Influence of dental caries on oral health-related quality of life, school absenteeism, and school performance among Nepalese schoolchildren

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Author Contributions

SK and VA made conception and designed the study. SK, MLL, MH and VA performed the acquisition of data. SK and JP performed the analysis and interpretation of data. SK, JP, MLL and VA participated in preparing the manuscript. MH reviewed the manuscript and gave his comments.

Abstract

Objectives: To evaluate the impact of untreated dental caries and its consequences on oral health-related quality of life (OHRQoL), school absenteeism and school performance in Nepal.

Methods: This is a population-based, national cross-sectional study. This study was conducted among three WHO index age groups (5-6, 12-, and 15-year-olds) of schoolchildren from 18/75 randomly selected districts of Nepal. Clinical findings on untreated dental caries lesions (*decay in primary and permanent dentition, dt/DT)* and its consequences (pufa/PUFA) were recorded, and the participants were graded into four categories based on the severity of untreated dental caries (GUDC). The Nepali version of Child Oral Impacts on Daily Performances (C-OIDP) was used to assess the information on OHRQoL. Similarly, school-related information (school absenteeism and school performance) was collected from the school registry. Generalized linear mixed models with random effects were used to evaluate the association between dental caries and OHRQoL, school absenteeism and school performance.

Results: Among the study sample, the mean (SD) C-OIDP score was 2.4 (5.0). It was observed that the 15-year-olds, those belonging to the Newari ethnic group, and children with high GUDC grades had poor OHRQoL. After adjusting for confounding factors, high dt+DT or pufa+PUFA was associated with higher impact on OHRQoL. Similarly, lower grades of GUDC (Grade 1 and Grade 2) also had less impact on OHRQoL than the most severe Grade 4. High dt+DT or pufa+PUFA were associated with maximum school absenteeism. Furthermore, high C-OIDP and a grade of GUDC ≥ 2 score were associated with poor school performance.

Conclusions: Untreated dental caries and its consequences have a considerable impact on OHRQoL. These conditions may contribute to high school absenteeism, and poor school performance.

Keywords:

Children, dental caries, oral health-related quality of life, school absenteeism, school performance

Introduction

Oral health-related quality of life (OHRQoL) is broadly explained as a multidimensional indicator that measures both functional limitations and psychosocial outcomes of oral diseases including emotional well-being.[1] The growing concern for oral health as part of general health, and the new concept of impacts of oral diseases on quality of life, are gaining global attention. However, in many deprived communities, and low- and middle-income countries, the matter is either not sufficiently studied or findings not sufficiently implemented, adding supportive evidence on disparities in outcomes of OHRQoL.[2,3]

Dental caries is one of the most common globally present non-communicable diseases, affecting 2.4 billion people.[4] In addition, about 66 million South Asian children (9.4% out of 621 million children) are affected with untreated dental caries.[4] Untreated dental caries may result in severe consequences such as acute pain and infections, which may negatively influence eating behaviors, sleep, self-esteem, and emotions. Furthermore, these oral problems also affect the schoolwork and learning process, as children are likely to miss school due to oral pain or infection, which are often consequences of untreated dental caries in children.[5] This was evident in recent systematic reviews, which concluded that children with a high dental caries rate have poor school attendance and poor academic achievement.[6,7] In a longitudinal study, when treatments for decayed teeth were provided, significant improvement on OHRQoL was demonstrated among South Brazilian adolescents.[8]

The most common self-reported oral health problems among Nepalese schoolchildren are toothache, tooth decay, bleeding gums, and bad breath;[9] these were supported by clinical findings in a recent study.[10] However, the impacts on OHRQoL due to untreated dental caries and its consequences among this population have not been studied previously. Furthermore, the Sustainable Developmental Goals (SDG) are set to ensure good health and promoting well-being at all ages (Goal 3), and to obtain quality and equitable education (Goal 4) globally, by the end of 2030.[11] While the United Nations has made efforts for the attainment of the SDG, the impact of oral conditions on these goals has not yet been investigated.

The aim of this study was to evaluate the impact of untreated dental caries and its severe consequences on OHRQoL, school absenteeism, and school performance among Nepalese schoolchildren. The hypothesis was that untreated dental caries and its consequences have a considerable impact on OHRQoL, and negatively influence school performance.

