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Sociodemographic disparities in oral health-related quality of life of schoolchildren in rural and urban areas

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Objective: To assess the association between residence place, socioeconomic conditions and oral health-related quality of life (OHRQoL) among schoolchildren from southern Brazil. ***Methods***: Participants were 9-14-year-old schoolchildren from rural and urban municipal schools from Rosário do Sul, Brazil. The Child Perceptions Questionnaire (CPQ11-14) was used to assess OHRQoL. A structured questionnaire collected data on sociodemographic condition (family income), residence place (urban or rural), use of dental services, and behavioral variables. Clinical oral examination recorded the presence of missing teeth and the gingival bleeding index. Multilevel Poisson regression analysis with a hierarchical approach assessed the association between predictors and CPQ11-14 scores. Rate ratios (RR) and 95% confidence intervals (CI) were estimated. ***Results***: A total of 373 schoolchildren were included (rural area=122; urban area=251), with a mean CPQ11-14 score of 11.83, ranging from 0 to 42. Low-income schoolchildren living in rural areas had 15% higher CPQ11-14 scores than high-income schoolchildren living in urban areas. In urban areas, family income predicted OHRQoL, with low-income schoolchildren having 9% higher CPQ11-14 scores than high-income children. In rural areas, schoolchildren with low household income had 19% higher CPQ11-14 scores than high-income children. ***Conclusion***: Schoolchildren from low-income families had a poorer OHRQoL irrespective of their area of residence (rural or urban). The association between family income and OHRQoL was more pronounced among children living in rural areas.

Keywords*: Quality of Life, Oral Health, Socioeconomic Factors, Rural Population, Urban Population*

Introduction

Oral health is an essential element of general health, physical and mental well-being (Glick *et al*., 2017). It might be affected by individual, social and geographic factors, leading to impacts on oral health-related quality of life (OHRQoL). OHRQoL is a multidimensional construct that measures the impact of oral disorders on important aspects of daily life (Locker and Allen, 2007). Measuring OHRQoL allows quantification of the experience of oral health in population groups and can identify inequities arising from differences in access to healthcare, expectations and treatment effectiveness.

The association between low socioeconomic status (SES) and poor OHRQoL is well established, being confirmed by a systematic review and meta-analysis (Knorst *et al*., 2021). Individuals with low SES might have 30% higher prevalence of negative impacts on OHRQoL. Despite this finding, limited evidence is available on the possible effect of living in rural areas on OHRQoL among individuals with different socioeconomic backgrounds (Gaber *et al*., 2018).

Place of residence and the cultural aspects shaped by it are a potential factor that may impact the OHRQoL, but few studies have addressed this issue. Adolescents and young adults living far from urban centers reported more significant impacts on OHRQoL in riverine communities of Amazonas, Brazil (Maia *et al*., 2018). Similarly, living in rural areas increased the prevalence of poor OHRQoL by 60% in Canadian adults, even after adjustment for confounding factors (Gaber *et al*., 2018). On the other hand, a recent study did not find differences in OHRQoL between adolescents living in rural and urban areas of Peru (Cadenas de Llano-Pérula *et al*., 2020). Another study of Indian adults found greater impact on OHRQoL among urban residents than rural residents. (Sanadhya *et al*., 2015).

To the best of our knowledge, there is no previous study assessing a possible interaction between rurality and SES on OHRQoL outcomes. Therefore, this study aimed to investigate the association between residence place, socioeconomic condition and OHRQoL of schoolchildren from southern Brazil. We hypothesized that the low SES impacts more on the OHRQoL of schoolchildren living in rural areas.

Methods

This cross-sectional study was reported according to the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines. It was designed to assess the OHRQoL of urban and rural schoolchildren from Rosário do Sul, in southern Brazil. According to official data provided by the Brazilian Institute of Geography and Statistics, this municipality had an estimated population of 39,707 inhabitants, of whom 4,776 lived in

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rural areas in 2010. Urban communities have a controlled fluoride levels in the public water supply (0.7–0.9 ppm F) in contrast to the rural areas, where the fluoride concentration is variable and insufficient to prevent dental demineralization. Schoolchildren aged between 9 and 14 years old and attending municipal public schools were eligible for the study. Those using fixed orthodontic appliances or with special dental needs were not included.

