

Correlation between dermatoglyphics and dental caries in children: A case-control study

Kishore kumar Singh¹, Kumari Menka², Kumar Anand³, Aashana Goel⁴,
Abhishek Dontulwar⁵, Jagadish Prasad Rajguru⁶

¹Department of Psychiatry, Nalanda Medical College, Patna, Bihar, ²Private Practitioner, Department of Pedodontics and Preventive Dentistry, Patna, Bihar, ³Department of Dentistry, IGIMS, Patna, Bihar, ⁴Department of Pedodontics and Preventive Dentistry, Adesh Institute of Research and Dental Sciences, Bathinda, Punjab, ⁵Department of Prosthodontics, Crown Bridge and Implantology, Dr Rajesh R. Kambe Dental College and Hospital, Akola, Maharashtra, ⁶Department of Oral and Maxillofacial Pathology, Hi-Tech Dental College and Hospital, Bhubaneswar, Odisha, India

ABSTRACT

Background: Dental caries is a microbiological disease affecting teeth which has both genetic as well as environmental factors. Dermatoglyphics is the study of fingerprint patterns and is also genetically determined. This study is aimed to determine a correlation between dermatoglyphic patterns and caries susceptibility among children. **Methods:** A total of 250 children (125 each of case and control groups) were selected. Dental caries status was evaluated using the DMFT index while dermatoglyphic study was performed by recording impressions using stamp pad-ink method. **Results:** Higher frequency of all dermatoglyphic patterns was observed among female subjects with caries as compared to caries-free subjects as well as compared to male subjects. **Conclusion:** Dermatoglyphics can be employed as a positive indicator of caries susceptibility among children and holds importance in the area as future caries predictor.

Keywords: Children, dental caries, dermatoglyphics

Introduction

Dental caries is considered to bear a multi-etiological basis wherein both environment and genetics play an important part.^[1] Cummins and Midlo in 1926 coined the term “Dermatoglyphics” (Gr. derma; skin, carve; carving). Failure of nerve shoots to grow into the epithelium is manifested as dermatoglyphic aplasia.^[2]

Dermatoglyphics is the “study of dermal ridge patterns on volar surfaces of fingers, palms, and soles.” Formation of ridges initiates in 13th week of prenatal life, while the formation of patterns is

completed by 19th weeks of development. The formation of ridge is influenced by neurovascular bundles present between epidermis and dermis during prenatal development while the ridge patterns are influenced by inadequate oxygenation, unusual sweat gland distribution, and epidermal growth alterations. These ridges are indicators of intrauterine dental abnormalities in sixth to seventh week of development. Individuals with plain loop, double loop, whorled arch, tented arch, and central pocket loop have demonstrated dental caries susceptibility. Any deviation in dermatoglyphic patterns is indicative of dental caries susceptibility.^[3]

Gallon in 1892 classified ridge patterns of distal phalanges into three basic types: whorls, loops, and arches. A) Arch pattern: This constitutes the simplest form of pattern. Types of arch patterns include: i) Simple or plain arch pattern: This comprises

Address for correspondence: Dr. Kishore kumar Singh, Department of Psychiatry, Nalanda Medical College, Patna, Bihar, India.

E-mail: drkksingh2013@gmail.com

Received: 18-01-2020

Revised: 12-03-2020

Accepted: 26-03-2020

Published: 30-06-2020

Access this article online

Quick Response Code:



Website:
www.jfmprc.com

DOI:
10.4103/jfmprc.jfmprc_108_20

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: WKHLRPMedknow_reprints@wolterskluwer.com

How to cite this article: Singh KK, Menka K, Anand K, Goel A, Dontulwar A, Rajguru JP. Correlation between dermatoglyphics and dental caries in children: A case-control study. J Family Med Prim Care 2020;9:2670-5.

