Detecting children's dental caries risk through finger-digit ratio

Syakriani Syahrir,1,* Andi S. Permatasari,1 Aini I. Baiduri,1 Syamsiah Syam,2 Yayah Inayah1

Abstract

Objective: This research aimed to determine whether fingerprints could be used to predict the risk of tooth decay.

Material and Methods: A total of 157 children aged 6 to 12 were included in the study. Their digit ratio (2D:4D ratio) was measured using digital callipers. Additionally, intraoral examinations were conducted to assess their caries status using the DMF-T index.

Results: A significant correlation between the digit ratio and the probability of dental caries was found in children aged 6-12 years at SD Inpres Panaikang. The statistical output shows a positive association between lower digit ratio values and an elevated risk of dental caries. The significance value of the analysis is 0.044, which is below the standard threshold of 0.05.

Conclusion: There is a correlation between the 2D:4D ratio and the risk of dental caries. Hence, the 2D:4D ratio can be used to predict the occurrence of caries.

Keywords: Caries, Children, Digit ratio
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Introduction

Health is regarded as a comprehensive notion that spans various dimensions, including physical, emotional, social and spiritual well-being. Oral health is "a functional and comfortable dentition that enables people to carry out their social responsibilities." Hence, oral health encompasses more than the lack of dental caries, gum disease, or even healthy teeth. Oral health is a factor that influences the overall quality of life. Collectively, the craniofacial complex enables us to communicate verbally, express joy through laughter, consume food through chewing, ingest liquids through swallowing, and express emotions through crying. Oral and dental diseases also lead to limitations in school, work, and home settings, resulting in reduced school and work attendance hours. Deteriorating dental health also impacts one's overall quality of life.1-2 The impact of oral diseases on the health and well-being of children worldwide is increasing. The prevalence of oral disorders, particularly dental caries, remains significantly high, affecting 60-90% of schoolchildren. According to the 2018 Basic Health Research data, dental caries in Indonesia was 81.5% among children aged 3-4 years and as high as 92.6% among those aged 5-9 years.2

Dental caries during childhood can negatively impact the oral health-related quality of life for children and their parents. A considerable number of dental cavities in this age group remain untreated, leading to adverse effects on children’s weight, growth, quality of life and cognitive development. This, in turn, can result in hospitalization and emergency dental visits.3 Early and accurate identification and examination of dental caries are essential for effectively managing dental patients. Various procedures are available to the doctor, but it is crucial to use strategies with adequate sensitivity and specificity to provide an accurate diagnosis and determine the most suitable treatment for the patient.4,5

The 2D-4D ratio measures the lengths of the second and fourth digits. Researchers have found that this ratio is a reliable indicator of the risk of tooth decay at an early age. The ratio is highly stable and consistent for everyone.6 Researchers have identified that the length of the index finger is frequently shorter than that of the ring finger. It was noted that the length of the ring finger in men was relatively more significant than that of their index finger, suggesting a low digit ratio. In contrast, females were more likely to exhibit the reverse pattern, characterized by a high digit ratio.7 Hence, this natural marker can also help predict a child’s susceptibility to tooth decay by evaluating their nutritional abilities, taste perception, and relationship. The dental literature needs more correlation between the 2D:4D ratio and dental caries experience. The research aims to emphasize the significance of a newly discovered biological indicator, hormonal fingerprint, in the early detection of tooth decay in young children.8

REFERENCE

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to the study, out of 84 male participants, 61 had a digit ratio in comparison to women. According and women. Specifically, men exhibit a lower presentation of the digit ratio between men with a higher incidence rate of caries. Therefore, it can be found that participants with a low-digit ratio had a significantly higher DMF-T index of 7.28 than those with a high-digit ratio. The age group with the highest number of participants was 10 years old, with 37 respondents. On the other hand, the age group with the lowest participants was 6.35, indicating a high level. The mean DMF-T index score for the 157 dental decay. Within the highest group, 63 participants involved a sample of 257 children between the ages of 6 and 12. The sample and research population were selected using a simple random sampling approach. The study was granted ethical approval of the number UH17120749. The study utilized a quantitative and descriptive observational method with a cross-sectional design. It was conducted at SD Inpres Panaikang and involved a sample of 257 children between the ages of 6 and 12. The sample and research population were selected using a simple random sampling approach. The study was granted ethical approval of the number UH17120749. The study included healthy children between the ages of 10 and 15 who had no physical or mental disabilities. Children with hand injuries or deformities, long-standing systemic illnesses, recent medication use, physical or mental disabilities, or whose parents did not provide consent were excluded from the study.

