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Review

Do fingerprints reveal the future of children or is it the intersection of dermatological science and health?

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Abstract: Dermatoglyphic patterns are lines formed by different patterns of epidermal structures located on the inner surface of the hands and feet. Epidermal patterns begin to form in the sixth week of pregnancy and once formed, they remain unchanged throughout life except for their size. Since finger patterns and our nervous system develop from the same ectoderm layer, scientists have begun to examine the relationship between fingerprint pattern anomalies and various diseases based on the idea that negativities in various systems, especially neurological disorders, may be reflected in fingerprint patterns. Studies have reported significant relationships between fingerprint anomalies and various diseases. As a result, it is expected that taking dermatoglyphic pattern samples will contribute significantly to the independent roles of pediatric nurses, supporting children's physical, cognitive and social healthy growth and development, detecting diseases at an early stage and maximizing health with appropriate guidance, and providing genetic counseling to parents.

Keywords: fingerprints; dermatoglyphics; child; counselling; health

1. Introduction

Dermatoglyphic structures are defined as lines formed with different patterns by epidermal structures located on the inner surface of the hands and feet [1]. The formation of patterns on the inner surface of the feet occurs approximately two weeks later than that of the patterns on the hands [2].

The formation of epidermal ridges commences approximately in the sixth week of gestation and reaches its maximum size in the 12th–13th week. The formation of epidermal ridges is influenced by both genetic and environmental factors [3]. Galton posited that the ultimate configuration of epidermal patterns, which reflect an individual's character, is established at birth. Once formed, these ridges remain static throughout an individual's lifetime, with the exception of changes in size. Epidermal ridge patterns are distinct in all individuals, including those of identical twins [4].

Chromosomal abnormalities manifest in the fetus as a consequence of genetic, intrauterine, or environmental factors. These anomalies result in an increased ADT angle, differentiation in the number of patterns, or changes in the number of ridge patterns between the a-b triradius and the formation of abnormal lines. The aforementioned abnormalities provide insight into an individual's predisposition to various medical conditions, personality disorders, and criminal tendencies [1]. At present, dermatoglyphic patterns can be used to identify more than 150 diseases with a success rate of 80%–99.9%. The representation of fingerprint patterns is based on the ATD angle, the a, b, c and d triradius, and so forth.

2. Fingerprint pattern types

There are three basic fingerprint patterns. These include the arch, the loop, and the whorl. Each pattern is further subdivided [5].

Arches: The simplest line without a triradius (**Figure 1**) [1].

Loops: It is characterized by a triradius with an opening on one side of the finger and a center. If the inlets and outlets are situated on the radial side, they are designated as radial loops; if on the ulnar side, they are classified as ulnar loops (**Figure 1**) [1].

Whorls: The most complex pattern is characterized by two triradii and a central point (**Figure 1**) [1].

Figure 1. Dermatoglyphic patterns.

2.1. Number of finger ridges

The numerical evaluation of the ridges observed in the dermatoglyphics of the fingertips involves the counting of the lines from the straight line adjacent to the triadial point to the center point. In the event that a finger exhibits more than one triradius, the side with the greater number of lines is selected. The total number of lines on ten fingers can then be calculated to determine the 'total number of finger lines' [1].

2.2. Palmar patterns and marks

The palmar area is subdivided into three distinct zones: the hypothenar, thenar and interdigital areas. The four interdigital zones are designated as I1, I2, I3, and I4, with I1 being the zone closest to the radial aspect of the hand and I4 being the zone closest to the ulnar aspect of the hand. The evaluation of I1 is typically conducted in conjunction with the thenar area. Areas I2, I3 and I4 may be observed to be 'open' with no discernible pattern, or alternatively, they may be found to contain a loop, whorl or vestige pattern. In the vestige pattern, the ridges exhibit a distinct orientation in comparison to the surrounding ridges, yet they are unable to form whorls or loops (**Figure 2**) [1].

