Original Article

Association between Dermatoglyphics and Early Childhood Caries among Preschool Children: A Pilot Study

Abstract

Context: Primary teeth and dermal ridges form around the same time in utero. Hereditary and intrauterine factors affecting the formation of primary teeth may affect dermal ridge formation also. **Aims:** This pilot study was conducted to see the association between dermatoglyphics and dental caries among preschool children **Settings and Design:** Cross sectional, case–control design. **Materials and Methods:** One hundred, healthy preschool children aged 3–6 years attending private kindergarten participated. They were divided equally into caries active and caries free group based on the oral examination. The fingerprint patterns were collected for all the fingers of both hands of children and categorized as loop, whorl or arch for each finger of the right and left hand. **Statistical Analysis Used:** Statistical analysis was performed using the Chi-square test and Independent *t*-test to compare the dermatoglyphics patterns between the caries-free group and the caries active group for each variable. **Results:** (1) Dental caries susceptibility of an individual decreases with an increase in the incidence of loop pattern, followed by whorl pattern and arch pattern; (2) Left hand loop was found statistically significant (P = 0.03); (3) Presence of loop pattern in left hand thumb predicts significantly lower risk of caries, whereas the presence of arch pattern in left hand thumb predicts significantly high risk of early childhood caries (P = 0.01). **Conclusions:** The caries free status of a preschool child increased with the presence of loop on the left thumb.

Keywords: *Dermatoglyphics, early childhood caries, preschool children'*

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Introduction

The incidence of early childhood caries (ECC) among children with deciduous teeth was 1.76 billion in 2016 and was reported to be one of the top ten conditions with the highest incidence in the Global Burden of Diseases, Injuries, and Risk Factors Study 2016.[1] The World Health Organization (WHO) also recognized ECC to be prevalent in both developed and developing countries.[2] While it is thought to be highly prevalent in children of low socioeconomic strata; however, recently, it has been reported that ECC is not limited to children of low socioeconomic status.[3] In Malaysia, the prevalence of ECC among 5-year-old children was reported to be 75.2% in 2012[4] and is a cause for concern.

Recent research has suggested that the high prevalence of ECC could be attributed to enamel hypoplasia, a form of development al defect of enamel (DDE). It has also been suggested that enamel abnormalities are greatly influenced by extrinsic factors, especially such as maternal and infant factors, that may be local or systemic and could occur in antenatal, perinatal, or postnatal period.[5] While the DDE can increase the risk of development of ECC, a parallel transition toward modern diets and lifestyle changes are additional risk factors. The WHO recognizes that ECC is preventable by correct management of the common risk factors;[2] however, the identification of individuals with high risk of developing ECC would help in targeted preventive measures.

Dermatoglyphics was first introduced by Cummins and Midlo in 1926[6] and is a combination of two Greek words of "Derma" and "Glyph," which means "skin" and "carve" respectively. Since its introduction, dermatoglyphics has played a key role in medicine, forensics as well as dentistry due to its exceptional value in forecasting various illnesses as well as in solving criminal forensic cases.

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Dermatoglyphics is the scientific study of the unique, naturally occurring ridges that can be seen on the fingers, palms of hands, and soles of feet after birth. Once formed they are permanent if there is no serious injury which can alter the pattern of the ridges. The connection between the dermal patterns and primary teeth lies in the fact that the epidermal ridges of the fingers and palms as well as facial structures such as lip, alveolus, palate, and tooth bud also form from the same embryonic tissue (ectomesenchyme) during the same embryonic period (6–9 weeks).[7] Since the dermal patterns as well as the primary teeth form around the same time, any factors that influences the dermal pattern may also influence the tooth formation, especially the enamel, thereby possibly having an effect on the susceptibility of the individual to dental caries.

In the present world, the prevention of diseases has taken center stage and preventive dentistry is coming to the forefront to reduce the burden on the health-care infrastructure. In order to reduce the burden of dental caries, biological markers have been studied to identify individuals at risk of developing oral diseases.[8] There is a need for a noninvasive tool that would help in assessing the susceptibility of a child to ECC. Dermatoglyphics can be one such noninvasive tool. Previous research on the association of dermatoglyphic and oral conditions has been mainly conducted in the middle east and the Indian subcontinent with varied results.[9-13]

In Malaysia, as mentioned before, the prevalence of dental caries in preschool children is high. Hence, there is a need for a screening tool that can indicate the susceptibility of a child toward dental caries. To the best of our knowledge, no studies have been reported to see the association between dermatoglyphics and dental caries in preschool children among the Malaysian population. The aim of this pilot study was to assess the association between dermatoglyphics and ECC among preschool children.