Clinical examination

The children were seated on the chair, and a thorough inspection was conducted under the light illumination. Two trained and calibrated examiners conducted a thorough clinical examination. One of the most important indicators of oral health used in epidemiological studies is the index of missing or filled permanent teeth (DMFT). The severity levels were categorized as follows: very low (DMFT index between 0.1 and 1.1), low (DMFT index between 1.2 and 2.6), moderate (DMFT index between 2.6 and 4.4), high (DMFT index between 4.5 and 6.5), and very high (DMFT index greater than 6.5). Caries were documented when a lesion was observed on the occlusal surface, characterized by under-mined enamel or a smooth surface, indicating either halted or active caries.

Calculation of 2D:4D Ratio

The researchers measured the length of the index finger (2D) figure 1 and ring finger (4D) figure 2 for all the young participants. The measurement started from the ventral proximal crease of the digit and ended at the tip. In the case of several creases at the bottom of the digit, the measurements were taken from the largest proximal wrinkle using a vernier calliper. The digit ratio was determined by dividing these numbers and computing the average of numerous measurements for both hands. This was then used to obtain the 2D:4D ratio for each hand individually. The whole participants were divided into children with a 2D:4D ratio less than 1 and ≥1 based on the calculations of 2D:4D.

Material and Methods

Table 1. Distribution of DMF-T index measurement categories in 6-12 Year-Old Primary School Students at SD Inpres Panaikang (n=157)

<table>
<thead>
<tr>
<th>DMF-T Index Categories</th>
<th>n</th>
<th>%</th>
<th>DMF-T Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very low</td>
<td>7</td>
<td>4.5</td>
<td>0.71</td>
</tr>
<tr>
<td>Low</td>
<td>12</td>
<td>7.6</td>
<td>2.00</td>
</tr>
<tr>
<td>Moderate</td>
<td>34</td>
<td>21.7</td>
<td>3.53</td>
</tr>
<tr>
<td>High</td>
<td>41</td>
<td>26.1</td>
<td>5.49</td>
</tr>
<tr>
<td>Very high</td>
<td>63</td>
<td>40.1</td>
<td>9.89</td>
</tr>
</tbody>
</table>

DMF-T Index of 157 Respondents: 6.35

Table 2. Prevalence of caries among primary school students aged 6-12 at SD Inpres Panaikang. (n=157)

<table>
<thead>
<tr>
<th>Risk Factors</th>
<th>Category</th>
<th>DMF-T Index</th>
<th>DMF-T Index Categories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td>Male</td>
<td>84</td>
<td>6.63</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>73</td>
<td>6.03</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age (year)</td>
<td>9</td>
<td>28</td>
<td>6.07</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>37</td>
<td>5.97</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>35</td>
<td>4.06</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>6</td>
<td>3.00</td>
</tr>
<tr>
<td>Digit ratio</td>
<td>Low</td>
<td>43</td>
<td>7.28</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>114</td>
<td>6</td>
</tr>
</tbody>
</table>

Table 3. Distribution of males and females in 2D:4D <1 or ≥1

<table>
<thead>
<tr>
<th>Variable</th>
<th>Digit Ratio</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low (2D:4D &lt;1)</td>
<td>High (2D:4D ≥1)</td>
</tr>
<tr>
<td>Sex</td>
<td>Male</td>
<td>61 (72.62%)</td>
</tr>
<tr>
<td>Female</td>
<td>20 (27.39%)</td>
<td>53 (72.61%)</td>
</tr>
<tr>
<td>Total</td>
<td>45</td>
<td>114</td>
</tr>
</tbody>
</table>

Table 4. Relationship between digit ratio and caries risk in primary school students aged 6-12 years at SD Inpres Panaikang (n=157)

<table>
<thead>
<tr>
<th>DMF-T Index</th>
<th>Digit Ratio</th>
<th>X²</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low (2D:4D &lt;1)</td>
<td>High (2D:4D ≥1)</td>
<td></td>
</tr>
<tr>
<td>Very low</td>
<td>0</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>0</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Moderate</td>
<td>9</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>14</td>
<td>27</td>
<td></td>
</tr>
<tr>
<td>Very high</td>
<td>20</td>
<td>41</td>
<td></td>
</tr>
</tbody>
</table>

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Results

Table 1 shows that among the 157 young individuals involved in the study, 7 participants (4.5%) exhibited a DMF-T index value of 0.71, indicating a lack of oral health. Out of the total number of respondents, 12 individuals (7.6%) had a DMF-T index value of 2, which falls into the category of low values. Out of the total number of respondents, 34 individuals, accounting for 21.7% of the sample, had a DMF-T index score of 3.53, categorizing them as being in the medium range. Out of 41 respondents, which accounts for 26.1% of the sample, their DMF-T index score was 5.49, indicating a significant presence of
The presence of the digit ratio between men and women is shown in the table 3 demonstrates a disparity between the highest and lowest ratio. With a higher incidence rate of caries.