Methods

This population-based, national cross-sectional study was conducted during the spring and summer of 2016. It was conducted among three WHO index age groups (5-6, 12-, and 15-year-old) of schoolchildren from 18/75 randomly selected districts of Nepal. To include samples representing different parts of the country, three districts from each administrative developmental region were selected using a stratified random sampling method that also represented three ecological regions (*Tarai, Hill, and Mountain*) of Nepal. One to two schools per district (*18 public schools + 9 private schools*) were selected conveniently.[10]

Details of the study (study sample, clinical examination, quality control, and quality assurance) were explained previously.[10] Altogether 1,151 schoolchildren were enrolled in this study after a power calculation. The power calculation was carried out by using the G*power software (GPOWER version 3.1, Samsovej 21, 8382 Hinnerup, Denmark) with 95% power and using the Mann-Whitney U test between means (difference in the number of decayed primary and permanent teeth, d/D = 0.3) with an alpha-type error at 0.05. All the children belonging to the age group of 5-6-year-olds, who were accompanied by their parents, were included in the study while randomization was carried out for 12- and 15-year-olds based on sampling fraction.[10]

Information on date of birth and age (*years*) was collected from the school authorities on the day of the examination. Information on ethnicity and place of residence (*ecological and developmental regions*) was also collected from the parents of 5-6-year-olds, and of 12- and 15-year-old participants.

Clinical findings on untreated dental caries lesions (*decay in primary and permanent dentition, dt/DT)* were recorded according to the standard criteria of the WHO.[12] Simultaneously, infections due to untreated dental caries (*visible pulp or pulp involvement, ulceration of the oral mucosa due to root fragments, a fistula, or an abscess, pufa/PUFA*) were also recorded as advised originally.[13] For untreated dental caries (dt+DT) and its consequences, a (pufa+PUFA) per tooth score was assigned. Furthermore, participants were categorized into four grades based on the grading of the severity of untreated dental caries (GUDC) combining d/D and pufa/PUFA as *Grade 1, Grade 2, Grade 3,* and *Grade 4*. The criteria for grades of GUDC are as follows: *grade 1* (healthy, dt+DT=0, and pufa+PUFA=0), *grade 2* (dt+DT=1-

4/≥4, and pufa+PUFA=0), *grade 3* (dt+DT=1-4/≥4, and pufa+PUFA ≤10%), and *grade 4* (dt+DT=1-4/≥4, and pufa+PUFA> 10%).

The findings were recorded manually on data collection sheets. Oral examinations were done by three-trained and calibrated Nepali dentists in the schoolrooms using external (LED) headlights, intra-oral mirrors, and the WHO Community Periodontal probes following the WHO guidelines and criteria.[12] The training included theoretical sessions followed by practical sessions conducted in April 2016 by senior researchers familiar with conducting similar studies. The inter-examiner kappa value for dt/DT was 0.87, for pufa/PUFA 0.63, and the intra-examiner agreement ranged from 0.84 to 0.97.[10]

For the assessment of OHRQoL, the Nepali version of Child Oral Impacts on Daily Performances (C-OIDP) was used. The Nepali C-OIDP was previously adapted and validated.[9] The C-OIDP consist of eight daily performances as follows; *eating food, speaking clearly, cleaning the mouth, sleeping or relaxing, emotional status, smiling, studying, and social contact*. Two trained dental hygienists, who acted as enumerators, carried out face-to-face interviews of the parents of the 5-6-year-olds and of the 12- and 15-year-old children.

Data on daily school attendance were recorded from the school registry, including the number of school days missed during the academic year (from April 2014 to March 2015). Similarly, school performance included the scores in three compulsory subjects (*Nepali, English, and Mathematics*) considered by the Ministry of Education, Nepal. The score from the final examination conducted in March 2015 was collected. The curriculum of compulsory subjects is consistent across the country, both for public or private schools.[14] The school authorities provided both data on school absenteeism and school performance during the filed survey.

The study protocol was approved by the Ethical Committee, School of Medical Sciences, Kathmandu University (IRC No. 60/15, KUSMS), and the Northern Ostrobothnia Hospital District (18/2016) also gave permission. The Ministry of Health and the Ministry of Education, Government of Nepal, gave their written permission for the study, and the district health and education authorities gave their permission. The entire study was conducted in full accordance with the World Medical Association Declaration of Helsinki. Prior to the study, the schools were contacted via an informative letter describing the purpose

and procedure of the examination. Written consent was obtained both from the school headmasters and from parents of the youngest children (5-6-year-olds). Verbal consent was obtained from the children belonging to the oldest age groups (12- and 15-year-olds).

