THE ASSOCIATION OF TOE DERMATOGLYPHICS WITH DENTAL CARIES AND BODY MASS INDEX IN CHILDREN: A CROSS-SECTIONAL STUDY

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ORIGINAL RESEARCH

ABSTRACT

BACKGROUND: Dermatoglyphics is the study of epidermal ridge patterns on the surfaces of fingers, toes, palms, and plantar regions. These ridges along with enamel develop from the ectoderm during the same gestational period. Since they share the same genetic information, dermatoglyphic can serve as a biomarker of dental caries in primary teeth. ***AIM:*** The aim of the present study was to assess the association between toe dermatoglyphic patterns and body mass index with the caries status of children between 3-6-years of age. ***METHODOLOGY****:* Based on the inclusion criteria and their def score, 85 children were divided into Group I (caries-free) and Group II (caries-prone) group. Toeprints were recorded using Cummins and Midlo method whereas height and weight of each participant was recorded for BMI calculation. ***RESULTS****:* A chi-square test for independence revealed that significant associations could be drawn between specific dermatoglyphic patterns with dental caries status and BMI. However, ANOVA and post-hoc Tukey HSD tests did not reveal a significant association between dermatoglyphics, dental caries status and BMI. ***CONCLUSION:*** This study concludes that toe dermatoglyphics can serve as a potential biomarker for primary teeth decay in children. The relationship between BMI and dental caries remains a subject for further exploration.

Keywords*:* Dermatoglyphics, Body Mass Index, Dental Caries, Pediatric Dentistry

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INTRODUCTION

According to the World Health Organization (WHO), over 530 million children have dental caries of primary teeth as of 2017.[1] The prevalence of early childhood caries (ECC) in India as of 2022 has been estimated to be 46.9%.[2] Based on these statistics, researchers

continuously try to explore factors that can act as predictors or determinants that can help in curtailing the spread of primary teeth decay. One such predictor is postulated to be dermatoglyphics.

The etymological meaning of the word dermatoglyphics is 'carving out of the skin'. This refers to the dermal ridges that are present on the palmar and plantar surfaces of hands and feet. Dermatoglyphics as a study was conceived in 1684 by Grew and was first used as a research intervention in India in 1880 by William Herschel. The term 'dermatoglyphics' itself was first coined in 1926 by Harold Cummins.[3,4]

The hypothesis that dental caries in primary teeth has a strong genetic influence was laid down in the 1970s. Metin Atasu is credited with conducting the first study to assess the association between dental caries and dermatoglyphics in 1992.[5]

Dermatoglyphic patterns then emerged as possible genetic markers for dental caries in primary teeth. This was strongly supported by the fact that both enamel and epithelium of ridges develop from the ectoderm between the 6^{th} to 7^{th} week of intrauterine life. The appearance of epidermal ridges at approximately 10^{th} to 11^{th} week of gestation represents the localized epithelial proliferation. This was first observed in 1976 by William J Babler.[6]

The information contained in the genome during this phase can well be dissipated. Any abnormal changes during this period can possibly be reflected in the tooth structure and development. Thus, dental caries in primary teeth, in addition to environmental factors can also have a genetic etiology.[6]

Carious lesions in primary and mixed dentition can directly affect their masticatory efficacy and alter their dietary habits. This can in turn affect their body mass index. Thus, the objective of this study was to explore the association between toe dermatoglyphics, dental caries and body mass index in children between 6-9 years of age. The reporting of this observation cross-sectional study is done in accordance with the STROBE guidelines.

MATERIALS AND METHODS

The study was carried out at a rural school in Sanand (Ahmedabad, Gujarat, India) in October 2023. Since the participants of this study were recruited from a school, a written consent was obtained from the school administration regarding the participation of the students in the study.

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Children between the age of 3-6 years were recruited for the study. The exclusion criteria were children with absence of toes, genetic disorders, mentally or physically handicapped, history or existing skin disorders, currently on chemotherapy or on antibiotics for 1 month or less, traumatic injury to the toes, and uncooperative children.

Sample size calculation was done using the formula $n=Z^2x\ p\ x\ (1-p)/E^2$ wherein the minimum sample size at a confidence interval of 95% (Z-score: 1.96) and at a margin of 5% and an estimated proportion of 0.265 was 75. The total sample of our study was 85.

Figure 1 Instruments used for the recording of toeprints and screening dental caries

The height and weight of children who met the eligibility criteria was then recorded for the calculation of body mass index (BMI) using the formula BMI = [weight(kg)/height(m^2)]. A quota sampling technique was then used where children were divided into a caries-free group (Group I: n=37) and a caries-prone group (Group II: n=48) based on their def assessment that was evaluated with mouth mirror and dental explorer by two different examiners (Figure 1).

Toeprints of the right toe were taken using the Cummins and Midlo's method. Children's toes were washed and cleaned with antiseptic lotion to remove all the dirt. Once they were dried, their right toes were firmly pressed against an ink pad. The toeprints were then recorded on a paper and analyzed with the help of a magnifying glass. Based on the analysis, the following patterns were recorded: fibular loop, arch with loop, plain whorl, arch with whorl, double whorl, plain arch, tented arch, and accidental.

All the data was then tabulated in Microsoft Excel and sent for statistical analysis (SPSS 20.0). Chi-square tests were used to determine the association between dermatoglyphic patterns and dental caries. Furthermore, ANOVA and post-hoc Tukey tests were used to assess the association of dermatoglyphic patterns with BMI.

RESULTS

Initially, 91 participants were screened for their caries status and BMI. However, five participants were excluded due to trauma to their toes and one participant was excluded for being on antibiotics. Thus, 85 participants were included for the study (Figure 2). The mean

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age of participants in the caries in Group I and Group II was 4.72 years and 4.99 years respectively.

