

Andreia Morales Cascaes<sup>1</sup>

Karen Glazer Peres<sup>II</sup>

Marco Aurélio Peres<sup>II</sup>

Flávio Fernando Demarco<sup>1</sup>

Iná Santos<sup>1</sup>

Alicia Matijasevich<sup>1</sup>

Aluísio J D Barros<sup>1</sup>

# Validity of 5-year-old children's oral hygiene pattern referred by mothers

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## ABSTRACT

**OBJECTIVE:** To determine the validity of oral hygiene questions for children, as commonly used in epidemiological studies, and assess their validity by family income and mother's education.

**METHODS:** A subsample of 1122 children from the 2004 Pelotas Birth Cohort, Southern Brazil (who had participated in a 2009 oral health study) was analyzed. The children received dental examinations, and their mothers were interviewed at home. The gold standard for oral hygiene was the Simplified Oral Hygiene Index; from its total score, the outcome was dichotomized into the absence (total score = 0) or presence (total score  $\geq 1$ ) of dental plaque. The mothers answered questions related to their child's oral hygiene, including daily toothbrushing, toothbrushing before sleeping and the combination of the two (oral hygiene). These responses were dichotomized into regular and irregular. The validity was determined by calculating the percentages and respective 95% confidence intervals for sensitivity, specificity, positive predictive value and negative predictive value.

**RESULTS:** The overall prevalence of dental plaque was 37.0%. The following sensitivities, specificities, positive predictive values and negative predictive values were observed: 29.6%, 82.5%, 49.8% and 66.6%, respectively, for irregular daily toothbrushing; 41.8%, 64.6%, 40.9% and 65.5%, respectively, for irregular toothbrushing before sleeping; and 48.8%, 60.8%, 42.2% and 67.0%, respectively, for irregular oral hygiene. The validity of the oral hygiene reporting varied across different levels of family income and mother's education. The sensitivity and positive predictive values were higher among children with lower incomes and less educated mothers, while opposite associations were observed for specificity and negative predictive value.

**CONCLUSIONS:** Oral hygiene questions answered by mothers of five year-old children are not an appropriate substitute for direct oral hygiene assessment by the clinical examination of dental plaque.

**DESCRIPTORS:** Child. Toothbrushing. Diagnosis, Oral. Questionnaires, utilization. Oral Hygiene. Validation Studies.

<sup>1</sup> Programa de Pós-Graduação em Epidemiologia. Centro de Pesquisas Epidemiológicas. Universidade Federal de Pelotas. Pelotas, RS, Brasil

<sup>II</sup> Programa de Pós-Graduação em Saúde Coletiva. Departamento de Saúde Pública. Universidade Federal de Santa Catarina. Florianópolis, SC, Brasil

### Correspondence:

Andreia Morales Cascaes  
Centro de Pesquisas Epidemiológicas  
Coletiva de Pós-Graduação em Epidemiologia  
Universidade Federal de Pelotas - UFPel  
Rua Marechal Deodoro, nº 1160, 3º piso  
96020-220 Pelotas, RS, Brasil  
E-mail: andreiacascaes@hotmail.com

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## INTRODUCTION

Estimates of health-outcome prevalence measures based on self-reported measurements present advantages, such as simplicity, time-efficiency and low information cost; these advantages have justified using self-reporting in population surveys.<sup>1,4</sup> Thus, incorporating oral health questionnaires into epidemiologic studies has become more common, as evidenced by the US National Health and Nutrition Examination Survey<sup>2</sup> and by Brazilian studies, such as the *Pesquisa*

*do Sistema de Vigilância de Fatores de Risco e Proteção para Doenças Crônicas por Inquérito Telefônico 2009 (VIGITEL– System of Risk Assessment and Protection against Chronic Diseases by Telephone Survey –)*<sup>a</sup> and the *Suplemento em Saúde da Pesquisa Nacional por Amostra de Domicílio 2008 (PNAD – National Survey by Domiciliary Sampling - Health Supplement)*.<sup>b</sup>

However, such strategies will only be useful if the questions are valid, i.e., if the individual self-assessment actually matches the epidemiological diagnose in most of the cases. In Brazil, researchers have investigated the validity of self-reported weight and height,<sup>21</sup> as well as diagnoses for hypertension<sup>5</sup> and diabetes.<sup>13</sup> These measures have been used to assess morbidity in population surveys and have demonstrated adequate accuracies.

