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Short Communication

Age- and Sex-specific Differences in Ratio of Occluding Pairs to Number of Present Teeth

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Abstract

The aim of this study was to determine age- and sex-specific differences in the ratio of occluding pairs (OPs) to number of present teeth (PT). The data were obtained from a periodontal disease examination carried out under a health promotion law in a city located northeast of Tokyo, Japan, in 2005. Data from a total of 5,131 (1,735 male and 3,396 female) 40-, 50-, and 60-year-old participants were analysed in this study. Occluding pairs were counted by analysing dental charts. Sex-related differences in the ratio of mean PT to OPs were found at 30 PT in 40-year-olds, at 22 PT and 28 PT in 50-year-olds, and at 24 PT and 28 PT in 60-year-olds. Age differences were only found at 28 PT in males. These differences in the ratio of PT to OPs were influenced by the presence of third molars and the type of tooth loss pattern. In some cases the PT-to-OP ratio is influenced by age and sex, but these differences are very small. Age and sex need to be considered when using PT to estimate OPs.

Key words: Occluding pairs — Age — Sex-related difference — Present teeth — Adults

Introduction

Studies have assessed the relationship between occluding pairs (OPs) and masticatory efficiency, masticatory ability, oral health-related quality of life, dental arch stability, temporomandibular disorders, and nutrition-related psychosocial factors such as satisfaction[2]. However, there have been few large-scale surveys providing data on occlusal condition[4,7,9]. The Survey of Dental Diseases in Japan[8] and the National Health Nutrition Examination Survey (NHANES)[10] provide important data concerning oral health status, but they do not include any data on occlusal condition. Therefore, in our previous study[11], we investigated the relationship between OPs and present teeth (PT)

Table 1 Occluding pairs by number of present teeth in males and females (40, 50, or 60 years old)

Age 40			PT	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	Male	(n)											(1)			(1)	(3)		
													3.0			3.0	4.0		
	Female	(n)		(1)									(2)			(1)	(1)	(2)	(1)
				0									0			2.0	1.0	3.5	2.0
	Test			—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
			PT	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
	Male	(n)				(4)	(4)	(4)	(6)	(19)	(22)	(41)	(53)	(100)	(267)	(113)	(64)	(35)	(37)
						5.8	6.5	7.5	8.2	9.5	10.3	10.8	11.6	12.6	13.7	13.7	14.1	15.0	16.0
	Female	(n)		(3)	(3)	(7)	(2)	(9)	(13)	(30)	(58)	(65)	(148)	(212)	(545)	(193)	(134)	(68)	(42)
				4.7	5.7	6.1	6.5	7.8	9.2	9.2	10.4	11.0	11.7	12.6	13.7	13.8	14.2	15.0	16.0
	Test			—	—	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	*	n.s.	n.s.
Age 50			PT	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	Male	(n)									(2)	(1)			(2)	(2)		(1)	(2)
											1.0	0			0.5	2.5		3.0	3.5
	Female	(n)			(1)		(1)			(1)	(1)		(3)	(1)	(5)	(1)	(4)	(1)	(1)
					0		0			0	1.0		0.7	0	1.8	2.0	2.8	5.0	6.0
	Test			—	—	—	—	—	—	—	—	—	—	—	n.s.	—	—	—	—
			PT	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
	Male	(n)		(3)	(7)	(5)	(7)	(15)	(9)	(22)	(32)	(34)	(53)	(60)	(90)	(42)	(25)	(16)	(18)
				5.0	6.3	7.2	7.4	7.8	8.3	9.0	10.1	10.9	11.6	12.5	13.5	13.7	14.1	15.0	16.0
	Female	(n)		(9)	(9)	(7)	(9)	(26)	(21)	(43)	(56)	(77)	(106)	(132)	(206)	(65)	(34)	(17)	(11)
				6.0	5.9	6.4	7.2	7.7	8.9	9.2	10.1	11.0	11.7	12.7	13.8	13.7	14.2	15.0	16.0
	Test			n.s.	n.s.	n.s.	n.s.	n.s.	*	n.s.	n.s.	n.s.	n.s.	n.s.	*	n.s.	n.s.	n.s.	n.s.
Age 60			PT	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	Male	(n)		(1)	(2)	(4)	(4)	(4)	(3)	(6)	(4)	(2)	(2)	(6)	(5)	(5)	(7)	(5)	(6)
				0	0	0	0.3	0	1.0	0.7	0.5	0	1.5	1.5	1.6	2.6	2.9	5.0	4.2
	Female	(n)			(1)	(2)	(3)	(4)	(5)	(9)	(2)	(6)	(6)	(8)	(11)	(16)	(16)	(15)	(15)
					0	0	0.3	0.3	0	0.2	0.5	0	1.2	0.9	2.3	2.4	3.2	4.9	4.3
	Test			—	—	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
			PT	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
	Male	(n)		(11)	(14)	(14)	(15)	(26)	(17)	(25)	(40)	(40)	(46)	(61)	(60)	(31)	(25)	(14)	(8)
				5.5	5.7	6.4	7.0	7.7	8.6	9.2	9.9	11.0	11.7	12.5	13.4	13.6	14.2	15.0	16.0
	Female	(n)		(19)	(19)	(32)	(28)	(41)	(47)	(51)	(84)	(94)	(103)	(123)	(146)	(49)	(28)	(16)	(9)
				5.2	5.7	6.4	7.4	7.7	8.7	9.3	10.2	10.9	11.7	12.6	13.7	13.8	14.3	15.0	16.0
	Test			n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	*	n.s.	n.s.	n.s.	*	n.s.	n.s.	n.s.	n.s.

