Community Dental Health (2019) **36,** 207–213
Received 5 March 2019; Accepted 8 June 2019

doi:10.1922/CDH_4575Lee07

Dental caries status and related modifiable factors among Nepali students

Hyo-Jin Lee[1*], Dilip Prajapati[2*] and Bo-Hyoung Jin[2,3]

[1]Department of Dental Hygiene, College of Dentistry and Research Institute of Oral Science, Gangneung-Wonju National University, 7 Jukheon-gil, Gangneung, 25457, South Korea; [2]Department of Preventive and Social Dentistry, School of Dentistry, Seoul National University, 101 Daehak-ro, Joungno-gu, Seoul, 03080, South Korea; [3]Dental Research Institute, School of Dentistry, Seoul National University, 101 Daehak-ro, Joungno-gu, Seoul, 03080, South Korea.
[*]The first two authors contributed equally.

Objective: This study aimed to assess the dental caries status of Nepali students and describe correlated modifiable factors. ***Basic research design:*** Cross-sectional analytic study. ***Participants:*** 730 grade two to four (6-14 years old) students from 23 different government schools in seven different districts in Nepal from December 2014 to February 2015. The schools were located in areas of low socioeconomic status without access to fluoridated water. ***Method:*** A trained, calibrated dentist performed visual examination using WHO criteria. Data on demographic variables, oral health behaviors, the number of shops (including sugary snacks) around each school and the distance from Dhulikhel city (where many medical and dental facilities are available) to each school were collected. Multivariable logistic regression was used to identify factors associated with dental caries. ***Results:*** Of the participants, 53.7% and 14.4% had decayed, missing and filled teeth (dmft) in the primary and permanent dentition, respectively. The mean number of primary decayed teeth (dt) was found to be 1.69, and the permanent DT was 0.22; mean dmft was 1.74 in primary dentition and 0.22 in permanent dentition. The number of markets near a school and the distance to the Dhulikhel city were associated with permanent (odds ratio [OR]: 1.67) and primary dmft (OR: 0.62), respectively, after adjusting for the related covariates. ***Conclusions:*** Most dental caries remains untreated. Students with more shops near their school and who attended schools closer to the city were more likely to have dental caries.

Keywords: *dental caries, dental health survey, oral health, Nepal, schools*

Introduction

Dental caries, the most common childhood disease (Fejerskov, 1997), is considered a public health problem, especially in vulnerable and low-income populations because of its high prevalence and social impact (Armfield, 2007; Christian *et al.*, 2019). Many factors cause dental caries, among the most important are dietary habits, especially the consumption of food that is high in refined carbohydrates (Marshall *et al*., 2005). Fluoride use and dental sealants are effective measures to prevent the disease. However, oral health behavior such as regular tooth brushing with fluoride toothpaste seems very rare among children in low-income countries (Petersen, 2008). Untreated dental caries has a high impact on the quality of life of children with low socioeconomic status (Martins-Júnior *et al*., 2012).

Untreated dental caries among children increases the risk of negative perceptions of dental disease and oral health, regardless of gender or malocclusion (Martins-Júnior *et al*., 2012). There might be negative impacts on engaging in social relations due to pain, and children might not be able to benefit fully in their education due to pain and discomfort. Previous studies have shown high levels of decay in the primary and permanent dentitions to be directly associated with toothache, missed school hours, and impaired daily life activities (Jürgensen and Petersen, 2009). Poor dental status may also affect speech development, with possible consequences of social stigma in adolescence, thus affecting social acceptance (Gao *et al*., 2014).

The World Health Organization (WHO) reported that 60-90% of school children had experienced dental caries worldwide (Petersen *et al*., 2005). The one national survey of oral health in Nepali children showed that 67% of 5 and 6-year-old school children experienced dental caries (Yee and McDonald, 2002). Given this caries prevalence rate, dental caries was more prevalent than malnutrition, affecting 49.0% of the child population (Ministry of Health, 2011). Prasai Dixit et al. (2013) also reported that 45% of Chepang school children aged 5-16 years in Nepal had experienced dental caries, and the dmft and DMFT were 1.15 and 0.57, respectively.

