

Exploring the risk factors for early-life sugar consumption: A birth cohort study

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Abstract

Background: Sugar consumption in early childhood is the primary cause of negative health outcomes, including early childhood caries.

Aim: To investigate risk factors associated with early-life sugar consumption.

Design: Explanatory variables were collected at baseline of a birth cohort in Porto Alegre, Southern Brazil. At six months of age, data were collected on child feeding practices, including the number of foods and beverages containing sugar. Multivariate Poisson regression analysis with robust variance was performed.

Results: Virtually all children (98.3%) had consumed sugar by the age of 6 months. Multivariable analysis showed that the number of sweet items was significantly larger in children whose mothers were less than 20 years of age (MR = 1.19; 95% CI: 1.05-1.36), those from non-nuclear families (MR = 1.12; 95% CI: 1.04-1.20), those whose mothers had less than eight years of schooling (MR = 1.34; 95% CI: 1.20-1.50) and those whose mothers smoked (MR = 1.23; 95% CI: 1.13-1.35). Moreover, the number of sweet items was significantly lower among children who breastfed in the first hour of life (MR = 0.85; 95% CI: 0.76-0.95).

Conclusion: Sugar consumption begins very early, especially in children with no access to breastfeeding in the first hours of life and those from younger, less educated, and smoking mothers.

KEYWORDS

breastfeeding, childhood, dental caries, risk factors, sugar

1 | INTRODUCTION

The consumption of foods and beverages with sugar in early life has been associated with an increased risk of overweight, obesity, and non-communicable diseases, such as cardiovascular disease, type 2 diabetes, and dental caries.¹⁻³ Early childhood caries is the first clinically important outcome that stems from the early introduction of sugar and can

affect children even before completing the first year of life.⁴⁻⁶ Besides the recognized role as substrate for the production of acid, which leads to the demineralization of the tooth structure, sugar intake in the first year of life can exert an impact on the future occurrence of caries through two plausible pathways: it promotes the growth of *Streptococcus mutans* and other acidogenic species and it modulates future food preferences in childhood and adolescence.^{5,7,8}

The early and increasing consumption of foods and beverages containing sugar in different communities of the world and the understanding of the role of sugar as a common risk factor for different adverse health outcomes indicates the need for urgent measures.^{5,9-11} The World Health Organization (WHO), American Heart Association and International Association of Paediatric Dentistry (IAPD) recommend a reduction in sugar consumption in early life and not offering sugar to children prior to two years of age.^{2,6,12} The planning of effective strategies for delaying the offer of sugar in early life depends on knowledge of the factors that determine the occurrence of this offer in different populations. A few studies, however, have performed a prospective investigation of the network of causality for the early introduction of sugar in order to contribute to the development of a model that takes into consideration the different levels of influence but is simple enough to provide objective information for the planning of effective strategies.^{1,9}

Therefore, the aim of this study was to investigate the consumption pattern of foods with sugar in the first six months of life with an emphasis on the identification of demographic, socioeconomic, anthropometric and behavioural factors associated with the number of items with sugar consumed up to the age of six months in a birth cohort of children from southern Brazil.

2 | MATERIAL AND METHODS

2.1 | Study design and participants

This study is part of the Ten Steps towards a Healthy Diet for Children Younger than Two Years of Age Implementation Project (clinicaltrials.gov NCT00635453), which is an initiative of the Brazilian Ministry of Health in partnership with the Pan American Health Organization. The present investigation consists of a birth cohort study involving children born in the city of Porto Alegre (southern Brazil) whose mothers were recruited during pregnancy at primary care units that met the following inclusion criteria: at least 100 appointments with children per month and no participation in any dietary intervention study. The exclusion criterion was mothers with HIV/AIDS.

Among the 52 primary care units in the city, 31 were considered eligible for the study and 20 were randomly selected. The sample size was calculated based on the estimate of the effect of an intervention addressing exclusive breastfeeding at 4 months of age. The number of participants recruited and retained at 6 months of age ($n = 596$) determined the sample size for the present cohort study. The post hoc calculation determined that this study had a power of 96% to detect a significant difference in the mean number of sweet items consumed between children with a lower socioeconomic status

WHY THIS PAPER IS IMPORTANT TO PAEDIATRIC DENTISTS

- Sugar consumption begins very early in life. The number of sweet items consumed was larger among children whose mothers were younger and had less schooling.
- Children breastfed in the first hour of life consumed less sweet items up to the age of six months.
- This information should be used by paediatric dentists and other health professionals to promote preventive messages and policies during prenatal and immediate postnatal period, which may contribute to the reduction of the burden of early childhood caries and other non-communicable diseases.

