

Prevalence of malocclusion traits in an Australian adult population

Marcus A. Tod
BDS_c(Qld), MDS_c(Qld), FRACDS
Private practice, Orthodontics,
Queensland,
Australia.

Aart A.R. Taverne
BDS_c, SpecDMO, DDentMed
Senior Lecturer in Orthodontics
University of Queensland,
Australia.

The prevalence of certain malocclusion traits in an Australian adult population was examined in a sample of 113 female and 103 male adult subjects aged between 18 and 64 years (average age = 38.1 years). If cross-sectional studies of younger population groups are to be used for research into the long-term physiological effects of malocclusion, it is essential to know if certain and specific malocclusion traits are stable over time. In this cross-sectional study, the prevalence of many malocclusion traits did not change; however, with advancing age, the incidence of posterior crowding, posterior rotations, posterior crossbite and anterior irregularity increased significantly.

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Introduction

Reports of the prevalence of malocclusion have been shown by Jago¹ to be highly variable. This variability was attributed to differences in the definition of malocclusion, as well as the ethnicity, age, sex, geographical location, social stratum and even the diet of the populations sampled. Jago suggested that rigid adherence to the concept of 'ideal' occlusion would mean that only three per cent of the population did not have a malocclusion. Clearly, a distinction needs to be made between malocclusion prevalence and treatment need.

Malocclusion has been described as a definite health problem.² It was thought that malocclusion could lead to greater plaque retention, increased cleaning difficulty, direct trauma to the periodontal tissues, and occlusal interferences that may aggravate periodontal disease or temporomandibular joint disorders.³ The benefits resulting from the treatment of malocclusion are reported to be: lower incidence of caries, improved periodontal health, reduced risk of incisor trauma and reduction of temporomandibular joint dysfunction. Despite extensive investigation, there is little conclusive evidence to suggest that the presence of malocclusion has a major impact on oral health, except for a limited number of gross and conspicuous occlusal traits.⁴

The difficulty in finding a causative relation between malocclusion and oral disease may be due to a complex interaction between malocclusion, perceived malocclusion, the patient's personality, dental hygiene habits, frequency of visits to the dentist and cooperation while undergoing treatment.⁵ Another aspect that confounds investigation into the disease implications of malocclusion is the possibility of a delayed response of the oral

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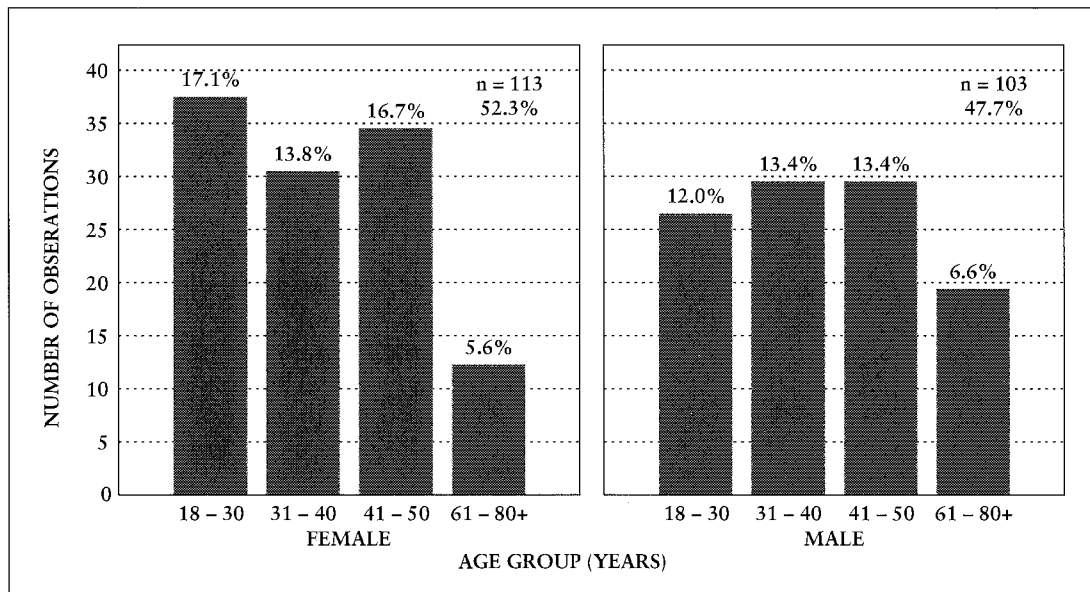


Figure 1. Frequency histogram of age group categorised by gender. (n = 216)

tissues to adverse effects; that is, the effects of malocclusion may not manifest until later in life. Cross-sectional examination of children or young adults is unsatisfactory in this regard. Also, before the long-term consequences of malocclusion can be examined, the relative stability of relevant occlusal traits must be known.