Nepal is a small, beautiful landlocked country in South Asia with tremendous geographic diversity, bordered by China to the north and open bordered with India to the south, east and west. It has a total area of 147,181 km^2, with a total population of 26.4 million and a literacy rate of 65.9% (2011 census) (Government of Nepal, 2014). Nepal ranked 145th on the Human Development Index in 2015 (United Nations Development Programme, 2015), and it's gross domestic product (GDP) ranked 104th in the world (The World Bank, 2015). Rural school children in Nepal have inadequate sources of oral health knowledge and access to treatment facilities. In addition, there are rural locations with only one outreach center for medical treatment, with occasional visits from dental experts from

Correspondence to: Bo-Hyoung Jin, Department of Preventive and Social Dentistry, School of Dentistry, Seoul National University, 101, Daehak-ro, Jongno-gu, Seoul, 03080, South Korea. Tel: +82-2-740-8783, Fax: +82-2-765-1722, E-mail: jjbh@snu.ac.kr

Dhulikhel hospital. Nepali children might have low levels of oral health knowledge, awareness and practice compared to their western counterparts (Yee and Mishra, 2004), but little is known about the oral health behaviors of children from developing or underdeveloped countries in comparison with children in developed countries (Al-Omiri *et al*., 2006).

Schools can provide an ideal setting to reach millions of children, and also ensure firm foundations for a healthy life at an early stage. In 2003, the WHO stated that oral health promotion is an essential element of a school health promotion and published a document about oral health promotion through schools (World Health Organization, 2003). In Nepal, the school-based health promotion approach could be adopted to address problems such as poor oral health and untreated dental caries because human and financial resources are limited. However, there are few reports of dental caries prevalence or oral health behaviors in Nepali school children (Yee *et al.*, 2006). Moreover, baseline data are needed to select and target prevention programs, such as fluoride mouth-rinsing and oral health promotion. Thus, this study aimed to assess the dental caries status of Nepali primary school students and to describe correlated modifiable factors.

Methods

This study was conducted in compliance with the principles of the Declaration of Helsinki. Ethical approvals were obtained from the Institutional Review Board (IRB) of the Research Department of the Kathmandu University School of Medical Science in Nepal and the School of Dentistry of Seoul National University (S-D20140010) in Korea. A cross-sectional study was conducted from December 2014 to February 2015 with a total of 730 students; attending grades 2, 3, and 4 in 23 different government primary and secondary schools. The schools were selected randomly from those located near 11 different outreach health centers run by Kathmandu University School of Medical Sciences Hospital (Dhulikhel Hospital) in Kavre (Figure 1). These included seven different districts of Nepal: Kavrepalanchowk, Sindhupalchowk, Dhading, Lalitpur, Dolakha, Nuwakot and Ramechaap (Figure 2).

Written informed consent was obtained from the principal of each school to administer a questionnaire. The school teachers obtained verbal consent from the students' parents to conduct a clinical examination. All students completed an interview that enquired about their age and

Figure 1. Outreach Health Centers with Shops near Schools and nearby District Government Hospitals

Outreach hospital near a school
District government hospital
Shops near schools where candy is available
H Kathmandu University Hospital in Dhulikhel city
K Kathmandu (capital)
1 Thangsin Health center - Nuwakot
2 Chattere Deurali Health Center - Dhading
3 Godamchaur Health Center - Lalitpur
4 Dhungkharka Health Centre - Kavre
5 Dapcha Health Center - Kavre
6 Bolde Health Centre - Kavre
7 Baluwa Health Center - Kavre
8 Bahunepati Health Center - Sindhupalchowk
9 Salambu Health Center - Kavre
10 Kirnetar Health Center - Dolakha
11 Hindi Health Center - Sindhupalchowk

