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# Oral health among HIV-positive and HIV-negative children in Phnom Penh, Cambodia: a cross-sectional study

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## ABSTRACT

**Background** HIV-positive children are at high risk for oral mucosal disorders. Additionally, their low immune status is associated with dental caries. However, little is known about how their dental caries and related risk factors, such as salivary flow, salivary pH level and oral health-related quality of life, differ from those of HIV-negative children. The study aimed to assess (1) dental caries and related risk factors in HIV-positive compared with HIV-negative children and (2) the association between these factors and HIV seropositive status in Phnom Penh, Cambodia.

**Methods** This was a cross-sectional study conducted as a baseline survey of a randomised controlled trial. The study setting was the National Pediatric Hospital's catchment area. The study population comprised 328 HIV-positive and 154 HIV-negative children aged 3–15 years and their caregivers. We collected clinical oral health data, questionnaire data to assess oral health-related quality of life and growth data.

**Results** The mean number of decayed, missing or filled permanent teeth (DMFT) and deciduous teeth (dmft) among HIV-positive children was 4.0 (SD 3.6) and 7.0 (SD 4.9), respectively. Among HIV-negative children, the respective values were 3.3 (SD 3.7) and 7.1 (SD 4.6). Living with HIV was positively associated with DMFT (adjusted OR 1.85, 95% CI 1.14 to 3.01) and salivary flow (β=0.72, 95% CI 0.44 to 1.00) and negatively associated with salivary pH (β=−0.13, 95% CI −0.24 to −0.02). However, HIV-positive status was not significantly associated with dmft or oral health-related quality of life.

**Conclusions** HIV-positive children had poorer oral health status regarding DMFT and salivary pH level. Specific strategies and further efforts are required to align their oral health status with that of HIV-negative children.

### What is known about the subject?

- HIV-positive children are at high risk for oral mucosal disorders.
- Their low immune status is associated with dental caries.

### What this study adds?

- HIV-positive children have a greater incidence of dental caries in permanent teeth compared to HIV-negative children.
- HIV-positive children have lower salivary pH levels and higher salivary flow compared to HIV-negative children.
- No difference was observed in the incidence of dental caries in deciduous teeth and oral health-related quality of life between HIV-positive and HIV-negative children.

## INTRODUCTION

Approximately 1.7 million children were living with HIV worldwide in 2018.[1] It is estimated that approximately 880 children are infected with HIV daily.[2] HIV-positive children experience various health disadvantages and are susceptible to opportunistic and other infectious diseases.[3]

Oral health is a critical issue for HIV-positive children. They are at high risk for oral mucosal disorders, including oropharyngeal candidiasis, parotid enlargement, herpes simplex and periodontal diseases[4–7] due to their defective immune systems and socioeconomic status.[4] Lower immune status is also associated with dental caries.[8] However, how their dental caries and related factors differ from those of HIV-negative children is unclear. While several recent studies have reported a high prevalence of dental caries among HIV-positive children,[9–13] comparison studies with HIV-negative children are scarce.[7] Furthermore, dental caries-related factors have rarely been compared in these populations. Low salivary flow and low saliva pH level are known risk factors for cavities. Eating habits, oral care practice and oral health-related quality of life (OHRQoL) are also essential for assessing oral health status. These indicators and related factors need to be studied further among HIV-positive and HIV-negative children to help create strategies for improving the oral health status of these populations.

In Cambodia, the number of HIV-positive children decreased by approximately 55%,

from 6500 cases in 2006 to 2900 cases in 2019.[14] However, the prevalence of dental caries among HIV-positive children and children in general is higher than the global average.[15] Oral health is, thus, an urgent health issue for Cambodian children.

This study, therefore, aimed to assess (1) dental caries and related risk factors such as salivary flow, salivary pH level and OHRQoL in HIV-positive compared with HIV-negative children and (2) the association between these factors and HIV seropositive status in Phnom Penh, Cambodia.

## METHODS

### Study design and site

A cross-sectional study was conducted as a baseline survey of a randomised controlled trial. The research protocol of the randomised controlled trial was previously published elsewhere.[16] Data were collected from February to April 2018 within the National Pediatric Hospital's catchment area in Phnom Penh, Cambodia.

