

Association of 2D:4D Ratio (Hormonal Fingerprints) with Dental Caries and Malocclusion among 18–25-year-old Dental Students

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ABSTRACT

Objective: The goal was to discover the association of hormonal fingerprints with dental caries and malocclusion in our study.

Methodology: A total of 200 dental college students of the age-group of 18–25 years were randomly selected. The hormonal fingerprint was created by using a Vernier caliper to measure the length of the index and ring fingers and determine their ratio. Standard mouth mirrors and community periodontal index (CPI) probes were used to assess caries. According to the World Health Organization (WHO) assessment form, 2013, the sum of the number of Decayed, Missing due to caries, and Filled Teeth (DMFT) in the permanent teeth index was used to assess caries. Malocclusion was assessed by using the dental esthetic index. For statistical analysis, SPSS software was utilized.

Results: According to the findings, the majority of study subjects had a second digit to fourth digit (2D:4D) ratio of <1. Prevalence of malocclusion was observed to be increasing with an increase in 2D:4D ratio. Caries occurrence was also found to increase with an increase in malocclusion.

Conclusion: Our study confirms that hormonal fingerprints can be used as an early predictor for dental caries and malocclusion.

Keywords: Caries, Hormonal fingerprints, Malocclusion, Second digit to fourth digit ratio.

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INTRODUCTION

A biological marker is something that can be used to detect a certain illness condition or another physiological state in an organism. They are used to assess, measure, and investigate normal and pathologic processes.¹ These are the tools that assist in illness diagnosis, prevention, or reversal of diseases.² According to the WHO, pulse, blood pressure, or anything else that establishes a relationship between a biological function and a potential hazard are examples of biomarkers.³ There are a number of biological indicators that have been established in dentistry too that predict the occurrence of oral disorders such as dental caries, periodontal disease, and malocclusion.⁴ The hormonal fingerprint, often known as the digit ratio, is one such biological marker. The digit ratio, also known as the hormonal fingerprint, is the 2D:4D ratio, which has been shown to be stable, repeatable, and reconcilable for each person.⁵ This ratio is sexually dimorphic and can be measured by various methods using digital Vernier calipers, radiographs, photographs, photocopies, and scanners.⁶ Hormonal fingerprints are nonhazardous and offer easy measurement, and that is why they have preferably been used in research.

The length of a human hand's fingers has been linked to a variety of physiological and psychological features as well as disease. As a result, we wanted to see if there was an association between hormonal fingerprints (2D:4D ratio) with dental caries and malocclusion in the Indian population.

METHODOLOGY

A cross-sectional descriptive study was undertaken on college students at Swami Devi Dyal Dental College and Research Institute

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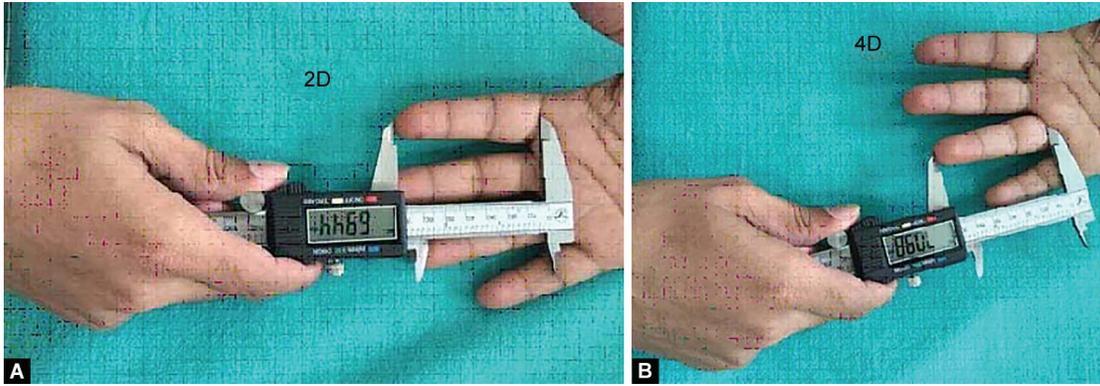
Conflict of interest: None

in Panchkula, India, to find out the association of the 2D:4D ratio with the prevalence of caries and malocclusion. The study was conducted from January 2021 to June 2021.

