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Validation of pairs of antagonist teeth for the evaluation of shortened dental arch in epidemiological studies

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Abstract: The aim of this study was to evaluate the accuracy of pairs of antagonist teeth (epidemiological criterion) for defining pairs of teeth in occlusal contact (clinical criterion) and to estimate the agreement between the prevalence of "shortened dental arch" (SDA) and "functional dentition" (FD) when occlusal units (OUs) or posterior occluding pairs (POPs) are defined by the epidemiological or clinical criterion. Data were collected in an epidemiological oral health survey conducted in a municipality in Minas Gerais, Brazil. OUs and POPs were defined by the epidemiological criterion (dental crown status) or clinical criterion "gold standard" (carbon paper record of occlusal contacts during habitual maximum intercuspation). SDA corresponded to the presence of an intact anterior region and three to five OUs. FD was based on the concomitant presence of ≥ 1 tooth in each arch, 10 teeth in each arch, 12 anterior teeth, ≥ 3 premolar POPs, and ≥ 1 molar POP bilaterally. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and accuracy of the epidemiological criterion were calculated. The study included 197 adults. Sensitivity, specificity, PPV, and NPV were 88.5, 87.9, 92.5, and 81.9%, respectively, and accuracy was 88.3%. The epidemiological criterion proved to be valid and could be used in epidemiological studies to calculate the prevalence of reduced dental configurations that consider POPs. The assessment of oral functionality is an aspect that should be included in the diagnosis of the clinical condition of patients, contributing to a more effective individual and collective oral health care plan.

Keywords: Dental Occlusion; Validation Study; Data Accuracy; Sensitivity and Specificity.

Introduction

The World Health Organization establishes the retention of 20 or more functional natural teeth throughout life without requiring the use of dentures as part of its oral health goals for the adult and elderly population.[1] To assess oral functioning, however, other factors beyond the minimum number of 20 teeth should be considered, such as the position of teeth.[2]

Thus, other functioning criteria, such as esthetics and occlusion, have been incorporated into the study of reduced dental configurations to

establish a definition of functional dentition (FD) encompassing oral functions. One such configuration is the "shortened dental arch" (SDA), which presupposes the preservation of the anterior teeth and posterior occlusal units (OUs) of premolars and molars.[3] Other studies have proposed and adapted a functional dentition classification system characterized by the number of natural teeth, the type of teeth present, the number of posterior occluding pairs (POPs),[4,5] and the periodontal status of the teeth.[6]

The presence of pairs of antagonist teeth has been used to identify OUs/POPs considering dental crown status in the examination for dental caries.[6-8] These studies have made important contributions to the discussion on FD in oral health epidemiology. However, as teeth can change position during one's lifetime due to pathological and/or physiological processes,[9,10] it is necessary to determine whether the presence of antagonist pairs of teeth is a valid measure for estimating the presence of pairs of teeth in occlusal contact. This evaluation is relevant because using valid measures in epidemiological studies avoids the occurrence of systematic errors and ensures reliable estimates. Moreover, other methods for occlusal contact analysis such as carbon and digital systems[11,12] can increase the time, cost and degree of complexity, which could make oral epidemiological examinations unviable.

Therefore, the present study aimed to evaluate the accuracy of pairs of antagonist teeth for measuring the presence of premolar and molar pairs in occlusal contact and estimate agreement between the prevalence of reduced dental configurations (SDA and FD) when OUs/POPs are defined by pairs of antagonist teeth (antagonist SDA, antagonist FD) or pairs of teeth in occlusal contact (occlusal contact SDA, occlusal contact FD). The correlation between number of pairs of antagonist teeth and pairs of teeth in occlusal contact was also investigated.

Methodology

A methodological study was developed as part of an oral health epidemiological survey of adults conducted in a small municipality in the state of Minas Gerais, Brazil, in 2018 and 2019.

The sample size was calculated to estimate the prevalence of oral health conditions in the population.[13,14] To determine the adequacy of the sample for the present methodological study, formulas were applied to evaluate the sensitivity and specificity of diagnostic methods.[15] The following parameters were used for the calculation: 95% confidence level, prevalence pairs of antagonist teeth and pairs of teeth in occlusal contact, and sensitivity and specificity estimated using the data of this study for premolars and molars separately. The values used to calculate the study sample are presented in Table 1. The highest sample required was 132 individuals.