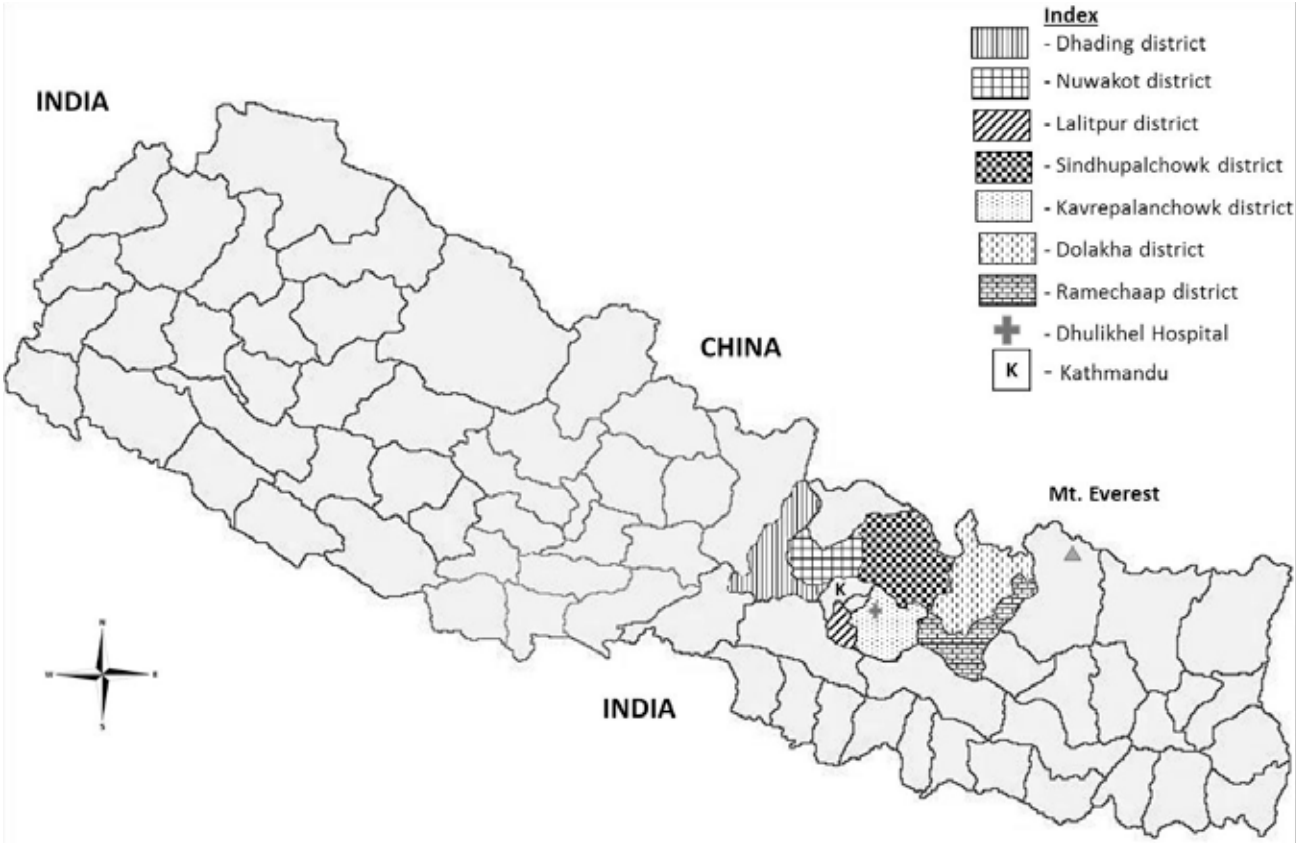

Figure 2. Districts involved in the Study

gender; oral health behaviors such as frequency of eating sweets and toothbrushing. Information on the number of shops (including sugary snacks) within a 1-kilometer radius of each school and the distance from Kathmandu city and Dhulikhel city to each school was obtained from the teachers from the 23 schools during a one-day training program held at Dhulikhel Hospital. The one-day training was held to educate all the teachers about the importance of oral health and prevention strategies.

