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ORIGINAL ARTICLE

Profile of orofacial dysfunction in Brazilian children using the Nordic Orofacial Test-Screening

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ABSTRACT

Objective: The parameters of orofacial dysfunction (OFD) in children can guide clinicians and researchers in the monitoring of deviations from normality. The aim for this study was to evaluate manifestation patterns and the prevalence of OFD in children.

Materials and methods: A population-based cross-sectional study was conducted involving 531 schoolchildren (8–10 years old) in a small city in southern Brazil. OFD was evaluated using the Nordic Orofacial Test-Screening (NOT-S). Poisson multiple regression analysis with robust variance was used to estimate adjusted NOT-S rate ratios (ratio of arithmetic means) among the different categories of covariables and their respective 95% confidence interval (RR: 95%CI).

Results: The mean NOT-S score was 2.1 (SD 1.4, median: 2.0; range: 0–8). The majority of children (87.6%) had at least one domain of the scale affected. The most affected were *Chewing and Swallowing* (50.5%), *Habits* (41.4%) and *Breathing* (26.4%). NOT-S scores were lower among children from higher income families (RR = 0.73; 95% CI: 0.61–0.87) and higher among those with difficulty regarding access to dental services (RR = 1.14; 95% CI: 1.01–1.28), those with sleep bruxism (RR = 1.18; 95% CI: 1.04–1.32) and those with open bite (RR = 1.65; 95% CI: 1.42–1.93).

Conclusions: The prevalence of OFD was high and both socioeconomic and clinical factors exerted an influence on NOT-S scores.

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Introduction

Orofacial functions involve vital aspects such as respiration and food/beverage intake. Such functions also play a fundamental role in interpersonal relations and communication [1]. Parafunctional habits, such as mouth breathing, altered tone of the masticatory muscles as well as changes in chewing, swallowing and speaking patterns, can affect the dynamics of the stomatognathic system, leading to orofacial dysfunction (OFD) [1].

Healthcare professionals should be trained in the diagnosis of OFD on the individual level as well as in population groups. The Nordic Orofacial Test-Screening (NOT-S) is one of the methods employed for the evaluation of orofacial function, the use of which has increased considerably in the last 10 years. The NOT-S is a validated, low-cost measure of easy application [1] that has been translated into several different languages (http://mun-h-center.se/en/Mun-H-Center/Mun-H-Center-E/NOT-S/), including Brazilian Portuguese [2]. This screening test has been administered to individuals with chronic diseases and syndromes [1], such as ectodermal dysplasia [3], Parkinson's disease [4], Prader-Willi syndrome [5] and Treacher Collins syndrome [6]. The NOT-S enables the identification of domains regarding impaired orofacialfunction [1] as well as the evaluation of the impact of clinical interventions on oral functions [7].

Another application of the NOT-S is the screening and monitoring of cases of OFD in healthy populations [8]. However, one must be cautious when comparing OFD results among studies, as different methods are used for the evaluation of orofacial functions and considerable variation is found in the criteria used for the definition of OFD. The studies that use more rigorous clinical criteria to define OFD report lower prevalence of impairment in comparison to those that adopt instruments aimed at tracking cases or population-based studies. Despite the difficulties in assessing its prevalence accurately, it is essential to know the expression patterns of this adverse condition in the healthy population. Thus, the NOT-S is a measure that indicates corresponding areas of orofacial function that require detailed evaluations for a precise diagnosis and adequate treatment plan [1].

OFD is known to increase with age [9], indicating that interventions aimed at triggering factors should be instituted in a timely manner to avoid the perpetuation and aggravation of the negative effects on orofacial structures. Among healthy children, the frequency of impairment on the NOT-S domains seems to be related to the age of the individuals

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analyzed [8]. Different studies involving a broad age range have found lower NOT-S scores among younger individuals [10,11], which indicates that researchers who employ this measure should offer a clear description of the age groups studied.

