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Comparison of dermatoglyphic patterns between children with and without Down syndrome

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Abstract

Background: Dermatoglyphic patterns develop during embryogenesis and are influenced by genetic and intrauterine factors. Trisomy 21 may alter epidermal ridge formation, making fingerprint patterns a potential non-invasive supportive marker of developmental variation.

Purpose: To compare participant-level categorical fingerprint patterns between children with and without Down syndrome.

Method: This comparative cross-sectional study included 59 participants: 29 children with Down syndrome and 30 children without Down syndrome. Fingerprint impressions were obtained using an ink pad and fingerprint paper, and each child was assigned one participant-level category (loop, whorl, or arch). Fisher's exact test compared the loop and whorl distributions because no arch patterns were observed; $p < 0.05$ was considered statistically significant.

Results: Loop patterns were reported in 23 children with Down syndrome (79.3%) and 27 children without Down syndrome (90.0%). Whorl patterns were reported in 6 children with Down syndrome (20.7%) and 3 children without Down syndrome (10.0%); no arch patterns were identified. The distribution was not significantly different between groups ($p = 0.299$).

Conclusion: Participant-level loop, whorl, and arch pattern distributions were not significantly different between children with and without Down syndrome in this sample. These broad categories should not be interpreted as a stand-alone diagnostic marker.

Keywords: Children; Dermatoglyphics; Down syndrome; Fingerprint patterns.

INTRODUCTION

Dermatoglyphics is the study of epidermal ridge configurations on the fingers, palms, toes, and soles. These ridge patterns form during fetal development and remain largely stable after formation, making them useful for describing developmental variation (Sudha et al., 2021; Sharma et al., 2018). The principal digital patterns are loops, whorls, and arches.

Down syndrome results from an additional copy of chromosome 21 and is associated with characteristic physical, developmental, and health-related features (Antonarakis et al., 2020; Bull, 2020). Because epidermal ridges develop during the same broad prenatal period in which chromosomal effects influence growth and morphogenesis, dermatoglyphic patterns have been investigated as possible supportive markers of trisomy 21.

Previous studies have reported differences in the frequencies of loops, whorls, arches, ridge counts, and palmar features among people with Down syndrome, but findings have varied across

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populations and methods (Hossain et al., 2021; Sariza et al., 2021; Kolgeci-Istogu et al., 2023). Other dermatoglyphic research has emphasized that classification procedures, the number of digits examined, and observer reliability can affect interpretation (Manikandan et al., 2019; Tewari et al., 2022; Tharay et al., 2020).

Dermatoglyphic recording is inexpensive and non-invasive; however, clinical usefulness requires reproducible group differences, standardized assessment, and adequate diagnostic accuracy. Historical enthusiasm for dermatoglyphics has therefore been accompanied by concern about overinterpreting nonspecific patterns (Asen, 2018). Evidence from Indonesian children remains limited, particularly in Bandar Lampung. This study compared participant-level categorical fingerprint patterns between children with and without Down syndrome.

RESEARCH METHOD

This comparative cross-sectional study was conducted in 2026 at participating special education schools and private elementary schools in Bandar Lampung, Indonesia. The study population comprised children with Down syndrome and children without Down syndrome who met the study eligibility criteria.

The sample included 59 participants: 29 children with Down syndrome and 30 children without Down syndrome.Eligible children available at the participating special education schools were included in the Down syndrome group, while eligible sixth-grade pupils from private elementary schools were recruited for the comparison group until the planned sample size was reached.

Data were collected using a participant or parent/guardian questionnaire, an ink pad, fingerprint paper, a magnifying glass, a stadiometer, and a body-weight scale. Each child was assigned one participant-level fingerprint category (loop, whorl, or arch), and age, body weight, and height were recorded..

Categorical variables were summarized using frequencies and percentages, while continuous variables were summarized using means, standard deviations, and ranges. Because no arch patterns were observed in either group, Fisher's exact test compared the loop and whorl distributions between groups. Statistical significance was set at $p < 0.05$. The study received ethical approval from the Research Ethics Commission of the Faculty of Medicine, Universitas Malahayati (No. 5170/EC/KEP-UNMAL/II/2026).

RESEARCH RESULTS

A total of 59 participants were included: 29 children with Down syndrome and 30 children without Down syndrome. Table 1 summarizes the participant characteristics.