### Study population and selection criteria

The study population consisted of HIV-positive and HIV-negative children and their caregivers. Eligible HIV-positive children were 3–15 years old, had a National Pediatric Hospital patient ID number, and had been receiving antiretroviral treatment (ART) for at least 3 months. We recruited age-stratified eligible HIV-negative children from outside the hospital setting. Eligible caregivers were aged ≧18 years and were the participating children's primary caregivers.

HIV-positive children were recruited using a multiple-step process from the National Pediatric Hospital's patient lists. Of 1113 eligible children, 320 were selected using an age-stratified random sampling method. A data analyst, who was not a primary member of the research team, performed the randomisation using a computerised algorithm.

HIV-negative children were also recruited using a multiple-step process. We selected three districts in Phnom Penh, where most of the participating HIV-positive children resided. From each district, we randomly selected three villages. Participants were recruited based on lists of residents aged 3–15 years provided by village leaders. Then, we selected age-stratified HIV-negative children as we did for HIV-positive children. There were no obvious differences between groups, except for the family wealth index.

### Sample size

The sample size was calculated in advance based on the original study, which is presented in the protocol.[16] We collected 482 participants (328 HIV-positive and 154 HIV-negative children). For this cross-sectional study, we analysed the sample's power based on the ratio of the higher decayed, missing or filled permanent teeth (DMFT) scores (>4 DMFT score) between HIV-positive and HIV-negative children (34.5% vs 45.6%). The power was 0.99 computed for a type I error of 0.05. Thus, we considered the sample size sufficient for this study.

### Data collection

Clinical oral health data, questionnaire data and growth data were used for the analyses. Clinical oral health data were collected by two teams consisting of a dentist and a dental assistant. The total number of decayed, missing or filled teeth was calculated as the DMFT score for permanent teeth and decayed, missing or filled deciduous teeth (dmft) score for deciduous teeth. A high DMFT/dmft score expressed an increased number of dental caries in permanent/deciduous teeth. Before data collection, one of our dentist researchers provided data collector dentists and dental assistants with a 1-day training session on assessing children's dental status using the WHO's guidelines.[17] Evaluations of intraexaminer and interexaminer reproducibility were performed: ten children's dental caries were checked by two dentists separately and the DMFT results were compared. Consistency of the DMFT/dmft assessment was >85%. If permanent and deciduous teeth were in the same jaw location, permanent tooth status was recorded, according to the guidelines. We measured children's salivary pH and salivary flow. Salivary pH was assessed using CAT21Buf (Morita, Osaka, Japan). We measured salivary flow per minute based on the average quantity of saliva secreted in 3 min with stimulation from tasteless chewing gum.

We conducted interviews with children and caregivers using a structured questionnaire developed in English in previous studies.[17–21] Three native Khmer-speaking health specialists on the research team reviewed the accuracy of the questionnaire translations and reliability. Before the interviews, the first author trained the interviewer research assistants for one full day on the survey procedures and tools.

We measured the children's OHRQoL using the Child Perceptions Questionnaire,[20] which has been validated in Cambodia.[21] This scale contains 16 questions across four subscales (oral symptoms, functional limitations, emotional well-being and social well-being). Responses were provided on a 5-point rating scale (never: 0; once or twice: 1; sometimes: 2; often: 3; every day or almost every day: 4). The sum of all questions was calculated (range: 0–64). A high score represented lower OHRQoL. In our study, Cronbach's alpha was 0.81.

We measured the children's overall HRQoL using the Paediatric Quality of Life Inventory 4.0.[19] This inventory has been validated for HIV-positive children and contains 23 questions across four subscales (physical, emotional, social and school functioning). To assess the children's nutrition status, we measured the z-scores of height for age and body mass index (BMI) for age using the WHO AnthroPlus.[22]