Manually recorded data were transferred into electronic database for analyses. SPSS software (IBM SPSS Statistic for Windows, version 24.0. Armonk, NY: IBM Corp.) was used for analyses. The oral impact on each daily performance experienced by the participants over the past three months was recorded. The severity of the impact and frequency of the occurrence on each daily performance were scored (*range 0 to 3*) as in the original instrument.[15] Later the impact score for each performance was calculated by multiplying the severity and frequency scores (*range 0 to 9*), and the overall score (*range 0 to 72*) was calculated as the sum of impact scores of all eight performances. Finally, the impact percentage score was obtained by dividing the overall score by 72 and multiplying by 100. Based on the highest performances or overall scores, the impact intensities of daily performances and overall score were categorized into six levels (*none, very little, little, moderate, severe, very severe*), following the guidelines of the original instrument.[15] Later, the intensity of impacts was re-categorized into four levels as *none, little (very little and little), moderate, and severe (severe and very severe)*.

Data on school attendance were calculated as proportions (*number of days of school absence divided by total number of school days and multiplied by 100)*, and categorized on the basis of mean percentage of absenteeism as minimum absenteeism (≤ 13%) and maximum absenteeism (>13%) of the total school days. In addition, an aggregate percentage for school performance (*total score in three subjects divided by 3 and multiplied by 100*) was also calculated.

Results were presented as means (standard deviation), and proportions. A chi-square test was performed to compare differences in proportions between the groups. Hierarchical modeling was used to assess the association between outcome variables, and covariates. A generalized linear mixed model with binary logistic regression was used to assess the association between overall C-OIDP score and socio-demographic factors, dt+DT (count variable), pufa+PUFA (count variable), and GUDC (grade1, grade≥2). No impact (C-OIDP score=0) was used as reference group. Model 1 was adjusted for socio-demographic factors (*age, gender, location, and ecological region*). Model 2, 3, and 4 were was adjusted for untreated dental caries (dt+DT), pufa+PUFA, and GUDC, respectively. Estimates for odds ratios

(OR) with a 95% confidence interval (95% CI) were also calculated for each model. For school absenteeism as outcome variable, generalized linear mixed model with binary logistic regression was used, and the clinical findings (dt+DT, pufa+PUFA, and GUDC), and C-OIDP score were explanatory factors. Here, dt+DT, pufa+PUFA, and C-OIDP scores were count variable, and GUDC was dichotomized as grade1, grade≥2. Minimum school absenteeism (≤13% of the total school days missed) was used as the reference group. Model 1 was adjusted for socio-demographic factors (*age, gender, location, and ecological region*). Model 2 was adjusted for dt+DT, and pufa+PUFA, and Model 3 was further adjusted for C-OIDP score. Similarly, Model 4 was adjusted for socio-demographic factors, GUDC, and C-OIDP score. Estimates for odds ratios (OR) with a 95% confidence interval (95% CI) were also calculated for each model. Concerning school performance as the outcome, aggregate percentage for school performance was used as continuous variable, and a generalized linear mixed model was performed. Model 1 was adjusted for socio-demographic factors (*age, gender, location, and ecological region*). Model 2 was adjusted for dt+DT, pufa+PUFA, and school absenteeism. Model 3 was further adjusted for C-OIDP score. Similarly, Model 4 was adjusted for socio-demographic factors, school absenteeism, GUDC, and C-OIDP score. Estimates for regression coefficient (β) and a 95% confidence interval (95% CI) were calculated. An empty linear mixed model (model 0), with schools as a random effect was performed to detect the effect of school. A significant effect was obtained with variance of 46.9%. Another empty linear mixed model, with schools and ecological region as a random effect was performed to detect the effect of school and ecological region. A significant effect was obtain with same variance value. Therefore, in all models, the sampling units (schools) were considered to be random effects. The level of significance was set at $p < 0.05$ for all the statistical tests.

Results

Of the 1,137 schoolchildren participating in this study, 936 (82.3%) had data on school performance, and 894 (78.6%) had data on school attendance. The proportion of schoolchildren with maximum school absenteeism (i.e. >13% of the total school days) was 45.1%. Concerning the OHRQoL, severe impact was among one-fifth of the participants. The highest impact was reported concerning eating food, followed by cleaning the mouth, and sleeping (Table 1).