Table 1. Characteristics of the study participants (N = 59)

Variable	Down syndrome (n = 29)	Without Down syndrome (n = 30)
Age, mean ± SD (range), years	12.03 ± 2.15 (8–18)	11.30 ± 0.47 (11–12)
Age group, n (%)		
8–10 years	1 (3.4)	0 (0.0)
11–12 years	23 (79.3)	30 (100.0)
13–15 years	2 (6.9)	0 (0.0)
16–18 years	3 (10.3)	0 (0.0)
Gender, n (%)		
Male	16 (55.2)	12 (40.0)
Female	13 (44.8)	18 (60.0)

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Body weight, mean ± SD (range), kg	36.0 ± 8.9 (15-69)	40.9 ± 9.4 (30-67)
Height, mean ± SD (range), cm	145.6 ± 10.7 (110-156)	149.0 ± 6.3 (139-160)

The mean age was 12.03 ± 2.15 years in the Down syndrome group and 11.30 ± 0.47 years in the comparison group. The Down syndrome group included 16 boys (55.2%), whereas the comparison group included 18 girls (60.0%). Because the groups differed in age distribution and were not matched by sex, body weight and height are presented descriptively and should not be directly interpreted as between-group differences.

Table 2. Fingerprint patterns by Down syndrome status (N = 59)

Fingerprint pattern	Down syndrome (n = 29), n (%)	Without Down syndrome (n = 30), n (%)	Total, n (%)	p value
Loop	23 (79.3)	27 (90.0)	50 (84.7)	0.299
Whorl	6 (20.7)	3 (10.0)	9 (15.3)	
Arch	0 (0.0)	0 (0.0)	0 (0.0)	

Loop patterns predominated in both groups. Whorl patterns were observed in 6 children with Down syndrome (20.7%) and 3 children without Down syndrome (10.0%), while no arch patterns were reported. Fisher's exact test indicated no statistically significant difference in the loop-versus-whorl distribution between groups (p = 0.299).

DISCUSSION

The principal finding was that participant-level categorical fingerprint patterns did not differ significantly between children with and without Down syndrome. Loops predominated in both groups, and whorls were numerically more frequent in the Down syndrome group; however, the p value of 0.299 indicates that the observed difference may be attributable to sampling variation.

The predominance of loops is broadly consistent with reports from Bangladeshi, Indonesian, and other populations, although the exact distribution of digital and palmar features has varied across studies (Hossain et al., 2021; Kolgeci-Istogu et al., 2023; Sariza et al., 2021). Such variation may reflect population differences, sample size, age composition, recording technique, the number of digits assessed, and the rules used to convert multiple finger-level observations into a participant-level category. The present result does not support using loop, whorl, and arch categories alone as a stand-alone marker of Down syndrome.

Age and sex differences between groups limit interpretation of the anthropometric summaries. Although altered growth trajectories in Down syndrome are well documented and condition-specific growth charts are recommended for clinical monitoring (Boontan & Rojnueangnit, 2021; Zemel et al., 2015), the present body-weight and height values were not compared using age- and sex-adjusted analyses. They should therefore be interpreted only as descriptive characteristics, not as evidence that one group was shorter or lighter.

Down syndrome is clinically and developmentally heterogeneous. Individual differences, comorbid health conditions, and access to appropriate health supervision may influence growth and development (Karmiloff-Smith et al., 2016; Windsperger & Hoehl, 2021; Bull et al., 2022). These potential confounders were not evaluated in the present analysis.

This study has several limitations. The sample was small and recruited from a single city, limiting precision and generalizability. The comparison group was not matched to the Down syndrome group by age or gender. Diagnostic confirmation, eligibility criteria, school selection, the number of digits examined, participant-level pattern assignment, assessor

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training, blinding, and inter-rater reliability require clearer reporting.

CONCLUSION

Participant-level categorical fingerprint patterns were not significantly different between children with and without Down syndrome in this study. Loops predominated in both groups, and whorls were numerically more frequent among children with Down syndrome, but the difference was not statistically significant. The findings do not support the use of loop, whorl, and arch categories alone to distinguish Down syndrome status.

SUGGESTION

Future studies should recruit larger, multicenter samples with age- and sex-matched comparison groups. Fingerprints from all digits should be collected using a standardized protocol and assessed by blinded, trained raters with documented inter-rater reliability. Quantitative measures, including ridge counts and atd angles, should also be considered. Anthropometric comparisons should use verified participant-level measurements and appropriate adjustment for age and sex.

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