Materials and Methods

After obtaining the approval from institutional ethical board, this case–control pilot study using purposive sampling, was conducted among selected private kindergartens in Melaka Tengah from April 2017 to February 2018. Since the study involved taking fingerprints of the children, prior consent was obtained from both the preschool authorities and the parents before commencing the study. All subject information obtained was kept confidential with the principal investigator.

Prior to commencement of the study, the co-investigators were trained and calibrated in recording dental caries using the WHO criteria[14] The inter-examiner and intra-examiner kappa coefficient was 0.8.

Parents of 3–6 years old children attending private kindergarten in Melaka Tengah, who had given consent for participation of their children in the study, were sent forms to collect the data on the bottle-feeding snacking pattern and oral hygiene measures of their children. All children with parental consent underwent intraoral examination on a portable dental chair at the preschool premises and infection control protocol was adhered to. All findings were recorded onto pedodontic charting form. As the children were examined, they were divided into caries active or caries free group. Since purposive sampling was used, examination was carried out till a sample of 50 caries active and 50 caries free children totalling a sample of 100 children was obtained. Normal, healthy children of both gender with ECC (dfs >0) based on the dfs index given by the WHO were grouped into caries active group while the others without any caries (dfs = 0) were grouped into caries free group. Children who were uncooperative, having permanent teeth, behavioral disorders, and skin diseases affecting fingerprints were excluded from the study.

Fingerprint recording

Fingerprints were recorded using the ink method as described first by Cummins and Mildo in 1943 to get clear smudge proof prints.[15] The hands of the children were thoroughly cleaned and allowed to dry. Each digit was checked for cleanliness and black duplicating ink was applied with a sponge head rolling paint brush. The most distal phalanx of each finger was then guided and pressed tightly against the fingerprint recording white paper which was clipped to a clip board placed on a table. The digits were rolled onto the paper from one end to the other to get a proper print. Sometimes, the impressions of the fingers were repeated up to three times to get the satisfactory smudge less fingerprints. The same procedure was repeated with the other hand. A total of 200 fingerprints were recorded from 100 participants. The prints were allowed to dry thoroughly and were analyzed with the help of magnifying glass (6xs).

A loop was documented as a series of ridges that enter the pattern area on one side of digit, recurves abruptly and leaves the pattern area on the same side. A single triradius is present, which is located laterally on the fingertip, where the loop is closed. A whorl varied from the loop in the feature of concentric arrangement of ridges, with two or more triradii in the latter. A whorl could be spiral, symmetrical, double looped, central-pocketed or accidental, depending upon the internal structure of the whorl pattern. While the arches had the simplest ridge pattern, created by the succession of one or more parallel ridges which crossed the finger from one side to the other without recurving. These patterns generally do not show the presence of triradii, apart from the tented arch is present that will have a triradii point near its midline.[16]

Data were entered in Microsoft Excel and were analyzed using the SPSS software version 12.0 (IBM SPSS ver 12.0, Chicago, IL, USA). Frequency and percentage were calculated to describe the demographic profile of

the children. Statistical analysis was performed using the Chi-square test and Independent *t*-test to compare the dermatoglyphics patterns between the caries active and the caries free groups. Odds ratio and its 95% confidence interval were also calculated. $P < 0.05$ was considered statistically significant.

Results

One hundred preschool children attending private kindergartens in Melaka Tengah participated in this pilot study. Most of the children were in the age group of 4–5 years and the sample was almost equally divided between both the genders [Table 1]. Comparison of independent variables that can influence dental caries, between the two groups was not found to be statistically significant [Table 2]. Loops were found to be the most common pattern in the left and right hand of both the groups followed by whorls [Figures 1 and 2]. The association between the fingerprint patterns of the right and left hand of caries active and caries free children was found to be statistically significant ($P < 0.05$) for the left hand only [Table 3]. Statistically significant association ($P < 0.05$) was found between left hand thumb whorl pattern and dental caries in preschool children [Table 4].

Discussion

The present pilot study conducted among 50 caries free and 50 caries active preschool children. It was observed that in this group of children, loops were the most common fingerprint pattern and presence of arch and whorl increased the risk of developing dental caries. We conducted this pilot study as the prevalence of ECC is high among Malaysian preschool children.

Dermatoglyphics are a living history of prenatal development.[17] They are unique to an individual and have many variations to it. Cummins first reported association of specific dermatoglyphics patterns in patients with down syndrome as far back as in 1939.[18] Since then dermatoglyphics has been used as a biomarker for conditions such as schizophrenia,[19] oral clefts,[20] diabetes,[21] and malocclusion.[16] Primary teeth formation starts around 6–8 week of intra uterine life (IUL). By the 5th month of IUL, the mineralization process of the enamel starts[22,23] and continues till the crown completion postnatally. The development of primary teeth is influenced by hereditary as well as well intrauterine factors and while the postnatal environmental factors do play a role in causation of ECC, their effect is of relatively short duration on the primary teeth as compared to that on permanent teeth. The dermal ridges start forming around 10–12 weeks IUL, and by 24 weeks, they have adult morphology. Dermal ridges have a heritable component, but part of the morphology of the dermal patterns is under the influence of intrauterine environmental factors.[17,19] As both primary teeth as well dermal ridges are formed around the same prenatal period and are affected by intrauterine factors, there could be an association between ECC and finger patterns.