All municipal public schools were invited to take part (4 urban and 6 rural). Two strategies were adopted to sample students considering their area of residence. In rural communities, a demographic census was performed due to the small number of eligible individuals (n=130). Simple random sampling via a random number table was used in the urban area to sample from a finite population of 607 schoolchildren (official data). The number of students selected in each school was proportional to school size. Considering an expected dental caries prevalence of 50% (worst case scenario), a power of 80%, a confidence level of 95% and adding a non-participation rate of 10%, 260 urban students were invited to participate. This number had been sufficient to estimate a difference between OHIP (Oral Health Impact Profile) means of 11.9 (standard deviation (SD) =11.8) in the exposed group (low SES) and 8.4 (SD=7.0) in the unexposed group (high SES) (Knorst *et al*., 2019).

Data were collected from March to October 2015. OHRQoL was measured using the 16-item version of the Child Perceptions Questionnaire (CPQ11-14) which has been adapted and validated in the Brazilian Portuguese language (Goursand *et al*., 2008). The items cover four domains: oral symptoms, functional limitation, emotional well-being and social well-being with response options of "Never"=0; "Once/twice"=1; "Sometimes"=2; "Often"=3; "Every day/almost every day"=4. The sum of item scores can vary from 0 to 64; with higher scores indicating greater negative impact of oral conditions on OHRQoL. Participants answered these questions before dental examination.

Another questionnaire containing demographic and socioeconomic questions was sent to the parents/legal guardians of the participants. Demographic variables comprised sex (girl or boy), skin color (white or non-white), age (> 12 years or ≤ 12 years) and area of residence, accessed through the address information (urban or rural). Family household income was classified as low (≤1 Brazilian minimum wage [BMW] or high (>1 BMW). One BMW was equivalent to approximately USD 250 at the time of data collection. The use of dental services was measured based on the following questions: last visit to a dentist (≤1 year or >1 year), the reason for the last visit (routine or pain/trauma) and the type of dental service (public or private). Oral health behavior comprised toothbrush frequency (≥ twice a day or < twice a day).

Clinical variables included the prevalence of missing permanent teeth (0 or ≥1 tooth), assessed as a component of the DMFT index (decayed, missing, or filled teeth) (WHO, 2013), and the Gingival Bleeding Index (GBI) (Ainamo and Bay, 1975), collected at four sites per tooth and then dichotomized as GBI ≤10% of bleeding sites or GBI >10% of bleeding sites. Clinical examination was performed in schoolrooms, with the students in a supine position, using a clinical mirror and a periodontal probe, under artificial light.

All examinations were performed by a single examiner (ADN), who was trained and calibrated for the used indexes. Examiner reproducibility was assessed after theoretical training and clinical examinations under the supervision of a benchmark examiner for dental caries. Ten individuals were assessed twice with a minimal interval of seven days. The intra-examiner kappa coefficient for dental caries was 0.84, and the inter-examiner (vs. an experienced professional) was 0.82. Whilst the examiner was trained in the use of the GBI by an experienced professional, no calibration was performed due to the temporary nature of this condition.

Statistical analysis was performed using STATA 12.0 software (Stata Corp, College Station TX, USA). A weight variable ("svy" command) based on the probability of selection and population distribution was used according to sex and school zone address.

The outcome variable was OHRQoL, measured using CPQ11-14 scores as a count variable. The main predictor variable was composed by a combination of two variables, family income and area of residence. In this way, four categories composed the new variable: urban/high income; rural/high income; urban/low income and rural/low income.

Preliminary analysis comparing the CPQ11-14 scores among categories of the predictors was carried out using Kruskal Wallis test (variables with 3 or more categories) or Mann-Whitney test (2-categories variables). Multilevel Poisson regression analysis was used to identify predictors of CPQ11-14 scores, considering participants as the first-level and area of residence as the second-level unit. The multilevel model used the scheme of fixed effect with random intercept. A multilevel hierarchical analysis was performed based on a contextual framework, adapted from the World Health Organization (Graham and White, 2016). Model 1 ("empty model") was an unconditional model; Model 2 included the main predictor variable (residence area/family income) and demographic variables; Model 3 was composed of Model 2 plus use of dental services; and Model 4 was composed of Model 3 plus behavioral and oral health variables. Variables with $p<0.20$ in the unadjusted analysis were included in adjusted model. The deviance (−2log likelihood) was measured to assess the quality of fit. The results are presented as rate ratios (RR) and their 95% confidence intervals (CI).