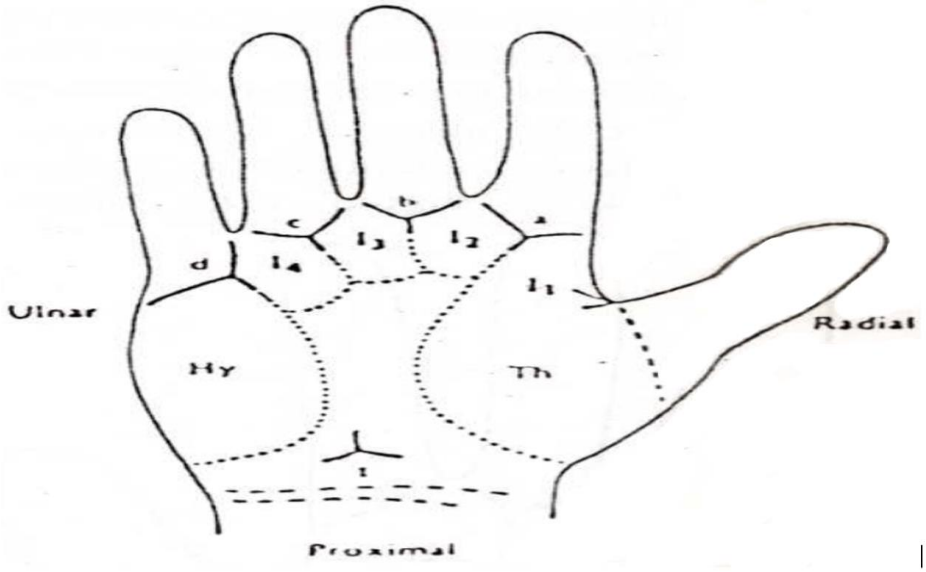

Figure 2. Palmar patterns.

Palmar lines and marks

In palmar analysis, the number of a-b, b-c and c-d lines between the triradius, which are formed at the base of each finger starting from the index finger and named a, b, c and d respectively is evaluated. The axial triradius is called 't' and may sometimes be more than one. An angle drawn with the apex at t and the arms at a and d defines the 'ATD angle'. If there is more than one axial t, the most distal t is used to define the angle [1].

Figure 3*. Palmar lines*

The palm of the hand exhibits three principal palmar lines: the distal transverse line, the proximal transverse line and the thenar line. Should the creases converge to form a singular flexion line, this is designated the 'Simian line'. The continuation of the proximal palmar line to the ulnar border of the palm is known as the 'Sydney line' (**Figure 3**) [1].