In the oral health field, some studies have also focused on this theme. Evidence from the literature has indicated that the validity of some self-reported measures of gingivitis and periodontal disease,<sup>3</sup> the presence of dental caries,<sup>17</sup> restorative needs<sup>18</sup> and orthodontic needs<sup>23</sup> are undesirably low, whereas tooth counts and the use of partial dentures<sup>15</sup> show acceptable validities. All of the oral health studies mentioned above were performed in adolescent, adult and elderly populations in developed countries. The validity of self-reported oral health measures in children has been poorly addressed,<sup>11</sup> and studies of this nature have not been performed in developing countries.

Childhood is a critical period for acquiring knowledge and habits, where these may subsequently affect health and behavior patterns.<sup>4</sup> Bacterial plaque control is recognized as a key factor for preventing dental caries, gingivitis and periodontitis, and it can be used to assess oral hygiene standards. Furthermore, such an assessment may aid in planning preventative and health-promotion educational programs, which commonly target school-children. In addition, it has been shown that oral hygiene standards in children are influenced by their socioeconomic factors and parents' attitudes towards oral health.<sup>12</sup>

Clinical-epidemiological indicators, such as the Simplified Oral Hygiene Index (OHI-S) proposed by Greene & Vermillion (1964),<sup>9</sup> have traditionally been used to assess the oral hygiene levels of individuals or communities. Classic oral hygiene questions, such as the frequency of daily toothbrushing, have been extensively used in research and population surveys to assess oral hygiene levels and, in some instances, as substitutes for clinical examinations.<sup>11</sup> However, the validity of such questions is not currently known, which makes them weak from a scientific point of view and compromises their use.

The aim of this study was to determine the validity of questions commonly used in epidemiological studies of children's oral hygiene to predict the presence of dental plaque, comparing overall validity with the results obtained by subgroups of socioeconomic status.

## METHODS

This study used data obtained from an oral health study nested in the 2004 Pelotas Birth Cohort (Brazil). The mothers of all the children born in the urban zone of the town of Pelotas in 2004 were identified and invited to participate in this cohort study. Approximately 99% of the 4,558 eligible children were included in the study soon after their births. At three months of age, the follow-up rate dropped to 96%, at 12 months to 94%, at 24 months to 93.5% and at 48 months to 92%. Further details of the cohort study's procedures can be found in the report by Barros et al (2006).<sup>1</sup>

The oral health study commenced in August 2009. The parents/guardians of all the cohort members born between September and December of 2004 who had been followed up to the age of four years (n=1303) were invited to participate in the study. The children were aged five (plus or minus a few weeks) and were in the deciduous stage of dentition (the scope of this study),<sup>22</sup> as defined by the World Health Organization's (WHO) criteria for epidemiological oral health studies.

A team of eight dentists and eight interviewers performed the fieldwork, which consisted of oral examinations for dental caries, occlusal problems, soft tissue lesions, the eruption patterns of first permanent molars and the presence of dental plaque. The tested questions were presented in a structured interview with the mother that involved questions related to the child's oral hygiene pattern. Information on the socioeconomic status of the family was obtained during a subsequent follow-up of the cohort. Both the intraoral examination of the child and the interview with the mother were performed in a single home visit. The interview preceded the intraoral examination so that the questionnaire responses would not be influenced by the outcome of the examination.

Prior to the domiciliary visits, the dentists underwent training and calibration with 100 children of the same age (who were not included in the study sample). Dental caries were recorded using the index of decayed, missing and filled surfaces, according to the WHO diagnostic criteria.<sup>22</sup> The children's oral hygiene status was assessed using a version of the OHI-S<sup>9</sup> that had been modified to address deciduous dentition. The diagnostic reproducibility of all the conditions and variables in the study was

<sup>a</sup> Ministry of Health. VIGITEL Brazil 2009. System of Risk Assessment and Protection against Chronic Diseases by Telephone Survey. Brasília, DF; 2010.