**Table 1** Sociodemographic characteristics and health status of the study population

| Characteristics | All (n=482) | | | | HIV-positive children (n=328) | | | | HIV-negative children (n=154) | | | | P value |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | n | % | Mean | SD | n | % | Mean | SD | n | % | Mean | SD | |
| General characteristics of the children | | | | | | | | | | | | | |
| Boy | 260 | 53.9 | | | 170 | 51.8 | | | 90 | 58.4 | | | 0.17 |
| Age | | | 10.8 | 3.0 | | | 10.8 | 3.0 | | | 10.6 | 2.9 | 0.41 |
| 3–5 | 30 | 6.2 | | | 19 | 5.8 | | | 11 | 7.1 | | | |
| 6–7 | 44 | 9.1 | | | 31 | 9.5 | | | 13 | 8.4 | | | |
| 8–10 | 120 | 24.9 | | | 77 | 23.5 | | | 43 | 27.9 | | | |
| 11–12 | 134 | 27.8 | | | 92 | 28.0 | | | 42 | 27.3 | | | |
| 13–15 | 154 | 32.0 | | | 109 | 33.2 | | | 45 | 29.2 | | | |
| Family Wealth Index | | | 1.2 | 0.3 | | | 1.2 | 0.4 | | | 1.3 | 0.3 | <0.01** |
| Oral health status | | | | | | | | | | | | | |
| Have dental caries | 458 | 95.0 | | | 309 | 94.2 | | | 149 | 96.8 | | | 0.23 |
| DMFT (n=447)† | | | 3.8 | 3.6 | | | 4.0 | 3.6 | | | 3.3 | 3.7 | 0.02* |
| dmft (n=265)‡ | | | 7.0 | 4.8 | | | 7.0 | 4.9 | | | 7.1 | 4.6 | 0.42 |
| Salivary pH | | | 6.1 | 0.5 | | | 6.0 | 0.6 | | | 6.2 | 0.4 | <0.01** |
| Salivary flow/min | | | 0.9 | 0.4 | | | 1.0 | 0.4 | | | 0.7 | 0.4 | <0.01** |
| Self-estimation of the health of teeth (excellent ~good) (n=443) | 111 | 25.1 | | | 85 | 28.3 | | | 26 | 18.2 | | | 0.02* |
| Oral health-related quality of life (n=451) | | | 28.0 | 7.4 | | | 27.8 | 7.6 | | | 29.7 | 7.5 | 0.38 |
| Oral symptoms | | | 8.9 | 2.7 | | | 8.9 | 2.9 | | | 8.8 | 2.5 | 0.83 |
| Functional limitation | | | 7.2 | 2.8 | | | 7.1 | 2.7 | | | 7.4 | 2.8 | 0.34 |
| Emotional well-being | | | 6.3 | 2.6 | | | 6.2 | 2.7 | | | 6.4 | 2.5 | 0.35 |
| Social well-being | | | 5.7 | 2.0 | | | 5.6 | 2.1 | | | 5.8 | 1.9 | 0.21 |
| Nutrition status | | | | | | | | | | | | | |
| Height for age in z-score (n=462) | | | –2.0 | 1.4 | | | –1.9 | 1.3 | | | –2.2 | 1.4 | 0.06 |
| Body mass index for age in z-score (n=462) | | | –0.9 | 1.2 | | | –1.0 | –0.9 | | | –0.7 | 1.3 | 0.04* |
| Overall health-related quality of life (n=450) | | | 80.0 | 10.3 | | | 79.8 | 10.6 | | | 80.2 | 9.7 | 0.82 |
| Physical functioning | | | 80.6 | 13.6 | | | 80.4 | 14.0 | | | 81.0 | 12.9 | 0.71 |
| Emotional functioning | | | 78.0 | 16.0 | | | 79.0 | 16.0 | | | 75.6 | 15.8 | 0.02* |
| Social functioning | | | 83.5 | 14.3 | | | 83.2 | 14.4 | | | 84.2 | 14.0 | 0.44 |
| School functioning | | | 77.5 | 16.4 | | | 76.4 | 16.8 | | | 80.0 | 15.5 | 0.04* |

Man-Whitney U test was used for continuous variables and $\chi^2$ test for nominal variables.
*P<0.05, **p<0.01.
†Children aged 6–15 years old were included for DMFT assessment.
‡Children aged 3–12 were included for the dmft evaluation.
DMFT, decayed, missing, or filled permanent teeth; dmft, decayed, missing or filled deciduous teeth.