The study protocol was approved by the Federal University of Santa Maria Research Ethics Committee (CAAE37862414.5.0000.5346). All participants and their parents/legal guardians signed informed consent. Participants received a report of their oral health status, and were referred to dental treatment as needed.

Results

All municipal schools took part. A total of 373 out of 390 (95.6%) schoolchildren participated, with a mean age of 11.8 years (SD =1.5, range 9 to 14). A response rate of 93.8% was obtained in rural schools (122 of 130 invited), and 96.5% in urban schools (251 of 260 invited). The main reason for non-participation was the lack of signed consent.

Table 1 presents the sample distribution, the mean CPQ11-14 scores by predictors, and the unadjusted multilevel Poisson regression analysis. The mean CPQ11-14 score was 11.83 (standard error = 0.78, range 0 to 42). No difference was observed for CPQ11-14 scores among

Table 1. Explanatory variables and CPQ11-14 scores in 373 school children.

	%	Mean (CPQ11-14) (SE)	RR (95%CI)*	p
Area/income†				
Urban/high income	38.8	10.77 (0.93)[a]	1.00	
Rural/high income	11.0	10.54 (0.96)[a]	0.98 (0.87, 1.10)	0.70
Urban/low income	26.0	11.93 (0.75)[a]	1.10 (1.00, 1.19)	0.03
Rural/low income	24.2	12.51 (2.01)[a]	1.15 (1.06, 1.26)	<0.001
Sex				
Girls	49.3	12,15 (0.91)[a]	1.00	
Boys	50.7	11.54 (0.88)[a]	0.95 (0.89, 1.00)	0.09
Skin color				
White	68.2	11.75 (0.53)[a]	1.00	
Non-white	31.8	10.85 (1.25)[a]	0.92 (0.86, 0.99)	0.03
Age				
> 12 y	58.4	12.78 (0.91)[a]	1.00	
≤ 12 y	41.6	10.63 (0.73)[a]	0.85 (0.80, 0.91)	<0.001
Use of dental services				
Last visit to a dentist				
< 1 year	66.5	10.71 (0.74)[a]	1.00	
> 1 year	34.5	12.95 (0.68)[b]	1.20 (1.12, 1.29)	<0.001
Reason for the last visit				
Routine	64.3	10.02 (0.67)[a]	1.00	
Pain/trauma	35.7	14.19 (0.60)[b]	1.39 (1.29, 1.49)	<0.001
Type of service				
Public	72.2	11.73 (0.36)[a]	1.00	
Private	27.8	10.73 (1.49)[a]	0.91 (0.84, 0.99)	0.03
Behavioral				
Tooth brushing frequency				
≥ Twice a day	83.9	11.13 (0.57)[a]	1.00	
< Twice a day	16.1	13.45 (1.41)[a]	1.21 (1.12, 1.32)	<0.001
Oral health				
Gingival bleeding index				
≤ 10% bleeding sites	52.3	11.28 (0.59)[a]	1.00	
> 10% bleeding sites	47.7	12.56 (1.16)[a]	1.11 (1.04, 1.18)	<0.001
Missing teeth				
0	85.0	11.47 (0.71)[a]	1.00	
≥ 1	15.0	14.14 (1.49)[a]	1.20 (1.10, 1.29)	<0.001

SE = Standard error; CI = Confidence interval; RR = rate ratio. † Missing data. *Multilevel Poisson regression analysis. Different letters indicate difference between categories (Kruskal Wallis test or Mann-Whitney test, p <0.05).

categories of the main predictor variable. However, the unadjusted model showed that schoolchildren with a low household income had a poorer OHRQoL, irrespective of the residence area (urban, RR=1.10; 95%CI=1.00 to 1.19; rural, RR=1.15; 95%CI=1.06 to 1.26). Additionally, all variables were associated with the outcome in the unadjusted analysis, except for sex.

In adjusted multilevel hierarchical Poisson models (Table 2), low-income children living in rural areas had 15% higher CPQ11-14 scores than high-income children living in urban areas (RR=1.15; 95%CI=1.05, 1.25) (Model 2). Among schoolchildren living in urban areas, family income was predicted OHRQoL, with low-income schoolchildren presenting 9% higher CPQ11-14 scores than high-income ones (RR=1.09; 95%CI=1.00, 1.18). Boys and ≤12 year-olds also had better OHRQoL. Model 3 shows that the use of public dental services, due to pain/trauma, and >1 year ago were associated with a poorer OHRQoL. Furthermore, as shown in Model 4, students reporting low tooth brushing frequency, with at least one missing tooth and a greater proportion of bleeding sites reported higher CPQ11-14 scores.