The present study is justified by the high prevalence of OFD as well as the need to characterize and discuss the parameters of NOT-S in children in a clearly stated age group (8–10 years), considering socioeconomic and occlusal characteristics.

Materials and methods

Ethical aspects

This study received approval from the Human Research Ethics Committee of the Federal University of Paraná (Brazil) and was conducted in compliance with the recommendations of the Declaration of Helsinki by the World Medical Association. Parents/caregivers who agreed to the participation of their children signed a statement of informed consent.

Study design and sample

An observational, cross-sectional study was conducted with a representative sample of male and female children aged 8–10 years enrolled at public schools in both urban (seven schools) and rural (two schools) areas in the municipality of Campo Magro, which is located in metropolitan Curitiba, capital of the state of Paraná, southern Brazil.

The sample size was calculated based on the formula for the estimation of the population mean with correction for a finite sample using a mean NOT-S score of 2.99, a SD of 1.57 [9], 95% confidence level, 5% acceptable rate of error and a total of 1023 schoolchildren in this age group in the municipality ($n = 299$). A factor of 1.5 was applied for the design effect, leading to a minimum sample of 448 children, to which 20% was added to compensate for possible dropouts, resulting in a total of 560 children.

To ensure representativeness, randomized selection of all children in the target age group ($n = 1023$) was performed maintaining the proportion of children enrolled in each school. Schoolchildren with clinical characteristics that indicated syndromes with orofacial manifestations were excluded from the study.

Training and calibration exercises

The data collection team was composed of two examiners who had undergone training exercises and determination of inter-examiner and intra-examiner agreement. This process involved theoretical and practical training. The supervisor and gold standard for the NOT-S was a member of the team that translated and validated the measure for Brazilian Portuguese. A pediatric dentist with large experience in epidemiological studies was the coordinator and gold standard for occlusal characteristics. Inter-examiner and intra-examiner agreement were determined based on the evaluation of 15 children who did not participate in the main study. Intra-examiner agreement was determined based on findings on two occasions separated by a 7-day interval (inter-examiner and intra-examiner Kappa coefficients >0.85 for the NOT-S >0.87 for open bite and >0.84 for crossbite; inter-examiner and intra-examiner intraclass correlation coefficients >0.98 for horizontal overjet).

Evaluation of OFD and clinical exam

Data were collected from July to November 2013. Socioeconomic data (guardian's schooling and mother's employment) and access to dental services were determined using a questionnaire filled out by parents/caregivers. OFD was determined using the Brazilian Portuguese version [2] of the NOT-S protocol [1]. This measure has 12 domains distributed between two sections. Six domains are based on an interview (sensory function, breathing, habits, chewing and swallowing, drooling and dry mouth) and six based on a clinical evaluation (face at rest, nose breathing, masticatory muscles and jaw function, oral motor function and speech). Each domain has one to five items. When at least one response is positive, a score of 1 point is attributed to a given domain, indicating that at least one action in the domain is classified as impaired, following the criteria employed for the NOT-S. The final score ranges from 0 to 12 points, with higher scores denoting a greater number of negatively affected domains. The parents/caregivers and their children participated in the answers.

The clinical exams for horizontal overjet, open bite and crossbite followed the criteria established by the WHO [12]. The measurements were taken with the child seated on a school chair under natural light, with the aid of a flat mouth mirror (Duflex®, Rio de Janeiro, RJ, Brazil) and a periodontal probe (Milenium®, São Paulo, SP, Brazil).

The reports of sleep bruxism were obtained through the following question posed to the parents/caregivers: 'How often has your child grinded his/her teeth when sleeping in recent weeks?' The responses were dichotomized as 'no' (never or a few times) and 'yes' (sometimes, often or always).