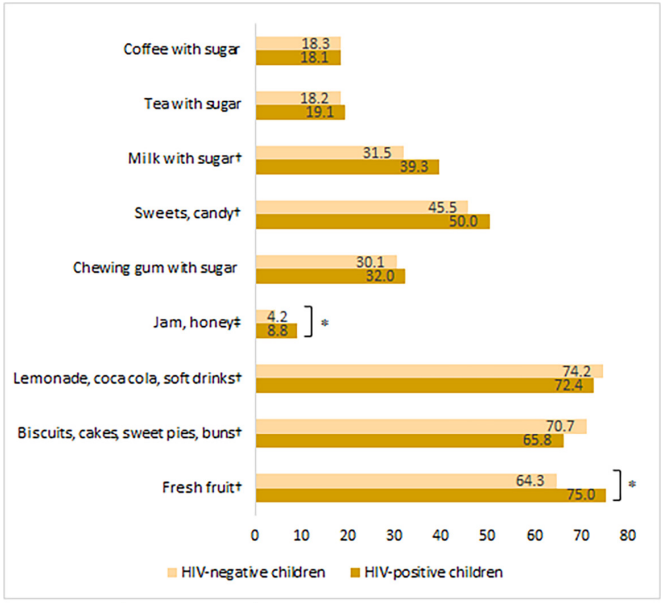
Table 2 Oral care of the study population

| Characteristics | All (n=482) | | HIV-positive children (n=328) | | HIV-negative children (n=154) | | P value |
|---|---|---|---|---|---|---|---|
| | N | % | n | % | n | % | |
| Oral care | | | | | | | |
| Have toothache or discomfort (often ~rarely)(n=448) | 290 | 64.7 | 195 | 63.5 | 95 | 67.4 | 0.43 |
| Visited a dentist in the past 12 months for pain or trouble with teeth, gums, or mouth (n=451) | 99 | 22.0 | 75 | 22.9 | 24 | 15.6 | 0.07 |
| Frequency of tooth brushing (n=452) | | | | | | | |
| Never | 111 | 24.6 | 61 | 19.7 | 50 | 35.0 | 0.02* |
| Twice a day | 133 | 29.4 | 95 | 30.7 | 38 | 26.6 | 0.37 |
| Three and more times a day | 115 | 25.4 | 81 | 26.2 | 34 | 23.8 | 0.58 |
| Self-estimation of the toothbrushing (excellent ~good) (n=435) | 298 | 68.5 | 209 | 70.1 | 89 | 65.0 | 0.53 |
| Timing of brushing (n=452, multiple answers) | | | | | | | |
| Brush before breakfast | 373 | 82.5 | 256 | 78.0 | 117 | 76.0 | 0.61 |
| Brush after breakfast | 40 | 8.8 | 28 | 8.5 | 12 | 7.8 | 0.78 |
| Brush after lunch | 156 | 34.5 | 109 | 33.2 | 47 | 30.5 | 0.55 |
| Brush after dinner | 49 | 10.8 | 32 | 9.8 | 17 | 11.0 | 0.66 |
| Brush after eating a snack | 5 | 1.1 | 4 | 1.2 | 1 | 0.6 | 0.57 |
| Brush just before going to bed | 259 | 57.3 | 180 | 54.9 | 79 | 51.3 | 0.46 |
| Duration of brushing (n=424) | | | | | | | 0.74 |
| 1 min | 118 | 27.8 | 88 | 30.4 | 30 | 22.2 | |
| 2 min | 99 | 23.3 | 62 | 21.5 | 37 | 27.4 | |
| 3 min | 110 | 25.9 | 70 | 24.2 | 40 | 29.6 | |
| 4 min and more | 97 | 22.9 | 69 | 23.9 | 28 | 20.7 | |
| Caregiver's help for the child's teeth brushing (n=439) | | | | | | | 0.06 |
| Caregiver brushes the child's teeth | 4 | 0.9 | 4 | 1.3 | 0 | 0 | |
| Caregiver finishes the child's teeth brushing | 0 | 0 | 0 | 0 | 0 | 0 | |
| Caregiver has never cared about the child's teeth brushing | 412 | 93.8 | 276 | 92.0 | 136 | 97.8 | |

Man-Whitney U test was used for continuous variables and $\chi^2$ test for nominal variables.
*p<0.01.
†
‡
dmft, decayed, missing or filled deciduous teeth; DMFT, decayed, missing or filled permanent teeth.