The clinical examination was based on the WHO (2013) oral health survey guidelines. All of the clinical examinations and data collection were performed by a single trained dentist from Nepal. A reliability test was performed between the researcher from Nepal and the head researcher from the Department of Preventive and Social Dentistry, Seoul National University (South Korea). The inter-examiner Kappa index was 0.956. The clinical examinations were performed at each school with a disposable dental mirror, cotton swab, and headlamp in a well-illuminated area, and were compliant with infection control procedures using new pair of gloves and new dental mirror for each child. The decayed, missing and filled teeth index and the decayed, missing and filled surfaces index (dmft/dmfs for primary dentition and DMFT/DMFS for permanent dentition) were used as the standard tools to determine disease levels.

The results of the oral examinations and questionnaires were analyzed using IBM SPSS Statistics Version 23.0 (Armonk, NY, USA: IBM Corp.). Descriptive and frequency analyses were used to describe the students' socio-demographic information and oral health behaviors. Explanatory variables consisted of age, gender, oral health behaviors, distance from the big city, and the number of shops near the school. We dichotomized the distance from the big city and the numbers of shops into two groups according to the mean value. Multivariable logistic regression analyses were applied to examine the associations between dmft or DMFT and the number of shops near each school or the distance from the big city, adjusting for the effects of covariates (age, gender, frequency of eating sweets and tooth brushing, the number of shops, distance from the big city). Statistical significance was determined at $p < 0.05$.

Results

The study population consisted of 730 students from 6-14 years of age (mean age 9.13, standard deviation 1.48), 50.8% were boys (369 students) and 49.2% were girls (358). Table 1 shows the distribution of socio-demographic variables and oral health behaviors. The mean number of shops near the school was 4.37 ± 2.39 (not shown in the table). Approximately one fifth (19.3%) of students brushed their teeth twice or more daily.

Table 1 reveals differences in oral health status in the primary and permanent dentition according to demographic variables and oral health behaviors. Students in schools closer to Kathmandu and Dhulikhel city had higher dmft scores ($P = 0.001$), and students with more shops near the school had higher DMFT scores ($P = 0.024$).

The prevalence of active dental caries was 53.7% and 14.4% in the primary and permanent dentitions respectively. There was a very low prevalence of missing and filled primary and permanent teeth (3.2% and 0% for primary and permanent missing teeth, respectively, and 0.1% for both primary and permanent filled teeth) (Table 2). The mean was found to be 1.69 for primary decayed teeth and 0.22 for permanent decayed teeth, whereas the means for primary dmft and permanent DMFT were 1.74 in primary dentition and 0.22 in permanent dentition (Table 2).

Table 1. Characteristics of 730 Nepali students and dental caries status according to demographic variables and oral health behaviors

Variables	*N*	*%*	*dmft*		*DMFT*	
			Mean ± SD	*P**	*Mean ± SD*	*P**
Age (n = 730)						
6-8 years	234	32.1	2.43 ± 3.06	< 0.001	0.16 ± 0.56	0.154
9-11 years	459	62.9	1.46 ± 1.97		0.24 ± 0.63	
12-14years	37	5.1	0.89 ± 1.47		0.30 ± 0.62	
Gender (n = 727)						
Male	369	50.8	1.75 ± 2.46	0.867	0.20 ± 0.58	0.288
Female	358	49.2	1.73 ± 2.35		0.24 ± 0.63	
Frequency of eating sweets (n = 697)						
Once or more a day	446	64.0	1.81 ± 2.44	0.434	0.22 ± 0.62	0.880
Less than once a day	251	36.0	1.66 ± 2.32		0.23 ± 0.62	
Frequency of tooth brushing (n = 730)						
Twice or more a day	141	19.3	1.62 ± 2.09	0.500	0.33 ± 0.80	0.048
Less than twice a day/Do not brush/Do not know	589	80.7	1.77 ± 2.47		0.19 ± 0.55	
Distance from a city (n = 730)						
Close	440	60.3	1.97 ± 2.59	0.001	0.22 ± 0.62	0.846
Further	290	39.7	1.40 ± 2.04		0.21 ± 0.59	
Number of shops near the school (n = 730)						
Fewer	353	48.4	1.84 ± 2.60	0.258	0.17 ± 0.54	0.024
More	377	51.6	1.64 ± 2.19		0.27 ± 0.66	