Statistical analysis

The data were organized and submitted to statistical analysis using the SPSS program (version 20.0, IBM Corp., Armonk, NY). The dependent variable was the NOT-S score, which was analyzed as a numerical variable. OFD was considered present when at least one NOT-S domain was affected and absent when no NOT-S domain was affected. Socio-demographic variables were dichotomized: child sex (male or female), mother's employment (works outside home or does not work outside home), guardian's schooling (>8 years or ≤ 8 years of formal study) and difficult access to dental services (no: no difficulty in accessing dental service; or yes: the child needed dental treatment and the family was unable to afford it or unable to schedule an appointment in public healthcare). The economic variable income *per capita* was

analyzed as a numerical variable based on multiples of the Brazilian monthly minimum wage.

Descriptive analysis (frequency of variables and measures of central tendency and dispersion) was first performed. The Kolmogorov–Smirnov test showed that the distribution of the total NOT-S score deviated from normality ($p < .001$). Spearman's correlation coefficient (*rs*) was calculated to determine the strength of the correlation between the NOT-S and *per capita* income (based on the minimum monthly wage). The Mann–Whitney *U* test was used for the comparison of the groups formed by the dichotomized variables referring to socioeconomic and occlusal characteristics regarding NOT-S scores. The level of significance was set to 5% ($p < .05$). As the outcome was represented by a score, Poisson multiple regression analysis with robust variance was performed to estimate adjusted rate ratios (ratio of arithmetic means) of the NOT-S and respective 95% confidence intervals (RR: 95%CI) among the different covariable categories. Variables with a *p* value <.20 in the univariate analysis were selected for incorporation into the multiple Poisson regression model with robust variance. Those variables with the best fit and those that remained significant ($p < .05$) after adjustment to the other variables were maintained in the final model.

Table 1. Distribution of children according to affected NOT-S domain and total score ($n = 531$), Campo Magro, Brazil, 2013.

	Affected	
	n	%
Interview		
Sensory function	27	5.1
Breathing	140	26.4
Habits	220	41.4
Chewing and swallowing	268	50.5
Drooling	7	1.3
Dry mouth	45	8.5
Clinical exam		
Face at rest	128	24.1
Nose breathing	31	5.8
Facial expression	23	4.3
Masticatory muscles and jaw function	105	19.8
Oral motor function	4	0.8
Speech	102	19.2
Total NOT-S score*	465	87.6

*At least one domain affected.

Results

Five hundred and thirty-one schoolchildren participated in the present study (94.8% response rate). The mean NOT-S score was 2.1 (SD 1.4, median: 2.0; range: 0–8). The majority of children had at least one negatively affected domain. Only 12.4% did not exhibit OFD. The most affected domains were *Chewing and Swallowing* (50.5%), *Habits* (41.4%) and *Breathing* (26.4%) (Table 1).

On the interview section of the NOT-S, the most frequently affected item was difficulty eating solid foods (50.8%), followed by nail biting, sucking on the thumb/digit, pacifier or other object (31.6%) and snoring (26.4%) (Table 2). On the clinical exam section, the most affected items were asymmetrical activity of the masseter muscles (20.2%), speech abnormalities (16.4%) and facial asymmetry (15.3%) (Table 3).

Demographic variables were not significantly associated with the NOT-S score. However, children with difficulty regarding access to dental services had significantly higher NOT-S scores (Table 4). An negative correlation was found with *per capita* monthly income ($rs = -.184$; $p \leq .001$), as children from families with a higher household income had lower OFD scores.

In the bivariate analysis, statistically significant associations were found between the NOT-S score and both occlusal factors and reports of sleep bruxism (Table 5). The Poisson multiple model demonstrated that *per capita* income, difficulty regarding access to dental services, sleep bruxism and open bite were independently associated with the NOT-S scores.

Table 2. Distribution of children according to answers to questions on NOT-S ($n = 531$), Campo Magro, Brazil, 2013.