Dickson⁶ conducted a cross-sectional comparison of four different age groups (spanning more than 55 years) with regard to overbite, overjet, and lower incisor crowding and spacing. Overjet and overbite reduced significantly with age, and lower incisor crowding increased. The overall conclusion was that 'the magnitude of these measurements had little effect on the loss of teeth, from any cause'. However, the study was not longitudinal and was somewhat unusual in its methodology; for example, in examining lower incisor crowding as a cause of tooth loss, the younger group (who had lost more premolars and incisors than the elderly group) was compared with the elderly group that had as a prerequisite for selection, the presence of at least 24 teeth. Although this investigation provided a useful insight into age-related changes, it was difficult to extrapolate the findings of one age group to another because of the the selection criteria and the different treatment philosophies of the eras of each age group.

The first longitudinal investigation into the stability of occlusal traits was conducted by Helm and Petersen⁷ over a twenty-year period,

with the baseline in adolescence. Overjet, overbite, crossbite, crowding and spacing were examined and the only significant changes seen were the deepening of overbites that were greater than 5 mm in adolescence, and an increase in anterior incisor crowding. The authors believed these changes 'reflect physiologic development'. The other traits remained stable in orthodontically untreated individuals. Longitudinal investigations into caries and periodontal disease, as manifestations of malocclusion, are difficult to plan and are time consuming, but the relative stability observed by Helm and Petersen suggests that a cross-sectional comparison of different age groups may be a valid approach, provided the groups are matched closely for sex, race, place of birth (ideally long-term residency) and socio-economic level.

In comparing the findings of investigations into the health-risks of malocclusion, the different interpretations of what constitutes a malocclusion should be considered carefully. While individual occlusal traits should not be considered as independent of each other, the assessment of their potentially singular or combined damaging effects cannot be undertaken if a broad encompassing description of malocclusion such as Angle's classification is used.⁸

This study aims to assess the prevalence of certain malocclusion traits in adults within four age brackets between eighteen and 65 years.

Materials and methods

A sample of 216 adult subjects (103 males and 113 females) was obtained in 1992 from participants in a periodontal research program conducted at the Colgate Oral Care Research Clinic on the St Lucia Campus of the University of Queensland. Most of the participants were university staff (academic and non-academic) and students, although a small number were not affiliated with the university. Study models were obtained with the subjects in centric occlusion.

Specific occlusal traits were measured from the study models using sliding callipers to the nearest whole millimetre, in accordance with the criteria of the World Health Organisation.⁹ For analysis, the occlusal traits were categorised as 'present' or 'absent'. Each case was also assessed using Angle's classification,¹⁰ with some modification according to the criteria suggested by Freer and Olive,¹¹ and by McCallum.¹²

The presence or absence of specific traits of malocclusion were differentiated by age group, gender and education, and then compared in contingency tables using the Chi-square statistic to test for significance of relation. When grouped by gender, the t-test for independent samples and the Mann-Whitney U-test were used to compare the means and rank sums, respectively, of mandibular and maxillary irregularity, anterior overjet, overbite and midline deviation. The Mann-Whitney U-test is a non-parametric test that requires the variable under consideration to be measured on at least an ordinal scale. It is the most powerful non-parametric alternative to the t-test for independent samples.¹³ A 'z-value' is calculated in this test and may be adjusted in the presence of multiple ties.

After grouping the above-mentioned occlusal variables by age category or education, one-way ANOVAs were performed. If significance was confirmed, the Tukey Honestly Significant Difference (HSD) test was then applied to determine across which subgroupings the differences occurred. Similarly, the Kruskal-Wallis ANOVA and the Median Test were applied for non-parametric comparison.

Results

The total sample of 216 subjects ranged in age from 18 to 64 years, with a mean age of 38.¹⁴ years and median age of 39 years. A breakdown of age group and gender for the sample is given in Figure 1. No significant

differences were found. Caucasians comprised 93.5 per cent of the total sample, with no single race dominating the remaining 6.5 per cent.

Of the total sample, 116 subjects (53.7%) had tertiary qualifications, 67 (31.0%) had completed school to senior high school level, and 31 (14.4%) had not obtained senior high school level. Two subjects (0.9%) gave no indication of their highest education level. A significantly greater proportion of the less educated individuals were over 40 years of age (Chi-square = 15.22, $p = 0.02$).

