Are severe occlusal problems more frequent in permanent than deciduous dentition?

Má oclusão severa é mais freqüente na dentição permanente do que na decídua?

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Abstract

Objective
To determine the prevalence and severity of occlusal problems in populations at the ages of deciduous and permanent dentition and to carry out a meta-analysis to estimate the weighted odds ratio for occlusal problems comparing both groups.
Methods
Data of a probabilistic sample (n=985) of schoolchildren aged 5 and 12 from an epidemiological study in the municipality of São Paulo, Brazil, were analyzed using univariate logistic regression (MLR). Results of cross-sectional study data published in the last 70 years were examined in the meta-analysis.
Results
The prevalence of occlusal problems increased from 49.0% (95% CI =47.4%-50.6%) in the deciduous dentition to 71.3% (95% CI =70.3%-72.3%) in the permanent dentition (p<0.001). Dentition was the only variable significantly associated to the severity of malocclusion (OR=1.87; 95% CI =1.43-2.45; p<0.001). The variables sex, type of school and ethnic group were not significant. The meta-analysis showed that a weighted OR of 1.95 (1.91; 1.98) when compared the second dentition period with deciduous and mixed dentition.
Conclusions
In planning oral health services, some activities are indicated to reduce the proportion of moderate/severe malocclusion to levels that are socially more acceptable and economically sustainable.

Resumo

Objetivo
Analisar a prevalência e severidade de problemas oclusais em populações em idades relacionadas à dentição decídua e permanente, e efetuar uma meta-análise para estimar odds ratio *ponderada para problemas oclusais comparando os dois grupos.*
Métodos
Foram analisados os dados de uma amostra probabilística (n=985) de escolares de cinco e de 12 anos de idade obtidos de um estudo epidemiológico transversal realizado no Município de São Paulo, Brasil, usando regressão logística múltipla. Mediante meta-análise, foram examinados os resultados de estudos transversais publicados nos últimos 70 anos.

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Resultados

A prevalência dos problemas oclusais aumentaram de 49,0% (IC 95% =47,4-50,6) na dentição decídua para 71,3% (IC 95% =70,3-72,3) na dentição permanente (p<0,001). O tipo de dentição foi a única variável estatisticamente associada à presença de má oclusão moderada/severa (OR=1,87; IC 95% =1,43-2,45; p<0,001). Sexo, tipo de escola e etnia não foram estatisticamente associados. A meta-análise mostrou que o odds ratio *ponderado foi 1,95 na comparação da dentição permanente com a dentição decídua/mista.*

Conclusões

No planejamento de ações e serviços odontológicos, algumas atividades são indicadas com a finalidade de reduzir a proporção de má oclusão moderada/severa para níveis mais aceitáveis socialmente e sustentáveis economicamente.

INTRODUCTION

The formation, maturation and wearing away of occlusion in deciduous and permanent dentition can be understood as points on the same continuum, the same phenomenon which undergoes constant change over time, whose ingredients or components act on, interact, and condition each other. Thus, the occlusal characteristics observed in both temporary and permanent dentition are part of a single process referred to as growth and development of maxillary bones and maturing occlusion.[3]

Statements bearing out this process can be found in some scientific studies.[15,19,20,22,24]

Maloccluded teeth can cause the individual psychosocial problems related to impaired dentofacial esthetics; disturbances of oral function, such as mastication, swallowing, and speech; and greater susceptibility to trauma, accentuated periodontal disease or tooth decay related to malocclusion.[16]

Oral-facial development thus conceived can be divided into two main stages: an early stage and a more advanced one. The early stages of development start in the pre-natal period and continue until the total substitution of the temporary dentition by the permanent one. Later stages include the phases from adolescence to the aging of the stomatognatic system.[16]

In the scientific literature, the number of epidemiological studies of malocclusion in both temporary and permanent dentition is small, and only a few allow an approach for determining whether the prevalence of occlusal problems in the secondary dentition is higher than that of the primary dentition. Malocclusion has become subject of attention in some regions where dental caries on children is declining. Knowing whether these problems are more frequently seen in a certain period of childhood development

may help decision makers in planning and managing health systems.