To investigate the effect of family income on OHRQoL among schoolchildren living in rural areas, the category "Rural/high income" was defined as the reference category. Children residing in rural areas with low household income had 19% higher CPQ11-14 scores than high-income ones, indicating poorer OHRQoL (Rural/low income, adjusted RR=1.19; 95%CI=1.05, 1.34).

Table 2. Multilevel Poisson regression analysis of predictors of CPQ 11-14 scores in 373 school children..

	Model 1[a] *RR (95%CI)*	*Model 2*[b] *RR (95%CI)*	*Model 3*[c] *RR (95%CI)*	*Model 4*[d] *RR (95%CI)*
Fixed component				
Intercept	11.83 (11.47, 12.20)	12.20 (11.35, 12.11)	10.46 (9.51, 11.51)	9.69 (8.73, 10.76)
Area/income				
Urban/high income				
Rural/high income		0.97 (0.86, 1.09)		
Urban/low income		1.09 (1.00, 1.18)		
Rural/low income		1.15 (1.05, 1.25)		
Sex				
Girls				
Boys		0.93 (0.87, 0.99)		
Skin color				
White				
Non-white		0.93 (0.87, 1.01)		
Age				
> 12 y				
≤ 12 y		0.85 (0.79, 0.91)		
Use of dental services				
Last visit to a dentist				
< 1 year				
> 1 year			1.22 (1.12, 1.31)	
Reason for the last visit				
Routine				
Pain/trauma			1.42 (1.31, 1.53)	
Type of service				
Public				
Private			0.89 (0.82, 0.97)	
Behavioral				
Tooth brushing frequency				
≥ Twice a day				
< Twice a day				1.16 (1.04, 1.29)
Oral health				
Gingival bleeding index				
≤ 10% bleeding sites				
> 10% bleeding sites				1.09 (1.00, 1.17)
Missing teeth				
0				
≥ 1				1.13 (1.01, 1.25)
Random component				
Deviance (-2 loglikelihood)	3020.38	2755.12	2000.60	1982.27

[a]Model 1: empty model, unconditional model. [b]Model 2: model 1 adjusted for contextual and demographic variables. [c]Model 3: model 2 adjusted for contextual, demographic, and use of dental services variables. [d]Model 4: fully adjusted for contextual, demographic, use of dental services, behavioral, and oral health variables. RR = rate ratio; CI = confidence interval.

Discussion

This study investigated a possible interaction between rural vs. urban residence and socioeconomic conditions on OHRQoL among schoolchildren from southern Brazil. Although individuals from households with a low family income had poorer OHRQoL irrespective of their area of residence, the association was stronger among those living in rural areas, thus corroborating the study hypothesis.

The mean CPQ11-14 score of 11.83 among our participants was similar to previous studies on this topic including Brazilian schoolchildren of similar age. Feldens et al. (2016) assessed the OHRQoL of South Brazilian schoolchildren aged 11-14 years and obtained a mean CPQ11-14 score slightly higher, of 12.8. On the other hand, two other studies found lower values; Aimée et al. (2017) found a median CPQ11-14 score of 9 among 10-15-year-olds from Midwest Brazil while de Paula et al. (2013) observed a mean score of 24.08 for the complete CPQ11-14 version with 36 questions among 12-year-old schoolchildren from Southeast Brazil (which would represent a mean score around 10.7 after a direct conversion to the short version with 16 questions for comparison purposes). However, it is important to highlight that these studies did not include children living in rural areas.

Rurality exposes individuals to some oral health risk factors. Previous literature supports the notion that living in environments far from urban centers leads to poorer access to oral health care and health information (Ardenghi *et al*., 2013). In addition, rural inhabitants have no access to fluoridated water, reduced access to education, and may experience socioeconomic deprivation (Maia *et al*., 2018; Maupome *et al*., 2013). A previous study using data derived from a national oral health survey covering 250 cities in Brazil found that studying in a rural area was an individual determinant, nearly doubling the risk of having untreated caries among 12-year-olds (Antunes *et al*., 2006). We found that rural children from families with low household income had 19% poorer OHRQoL than their high-income rural counterparts. Likewise, low-income urban schoolchildren had 9% poorer OHRQoL than high-income urban schoolchildren. Comparing these estimates, it was also possible to observe that rurality was associated with a greater magnitude of association (19% vs. 9%), suggesting that living in a rural area exerted an additional detrimental effect on OHRQoL among low-SES schoolchildren. It is possible to speculate that in the urban setting, low-SES families are more likely to mitigate the effects of socioeconomic deprivation due to the easier access to services and products while in the rural setting they do not. Therefore, the difference between high-SES and low-SES families living in rural areas would be more evident. Considering the more accentuated socioeconomic gradient in the OHRQoL of children living in rural areas, there is a need to improve oral health public policies focused on this population group. In this sense, not only could access to municipality primary care centers be facilitated, but strategies for prevention and non-invasive treatment should be implemented in these places, adapting to social and geographical realities where necessary.