of ridges crossing fingertips from one to another side without curving; ii) Tented arch pattern: This pattern is characterized by a point of confluence termed as “triradius” as the ridges radiate from this point to three directions. This triradius is localized near midline axis of distal phalanx; B) Loop pattern: It is the most common ridge pattern. In this, ridges enter on one side, undergo abrupt recurve, and leave on the same side. If the ridge opening is on ulnar side, the loop is called “ulnar loop”; if it opens on a radial side, it is called “radial loop.” The triradius is laterally located on one side where loop has closed end. These may vary in size and shape or may be plain or double loops; C) whorls: This pattern contains two or more triradii. Henry in 1973 used the “whorl” for ridged encircling core. He designated more complex patterns as “composites.” The “concentric whorl pattern” is arranged as succession of concentric elliptical rings. “Double or spiral whorl pattern” is seen as spirals around a core either in clockwise or anti-clockwise direction. Complex patterns comprised of triradii and whorls are termed as “Accidentals.” Sometimes, configurations composed of loop or whorl or triple loops can also be classified as “Arch with loop” and “Arch with whorl.”^[2]

The dermatoglyphics also plays an important role in forensic sciences and is used to identify unknown fingerprints of individuals. Three types of fingerprints are technically studied in addition to morphological types such as plastic impressions (made in soft material like butter, soap, etc.), visible prints (prints made when fingers have been covered in blood, dirt, oil, paint, etc.), and latent prints (prints not visible to the human eye, hidden, unseen until treated). Automated fingerprint identification system scan is used in various setups. Fingerprints are put into a computer database, which transforms them into digital minutiae. This is then used to identify unknown prints with several possible matches. In the end, a technician still makes the final ID of the unknown to the known print.^[4]

Data pertaining to dermatoglyphics can be used to study genetic predisposition of few diseases including dental caries.^[1]

This study aimed toward determining a correlation between the dermatoglyphic patterns and dental caries prevalence in primary dentition bearing children.

Materials and Methods

This was a case-control study comprising of 250 primary dentition bearing children who were selected based upon the following exclusion criteria: 1) absence of digits, 2) genetic disorders, 3) subjects undergoing chemotherapy, 4) mentally or physically handicapped subjects, 5) subjects with skin disorders, 6) trauma to finger-tips, and 7) uncooperative children. The study protocol was approved from institutional ethical committee on 07/03/19. Of these, 125 subjects belonged to case study group (with dental caries) while control group (caries-free) also comprised of 125 subjects. Prior to data collection, informed written consent was obtained after explaining the study. Clinical

oral examination was performed using mouth mirror and probe. The caries status was recorded as DMFT index score.

For recording fingerprints, the method employed by Sanghavi *et al.* (2016) was used.^[5] Prior to recording fingerprint patterns, hands were washed using soap and water and allowed to air-dry. Following this, the fingers were pressed onto inked stamp-pad and uniform pressure was applied by using a roller. Print patterns were recorded on an A4-sized white paper.

Finger-prints of all five digits were made using a stamp paper and ink on an A4-sized white sheet. These prints were studied using magnifying lens. The fingerprints were analyzed as per standard classification. Fingerprint patterns were classified as: a) whorl pattern, b) loop pattern, subclassified into i) ulnar and ii) radial loops, and c) arch pattern, which was subdivided into i) plain and ii) tented arch patterns. Other patterns were double loop whorls, central pocket whorls, and accidental whorls [Figure 1].

Data obtained was recorded in Microsoft Excel Worksheet and statistical analysis was performed using “T-test.” A *P* value of < 0.05 was considered to be significant.