(mean: 6.9 ± 3.1) and higher socioeconomic status (mean: 5.9 ± 3.0).

The Human Research Ethics Committee of the Federal University of Health Sciences of Porto Alegre approved each evaluation phase of the study, which included interviews and a dental examination. The parents/guardians of the children received clarifications regarding the intervention and signed a statement of informed consent in all phases of the data collection process.

2.2 | Data collection

At baseline (end of pregnancy), interviews were held with the mothers to obtain information on sociodemographic characteristics: mother's age, whether the child was the first child, mother's schooling, mother's smoking, family income, social class, and family structure. Social class was collected according to the criteria of the Brazilian Association of Market Survey Institutes (ANEP—ABIPEME) into A1, A2, B1, B2, C, D, and E and subsequently categorized as $\leq C$ (lower socioeconomic status) or $\geq B$ (higher socioeconomic status). After the birth of the child, information was obtained on the demographic and anthropometric characteristic of the child (sex, birthweight, and length) and number of hours between birth and the onset of breastfeeding.

At 6 months of age, undergraduate students of the nutrition course interviewed the mothers to collect information on the feeding practices of the children using structured interviews and the 24-hour recall method. Interviews were held to investigate whether the children had consumed specific foods and beverages with sugar and the age of the children (in months) when these items were first introduced into the diet. The 24-hour recall method was used to complement

this information by recording all foods and beverages consumed by the children the previous day, time of consumption, the occurrence of bottle feeding, amount consumed, and commercial brands. The interviewers had previously received eight hours of theoretical and practical training supervised by the investigator who coordinated the collection of the dietary data. These instruments enabled recording the primary outcome of the study: the number of foods and beverages with sugar (added by the manufacturer or by the person who prepared the item) consumed in the first six months of age.

2.3 | Data analysis

The statistical analysis was performed with the aid of SPSS version 20. The number of items with sugar consumed by six months of age was described using measures of central tendency and dispersion. As the data exhibited normal distribution, the outcome variable was compared between categories of the independent variables using the t test for independent samples and analysis of variance (ANOVA). Poisson regression analysis with robust variance was performed, with the calculation of crude and adjusted mean ratios (MR) and respective 95% confidence intervals. All variables in the crude model were incorporated into the multivariate model.

TABLE 1 Characteristics of participants at baseline of cohort and six months of age

	Initial cohort ^a		Analysed sample ^b	
	%	Mean (SD)	%	Mean (SD)
Mother's characteristics and family environment				
Mother's age at birth (y)		25.4 (6.7)		25.5 (6.7)
Mother's schooling		8.5 (2.7)		8.5 (2.7)
Previous child	55.4		54.9	
Nuclear family	52.0		52.0	
Family income < 3 BMMW	67.8		67.4	
Child's characteristics				
Male sex	52.4		52.5	
Birthweight (g)		3286 (506)		3290 (506)
Length at birth (cm)		49.0 (2.5)		49.1 (2.5)

Abbreviation: BMMW, Brazilian monthly minimum wage.

^an = 715 at birth.

^bn = 596 at 6 months of age.

3 | RESULTS

Data on sugar intake were available for 596 children at six months of age, corresponding to an 83.3% response rate of the 715 children included at the onset of the study. Almost all losses were due to inability to locate the address. The characteristics of the mothers, family environment and children were similar between the baseline cohort and the sample analysed at six months of age (Table 1). A total of 52% of the children were born into nuclear families. Family income was less than three times the Brazilian monthly minimum wage (approximately 750 dollars) among two-thirds of the sample. Mother's age ranged from 13 to 44 years (mean: 25.5 ± 6.7), and mother's schooling ranged from 0 to 17 years (mean: 8.5 ± 2.7). The children were equally distributed in terms of sex (52.5% boys). A total of 6.1% were born with low birthweight, and 57.4% were breastfed within the first hour of life.