A history of orthodontic treatment was indicated by 45 individuals (20.8% of the total sample), 27 of whom indicated that one or more teeth had been extracted for orthodontic purposes. Of those with no stated history of orthodontic treatment, 16 indicated that one or more teeth had been extracted for orthodontic purposes. Thus, 43 individuals (20.1% of the total sample) had a history of tooth removal for orthodontic reasons. Exactly twice as many females (30) as males (15) indicated previous orthodontic treatment history and this was significant (Chi-square = 4.54, $p = 0.03$). No significant association was found between age category, nor between education level and orthodontic history.

The reliability of the assessment of the principle occlusal traits was determined by repeating these measurements on a randomly selected subsample of 30 patients. The second measurements were performed four weeks after the first to minimise the recollection of each case.

The non-parametric Sign Test was applied in the comparison of nominal variables (anteroposterior molar relation, anterior contact, Angle's classification, crowding/spacing, rotations, soft tissue contact, posterior crossbite and posterior openbite), and the Wilcoxon Matched Pairs Test in the comparison of ordinal variables (diastema, irregularity, anterior overbite and overjet). Two-tailed paired Student's t-tests were also used to compare these variables. No significant differences were seen between any of the original and repeated measurements at the $p < 0.05$ level.

The frequencies of the occlusal traits measured in this sample are given in Table I. The means, medians, ranges and standard deviations for anterior irregularity, overjet and overbite are given in Table II. The distribution for the modified Angle's classification is given in Table III. Overall, 67.1 per cent of the sample were Class I, 28.7 per cent Class II and 4.2 per cent Class III. No significant differences were observed when grouped by age category, gender and education.

Table 1. Overall and age group distribution of occlusal traits (%). Italic rows represent those traits shown to be significantly different with age using Chi-square analysis ($\alpha = 0.05$). $n = 216$, [] = number of missing values

OCCUSAL TRAIT	TOTAL	18-30	31-40	41-50	51-60
Supernumerary	0.5	0.0	0.0	1.6	0.0
Malformed	4.2	1.6	3.4	6.4	6.5
Impacted and/or Retained	1.9	0.0	3.4	3.2	0.0
Anterior MX Crowding ≥ 2 mm [3]	25.9	15.9	27.1	33.3	32.3
<i>Anterior MX Spacing ≥ 2 mm [3]</i>	13.0	17.5	20.3	6.7	3.2
Posterior MX Crowding ≥ 2 mm [1]	4.6	1.6	10.2	3.2	3.2
<i>Posterior MX Spacing ≥ 2 mm [1]</i>	22.2	9.5	20.3	24.2	48.4
Anterior MD Crowding ≥ 2 mm	45.4	38.1	49.2	49.2	45.2
Anterior MD Spacing ≥ 2 mm	7.0	4.8	3.4	11.1	9.7
<i>Posterior MD Crowding ≥ 2 mm</i>	18.5	6.4	23.7	20.6	29.0
<i>Posterior MD Spacing ≥ 2 mm</i>	25.0	9.5	20.3	38.1	38.7
Diastema ≥ 2 mm	4.6	4.8	5.1	4.8	3.2
<i>MX Irregularity ≥ 2 mm</i>	43.1	27.0	49.2	47.6	54.8
MD Irregularity ≥ 2 mm	33.8	27.0	35.6	39.7	32.3
<i>Anterior MX Rotation $>15^\circ$</i>	37.5	23.8	33.9	46.0	54.8
Anterior MX Rotation $\geq 30^\circ$	6.9	3.2	6.8	9.5	9.7
Posterior MX Rotation $>15^\circ$	31.5	20.6	40.7	33.3	32.3
Posterior MX Rotation $\geq 30^\circ$	11.1	6.4	11.9	15.9	9.7
Anterior MD Rotation $>15^\circ$	36.6	28.6	39.0	41.3	38.7
Anterior MD Rotation $\geq 30^\circ$	6.5	3.2	5.1	11.1	6.5
<i>Posterior MD Rotation $>15^\circ$</i>	33.3	20.6	39.0	33.3	48.4
<i>Posterior MD Rotation $\geq 30^\circ$</i>	14.8	4.8	18.6	12.7	32.3
Soft Tissue Contact	11.6	15.9	11.9	6.4	12.9
Posterior Openbite [1]	7.4	6.5	1.7	12.7	9.7
<i>Posterior Crossbite</i>	30.6	14.3	30.5	34.9	54.8
<i>Posterior Crossbite # $n = 98$</i>	20.4	9.5	22.6	29.4	50.0
Reverse Overjet [1]	2.3	1.6	1.7	3.2	3.2
Anterior Overjet ≥ 6 mm [1]	16.2	12.7	17.0	17.7	19.4
Anterior Overjet ≥ 9 mm [1]	5.6	3.2	8.5	6.5	3.2
Anterior Contact [1]	84.3	88.9	86.4	82.3	77.4
Anterior Overbite >5 mm [1]	11.6	12.7	10.2	11.3	12.9
Anterior Openbite [1]	4.2	4.8	5.1	3.2	3.2
Midline Deviation >2 mm [5]	8.8	5.0	11.9	9.8	9.7
Angle's Class I	67.1	76.2	68.0	61.9	58.1
Angle's Class II	28.7	22.2	30.4	31.8	32.3
Angle's Class III	4.2	1.6	1.7	6.4	9.7