Results

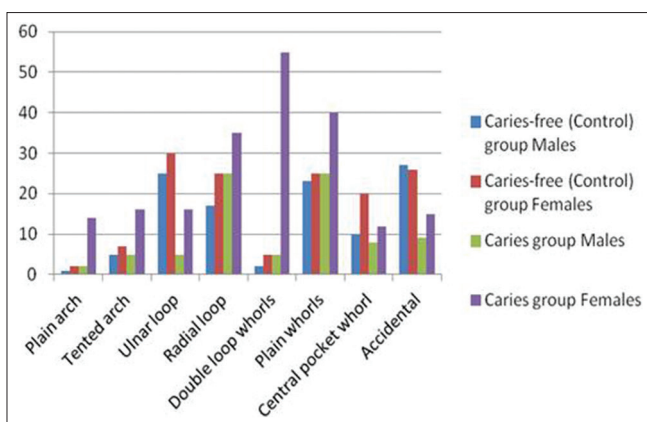
Distribution of dermatoglyphic patterns and dental caries was noted as a) dental caries and whorl patterns; b) dental caries and loop patterns; c) dental caries and arch patterns; d) dental caries and accidental pattern; e) dental caries and double loop whorls; and f) dental caries and central pocket whorl patterns [Graph 1]. All female subjects showed a higher distribution of fingerprint patterns among females than male subjects [Table 1].



Figure 1: Different fingerprint patterns

Table 1: Dermatoglyphic patterns' distribution in carious and caries-free children

Fingerprint patterns	Caries-free (Control) group		Caries group	
	Males	Females	Males	Females
Plain arch	01	02	02	14
Tented arch	05	07	05	16
Ulnar loop	25	30	05	16
Radial loop	17	25	25	35
Double loop whorls	02	05	05	55
Plain whorls	23	25	25	40
Central pocket whorl	10	20	08	12
Accidental	27	26	09	15
Total numbers	110	140	90	160

**Graph 1:** Graph depicting dermatoglyphic pattern distribution among study and control groups

Discussion

Dental caries is a multi-factorial oral disease which is characterized by demineralization of inorganic and destruction of organic contents of teeth.^[6]

Fingerprints are unique to an individual because they are genetic characteristics of growth and are tailored individually.^[7] Genetically regulated processes that influence dental caries include enamel structure, eruption, morphology of teeth, salivary composition and flow, and immune response.^[8] The genetic basis of dental caries has been proven by twin studies on caries susceptibility and studies on inherited enamel variations.^[9]

The first appearance of epidermal ridges takes place at approximately 10th to 11th week of gestation which represents localized epithelial proliferations. This was first described by William J Babler in 1976. Characteristic ridge patterns' formation takes place during primary ridge formation. At around 14 weeks, this primary ridge formation ceases while secondary ridges start to form at around 14 weeks of intrauterine development.^[8] Secondary ridges are modified sebaceous glands on apex of primary ridges located at fixed intervals. Thus, dermatoglyphics is now considered to be an important

tool in understanding diseases with genetic backdrop.^[10] These fingerprint patterns after completion remain unaffected by environmental factors, thus establishing their role as an ideal identification marker. Genetic disorders with proven association with dermatoglyphics include cleft lip and/or palate, hereditary ectodermal dysplasia, malocclusion, bruxism, and Ellis–Van Creveld syndrome.^[11] Dermatoglyphics has been considered to be “window of congenital abnormalities” and is an indicator of both dental and systemic intrauterine abnormalities.^[12] Traditionally, dermatoglyphics plays a significant role in forensics by aiding in an individual's identification. Recently, it has found its usage in Dentistry due to association with diseases such as periodontitis, Down's syndrome, dental caries, malocclusion, etc.^[13,14]

There are three types of finger-print patterns: a) Visible prints: These are also known as “patent prints” as they are visible to naked eye; b) Latent prints: These are not apparent to the naked eye and are made visible by dusting or uses of fuming and chemical agents; and c) Plastic or impressed prints: These prints are indentations left upon soft and pliable surfaces like wax, clay, etc., These are visible to naked eye as well.^[8] As per FBI identification division of 1957, fingerprints are of the following types:^[15]