<sup>b</sup> Brazilian Geography and Statistics Institute. National Survey by Domiciliary Sampling (PNAD). Rio de Janeiro: IBGE; 2008.

assessed using simple and weighted kappa statistics; the intraclass correlation coefficient was also calculated. For dental caries, the lowest intraclass coefficient obtained was 0.93. The training for the dental plaque scoring was provided via a theoretical discussion that was illustrated with images of the various degrees of the condition. Because a plaque examination and gingival bleeding assessment modify the local environment, it was not possible to analyze their reproducibility. The children were examined while seated and under an artificial light (headlamp). The examiners wore the appropriate protective clothing and equipment and followed all the relevant health and safety guidelines.

The OHI-S (modified for deciduous dentition) was used as the gold standard for oral hygiene assessment in this validation study. The presence of plaque was verified on the buccal surface of 6 index teeth: the upper right second deciduous molar (tooth 55), the upper right central deciduous incisor (tooth 51), the upper left second deciduous molar (tooth 65), the lower right second deciduous molar (tooth 85), the lower left central deciduous incisor (tooth 71), and the lower left second deciduous molar (tooth 75). According to the OHI-S, dental plaque is defined as a soft organic material loosely adhering to the tooth surface. The tooth surface covered by plaque was estimated by visual examination according to the following criteria: 0 = no plaque present; 1 = plaque covering no more than 1/3 of the surface in question; 2 = plaque covering more than 1/3, but no more than 2/3 of the surface; 3 = plaque covering more than 2/3 of the surface; 9 = tooth excluded, no information. This last category was considered as missing data. The total OHI-S score was calculated and later dichotomized into plaque absent (total score = 0) or plaque present (total score  $\geq 1$ ).

The variables on the child's oral hygiene were answered by the mothers and included: i) daily brushing frequency, by the question "In general, how many times a day does <child> brush <his/her> teeth?" The answer choices were never/not every day, once, twice and three times or more. These were later grouped into irregular (never or once) or regular (twice or more). ii) brushing before sleeping, by the question "Before bed, does <child> brush <his/her> teeth?" The possible answers were never, sometimes and always, which were later grouped into irregular (never or once) or regular (always). Oral hygiene was defined by the combined frequencies of daily brushing and brushing before bed. This was categorized as good (regular brushing frequency and regular bedtime brushing), fair (irregular brushing frequency and regular bedtime brushing or *vice-versa*) or poor (irregular brushing frequency and irregular bedtime brushing). These categories were later narrowed into irregular (poor and fair) and regular (good). The categorization of oral hygiene into regular and irregular patterns followed guidelines from the literature.<sup>20</sup>

The analyses were performed according to the family income at the child's birth, which was categorized into quartiles. In addition, the education level of the mother was based on completed school years and categorized as 0 to 4, 5 to 8, 9 to 11 and 12 or more years.

The data were entered twice into the EpiInfo 6.04 statistical software and checked for consistency. The statistical analysis was performed using Stata 11.0. Absolute and relative frequencies were extracted for each variable. Plaque prevalence with its 95% confidence interval (95%CI) for each subgroup was presented according to the studied variables. The validity was determined by comparing the mother's report of the child's oral hygiene with the clinical examination findings by the dentists and calculating the percentage values and respective 95%CI for sensitivity (SE), specificity (SP), positive predictive value (PPV) and negative predictive value (NPV). The SE consisted of the fraction of children with dental plaque (according to the gold standard) whose mothers reported an irregular oral hygiene pattern. The SP was obtained from the proportion of plaque-free children whose mothers reported a regular oral hygiene pattern. The PPV was obtained from the proportion of children with plaque (the true positives) whose mothers reported an irregular oral hygiene pattern. The NPV was obtained from the proportion of plaque-free children (true negatives) whose mothers reported a regular oral hygiene pattern.

The project was approved by the Ethics Committee of the Federal University of Pelotas (process number 100/2009 on 29/06/2009). Informed consent was obtained from all of the participants' mothers.