ECC is known to develop in the presence of poor oral hygiene and intake of sugary foods.[3] In the present pilot study, risk factors commonly associated with ECC, namely bottle feeding, snacking pattern, and oral hygiene factors were not found to be significant between the two groups. One factor that could possibly explain this finding is the presence of DDE in the primary teeth of the caries active preschool children. In caries active children, the presence of DDE in the primary teeth could cause a defect in the enamel predisposing them to ECC[5] compared to caries free children who probably did not have DDE while the other factors, namely snacking, oral

Table 1: Sociodemographic profile of the sample (*n*=100)

Variables	*n* (%)
Age	
3	9 (9.00)
4	42 (42.00)
5	31 (31.00)
6	18 (18.00)
Gender	
Male	53 (53.00)
Female	47 (47.00)
Ethnicity	
Malay	63 (63.00)
Chinese	31 (31.00)
Indian	6 (6.00)

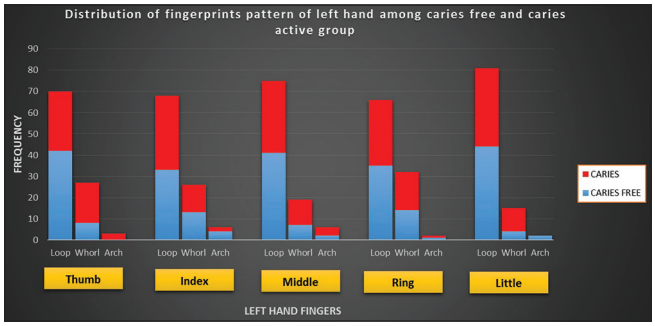

Figure 1: Finger print pattern in the left hand

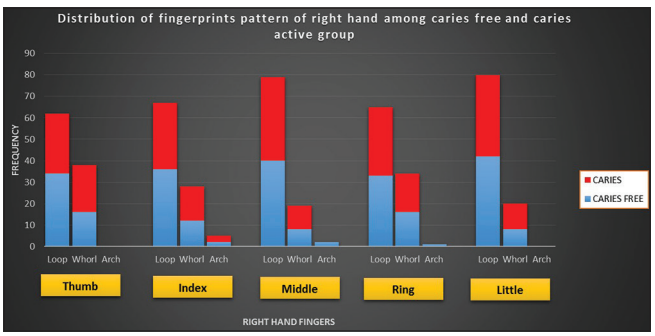

Figure 2: Finger print pattern in the right hand

Table 2: Association between bottle feeding, tooth brushing, and snaking per day with caries active and caries-free children

Variables	*n*	Caries active, *n* (%)	Caries free, *n* (%)	OR (95% CI)	*P**
Bottle-feeding					
Yes	55	28 (50.91)	27 (49.09)	1.08 (0.49-2.38)	0.84
No	45	22 (48.89)	23 (51.11)	Reference	Reference
Toothbrushing per day					
Once	22	10 (45.45)	12 (54.55)	Reference	Reference
Twice	64	33 (51.56)	31 (48.44)	1.28 (0.48-3.38)	0.62
Thrice	14	7 (50.00)	7 (50.00)	1.20 (0.31-4.59)	0.79
Snacking per day					
None/weekly	25	9 (36.00)	16 (64.00)	Reference	Reference
Once	49	27 (55.10)	22 (44.90)	2.18 (0.81-5.88)	0.12
Twice	16	10 (62.50)	6 (37.50)	2.96 (0.81-10.87)	0.10
Thrice	8	4 (50.00)	4 (50.00)	1.19 (0.26-5.34)	0.82
Frequent	2	0	2 (100.00)		

*Significance level: $P<0.05$; Chi-square test. OR: Odds ratio; CI: Confidence interval

Table 3: Association of different types of fingerprints between caries active and caries free group (*n*=50)

Variable	Caries active		Caries free		Statistical significance (*P*)*
	Mean	SD	Mean	SD	
Right hand					
Loop	3.36	1.79	3.68	1.33	0.31
Whorl	1.58	1.82	1.20	1.28	0.23
Arch	0.06	0.24	0.12	0.48	0.43
Left hand					
Loop	3.26	1.70	3.90	1.15	0.03*
Whorl	1.46	1.73	0.92	1.16	0.07
Arch	0.28	0.76	0.18	0.56	0.46
Both hands					
Loop	6.62	3.24	7.58	2.11	0.08
Whorl	3.04	3.37	2.12	2.14	0.11
Arch	0.34	0.87	0.30	0.86	0.82

*Significance level: $P<0.05$; Chi- square test. SD: Standard deviation

hygiene, and bottle feeding were not significant. Evaluation of DDE was not the aim of this pilot study.

