Original Article

Oral Health Status of Schoolchildren Living in Remote Rural Andean Communities: A Cross-Sectional Study

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ABSTRACT

Objective: Oral health promotion (OHP) was introduced in Peruvian primary schools in 2013, and no evaluation has been undertaken in rural areas since then. To measure OHP outcomes, this cross-sectional study aimed to assess the oral health (OH) status of schoolchildren living in a remote rural area of the Cusco region. **Materials and methods:** Sixty-six children were recruited in three remote rural communities and in a rural district capital. Six dimensions of OH (knowledge, attitudes, behaviors, dental plaque, dental caries, and quality of life related to OH) were measured using self-administered questionnaires and dental examinations. Wilcoxon–Mann–Whitney tests were conducted to compare outcomes between two types of settings (remote rural community and district capital). Multiple linear regression models were fit to identify which variables can explain the variance observed in the decayed, missing, and filled teeth (DMFT) index. **Results:** The median percentage of dental plaque in remote rural communities was 78.7% (interquartile range [IQR] 71.5–82.8) and 78.6% (IQR 72.7–82.2) in the district capital (P = 0.90). The prevalence of dental caries was estimated to be 94.1% (95% confidence interval [CI] 71.1–>99.9) in the district capital and 98.0% (95% CI 88.3–>99.9) in remote rural communities (P = 0.43). **Conclusion:** These results suggested that OHP interventions had not reached their full potential. Identifying different factors that influence the reported outcomes would provide a more comprehensive understanding and help to tailor OHP interventions.

Keywords: *Dental caries, oral health-related quality of life, preventive dentistry, rural communities, schoolchildren*

Introduction

Dental caries (DC) is the most common oral health (OH) disease worldwide.[1,2] Its prevalence is increasing among schoolchildren in developing countries, including Latin America.[2] This problem affects primarily children of the poorest and marginalized populations,[2] who usually experience multiple consequences,[1,2] as do their parents, and the local health system.[1] In Peru, OH status and DC are recognized as important problems among schoolchildren in remote Andean rural areas where the vast majority of the population is Aboriginal and lives in poverty,[2,3] but there is currently a lack of OH empirical data for those communities.[3]

Despite mixed evidence,[4] oral health promotion (OHP) interventions for schoolchildren can counter this problem.[1] In 2007, the Peruvian Ministry of Health developed an OHP strategy that was then improved over the following 6 years as OHP interventions were introduced conjointly with other health promotion

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interventions in primary schools. OH professionals annually perform various OHP activities in schools including (1) training on oral hygiene and eating habits; (2) toothbrushing and flossing demonstrations; (3) distribution of toothbrushes and fluoride-containing toothpaste; and (4) application of fluoride and/or sealants. Teachers are also involved in OH as they promote daily toothbrushing at school.[5-7]

On the basis of a logic model elaborated from various documents describing the implementation of school-based OHP interventions in Peru, short-term expected outcomes are to increase OH knowledge and positive attitudes about OH among schoolchildren. In the medium term, targeted outcomes are an increase in daily toothbrushing and oral hygiene levels, while in the long term, main outcomes are a decrease in DC and an increase in the oral health-related quality of life (OHRQoL) among schoolchildren.[8]

With a shortage of dentists, lack of resources, and low involvement of other health professionals in OH,[9] the current deployment of Peruvian OHP interventions is uneven.[10] In some parts of the country, promising results, such as increased toothbrushing, have been shown.[11,12] No data are however available in Andean rural areas where favorable outcomes appear to be emerging slowly.[3] There is also no information if there is a difference between the OH status of schoolchildren living in a rural area (such as district capitals) where the access to OH professionals and OHP interventions is easier and those living in more remote rural areas. This research aimed (1) to assess the OH status of schoolchildren living in Andean rural areas; (2) to compare the outcomes of OHP interventions on the OH status of schoolchildren living in a rural district capital with those living in surrounding remote rural communities; and (3) to identify the factors associated with the prevalence of DC among schoolchildren.

Materials and Methods

Design

This research is part of a broader project to evaluate through a realist approach the effectiveness of OHP interventions carried out in remote rural Andean communities within the Peruvian national strategy promoting OH in primary schools.[8] To achieve this phase of the project, we used a cross-sectional design to measure the OH status of schoolchildren.