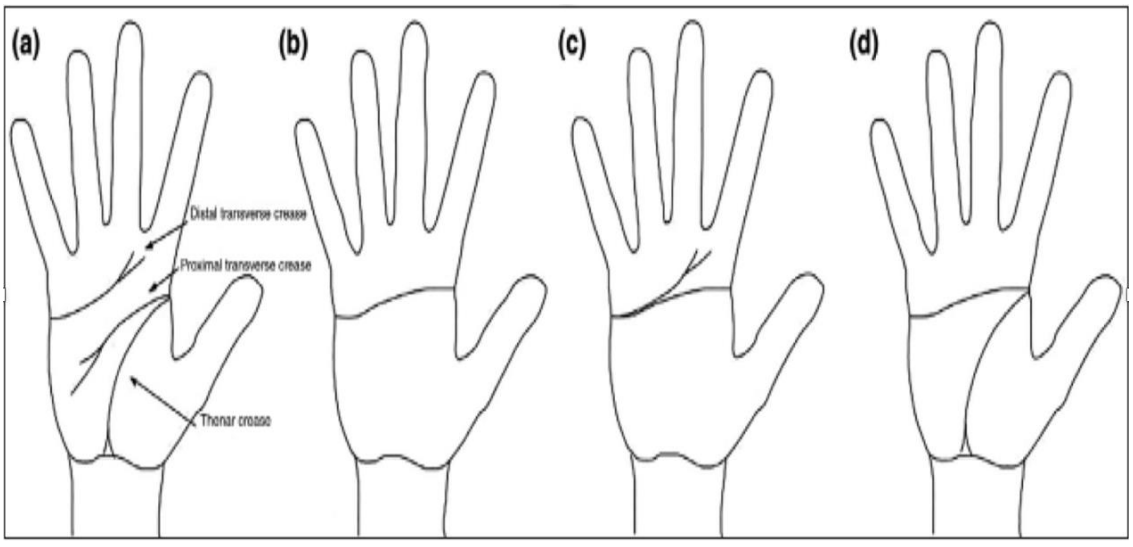

Figure 3. Palmar Lines. normal palmar crease **(a)** palmar crease variations; **(b)** simian crease; **(c)** sydney crease; **(d)** suwon crease.

3. Dermatological patterns associated with clinical disorders

Abnormalities in dermatoglyphic patterns are indicative of a heritable anomaly that manifests during the prenatal period. Consequently, deviations from the norm observed in dermatoglyphic patterns can serve as a rapid and straightforward diagnostic tool for certain diseases [6]. Furthermore, the utilization of dermatoglyphic patterns for diagnostic purposes is advantageous due to their availability in the postnatal period, rapid evaluation, cost-effective sample collection and painlessness in patients of all age groups [2]. Researchers have reported that dermatoglyphic analyses can be used as an auxiliary method in the evaluation of diagnosis, prognosis and treatment of many diseases, including schizophrenia, Down syndrome and autism [7]. Furthermore, dermatoglyphic patterns have been observed to deviate from the norm in individuals diagnosed with various types of cancer, idiopathic epilepsy, panic disorder, multiple sclerosis, and congenital diseases, as well as in patients with heart diseases where genetic predisposition plays a role in the etiology [8].

3.1. Down syndrome

Additionally, dermatoglyphic anomalies have been identified in individuals with Down syndrome. An increased number of ulnar loops, radial loops in the fourth and fifth fingers, and a widened ATD angle are frequently observed in individuals with Down syndrome. Furthermore, the simian line is regarded as the hallmark of Down syndrome [1].

3.2. Prenatal stress and dermatoglyphics

It has been established that there is a correlation between the dermatoglyphic patterns of children, and the stress experienced by the mother during the prenatal period. The objective of the study was to examine the impact of maternal exposure to a sudden, natural disaster occurring between the 14th and 22nd weeks of pregnancy, a period that coincides with the development of fetal fingerprints, on the formation of these prints. The fingerprints of children born to pregnant women who were exposed to a natural disaster that resulted in economic losses of 2.7 billion Canadian dollars and 24 deaths in January 1998 were evaluated. The study, which comprised 77 experimental and 57 control groups, revealed a greater prevalence of asymmetries in the fingerprints of the children in the experimental group compared to the control group. Furthermore, a notable correlation was identified between the post-stress cortisol levels of the mother and the fingerprint asymmetries observed in her children. The study revealed that prenatal maternal stress during the period of fingerprint development, particularly if the mother experienced elevated distress levels, resulted in greater dermatoglyphic asymmetry in her children [9].

3.3. Schizophrenia

As ectoderm and brain development originate from the same tissue, an abnormality observed in ectoderm tissue is thought to indicate an important problem in brain development. Therefore, in fingerprint analyses conducted with schizophrenia patients, more frequent simian lines were found compared to healthy control groups, and some fingerprint patterns were reported to be less and asymmetric. Research

indicates that prenatal damage may be associated with an underlying vulnerability that leads to symptoms such as minor physical anomalies and fluctuating dermatoglyphic patterns. These, in turn, interact with neurodevelopmental and environmental factors, ultimately contributing to the development of psychosis [10,11]. According to the study by Fern Russak, Ives, Mittal, and Dean, which compared the dermatoglyphic patterns of a total of 51 individuals diagnosed with schizophrenia and 45 healthy individuals aged between 12 and 21 years, no significant differences were found for demographic variables such as age, gender, education, or parental education. The present study found no significant differences in fluctuating dermatoglyphic asymmetries between male and female subjects. However, patients diagnosed with schizophrenia exhibited significantly higher total dermatoglyphic asymmetries compared to healthy controls ($p \leq 0.05$). These findings suggest that fluctuating dermatoglyphic asymmetries may be part of the range of minor physical anomalies associated with abnormal neurodevelopment in psychosis [12].

