Original article:

Assessment of 2D:4D ratio for the early diagnosis of caries and malocclusion in 7-15-year-old children

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Abstract:

Background: The ratio between 2nd and 4th digit length is termed as hormonal fingerprint and is used as an indirect marker in many medical diseases.Dental studies pertaining to the importance of hormonal fingerprint on oral health are very sparse. ***Aim and objectives:*** To study the correlation of dental caries and malocclusion with hormonal fingerprints. ***Materials and Methods:*** A total of 100 children of age group 7-15 years and both genders were randomly selected and included in the present study. The hormonal fingerprint (2D:4D ratio) wasdone by measuring the length ratio of the index and ring finger with the help of digital vernier caliper. Caries assessment wascarried out using standard mouth mirrors and Community Periodontal Index probes. WHO assessment form (1997) was followed for assessment of dentition status and treatment need.Occlusal characteristics evaluated were molar relation, anterior and posterior crossbite, open bite, deep bite and lower anterior crowding. The subjects were divided into high 2D:4D, equal 2D:4D digit ratio and low 2D:4D. All the measurements were done by two investigators. The data collected were tabulated and statistically analyzed using Chi-square and ANOVA test. ***Results:*** Out of 100 children, 34% were males and 66% were females. Most of the participants were 7-8 years old (12 males and 15 females). Majority of the participants (87% for the right hand and 80% for left hand) had low 2D:4D ratio, only 6% for right and 11% for the left hand had high 2D:4D ratio and the remaining had equal 2D:4D ratio. Statistically insignificantcorrelation between 2D:4D ratio and deft/DMFT score and occlusal status of an individualwere found. ***Conclusion:***The insignificant results of 2D:4D ratio with all the parameters assessed validates that hormonal fingerprints could not be employed as an early predictor of caries and malocclusion in an individual.

Keywords: 2D:4D ratio, Caries, Hormonal fingerprints, Malocclusion.

Bangladesh Journal of Medical Science Vol. 20 No. 01 January'21. Page : 154-158
DOI: https://doi.org/10.3329/bjms.v20i1.50362

Introduction

Regardless ofenormous achievements in the oral health of populations globally, still there are several issues remaining in many communities all over the world, particularly among underprivileged groups in developed and developing countries. One of these major oral health issues is dental caries, affecting 60-90% of schoolchildren and the vast majority of adults.[1]Acommon complication of malocclusion is dental caries as it is difficult for patients to maintain good oral hygiene that results in the increases of plaque accumulation on the teeth surfaces and hence is more susceptible to caries development.[2]Malocclusion may not be life-threatening, but their high prevalence puts them in focus of public healthcare as it compromises the oral health and also can lead to psychological and social problems.[3] Hence, oral health diseases and disorders can negatively affect a child's life.

Currently, the so-called hormonal fingerprint also called second-to-fourth digit ratio (2D:4D ratio) has

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been a focus of research.Itis the relative length of the 4th digit compared to the 2nd digit andis found to be more steady, reproducible and reliable for each individual.Many studiesconfirm that 2D:4D ratio is sexually differentiated in humans-males tend to have lower ratio than females. The explanation for this sexual dimorphism is that men tendto have greater relative length of the ring finger as compared to their index finger. The main mechanism explaining this sexual difference is that the common genes Homeobox (Hox) A and Hox D are responsible for the development of digits and gonads. The steadiness of this digit ratio throughout the life is due to the timing of gene regulation which is constant. The other proposed mechanism is that finger ratio is a function of androgen sensitivity rather than androgen concentration, that is, the two digit ratio affected by exposure to androgens e.g., testosterone while in the uterus, and that this 2D:4D ratio can be considered a crude measure for prenatal androgen exposure, with lower 2D:4D ratios pointing to higher prenatal androgen exposure. These dissimilarities in the digit ratios are established by the 13th or 14th week of intrauterine life (second trimester) and exhibit substantial constancy over the lifetime.[4]

This ratiotends to vary among different ethnic groups, and surprisingly,this variation is far larger than differences between the sexes as shown in the study conducted by Manning *et al.*where in addition to the significant sexual dimorphism in 2D:4D, the mean ratios varied between the English, Scottish, Uygur, Han and Jamaican children.[5]

Objectives

Hence, this paper was undertakento study the correlation between 2D:4D ratio and dental caries and malocclusion prevalence inNorthern Province of Saudi Arabia, to identify caries and malocclusion prone individuals, so as to facilitate the prevention of these problems.

To our knowledge, this kind of procedure has not been investigated yet in any part of Saudi Arabia.

Materials and Method

Study duration:January 2018 to March 2018.

Ethical clearance:Local Committee of Bioethics (Approval no. 12-16-8/39) approved the study.

Sample population, size and characteristics:

A total of 100 children, 7–15 years of age and both genders, reporting to the College of Dentistry, Jouf University, Sakakawere selected by systematic random sampling method based on the following inclusion and exclusion criteria.