Individuals who wore a fixed orthodontic appliance, with cognitive or mental impairment, completely edentulous (upper and lower) individuals, and those with complete removable or implant-supported dentures were excluded from the study.

Participants were selected using a one-stage cluster sampling method (all urban census sectors) with probability proportional to the number of streets per census sector. After identifying the census sectors, a simple drawing was performed for the selection of streets (primary sampling unit). The number of streets selected in each census sector

Table 1. Parameters used for sample calculation of the study.

Parameter	Prevalence of presence of the epidemiological/ clinical criterion	Sensitivity	Prevalence of absence of the epidemiological/ clinical criterion	Specificity
Premolars (pairs of antagonist teeth)	78.63	92.7	21.37	88.1
Premolars (pairs of teeth in occlusal contact)	75.45		24.55	
Molars (pairs of antagonist teeth)	47.73	92.3	52.27	80.2
Molars (pairs of teeth in occlusal contact)	54.41		45.59	

was proportional to the total number of streets in the municipality. All homes on the selected streets were visited and all adults 30 to 49 years of age were invited to participate in the study. Those who agreed to participate were examined and interviewed at home. An enrollment chart was used to identify the streets, homes visited, and records of participation: included eligible adults, non-eligible adults based on exclusion criteria, and losses (refusals and individuals that were not found after three or more attempts).

The field teams (four teams divided among the census sectors) formed by one examiner (dentist) and one annotator were trained during four workshops (duration: 32 hours) addressing theoretical and practical aspects of the oral health conditions analyzed. Intra-examiner and inter-examiner Kappa agreement coefficients were > 0.80 and 0.70–1.0, respectively. Further details on the training are described elsewhere.[13,14]

Data collection was performed through interviews with the participants and oral examinations. A headlamp with LED light was used to facilitate the examination of the oral cavity. An interview was used to collect data on sex (male or female), age, self-declared skin color (following the classification of the Instituto Brasileiro de Geografia e Estatística (IBGE [Brazilian Institute of Geography and Statistics] and grouped as white or black + brown + yellow + indigenous),[16] schooling (≥ four; five to eight; nine to 11; 12 or more years of study) and monthly family income (up to US$387, from US$387 to US$645, and more than US$645).

Each individual was classified independently according to two dental configurations: SDA[3] and FD.[4] SDA was defined as the presence of an intact anterior region and three to five OUs formed by natural teeth with no edentulous spaces between them, with the following possible distributions of posterior teeth: three OUs (occluding pairs of premolars), four OUs (four occluding pairs of premolars), or five OUs (three occluding pairs of premolars + one occluding pair of molars).[17] In this definition, one occluding pair of premolars constitutes one OU, whereas one occluding pair of molars constitutes two OUs.[18]

FD was based on functional dentition classification system hierarchized in levels according to the following criteria: Level I (≥ one tooth in each arch), Level II (10 teeth in each arch), Level III (12 anterior teeth), Level IV (≥ three premolar POPs), and Level V (≥ on molar POP bilaterally).[4]

The evaluation of OUs and POPs was based on the presence of all natural teeth (including third molars) and considered two criteria: pairs of antagonist teeth or pairs of teeth in occlusal contact.

The pairs of antagonist teeth – denominated the epidemiological criterion – were identified by the record of the dental crown status during the oral examination, adopting the codes and criteria for the evaluation of dental caries recommended by the World Health Organization (2013).[19] OUs/POPs data were obtained considering crown status of the teeth: sound, carious, filled with caries, filled without caries, or with pit-and-fissure sealant (DMFT codes 0, 1, 2, 3 and 6). This criterion was based on the presence of antagonist teeth regardless of occlusal contact, as widely employed in the literature.[6-8] For example, the presence of teeth 16 and 46 was defined as a pair of antagonist teeth.