1. Arch pattern: It is found in approximately 5% of general population. It can be subclassified into a) Type 1: Plain arch and b) Tented arch.^[15]
2. Loop pattern: It is found in approximately 70% of total population. This can be subclassified into a) Type 1: Ulnar and b) Type 2: Radial loop pattern.^[15]
3. Whorl pattern: It is seen in 25% of population. It can be subclassified into a) Type 1: Double loop pattern; b) Type 2: Plain; c) Type 3: Central pocket; and d) Type 4: Accidental patterns.^[15]

There are three landmarks in fingerprint patterns: a) Triradii, b) Cores, and c) Radiant.^[2]

- a. Triradii: This is formed by meeting of three ridge systems, the center of which is termed as “triradial point” with an approximate angulation of 120°.
- b. Core: This forms the center of a pattern and is of two types: i) In loop pattern: The core is represented by straight ridge or two or more parallel ridges and b) In whorl pattern: The center looks like a lot or a circle or and ellipse.
- c. Radiant: These are formed by ridges moving outwards from triradius.

Methods used in recording fingerprint patterns include^[15]

- a. Ink method: This is the most commonly used technique which uses an inking slab, paper, ink, and roller.
- b. Farrot inkless method: In this method, a commercially available patented solution and a special paper are used.
- c. Transparent adhesive tape method: Herein, a fingerprint is recorded by application of dry colored pigment and lifting the print using a transparent adhesive tape. These pigments may be carbon paper, carbon or India ink, powdered graphite, etc.^[15]

- d. Photographic technique: This technique is based upon utilization of total internal reflection obtained by pressing an object over prism surface. The image magnification is then photographed using a polarized camera.
- e. Biometrics: This method uses automatic machines for scanning fingerprints and recording them.^[16]

In addition, there are other special techniques such as radiodermatography (here, the correlation between print pattern and underlying bone is assessed) and hygrography (it is the study of pores).

There are certain limitations in studying fingerprint patterns, i.e. 1) Good quality ink has to be used for interpretation of prints, 2) Adequate quantity of ink should be dispensed for uniform ink recording, and 3) Malformations in fingers or extremities can affect proper print pattern recording.^[16]

Metin Atasu in 1992 compared dermatoglyphic patterns between caries-free and caries affected students and found that those with caries had more whorl pattern as compared to caries-free students who had more of ulnar loop pattern.^[17,18] Ahmed *et al.* found ulnar loop patterns more frequently in caries-free group while the whorl pattern was most common in carious subjects.^[19] Sharma and Somani also observed an increased frequency of ulnar loops in caries-free children.^[20]

Sharma *et al.* demonstrated the prevalence of whorl pattern in caries subjects while the loop pattern was more seen in caries-free subjects. The whorl pattern showed a significant correlation with *S. mutans* ($P = 0.4$) and *Lactobacilli* ($P = 0.015$) counts in the caries group. It was also established by this study that more than four numbers of whorls were a moderate while less than six number of loops carried good caries prediction.^[21]

Shetty *et al.* conducted a study on 168 students to evaluate the association between dermatoglyphics, dental caries, and oral hygiene status. A statistically significant association was seen between the dermatoglyphics and dental caries experience ($P < 0.05$). Loop pattern was associated with high DMFT score. Individuals with arch pattern were found to be caries-free. Association of dermatoglyphics with plaque index scores did not reveal statistically significant results.^[22]

Asif *et al.* evaluated dermatoglyphics in 400 deaf and mute children with or without caries. They found that the arch pattern was most commonly found though it was statistically nonsignificant. Among females of both study groups, arch pattern was the most common followed by loop while among males, arch pattern was more frequent in caries-free group while in caries group, arch pattern was most commonly reported followed by loop pattern.^[23]

Veeresh recorded the DMFT (decayed, missing, filled teeth) score of 300 female subjects within the age group of 18–25 years and

accordingly divided into 3 groups of 100 each: group 1 (DMFT score = 0), group 2 (DMFT score <5), and group 3 (DMFT score ≥ 5). The mean salivary pH was least in group 3. It was evaluated that the predominant dermatoglyphic pattern observed in groups 1 and 2 was loop pattern, whereas, in group 3, whorl pattern was predominant.^[24]