dmft, decayed, missing and filled teeth in primary dentition.
DMFT, decayed, missing and filled teeth in permanent dentition.
SD, standard deviation.
* t-test.

Table 2. Dental caries and treatment experience among Nepali students (n=730)

Variables	*N*	*(%)*	*Mean ± SD (Range)*
Decayed primary teeth (dt)	392	(53.7)	1.69 ± 2.34 (0 - 13.00)
Decayed permanent teeth (DT)	105	(14.4)	0.22 ± 0.61 (0 - 4.00)
Missing primary teeth (mt)	23	(3.2)	-
Missing permanent teeth (MT)	0	(0.0)	-
Filled primary teeth (ft)	1	(0.1)	0.01 ± 0.04 (0 - 1.00)
Filled permanent teeth (FT)	1	(0.1)	0.01 ± 0.04 (0 - 1.00)
Decayed, missing, and filled primary teeth (dmft)	393	(53.8)	1.74 ± 2.40 (0 - 13.00)
Decayed, missing, and filled permanent teeth (DMFT)	106	(14.5)	0.22 ± 0.61 (0 - 4.00)

SD, standard deviation.

Students who brushed their twice or more a day had higher DMFT scores ($P = 0.048$). After adjusting for age, gender, frequency of eating sweets and tooth brushing, students living further from a city exhibited less dmft (odds ratio [OR]: 0.62, 95% confidence interval [CI]: 0.45 – 0.86, Table 3). Students with more shops near their school exhibited higher DMFT (OR: 1.67, 95 % CI: 1.06 – 2.63) after adjusting for the effects of covariates (Table 3).

Discussion

This study was conducted to assess the dental caries status of Nepali primary school students and to describe correlated modifiable factors.

Almost half of the students brushed their teeth only once a day, 19.3% brushed more than twice a day, and the remaining students (29.0%) did not brush their teeth on a regular basis (not shown in the table). Findings from a similar study among ethnic Chepang children in Nepal reported that 56% brushed daily, and only 24% brushed twice daily (Prasai Dixit *et al*., 2013). These data suggest that brushing teeth twice daily is not a common practice in Nepal. However, regular toothbrushing with fluoridated toothpaste is recommended for good oral health (Davies *et al*., 2003). One reason for not brushing may be the unavailability of toothpaste and toothbrushes, because of economic conditions and a low priority towards oral health. Therefore, students should be encouraged to brush at least twice daily and may benefit from understanding the importance of oral health through an oral health program. A school-based oral health care program could supply oral care products with the support of the government or non-government organisation.

Table 3. Caries and treatment experience by the number of markets near schools and distance from a city among Nepali students (n = 694)

	Variable	*Adjusted OR*	*95% CI*	*P- value*[*]
dmft[†]	*Distance from the city*			
	Closer	Reference	-	-
	Farther	0.62	0.45 – 0.86	0.004
	The number of shops near the school			
	Fewer	Reference	-	-
	More	1.01	0.74 – 1.39	0.944
DMFT[‡]	*Distance from the city*			
	Closer	Reference	-	-
	Farther	0.96	0.62 – 1.50	0.860
	The number of markets near the school			
	Fewer	Reference	-	-
	More	1.67	1.06 – 2.63	0.026

dmft, decayed, missing and filled teeth in primary dentition.
DMFT, decayed, missing and filled teeth in permanent dentition.
[*]Determined from multivariable logistic regression analysis adjusting for age, gender, frequency of eating sweets and tooth brushing.
[†]dmft was defined as having two or more dmft.
[‡]DMFT was defined as having one or more DMFT.