All of the procedures used in this study adhered to the Helsinki Declaration. The Institutional Ethical Clearance Committee of Swami Devi Dyal Dental College, Barwala, Panchkula, Haryana, provided ethical clearance. To determine the viability of the study, a pilot study of 20 students was conducted. During the examination, the time required for each subject's assessment and the DAI's practical application was assessed.

Examiner Training and Calibration

With the help of one recorder, two trained and calibrated examiners completed a comprehensive clinical examination.



Figs 1A and B: 2D:4D ratio measurement using Vernier caliper

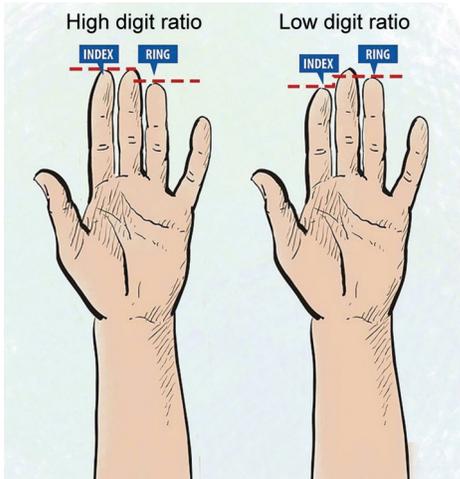


Fig. 2: Depicts the various 2D and 4D ratios

Another investigator double-checked one investigator's findings. To investigate inter-examiner reliability, 10% of the students were assessed by each of the two investigators; Kappa values of 0.88 and 0.87, respectively, were observed. Re-examination of 10% of the samples was used to measure intra-examiner reproducibility. There was a high level of agreement amongst examinations conducted by the same examiner. Ten study subjects were re-examined by each examiner at the end of the day during the survey to ensure intra-examiner consistency.

The convenience sampling was done using a non-probability method. A total of 200 subjects were surveyed in order to identify a statistically significant difference of 10% with a 95% confidence interval. Individuals between the ages of 18 and 25 who were not taking any medication that affected salivary flow, had no systemic illness, physical, or mental handicap, and were classified as American Society of Anesthesiology (ASA) class I by the American Society of Anesthesiologists included in the study.⁷ Individuals who did not give consent, with hormonal imbalance, who could not be included under class I ASA physical status, under orthodontic therapy, and with deformed digits were excluded. Before participating, all of the students signed a written informed consent form.

Examination Procedure

Students were seated in a dental chair, where they were examined using sterile mouth mirrors and CPI probes under a light attached to the chair.

To record caries status, the WHO standard criteria indicated in the WHO oral health proforma, 2013 were used (DMFT). Caries were classified as pit and fissure or smooth surface caries, which could be active or inactive. World Health Organization developed a scale to classify caries severity based on DMFT values: DMFT values between 0.0 and 1.1 were very low; 1.2–2.6 were low; 2.7–4.4 were moderate; 4.5–6.5 were high; and values greater than 6.6 were extremely high.⁸ For the convenience of the study, we merged very low and low into one category, i.e., low; high and very high into one category, i.e., high. As a result, the individuals were split into three categories based on their DMFT scores: high, medium, and low. So, those with a total DMFT score between 0 and 2.6 was considered low; medium prevalence between 2.7 and 4.4; and high prevalence with a score of greater than 4.5 was considered.

The DAI, as described in the WHO Oral Health Survey Basic Methods, was used to conduct malocclusion examinations with the help of a CPI probe and a plane mouth mirror.⁹ The DAI is simple to use and produces a single score by statistically identifying clinical and esthetic components. Individuals with scores ≤ 30 were considered normal and those >30 were considered to have malocclusion.

Measurement of 2D:4D Ratio

Participants were asked about hand injuries before being gauged. With the use of a digital Vernier caliper with a 0.1 mm accuracy level, the length of 2D (index finger) and 4D (ring finger) was measured from the ventral surface of the right hand from the middle of the basal crease to the tip of the digit (Fig. 1). The mean of three observations for every subject was recorded because the digital Vernier caliper is sensitive to every reading. Direct digit length measurement is more time-consuming but has adequate repeatability.