Pairs of teeth in occlusal contact – denominated the clinical criterion – were identified by the record of occlusal contacts during maximum intercuspation determined by marks on carbon paper (Bausch®, thickness of 200 µm) (Figure 1). This criterion was considered the "gold standard" in the present study, as it corresponds to "the complete intercuspation of the opposing teeth independent of condylar position, sometimes referred to as the best fit of the teeth regardless of the condylar position"[20]. In addition, the occlusion pattern between maxillary and mandibular posterior teeth was recorded (denominated the "reference") as: "does not occlude", "occlusion between natural teeth", "occlusion between natural tooth and prothesis", "occlusion between prostheses", and "reference maxillary tooth absent". In the presence of contact(s), the mandibular posterior tooth or teeth that occluded with each maxillary tooth was/were recorded. For example, when evaluating tooth 14, the examiner may identify one or more contacts with teeth 43, 44, 45 or even 46, depending on the occlusion pattern of the participant. The same examiner evaluated the dental crown and recorded the occlusal contacts on the same participant.

Figure 1. Record of pairs of teeth in occlusal contact using carbon paper (Bausch®).

The data were initially analyzed descriptively to characterize the sample in terms of socio-demographic aspects, dental caries, and tooth loss. The validity of the epidemiological criterion for estimating the presence of pairs of teeth in occlusal contact (clinical criterion) was determined by sensitivity (the extent to which the presence of a pair of antagonist teeth correctly identifies the presence of a pair of teeth in occlusal contact), specificity (the extent to which the absence of a pair of antagonist teeth correctly identifies the absence of a pair of teeth in occlusal contact), positive predictive value (PPV) (probability of a pair of antagonist teeth truly being a pair of teeth in occlusal contact), negative predictive value (NPV) (probability of the absence of a pair of antagonist teeth truly corresponding to the absence of a pair of teeth in occlusal contact), and accuracy (proportion of absence or presence of pairs of antagonist teeth that truly correspond to absence or presence of pairs of teeth in occlusal contact).[21,22] Pairs of antagonist teeth or pairs of teeth in occlusal contact were the unit of analysis for the estimates of validity. A 2 x 2 table was used to record the presence/absence of pairs of posterior teeth according to the clinical criterion (gold standard) and epidemiological criterion (test). The same was done for pairs of premolars and molars, separately. The same validity estimates were generated for the dental configurations (test: antagonist SDA and antagonist FD; gold standard: occlusal contact SDA and occlusal contact FD) considering the individual as the unit of analysis.

Agreement was calculated using the prevalence of SDA and FD when OUs/POPs were defined by pairs of antagonist teeth (antagonist SDA, antagonist FD) or pairs of teeth in occlusal contact (occlusal contact SDA, occlusal contact FD) using the Kappa statistic[21] and Bangdiwala's β-statistic. Bangdiwala's β is defined from a 2 x 2 table as the ratio of the sums of squares of the diagonal frequencies over the sum of cross-products of the marginal totals[23]. An agreement chart was created. Details on the calculations and creation of the graphs are described in Table 2.

Records indicate the marginal totals by rectangles and diagonal agreement by dark squares within the rectangles and allow the evaluation of symmetry (whether the difference in the marginal column (f1 – f2) has the same sign as the difference in the marginal row (g1 – g2)) and the balance (whether the ratio of column marginals (f1/f2) and the ratio of row marginals (g1/g2) are close to 1) of the marginal distributions. The diagonal line allows assessment of the dimension of the bias index, which is the extent of the disagreement on the proportion of positive (or negative) cases and is obtained by the formula BI = (x12 – x11)/N. When BI=0, the vertex of the rectangles meets the diagonal line. A negative bias means that x21 is greater than X12 and has the diagonal line below the vertex, passing through the rectangle corresponding to the area f1 x g2. In this case, the disagreements are asymmetrical.

Spearman's correlation coefficient (*r*) was estimated between the number of OUs/POPs of pairs of antagonist teeth and pairs of teeth in occlusal contact as well as for premolars and molars separately. All analyses were performed with corrections for the design effect and sampling weight

Table 2. Notations referring to Bangdiwala's statistical analysis. B-statistic.