The prevalence of dental caries in primary teeth (53.7 %) observed among the 6-14-year-old children was consistent with previous studies conducted in Nepal (Adhikari *et al*., 2012; Limbu *et al*., 2013; Shakya *et al*., 2014). The means for dmft and DMFT were 1.74 and 0.22, respectively, with the mean dmft slightly higher than in a study among ethnic children aged 5-16 years old in Nepal (1.15 dmft and 0.57 DMFT) (Prasai Dixit *et al*., 2013). Differences between these studies might be explained partly by age differences and by regional and environmental characteristics (accessibility of sugary foods). Despite the lack of health facilities in Nepal, the prevalence of dental caries seems relatively low compared to other developing or underdeveloped countries. This phenomenon may be because local daily food habits involve the consumption of primarily high-fiber foods.

Additionally, sugary foods are less commonly available in rural areas, so that rural children may consume smaller amounts of unrefined-carbohydrates. Sugars are the most important dietary factor in the development of dental caries (Newbrun, 1969; Sheiham, 1983). On the other hand, Zero (2004) suggested that the relationship between sugar consumption and caries had weakened due to the impact of preventive treatments such as fluoride use and other environmental, social, economic, political, educational and genetic factors, especially in industrialized countries (Zero, 2004). In this study in a developing country, the findings may support the relationship between sugar and dental caries, because any effects of preventive strategies or other factors may be relatively low. Children from schools with fewer shops offering sugary foods nearby had lower mean DMFT scores than those from schools with more shops available. Also, students living further from a big city had lower availability of sweet or sugary foods. Students in schools closer to Kathmandu or Dhulikhel had higher dmft scores than those living further from the city. Therefore, whilst Nepalis' traditional dietary habits seem good for health, sugary food consumption can affect the development of dental caries, especially among younger children. Thus, school-based oral health promotion programs must consider childrens' environments such as the supply of healthy food and the availability of oral care products.

No students had missing permanent teeth, although 3.2% had missing primary teeth. Surprisingly, among all the students, only one primary and one permanent tooth were filled, indicating that more than 90% of the students had never visited a dental clinic for treatment, supporting the results of Yee et al. (2003). This rate seems very high compared to the rate of school children visiting dental clinics observed in other studies (Limbu *et al*., 2013; Ministry of Health, 2011; Yee *et al*., 2006). Access to medical and dental treatment for students in rural areas is challenging; thus, the prevalence of the dental disease may be best controlled by prevention through daily self-care. Also, considering their ages, caregiver (parents and grandparents) is necessary.

There is a lack of national-level oral health policy and regulation that can be attributed to the neglect of oral health and political conflicts in Nepal. That leads to low levels of positive oral health behaviors among rural children and a lack of available dental services. When combined with these children's socioeconomic conditions, poorer oral health is the result. The present study was conducted in government schools in rural areas where only students with very low socioeconomic status were enrolled. Socioeconomic factors are associated with oral hygiene and health; poorer oral health status was more common in lower socioeconomic groups (Piovesan *et al*., 2014). However, most other studies have suggested that students have good knowledge of fluoride and teeth (Priya *et al*., 2013), demonstrating the need to emphasize the importance of oral health to students in Nepal.

Nepal has very little or no oral health data from multiple government schools in different regions. Approximately 80% of schools are community-based government schools (Thapa, 2011). This study targeted rural students, who represent most of the primary- and secondary-level students in Nepal. Following the data collection, oral health education was provided the students and teachers by distributing an oral hygiene kit (toothbrush and toothpaste with dental education books) and by providing simple dental treatment to students who needed it.