Posterior crossbite in cases without posterior tooth loss (excluding third molars).

No significant gender associations were found for any of the occlusal variables; however, no females recorded a reverse overjet, and more males (8.8%) than females (2.7%) had an overjet of greater than 9 mm. No gender differences were found for diastema, anterior irregularity, overbite, overjet, and midline deviation.

Significant differences in the occurrence of certain occlusal traits were observed when four different age categories (18-30 years, 31-40 years, 41-50 years, 51-60+ years) were compared in contingency tables using Chi-square analyses. Individuals in the younger age groups had significantly more spacing in the anterior maxilla (Chi-square = 8.58) that could not be attributed to extraction spacing. More spacing in the posterior maxilla and mandible was seen particularly in the oldest

age group (Chi-squares = 18.35 and 17.6 respectively); this was mainly attributed to extraction spacing. Despite this, a significant tendency towards increased mandibular posterior crowding was observed in these older age groups (Chi-square = 9.7), with the least frequency (10% of those with crowding) in the youngest age group. Maxillary incisor irregularity (>1 mm) and anterior maxillary rotation ($>15^\circ$) showed a significant, positive association with age (Chi-squares = 9.8 and 11.30 respectively). This relation could not be demonstrated with mandibular incisor irregularity. The relative frequency of individuals with posterior crossbite was increased in older age groups (Chi-square = 17.04); as it was in the cases with no posterior tooth loss (excluding third molars) (Chi-square = 8.31).

Table II. Distribution of maxillary irregularity, mandibular irregularity, anterior overjet and overbite.

ATTRIBUTE	GENDER	N	MEAN	MEDIAN	S.D.	RANGE
MAXILLARY IRREGULARITY	FEMALE	113	1.39	1	0.89	0 - 4
	MALE	102	1.47	1	0.91	0 - 6
	TOTAL	215	1.43	1	0.90	0 - 6
MANDIBULAR IRREGULARITY	FEMALE	113	1.23	1	0.80	0 - 3
	MALE	103	1.31	1	0.91	0 - 5
	TOTAL	216	1.27	1	0.85	0 - 5
ANTERIOR OVERJET	FEMALE	113	3.92	4	1.81	0 - 10
	MALE	102	3.96	4	2.51	-3 - 11
	TOTAL	215	3.94	4	2.17	-3 - 11
ANTERIOR OVERBITE	FEMALE	113	3.15	3	1.88	-1 - 10
	MALE	102	3.31	3	2.41	-2 - 14
	TOTAL	215	3.23	3	2.14	-2 - 14

No significant gender differences were detected ($\alpha = 0.05$)

Table III. Distribution of modified Angle's classification for total sample ($n = 216$).

CLASSIFICATION	COUNT	%
Class I	145	67.1
Class II Division 1	21	9.7
subdivision	12	5.6
Class II Division 2	8	3.7
subdivision	8	3.7
Class II Indefinite	5	2.3
subdivision	5	3.7
Class II	5	2.3
subdivision	5	1.9

When a one-way ANOVA was performed with age category as the grouping variable, only anterior maxillary irregularity was noted to have a significant F value. A Tukey Honestly Significant Different (HSD) test showed the youngest age category had significantly less irregularity (1.11 mm) than the three older groups (1.54 mm, 1.53 mm, 1.65 mm) which were not significantly different from each other. This was confirmed non-parametrically by the Kruskal-Wallis ANOVA ($H = 12.25$, $p = 0.01$) and the Median Test (Chi-square = 9.99, $p = 0.02$).

Anterior maxillary irregularity was the only trait to show a significant association with education level (Chi-square = 11.87, $p = 0.003$): tertiary-educated individuals had the least maxillary irregularity. Given that no significant education differences existed with respect to previous orthodontic history, nor to the number of missing teeth, this finding is difficult to explain. No other occlusal trait associations were observed when grouped by education level.