## RESULTS

The questionnaire response rate for this study was 86.6% (n=1129). The final sample included only those subjects who also underwent the clinical examination for dental plaque (n=1122).

The distribution of the studied variables, the prevalence of dental plaque according to sex, skin color and the child's oral hygiene pattern (as reported by their mothers), the family income and the mothers' education levels are shown in Table 1. Just over half (52.3%) of the children were boys, and the majority were white (66.7%). Approximately 80% of the mothers reported that their children brushed their teeth twice or more per day; however, 42.7% of the children presented oral hygiene pattern considered irregular. The global prevalence of dental plaque was 37% (95%CI 34.1;39.9); it was higher among those with an irregular daily brushing pattern (49.8%, 95%CI 43.5;56.1) and irregular oral hygiene (42.2%, 95%CI 37.7;46.6) than among those in the regular categories. The prevalence of dental plaque were higher in children

**Table 1.** Dental plaque prevalence in the studied 5-year-old, according to socioeconomic factors and oral hygiene habits. Pelotas Birth Cohort, Southern Brazil 2009. (*n*=1122)

Variables	Distribution		Prevalence of Dental Plaque <sup>a</sup>	
	n	%	n	% (95%CI)
Presence of Dental Plaque			415	37.0 (34.1;39.9)
Sex				
Male	587	52.3	233	39.7 (35.7;43.7)
Female	535	47.7	182	34.0 (30.0;38.0)
Skin color <sup>b</sup>				
White	747	66.7	264	35.3 (31.9;38.8)
Mixed	220	19.6	83	37.7 (31.3;44.2)
Black	139	12.4	63	45.3 (37.0;53.6)
Indigenous	7	0.6	1	14.3 (0.0;42.3)
Asian	8	0.7	4	50.0 (12.9;87.1)
Frequency of daily toothbrushing <sup>c</sup>				
Regular	875	78.0	292	33.4 (30.2;36.5)
Irregular	247	22.0	123	49.8 (43.5;56.1)
Brushing before bed <sup>b,d</sup>				
Regular	698	62.3	241	34.5 (31.0;38.1)
Irregular	423	37.7	173	40.9 (36.2;45.0)
Oral hygiene <sup>b,e</sup>				
Regular	642	57.3	212	32.0 (29.4;36.7)
Irregular	479	42.7	202	42.2 (37.7;46.6)
Family income by quartiles				
1 (poorest)	282	25.1	115	40.8 (35.0;46.5)
2	286	25.5	116	40.6 (34.9;46.3)
3	316	28.2	119	37.7 (32.3;43.0)
4 (wealthiest)	238	21.2	65	27.3 (21.6;33.0)
Mother's education in school years <sup>b</sup>				
12 or more	123	11.2	27	22.0 (14.0;29.4)
9 to 11	392	35.7	132	33.7 (29.0;38.4)
5 to 8	440	40.0	183	41.6 (37.1;46.3)
0 to 4	144	13.0	68	47.2 (39.0;55.5)

<sup>a</sup> Dental plaque prevalence as measured by the Simplified Oral Hygiene Index.

<sup>b</sup> Variables with missing information. The highest number of missing observations was 23.

<sup>c</sup> Never brushes, does not brush every day, or brushes only once daily.

<sup>d</sup> Never or sometimes brushes before bed.

<sup>e</sup> Combination of irregular daily toothbrushing frequency and irregular bedtime brushing.

with families in the lowest income quartile (40.8%, 95%CI 35.0;46.5) and less educated mothers (47.2%, 95%CI 39.0;55.5) than in those with higher income (27.3%, 95%CI 21.6;33.0) and 12 or more years of education (22.0%, 95%CI 14.0;29.4).

The validity in relation to the OHI-S of the maternal reporting of the children's oral hygiene patterns is presented in Table 2. A low SE was observed for irregular daily brushing (29.6%, 95%CI 25.3;34.3); but when bedtime brushing was also considered (the variable denominated oral hygiene), the sensitivity increased to 48.8% (95%CI 43.9;53.7). The opposite occurred with the SP values, which showed higher values in the irregular daily brushing group (82.5%, 95%CI 79.5;85.2) and lower values for the oral hygiene variable (60.8%, 95%CI 57.1;64.4). The brushing frequency variable had the highest PPV (49.8%, 95%CI 43.4;56.2), while the NPV for all three variables showed similar values, ranging from 65.0% to 67.0%.