The purpose of this study was to summarize evidence to answer the following question: Are occlusal problems more frequent and more severe at the age related to permanent dentition than at the age of deciduous dentition? If so, in what extent?

METHODS

The study was conducted in two phases.

Phase 1

First, data from a schoolchildren's oral heath survey conducted in São Paulo, Brazil, in 1996, were examined. Estimates of caries prevalence were designed and included data from a multistage random sample of 2,491 schoolchildren aged 5 to 12 years. The sample subjects were randomly drawn from schools distributed throughout the city. The list of the educational units was retrieved from the "Secretaria de Educação do Estado de São Paulo" (Education Department of the State of São Paulo). Four strata corresponding to public and private preschools and public and private elementary schools were created. Thirty schools were randomly selected in each stratum and 103 educational units distributed in 58 city districts participated. Data regarding age, sex, type of school (public or private), and ethnic group (African Brazilian, white, yellow or black) were collected.[23]

Occlusal status was ascertained using the occlusal index recommended by the World Health Organization,[25] divided into three categories: [0] *no malocclusion*; [1] *mild malocclusion*: minor anomalies such as one or more rotated or tilted teeth or slight crowding or spacing, which disturb the regular teeth alignment; [2] *moderate/severe malocclusion*: more seri-

ous anomalies generally regarded as unacceptable and affecting facial appearance, or a significant reduction in chewing function, or impairment of speech; specifically, the presence of one or more of the following conditions of the four anterior incisors: maxillary overjet estimated to be 9 mm or more; mandibular overjet; anterior crossbite equal to or greater than a full tooth; open bite; midline shift estimated to be more than 4 mm; and crowding or spacing estimated to be more than 4 mm. The examiners followed a number of adaptations recommended by the Collective Oral Health research group of the School of Public Health of the University of São Paulo, in which no defined occlusal deviations in these criteria such as posterior crossbite (uni or bilateral), overbite or vertical crossing over above 2 mm, should be categorized as code [1] in order not to overestimate the malocclusion severity in the study population.

Before data collection, the examiners were calibrated to increase agreement related to conditions found in the field. The inter-examiner error measured in this process was 26.7%. During data collection, 163 children (6.5% of the sample) were reexamined to calculate intra-examiner error, which was 4.9%.

To compare occlusal status between deciduous and permanent dentitions, 985 children aged 5 and 12 were investigated (response rate of 82.9%). Data on ages 6 to 11 was excluded from the database for two reasons: first, the sample size was practically twice as large for ages 5 and 12, and thus adequate for inferences concerning the population of those age groups for the whole city;[12] and second, the transition period from temporary to permanent dentition could add confounding factors to the use of occlusal indexes since this period is marked by intense biological dynamism[5] which could increase the wide variation of opinions on occlusion status among professionals.[17]

Though inter-examiner error reached scores higher than recommended,[25] it was observed that many of these discrepancies had occurred due to the difficulty of making a distinction between the variable categories "normal" and "mild", as seen with other epidemiological instruments. As the main goal of the analysis was to compare the prevalence of more severe occlusal problems in the ages 5 and 12, and since accidental results are unlikely to occur after a great number of observations, this limitation of the measurement instrument was not considered detrimental to the reliability of the results obtained given the sample size (n=985).

The Chi-square test and univariate logistic regression model were used to analyze the relationship between moderate/severe malocclusion (Y=1) and no malocclusion and mild malocclusion (Y=0) and independent variables (gender (X_1), school (X_2), ethnics (X_3) and dentition (X_4)). The probability of moderate or severe malocclusion [Prob(Y=1)] was esti-

$$\hat{p} = prob\,(Y=1\,/\,X_i) = \frac{1}{1 + \exp^{-(\beta_0 + \beta_i X_i)}}$$

mated using the following logistic function:

where β_i are the regression coefficients and the odds ratio (OR=exp(β_i)).

The software packages used were C-sample at Epi Info 6.04b, developed by the US's Centers for Disease Control and Prevention, and Multiple Logistic Regression by Unconditional and Conditional Methods (MULTLR), v. 07/89, developed by Nelson Campos Jr. and Eduardo L. Franco at the Ludwig Institute for Cancer Research, São Paulo.