Table 2 shows the prevalence of the introduction of sugary items in each of the first six months of life. Before completing the first month of life, tea with sugar and added sugar had already been consumed by 17.0% and 15.1% of the infants, respectively. At three months of age, half of the infants had already had tea with sugar and 40.9% had consumed some item with added sugar. At six months of age, 98.3% (586/596) of the children had consumed foods and beverages with sugar. The most consumed sweet items at six months of age were tea with sugar (72.6%), cookies (69.5%), sugar added to food/beverage (66.4%), *Petit Suisse* (a fresh fermented milk product with a high sugar content) (64.2%), and gelatin (63.1%). The number of sweet items consumed at six months of age ranged from 0 to 15 (mean: 6.6 ± 3.2; median: 6.0 [P25-P75 4.0-9.0]) (Figure 1). Bottle feeding was used by 94.3% of children at six months of age and was the vehicle by which tea with sugar, soda, flavoured powdered drinks, gelatin, and chocolate milk were offered to the children. Moreover, among the 362 children who used a bottle for milk consumption at six months of age, sugar was added to the milk in 86.2% (n = 312) of cases, ranging from one to nine bottles per day, with a mean (SD) of 3.4 (1.6) bottles.

The number of sweet items consumed at six months of age was significantly higher among children whose mothers were younger ($P < .001$), those whose mother's had less schooling ($P < .001$), those whose mothers were smokers ($P < .001$), those whose families had a lower income ($P = .001$), those whose families were in a lower social class ($P < .001$), those whose family structure was non-nuclear ($P < .001$), and those who had a smaller length at birth ($P = .015$) (Table 3).

Table 4 displays the results of the simple and multivariate regression analyses. After adjusting for confounding variables, the number of sweet items was 19% higher among children whose mothers were younger than 20 years of age (MR = 1.19; 95% CI: 1.05-1.36), 12% higher among those whose families were non-nuclear (MR = 1.12; 95% CI:

Sugary foods	Prevalence (%) of consumption according to child's age						
	<1 mo	1 mo	2 mo	3 mo	4 mo	5 mo	6 mo
Tea	(17.0)	(24.5)	(37.6)	(50.7)	(63.0)	(69.3)	(72.6)
Cookies	(0.0)	(0.3)	(1.4)	(8.3)	(25.3)	(52.7)	(69.5)
Added sugar	(15.1)	(20.9)	(30.0)	(40.9)	(52.3)	(61.1)	(66.4)
Petit Suisse	(0.4)	(0.4)	(2.2)	(9.3)	(26.7)	(49.5)	(64.2)
Gelatin/Pudding	(0.0)	(0.1)	(1.7)	(11.4)	(28.3)	(50.8)	(63.1)
Soft drink	(0.0)	(0.3)	(1.1)	(3.9)	(11.0)	(26.3)	(37.8)
Candies	(0.1)	(0.3)	(0.9)	(3.7)	(9.5)	(23.3)	(36.4)
Sandwich cookie filling	(0.0)	(0.1)	(0.6)	(1.6)	(7.9)	(19.3)	(32.7)
Chocolate	(0.0)	(0.0)	(0.9)	(1.6)	(6.4)	(16.8)	(26.3)
Honey	(6.2)	(7.6)	(10.8)	(14.2)	(17.8)	(19.8)	(21.4)
Ice cream/ Popsicles	(0.0)	(0.0)	(0.4)	(2.2)	(5.2)	(12.5)	(20.6)
Flavoured powdered drinks	(0.1)	(0.1)	(0.9)	(2.2)	(4.8)	(13.0)	(20.1)
Savoury chips	(0.0)	(0.0)	(0.0)	(0.7)	(3.2)	(8.8)	(16.9)
Coffee	(0.3)	(0.4)	(0.4)	(1.5)	(2.5)	(7.5)	(12.9)
Chocolate milk	(0.0)	(0.3)	(0.4)	(0.9)	(2.2)	(5.9)	(10.3)

TABLE 2 Prevalence of introduction of sugary items in the first six months of age (n = 596)