There are limitations to this study. Since the age of the school children varied from 6-14 years old, the data may be inaccurate for those students who were too young to answer the questions (children's parents could be involved to ensure higher accuracy). In addition, the students might not accurately recall the number of times they brushed their teeth or ate sweets. The broad age range of the children arises because there is no regulation of school entrance policy in Nepal and because the study took place in rural areas where many children study together without considering their chronological ages. The study cannot fully explain the role of individual children's dietary habits and food available near the study area as factors for dental caries. The other factors, such as distance from a city and the proximity of shops to schools, may also be subject to measurement error by teachers. Also, we only evaluated the inter-examiner reliability for a clinical examination, not the intra-examiner reliability due to the condition of examination environments. However, this study included a large sample consisting of different ethnic groups and cultures with low socioeconomic status from different regions of Nepal (23 government schools from seven districts). The modest dispersal of the sites may also have caused sampling bias. There are few appropriate national data regarding oral health (only one National Oral Health 'Pathfinder' Survey to date, conducted in 2004). As this study covered multiple areas of interest, its findings demonstrate the need for a national oral health survey.

Conclusion

Among Nepali students most dental caries remained untreated. Students with more shops near their school and who attended schools closer to a city had higher dental caries levels. Policies and programs including school-based preventive measures and clinical treatment for dental caries are needed in rural areas of this underdeveloped country, in particular, considering their accessibility to sugary snacks.

Acknowledgements

We would like to express our gratitude to Dr. Kafle and Dr. Saujanya in Dhulikhel Hospital (Kathmandu University Hospital) in Dhulikhel, Nepal and Raphael International in Seoul, South Korea.

The authors have no conflicts of interest and financial support to report related to this study.

References

Adhikari, R.B., Malla, N. and Bhandari, P.S. (2012): Prevalence and treatment needs of dental caries in school-going children attending dental outpatient department of a tertiary care centre in western region of Nepal. *Nepal Journal of Medical Sciences* **1**, 115-118.

Al-Omiri, M.K., Al-Wahadni, A.M. and Saeed, K.N. (2006): Oral health attitudes, knowledge, and behavior among school children in North Jordan. *Journal of Dental Education* **70**, 179-187.

Armfield, J.M. (2007): Socioeconomic inequalities in child oral health: a comparison of discrete and composite area-based measures. *Journal of Public Health Dentistry* **67**, 119-125.

Christian, B., Ummer-Christian, R., Blinkhorn, A., Hegde, V., Nandakumar, K., Marino, R. and Chattopadhyay, A. (2019): An epidemiological study of dental caries and associated factors among children residing in orphanages in Kerala, India: Health in Orphanages Project (HOPe). *International Dental Journal* **69**, 113-118.

Davies, R.M., Davies, G.M. and Ellwood, R.P. (2003): Prevention. Part 4: Toothbrushing: what advice should be given to patients?. *British Dental Journal* **195**, 135-141.

Fejerskov, O. (1997): Concepts of dental caries and their consequences for understanding the disease. *Community Dentistry and Oral Epidemiology* **25**, 5-12.

Gao, J., Ruan, J., Zhao, L., Zhou, H., Huang, R. and Tian, J. (2014): Oral health status and oral health knowledge, attitudes and behavior among rural children in Shaanxi, western China: a cross-sectional survey. *BMC Oral Health* **14**, 144.

Jürgensen, N. and Petersen, P.E. (2009): Oral health and the impact of socio-behavioural factors in a cross sectional survey of 12-year old school children in Laos. *BMC Oral Health* **9**, 29.

Limbu, S., Dikshit, P., Mehata, S. and Thapa, P. (2013): Dental Caries prevalence and treatment needs in children aged upto16 years attending at Kantipur Dental College and Hospital. *Journal of Nepal Dental Association* **13**, 9-15.

Marshall, T.A., Broffitt, B., Eichenberger-Gilmore, J., Warren, J.J., Cunningham, M.A. and Levy, S.M. (2005): The roles of meal, snack, and daily total food and beverage exposures on caries experience in young children. *Journal of Public Health Dentistry* **65**, 166-173.