n.s.: not significant, *: $p<0.05$, —: Data were analysed only for groups containing 3 or more participants.

and found there to be a direct relationship. That is to say, the number of OPs can be estimated from the number of PT. In that study, we analysed only 60-year-old participants, including both males and females. To our knowledge, however, no studies have investigated the effect of age and sex on OPs. The purpose of this study was to evaluate age and sex differences in the PT-to-OP ratio.

Methods

Data were collected from a periodontal disease examination conducted in a city located northeast of Tokyo, Japan, in 2005. This examination targeted people aged 40, 50, or 60 years, and was based on a health promotion law. Data obtained from 5,131 (1,735 male and 3,396 female) participants were analysed in this study. Number of PT was obtained from individual dental charts. Completely and partially erupted permanent teeth were defined as "present teeth" (*i.e.*, existing teeth) in this study. Supernumerary teeth, the pontics of bridge prostheses, and implant-supported superstructures were not counted as PT.

Table 2 Occluding pairs by number of present teeth in 40-, 50- and 60-year-olds (male and female)

Male	Age		PT	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	40	(n)											(1)			(1)	(3)		
													3.0			3.0	4.0		
	50	(n)									(2)	(1)			(2)	(2)		(1)	(2)
											1.0	0			0.5	2.5		3.0	3.5
	60	(n)		(1)	(2)	(4)	(4)	(4)	(3)	(6)	(4)	(2)	(2)	(6)	(5)	(5)	(7)	(5)	(6)
				0	0	0	0.3	0	1.0	0.7	0.5	0	1.5	1.5	1.6	2.6	2.9	5.0	4.2
	Test			—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	Age		PT	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
	40	(n)				(4)	(4)	(4)	(6)	(19)	(22)	(41)	(53)	(100)	(267)	(113)	(64)	(35)	(37)
						5.8	6.5	7.5	8.2	9.5	10.3	10.8	11.6	12.6	13.7	13.7	14.1	15.0	16.0
	50	(n)		(3)	(7)	(5)	(7)	(15)	(9)	(22)	(32)	(34)	(53)	(60)	(90)	(42)	(25)	(16)	(18)
				5.0	6.3	7.2	7.4	7.8	8.3	9.0	10.1	10.9	11.6	12.5	13.5	13.7	14.1	15.0	16.0
	60	(n)		(11)	(14)	(14)	(15)	(26)	(17)	(25)	(40)	(40)	(46)	(61)	(60)	(31)	(25)	(14)	(8)
				5.5	5.7	6.4	7.0	7.7	8.6	9.2	9.9	11.0	11.7	12.5	13.4	13.6	14.2	15.0	16.0
	Test				—	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	*	n.s.	n.s.	n.s.	n.s.
Female	Age		PT	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	40	(n)		(1)									(2)			(1)	(1)	(2)	(1)
				0									0			2.0	1.0	3.5	2.0