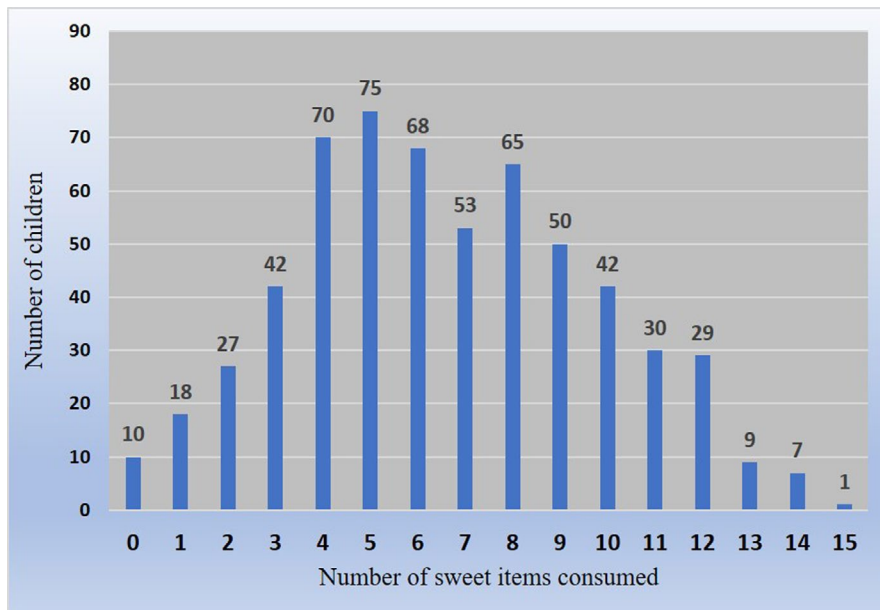


FIGURE 1 Absolute frequency of children according to number of sweet items consumed at 6 mo of age

1.04-1.20), 34% higher among those whose mothers had less than eight years of schooling (MR = 1.34; 95% CI: 1.20-1.50) and 23% higher among those whose mothers smoked (MR = 1.23; 95% CI: 1.13-1.35). The number of sweet items was 15% lower when the child had breastfed in the first hour of life (MR = 0.85; 95% CI: 0.76-0.95) and 13% lower when the child had breastfed between the first and 10th hour of life (MR = 0.87; 95% CI: 0.77-0.98). None of the anthropometric variables at birth were associated with the outcome after

adjusting for confounding factors and family income lost its significance after the multivariate adjustment.

4 | DISCUSSION

This study found an extremely early exposure to sugar in the first months of life and a significant gradient in the number of sweet items consumed up to six months of age associated with

TABLE 3 Mean and standard deviation (SD) of sweet items at 6 mo of age according to independent variables

Variables	N	(%)	Number of items with sugar		P-value
			Mean	(SD)	
Mother's age					<.001
<20 y	126	(21.1)	7.4	(3.1)	
20-30 y	329	(55.2)	6.6	(3.1)	
>30 y	141	(23.7)	5.8	(3.1)	
Family structure					<.001
Non-nuclear	286	(48.0)	7.1	(3.1)	
Nuclear	310	(52.0)	6.1	(3.0)	
Mother's schooling					<.001
<8 y	187	(31.4)	7.8	(2.7)	
8-10 y	219	(36.7)	6.7	(3.1)	
>10 y	190	(31.9)	5.1	(3.0)	
Family income					.001
<3 BMMW	402	(67.5)	6.9	(3.1)	
≥3 BMMW	194	(32.5)	5.9	(3.0)	
Social class					<.001
≤C	475	(79.8)	6.8	(3.0)	
≥B	120	(20.2)	5.5	(3.2)	
Mother's smoking					<.001
No	319	(53.4)	6.0	(3.1)	
Ex-smoker	159	(26.8)	6.4	(2.9)	
Yes	118	(19.8)	8.4	(2.7)	
Only child					.663
No	327	(55.0)	6.6	(3.0)	
Yes	269	(45.0)	6.5	(3.3)	
Sex					.606
Male	313	(52.5)	6.5	(3.1)	
Female	283	(47.5)	6.6	(3.2)	
Birthweight					.144
<2500 g	36	(6.1)	7.3	(3.0)	
≥2500 g	552	(93.9)	6.5	(3.1)	
Length at birth					.015
<48 cm	140	(24.0)	7.2	(3.2)	
≥48 cm	443	(76.0)	6.3	(3.1)	
Onset of breastfeeding					.082
First hour	339	(57.4)	6.5	(3.2)	
1 to 10 h	191	(32.4)	6.5	(3.1)	
>10 h	60	(10.2)	7.4	(3.2)	

Abbreviation: BMMW, razilian monthly minimum wage.

demographic, socioeconomic and family characteristics. The most important findings were the significantly greater exposure to sugar among children whose mothers were younger, had less schooling and were currently smokers as well as the lower exposure to sugar among children who breastfed in the first hours of life.