Severe impact was reported among the oldest ones (15-year-olds), children belonging to the Newari ethnic group, and children with high GUDC grades. Moreover, untreated dental caries (dt+DT≥1) and its consequences (pufa+PUFA≥1) also had high impact on OHRQoL (Table 2).

The youngest children (5-6-year-olds) had significantly less impact on OHRQoL than 15-year-olds. Children living in urban also had higher impact on OHRQoL than those living in rural areas. The same was true for those living in Mountain and Hilly region than the Tarai region. After adjusting for possible confounding factors, the regression models revealed that high dt+DT, or pufa+PUFA, or GUDC were associated with high impact on OHRQoL, and lower grades of GUDC (Grade 1 and Grade 2) had less impact on OHRQoL than most severe Grade 4 (Table 3).

High restorative treatment need (dt+DT) and the GUDC (≥2) as well as high impact on OHRQoL were all associated with school absenteeism (Table 4). Again, high school absenteeism was significantly associated with poor school performance. High C-OIDP and grade of GUDC ≥ 2 scores showed a weak negative association with school performance (Table 5).

Discussion

A high prevalence of untreated dental caries with its severe consequences has a significantly high impact on OHRQoL, as indicated by C-OIDP scores. These conditions were also associated with high school absenteeism. Similarly, high C-OIDP score was associated with high school absenteeism, which was further negatively associated with poor school performance. Not surprisingly, high school absenteeism was significantly associated with poor school performance.

To our knowledge, this population-based study is the first one to include data on dental status, OHRQoL, school absenteeism, and school performance in Nepal. Also, there have been no studies on school absenteeism and school performance among Nepalese schoolchildren. Another strength of this study is including the randomized sample sites from all three ecological regions, and schoolchildren from all major ethnic groups. Furthermore, schoolchildren were included from both public and private schools, and from both urban and rural areas. Data on school performance and school absenteeism can be considered comprehensive, being around 80%. Missing data on those topics may have been mainly due to changing place of residence specifically among 12- and 15-year-olds. Most of the youngest children

were attending their first school. In addition, Nepalese schoolchildren may have missed schools also due to other reasons than untreated dental caries; they can be investigated in the future. Despite of the fact that all schools used same curriculum, variation on scoring and testing among schools were not considered here. In Nepal, regional level exam is conducted in the end of class ten, while national level exam in the end of class twelve. The cross-sectional nature of the study hinders investigating causal relations.

Neither clinical indices nor OHRQoL measures alone are capable of defining the broader picture of oral health. The findings presented here incorporated these determinants of oral condition to describe the experiences of children who have untreated dental caries. The inclusion of school-related information can also be useful in understanding the relationship between children's oral health, cognitive development, and educational attainment.

Although the youngest age group (5-6-year-olds) had the highest burden of untreated dental caries and its consequences, there was a significantly lower impact on proxy-reported OHRQoL when compared with other age groups.[10] It can be speculated that an adolescent suffering from toothache may be more detailed in while explaining dental symptoms and consequences than a proxy reporting or rating on behalf of a child. Concerning 5-6-year-olds, their parents may have had a poor perception of their child's oral health condition, and consequently OHRQoL impacts may have been underestimated. Another consideration may be that the C-OIDP index was not relevant to this particular age group, in spite of the validation of the index.[9] Similar discrepancy was reported in a recent study conducted among 7-17-year German children.[16] However, gingival bleeding and dental trauma were more common among the 15-year-olds than the younger ones, which might have influenced OHRQoL as well.[10] Therefore, a condition-specific OHRQoL impact study should be conducted in the future. Furthermore, the inclusion of all the age groups in the same analysis may be criticised. There was a difference between age groups in both outcome variables and the explanatory factor (untreated dental caries), and so age was considered as a confounder factor in all models. In addition, the caries process and its social and personal consequences are similar regardless of age group or dentition.