	Affected			
	Yes		No	
Domain/Questions	*n*	%	*n*	%
Sensory function				
Does brushing your teeth elicit a gag reflex?	23	40.3	508	95.7
Do you put so much food in your mouth that it becomes difficult to chew?	2	0.4	529	99.6
Breathing				
Do you use any breathing support?	–	–	531	100
Do you (does your child) snore when you (he/she) sleep(s)?	140	26.4	391	73.6
Habits				
Do you (does your child) bite your (his/her) nails or suck your (his/her) fingers or other objects every day?	168	31.6	363	68.4
Do you (does your child) bite your (his/her) suck or bite your (his/her) lips, tongue or cheeks every day?	38	7.2	493	92.8
Do you (does your child) bite your (his/her) teeth hard or grind your (his/her) teeth during the day?	55	10.4	476	89.6
Chewing and swallowing				
Does not eat with the mouth (nasogastric tube, gastrostomy, etc.)	–	–	531	100
Do you find it difficult to eat foods with a certain consistency (harder foods)?	270	50.8	261	49.2
Does it take you 30 min or more to eat a main meal?	6	1.1	525	98.9
Do you swallow large bites without chewing?	7	1.3	524	98.7
Do you often cough during meals?	2	0.4	529	99.6
Drooling				
Do you get saliva in the corner of the mouth or on your chin almost every day?	7	1.3	524	98.7
Dryness of mouth				
Do you have to drink to be able to eat a cracker?	44	8.3	487	91.7
Do you suffer from pain in the mucous membranes in your mouth or on your tongue?	2	4	529	99.6

Table 3. Distribution of children according to characteristics of NOT-S clinical exam ($n = 531$), Campo Magro, Brazil, 2013.

	Affected			
	Yes		No	
Domain/Clinical evaluation and requests	*n*	%	*n*	%
Face at rest				
Asymmetry	81	15.3	450	84.7
Deviant lip position	61	11.5	470	88.5
Deviant tongue position	–	–	531	100
Involuntary movements	–	–	531	100
Nose breathing				
Close your mouth and take 5 deep breaths through your nose (smell)	31	5.8	500	94.2
Facial expression				
Close your eyes tightly	4	0.8	527	99.2
Show your teeth	19	3.6	512	96.4
Try to whistle/blow	1	0.2	530	99.8
Masticatory muscles and jaw function				
Bite hard on your back teeth	107	20.2	424	79.8
Open your mouth as wide as you can	2	0.4	529	99.6
Oral motor function				
Stick out your tongue as far as you can	3	0.6	528	99.4
Lick your lips	1	0.2	530	99.8
'Blow up' your cheeks and hold for at least 3 s	–	–	531	100
Open your mouth wide and say ah-ah-ah	–	–	531	100
Speech				
Does not speak	1	0.2	530	99.8
Count out loud to 10	87	16.4	444	83.6
Say PATAKA, PATAKA, PATAKA	24	4.5	507	95.5

Table 4. Distribution of children according to demographic–socioeconomic variables, access to dental services and NOT-S score ($n = 531$), Campo Magro, Brazil, 2013.

		NOT-S score				
Variable	Freq. (%)	Mean (SD)	Median	Min	Max	*p* value*
Sex						
Male	244 (46)	2.02 (1.34)	2	0	8	.321
Female	287 (54)	2.04 (1.4)	2	0	6	
Mother's employment						
Works outside home	336 (70.1)	2.03 (1.4)	2	0	6	.960
Does not work outside home	143 (29.9)	2.02 (1.31)	2	0	6	
Guardian's schooling (years of study)						
>8 years	269 (51.1)	1.98 (1.31)	2	0	6	.657
≤8 years	257 (48.9)	2.09 (1.43)	2	0	8	
Difficult access to dental services**						
No	310 (58.9)	1.89 (1.36)	2	0	8	**.001**
Yes	216 (41.1)	2.31 (1.43)	2	0	6	

Min: minimum; Max: maximum.
*Mann–Whitney *U* test; significant results at 5% level in bold type.
**Difficult access to dental services considered when 'yes' was answered to 'Has your child ever needed dental treatment and you were unable to afford it or unable to schedule an appointment?'
Total frequencies less than 531 due to non-responses.