Occlusal contact / Antagonist	Yes	No	Total
Yes	X11	X12	G1
No	X21	X22	G2
Total	F1	F2	N

Note: It reflects the marginal totals by rectangles and diagonal agreement by darkened squares within the rectangles and permit evaluate the symmetry (whether the difference in column marginal (f1 – f2) has the same sign as the difference in row marginal (g1 – g2)) and the balance (whether the ration of column marginals (f1/f2) and the ratio of row marginal (g1/g2) are close to 1) of the marginal distributions. The diagonal line allows us to assess the dimension of the bias index, which is the extent of the disagreement on the proportion of positive (or negative) cases and is obtained by fórmula BI = (x12 – x11)/N. When BI=0, the vertex of the rectangles meets the diagonal line. A negative bias means that x21 is greater than X12 and has the diagonal line below the vertex, passing through the rectangle corresponding to the area f1 x g2. In this case, the disagreements are asymmetrical.

using Stata v. 15. The data were recorded using a digital device and an application for the automatic generation of the database. The participants agreed to participate by signing the informed consent. This study was conducted according to the ethical precepts stipulated in the Declaration of Helsinki and received approval from the institutional review board of Universidade Federal de Minas Gerais (certificate number: 82540517.9.0000.5149).

Results

One hundred ninety-seven adults participated in the study. Women predominated in the sample (70.25%) and the mean age was 39.91 years (SD = 4.24). The majority (76.40%) had at least one tooth with caries (Table 3). The mean DMFT index was 14.83 (SD = 7.04) teeth: 2.33 (SD = 2.81) for the D component, 3.37 (SD = 4.00) for the M component, and 9.13 (SD = 5.71) for the F component. The mean number of missing teeth was 5.45 (SD = 4.22). Considering SDA, 77.8% of the participants presented the epidemiological criterion and 87.5% presented the clinical criterion. For FD, 91.5% of the participants met the epidemiological criterion and 95% met the clinical criterion. The distribution of individuals according to hierarchical dental functional classification system on five levels considering clinical and epidemiological criteria is presented in Figure 2.

Considering the pairs of premolars, 573 presented both the epidemiological criterion and the clinical criterion, while for the molars, 515 presented both criteria. The occlusal contacts of posterior teeth were with antagonists for 85.9% and 70.7% of the premolars and molars pairs, but there were also occlusal contacts of posterior teeth with others neighboring teeth (85.9% for premolars and 70.7% for molars).

The sensitivity, specificity, PPV, and NPV values are displayed in Table 4. Considering all pairs of posterior teeth, these values were 88.5, 87.9, 92.5, and 81.9%, respectively. Accuracy was 88.3% considering posterior teeth, 91.7% for premolars and 86% for molars. The false-positive and false-negative rates were 7.5% and 18.1%, respectively.

The sensitivity, specificity, PPV, and NPV values were respectively 87.5, 98.8, 77.8 and 99.5% for antagonist SDA and 95.1, 90.5, 91.5 and 94.5% for antagonist FD. Accuracy for antagonist SDA and antagonist FD was 98.4 and 92.9%, respectively.

Tables 5 and 6 displays the results of observed agreement, Kappa coefficients, and β-statistic values regarding the prevalence of antagonist SDA and occlusal contact SDA as well as antagonist FD and occlusal contact FD. These coefficients ranged from 0.82 to 0.98, indicating nearly perfect agreement.[21,24] Figures 3 and 4 show a large black area within the rectangle, demonstrating a good level of agreement. The SDA distribution had symmetrically imbalanced marginal totals and FD had symmetrically balanced marginal totals. The bias index was positive for both SDA and FD, with values of 0.005 and 0.02, respectively. This result is illustrated by the diagonal line in the figure located very close to the vertices of the rectangles.

A strong positive correlation was found for OUs/POPs between pairs of antagonist teeth and number of pairs of teeth in occlusal contact considering posterior teeth (r = 0.85), premolars (r = 0.81), and molars (r = 0.83).

Discussion

The present study has two main findings. First, the epidemiological criterion proved valid for estimating

the presence of pairs of teeth in occlusal contact in epidemiological studies. Second, good agreement was found regarding the prevalence of SDA and FD by both criteria, supporting the use of the epidemiological criterion to estimate the prevalence of reduced dental configurations that take into consideration pairs of posterior antagonist teeth.

This study has several strengths. The examinations were based on guidelines of the World Health Organization (oral health surveys) for defining the epidemiological criterion. Another strength was that additional agreement statistics and correlation analysis were employed to demonstrate the consistency of the epidemiological criterion in

Table 3. Distribution of adult participants according to investigated variables. Rio Acima, Minas Gerais, Brazil, 2019.