Participants

Schoolchildren (9–13 years of age) were recruited from three remote rural communities and a small rural district capital in the Cusco region. Children from 9 to 13 years old were chosen because the majority of permanent teeth are present at this age.[13] A census was conducted among all eligible children whose parents had given their consent. Each participant had to speak Spanish or Quechua and to live in the selected communities or in the district capital. The study population was 61 students in the remote rural communities and 40 students in the rural district capital (small rural town).

Data collection

Two data collection methods were used to measure OH status: self-administered questionnaires and dental examination. To measure OH knowledge, attitudes, and behaviors, we used the Spanish version of the *Questionnaire on Knowledge, Attitudes and Behaviors related to Oral Health* (QKAB-OH).[14] This self-administered questionnaire designed by Poutanen *et al.*[15] for schoolchildren consists of 36 Likert scales.[14] The original QKAB-OH was translated into Spanish using a reverse parallel translation process, adapted for rural Andean communities, and validated with 70 schoolchildren living in rural setting. The internal consistency of the Spanish version is satisfactory with Cronbach α of 0.73.[14]

The Peruvian Spanish version of *Child Oral Impacts on Daily Performance* (Child-OIDP) was used to measure OHRQoL. This questionnaire has been translated into Spanish and adapted. It assesses the impact of OH status on eight daily performances (eating, speaking, cleaning mouth, sleeping, emotional status, smiling, studying, and social contact). Child-OIDP score shows the cumulative impact of OH status on quality of life. Cronbach α for internal consistency is 0.62, and test–retest reliability with an intraclass correlation coefficient is 0.85.[16]

To compile this questionnaire, the frequency and severity of each performance is multiplied to get its impact score. Then the impact scores of all eight performances are summed up and reported as a percentage.[16]

Since Quechua is the most common language of the targeted communities, the QKAB-OH and Child-OIDP were translated from Spanish into Quechua by an anthropologist and a translator speaking both languages and were reviewed in committee (DAB and the two translators). The questionnaires were afterward pretested with two community workers, and validated qualitatively with four children speaking Quechua. This qualitative validation included a retrospective feedback interview with every participant to identify any incomprehension or difficulty with each item of the questionnaires.[17]

The presence of dental plaque, a good indicator of a child's oral hygiene,[18] was measured using the *Indice de placa comunitario* (IPC). IPC score represents dental surfaces with dental plaque on the total of dental surfaces examined and it is expressed as a percentage.[19] This index was developed to simplify oral hygiene evaluation and was validated with 83 children. Following the validation process, the IPC has a good sensitivity (96%) and specificity (75%).[19]

The prevalence of DC was reported using the decayed, missing, and filled teeth (DMFT) index because the majority of permanent teeth were present in our target population. The DMFT index is the sum of decayed (D), missing due to decay (M), and filled (F) permanent teeth (T) for an individual.[13]

Graduating students in dentistry completed dental examinations following the recommendations of World Health Organization.[13] To ensure standardization, a calibration exercise was conducted, resulting in a κ index of 0.82 for DMFT and 0.76 for IPC.

Age and gender were also collected, as sociodemographic variables.

Statistical analysis

As conducted and explained by Poutanen *et al.*,[15] each item in the QKAB-OH was dichotomized as favorable or unfavorable and then reported as an overall percentage for each category (knowledge, attitude, and behavior). Weighting was applied to questionnaires that were more than 50% completed but not completed entirely.

All variables were summarized using descriptive analyses. Discrete and continuous quantitative data with a normal distribution were presented as the mean and standard deviation (SD), whereas unusually distributed quantitative data were presented as the median and interquartile range (IQR) (25th and 75th percentiles). Proportions were presented with 95% confidence interval (CI).

The main outcomes were abnormally distributed, so Wilcoxon–Mann–Whitney tests were used to compare ordinal and interval variables between children living in remote rural communities and those living in the district capital. Chi-square tests were used for categorical variables. Correlations (Pearson's and Spearman's rank) were also performed between various independent variables and the dependent variable (prevalence of DC) to select the independent variables that would enter the multiple linear regression model. Three independent variables were selected (age, place of residence, and presence of dental plaque) to perform the multiple linear regression (forward entry). The four postulates for multiple linear regression (normality, linearity, homoscedasticity, and multicollinearity) were tested.[20] We used Statistical Package for the Social Sciences software, version 24.0 (IBM, Chicago, IL), with a significance level set at $P < 0.05$.