	50	(n)			(1)		(1)			(1)	(1)		(3)	(1)	(5)	(1)	(4)	(1)	(1)
					0		0			0	1.0		0.7	0	1.8	2.0	2.8	5.0	6.0
	60	(n)			(1)	(2)	(3)	(4)	(5)	(9)	(2)	(6)	(6)	(8)	(11)	(16)	(16)	(15)	(15)
					0	0	0.3	0.3	0	0.2	0.5	0	1.2	0.9	2.3	2.4	3.2	4.9	4.3
	Test			—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	Age		PT	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
	40	(n)		(3)	(3)	(7)	(2)	(9)	(13)	(30)	(58)	(65)	(148)	(212)	(545)	(193)	(134)	(68)	(42)
				4.7	5.7	6.1	6.5	7.8	9.2	9.2	10.4	11.0	11.7	12.6	13.7	13.8	14.2	15.0	16.0
	50	(n)		(9)	(9)	(7)	(9)	(26)	(21)	(43)	(56)	(77)	(106)	(132)	(206)	(65)	(34)	(17)	(11)
				6.0	5.9	6.4	7.2	7.7	8.9	9.2	10.1	11.0	11.7	12.7	13.8	13.7	14.2	15.0	16.0
	60	(n)		(19)	(19)	(32)	(28)	(41)	(47)	(51)	(84)	(94)	(103)	(123)	(146)	(49)	(28)	(16)	(9)
				5.2	5.7	6.4	7.4	7.7	8.7	9.3	10.2	10.9	11.7	12.6	13.7	13.8	14.3	15.0	16.0
	Test			n.s.	n.s.	n.s.	—	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.

n.s.: not significant, *: $p<0.05$, —: Data were analysed only for groups containing 3 or more participants.

The number of OPs was determined by analysing the dental records of the above-mentioned participants. Any opposing pair of maxillary and mandibular teeth with the same tooth number was counted as one OP; therefore, the maximum number of OPs in a 32-tooth dentition was 16.

1. Statistical methods

Homoscedasticity of data was evaluated by the Levene test. A student's *t*-test (in the case of homoscedasticity) or the Welch *t*-test (in the case of non-homoscedasticity) was then performed to examine differences between males and females. Analysis of age differences was performed by using the Kruskal-Wallis test. Differences in the percentage of people having each tooth type were tested by the chi-squared test. Data were analysed only for groups containing 3 or more participants. P-values of less than 0.05 were regarded as signifying statistical significance.

Results

The number of OPs by PT for males and females is shown in Table 1. There were no differences for most PT numbers. There were significant but minor sex differences at the following ages and PT numbers: in 40-year-olds, there was a significant difference at 30 PT, where males had 14.1 OPs and females had 14.2; in 50-year-olds, there were differences at 22 PT (males: 8.3 OPs; females: 8.9 OPs) and 28 PT (males: 13.5 OPs; females:

Table 3 Percentage of participants who have each tooth type (by sex and age)