A study conducted by Navit *et al.* in early childhood caries showed that the “whorl” finger-print pattern was more prevalent in caries-free children and the subjects with early childhood caries did not demonstrate a significant predilection for any one of the ridge patterns.^[6] Thakker *et al.* showed a statistically significant increase in whorl frequency in children with dental caries experience.^[25] Anitha *et al.* concluded that an increase in ulnar loops in caries-free and whorls in children with dental caries.^[26]

Sengupta *et al.* in their study on 200 children diagnosed with dental caries and 100 without dental caries showed that among male subjects, a significant decrease in whorl pattern was seen in non-carious; however, opposite was observed among female subjects. In females, significantly less numbers of ulnar loops were seen in caries group, while no statistically significant observation was seen among male subjects.^[27]

Archana *et al.* reported whorl pattern in 50.8%, ulnar loop in 45.2%, radial loop in 3.2%, and arch pattern in 0.8% in dentulous subjects, while in edentulous subjects, an overall reduction in ridge pattern was seen as whorl (49.8%), ulnar loops (37.4%), and radial loops (2.8%) while arch pattern increased to 10%.^[28]

Srilatha *et al.* showed significant as well as a positive correlation of dental caries with *S. mutans*, while ulnar loops and total ridge count demonstrated negative correlation.^[29]

Chinmaya *et al.* showed a higher prevalence of dental caries in subjects with whorl pattern with comparison to other patterns, while subjects with loop pattern demonstrated lowest dental caries prevalence. This was found to be statistically significant ($P < 0.05$). The whorl pattern subtypes of central pocket whorl along with terminal loop showed maximum caries prevalence.^[30]

Erkatehy and Sheta reported an increase in whorl frequency and reduction in loop frequency in caries group on comparison with caries-free group.^[31]

Sanghavi *et al.* also observed high whorl pattern numbers in carious subjects, while a greater numbers of loop pattern was seen in caries-free subjects.^[5]

Nallanchakrava *et al.* in their dermatoglyphic analysis in specially-abled subjects with dental caries found a higher number of “loop patterns” when compared to control group.^[32]

Upadhyaya *et al.* concluded in their study more frequency of whorls in caries group than in caries-free group. The loop and

arch patterns were more frequent in caries-free subjects than in control group.^[33] Deepti *et al.* reported that the loop pattern was most prevalent in subjects with dental caries followed by whorl pattern, while the ulnar loop pattern was common in both caries—positive as well as control subjects.^[34] In addition, Sharma and Somani demonstrated a higher prevalence of loop pattern in caries-free subjects than in subjects with dental caries.^[35]

Implications for Clinical Practice

Dermatoglyphics has proven to be a very useful, noninvasive, and economical tool for the preliminary diagnosis of diseases of suspected genetic origin like dental caries. An association of dermatoglyphics and dental caries may be helpful in identifying the possible genetic predisposition and early prediction of dental caries in children, so as to initiate oral health measures at an early stage.^[36] Both dermatoglyphics and dental caries are genetically determined diseases; hence, studies on their correlation have been focused upon so as to ascertain it as a positive indicator of disease. This paper adds data on dental caries prevalence and dermatoglyphic pattern among pediatric subjects. Although there is some contradictory data available, the evidence of such makes it more the reason why such studies should be carried out.^[37]

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patients have given their consent for their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