If there were multiple creases in any participant's hand, then the one which was most proximal to the hand was considered. Because digit ratios change between left- and right-handed people,⁷ only right-handed people were chosen, and the digit lengths of the ventral surface of the right hand were measured for all the study subjects. Divide these values to get the 2D:4D ratio. The participants were split into two groups: those with a high 2D:4D ratio and those with a low 2D:4D ratio. A high 2D:4D ratio meant that the ratio was greater than 1, and low 2D:4D ratio meant that the ratio was lower than 1 (Fig. 2).

Pearson's correlation coefficient, Chi-square test, and ANOVA were used to analyze the data in SPSS. $p \leq 0.05$ was selected to be the level of statistical significance.

Table 1: Distribution of 2D:4D ratio <1 or >1 according to sex among the study population

Sex	<1	%	>1	%	Total
Males	75	73.5	27	26.4	102
Females	71	72.4	27	27.5	98
Total	146	73	54	27	200

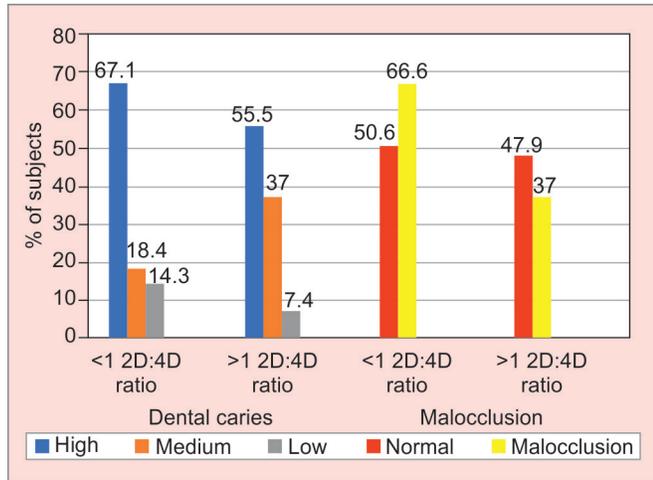


Fig. 3: Shows comparison of 2D:4D ratio with dental caries and malocclusion among the study subjects

Table 2: Comparison between prevalence of malocclusion and the prevalence of dental caries among the study subjects

Caries	Normal	%	Malocclusion	%	Total
High	68	61.8	60	66.6	128
Medium	21	19.0	26	28.8	47
Low	21	19.0	4	4.4	25
Total	110	100	90	100	200

RESULTS

In the 200 study subjects, 54 (27%) had a high 2D:4D ratio, while 146 had a low 2D:4D ratio (73%). In total, 75 boys (73.5%) had a low 2D:4D ratio of less than 1, while 27 (26.4%) had a high 2D:4D ratio of >1. A low 2D:4D ratio of less than 1 was found in 71 (72.4%) of the 98 females, while a high 2D:4D ratio of more than 1 was found in 27 (27.5%) (Table 1).

Out of 146 subjects with low 2D:4D ratio, i.e., <1, 98 (67.1%) subjects had a high DMFT score, 27 (18.4%) had medium, and 21 (14.3%) subjects had a low DMFT score. Out of 54 subjects with high 2D:4D ratio, i.e., >1, 30 (55.5%) had high DMFT score, 20 (37%) subjects had medium DMFT score, and 4 (7.4%) subjects had a low DMFT score. Out of 146 subjects with low 2D:4D ratio, 74 (50.6%) were found to have a normal occlusion, however, 70 (47.9%) were found to have malocclusion. Out of 54 subjects with high 2D:4D ratio, 36 (66.6%) had normal occlusion and 20 (37%) had malocclusion (Fig. 3).

Out of 110 study subjects with normal occlusion, 68 (61.8%) had a high DMFT score, 21 (19%) had a medium, and 21 (19%) had a low DMFT score. Out of 90 subjects with malocclusion, 60 (66.6%) had a high, 26 (28.8%) had medium, and 4 (4.4%) had a low DMFT score (Table 2).