Discussion

To the authors' knowledge there have been no random studies of the prevalence of malocclusion in a broad adult Australian population. (Freer and Taverne have conducted a study using adults from a narrower age group; however, their results have not yet been published.)

Direct comparison with other studies is difficult because of variations in defining particular traits and the broad age spectrum that the present study covers. Also, there is a tendency in the literature to explain a prevalence of malocclusion in a given population on the basis of a select group of traits: for example, Espeland and Stenvik,¹⁴ used criteria based only on anterior spacing, crowding, irregularity and overjet, and found that 20.8 per cent of their total sample had no 'malocclusion'. Using the same descriptive criteria, the present study also found exactly 20.8 per cent of the total sample had no 'malocclusion'. Espeland and Stenvik,¹⁴ also found no sex difference; however, using the same criteria, the present study found that 28 per cent of females had no 'malocclusion' compared with only 13 per cent of males (Chi-square = 7.13, $p = 0.008$).

The prevalence of the individual malocclusion traits in the adult sample was broadly similar to the results of other adult prevalence studies.^{7,15-18} Anterior mandibular crowding was observed in 45.4 per cent of the sample; which was similar to the 42.9 per cent of females observed to have mandibular crowding by Mohlin,¹⁶ but greater than that observed in adult males (20.8%) by Ingervall *et al.*¹⁵

Anterior overbite greater than 5 mm was seen in 11.6 per cent of the sample; which is comparable to the findings by Ingervall (19% ≥ 5 mm). Overjet ≥ 6 mm was present in 16.2 per cent of the sample; which was less than the 23 per cent observed in adults by Burgersdijk *et al.*¹⁷ but greater than that observed by Ingervall *et al.*¹⁵ and Mohlin¹⁶ (10.7% and 9.8%, respectively).

Some difficulty was experienced in using Angle's classification in certain instances, particularly where drift after tooth loss had occurred. Despite this, intra-examiner reliability was demonstrated to be satisfactory, and the results are similar to those of comparable samples.^{16,18} The modified Angle's classification proposed by Katz¹⁹ is yet to be investigated to assess whether it represents a significant improvement for classification purposes. This would be particularly interesting in cases where molar drift after tooth loss has occurred.

Contrary to the findings of Salonen *et al.*¹⁸ malocclusion prevalence did not decrease with age, and the frequency of most traits remained relatively stable or increased. Anterior maxillary spacing decreased with age while anterior maxillary irregularity and posterior maxillary spacing increased (the latter mainly due to extractions). It may be possible that anterior maxillary changes are independent of posterior maxillary changes. The most significant increase in maxillary irregularity was between the 18 to 30 year and the 31 to 40 year groups, with the increase thereafter being insignificant. An increase in posterior mandibular crowding with age was seen in those adults who retained their posterior teeth. Unlike the changes noted by Helm and Petersen,⁷ from adolescence to 35 years of age no increase in deep overbite or mandibular crowding was detected. While Dickson⁶ noted small but significant reductions in overjet and overbite and an increase in lower incisor crowding, similar trends could not be confirmed in the present sample.

The large observed increase in posterior crossbite incidence with age was also noted to a lesser extent by Helm and Petersen.⁷ They explained this to be associated with increased tooth loss and subsequent rotations. However, in the present sample, posterior crossbite was seen to increase significantly with age, even in the 98 cases without posterior tooth loss (excluding the third molars). This may be explained by the increased posterior crowding, rotations, and Class II and Class III malocclusions observed in the older age groups.

(It must be realised that only one tooth in crossbite was required to register the presence of a posterior crossbite.) Posterior mandibular crossbite was significantly associated with the presence of posterior mandibular rotations, but not with posterior maxillary rotations. While these are valid explanations, an analysis of arch width change in adults would be interesting. Buschang *et al.*²⁰ demonstrated that the arch forms of females over 35 years of age were broader and shallower compared with the arch forms in females between 17 and 35 years of age. They did not assess the change of maxillary arch form relative to mandibular arch form.

Conclusion

The prevalence of certain malocclusion traits (anterior irregularity, posterior mandibular crowding, posterior rotations, posterior crossbite) increased with age.

Posterior changes, particularly crossbites, occurred even in the absence of posterior tooth loss. Further investigation into age-related arch width and arch depth changes may thus be warranted in adults, particularly those with intact dentitions.

Address for correspondence and reprints:

Dr Marcus Tod
P.O. Box 6222,
Upper Mount Gravatt
Brisbane Queensland 4122
Australia

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