In addition, our use of the C-OIDP among 15-year-olds may be contentious. The reason for using instrument was its ease of use (shorter) and simplicity in measuring the impact of oral diseases on daily

activities. Furthermore, no major discrepancies in domains and scoring methods between C-OIDP and OIDP (Oral Impacts on Daily Performances) are apparent, yet studies have not been conducted to compare their use among 15-year-olds, to our knowledge. The use of C-OIDP among 15-year-olds in different cultural settings was also reported in a recent systematic review.[17] However, the OIDP is commonly used among adults, and incorporates the frequency and severity of the oral impacts in the previous six months using a 5-point Likert scale.[18]

Similarly, significant differences in the C-OIPD score between ethnic groups were found in this study. This may be explained by the findings from our previous study, which concluded that the Newari and Janajati children had a higher prevalence of untreated dental caries than children belonging to the other ethnic groups.[10] Ethnic disparities in OHRQoL was also observed among adults in London, where Asian adults had better OHRQoL than their black and white counterparts.[19]

This study emphasizes the role of the restorative treatment need (dt+DT) and consequences of untreated dental caries (pufa/PUFA and GUDC) on OHRQoL. These conditions had a significant impact on daily activities such as eating, cleaning the mouth, sleeping, and even carrying out schoolwork. They clearly reflect negatively in well-being. The possible explanation may be pain due to dental caries and pulpitis (*eating and sleeping*). This also explains the high impact on cleaning the mouth (*difficulty during tooth brushing or when rinsing mouth*).[20]

Role of untreated dental caries and OHRQoL on school attendance was evident here. Likewise, overall OHRQoL and severity of untreated dental caries (GUDC) were negatively associated with school performance. Literature shows that adequate sleep is associated with improved cognitive function.[21,22] This could explain how oral diseases (particularly dental caries) have an impact on OHRQoL, which again negatively influence school performance. Association between untreated dental caries and high school absenteeism consequently resulting in poor school performance is in concordance with recent systematic reviews, which most likely is the case here as well.[6,7] Kaewkamnerdpong and Krisdapong (2018) also reported similar findings. They concluded that dental caries influenced OHRQoL, which was associated with school performance.[23] However, longitudinal studies are needed to evaluate the detailed causes for OHRQoL and their impact on both school absenteeism and school performance.

This study provides insight into the impact of untreated dental caries on the attainment of the SDGs. Policy makers and responsible authorities must be aware of this, and oral health promotion and preventive measures should be an integral part of health agendas in Nepal. The findings here also demonstrate a need for preventive and dental treatment among Nepalese schoolchildren. Furthermore, considering the sample sites, study population selection, and participation rate, the study findings can be considered representative. However, the current economic status and geographic topography of Nepal might hinder the dental treatment aspect, as it is considered the most expensive area of health expenditures.[24] Moreover, preventive methods (tooth brushing twice daily with fluoridated toothpaste, or inexpensive fluoride supplements), and control of dental caries are of utmost importance in Nepal. In addition, school-based dental programs may be beneficial in reducing the impact of oral conditions on quality of life and SDGs. In particular, there is recent evidence that supervised school toothbrushing programs in the low-income areas can improve OHRQoL.[25] It is also recommended to emphasize oral health from an early age, as these affect general health and growth and may even influence learning and cognitive improvement.[20]

In conclusion, high prevalence of untreated dental caries and its consequences have a considerable impact on schoolchildren's OHRQoL as indicated by C-OIDP. Specifically, eating, cleaning the mouth, sleeping, and carrying out schoolwork are affected by untreated dental caries and its severe consequences. These conditions may have some impact on school performance and (subsequently) economic development over time.

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Table 1. Prevalence, mean (SD), and impact intensity (%) of the oral health-related quality of life among Nepalese schoolchildren (C-OIDP and its 8 items scores)

	Overall Impact	Eating food	Speaking clearly	Cleaning mouth	Sleeping or relaxing	Maintaining usual emotional stability	Smiling or laughing	Carrying out schoolwork	Contact with people
Prevalence	39.3	34.0	6.6	23.9	8.6	3.4	7.1	5.1	3.4
Mean (SD)	2.4 (5.0)	0.9 (1.7)	0.1 (0.7)	0.6 (1.5)	0.2 (1.0)	0.1 (0.6)	0.2 (1.1)	0.1 (0.7)	0.1 (0.6)
Impact intensity (%)									
None	60.7	66.0	93.4	76.1	91.4	96.6	92.9	94.9	96.6
Little	11.5	21.9	5.3	14.6	5.2	2.2	4.2	3.0	1.9
Moderate	8.8	8.5	0.9	6.6	1.7	0.8	1.3	1.5	1.1
Severe	19.1	3.6	0.5	2.7	1.6	0.4	1.6	0.6	0.4