Variables	Total	%	95%CI*
Sociodemographic and economic characteristics			
Sex			
Male	57	29.75	23.55 – 36.80
Female	140	70.25	63.20 – 76.45
Self-declared skin color**			
White	23	11.90	7.50 – 18.38
Black + Brown + Yellow + Indigenous	172	88.10	81.62 – 92.50
Schooling (in years of study)			
≤ 4	48	28.03	20.92 – 36.45
5 to 8	37	19.43	14.52 – 25.51
≥ 9	112	52.54	43.01 – 61.88
Family income (US)***			
≤ US$387.00	67	36.16	26.67 – 46.87
US$387.00 to US$645.00	64	34.03	27.95 – 40.68
more than US$645.00	63	29.81	22.03 – 38.97
Oral health conditions			
Presence of caries			
Decayed component = 0	52	23.60	19.14 – 28.72
At least one decayed tooth	145	76.40	71.28 – 80.86
Epidemiological criterion (shortened dental arch considering the presence of antagonist pairs of teeth)			
No	188	94.92	89.91 – 97.51
Yes	9	5.08	2.49 – 10.09
Clinical criterion (shortened dental arch considering occlusal contact pairs) ****			
No	187	95.86	91.98 – 97.9
Yes	8	4.14	2.1 – 8.02
Epidemiological criterion (functional dentition according to the dentition classification system considering the presence of pairs of antagonist teeth)			
No	91	45.69	38.33 – 53.25
Yes	106	54.31	46.75 – 61.67
Clinical criterion (functional dentition according to the dentition classification system considering pairs of occlusal contact)			
No	95	48.15	41.63 – 54.74
Yes	102	51.85	45.26 – 58.37

*Estimates considering complex sample and sample weight; **n = 195 individuals; ***n = 194 individuals; ****n = 195 individuals.