## Statistical analyses

We first conducted descriptive analyses to assess the distribution of variables. Participants with incomplete oral health data were excluded. We included children 6–15 years old for DMFT assessment and 3–12 years old for dmft evaluations, considering the general age of tooth eruption. Then, we compared the variables between HIV-positive and HIV-negative children to assess the bivariate association between HIV seropositive status and different variables, including sociodemographic characteristics, oral health status and oral care practices. Mann-Whitney U tests and $\chi^2$ tests were used to compare continuous and nominal variables, respectively. Next, we conducted multivariable analyses to examine the association between HIV seropositive status and oral health-related variables such as dental caries, salivary flow, salivary pH and OHRQoL. Logistic regression analysis was used to assess associations with DMFT and dmft. The cut-off points for DMFT and dmft were set using a median (DMFT=4; dmft=8) as there was no a priori cut-off point and the data were not normally distributed. Linear regression analysis was used to assess relationships with salivary pH, salivary flow and OHRQoL. We included variables significantly associated with HIV seropositive status and dental caries in the model (p<0.20).[23] Age and sex, which are associated with growth and tooth eruption, were also included.[24] We did not include variables with frequency <5. Finally, we included variables such as age, sex, wealth index, BMI for age, emotional functioning, school functioning, self-estimation of the health of teeth and frequency of teeth brushing. A p<0.05 was set as the statistical significance level. All data analyses were performed using IBM SPSS, V.24.0 (SPSS).




*p < 0.05. †not applicable = 1, ‡not applicable = 3.

**Figure 1** Foods consumed more than several times a week (in the past 3 months).

We obtained written informed consent from caregivers before data collection and oral consent from the children. Participation was voluntary and confidentiality was maintained.

### Patient and public involvement

Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

## RESULTS

Data were collected from 491 participants, but nine participants were excluded because of incomplete oral health status data. In total, 328 HIV-positive and 154 HIV-negative children were included in this study, 53.9% of whom were boys; the mean age was 10.8 years (SD 3.0).

### Oral health status

The mean DMFT was 3.8 (SD: 3.6) and the mean dmft 7.0 (SD: 4.8; table 1). The mean salivary pH was 6.1 (SD: 0.5) and mean salivary flow/min 0.9 mL (SD 0.4). The mean OHRQoL score was 28.0 (SD 7.4). Approximately one-fourth of children had never brushed their teeth, but most brushed their teeth more than twice a day (table 2). Caregivers of 93.8% of the children had never attended to the children's toothbrushing.

### Differences between HIV-positive and HIV-negative children

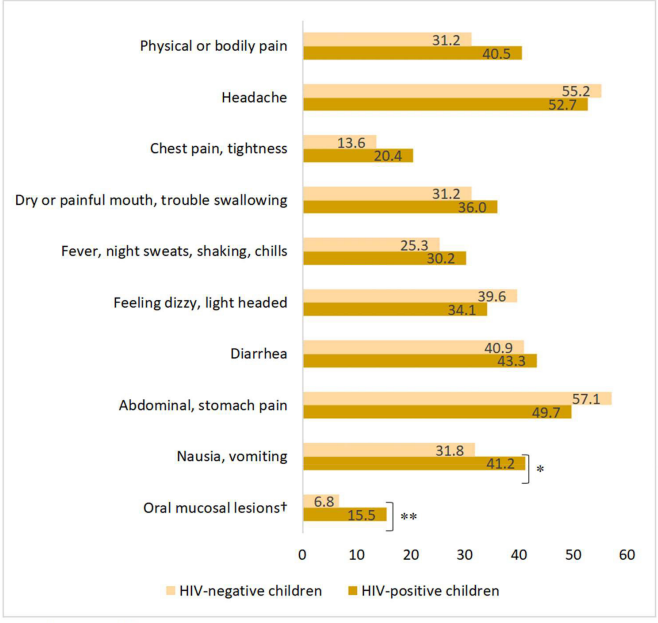
Compared with HIV-negative children, HIV-positive children lived in households with a lower wealth index (table 1), had higher mean DMFT scores, lower salivary pH, higher salivary flow and better oral health perception. The frequency of those who had never brushed their teeth was lower among HIV-positive compared with HIV-negative children (table 2). HIV-positive children consumed fresh fruit and jam/honey more frequently and consumed biscuits/cakes/sweet pies/buns less frequently than did HIV-negative children (figure 1). A higher proportion of HIV-positive children had oral mucosal lesions and nausea/vomiting compared with HIV-negative children (figure 2).