Scores were higher among children from low-income families (RR = 0.73), those whose parents reported difficulty regarding access to dental services (RR = 1.14), those who had reports of sleep bruxism (RR = 1.18) and those with open bite (RR = 1.65) (Table 6).

Discussion

In this group of healthy children, although NOT-S scores were low, the prevalence of those with at least one affected

Table 5. Distribution of children according to clinical variables, sleep bruxism and NOT-S scores ($n = 531$), Campo Magro, Brazil, 2013.

	NOT-S score					
Variables	Freq. (%)	Mean (SD)	Median	Min	Max	*p* value*
Open bite						
Present	34 (6.4)	3.29 (1.19)	3	1	6	**<.001**
Absent	497 (93.6)	1.98 (1.38)	2	0	8	
Crossbite						
Present	85 (16)	2.32 (1.42)	2	0	5	**.029**
Absent	446 (84)	2.02 (1.27)	2	0	8	
Horizontal overjet						
Normal**	295 (55.6)	1.94 (1.31)	2	0	6	**.041**
Altered***	236 (44.4)	2.23 (1.5)	2	0	8	
Grinds teeth during sleep						
No	415 (79.1)	2.07 (1.41)	2	0	6	**.012**
Yes	110 (20.9)	2.16 (1.44)	2	0	8	

Min: minimum; Max: maximum.
*Mann–Whitney *U* test; significant results at 5% level in bold type.
**Normal = 0–3mm; ***altered = <0 mm or >3 mm.
Total frequencies less than 531 due to non-responses.

Table 6. Poisson multiple regression model for orofacial dysfunction, Campo Magro, Brazil, 2013.

Variables	*p* value*	RR	95% CI
Per capita income (BMW)	**.001**	0.73	0.61–0.87
Difficult access to dental services			
Yes	**.033**	1.14	1.01–1.28
No		1	–
Grinds teeth			
Yes	**.009**	1.17	1.04–1.32
No		1	–
Open bite			
Yes	**<.001**	1.65	1.42–1.93
No		1	–
Horizontal overjet			
Altered	.072	1.11	0.99–1.25
Normal		1	–

*p value referring to Poisson multiple regression, significant results at 5% level in bold type.
BMW: Brazilian monthly minimum wage ($301 dollars – July 2013).
RR: rate ratio.

NOT-S domain was high, indicating that a more detailed evaluation should be considered [1]. Moreover, the findings indicate that NOT-S scores were lower among children from higher income families and higher among those with greater access to dental services, those with sleep bruxism and those with open bite. Special attention should be provided to children from lower income families and those with low access to dental services, as their NOT-S scores were higher. In addition, children presenting open bite or sleep bruxism also showed higher NOT-S scores compared to those without the respective characteristics, claiming also for special oral care.

The NOT-S is a relatively recent measure and the standardization of the OFD data obtained using this measure, which should include at least the mean score, range and indication of the most affected domain, has been suggested to facilitate comparisons among different populations [8]. Considering the association between the variation in the items evaluated and age, a specific age group was defined in the present study (8–10 years). This group was selected due

to the few studies involving such an age range and the fact that this group represents a methodological challenge (children with mixed dentition). Moreover, this age group is that which exhibits considerable frequency in the use of dental services.

A high prevalence of OFD was found among these 8- to 10-year-old children. The most affected domains were *Chewing and Swallowing* and *Habits*. Previous studies involving healthy Brazilian children using the NOT-S report similar findings [9–11]. The high prevalence of parafunctional habits in this age group may account for the considerable effect on these domains. Moreover, taking the mixed dentition into account, one cannot discard the presence of primary teeth in the final phase of physiological exfoliation, which may increase the frequency of difficulties chewing, with a consequent increase in NOT-S scores.

The most affected domains were in the interview section. This seems to be a characteristic of the NOT-S and several studies involving children report the same finding [9–11], likely because the conditions perceived and reported by the children examined may not yet have demonstrated a perceptible clinical manifestation.