Age, Sex, PT	n	Upper								Lower							
		Molar			Premolar		Incisors			Molar			Premolar		Incisors		
		Third (%)	Second (%)	First (%)	Second (%)	First (%)	Canine (%)	Lateral (%)	Central (%)	Third (%)	Second (%)	First (%)	Second (%)	First (%)	Canine (%)	Lateral (%)	Central (%)
40 yrs., 30 PT																	
Male	64	56.3	99.2	98.4	100	97.7	99.2	99.2	99.2	62.5	99.2	93.8	96.9	100	100	98.4	100
Female	134	50.0	98.1	99.3	99.3	100	100	100	100	65.3	98.1	91.4	98.9	99.6	100	100	100
Chi-Square test		n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
50 yrs., 22 PT																	
Male	9	0	66.7	44.4	44.4	88.9	100	83.3	94.4	22.2	55.6	33.3	83.3	94.4	100	100	88.9
Female	21	2.4	42.9	61.9	71.4	78.6	85.7	78.6	95.2	2.4	45.2	42.9	69.0	88.1	92.9	95.2	95.2
Chi-Square test		n.s.	n.s.	n.s.	*	n.s.	n.s.	n.s.	n.s.	*	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
50 yrs., 28 PT																	
Male	90	10.6	97.8	96.1	97.8	100	98.9	98.9	97.8	19.4	95.6	89.4	98.9	100	98.9	100	100
Female	206	5.1	99.3	98.1	98.5	98.8	100	100	100	10.2	97.1	95.4	98.8	99.3	100	99.8	99.8
Chi-Square test		*	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	*	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
60 yrs., 24 PT																	
Male	40	16.3	70.0	72.5	91.3	96.3	98.8	91.3	92.5	12.5	48.8	42.5	80.0	92.5	97.5	98.8	98.8
Female	84	1.8	63.1	70.2	83.9	92.9	99.4	92.3	90.5	5.4	67.3	48.8	86.3	96.4	100	98.2	97.6
Chi-Square test		*	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	*	*	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
60 yrs., 28 PT																	
Male	60	12.5	94.2	98.3	97.5	99.2	99.2	98.3	99.2	23.3	92.5	87.5	99.2	99.2	100	100	100
Female	146	3.4	97.9	99.0	98.6	99.7	100	100	99.7	13.0	97.6	93.2	98.6	99.3	100	100	100
Chi-Square test		*	*	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	*	*	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Males, 28 PT																	
40 yrs.	267	7.9	98.5	97.8	99.4	99.4	99.4	99.4	99.1	11.6	97.2	92.5	98.7	99.4	100	99.6	100
50 yrs.	90	10.6	97.8	96.1	97.8	100	98.9	98.9	97.8	19.4	95.6	89.4	98.9	100	98.9	100	100
60 yrs.	60	12.5	94.2	98.3	97.5	99.2	99.2	98.3	99.2	23.3	92.5	87.5	99.2	99.2	100	100	100
Chi-Square test		n.s.	*	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	*	*	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.

n.s.: not significant. Data were showed only which were differences in mean OPs by sex or age. *: $p<0.05$

13.8 OPs); in 60-year-olds, there were differences at 24 PT (males: 9.9 OPs; females: 10.2 OPs) and 28 PT (males: 13.4 OPs; females: 13.7 OPs).

The number of OPs by PT for different ages is shown in Table 2. There were significant differences at 28 PT in males, where 40-year-olds had 13.7 OPs, 50-year-olds had 13.5 OPs, and 60-year-olds had 13.4 OPs. In females, there were no significant age differences.

The percentage of participants who had each tooth type is presented in Table 3. This table shows only data for groups in which there was a significant sex or age difference in the PT-to-OP ratio. In 40-year-olds with 30 PT, there were no significant differences in the percentages of males and females with each tooth type. In 50-year-olds with 22 PT, there were differences in the percentage of males and females with upper second premolars and lower third molars. In 50-year-olds with 28 PT, there were differences in the upper and lower third molars. In 60-year-olds with 24 PT, there were differences in the upper and lower third molars, as well as the lower second molars. In 60-year-olds with 28 PT, there were differences in the upper and lower third molars as well as the upper and lower second molars. In males with 28 PT, there were differences in the percentage of 40-, 50-, and 60-year-olds with upper and lower second molars as well as lower third molars.

The mean number of OPs of each tooth type is presented in Table 4. This table shows only data for groups in which there was a significant sex or age difference in the PT-to-OP ratio. In 40-year-olds with 30 PT, there were no significant differences between males and females in the number of OPs of each tooth type. In 50-year-olds with 22 PT, there were differences in the number of first molar

Table 4 Mean number of OPs by tooth type (by sex and age)