Inclusion criteria

- Children of the age range of 7 to 15 years,
- Children with no systemic illness, physical or mental disability, and
- Children not under any dental caries preventive program.

Exclusion criteria

- Children without parents' consent,
- History of taking any medication in the past two months, and
- Children under orthodontic therapy.

Physical examination and finger ratio measurement

The accompanying Parents/Guardianof the participantsduly signed individual informed consentformconsisting details about the aim of the study and the research procedures.

1. Clinical Examination:

WHO standard criteria mentioned in the WHO oral health proforma, 1997 was followed to record caries status (deft and DMFT). Two experienced examiners carried out a completeclinical examination. After making children comfortable on the dental chair, an oral examination was conducted using sterile mouth mirrors and explorers. Caries was entered as a pit and a fissure or a smooth surface that may be active or arrested lesion. The occlusal characteristics recorded were the molar relation, anterior and posterior crossbite, open/deep bite, and mandibular anterior crowding.Presences of either one or more of the above-mentioned traits were considered under malocclusion.

*2. Estimation of 2D:4D ratio:***(Figure 1 and 2)**

The 2D:4D ratiowas measured for all the children from the ventral proximal crease of the digit to the tipwith the help of digital vernier caliper wherein if multiple creases were present at the base of the digit then the measurement wastaken from the most proximal of these creases.The ratioswereexamined for the left and right hands.All the participants were categorized into high 2D:4D, equal 2D:4D digit and low 2D:4D ratio.

Statistical analysis

Data were analyzed with SPSS (Version 20, Chicago Inc.) using Pearson's correlation coefficient, Chi-Square test, and ANOVA. Statistical significance was set at $P \leq 0.05$.

Results

The study population was divided into children with 2D:4D ratio <1, =1 and >1 based on the ratio calculation. Out of 100 children, 34% were males and 66% were females. Most of the participants were 7-8 years old (12 males and 15 females) and least belonged to the age group of 14-15 years.**(Graph 1)**

Majority of the participants (80% for left hand and 87% for the right hand) had low 2D:4D ratio, only 6% for right and 11% for the left hand had high 2D:4D ratio and the remaining had equal ratio.**(Table 1)**

2D:4D with caries

ANOVA with Tukey's HSD revealed a statistically insignificant correlation between 2D:4D ratio and the deft/DMFT score of an individual. **(Table 2)**

2D:4D with occlusion

Among 100 children, 53% of them were identified with malocclusal characteristics. The Pearson's correlation and Chi-square test showed an insignificant correlation between 2D:4D ratio and occlusal status of an individual (p=0.401 for left hand and 0.700 for the right hand). **(Table 3)**

Discussion

In the past 5 years, many papers have documented the relations between 2D:4D and human traits and behaviors.[6]Being identified as a new risk marker in themedical field, 2D:4D digit ratio has been used to envisage manymedical diseases at a very early stage of life.In dentistry,the studies pertaining to the effect of hormonal fingerprint on oral health are very sparse[7] and this has led to an attempt that 2D:4D might be useful for the prediction of caries risk and malocclusion for the individual.

In the present study, most of the participants had low 2D:4D ratio for both the hands. Similar results were shown by Priyanka GND*et al.* (2016)[4]where the authors' conducted the study to focus on the role of hormonal fingerprints in the early detection of malocclusion, caries, the influence of Body Mass Index (BMI) on caries and malocclusion along with identifying the association of BMI with 2D:4D ratio. Overall, 300 children from both sexes of age group 10 and 15 years were selected and digital vernier caliper was used for the measurements. Their study showed that majority of the participantshad 2D:4D<1.

But unlike in the current study where insignificant results were found between 2D:4D ratio and caries and malocclusion status of an individual, Priyanka GND *et al.* (2016)[4] found that the rate of occurrence of malocclusion had a direct relationship with the ratio as the ratio increased with the increasing rate of malocclusion with a statistically significant p-value of <0.001. In relation to BMI, higher values were associated with normal occlusal conditions (p=0.041) and lower 2D:4D ratio (p=0.037). High caries incidence was observed in children with malocclusion. Hence, they concluded that 2D:4D ratiocould be used as an early predictor of the occurrence of malocclusionand BMI which in turn influences the caries index.

Similarly, the study conducted by Lakshmi CR*et al.* (2016)[8] on 500 children with the age range of 6 and 14 years from both sexes to evaluate the association between genetic taste sensitivity, dietary preferences, and salivary flow rate for identification of individuals at higher risk of developing dental caries proposed a positive relation between low 2D:4D ratio, non-tasters, sweet likers, and high caries index with a highly significant statistical difference. Verma P *et al.*(2013)[9]conducted a study to determine the correlation between 2D:4D ratio and caries riskin 250 children with age ranging from 6 to 16 yearsusing PROP (6-*n*-propylthiouracil) sensitivity test. They reported a positive correlation between low 2D:4D ratio, i.e. high prenatal androgen levels and high caries index in an Indian population.It was concluded that the hormones have an impacton taste perception and dietary preferences, which in turninfluence their caries index.