Table 3: The mean and standard deviation of the comparison between DMFT and malocclusion in the study population were cross-tabulated. With a significant *p*-value (*p* = 0.017*) more caries experience was seen with a deviated occlusal situation

	Mean	Std. deviation	Number
Occlusal grading	1.49	0.501	200
DMFT	0.79	1.151	200
<i>p</i> -value	0.017		

DMFT, decayed, missing due to caries, and filled teeth

The mean and standard deviation of the comparison between DMFT and malocclusion in the study population were cross-tabulated. With a significant *p*-value (*p* = 0.017*), more caries experience was seen with a deviated occlusal situation (Table 3).

DISCUSSION

The association between the 2D:4D ratio and human features and behaviors has been demonstrated in numerous articles over the last 5 years.^{5,6} There are very few dental studies on the impact of hormonal fingerprints on oral health.

It was revealed that right-hand 2D:4D ratios and sex had a statistically significant and positive relationship, with male mean 2D:4D being lower than female mean 2D:4D ratio. This shows that men’s prenatal testosterone levels were greater and their prenatal estrogen levels were lower than women’s. The 2D:4D ratio, which causes the 4th digit to be longer than the 2nd, has been proven to be a viable marker for prenatal testosterone.¹⁰ This suggests that men may have had higher prenatal testosterone levels and lower prenatal estrogen levels than women. The 2D:4D ratio has been found to be a reliable indicator of prenatal testosterone levels, which causes the 4th digit to be longer than the 2nd.¹⁰ Our data suggest that males have a lower 2D:4D ratio than females, which is consistent with the findings of Manning et al.,¹¹ who found comparable results. Brown et al.¹² and Lutchmaya et al.¹³ examined the associations of 2D:4D ratios with fetal testosterone (FT) and fetal estrogen (FE) from amniotic fluid in a sample of 33 children and found sexual dimorphism in the 2D:4D ratio. Boys showed higher 2D:4D ratios than girls in another study by Bloom,¹⁴ which contradicted our findings.

A positive correlation was reported between a high 2D:4D ratio and a high caries index, which was similar to the findings of Verma et al.¹⁵ and Priyanka et al.,⁵ but not to the findings of Lakshmi et al.¹⁶

In contrast to a study done by Premkumar and Gurumurthy, a relationship between high 2D:4D ratio and greater rates of malocclusion was reported, which was in agreement with Priyanka et al.⁵ and in contrary to a study conducted by Premkumar and Gurumurthy.¹⁷ These data suggested that testosterone is involved in mandibular development. The fact that hormones act as epigenetic factors in craniofacial growth and development, as demonstrated in the current study, where significant correlations were found between the 2D:4D ratio and an individual’s caries and malocclusion status, backs up the theory that hormones (especially testosterone) influence bone growth.

The deciduous teeth (DT) and DMFT components were found to be substantially associated to DAI. It was discovered that as we progressed from mild malocclusion to severe malocclusion, the risk of caries rose. Borzabadi-Farahani et al.¹⁸ reported that subjects with DAI scores of >35 had a considerably higher caries experience when the occurrence of caries was linked to the DAI. In our study, lower 2D:4D ratio was associated with reduced prevalence of malocclusion, while higher dental caries was associated with

more deviated occlusal characteristics. As a result, it is reasonable to conclude that those with a larger 2D:4D ratio have more caries.

As a result, 2D:4D gives a window into an infant's prenatal existence that not only reveals information about behavior, illness risk, IQ, and reproductive capacity but it also reveals the probabilities and chances of dental cavities and malocclusion patterns, but also reveals the possibilities and probabilities in the pattern of dental caries and malocclusion. However, because the 2D:4D ratio and body mass index (BMI) are multifactorial in nature and require a larger sample size, further research is needed to demonstrate their practical utility in pediatric dentistry.

CONCLUSION

Despite a lot of significant clinical and public health initiatives over the last many years to reduce dental caries, it is still the most frequent childhood disease and the most common health condition globally. Malocclusion is another serious oral health issue in India, with a prevalence of 42%. However, financial constraints frequently prohibit people from receiving timely dental care. If there are measures that can serve as predictors of dental caries and malocclusion in such a scenario, the financial load on a developing country like India would be greatly decreased. Hormonal fingerprints are a new class of biological indicators that can be used to predict the occurrence of malocclusion and tooth caries. The current study confirms the involvement of hormones in malocclusion prevalence, which has an impact on caries prevalence and could be employed as a predictor of malocclusion and dental caries in children.

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