Phase 2

During the second phase, research over the past 70 years was examined and some cross-sectional epidemiological studies were reanalyzed using meta-analysis.[6] The problem explored was the effect observed in the probability of occurrence of malocclusion between early development stages (mainly related to the deciduous dentition) and late development stages (mainly related to the permanent dentition). Two variables were investigated in literature review to answer the study hypothesis: moderate or severe occlusal problems as an outcome variable, and age as probably associated with the effect and representative of the development stages of interest in the study.

The studies were identified using the following keywords: *malocclusion, epidemiology, schoolchildren, deciduous dentition, permanent dentition*, in three databases: Medline of National Library of Medicine (http://www.ncbi.nlm.nih.gov/pubmed/), Lilacs (Latin American and Caribbean Literature in Health Sciences), from the PAHO/WHO Latin American and Caribbean Information Center in Health Sciences (http://www.bireme.br), and Bibliografia Brasileira de Odontologia (Brazilian Dentistry Bibliography), from the Information Center in Oral Health Sciences conducted by Documentation Service of the "Faculdade de Odontologia da Universidade de São Paulo" (Dental School of the University of São Paulo).

Given that surveys based on scientific studies listed in electronic databases are liable to miss relevant published studies[1] and that conclusions may be bi-

ased when the studies included in the meta-analysis do not represent all investigations carried out in the field of research,[11] a thorough examination of all references listed in the first studies found was carried out as an alternative strategy to identify studies which could possibly be overlooked when only the electronic means is used.

The main inclusion criterion for sectional studies was the selection of original scientific articles in which the same measurement instrument for occlusion was applied in population samples with age ranges related to deciduous and permanent dentition to allow for the post-stratification into two strata related to the development stages. Six studies were included based on this criterion. Studies related to a certain occlusion development stage, e.g. early or late, were also included as long as they allowed for comparison in time and space. When any two surveys matched this and each of them related to one type of dentition, both were included. Based on this criterion, surveys by the United States Health Statistics Division assessing the occlusal status of children aged 6 to 11 and adolescents aged 12 to 17 was in the periods of 1963-65 and 1966-70, respectively, were selected and considered a single study for analysis. Data from the Third National Health and Nutrition Examination Survey in United States were not included as they did not have information about occlusal conditions near deciduous dentition. Rates related to moderate/severe malocclusion were considered whenever possible.

After the selection of studies, individual re-analysis was carried out. The results presented by the authors were examined using contingency tables (2x2) in order to test the presence and intensity of the association between occlusal problems and type of dentition. The relationship between these variables was analyzed using Chi-square test with Yates correction and the odds ratios of the outcome variable (and their respective 95% confidence intervals).

To calculate the weighted odds ratio it was first checked whether the odds ratios were homogeneous or not through the χ^2 test, according to the following expression:

$$\chi^2 = \sum w_i (\log OR - OR_{weighted})^2$$

where the degrees of freedom of $\chi^2_{crític}$ = number of studies -1

Then, if odds ratios were homogeneous – which means that the different studies produced estimates corresponding to common effects – the *fixed effect analysis method*[11] was applied and weighted odds ratios with their respective confidence intervals (95%) were calculated, according to the following statistical expressions:

$$OR_{weighted} = \sum w_i \cdot \ln(OR) / \sum w_i$$
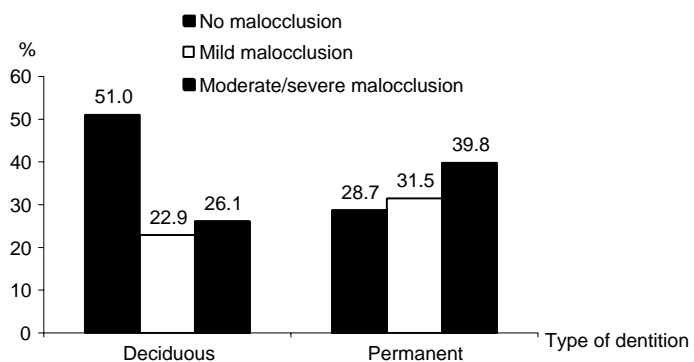
Percentual distribution of schoolchildren according to occlusal status and type of dentition. São Paulo, 1996.