Age, Sex, PT	n	Molar			Premolar		Incisors		
		Third	Second	First	Second	First	Canine	Lateral	Central
40 yrs., 30 PT									
Male	64	0.47	1.97	1.84	1.94	1.95	1.98	1.95	1.98
Female	134	0.54	1.93	1.81	1.96	1.99	2	2	2
Test		n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
50 yrs., 22 PT									
Male	9	0	0.67	0	0.67	1.67	2	1.67	1.67
Female	21	0	0.38	0.48	1.10	1.48	1.81	1.67	1.95
Test		n.s.	n.s.	*	n.s.	n.s.	*	n.s.	n.s.
50 yrs., 28 PT									
Male	90	0.07	1.87	1.72	1.93	2	1.96	1.98	1.96
Female	206	0.06	1.93	1.87	1.95	1.97	2	2	2
Test		n.s.	n.s.	*	n.s.	*	n.s.	n.s.	n.s.
60 yrs., 24 PT									
Male	40	0.10	0.55	0.43	1.43	1.78	1.93	1.83	1.83
Female	84	0	0.85	0.62	1.40	1.97	1.98	1.81	1.76
Test		*	*	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
60 yrs., 28 PT									
Male	60	0.07	1.75	1.72	1.93	1.80	1.98	1.97	1.98
Female	146	0	1.91	1.84	1.95	1.98	2	2	1.99
Test		*	*	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Males, 28 PT									
40 yrs.	267	0.06	1.91	1.81	1.96	1.98	1.99	1.98	1.98
50 yrs.	90	0.07	1.87	1.72	1.93	2	1.96	1.98	1.96
60 yrs.	60	0.07	1.75	1.72	1.93	1.80	1.98	1.97	1.98
Test		n.s.	*	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.

n.s.: not significant. Data were showed only which were differences in mean OPs by sex or age. Data were added left and right, therefore the maximum of the number of OPs was 2. *: $p<0.05$

and canine OPs in males and females. In 50-year-olds with 28 PT, there were differences in the number of first molar and first premolar OPs. In 60-year-olds with 24 PT, there were differences in the number of third and second molar OPs. In 60-year-olds with 28 PT, there were again differences in the number of third and second molar OPs. In males with 28 PT, there were age-related differences in the number of second molar OPs.

Discussion

Although the term "occlusal pairs" is frequently used, there is no consensus on its definition, or indeed on precisely how they ought to be counted. There are many problematic determinations that must be made, such as when one tooth is occluded with two opposing teeth. Käyser[3] counted one pair of occluding premolars as one unit and one pair of occluding molars as two units. Lin *et al.*[4] and Ueno *et al.*[9] included the pontics of bridge prostheses in their count. Baba[1] counted OPs using dental charts, which is the same method employed in the current study. The number of OPs may also be influenced by occlusal status, but malocclusion which influences the OP count was considered to be negligible in this study because of the large sample size.

In counting OPs in this study, any opposing pair of maxillary and mandibular teeth with the same tooth number was counted as one OP. In our evaluation of the sex differences in the PT-to-OP ratio, it became clear that the difference in the percentage of males and females with third molars influenced the

number of OPs. Most of the percentage of 50- and 60-year-old females with upper and lower third molars was significantly lower than that of males (Table 3). Furthermore, among 60-year-olds, there were significant differences in the percentage of males and females with lower second molars at 24 and 28 PT (Table 3). There were also sex differences in the number of first molar OPs in 50-year-olds and in the number of second or third molar OPs in 60-year-olds (Table 4). These results show that there were differences between males and females in the percentage of participants with different types of PT and in the mean number of OPs for certain tooth types.

It is well known that the reasons for tooth loss change with age. With advancing years, periodontal disease becomes a more predominant cause of tooth loss than dental caries. Morita *et al.*[6] reported that periodontal disease was the principal cause of tooth loss only in males between the ages of 46 and 65. Maxillary premolars and molars in males were extracted for periodontal disease just as often as for caries. McCaul *et al.*[5] reported that upper and lower second molars were more frequently extracted due to periodontal disease than first molars in elderly patients. These patterns of tooth loss are likely responsible for the age differences in the percentage of participants with different types of PT and in the number of OPs by tooth type in cases where the number of PT is equivalent (Tables 3 and 4).

The ratio of PT to OPs is influenced by the presence of third molars and type of tooth loss pattern. This ratio is in some cases influenced by age and sex, but the differences are very small. Age and sex need to be considered when using PT to estimate the number of OPs.

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