Chi-square tests revealed specific dermatoglyphic patterns that showed significant corelation ($p<0.05$) with dental caries status and BMI. The patterns significantly associated with caries were fibular loop, arch with loop, tented arch, and accidental. The patterns that were significantly associated with BMI were fibular loop, plain whorl, plain arch, tented arch, and accidental (Table 1). ANOVA followed by post-hoc Tukey HSD tests revealed that no significant relation could be established between dental caries status and BMI (Table 2 and Table 3).

	Dermatoglyphic Pattern	Chi-square value	Df	p-value
DENTAL CARIES	Fibular loop	1.17	5	0.045
	Arch with loop	4.22	5	0.046
	Plain whorl	3.42	5	0.637
	Arch with whorl	0.76	5	0.976
	Double whorl	1.78	5	0.883
	Plain arch	3.84	5	0.573
	Tented arch	3.92	5	0.049
	Accidental	4.96	5	0.041
BMI	Fibular loop	1.84	10	0.049
	Arch with loop	4.9	10	0.94
	Plain whorl	4.24	10	0.046
	Arch with whorl	1.9	10	0.999
	Double whorl	2.61	10	0.991
	Plain arch	3.51	10	0.006
	Tented arch	3.64	10	0.047
	Accidental	5.68	10	0.048

Table 1 Corelation between specific dermatoglyphic patterns with Dental Caries and BMI

Group 1	Group 2	Mean Diff	p-adj	lower	upper
Healthy	Overweight	0.875	0.4067	-0.7644	2.5144
Healthy	Underweight	0.2	0.9	-1.4394	1.8394
Overweight	Underweight	-0.675	0.5425	-2.3144	0.9644

Table 2 Post-hoc Tukey test

	Mean BMI	SD	95% CI	p-value
Group I	0.4	0.55	(0.00,0.80)	0.177
Group II	1.5	1.05	(0.50,2.50)	
Total	0.9	0.99	(0.53,1.27)	

Table 3 ANOVA test

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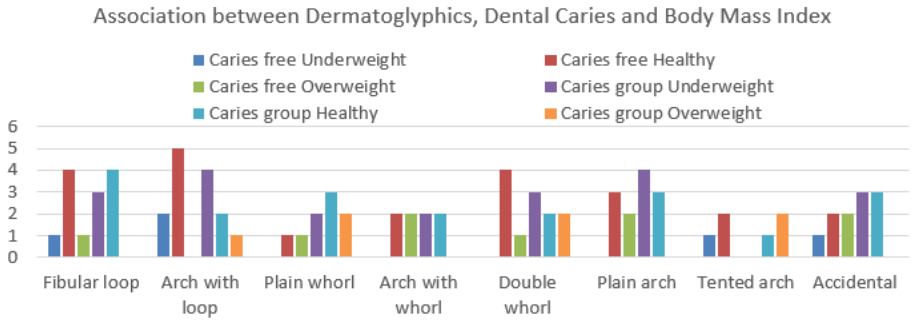

Figure 1 Distribution of samples as per their dermatoglyphic pattern, BMI, and caries status

DISCUSSION

Dermatoglyphics has been used in biology, medicine, and genetics as a potential biomarker in intrauterine anomalies and diseases like breast carcinoma, diabetes mellitus, Down's syndrome, multiple sclerosis, Alzheimer's disease. It has also been associated with disorders affecting the oral cavity like malocclusion, bruxism, periodontal diseases, and submucous fibrosis.[3] The purpose of this was to observe if a correlation could be drawn between caries-free and caries-prone children to their dental caries status when matched with their toe dermatoglyphic pattern.

Previous studies that have tried to establish a link between dental disorders and dermatoglyphics have mainly focused on the dermal patterns of fingers and palms. The novelty of this study is that the dermatoglyphic pattern taken into consideration is of the toe which is also of ectodermal origin.

Similar to fingers, dermatoglyphic patterns seen on the toes have a plain arch, tented, loop, and whorls. These are differentiated based on three primary landmarks that are observed in the ridge patterns. These are the core, triradii, and radiant. When two or more of these patterns present together, they are termed as accidentals, arch with loop, or arch with whorl, depending on the composite and complex pattern observed.[6]

Previous dermatoglyphic patterns have presented with contrasting results when it comes to determining which pattern shows a better correlation with dental caries in children. Based on the results of our study, the incidence of dental caries was higher in children with a loop pattern, specifically the fibular loop and arch with loop pattern. These results are similar to previous studies carried out by Navit et al.,[4] Shetty et al.,[7] Sengupta et al.[8] in children, but

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contrasting to some others that showed the whorl pattern to be significantly related to dental caries (Abhilash PR et al., Nezam et al., Uma et al., Shah et al.)[5,9,10,11] in children.

While specific toe dermatoglyphic patterns were associated with BMI of both groups, there was no correlation established between BMI and dental caries status. This result is in line with recent systematic reviews that have shown inconclusive relationship between BMI and dental caries status (Angelopoulou et al., Nicolau et al., Chen et al.).[12-14]

Apart from the universal academic shortcoming of not having a bigger sample size, this study has a few limitations. The use of ink for recording ridge patterns can often be inaccurate due to smudges and compromised ink quality. This in turn can compromise the interpretation of the dermatoglyphic pattern because of high subjectivity.

CONCLUSION

The conclusion of this study within all its limitations is that toe dermatoglyphic patterns can serve as a potential biomarker for primary teeth decay in children. However, the relation of BMI with dental caries and toe dermatoglyphics in children remains an area for further exploration.

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