3.4. Autism

Reduced Purkinje fibers, hypoplasia of the brain stem, and posterior cerebellum have been identified in children diagnosed with autism syndrome. Given that the formation of different neurons occurs during the fifth gestational week, this period is considered a critical window for the development of autism. A higher number of digital arches and a lower number of loops were observed in both hands of autistic boys compared to controls. Furthermore, the ATD angle was observed to be more pronounced in autistic males [1]. In another study, the finger patterns of autistic boys and healthy boys were compared. This study was conducted on 182 boys with infantile autism aged between 5 and 15 years (mean age 7.2 years), while the control group consisted of 182 healthy men aged between 30 and 50 years (mean age 38.7 years). The autistic boys had a significantly higher number of arches (9.17%) and a lower number of loops (28.40%) on the fingertips of both hands compared to the control group (4.34%). In particular, a higher number of arches were found on the fourth and fifth fingers of both hands. In addition to this feature, autistic boys had a lower total number of ridges and a wider ATD angle. It was reported that dermatoglyphic science will support the diagnosis of autism [13].

3.5. Cerebral palsy

A significant correlation has been identified between cerebral palsy and dermatoglyphic structures in numerous studies. A study compared the fingerprints of children diagnosed with cerebral palsy with those of a close family member. The study cohort comprised 60 children, with an equal number of males and females. The study employed the use of digitophalangeal dermatoglyph prints obtained from the parents of the children (60 mothers and 60 fathers) and 400 phenotypically healthy adults, who served as the control group. The study demonstrated that dermatoglyphic discrepancies were more prevalent in children with cerebral palsy and their fathers. The differences in dermatoglyphic patterns were significantly less pronounced between mothers and daughters with cerebral palsy, as well as between mothers and the control group of healthy women. The results of the study lend support to the

hypothesis that genetic predisposition may play a role in the occurrence of central nervous system lesions and that paternal influence may be more pronounced [14].

3.6. Mental ability

Given that neural tissue and epidermis originate embryonically from the ectodermal structure and that embryological-fetal development occurs in the second trimester of intrauterine life, it can be posited that IQ and dermatoglyphics have a common embryonic origin. It has therefore been proposed that dermatoglyphic variables may prove useful in predicting IQ range. For example, a study reported that IQ increased as the ATD angle decreased in adolescents with gifted and normal intelligence levels [1].

3.7. Physical ability

As indicated by extant research, the elongation of the index finger in women is associated with elevated estrogen levels, while the elongation of the ring finger in men is associated with elevated testosterone levels. Moreover, elevated testosterone levels have been demonstrated to engender a predisposition towards physical activities, enhanced robustness and augmented performance. Altıntaş et al. conducted a study in which they compared the fingertip dermal patterns of elite athletes and a control group. The study revealed a significant decrease in the prevalence of arch patterns in the third finger of the left and right hands in male elite athletes compared to the male control group. While no arch pattern was found on the fifth finger of the right hand in male elite athletes, arch patterns were found more on the left and right hands in the male control group. The total number of lines recorded was 128.7 ± 1.2 in the male elite athlete group and 147.67 ± 0.89 in the male control group. A statistically significant decrease in the total number of lines on the fingertips of male elite athletes compared to the male control group was also observed. Furthermore, it was observed that the ATD angle was significantly narrower in male elite athletes compared to the male control group [2]. Consequently, it can be deduced that fingerprint analysis has the potential to serve as a valuable method in guiding children towards areas that are conducive to their abilities by analyzing their fingerprints.