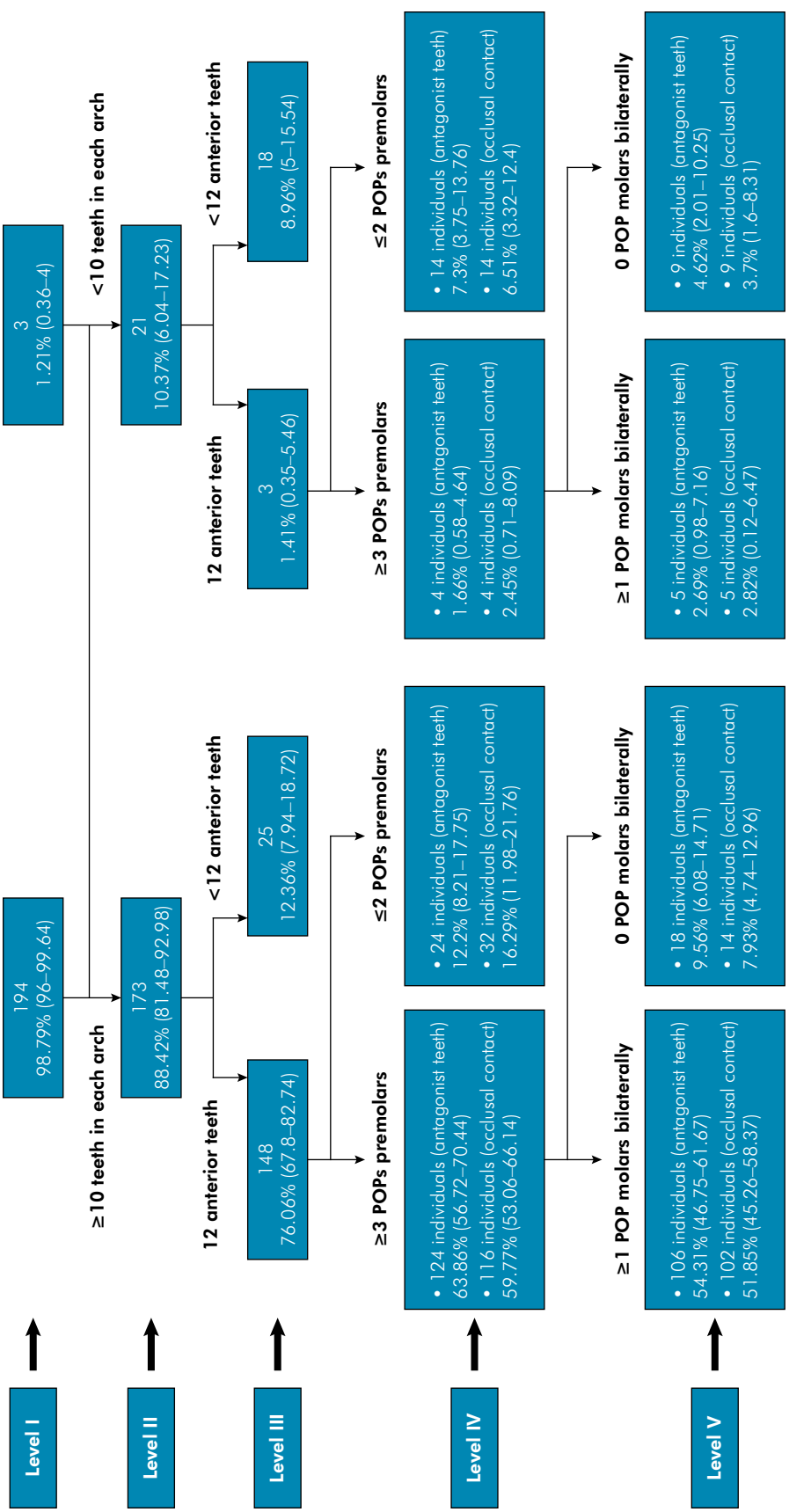


Figure 2. Distribution of individuals into five levels considering clinical and epidemiological criteria according to hierarchical dental functional classification system.

estimating the clinical criterion. Besides the Kappa statistic, which calculates the proportion of agreement that is greater than that expected by chance, the β-statistic was also calculated because it performs better than the Kappa statistic in different scenarios and at different prevalence rates. The magnitude of the Kappa statistic is influenced by the prevalence index and the bias index.

The study also has limitations that should be considered. For dental crown assessment, the criteria of the World Health Organization does not include the the indication for extraction due to caries or for orthodontic purposes. A tooth indicated for extraction may have a destroyed crown and may be considered an antagonist tooth but without contributing to occlusal contacts

Table 4. Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of epidemiological criterion for premolars and molars.

Epidemiological criterion (presence of pairs of antagonist teeth)	Clinical criterion (presence of pairs of teeth in occlusal contact, gold standard)		Sensitivity value	Specificity value	PPV value	NPV value
	Yes	No	% (95%CI)	% (95%CI)	% (95%CI)	% (95%CI)
Premolars (n = 786)						
Yes	573	45	96.6 (94.8–97.9)	76.7 (70.1–82.5)	92.7 (90.4–94.6)	88.1 (82.2–92.6)
No	20	148				
Molars (n = 1169)						
Yes	515	43	81.0 (77.7–84.0)	91.9 (89.3–94.1)	92.3 (89.8–94.4)	80.2 (76.8–83.3)
No	121	490				

Missing for premolars: 1 missing for POP 15; 1 missing for POP 24; Missing for molars: 1 missing for POP 16; 2 missing for POP 17; 5 missing POP 18; 1 missing for POP 26; 1 missing for POP 27; 3 missing POP 28. Probability of false positive for premolars: 7.3%; probability of false positive for molars: 7.7%; probability of false negative for premolars: 11.9%; probability of false negative for molars: 19.8%.

Table 5. Observed agreement, Kappa coefficient and β-statistic value regarding prevalence of SDA (n = 195) between epidemiological and clinical criteria.

Epidemiological criterion		Clinical criterion	
		Occlusal contact SDA	
		Yes	No
Antagonist SDA*	Yes	7	2
	No	1	185
Agreement measures	Agreement = 98.46%	*Kappa*= 0.82	Bangdiwala's β-statistic = 0.98**

SDA: Shortened Dental Arch. *n total =195 individuals (1 *missing* POP 15 and 1 *missing* POP 16); **Prevalence Index: 0.91; Bias Index: 0,005.

Table 6. Observed agreement, Kappa coefficient and β-statistic value regarding prevalence of FD (n = 197) between epidemiological and clinical criteria.