$\chi^2 = 51.6$ $p < 0.0010$

Figure 1 - Percentual distribution of schoolchildren according to occlusal status and type of dentition. São Paulo, 1996.

Table 1 – Logistic regression analysis of moderate/severe malocclusion. São Paulo, 1996.

Variable	Categories (N)	Prob (Y=1)	O R	95% CI (OR)	p (Wald)	ln L(p)	p (χ^2)
Sex	0: Men (483)	0.34					
	1: Women (502)	0.32	0.94	0.72-1.22	0.6223	-624.509	0.6223
[Prob (Y=1)=1/(1+exp (-0.6746 - 0.0668 X_1)]							
School	0: Private (483)	0.33					
	1: Public (502)	0.33	1.01	0.77-1.31	0.9605	-624.629	0.9605
[Prob (Y=1)=1/(1+exp (-0.7118 + 0.0067 X_1)]							
Ethnic groups	0: White (565)	0.32					
	1: Yellow (26)	0.42	1.57	0.71-3.48	0.2689		
	2: African-Brazilian* (333)	0.33	1.05	0.79-1.41	0.7162		
	3: Black (61)	0.39	1.39	0.81-2.39	0.2376	-623.434	0.4949
[Prob (Y=1)=1/(1+exp (-0.7603 + 0.4501 X_1 + 0.0536 X_2 + 0.3274 X_3)]							
Dentition	0: Deciduous (490)	0.26					
	1: Permanent (495)	0.40	1.87	1.43-2.45	<0.0001	-614.154	<0.0001
[Prob (Y=1)=1/(1+exp (-1.0396 + 0.6257 X_1)]							

*Note: Subjects with skin between white and black presenting mixed traits not included in white, black or yellow categories were considered African-Brazilian.

where w_i is the opposite of standard error square

C. I. $(OR_{weighted}) = OR_{weighted} \pm 1.96 . SE (OR_{weighted})$

where $SE (OR_{weighted}) = 1 / \sum w_i$

RESULTS

The prevalence of any occlusal problems increased from 49.0% (95% CI =47.4%-50.6%) in the deciduous dentition to 71.3% (95% CI =70.3%-72.3%) in the permanent dentition (p<0.001) as shown in Figure 1.

Dentition was the only significant variable associated to the severity of malocclusion (OR=1.87; 95% CI =1.43-2.45; p<0.001). Logistic regression analysis indicated that the risk estimate for the population with permanent dentition to have severe/moderate malocclusion grew from 26% to 40% as shown in Table 1. The variables sex, type of school, and ethnic differences between Whites and African-Brazilians were not statistically significant. Thus, the data was analyzed using only the univariate logistical regression model.

The meta-analysis was carried out based on major studies published over the twentieth century. In Table 2, samples, ages, and results of these studies are described. The estimates showed that the proportion of the population aged 12 years and over with moderate/severe occlusal problems is much greater than the proportion of those cases in the younger population, supporting the in-ferences generated by the occlusal analysis in the sample of schoolchildren aged 5 and 12 from the municipality of São Paulo.

It was observed that the problems increased on a scale of 1.29 to 7.41 times. The prevalence was higher in development stages related to permanent dentition. Two calculations were performed in the meta-analysis: the first one included all studies and the second one excluded the study by Enrich et al[2] due to sample size difference when compared to other studies. The results obtained were similar (Table 2).

Figure 2 shows odds ratios, their respective confidence intervals and weighted odds ratios for each study. The results showed that the weighted OR was
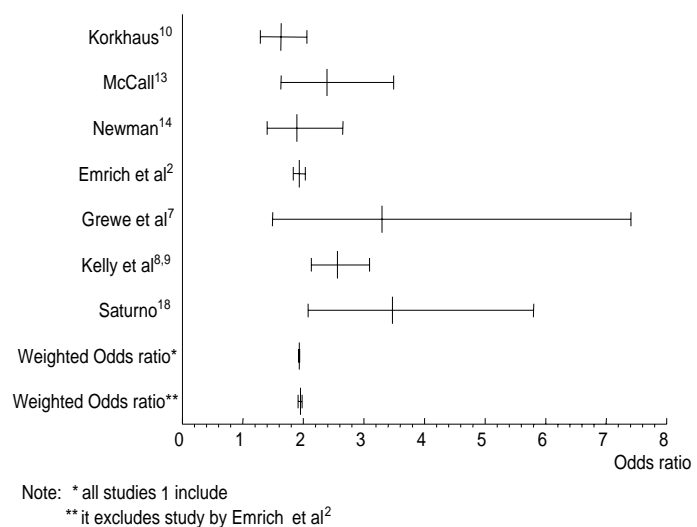