Table 3 shows the validity of the oral hygiene patterns in relation to family income. The assessment of each question varied according to the level of family income. For all three variables, the SE values for the oral hygiene patterns reported by the mothers were higher among the individuals with lower family income. The oral hygiene variable was more sensitive than each of its components assessed separately. The proportion of children with plaque who were reported to have an irregular oral hygiene pattern was 54.8% (95%CI 54.2;64.1) among those with lower family income, compared to 32.3% (95%CI 21.2;45.1) for those with a higher family income. However, the specificity of the questions increased with family income, particularly in the case of brushing frequency. Among the higher-income families, 69.0% (95%CI 61.5;75.7) of the plaque-free children were reported to have a regular oral hygiene pattern, and this figure fell to 54.8% in lower-income families (95%CI 45.2;64.1).

The validity results grouped by the mother's education level (Table 4) followed a pattern similar to that described for family income, i.e., higher SE for oral hygiene and higher SP for the frequency of daily brushing in all the education categories. The increase in the SE for the questions was inversely proportional to the number of years that the mother attended school, while the opposite effect was observed for the SP values. The PPV was higher among the children of less educated mothers, and the contrary was observed for the NPV.

## DISCUSSION

The questionnaire on oral hygiene patterns, as answered by the mothers of 5-year-old children, showed an unsatisfactory performance in assessing actual oral hygiene; therefore its validity as a substitute for the intraoral examination of dental plaque is questionable. Although no universally accepted criteria for an accurate test exists, some authors have defined a test to be accurate if the sum of its SE and SP values is higher than 120%.<sup>3</sup> In the present study, despite using the lowest summation, a desirable level of accuracy was not obtained.

**Table 2.** The validity of oral hygiene patterns in relation to dental plaque (Simplified Oral Hygiene Index) in 5-year-old children. Pelotas Birth Cohort, Southern Brazil, 2009. (n=1122)

Validity	Test		
	Irregular daily brushing <sup>a</sup>	Irregular bedtime brushing <sup>b</sup>	Irregular oral hygiene <sup>c</sup>
SE (95%CI)	29.6 (25.3; 34.3)	41.8 (37.0; 46.7)	48.8 (43.9; 53.7)
SP (95%CI)	82.5 (79.5; 85.2)	64.6 (61.0; 68.2)	60.8 (57.1; 64.4)
PPV (95%CI)	49.8 (43.4; 56.2)	40.9 (36.2; 45.8)	42.2 (37.7; 46.7)
NPV (95%CI)	66.6 (63.4; 69.7)	65.5 (61.8; 69.0)	67.0 (63.2; 70.6)

SE= Sensitivity; SP= Specificity; PPV= Positive Predictive Value; NPV= Negative Predictive Value.

<sup>a</sup> Never brushes, does not brush every day or brushes only once daily.

<sup>b</sup> Never or sometimes brushes before bed.

<sup>c</sup> Combination of irregular daily toothbrushing frequency and irregular bedtime brushing.

Substituting more accurate measures for the presence of diseases or conditions by simpler tests, such as questionnaires, is acceptable, with the understanding that classification errors may occur. The simpler tests are only useful when the risks are known and judged low based on a solid assessment of validity using the appropriate gold standard.<sup>8</sup>

The results of the present study must be interpreted with caution because limitations on the data collection for the gold standard may have occurred. The OHI-S advocates a visual examination with the aid of a dental probe to determine the extent of plaque. The use of a plaque-disclosing solution, although not recommended for epidemiological surveys, could facilitate visualizing the extent of plaque; this method would thus provide a

more accurate diagnosis, with a higher number of true positives observed. Another relevant point is that the OHI-S originally assessed the smooth surfaces of the teeth (buccal, palatal or lingual) in up to 12 readings. The OHI-S was modified in the present study, and only the buccal surfaces were examined in a total of six readings. Once again, the evaluation of a lower number of dental surfaces may have reduced the number of true positives and caused a lower prevalence estimate. Such factors may have reduced the actual prevalence of dental plaque as identified by the gold standard, which could consequently have led to a decrease in the PPV for the test questions.

