey (Chher et al., 2016), but higher than those of the 1999 Vietnam National Oral Health Survey (mean DMFT = 6.2) (Do et al., 2011). In addition, our participants aged 12–14-year-old demonstrated a slightly higher mean DMFT (4.0 ± 2.9) in comparison to 12–13-year-old adolescents (3.2 ± 2.9) of the 2011 survey (Chher et al., 2016), which may raise some concern about eating and drinking habits. The mean DMFT of the study was 5.8 ± 3.8 ranging between 0 and 19 teeth affected. This may be explained by the recent trend of increasing sugar consumption in Cambodia, as aforementioned, and insufficient fluoride exposure (Petersen and Ogawa, 2016). Exactly, dental caries has been associated to an increased consumption of sugar (Chen et al., 2018)

and sugarcane production has become a large industry in Cambodia during the continuing economic development (WHO, 2015). In relation to the fluoride exposure, the problem in Cambodia is that some regions have too much fluoride and arsenic in drinking water, and other regions have insufficient exposure of fluoride (Feldman et al., 2007). Small amounts of fluoride are beneficial for teeth, but high amounts can destroy them and be accumulated in bones leading to crippling skeletal damage; therefore, children are at risk (Psoter et al., 2005). Other causes of high level of dental caries in Cambodia can be linked to hygiene habits, which are still lacking. For example, one in five 12 years old from rural children had never brushed their teeth (Chu et al., 2008). Also, levels of salivary *Streptococci mutans* can be also causes of caries in infants (Maciel et al., 2001).

In low- and middle-income countries, most of the dental caries is untreated, and teeth are often extracted when they cause pain or oral infection (WHO, 2017b). During this study, and when the examination took place in schools far away from the NGO's dental clinics, it was not possible to treat deep dental caries, because of the high number of children and missing material and impossibility of cross infection control for all.

It should be highlighted the enormous and negative potential effects of the actual world pandemic caused by the Coronavirus in these already vulnerable Cambodian children and adolescents. Therefore, prevention is even more urgent nowadays, especially in Cambodia. Nutritional and oral health literacy should be encouraged through healthy eating habits, such as, reducing sugar consumption in foods and drinks, increasing healthy eating and drinking habits (Bernabé and Sheiham, 2014; Machado-Rodrigues et al., 2018; Nogueira et al., 2020; Silva and Silva, 2017), oral health hygiene behaviors (brushing teeth after meals and before going to bed) and enhancing exposure to fluoride (via toothpaste or fluoridating water) (Chher et al., 2016). Although it seems that the burden of untreated caries is changing from children to adults (Kassebaum et al., 2017), is also imperative to obtain a baseline oral health information to local authorities and oral health systems be able to plan and identify those more vulnerable, children.

Limitations

The limitations of this study should be considered when interpreting these results. Firstly, the prevalence of children according to age was different with the oldest group being the less represented (n = 19; 92 children aged 12–14yrs and 233 children aged 6–11yrs). Secondly, it was a cross-sectional study, which limits the ability to identify the cause-effect relationship. Thirdly, malnutrition, food consumption patterns including sugary foods and oral health hygiene habits were not monitored.

Conclusions and implications

This study demonstrated a poor nutritional status, the presence of malnutrition and a remarkably high prevalence of dental caries in vulnerable and at-risk Cambodian children and adolescents (orphans, victims of abuse and/or abandoned) with great incidence in young ages from 6 to 11 years old. Participants with low BMI-for-age (underweight) were the most affected by dental caries presenting significantly high levels of DMFT index. The recent trend of enormous consumption of sugar in Cambodia and the lack of oral hygiene habits may be negatively affecting children and adolescents' dental caries prevalence, especially in this moment of the pandemic by COVID-19. Therefore, prevention is urgent and longitudinal studies monitoring oral and general health with nutritional disorders are much needed, especially in evaluating early childhood dental caries experience and nutritional intakes, with particular attention for children from lower and study's age-strata, and interactions between risk and protective factors also related to infant feeding practices. Nutritional and oral health literacy should be encouraged.

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