Regarding aspects related to the clinical exam, the most frequent findings were asymmetrical activity of the masseter muscles, altered speech and facial asymmetry. Previous studies involving the use of the NOT-S also found a greater negative impact on these same items of the clinical exam section [1,9,10,13]. Like any other screening tool, caution should be exercised when interpreting the findings of the NOT-S, especially when similar items are evaluated using different methods. For instance, a report of snoring is enough to determine a compromised breathing pattern on the interview section, which could lead to the inclusion of individuals who do not have any physical obstruction of the airways, but snore due to relaxation of the laryngeal muscles. In contrast, the evaluation of breathing on the clinical section is based on the impossibility to perform nose breathing adequately, which is more associated with a physical obstruction. The present findings demonstrated this characteristic of the NOT-S, as greater impairment on the breathing domain was found using the interview section in comparison to nose breathing determined using the clinical section. Similar results were found in another study with Brazilian children [10].

Among the clinical variables, the NOT-S score was associated with open bite, crossbite and increased overjet, which are often the result of parafunctional habits and respiratory problems. Abnormal chewing and swallowing patterns as well as parafunctional habits (pacifier use, sleep bruxism and awake bruxism) and respiratory problems are common findings among individuals with OFD [9,11,13] and those with occlusal abnormalities [10,14–20].

Sleep bruxism and open bite were independently associated with the NOT-S score, whereas overjet was not independent of the other variables incorporated into the model. It should be noted that all clinical variables that demonstrated statistical significance in the bivariate analysis were included into the multiple model with the exception of crossbite. Such care was taken because this clinical characteristic had previously been analyzed as a part of the outcome variable (NOT-S score) on the facial asymmetry item and its incorporation into the model could have led to bias.

In the multiple model, children from low-income families and those with less access to dental services had higher NOT-S scores. It is likely that such children have less opportunity regarding early diagnosis and adequate treatment, leading to the perpetuation of the negative effects on orofacial structures when OFD triggering factors are not identified early enough [11].

The present findings should be considered in the context of the study limitations. Dental caries were not taken into account, due to operational aspects of the study. Since large caries lesions could affect the ability for chewing and, consequently, swallowing, they must be considered in further studies to guarantee proper evaluation of Chewing and Swallowing domain.

Another limitation of the present study is the risk of false positives, as the NOT-S has a high degree of sensitivity, but a low degree of specificity [1]. Slight variations can occur due to differences in the interview methods, as children have difficulty answering some questions on the NOT-S and require the assistance of parents/caregivers [1]. Thus, the parents/caregivers participated in the answers in order to minimize this problem. Furthermore, this is a population-based study specifically based on a population of 8- to-10-year-old schoolchildren from a small city in Brazil. Therefore, generalizations to other populations should be performed with caution.

The main objective of this study was to define OFD in a healthy population to allow comparisons with the findings of other studies and other population groups. Thus, children with syndromes were excluded, as studies evaluating OFD with the aid of the NOT-S have found higher mean total scores among such individuals [1,4–6,8] than studies involving healthy individuals [9–11,13].

When not treated, OFD tends to aggravate with age [9]. The early diagnosis of this condition can enable the adoption of timely preventive and interceptive actions to avoid or minimize their consequences [14]. Moreover, the use of low-cost assessment tools for the screening of OFD that are easy to administer constitutes a strategy aimed at minimizing the difficulty regarding access to dental services by directing efforts at more vulnerable groups.

In conclusion, a high prevalence rate of OFD was found among the children analyzed and both socio-economic and clinical factors exerted an influence on NOT-S scores. The use of simple, reliable assessment tools, such as the NOT-S, with well-established parameters facilitates the diagnosis of small deviations. The present findings can enable pediatric dentists to understand the response pattern regarding the OFD using NOT-S in a population of healthy children, thereby increasing the possibility of the early identification of OFD.

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