Note: * all studies 1 include
      ** it excludes study by Emrich et al[2]

Figure 2 - Value of weighted odds ratio and of odds ratio from epidemiological studies on occlusal problems and type of dentition, and respective 95% confidence intervals.

Table 2 – Re-analysis of studies of malocclusion prevalence, according to author (year), sample size, compared ages, odds ratio and confidence intervals, statistical significance, and standard error.

Author *	N	Age	Malocclusion Yes	No	OR	95% CI (OR)	p-value	Standard error
Korkhaus[10]	1,211	14	314	254	1.63	1.29; 2.06	0.0001	0.219
		6	277	366				
McCall[13]	775	7-11	371	252	2.39	1.63; 3.49	0.0001	0.516
		2-6	58	94				
Newman[14]	821	13	162	119	1.89	1.40; 2.56	0.0001	0.342
		6	226	314				
Emrich et al[2]	25,987	12-14	6,880	8,071	1.93	1.83; 2.03	0.0001	0.051
		6-8	3,381	7,655				
Grewe et al[7]	124	12	38	23	3.30	1.49; 7.41	0.0020	2.097
		6	21	42				
Kelly et al[8,9,**]	2,000	12	567	433	2.56	2.13; 3.09	0.0001	0.270
		6	338	662				
Saturno[18,***]	909	13	61	340	3.47	2.08; 5.80	0.0001	0.352
		7	25	483				
Weighted odds ratio					1.93***			
					1.95****			

*See the complete references in the list in the end of the article
**The cut-off value was TPI>3
***Yes = only severe malocclusion
***All studies included
****Emrich et al[2] study excluded

1.95 [1.91; 1.98] when comparing the second dentition period with deciduous and mixed dentition.

DISCUSSION

Since 1928 studies have been published evaluating the relationship between demographic characteristics and malocclusion in children. But none of them analyzed the effect observed in the odds of occurrence of malocclusion between early and late development stages. Analyzing the data from a new perspective helped clarify the role of type of dentition in the prevalence of malocclusion.

Meta-analysis is a research strategy that has been increasingly applied to help decision-making based on scientific evidence in health. Statistical analysis of an ensemble of studies, considered as primary units, focuses on the contrast and combination of results from different studies to identify both the consistent standards and the sources of discrepancies between the results. The importance of combining the data in this study was to have an estimate that summarizes the effect of time period or type of dentition on the severity of occlusal conditions. This may be useful to assess changes in the severity rate of malocclusion between deciduous and permanent dentition.

Only a handful of studies compared the frequency of occlusal problems between the two types of dentition. In fact, the number of studies that allows this comparison at similar time and place is small. In the last two decades the majority of the studies investigated populations in late stages of dental development. Moreover, it should be noted that the scientific production related to the epidemiology of malocclusion is virtually negligible both in the field of oral health epidemiology, where predominates studies of dental caries and the effects of fluoride use, and orthodontics, mainly concerned with the study of cranial-facial characteristics in individuals/population groups and the effects of orthodontic/orthopedic therapy in patients. In both fields, instruments and methods used to determine the distribution of these problems and related factors never reached a reasonable minimal consensus in the scientific community. If even the concept of normal occlusion has been and still is object of never-ending arguments, since cranial-facial growth and development standards are not the same for different population groups, what can be said of the instruments and methods used in research? On one hand, the number of epidemiological investigations related to this phenomenon has been increasing in recent years; on the other hand, the application of more sophisticated methods of statistical analysis, design of more representative population samples and

use of occlusal indices adequate to the purposes of each study are very recent features.