Table 2. Distribution of the study participants according to their C-OIDP impact intensity (%) starified by sociodemographic characteristics and dental caries status

Characteristics	C-OIDP impact intensity (%)				
	None	Little	Moderate	Severe	*p-value*
Age					
5-6-year-olds	64.9	14.5	7.0	13.6	*0.049*
12-year-olds	60.3	16.7	7.0	16.0	
15-year-olds	57.7	12.0	7.6	22.7	
Gender					
Boys	60.1	13.8	6.5	19.6	*0.402*
Girls	60.7	15.1	8.1	16.1	
Location					
Urban	57.8	16.6	7.1	18.6	*0.114*
Rural	63.8	11.8	7.4	17.0	
Ecological Region					
Mountain	59.2	13.4	9.6	17.8	*0.091*
Hilly	59.8	13.5	7.2	19.5	
Terai	63.4	18.1	4.0	14.5	
Ethnic Group					
Brahaman/ Chhetri	62.8	15.2	6.3	15.8	*0.035*
Tarai Madhesi	72.7	9.1	0.0	18.2	
Dalits	60.4	15.6	11.5	12.5	
Newar	48.6	17.1	8.6	25.7	
Janajati	57.7	12.4	9.1	20.8	
Muslim	50.0	25.0	0.0	25.0	
Untreated dental caries					
dt+DT=0	76.8	8.4	4.6	10.2	*<0.001*
dt+DT≥1	53.0	17.2	8.4	21.4	
Consequences of untreated dental caries					
pufa+PUFA=0	68.1	11.9	5.8	14.1	*<0.001*
pufa+PUFA ≥1	38.0	21.8	11.3	28.9	

Grading the severity of untreated dental caries					
Grade 1	76.8	8.4	4.6	10.2	*<0.001*
Grade 2	61.9	14.5	6.7	16.9	
Grade 3	40.5	20.0	10.8	28.7	
Grade 4	31.0	26.8	12.7	29.6	

Table 3. Association between oral health-related quality of life (C-OIDP) and socio-demograpic factors, untreated dental caries and its severe consequences

Explanatory factors	C-OIDP score (≥1) OR (95% CI)			
	Model 1	Model 2	Model 3	Model 4
Age group				
5-6-year-olds	0.66 (0.45,0.96)*	0.25 (0.16,0.41)**	0.28 (0.18,0.45)**	0.27 (0.17,0.42)**
12-year-olds	0.94 (0.69,1.27)	0.97 (0.70,1.33)	0.95 (0.69,1.30)	0.86 (0.63,1.19)
15-year-odls	1	1	1	1
Gender				
Boys	0.94 (0.72,1.23)	0.91 (0.68,1.20)	0.94 (0.71,4.44)	0.94 (0.70,1.26)
Girls	1	1	1	1
Location				
Urban	1.75 (0.77,3.94)	1.64 (0.69,3.88)	1.81 (0.75,4.37)	1.85 (0.74,4.62)
Rural	1	1	1	1
Ecological region				
Mountain	1.55 (0.52,4.62)	1.11 (0.35,3.56)	1.28 (0.39,4.21)	1.06 (0.30,3.71)
Hill	1.19 (0.50,2.84)	0.96 (0.38,2.44)	1.14 (0.44,2.94)	0.92 (0.34,2.51)
Tarai	1	1	1	1
dt+DT	-	1.25 (1.18,1.32)**	-	-
pufa+PUFA	-	-	1.93 (1.65,2.26)**	-
GUDC				
Grade 1	-	-	-	0.05 (0.02,0.10)**
Grade 2	-	-	-	0.12 (0.06,0.24)**
Grade 3	-	-	-	0.39 (0.19,0.74)*
Grade 4	-	-	-	1

***p-value <0.001, *p-value <0.05*

OR (95% CI): Odds Ratio (95% confidence interval)

Model 1: adjusted for socio-demographic factors (*age, gender, location, and ecological region*); Model 2: further adjusted for dt+DT; Model 3: adjusted for pufa+PUFA; and Model 4 further adjusted for the GUDC.