In theory, the SE and SP of a test are independent from the prevalence of the outcome; in practice, however, a

**Table 3.** The validity of oral hygiene pattern in relation to dental plaque (Simplified Oral Hygiene Index) in 5-year-old children by family income quartiles. Pelotas Birth Cohort, Southern Brazil, 2009. (n=1122)

Test Validity	Family Income Quartile			
	1 (poorest)	2 <sup>o</sup>	3 <sup>o</sup>	4 (wealthiest)
Irregular daily toothbrushing				
SE (95%CI)	32.2 (23.8;41.5)	28.4 (20.5;37.6)	36.1 (27.5;45.4)	15.4 (7.63;26.5)
SP (95%CI)	77.2 (70.1;83.4)	81.7 (75.0;87.2)	81.7 (75.6;86.9)	89.1 (83.5;93.3)
PPV (95%CI)	49.3 (37.6;61.1)	51.6 (38.7;64.2)	54.4 (42.8;65.7)	34.5 (17.9;54.3)
NPV (95%CI)	62.3 (55.3;68.9)	62.4 (55.7;68.8)	67.9 (61.6;73.8)	73.8 (67.3;79.6)
Irregular bedtime brushing				
SE (95%CI)	48.7 (39.3;58.2)	43.5 (34.3;53.0)	42.9 (33.8;52.3)	24.6 (14.8;36.9)
SP (95%CI)	57.5 (49.6;65.1)	61.5 (53.8;68.9)	65.5 (58.4;72.1)	73.6 (66.4;79.9)
PPV (95%CI)	44.1 (35.3;53.2)	43.5 (34.3;53.0)	42.9 (33.8;52.3)	25.8 (15.5;38.5)
NPV (95%CI)	61.9 (53.8;69.6)	61.5 (53.8;68.9)	65.5 (58.4;72.1)	72.3 (65.1;78.8)
Irregular oral hygiene				
SE (95%CI)	54.8 (45.2;64.1)	47.8 (34.4;57.3)	52.9 (43.6;62.2)	32.3 (21.2;45.1)
SP (95%CI)	54.5 (46.6;62.2)	58.6 (50.8;66.1)	60.9 (53.7;67.8)	69.0 (61.5;75.7)
PPV (95%CI)	45.3 (36.9;54.0)	44.0 (35.1;53.2)	45.0 (36.6;53.6)	28.0 (18.2;39.6)
NPV (95%CI)	63.6 (55.2;71.5)	62.3 (54.2;69.8)	68.2 (60.8;75.0)	73.2 (65.7;79.8)

SE= Sensitivity; SP= Specificity; PPV= Positive Predictive Value; NPV= Negative Predictive Value.

<sup>a</sup> Never brushes, does not brush every day or brushes only once daily.

<sup>b</sup> Never or sometimes brushes before bed.

<sup>c</sup> Combination of irregular daily toothbrushing frequency and irregular bedtime brushing.

**Table 4.** The validity of oral hygiene pattern in relation to dental plaque (Simplified Oral Hygiene Index )in 5-year-old children by the mother's education. Pelotas Birth Cohort, Southern Brazil, 2009. (n=1122)