### Factors associated with dental caries

Table 3 shows the results of the multiple logistic regression analysis of factors associated with dental caries. HIV seropositive status was positively associated with DMFT (adjusted OR 1.85, 95% CI 1.14 to 3.01). Table 4 shows that seropositive status was negatively associated with salivary pH level (β: −0.13, 95% CI −0.24 to −0.02) and positively associated with salivary flow (β: 0.72, 95% CI 0.44 to 1.00). OHRQoL was negatively associated with emotional functioning sub-scale (β: −0.14, 95% CI −0.18 to −0.10), school functioning sub-scale (β: −0.09, 95% CI −0.13 to −0.05), and self-estimation of oral health (β: −0.22, 95% CI −4.74 to −2.34).

## DISCUSSION

HIV-positive children in this study had significantly higher mean DMFT scores than HIV-negative children, similar to previous studies.[25] Curiously, according to their oral care practices and eating habits, HIV-positive children appeared to have better oral health status. They consumed more fresh fruits, which may have less of an effect on dental caries than sucrose, as indicated in a previous study.[26] Conversely, the HIV-negative children consumed significantly more sugary snacks, and a




*p < 0.05, **p < 0.01.

†Oral mucosal lesions include ulceration, acute necrotizing ulcerative gingivitis, candidiasis, abscess, and other conditions.

**Figure 2** Disease symptoms of the study population (in the past month).

Table 3 Factors associated with dental caries among the study population

| | DMFT† (6–15 years old children, n=452) | | dmft‡ (3–12 years old children, n=328) | |
|---|---|---|---|---|
| | Adjusted OR | 95% CI | Adjusted OR | 95% CI |
| HIV-positive | 1.85 | 1.14 to 3.01* | 0.65 | 0.34 to 1.27 |
| Age | 5.03 | 3.07 to 8.25** | 0.13 | 0.06 to 0.27** |
| Boy | 0.68 | 0.45 to 1.04 | 2.10 | 1.12 to 3.93* |
| Wealth index | 0.97 | 0.83 to 1.12 | 0.79 | 0.63 to 0.98* |
| BMI for age | 1.21 | 1.00 to 1.47 | 0.91 | 0.70 to 1.18 |
| Emotional functioning | 1.00 | 0.98 to 1.01 | 0.99 | 0.97 to 1.01 |
| School functioning | 1.01 | 1.00 to 1.02 | 1.00 | 0.98 to 1.02 |
| Never brushed their teeth | 1.32 | 0.79 to 2.20 | 0.82 | 0.41 to 1.62 |

*p<0.05, **<0.01
†median (DMFT=4) was the cut-off point.
‡Median (dmft=8) was the cut-off point.
BMI, body mass index; dmft, decayed, missing or filled deciduous teeth; DMFT, decayed, missing or filled permanent teeth.

significantly high percentage had never brushed their teeth. Despite HIV-positive children's better oral health practices, their poorer dental status could be partially explained by lower salivary pH levels. Their experience of dental caries and lower salivary pH levels may be explained by early childhood medications being administered mostly in syrup form, thus containing high amounts of sucrose, which may foster low-endogenous pH.[27] As suggested in our previous study, poor dental status may also relate to the immune deficiency of HIV-positive children, as DMFT is associated with lower CD4 counts.[8] Compromised immune systems might affect dental caries more than other practical or pathological issues.

Unlike DMFT, dmft did not significantly differ between HIV-positive and HIV-negative children, as in previous studies.[25 28] In our study, the mean pH level was 6.0 in both populations, which approximates the pH limit for decalcification of deciduous teeth and may explain why both groups exhibited equal pH levels and risk of dental caries. Therefore, social or caregiver-related factors seemed to affect the health of deciduous teeth more than seropositive status in our study. This could be because young children spend more time with their caregivers than older children do and they are influenced by the caregiver's oral health behaviour and literacy.[29 30]