Table 4. Association between school absenteeism and socio-demographic factors, untreated dental caries and its severe consequences, and C-OIDP score

Explanatory factors	School absenteeism (>13%) OR (95% CI)			
	Model 1	Model 2	Model 3	Model 4
Age group				
5-6-year-olds	5.28 (2.97,9.38)**	4.25 (2.29,7.92)**	5.01 (2.53,9.95)**	6.18 (3.29,11.65)**
12-year-olds	1.06 (0.66,1.70)	1.04 (0.64,1.68)	1.08 (0.67,1.74)	1.09 (0.67,1.76)
15-year-odls	1	1	1	1
Gender				
Boys	0.94 (0.63,1.39)	0.93 (0.63,1.38)	1.05 (0.69,1.58)	1.06 (0.70,1.60)
Girls	1	1	1	1
Location				
Urban	0.04 (0.01,0.49)*	0.04 (0.01,0.48)*	0.05 (0.01,0.58)*	0.05 (0.01,0.59)*
Rural	1	1	1	1
Ecological region				
Mountain	0.03 (0.01,0.86)*	0.03 (0.01,0,79)*	0.04 (0.01, 0.94)*	0.04 (0.01,0.98)*
Hill	0.15 (0.01,2.12)	0.14 (0.01,2.00)	0.16 (0.01,2.28)	0.16 (0.01,2.37)
Tarai	1	1	1	1
dt+DT	-	1.11 (1.02,1.21)*	1.09 (0.99,1.19)	-
pufa+PUFA	-	0.87 (0.72,1.05)	0.92 (0.75,1.14)	-
C-OIDP score	-	-	1.01 (0.97,1.06)	1.02 (0.97,1.06)
GUDC				
Grade ≥2	-	-	-	1.08 (0.67,1.74)
Grade 1	-	-	-	1

***p-value <0.001, *p-value <0.05*

OR (95% CI): Odds Ratio (95% confidence interval)

Model 1: adjusted for socio-demographic factors (*age, gender, location, and ecological region*); Model 2: further adjusted for dt+DT, and pufa+PUFA; Model 3: further adjusted for C-OIDP score; and Model 4: adjusted for the socio-demographic factors, C-OIDP score, and the GUDC.

Table 5. Association between school performance and socio-demographic factors, untreated dental caries and its severe consequences, school absenteeism, and C-OIDP score

Explanatory factors	School performance β (95% CI)			
	Model 1	Model 2	Model 3	Model 4
Age group				
5-6-year-olds	17.10 (14.68,19.52)**	18.45 (15.79,21.12)**	16.92 (13.93,19.92)**	17.77 (15.03,20.52)**
12-year-olds	5.70 (3.81,7.57)**	5.82 (3.92,7.71)**	5.84 (3.94,7.74)**	5.94 (4.03,7.84)**
15-year-odls	1	1	1	1
Gender				
Boys	-0.69 (-2.37,0.99)	-0.41 (-2.10,1.28)	-0.11 (-1.86,1.64)	-0.19 (-1.95,1.56)
Girls	1	1	1	1
Location				
Urban	5.00 (-6.77,16.77)	2.18 (-0.14,13.51)	2.04 (-9.46,13.54)	2.08 (-9.45,13.62)
Rural	1	1	1	1
Ecological region				
Mountain	3.05 (-12.53,18.63)	-2.30 (-17.34,12.74)	-2.78 (-18.03,12.48)	-2.48 (17.79,12.82)
Hill	5.65 (-7.18,18.49)	2.47 (-9.88,14-82)	2.10 (-10.43,14.63)	2.35 (10.22,14.92)
Tarai	1	1	1	1
dt+DT	-	0.10 (-0.28,0.49)	0.06 (-0.34,0.47)	-
pufa+PUFA	-	-0.13 (-1.04,0.78)	0.38 (-0.70,1.26)	-
School absenteeism	-	-0.37 (-0.49,-0.26)**	-0.38 (-0.49,-0.27)**	-0.38 (-0.49,-0.26)**
C-OIDP score	-	-	-0.12 (-0.31,0.07)	-0.08 (-0.28,0.11)
GUDC				
Grade ≥2	-	-	-	-1.12 (-3.02,0.79)
Grade 1	-	-	-	1

** *p-value < 0.001*

β (95% CI) : estimate of regression coefficient (95% confidence interval)

Model 1: adjusted for socio-demographic factor (*age, gender, location, and ecological region*); Model 2: further adjusted for dt+DT, pufa+PUFA, and school absenteeism; Model 3: further adjusted for C-OIDP score; and Model 4: adjusted for the socio-demographic factors, school absenteeism, C-OIDP score, and the GUDC.