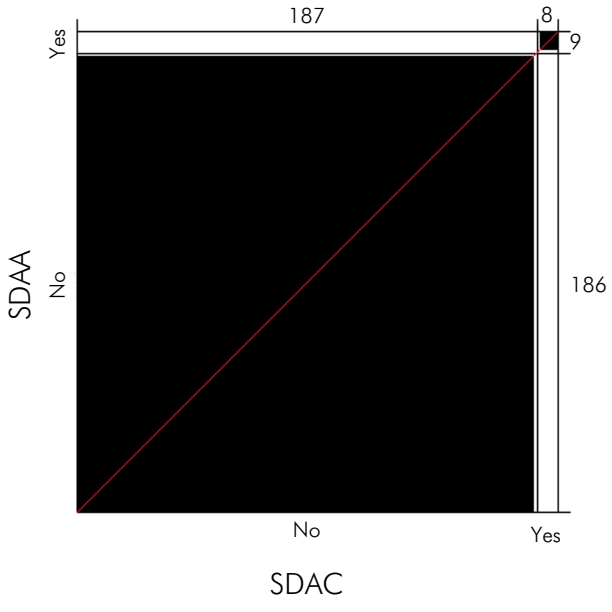
Epidemiological criterion		Clinical criterion	
		Occlusal contact FD	
		Yes	No
Antagonist FD	Yes	97	9
	No	5	86
Agreement measures	Agreement = 92.89%	*Kappa* = 0.86	Bangdiwala's β-statistic = 0.86*

FD: functional dentition; *Prevalence Index: 0.06; Bias Index: 0,02.

because it is not functional. Such cases increase the number of false positives and an individual may be misclassified as having a shortened dentition. When a tooth is extracted for orthodontic reasons and its antagonist is maintained in the oral cavity, the number of antagonist pairs changes. If only one maxillary premolar were lost, such as tooth 14, for example, there would be no 14-44 pair. However, there would also be no record for the occlusal contact of tooth 14, as this would be from the maxillary tooth. In this case, there would be little effect on the estimates presented. However, if only one mandibular premolar were lost, the antagonist pair would be missing and the existing maxillary teeth could make contact with other mandibular teeth. In this case, a greater percentage of false negatives would occur when using the epidemiological criterion.

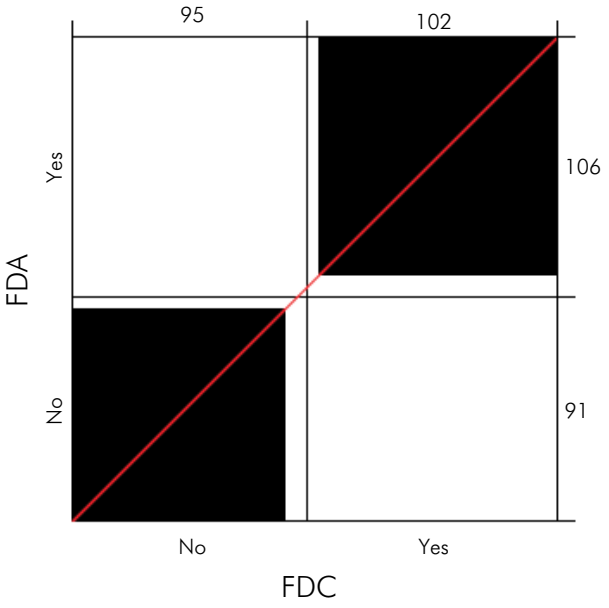
The sensitivity and specificity values indicated that the epidemiological criterion was valid for differentiating the presence or absence of occlusal contacts on posterior teeth. The results may also be analyzed considering the possibility of false positives and false negatives. The probability of false positives was around 7% considering all pairs of posterior teeth. The occurrence of false positives can lead to a classification error, as an individual may be erroneously considered to have FD based on the epidemiological criterion without, however, having corresponding occlusal contacts. From the epidemiological standpoint, the overestimation of FD could indicate that there is less need for rehabilitating prosthetic treatment in a particular group or that tooth loss is less severe than is actually is. Considering SDA and FD, less than 5% of the sample of adults was misclassified as meeting the dental configuration criteria without, however, having teeth in occlusal contact.