Dermatoglyphics can be a user-friendly and a noninvasive screening tool for ECC. In order to replicate its usage as a screening tool and to test the ease of its usage in preschool children, the data related to dermatoglyphics were collected using Cummin and Midlo method of fingerprint recording using black duplicating printing ink. Recording fingerprints in this group of children were easy as the children did not perceive it as a scary technique.

In the present study, 200 dermatoglyphics patterns of 100 children were analyzed. Loops were the most common fingerprint pattern observed and arches were the least. In the caries free group, there were no arches recorded. These findings are consistent with previous studies where, caries free individuals were found to have greater frequency of loops.[7,10,24]

Caries-free children were found to have more loops on the left hand compared to the caries active children, and this difference was statistically significant ($P = 0.03$). Further, analysis of all the fingerprints of the left hand showed that the presence of loop on the thumb was statistically significant among the caries-free children compared to caries active children. The presence of whorl on the left thumb increased the risk of having ECC (odds ratio - 3.56). Increase risk of dental caries with presence of whorls has been reported in previous studies.[10,12,24] However, not many studies have shown the association between fingerprint pattern specific to a particular finger of a hand, as we found in our pilot study. In a previous study[25] done among Indian children aged 3–6 years, it was reported that the presence of whorl on the ring finger of the right hand was associated with lower risk of caries. This difference seen between our study and the Indian study could be related to the ethnic variation. Babler[17] showed that there is a great difference between various populations as related to the growth of specific epidermal ridges, this could account for the difference seen between our study and study by Navit *et al.*[25]

Limitation

Since our study is a pilot study, it was limited to a small geographical area, and hence, the results cannot be generalizable at this stage. The data collected on key risk factors such as tooth brushing, snacking pattern, and bottle feeding were through an open-ended questionnaire, which has its inherent bias.

Conclusions

Based on the results of this pilot study, loops were the most prevalent pattern for both groups. The presence of loop on left hand thumb indicates lowest risk of dental caries. The presence of whorl on left hand thumb indicates high risk of dental caries. Therefore, fingerprint recording can be a potential, inexpensive, noninvasive tool for ECC screening.

The results of this pilot study are promising for this population, to use dermatoglyphics as a screening tool for

Table 4: Association of individual fingerprint patterns of the left hand among caries and caries-free group of preschool children attending private kindergartens in Melaka Tengah

Variable	*n*	Caries active, *n* (%)	Caries free, *n* (%)	OR (95% CI)	*P**
Left hand					
Thumb					
Loop	70	28 (40.00)	42 (60.00)	Reference	Reference
Whorl	27	19 (70.37)	8 (29.63)	3.56 (1.37-9.25)	0.01*
Arch	3	3 (100.0)	0	NA	NA
Index					
Loop	68	35 (51.47)	33 (48.53)	Reference	Reference
Whorl	26	13 (50.0)	13 (50.0)	0.94 (0.38-2.33)	0.90
Arch	6	2 (33.33)	4 (66.67)	0.47 (0.08-2.75)	0.39
Middle					
Loop	75	34 (45.33)	41 (54.67)	Reference	Reference
Whorl	19	12 (63.16)	7 (36.84)	2.07 (0.73-5.83)	0.17
Arch	6	4 (66.67)	2 (33.33)	2.41 (0.42-13.98)	0.31
Ring					
Loop	66	31 (46.97)	35 (53.03)	Reference	Reference
Whorl	32	18 (56.25)	14 (43.75)	1.45 (0.62-3.39)	0.39
Arch	2	1 (50.0)	1 (50.0)	1.93 (0.07-18.82)	0.93
Little					
Loop	81	37 (45.68)	44 (54.32)	Reference	Reference
Whorl	15	11 (73.33)	4 (26.67)	3.27 (0.96-11.13)	0.06
Arch	4	2 (50.0)	2 (50.0)	1.19 (0.16-8.86)	0.87

*Significance level: $P<0.05$; Chi-square test. OR: Odds ratio; CI: Confidence interval; NA: Not available

ECC and to help institute-targeted preventive measures. A larger scale study needs to be conducted in this age group keeping in mind all the confounding factors as well as recording DDE to confirm the association of dermatoglyphics with ECC.

Ethical clearance

Research and ethics approval - MMMC/FOD/AR/B5/EC-2017 (03).

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Conflicts of interest

There are no conflicts of interest.

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