The relationship between low SES and poor OHRQoL concurs with previous studies (Graham and White, 2016), endorsing the evidence that socioeconomically disadvantaged people tend to have less health information, reduced access to services and fewer resources to be spent with health care (WHO, 2010). In addition, children with low SES are more prone to material and psychosocial risk factors that affect OHRQoL (Singh *et al*., 2019). It is important to emphasize that only public schools were included in the present study, as there was no private school in the rural area for comparison purposes. In this regard, a previous study showed that type of school could be used as an alternative indicator for socioeconomic status in Brazil, since significant associations between public school and low parents' education, low household income and high household overcrowding were detected (Piovesan *et al*., 2011). Therefore, it is possible to speculate that we would have a more heterogeneous sample of SES if we had included private schools. Notwithstanding, the disparities between high and low SES was sufficient to show differences in OHRQoL in only public schools.

Boys and younger individuals (≤12 years) also had better OHRQoL, consistent with the previous literature. OHRQoL is coherent with the cumulative aspect of dental diseases (Peres *et al*., 2019). Furthermore, older children tend to have better perceptions of their health (Riley, 2004). The association between sex and OHRQoL has been shown previously (Bulgareli *et al*., 2018), and may be related to girls being more concerned about their health and physical appearance than boys.

Children who had visited a dental professional with oral problems had higher CPQ11-14 scores. This indicator reveals a curative-based approach and isolated interventions. The treatment of sequelae or symptoms disregarding the multifactorial etiology of the dental diseases does not have the potential to improve oral health or promote quality of life (Heilmann *et al*., 2015). Poorer OHRQoL was found among schoolchildren who visited the dentist more than a year ago. A previous longitudinal investigation corroborated this result, showing that poor OHRQoL leads to irregular service use, despite opportunities for access and subsidies (Torppa-Saarinen *et al*., 2019). The present study highlighted the use of private service as a protective factor for poor OHRQoL, reflecting socioeconomic differences between the groups attending the two services. Children from affluent families are more prone to search for private services and have lower risks of dental diseases.

Children who brushed their teeth less frequently had poorer OHRQoL. This association is conceivable as oral hygiene behaviors, such as frequent tooth brushing, effectively prevent oral diseases and are associated with less oral health impact (Loe *et al*., 1965). Further, oral problems could impair frequent tooth brushing due to discomfort and pain, discouraging the habit. Missing teeth was related to worse OHRQoL conditions which is in accordance with previous studies (Brennan and Spencer, 2014). Tooth loss can lead to functional impairment and aesthetic damage, thus impacting on both oral health-related and general quality of life (Gerritsen *et al*., 2010). The negative relationship between gingivitis (gingival bleeding) and OHRQoL found in the present study is also in agreement with the previous literature on this topic.

Among the strengths of this study, is the use of the census strategy to select rural schoolchildren, which ensured external validity. All municipal urban and rural schools agreed to participate. Therefore, we may consider our sample as representative of the population. Internal validity was provided using a validated questionnaire to measure OHRQoL and a calibrated examiner. Among the limitations, the cross-sectional design prevents causal inference. The use of CPQ11-14 for all participants, regardless of age may have restricted validity. The use of age-specific instruments (CPQ8-10 and CPQ11-14) would have to be managed during data analysis. This would have split the sample according to instrument and so reduced sample size and study power. Considering these difficulties and the previous literature supporting the use of CPQ11-14 in younger children (Foster Page *et al*., 2013), we do not believe this aspect has impacted the study results.

In conclusion, schoolchildren from low-income families had poorer OHRQoL irrespective of their area of residence (rural or urban). This association was more pronounced among schoolchildren living in rural areas.

Conflicts of Interest

The authors declared no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

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