The IAPD recommends that strategies to prevent early childhood caries should include avoiding sugar intake for children under age two years old.⁶ Studies, however, have reported a high proportion of the consumption of foods and beverages with sugar before children complete the first year of life.^{9,10,13} To the best of our knowledge, the present finding that nearly all children had consumed sugar by six months of age has not previously been reported. In a study conducted in the United States, 44% of children between six and 11 months of age had already consumed sweet foods and beverages.¹⁰ In a study conducted in Finland, nearly half the children consumed beverages with sugar before completing six months of age.¹⁴ Three-quarters of the children in a study conducted in Mexico consumed foods and beverages with sugar prior to completing the first year of life.¹⁵ It is possible that these differences are due to the socioeconomic and cultural characteristics of the samples analysed. It is, however, plausible that the data collection method may have contributed to the determination of some items with sugar that are often unintentionally overlooked by parents and caregivers.

The strong socioeconomic gradient in relation to sugar intake has been reported previously.^{12,16,17} The strength of the association between mother's schooling and the number of sweet items consumed is, however, noteworthy, whereas the association with family income lost its significance after the adjustment by confounding factors. This same phenomenon has been described in another population in southern Brazil.¹⁶ It is possible that the early offer of sweetened items has a much stronger relation to the care that mothers give to their children and psychosocial aspects than family income, which is generally associated with the capacity to acquire consumer goods. Among the most prevalent psychosocial characteristics in mothers with a higher level of schooling, perceived susceptibility, and self-efficacy, respectively, convey how a mother evaluates her child's risk of developing a health problem and her belief in her capacity to exercise control over the events that affect her life.¹⁸⁻²⁰ These findings suggest that a lower offer of sugar is one of the possible pathways by which a higher level of mother's schooling protects children from early childhood caries.

The greater offer of items with sugar among adolescent mothers may be associated with greater insecurity in dealing with the demands of an infant, along with the greater influence of other family members. In general, foods with sugar are recognized as having the potential to calm a child. The association between smoking on the part of the

Variables	Crude analysis			Adjusted analysis		
	MR ^a	(95% CI)	P	MR	(95% CI)	P
Mother's age			<.001			
<20 y	1.27	(1.13-1.42)		1.19	(1.05-1.36)	.007
20-30 y	1.13	(1.02-1.26)		1.14	(1.04-1.26)	.006
>30 y	1.00			1.00		
Family structure			<.001			
Non-nuclear	1.16	(1.07-1.25)		1.12	(1.04-1.20)	.003
Nuclear	1.00			1.00		
Mother's schooling			<.001			
<8 y	1.52	(1.38-1.68)		1.34	(1.20-1.50)	<.001
8-10 y	1.31	(1.18-1.45)		1.23	(1.10-1.37)	<.001
>10 y	1.00			1.00		
Family income			.001			
<3 BMMW	1.00			1.00		
≥3 BMMW	0.86	(0.79-0.94)		0.96	(0.88-1.05)	.420
Social class			<.001			
≤C	1.24	(1.11-1.39)		1.08	(0.97-1.22)	.166
≥B	1.00			1.00		
Mother's smoking			<.001			
No	1.00			1.00		
Ex-smoker	1.07	(0.98-1.18)		1.05	(0.97-1.15)	.237
Yes	1.40	(1.29-1.52)		1.23	(1.13-1.35)	<.001
Only child			.667			
No	1.01	(0.94-1.10)		1.04	(0.95-1.14)	.375
Yes	1.00			1.00		
Sex			.606			
Male	0.98	(0.90-1.05)		0.99	(0.92-1.06)	.832
Female	1.00			1.00		
Birthweight			.114			
<2500 g	0.89	(0.77-1.02)		0.98	(0.85-1.13)	.795
≥2500 g	1.00			1.00		
Length at birth			.014			
<48 cm	1.12	(1.02-1.22)		1.03	(0.94-1.13)	.504
≥48 cm	1.00			1.00		
Onset of breastfeeding			.065			
First hour	0.87	(0.77-0.99)		0.85	(0.76-0.95)	.006
1 to 10 h	0.87	(0.76-0.98)		0.87	(0.77-0.98)	.027
>10 h	1.00			1.00		

Abbreviation: BMMW, Brazilian monthly minimum wage.