Results

Of the 101 students eligible for this research project, 66 participated in the data collection process, translating into a participation rate of 65%. Data collection took place in June 2016. Sociodemographic data are shown in Table 1.

Oral health knowledge, attitudes, and behaviors

OH knowledge, attitudes, and behaviors of schoolchildren participants are presented in Table 2. A large range in the percentage of positive OH knowledge and eating behaviors was observed among the participants. Among the OH behaviors, the survey highlighted that 88.2% (95% CI 64.4–98.0) of schoolchildren living in the district capital and 91.8% (95% CI 82.5–98.5) living in remote rural communities brushed their teeth at least twice a day ($P = 0.47$). Toothpaste with fluoride was used twice daily by 88.2% (95% CI 64.4–98.0) and 81.6 % (95% CI 68.4–90.3) of schoolchildren living in the capital district and remote rural communities, respectively ($P = 0.37$). Finally, 23.5% (95% CI 9.1–47.8) of schoolchildren living in the capital district used dental floss at least twice a week. This statistic was estimated to be 16.3% (95% CI 8.3–29.3) among schoolchildren in remote rural communities ($P = 0.51$).

Dental plaque, dental caries, and oral health-related quality of life

Participants' dental plaque, DC, and OHRQoL are also presented in Table 2. The prevalence of DC was 94.1% (95% CI 71.1–>99.9) in the district capital and 98.0% (95% CI 88.3–>99.9) in remote rural communities ($P = 0.43$). Most schoolchildren living in the district capital (94.1%; 95% CI 71.1–>99.9) and in remote rural communities (91.8%; 95% CI 80.3–97.3) reported being impacted in at least one of the eight daily performances included in OHRQoL scale ($P = 0.76$). Schoolchildren living in remote rural communities perceived that their OH impacts more on their daily activities associated with OHRQoL, but the difference is significant for only two activities (smiling [$P = 0.01$] and studying [$P = 0.05$]) between the two study groups [Table 3].

We used a multiple linear regression model to test which variables were associated with DMFT among schoolchildren living in the district capital and rural

communities. The results of the regression model indicated that four predictors explained 26.0% of the variance observed (R^2 = 0.26, F = 5.89, P = 0.002). Age (β = 0.94, P = 0.01), percentage of dental plaque (β = 0.10, P = 0.03), and place of residence (district capital = 0, rural communities = 1; β = 2.11, P = 0.04) significantly predicted DMFT.

Discussion

The objective of this research was to assess and compare the OH status of schoolchildren living in a rural district capital and in remote rural communities. Three major findings emerged from this study. First, despite a significantly lower OH knowledge compared with schoolchildren living in the district capital, and a high percentage of dental plaque, most participants from remote rural communities brushed their teeth and used fluoride toothpaste daily. Second, DMFT was significantly higher among schoolchildren living in remote rural communities than those living in the district capital. Finally, OH status had a substantial impact on the OHRQoL of all participants.

Despite the achievement of OHP activities in school settings, our results showed that schoolchildren from remote rural communities have significantly lower OH knowledge than those living in the capital district. Comparisons with similar studies[12,21,22] are difficult due to methodological differences in study design; however, the level of OH knowledge appears higher than that measured in this study of schoolchildren living in remote rural Andean communities. In some studies, the adaptation of OH activities to local realities, the involvement of a range of stakeholders in OHP activities, and the use of various interactive educational strategies have facilitated improvements in schoolchildren's OH knowledge.[12,22] Considering these elements when carrying out OHP activities to improve OH knowledge of schoolchildren living in remote rural communities appears to be key.