- Shinkaruk-Dykovytska M, Borisenko A. Local administration-territorial specificity dermatoglyphics of men in Ukraine affected by caries at various levels of intensity. *Curr Issues Pharm Med Sci* 2015;28:51-4.
- Ramani P, PR Abhilash, Sherlin HJ, Anuja N, Premkumar P, Chandrasekar T, *et al.* Conventional dermatoglyphics-Revived concept: A review. *Int J Pharm Bio Sci* 2011;2:446-58.
- Chandrasekaran S, Chellammal R, Ganapally DM. Dermatoglyphics: A tool in dentistry. *J Adv Pharm Edu Res* 2017;7:248-52.
- Sharma A, Sood V, Singh P, Sharma A. Dermatoglyphics: A review on fingerprints and their changing trends of use. *Chrised J Health Res* 2018;5:167-72.
- Sanghavi PH, Soni HK, Joshi MU. Correlation of dental caries and dermatoglyphics in pediatric cases. *Ind J Dent Sci* 2016;8:131-4.
- Navit S, Chadha D, Khan SB, Singh RK, Johri M, Navit P, *et al.* The mystery of handprints assessment and correlation of dermatoglyphics with early childhood caries: A case-control study. *J Clin Diagn Res* 2015;9:Z44-8.
- Mittal M, Puri A, Gupta R, Nangia R, Sachdeva A, Guleria M. Dermatoglyphics and dental caries: A comparative study in Sikhs and Non-Sikh population. *Ind J Forens Odontol* 2013;6:81-6.
- Abhilash PR, Divyashree R, Patil SG, Gupta M, Chandrashekhar T, Karthikeyan R. Dermatoglyphics in patients with dental caries: A study on 1250 individuals. *J Contemp Dent Pract* 2012;13:266-74.
- Somani R, Gupta MP, Jaidka S, Singh DJ, Puri V, Kumar D. Dermatoglyphics as a noninvasive tool for predicting dental caries in cerebral palsy and healthy children: An *in vivo* study. *Int J Cl Pediatr Dent* 2019;12:237-42.
- Chand SC, Parmar HR, Patel JKL, Bathvar AK, Garasiya MK, Nisarta PK. Praiseworthiness of dermatoglyphics in determining dental caries vulnerability among Gujarati children: A cross-sectional study. *Nat J Comm Med* 2018;9:453-7.
- Kaur K, Mahajan N, Singh A, bansal S, Kaur R. Dermatoglyphic patterns in children with dental caries: An *in vivo* study. *Ind J Dent Sci* 2018;10:16-20.
- Khokar V, Tarannum G, Pathak A. dermatoglyphics interpretation of dental caries: An *in vivo* study. *Ind J Dent Med Res* 2015;1:54-6.
- Chandrasekaran S, Chellammal R, Ganapathy DM. Dermatoglyphics: A tool in dentistry. *J Adv Pharm Edu Res* 2017;7:248-52.
- Shetty SS, Li GSM, Babji NAB, Yusof LSBM, Yang NNJ, Jun TD, *et al.* Dermatoglyphics: A prediction tool for malocclusion. *J Datta Meghe Inst Med Sci Univ* 2019;14:27-30.
- Thaker M, Dodiya D. Dermatoglyphics and its relation with various dental diseases. *Int J Adv Sci Engineer Tech* 2017;5:11-6.
- Kaur V, Kaur TP, Sharma M, Yadav T, Malhotra A. Dermatoglyphics, the hidden potential in dentistry- A review. *J Adv Med Dent Sci Res* 2018;6:110-3.
- Jain G. "Dermatoglyphics"- The science of lines and patterns and its implications in dentistry. *Int J Contemp Med Res* 2016;3:2973-7.
- Metin Atasu. Dermatoglyphic findings in dental caries: A preliminary report. *J Clin Pediatr Dent* 1998;22:147-9.
- Ahmed RH, Aref MI, Hassan RM, Mudrammed NR. Dermatoglyphic study on patients with dental caries while wearing dental fillings and its correlation to apoptosis that induced by using dental fillings. *Nature Sci* 2010;8:54-7.
- Sharma A, Somani R. Dermatoglyphic interpretation of dental caries and its correlation to salivary bacteria interactions: An *in vivo* study. *J Ind Soc Pedod Rev Dent* 2009;27:17-21.
- Sharma R, Singh NN, Sreedhar G. Dermatoglyphic findings in dental caries and their correlation with salivary levels of *Streptococcus mutans* and *Lactobacillus* in school-going children in and around Moradabad. *J Oral Maxillofac Pathol* 2018;22:360-6.
- Shetty SS, Saran R, Swapna BV, Shetty S. Association of dermatoglyphics with dental caries and oral hygiene status. *SRM J Res Dent Sci* 2018;9:29-31.
- Asif SM, Lahig AR, Babu DBG. Dermatoglyphics: A tool in detection of dental caries. *Br J Med Medic Res* 2016;12:1-5.