3.8. Hand preference

The term “left-handedness” is used to describe the phenomenon of the left hand being more proficient than the right hand. The development of left-handedness is paternally influenced and contingent upon the proximity of the dominant hand to the oral cavity of the fetus. There is a potential increased risk of developing schizophrenia in individuals who are left-handed. A study found that left-handers exhibited a greater number of radial rings and tented arches, as well as a lower prevalence of helical and simple arches, compared to right-handers [3]. A study was conducted with students from a higher education institution in Nigeria to examine the relationship between students’ fingerprint patterns and hand preference. In the study, which was conducted with 148 left-handed and 131 right-handed students, the prevalence of spirals on the left hand was 51.6% among right-handed individuals, while on the right hand, it was 50.8%. Similarly, the distribution of spirals in the left hand was 56.8% and 60.4% in

the right hand. The t-test analysis of the obtained results indicated that there was no statistically significant relationship between whorl fingerprint patterns and hand use ($p > 0.05$) [15].

3.9. Premature birth

In a study, 490 newborns without any syndrome were examined in terms of the Simian and Sydney lines, premature birth, and low birth weight. The results of the study indicated that there was no statistically significant correlation between premature birth and low birth weight with the Simian line. Conversely, the Sydney line was found to be associated with a twofold increased risk [1]. The findings of this study will enable pediatric nurses to readily identify infants with Sydney lines and safeguard them from the adverse effects of preterm birth and low birth weight during the initial stages. In their investigation, "Todd et al. [16] observed that arch patterns are more prevalent in clinical syndromes characterized by arrested embryological development and diminished developmental maturation". According to a study conducted with 142 premature and 63 healthy term newborns, it was determined that the total number of a-b backs decreased as the birth week and weight of premature babies decreased ($p < 0.05$). The study indicated that neurodevelopmental impairment seen in young adults may have an etiology prior to early birth [17].

3.10. Vitiligo

In a study comparing the dermatoglyphic patterns of 40 patients with generalized vitiligo and 120 healthy control groups, the ulnar loop was found to be the most common pattern in both vitiligo patients and the control group. No significant difference was found between the control and experimental groups in terms of fingerprint pattern when compared between male and female genders. It was concluded that there was no relationship between vitiligo and fingerprint pattern, and it was recommended to conduct a study with a larger population [6]. 112 vitiligo and 104 control groups were used in the study conducted in India to investigate finger and palmar dermatoglyphic patterns in vitiligo patients. As a result of the study, it was found that the percentage of total loops, total ulnar loops and finger ridges increased in the right hypothenar, tenar and interdigital areas of the hands of male vitiligo patients, while the percentage of total radial loops, spirals and arches decreased in the right interdigital 3 and 4 areas. When female vitiligo patients were analyzed, an increase in the number of arches was observed in the right hypothenar and ID1 areas, while a decrease was observed in the total number of radial and ulnar loops and the number of spirals in the right ID2 and left ID3 areas. An increase in ATD angle was found in both sexes [18].

3.11. Acute lymphoblastic leukaemia

Acute lymphoblastic leukaemia is one of the childhood leukaemias that presents with a range of clinical manifestations resulting from the abnormal proliferation of white blood cells. It is most commonly observed in children between the ages of two and ten years, with a peak incidence between the ages of three and four years. Acute lymphoblastic leukaemia (ALL) represents 70% of childhood leukaemias and is a

highly lethal condition. It is therefore crucial to facilitate early diagnosis in order to optimize the chances of survival for children. It was therefore hypothesized that, given the parallel development of blood cells and finger patterns, a relationship might exist between fingerprint analysis and leukemia. "Bukelo et al. [19] conducted a comparative analysis of the palmar pattern in 24 pediatric patients (11 boys and 13 girls under the age of 16) diagnosed with ALL in the pediatric oncology service, and a control group of 24 healthy children of the same age". The study revealed that the number of abridges was higher than that observed in the control group. Furthermore, the mean APD angle was observed to be higher than that of the control group. The findings of this study indicate that dermatoglyphic features in children with ALL may indicate a potential tendency and relationship. In conclusion, while dermatoglyphic analysis is not a diagnostic tool in itself, it can be employed as an early preventive measure for pediatric nurses in the context of childhood cancers where early diagnosis is of paramount importance. This is particularly the case when used for screening purposes in children from high-risk families [19].