The analysis of data related to the characteristics of occlusion obtained through the oral health survey conducted in 1996 with children in the city of São Paulo showed that the type of dentition had a strong association (OR=1.87; 95% CI =1.43-2.45; p<0.001) with more severe occlusal problems when age 5 related to deciduous dentition was compared to age 12 related to permanent dentition.

Besides the fact that there is low correlation between a single age and type of dentition, another limitation of this cross-sectional study was the lack of control for the orthodontic treatment variable. As only a little bit of schoolchildren has access to orthodontic treatment this aspect probably did not influence the results observed between the two dentitions. It should be taken into account that, although the sample was sufficiently large to show changes in the rate of malocclusion from one dentition to another, individual changes in the categories could not be assessed. This would have required longitudinal data collection.

Some epidemiological studies of dental occlusion which prevalence and/or severity of changes were analyzed showed that malocclusion increases with age.[2,7,10,13,14,18]

Meta-analysis was applied to the results of these studies. Unlike the first phase when there was no difficulty in establishing equivalence criteria between age and dentition, in the second one, the pure application of this rule was not possible because there were no studies with such characteristics. The option was to expand this rule. Then, prevalence estimates at 6, 7, and 8 years of age were considered for indication of occlusal conditions on development stages close to deciduous dentition. The sole exception was McCall's study[13] that conducted examinations at ages between two and 11 years old, and stratified the results into two groups: 2-6 and 7-11 years old.

The final results of meta-analysis showed that odds of malocclusion in development stages related to permanent dentition were almost twice when compared to deciduous dentition (weighted OR=1.95) strengthening the association observed (OR=1.87) in the cross-sectional study between both dentitions.

In regard to that, Kelly & Harvey[9] stated that the mean values of the Treatment Priority Index (TPI) in adolescents (12-17 years old) were usually two points higher than in children aged 6-11. Furthermore, and

especially in Appendix I where the examiner training and criteria used for TPI are described, the authors' perception becomes clear when they report that: "the results of the replicate examinations indicate that the level of examiner agreement was not as high during the survey of youths as it was during the survey of children. The lower level of agreement during the survey of youths is at least partly due to the fact that the variability of tooth displacement scores, and therefore of TPI scores, is greater among youths than among children. For instance, about 26% of U.S. youths aged 12-17 have tooth displacement scores greater than 7, but only about 2% of children 6-11 have scores that high. And about twice as many youths (25.1%) as children (11.4%) have TPI scores greater than 7. Thus there is a greater probability of wider measures during the examinations conducted on youths than during those conducted on children".

Similarly, Saturno[18] reported that: "when analyzing the severity of malocclusions and the need for orthodontic treatment we found the explanation for the evidence that abnormalities increase with age, provided that neither preventive nor interceptive measures were taken in earlier ages". Analyzing traits of malocclusion related to different stages of dental development, Thilander et al[21] observed 17.4% of crowding at deciduous dentition contrariwise 59.4% at permanent dentition. The prevalence of malocclusion was also significantly higher among 12-13 year old subjects compared to 5-6 year old subjects in a recent study in India.[4]

If this knowledge is not refuted by further studies – it is important to emphasize the temporary character of scientific observations and theories, and that longitudinal studies are highly advisable for the consolidation of this knowledge as an epidemiological fact – it should be, from a public health point of view, considered some of the possible implications for health care systems.

Summing up, surveys and screenings for identification and treatment of severe cases are recommended not only in the permanent dentition, but also in the deciduous/mixed dentition. This aspect and the introduction of specific protection activities in maternal-childhood programs directed to oral-facial development from ages 0-6 are measures that should be considered in the normative and strategic planning carried out in health care systems. Early treatment of caries and preventive programs including oral hygiene, use of fluoride, and control of environmental factors associated to malocclusion such as short-term breast-feeding, premature tooth loss, respiratory infection, deleterious suction habits, dietary lower consistency seem still to be the best means of reducing the high prevalence of malocclusion. Methods of intervention should be investigated and implemented as early as possible in order to increase the proportion of normal occlusion population on one hand, and on the other hand, to reduce the proportion of moderate/severe malocclusion to levels which are socially more acceptable and economically sustainable.

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