Other Latin American studies[11,23,24] have reported acceptable frequency and execution of toothbrushing; one study performed in Nicaragua reported a much lower toothbrushing rate (46% at least once a day) among children.[25] Our results in remote rural

Table 1: Sociodemographic characteristics

Characteristics	Sample (N = 66)
Age—mean (SD)	11.0 (1.2)
Gender, male—*n* (%)	31 (47.0)
Place of residence—*n* (%)	
District capital	17 (25.8)
Community 1	8 (12.1)
Community 2	21 (31.8)
Community 3	20 (30.3)

SD = standard deviation

Table 2: OH status of schoolchildren participants

OH dimensions—median (IQR)	District capital (n = 17)	Remote rural communities (n = 49)	P
Positive OH knowledge (%)	75.0 (50.0–100.0)	50.0 (25.0–75.0)	0.01
Positive OH attitudes (%)	74.1 (72.2–77.0)	77.8 (72.7–84.7)	**0.03**
Positive eating behaviors (%)	50.0 (33.3–66.7)	66.7 (40.0–66.7)	0.60
Nonsmoking (%)	100.0 (100.0–100.0)	100.0 (100.0–100.0)	1.00
Positive OH behaviors (%)	66.7 (66.7–66.7)	66.7 (66.7–66.7)	0.45
Dental plaque (%)	78.6 (71.5–82.8)	78.7 (72.7–82.2)	0.90
DMFT index	4.0 (2.5–6.0)	6.0 (4.0–9.0)	**0.01**
Impact on OH-related quality of life (%)	9.7 (3.5–22.9)	16.7 (6.3–29.2)	0.10

OH = oral health, IQR = interquartile range (25th–75th percentiles), DMFT = decayed, missing, and filled teeth.

Bold font indicates statistically significant results.

Table 3: OH impact on daily activities and QoL in schoolchildren participants

Daily activities and QoL	District capital (n = 17)	Remote rural communities (n = 49)	P
Eating	82.4 (58.2–94.6)	73.5 (59.6–83.9)	0.46
Speaking	29.4 (13.0–53.4)	36.7 (24.6–50.8)	0.59
Mouth cleaning	64.7 (41.2–82.8)	61.2 (47.2–73.6)	0.80
Sleeping	41.2 (21.6–64.1)	51.0 (37.5–64.4)	0.48
Emotional status	82.4 (58.2–94.6)	59.2 (45.2–71.8)	0.08
Smiling	11.8 (2.0–35.6)	53.1 (39.4–66.3)	**0.01**
Studying	29.4 (13.0–53.4)	57.1 (43.3–70.0)	**0.05**
Social relations	29.4 (13.0–53.4)	42.9 (30.7–57.7)	0.30

OH = oral health, QoL = quality of life, 95% CI = confidence interval at 95%.

Bold font indicates statistically significant results.

communities could be partially explained by daily promotion of toothbrushing at school.[5] Other factors such as social environment and parents' OH beliefs, attitudes, and practices also affect schoolchildren's frequency of toothbrushing,[23-25] and confirm the importance of involving parents in OHP activities.[23]

A vast majority of our participants (from remote rural communities and district capital) had a high percentage of dental plaque, which indicated a poor level of oral hygiene.[18] These results are of concern, particularly since schoolchildren from both settings reported brushing their teeth on a regular basis. These findings may indicate a social desirability bias.[26] It may also point out that toothbrushing is not performed adequately considering the level of oral hygiene we reported is similar to another study where children reported brushing their teeth less.[25] A few other studies conducted in Latin America also indicated that oral hygiene is significantly lower for children living in rural areas, but there is unfortunately no data on OH behaviors for this population.[27,28]

DMFT observed in this work is much higher in Andean remote rural communities surveyed than in other Latin American studies where it was reported to range from 0.56 to 3.54.[25,27,29-32] The 2015 World Health Organization target for children 12 years old and younger is less than 1.5.[33] The prevalence of DC was also greater among schoolchildren living in remote rural communities than has been reported in other rural areas.[27,28,31,32] This difference between remote rural and urban areas might be explained by an unequal access[27,28] or an underutilization[27] of OH curative care in remote rural areas. The lower socioeconomic status of families living in remote rural communities is another factor that might explain an higher level of DC among schoolchildren in rural areas.[27]

It is well recognized that DC and other OH conditions can have important functional and psychosocial impacts on children.[34] Comparing results from other studies on OHRQoL,[29,35,36] the OH overall impact on our sample was greater especially in remote rural communities. Considering the significant impact on many daily activities of children living in remote rural communities, it is necessary to prioritize curative and preventive OH interventions in order to limit current and future consequences for children.[29]