Martins-Júnior, P.A., Oliveira, M., Marques, L.S. and Ramos-Jorge, M.L. (2012): Untreated dental caries: impact on quality of life of children of low socioeconomic status. *Pediatric Dentistry* **34**, 49-52.

Ministry of Health. (2011): *Annual Report Department of Health Services 2066/2067 (2009/2010)*. Kathmandu: Ministry of Health.

Government of Nepal. (2014): *[Nepal in figures 2014, central bureau of statistics, Government of Nepal, 2011 census]*. http://cbs.gov.np/wp-content/uploads/2012/11/VDC_Municipality.pdf.

Newbrun, E. (1969): Sucrose, the arch criminal of dental caries. *ASDC Journal of Dentistry for Children* **36**, 239-248.

Petersen, P.E., Bourgeois, D., Ogawa, H., Estupinan-Day, S. and Ndiaye, C. (2005): The global burden of oral diseases and risks to oral health. *Bulletin of the World Health Organization* **83**, 661-669.

Petersen, P.E. (2008): Oral health. In, *International Encyclopedia of Public Health*. Kris Heggenhougen, K. and Quah, S. pp677-685. San Diego: Academic Press.

Piovesan, C., Tomazoni, F., Del Fabro J, Buzzati, B.C., Mendes, F.M., Antunes, J.L. and Ardenghi, T.M. (2014): Inequality in dental caries distribution at noncavitated and cavitated thresholds in preschool children. *Journal of Public Health Dentistry* **74**, 120-126.

Prasai Dixit, L., Shakya, A., Shrestha, M. and Shrestha, A. (2013): Dental caries prevalence, oral health knowledge and practice among indigenous Chepang school children of Nepal. *BMC Oral Health* **13**, 20.

Priya, M., Devdas, D., Amarlal, D. and Venkatachalapathy, A. (2013): Oral health attitudes, knowledge and practice among school children in Chennai, India. *Journal of Education and Ethics in Dentistry* **3**, 26-33.

Shakya, A., Shrestha, M., Srivastav, A. and Kayastha, B. (2014): Oral health related knowledge, attitude, and practice among school children of Jyamrung Nepal. *Journal of Chitwan Medical College* **4**, 1-4.

Sheiham, A. (1983): Sugars and dental decay. *Lancet* **1**, 282–284.

Thapa, A. (2011): *Does private school competition improve public school performance? The case of Nepal* [dissertation]. Graduate School of Art and Science: Columbia University.

The World Bank. (2015): *[World Development Indicators]*. http://databank.worldbank.org/data

United Nations Development Programme. (2015): *Human Development Report 2015*. New York: the United Nations Development Programme.

World Health Organization. (2003): *Oral health promotion: an essential element of a health-promoting school*. Geneva; WHO Information Series on School Health.

World Health Organization. (2013): *Oral health surveys: basic methods*. 5th ed. Geneva: World Health Organization.

Yee, R. and McDonald, N. (2002): Caries experience of 5-6-year-old and 12-13-year-old schoolchildren in central and western Nepal. *International Dental Journal* **52**, 453-460.

Yee, R., McDonald, N. and Helderman, W.H. (2006): Gains in oral health and improved quality of life of 12-13-year-old Nepali schoolchildren: outcomes of an advocacy project to fluoridate toothpaste. *International Dental Journal* **56**, 196-202.

Yee, R., McDonald, N. and Walker, D. (2003): An advocacy project to fluoridate toothpastes in Nepal. *International Dental Journal* **53**, 220-230.

Yee, R. and Mishra, R. (2004): *Nepal National Oral Health 'Pathfinder' Survey 2004*. Kathmandu: Ministry of Health.

Zero, D.T. (2004): Sugar – the arch criminal?. *Caries Research* **38**, 277-285.

Zhu, L., Petersen, P.E., Wang, H.Y., Bian, J.Y. and Zhang, B.X. (2005): Oral health knowledge, attitudes and behavior in China. *International Dental Journal* **55**, 231-241.