Salivary flow was significantly higher in HIV-positive than in HIV-negative children. Salivary gland disease is a common manifestation among HIV-positive children receiving ART[31]; thus, previous studies have often reported low salivary flow in this population.[25 32] Simultaneously, a previous study reported no significant difference between HIV-positive people receiving ART and HIV-negative people.[33] The reason for our contradictory finding is not clear and may result from factors we did not assess. However, children's eating habits may have affected their salivary flow level to some extent. In our study, HIV-positive children were likely to consume more fresh fruit than HIV-negative children were, and the chewing required when consuming fruit stimulates salivary flow.[34]

Table 4 Factors associated with oral health status among the study population

| | Salivary pH | | Salivary flow | | Oral health-related quality of life | |
|---|---|---|---|---|---|---|
| | β | 95% CI | β | 95% CI | β | 95% CI |
| HIV-positive | −0.13 | −0.24 to −0.02* | 0.72 | 0.44 to 1.00** | 0.03 | −1.34 to 1.39 |
| Age | −0.02 | −0.12 to 0.08 | 0.28 | 0.02 to 0.54* | −2.12 | −3.38 to −0.85** |
| Boy | 0.04 | −0.06 to 0.13 | 0.43 | 0.18 to 0.68** | 0.23 | −0.98 to 1.44 |
| Wealth index | 0.03 | <−0.01 to 0.07 | 0.04 | −0.04 to 0.13 | −0.39 | −0.82 to 0.04 |
| BMI for age | 0.02 | −0.02 to 0.07 | 0.03 | −0.09 to 0.13 | −0.28 | −0.81 to 0.25 |
| Emotional functioning | <0.01 | <−0.01 to 0.00 | <−0.01 | −0.01 to 0.01 | −0.14 | −0.18 to −0.10** |
| School functioning | <0.01 | <−0.01 to 0.00 | <−0.01 | −0.01 to 0.01 | −0.09 | −0.13 to −0.05** |
| Self-estimation of the health of teeth (excellent ~good) | <−0.01 | −0.12 to 0.11 | −0.03 | −0.32 to 0.26 | −4.74 | −5.12 to −2.34** |
| Never brushed their teeth | 0.08 | −0.04 to 0.20 | 0.08 | −0.22 to 0.38 | 1.29 | −0.16 to 2.74 |

*P<0.05, **p<0.01.
BMI, body mass index.

No significant association was observed between OHRQoL and HIV-seropositive status in this study. The same result was found in a previous study conducted with HIV-positive and HIV-exposed uninfected children.[28] In our study, the HIV-positive children had slightly lower scores for oral symptoms in OHRQoL but slightly higher scores for the other factors. This result may explain why HIV-positive children did not perceive any psychological or physiological inferiority compared with HIV-negative children. As all our participating HIV-positive children were receiving ART, the prevalence of oral lesions and related differences in appearance may have been limited. They might not have perceived oral health-related complex resulting from common HIV symptomatic oral diseases. Better quality of life is a significant advantage of HIV-positive children receiving ART.

Aside from the oral health status, no inferiority was observed in the overall health status of HIV-positive compared with HIV-negative children. When looking at the overall HRQoL, no difference was observed in the total score. However, their emotional functioning subscale was better and the school functioning subscale was lower than that of HIV-negative children. This result differed from an Indian study in which physical, emotional, and school functioning subscales were lower in HIV-positive children.[35] However, in this Indian study, those who underwent ART had a better quality of life; thus, it is no wonder that our study participant HIV-positive children receiving ART had similar HRQoL. This was also supported by the fact that their perceived disease symptoms were almost similar to those of HIV-negative children. However, ART may not be effective enough to improve the children's nutrition status. Their BMI for age was lower than that of HIV-negative children, which is a well-known health symptom in HIV-positive children.[36]

This study has some limitations. It was a cross-sectional study conducted at a single-centre study site. Thus, the data collected may not be generalisable. The number of children aged 3–7 years was relatively small due to the declining number of newly infected children in Cambodia. Therefore, oral hygiene features of deciduous teeth were mainly reflected in children aged >8 years. Despite these limitations, this study is one of the few comparing the oral health status of HIV-positive and HIV-negative children stratified by age. Further, data on HIV-positive children were collected from the largest pediatric-specialised hospital in Cambodia. Thus, the results may reflect essential aspects of this population. The results call for specific strategies and increased efforts by clinical and public health programmes to improve dental care in HIV-positive children. This study did not examine whether oral health risks were caused by children's seropositive status. Further longitudinal studies are needed to examine this relationship.

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