The probability of false negatives indicates that the record was negative for the test (epidemiological criterion) but positive for the clinical criterion (gold standard), which can result in an underestimation of the measure studied. Considering individuals classified with SDA by the epidemiological criterion, one adult (0.5%) was misdiagnosed as not



SDA-A: SDA considering the presence of pairs of antagonist teeth; SDA-C: SDA considering the presence of pairs of teeth in occlusal contact.

Figure 3. Agreement chart for prevalence of shortened dental arch when OUs/POPs were defined by pairs of antagonist teeth (SDA-A) or pairs of teeth in occlusal contact (SDA-C).



FD-A: FD considering the presence of pairs of antagonist teeth; FD-C: FD considering the presence of pairs of teeth in occlusal contact.

Figure 4. Agreement chart of the prevalence of functional dentition when OUs/POPs were defined by pairs of antagonist teeth (FD-A) or pairs of teeth in occlusal contact (FD-C).

having a shortened dentition and five adults were misdiagnosed as not having FD (2.5%). However, the false negatives in this study were considered to have little effect on the estimates of SDA/FD. False negatives occurred because the record of occlusal contacts between a maxillary tooth and any natural mandibular tooth was considered to demonstrate the validity of the epidemiological criterion, as individuals may have different occlusion patterns and teeth positioning. The results showed that occlusal contacts were most often identified between antagonist teeth, whereas molar contacts were more frequent between a maxillary tooth and a mandibular tooth adjacent to the antagonist. The explanation is the greater loss of molars[25] and greater tooth migration of these teeth.

The PPV and NPV were between 77.8% and 99.5%. Unlike sensitivity and specificity, which are considered characteristics of the test, the predictive value is affected by the prevalence of the condition studied in the population. In the present study, a lower PPV was found for SDA (77.8%), as this condition was less prevalent (antagonist SDA: 5.08%; occlusal contact SDA: 4.14%). Moreover, the prevalence of SDA and FD was similar when the epidemiological or clinical criterion was considered. The agreement coefficients were obtained to estimate the extent to which individuals are classified the same using the two criteria studied. All coefficients indicated that individuals were classified similarly when using the clinical and epidemiological criteria. These results reinforce the use of the criterion of antagonist teeth in epidemiological studies, indicating a high probability that individuals with or without a shortened dentition are adequately identified. These findings are of practical importance since epidemiological studies play an important role in national oral health policies that guide the planning and organization of services, assistance, the availability of supplies, and the training of health professionals, for example.

The overall agreement between antagonist SDA and occlusal contact SDA was nearly 100% and the Kappa coefficient indicated a high level of agreement (0.82). The lower Kappa value in comparison to overall agreement is explained by the distribution of symmetrically imbalanced marginal totals of the cross-tabulation and the high prevalence index.[26,27] In this type of distribution, the β-statistic was closer to overall agreement (0.98). For interpretation purposes, therefore, we may assume a near perfect agreement. For FD, the overall agreement was 92.98% and the Kappa coefficient was 0.86. In this case, as the cross-tabulation had symmetrically balanced marginal totals and the prevalence index was low, the Kappa values are closer and lower than the values of overall agreement. The bias index is another factor that influences the magnitude of the Kappa coefficient index.[28] In this study, low bias index values were found for both FD and SDA, with no substantial effects on the interpretation of the coefficients. Considering the high level of agreement, as expected, the strong positive correlation underscores the similarity between the two criteria for identifying OUs/POPs in quantitative terms. Thus, studies that intend to estimate the number of OUs/POPs can use either of the two criteria (epidemiological or clinical).

Although the average number of missing teeth was low in the present study, we believe that the sensitivity and specificity would be consistent in samples of adults with different missing tooth profiles, as they are properties of the test. However, the prevalence estimates and predictive values may have been influenced by the homogeneity of the sample in terms of sociodemographic characteristics and dental configurations. Thus, further validation studies should be conducted with samples that have different missing tooth profiles and age groups.

Conclusion

The present study contributes to the validation of the epidemiological criterion in the evaluation of SDA and FD and strengthens the credibility of findings described in previous studies.[7,8,29] Therefore, this study indicates that the epidemiological criterion can be used in population-based studies, provides valid estimates, and makes field research more viable with lower cost and shorter duration. In conclusion, the epidemiological criterion proved to be valid for the analysis of the prevalence of

shortened dental configurations that consider posterior tooth occlusion.

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