Overall, the OH status of schoolchildren living in remote Andean rural areas is of concern as compared with other parts of Latin America. The current OHP strategy developed and implemented by the Peruvian Ministry of Health is not having the required impact in remote Andean rural communities. OH and the implementation OHP interventions are generally complex[1,4,23] and the results described in this study likely arose from multiple factors at different hierarchical levels.[1,4,37] First, OH in children is often not perceived as a priority by governments because it contributes little to reduce the infant mortality rate, and societal costs associated with low OH status among children are underestimated.[1] Next, rural communities in Latin America have undergone, in last decades, major changes in their traditional lifestyle, including the introduction of various processed foods rich in refined sugar, which increase the prevalence of DC among children.[38] Other factors specific to rural areas, such as the geographical remoteness (which limits access to fresh healthy foods, OH products,[38] and OH services[27,28,39]), and social and cultural particularities[40] might explain the actual OH status among schoolchildren living in rural area. Several other factors associated with the health systems such as the lack of financial, material and human resources,[1,40] downstream implementation process, insufficient cooperation with local stakeholders,[1] and "health-system-related determinants"[40] might also help to explain the current situation.

To understand more precisely which interactions of factors contribute most strongly to the present OH status of schoolchildren, it is necessary to have a more holistic vision[28,41] and several levels of analysis (macro, meso, and micro).[41] This process can help to tailor OHP interventions to the realities of remote rural communities,[28,39] and encourage the involvement of different local stakeholders in OHP activities.[1]

Strengths and limitations

Only few studies on OH have been conducted in rural and with Aboriginal populations. To the best of our knowledge, this is one of the first studies published on the OH level of schoolchildren living in remote rural Andean communities.

We intentionally chose to use validated tools to measure different OH components and thus target the multiple facets of OH. Following guidelines,[17] questionnaires were adapted for rural area studied, pretested, and validated qualitatively to ensure internal and external validity. The cross-sectional evaluation of OH status "snapshot" research design facilitates the assessment of multiple outcomes as we did in this study.[42] Although we did not have time and resources for ongoing monitoring in this research, tools developed in this work may be used for such a program.

The modest sample size may limit the generalizability of the results. The sample size was to ensure capacity and quality in the next phase of this project that includes interviews with various stakeholders. Recruitment

was also limited to ensure that each community could receive sufficient attention to foster the development of trust. Success in this regard is reflected in a satisfactory response rate, considering that these communities have had little contact with research projects in the past and that many children expressed fear of dental examinations, which could have hindered their participation.[43]

Marked differences between reported OH behaviors and the presence of dental plaque may indicate a social desirability bias. This type of bias is particularly prevalent for socially desirable behaviors as well as "collectivistic cultures that emphasize good relationships with other group members."[26]

Conclusion

This research provides data on various aspects of OH status of schoolchildren living in remote Andean rural areas. These suboptimal results highlight the complexity of implementing OHP interventions and the need to consider different factors that may influence success.[1,4,37] These results contribute to the discussion of how to reorient health promotion interventions in remote rural communities to improve OH status and reduce the negative consequences for schoolchildren.[28,39]

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Conflicts of interest

There are no conflicts of interest.

Authors' contributions

DAB, LRT and IG contributed to the development of the study design. DAB participated in the data collection process. DAB is responsible for the drafting of this paper; LRT and IG provided comments on the drafts and have read and approved the final version.

Ethical policy and institutional review board statement

All the procedures have been performed as per the ethical guidelines laid down by Declaration of Helsinki. Ethics approval was granted in April 2016 from the *Comité d'éthique de la recherche en santé chez l'humain du Centre hospitalier universitaire de Sherbrooke* (project no. 2016-1344). We also engaged with local authorities to comply with local ethics requirements.

Patient declaration of consent

Formal consent from parents and child assent were obtained. Parents were informed that the data collected would be used for research purposes only and would remain confidential.

To obtain formal consent of parents, a meeting with the members of each participating community was organized to introduce the research project. At the end of this meeting, parents who wanted their children to participate in the research project were invited to meet a research assistant speaking Quechua and Spanish. The research assistant orally explained the consent form to the parents and if they agreed to the participation of their child, they signed it.[8]

A distinct consent form was signed for each child. Consent forms were available in Quechua and Spanish. To get the verbal assent of participating children, a research assistant briefly explained the research project to them before data collection and asked them separately whether they agreed to participate. The child's verbal assent was recorded on the consent form signed by their parent.[8]

Data availability

The data set used in the current study is available on request from Dave Bergeron by email at Dave_Bergeron@uqar.ca.

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