24. Veeresh T. Correlation between dermatoglyphics, dental caries and salivary pH: An *in vivo* study. *Ethiop J Health Sci* 2019;29:929-34.
25. Thakker VP, Rao A, Rastogi P, Shenoy R, Rajesh G, Mithun Rai BH. Dermatoglyphics and dental caries: A cross-sectional study among 12 years old school children in Mangalore, India. *Ind J Forens Med Path* 2014;7:19-25.
26. Anitha C, Konde S, Raj NS, Kumar NC, Peethamber P. Dermatoglyphics: A genetic marker of early childhood caries. *J Ind Soc Pedod Prev Dent* 2014;32:220-4.
27. Sengupta AB, Bazmi BA, Sarkar S, Kar S, Ghosh C, Mubtasum H. A cross-sectional study of dermatoglyphics and dental caries in Bengalee children. *J Ind Soc Pedod Prev Dent* 2013;31:245-8.
28. PJ Archana, B George, ST Sebastian, RR Soman, VM Mulamoottil. An assessment of relationship between dermatoglyphics and tooth loss. *Int J Forens Odontol* 2018;3:86-9.
29. Srilatha A, Doshi D, Kulkarni S, Reddy MP, Reddy BS, Satyanarayana D. determination and comparison of dermatoglyphic patterns and salivary streptococcus mutans counts and its correlation with dental caries among 3 to 6-year old children. *Oral Health Prev Dent* 2018;16:291-7.
30. Chinmaya BR, Smitha BV, Tendon S, Khurana C. Dermatoglyphics: An indicator of dental caries in humans. *J Ind Assoc Publ Health Dent* 2016;14:272-5.
31. Erkwatehy WM, Sheta ARA. Dermatoglyphics as a non-invasive anatomical marker in early childhood caries. *Int J Dent Oral Sci* 2016;3:366-71.
32. Nallanchakrava S, Muppa R, Ambati S, Metto S, Reddy DA, Kiran P. Dermatoglyphics as a noninvasive diagnostic tool for predicting caries risk in specially abled children. *Adv Hum Biol* 2015;5:44-8.
33. Upadhyaya N, Gupta S, Khandekar S, Dive A, Thakur S, Mishra R. Dermatoglyphics: A new diagnostic tool in dental caries prediction. *EC Dent Sci* 2017;14.4:174-80.
34. Deepti A, Dagrus K, Shan V, Harish M, Pateel D, Shah N. Dermatoglyphics: A plausible role in dental caries and malocclusion. *Ind J Oral Health Res* 2016;2:32-5.
35. Sharma A, Somani R. Dermatoglyphic interpretation of dental caries and its correlation to salivary bacterial interactions: An *in vivo* study. *J Ind Soc Pedod Prevent Den* 2009;1:17-22.
36. Somani R, Gupta MP, Jaidka S, Singh DJ, Puri V, Kumar D. Dermatoglyphics as a noninvasive tool for predicting dental caries in cerebral palsy and healthy children: An *in vivo* study. *Int J Clin Pediatr Dent* 2019;12:237-42.
37. Bozhchenko AP, Gomom AA. The role of the combinatorial analysis in forensic medical dermatoglyphics: The possibilities and variants of its application in research and expert studies. *Sud Med Ekspert* 2018;61:17-20.