Validity	Mother's education (in school years completed)			
	0 to 4	5 to 8	9 to 11	12 or more
Irregular daily brushing				
SE (95%CI)	39,7 (28,0;52,3)	33,9 (27,1;41,2)	25,0 (17,9;33,3)	3,72 (0,1;19,0)
SP (95%CI)	71,1 (59,5;80,9)	79,3 (73,8;84,1)	85,4 (80,5;89,4)	90,6 (82,9;95,6)
PPV (95%CI)	55,1 (40,2;69,3)	55,9 (44,4;63,2)	46,5 (34,5;58,7)	10,0 (0,3;44,5)
NPV (95%CI)	56,8 (46,3;67,0)	62,7 (57,1;67,9)	69,2 (63,8;74,2)	77,0 (68,1;84,4)
Irregular bedtime brushing				
SE (95%CI)	43,3 (31,2;56,0)	46,4 (39,1;54,0)	37,1 (28,9;46,0)	33,3 (16,5;54,0)
SP (95%CI)	56,6 (44,7;67,9)	59,4 (53,1;65,4)	66,9 (60,8;72,6)	79,2 (69,7;86,8)
PPV (95%CI)	46,8 (34,0;59,9)	45,0 (37,7;52,4)	36,3 (28,2;45,0)	31,0 (15,3;50,8)
NPV (95%CI)	53,1 (41,7;64,3)	60,8 (54,4;66,9)	67,7 (61,6;73,4)	80,9 (71,4;88,2)
Irregular oral hygiene				
SE (95%CI)	52,2 (39,7;64,6)	52,5 (45,0;59,9)	46,2 (37,5;55,1)	33,3 (16,5;54,0)
SP (95%CI)	53,9 (42,1;65,5)	56,3 (49,9;62,4)	62,3 (56,1;68,2)	74,0 (64,0;82,4)
PPV (95%CI)	50,0 (37,8;62,2)	46,2 (39,2;53,2)	38,4 (30,8;46,4)	26,5 (12,9;44,4)
NPV (95%CI)	56,2 (44,1;67,8)	62,3 (55,7;68,6)	69,5 (63,2;75,4)	79,8 (69,9;87,6)

SE= Sensitivity; SP= Specificity; PPV= Positive Predictive Value; NPV= Negative Predictive Value.

<sup>a</sup> Never brushes, does not brush every day or brushes only once daily.

<sup>b</sup> Never or sometimes brushes before bed.

<sup>c</sup> Combination of irregular daily toothbrushing frequency and irregular bedtime brushing.

low prevalence estimate suggests a lower sensitivity and higher specificity when compared to those obtained from a population with a higher prevalence.<sup>8</sup> In the present study, the global prevalence of dental plaque was 37.0%, which is identical to that found in a preschool population in Belgium<sup>7</sup> and is lower than the prevalence reported in other places, such as 83.0% for pre-school children in Jordan.<sup>19</sup> Children with lower-income families, less-educated mothers<sup>12</sup> and irregular oral hygiene habits<sup>16</sup> have been found to have higher prevalence of dental plaque, consistent with findings of this study. The stratification by family income and mother's education revealed differences in the validity of the questions, which clearly distinguished the extremes of the strata.

In practical terms, what really matters is the PPV since it gives the probability of a positive individual actually having the outcome of interest. The PPV is heavily influenced by the prevalence of the outcome, unlike the SE or SP.<sup>8</sup> According to this study, the probability of identifying individuals with dental plaque in children whose mothers have reported an irregular oral hygiene pattern was, in general, lower than 50%. The prevalence differences between the income and education groups could explain the variations in performance of the tests used.

The twice-daily minimum toothbrushing frequency is the most accepted evidence of adequate levels of oral

hygiene. Additional factors, such as brushing time,<sup>6</sup> the use of toothpaste, features of the toothbrush bristles, the use of dental floss, brushing technique and manual dexterity, can interfere with the efficacy of good oral hygiene.<sup>10</sup> In the case of children younger than six years, it is recommended that the brushing be performed by an adult until the child has developed sufficient manual dexterity and cognitive skills to perform their toothbrushing independently.<sup>4</sup> Therefore, children's oral hygiene is also influenced by their mother's attitudes towards this practice. The low validity of the oral hygiene questions in this study suggests that toothbrushing frequency per se is not the best predictor of oral hygiene in children.

Investigating the validity of self-reported oral health assessments in population surveys is highly relevant given the high costs of applying more accurate methods of clinical epidemiological diagnosis, such as intraoral examination. This study showed a high rate of false positives (52% to 70% overall), which suggests that reports from mothers on the oral hygiene of their 5-year-old children are not good substitutes for clinical intraoral examination; therefore, the presence of dental plaque should be directly assessed. More precise questions should be formulated and tested in future validation studies.

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