As shown in **Table 4**[4,8-10]that summarizes the studies conducted by different authors' to evaluate the association between 2D:4D ratio with various parameters pertaining to dentistry, all the studies obtained positive results which is inconsistent with the present study where all the parameters studies were found to be unassociated with 2D:4D ratio.

Limitations of the study

1. A larger population has to be evaluated to enhance the validity of the study.
2. Region-wise multi-centric research should be conducted in selected populations/geographic identical populations to eliminate various bias factors like nutrition, climate, and dietary habits.

Conclusion

The present research foundinsignificantoutcome between all the parameters evaluated. Thus, to conclude, the hormonal fingerprints cannot be used as predictors for identification of caries and malocclusion prone individuals.

Ethical Approval: Institutional ethical approval has been taken.

Conflict of interest: The authors declared no conflict of interest

Authors' contributions:

Data gathering and idea owner of this study: RI, FA, NP, MKA

Study design:RI, FA, NP, MKA

Data gathering: RI, FA

Writing and submitting manuscript:RI, FA, NP, MKA

Editing and approval of final draft:RI, FA, NP, MKA

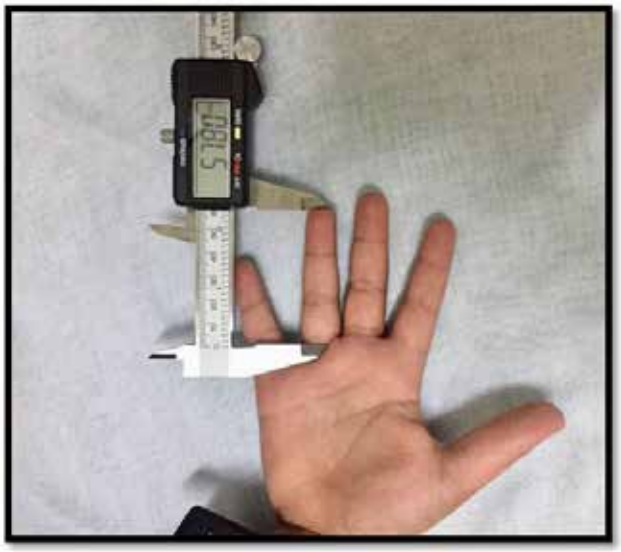

Figure 1. Measurement of 2D:4D ratio using digital vernier caliper

Graph 1. Age-Gender distribution of participants

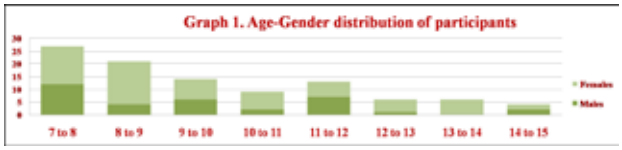

Figure 2. Three possible 2D:4D ratio outcome[4]

Table 1. Distribution in terms of gender and digit ratio

2D:4D ratio		Males (N=46)	Females (N=54)	Total	Chi square	
					Test value	P value
Right hand	High	9	8		1.29	0.523
	Equal	7	9			
	Low	30	37			
Left hand	High	3	8		0.207	0.902
	Equal	3	6			
	Low	28	52			

Table 2. Comparison between 2D:4D and Deft/ DMFT among the study population

2D:4D ratio		Deft	ANOVA		DMFT	ANOVA	
			Test value	P Value		Test value	P Value
Right hand	High	5	1.281	.282	5	0.118	0.889
	Equal	7			7		
	Low	88			88		
Left hand	High	11	1.188	.309	11	0.13	0.987
	Equal	9			9		
	Low	80			80		

Table 3: Comparison between 2D:4D and malocclusion among the study population

2D:4D ratio		Malocclusion		Total	Chi-Square test	
		Present	Absent		Test value	P Value
Right hand	High	2	3	5	0.713	0.700
	Equal	3	4	7		
	Low	48	40	88		
Left hand	High	4	7	11	1.826	0.401
	Equal	4	5	9		
	Low	45	35	80		

Table 4: Summary of the studies conducted to evaluate the association between 2D:4D ratio with various parameters

S. No	Author's Name	Year of Study	Parameters compared with 2D: 4D ratio	Result
1	Verma*et al.*[9]	2013	Caries Risk	Positive
2	Premkumar *et al.*[10]	2013	Mandibular growth	Positive
3	GND Priyanka *et al.*[4]	2016	Malocclusion and BMI	Positive
4	Lakshmi CR *et al.*[8]	2016	Caries risk and salivary flow rate	Positive
5	Present Study	2018	Caries risk and malocclusion	Negative

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