^aMean ratio.

TABLE 4 Crude and adjusted mean ratios (MR) and 95% confidence intervals (CI) of number of items with sugar consumed at 6 mo according to independent variables

mother and dental caries in children has previously been described.^{21,22} The findings of this study suggest that maternal smoking may be a marker of less resilience in the

face of stress, which may materialize in difficulties regarding the routine of child care and exert an influence on the greater offer of sugar.²³

Having a nuclear family was a protection factor against the introduction of foods and beverages with sugar. Family structure can exert an influence on child health through different pathways, such as the physical, emotional, and financial environment as well as health-related behaviours.^{24,25} It is possible that the presence of both parents translates to greater mutual support and care in the adoption of healthy practices in the first year of a child's life.

To the best of our knowledge, this is the first study to find an association between the onset of breastfeeding in the first hours of life and a lower introduction of sugary items in the first months of life. Although a cause-and-effect relation cannot be determined, it is possible that mothers who begin breastfeeding in the first hours after the birth of a child—which is recommended at prenatal services in this and other countries—are also more sensitive to counselling with regard to other healthy dietary practices. Moreover, such mothers have a greater likelihood of extending exclusive breastfeeding and reducing the introduction of beverages with sugar. Regardless of the mechanism by which exposure affects the outcome, this finding indicates that special attention should be given to mothers of children who do not initiate breastfeeding in the first hours after birth, as this is a significant risk factor for the early introduction of sugar.

The present investigation may have implications for clinical practice and future studies. The data are extremely worrisome, considering the current evidence of the associations between sugar intake and obesity, cardiovascular disease, diabetes, and dental caries, underscoring the need for urgent measures. Interventions for the promotion of a healthy diet and the reduction of sugar intake have generally had a moderate effect or even no effect at all.^{6,26} Policies and programmes should be focused especially on groups of a lower socioeconomic status, which are those that introduce sugar at an earlier age and have a greater burden of diseases. Such policies should also have a broad scope. Besides counselling a change in behaviour, more upstream strategies are needed to promote healthy environments at preschools, place warning labels on foods and increase the tax on sugar.^{27,28} Nudge interventions have recently been described, which are those that influence laws and policies while maintaining freedom of choice but guiding people in 'certain directions'. This involves simple, objective messages to make the healthy choice the easiest and most attractive choice through greater access, availability, and visualization.²⁹ The effect of broader measures on the reduction of diseases remains scarce, but studies have demonstrated that such measures can significantly contribute to the promotion of healthy eating and potentially contribute to a reduction in inequality.³⁰

Some characteristics of this study should be considered. A considerable proportion of dropouts occurred between birth and six months of age. The proportion, however, was similar to that reported in other birth cohort studies, especially in

low- and middle-income countries. Moreover, the similarity in the characteristics at baseline and the sample analysed in this study indicates a low probability of selection bias. The follow-up time of the cohort was short, but this is not a problem, since dietary practices, including the introduction of items with sugar, were already established by six months of age. Moreover, collecting the outcome variable at 12 or 18 months of age would increase the possibility of recall bias.

In conclusion, virtually all children in the present cohort study had items with sugar introduced in the first six months of life and the risk factors for the greater number of sweet items consumed were younger mothers, lower mother's schooling, mothers who smoked, a non-nuclear family and the absence of breastfeeding in the first hours of life. These findings may contribute to the development of strategies for the promotion of healthy eating practices in the first years of life.

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CONFLICT OF INTEREST

The authors do not have any conflict of interest regarding this paper.

AUTHOR CONTRIBUTIONS

CAF contributed to study design, conducted the data analysis, and drafted and critically reviewed the manuscript; MRV contributed to study design, data interpretation, and critically reviewed and revised the manuscript. RRM and PSB contributed to data interpretation and critically reviewed the manuscript; PHR contributed to data collection and critically reviewed the manuscript; PFK contributed to study design, data interpretation, and critically reviewed and revised the manuscript. All authors approved the version to be published.

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