3.12. Migraine

A study examined the dermatoglyphic characteristics of patients with migraine and found that both right- and left-hand fingerprint line counts, a-b line counts, and total line counts were increased in patients with migraine. In addition, the ATD angle of both hands was found to be statistically significantly higher in patients with migraine than in the control group [7].

3.13. Obstructive sleep apnea

A study conducted by "Çakmak et al. [20] evaluated 50 obese subjects in their study to determine the finger patterns that can be seen in obese individuals and to determine the frequency of these patterns and found that the ulnar loop pattern decreased in male obese individuals while the whorl pattern increased ($p < 0.001$). No difference in these patterns was found in female obese subjects ($p > 0.05$). On the other hand, a significant decrease ($p < 0.05$) was found in the total number of lines in obese subjects compared to the control group, while no significant difference was observed in the number of a-b lines. In addition, a significant increase ($P < 0.05$) was observed in both the ATD angle and the frequency of samples in the 1st and 4th interdigital regions in obese males, whereas this increase was not significant ($P > 0.05$) in obese females. Again, a significant increase ($p < 0.05$) was observed in obese women in the Sidney and type 1 transitional monkey lines".

3.14. Obesity

A study conducted by "Canbolat et al. [21] investigated the relationship between obstructive sleep apnea and dermatoglyphic patterns. In their study, the dermal structures of the fingertips and palms of the right and left hands of both the healthy and patient groups were examined. The total number of fingertip ridges, the total number of a-b ridges and the ATD angle were used as dermal patterns. In the study, the total number of fingertip ridges, although not statistically significant, was found to be higher in female and male apnea patients than in healthy subjects. In addition, a

statistically significant difference was found between the right and left ATD angle values of all healthy individuals and all apnea patients regardless of gender".

3.15. Predisposition to commit a crime

The use of fingerprints to identify criminals and corpses was first studied by Henry Faulds in 1880, who discovered that the structures found here cannot be changed throughout life [22]. Since then, the use of fingerprints has been a common method used by both scientists and criminals. In their study, "Delice et al. [23] examined the fingerprint types of suspects involved in different crimes and investigated whether there was a relationship between the fingerprint pattern and the type of crime. The fingerprint types of 8555 suspects, about half of whom were male and half female, were analyzed using descriptive statistics and the Chi-square test. The results showed that the fingerprint types were generally distributed as 52.1% ulnar, 40.7% spiral, 7.2% arch and other, and that the distribution of male and female fingerprint types was significantly different from each other. According to the results of the study showing the relationship between fingerprint type and crime type, men involved in sexual assault against children and organized crime had fingerprint types in eight out of ten fingers, men involved in terrorist crimes had fingerprint types in six out of ten fingers, men involved in prostitution and livata crimes had fingerprint types in two out of ten fingers, and men involved in sexual assault and women involved in terrorist crimes had fingerprint types in one out of ten fingers at a significantly different rate than those involved in other crimes. According to the findings, the most significant difference was observed in men involved in sexual assault against children and organized crime".