According to the data, males had a higher DMF-T index of 11.67, while females had a DMF-T index of 6.63 compared to females. Additionally, out of 73 female respondents, 20 had a high digit ratio, while 53 had a high digit ratio.

The results of the Chi-square analysis displayed in table 4 suggest a significant correlation between the digit ratio and the probability of dental caries in children aged 6-12 years at SD Inpres Panaikang. The statistical output shows a positive association between lower digit ratio values and an elevated risk of dental caries. The significance value of the analysis is 0.044, which is below the standard threshold of 0.05.

**Discussion**

The hormonal fingerprint is a promising biomarker for early diagnosis, prognosis, and lifestyle management, which can help postpone the onset of diseases or enable early detection of many diseases. However, in dentistry, this technology is still in the developmental stage. The term “hormonal fingerprint” is synonymous with the 2D:4D ratio. The 2D:4D ratio concisely assesses the baby’s prenatal development, providing insights into their behavior, susceptibility to diseases, cognitive abilities, and reproductive potential. The hormone fingerprinting in dentistry to detect malocclusion and caries at an early stage. Additionally, they investigate the impact of the Basal Metabolic Index (BMI) on malocclusion and caries.

The 2D:4D ratio is generally lower in men and higher in women. Individuals with shorter index fingers are exposed to higher testosterone, while those with longer index fingers are exposed to higher estrogen. This difference in digit ratio is determined by 13 or 14 weeks of intrauterine life (second trimester) and shows substantial stability throughout life. Digit length may vary during growth and development phases, but the ratio will remain unchanged due to prenatal androgen exposure. The value of the digit ratio is divided into two categories <1 dan ≥ 1.

A present study was conducted on 157 children to determine the relationship between caries risk and the 2D:4D ratio. The study results indicate that, on average, the 2D:4D ratio is lower in males than in females, which aligns with earlier findings by Manning et al. and Kangassalo et al. This is because a reduced 2D:4D ratio in males indicates elevated prenatal testosterone levels and decreased prenatal estrogen levels compared to females. The 2D:4D ratio is a dependable indicator of prenatal testosterone, which leads to the elongation of the fourth digit about the second digit. More precisely, an individual can have a low
2D:4D (masculine) digit ratio due to elevated prenatal androgens, diminished prenatal estrogen, or a combination of both.\textsuperscript{13}

The study classified its results based on the DMF-T index category. As illustrated, the highest proportion of individuals falling into the very high DMF-T index category is 53 (40.1%), with an index value of 9.89. This is because school-age children, especially those in elementary school, are more prone to oral and dental illnesses due to their poor eating and drinking habits and lack of proper dental care. They have a tendency to snack on food and drinks carelessly and rarely brush their teeth after consuming sweet foods, which can lead to dental problems. This finding is consistent with Aprilianti et al.’s research, which reveals that daily bad habits such as consuming sweet foods and using the wrong toothbrush frequently cause primary school students to develop caries.\textsuperscript{4} Additionally, it was observed that when the children develop permanent teeth, the average DMFT value increases with age, indicating a higher occurrence of tooth decay at a later stage.

Elementary school-age children, who are typically between the ages of 6 and 12, have both primary and permanent teeth. As a result, they are more prone to experiencing oral health issues. Habits and actions that are not aligned with maintaining healthy teeth and mouth can lead to oral and dental problems in school-age children. Boys are more prone to cavities due to their tendency towards disobedience and lack of interest in oral health.\textsuperscript{15}

The examinations conducted on elementary school children aged 6-12 in present study reveal that those with lower 2D:4D ratio values display a notably higher DMF-T index, with a score of 7.28. In contrast, individuals with elevated 2D:4D ratios exhibit a notable DMF-T score 6. Issraini’s research indicates that persons with a lower 2D:4D ratio are more susceptible to caries and prefer sweet meals.\textsuperscript{10}

The digit ratio was found to have a clear and positive link with the occurrence of dental caries in both primary and permanent dentition. This indicates a direct relationship between the digit ratio and the experience of caries in primary dentition.\textsuperscript{14,15} Hence, the digit ratio can be regarded as a consistent and unchanging anatomical indicator for predicting the likelihood of dental caries in primary dentition. An early diagnosis will not only result in healthy teeth and good oral health, but it will also help prevent the development of lifestyle disorders, minimizing the financial burdens on the family and the healthcare sector.

Conclusion
The hormonal fingerprint is a promising biomarker for early diagnosis, prognosis, and lifestyle management, which can help postpone the onset of diseases or enable early detection of many diseases. The 2D:4D ratio has a notable correlation with caries, making it a reliable predictor for caries occurrence. An early diagnosis will not only result in healthy teeth and good oral health, but it will also help prevent the development of lifestyle disorders, minimizing the financial burdens on the family and the healthcare sector.

Acknowledgment
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Conflict of Interest
The authors report no conflict of interest

References


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