3.16. Congenital cataract

A study was conducted to investigate the relationship between congenital cataract and finger patterns. The dermatoglyphics of 35 congenital cataract patients (17 boys and 18 girls) were analyzed and compared with the dermatoglyphics of 80 control subjects (42 boys and 38 girls). The dermatoglyphics of 35 patients diagnosed with congenital cataracts (17 boys and 18 girls) were analyzed and compared with the dermatoglyphics of 80 control subjects (42 boys and 38 girls). In this study, an increase in the number of whorl patterns on the fingertips of male patients, a decrease in the arch types of female patients, an increase in the number of TRCs, palmar III loops and t triradii, IV loops and t triradii, and a decrease in the ATD angle on the left hand of female patients were observed. Furthermore, the frequency of opening the baseline at place number 4 is high. It is hypothesized that the dermatoglyphic study will contribute as an auxiliary method to the studies to be performed with congenital cataract, as it is a cost-effective, rapid and non-invasive technique that can be applied to patients without causing trauma [24].

3.17. Fanconi anemia

The study examined the dermatoglyphic specimens on the fingers and palms of 18 patients with Fanconi anemia (FA), 11 of whom were male. The ulnar loops and total number of finger lines were observed to be high, while the whorl types and ATD

angle were noted to be low in the left hands of FA patients. The number of II loops and T triradius were elevated, whereas IV loops and T' triradius were diminished in the palmar region of the patients. Furthermore, the frequency of the A baseline terminating at the 5' point was observed to be higher than that observed in the control group. No significant difference was observed in the number of a-b lines. In conclusion, significant differences were observed in the dermatoglyphic patterns on the fingers and palms of patients with Fanconi anemia (FA). When these findings are considered alongside other clinical features of FA, they may prove useful in diagnosing the disease [25].

4. Conclusion

Dermatoglyphs, a term derived from Greek, have exerted a profound influence on academics, medical professionals, and numerous other groups since antiquity. Dermatoglyphic patterns are currently employed in a number of fields, including personal identification, forensic purposes, twin diagnosis, racial variation and security services.

Dermatoglyphic pattern sampling offers significant advantages in terms of cost-effectiveness, efficacy, and lack of hospitalization or trauma. The diagnosis of children typically requires the performance of examinations such as blood sampling, which are known to cause pain and trauma to children. Dermatoglyphic analysis offers significant advantages in the diagnosis of diseases.

It is an indisputable reality that the physical and mental challenges associated with illness have a profound impact on both the individual afflicted and their loved ones. It is therefore crucial to identify risk factors prior to the onset of disease, enabling the implementation of protective measures tailored to the individual's predisposition to that particular disease. In the current era, given the growing body of evidence indicating the link between early symptoms and disease risk, new markers can be identified as potential risk factors, thereby facilitating the prevention of adverse outcomes associated with disease. In our country, the disease has reached an advanced stage by the time many children are diagnosed with it. This situation results in children requiring hospitalization for extended periods, placing a significant burden on their families and the national economy. Dermatoglyphic pattern analysis enables the identification of children who are susceptible to specific diseases, thereby facilitating the implementation of preventive measures at an early stage.

In the present era, dermatoglyphics offers insights into the correlation between dermatoglyphics and a range of medical conditions, in addition to other attributes such as cognitive abilities and athletic capabilities. Consequently, as each child's fingerprints are distinctive, an analysis of dermatoglyphic patterns can facilitate an understanding of the innate potential, personality and preferences of children.

In our country, the education system and families have an unrealistic expectation of children, namely that they will excel in all subjects and sports. Consequently, children may develop feelings of inadequacy and subsequently experience physical and mental health issues in the future, such as low self-esteem. Dermatoglyphic analysis can facilitate the healthy growth and development of children by directing them to areas that align with their abilities.

Furthermore, it will be imperative for pediatric nurses to provide assistance to families independently, particularly in the domain of genetic counseling, through the utilization of dermatoglyphic analysis of hands and feet, which does not necessitate any medical intervention.

Furthermore, researchers specializing in dermatoglyphic science should be cognizant of the fact that the data obtained from this study is derived from small sample groups or different demographic groups. It is imperative that parents give due consideration to privacy and confidentiality concerns, such as the copying of personal data. Additionally, researchers must exercise caution with regard to issues such as the misuse of biometric data, fraud, and identity theft.

Conflict of interest: The authors declare no conflict of interest.

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