Systematic Review

The "Loop" Fingerprint Pattern as a Component of Autism Spectrum Disorder Risk Screening: a Systematic Review

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Abstract

The abnormal genetic makeup of a genetic disease will be reflected in the dermatoglyphic pattern. Early detection and diagnosis of autism spectrum disorder (ASD) are necessary to help ASD individuals receive early intervention so that delays in communication, social, and behavioral development can be addressed. This review aims to determine whether loop fingerprint patterns can be a component of ASD risk screening. Systematic search on a database and a manual handsearching from articles which were not indexed in the major electronic databases to identify articles reporting the association of fingerprint patterns with ASD. Data extracted from each research article included author name, study characteristics, sample characteristics, ASD diagnosis criteria, fingerprint scanning method, and frequency of fingerprint findings. After the selection process, three articles were obtained for analysis. This review found that two studies reported that the ASD group had a significantly higher frequency of loop patterns on the left index finger. Additionally, one study reported that the ASD group had a higher frequency of arch patterns on all fingers of the right and left hands. This systematic review concludes that the loop fingerprint pattern on the left index finger may be an additional component in screening for ASD risk.
Keywords: *autism, dermatoglyphic, fingerprint, screening.*

Pola Sidik Jari "Loop" Sebagai Komponen Skrining Risiko Autism Spectrum Disorder: Tinjauan Sistematis

Abstrak

Susunan abnormal genetik pada penyakit genetik akan tercermin dalam pola dermatoglifi. Deteksi dini dan diagnosis autism spectrum disorder (ASD) diperlukan untuk membantu individu ASD mendapatkan penanganan lebih awal, sehingga keterlambatan dalam perkembangan komunikasi, sosial, dan perilaku dapat diatasi. Tinjauan ini bertujuan untuk menentukan apakah pola sidik jari loop dapat menjadi komponen skrining risiko ASD. Penelitian ini menggunakan metode pencarian sistematis pada basis data dan menggunakan metode tambahan pencarian manual dari artikel yang tidak terindeks dalam basis data elektronik untuk mengidentifikasi artikel yang melaporkan hubungan antara pola sidik jari dengan ASD. Data yang dikumpulkan dari setiap artikel penelitian meliputi nama penulis, karakteristik penelitian, karakteristik sampel, kriteria diagnosis ASD, metode pemindaian sidik jari, dan frekuensi temuan sidik jari. Setelah proses seleksi, didapatkan tiga artikel untuk dianalisis. Didapatkan dua studi melaporkan kelompok ASD memiliki frekuensi pola loop yang lebih tinggi secara signifikan di jari telunjuk kiri. Selain itu, satu studi melaporkan bahwa kelompok ASD memiliki frekuensi pola archus yang lebih tinggi pada total semua jari tangan kanan dan kiri. Tinjauan sistematis ini menyimpulkan bahwa pola sidik jari loop pada jari telunjuk kiri dapat menjadi komponen tambahan dalam skrining risiko ASD.
Kata kunci*: autism, dermatoglifi, sidik jari, skrining.*

Introduction

Dermatoglyphics is the study of images of tendrils or patterns found on the tips of the fingers and palms on the hands or feet.[1] Fingerprint patterns are one of the essential components studied in dermatoglyphics and have the potential to be a screening component for genetically related diseases. An abnormal genetic arrangement in a genetic disease will be reflected in the dermatoglyphic pattern.[2,3] Dermatoglyphics are often used to diagnose genetic-related diseases such as mental retardation, autism, schizophrenia, and Alzheimer's, with a probability of 80-99.9%.[4]

The World Health Organisation[5] states that 1 in 100 children worldwide has an autism spectrum disorder (ASD). The Centre of Disease Control in 2018 estimated that 1 in 59 children in the US has ASD, a 15% increase compared to 2014. The Diagnostic and Statistical Manual of Mental Disorders-V (DSM-V) defines ASD as a group of cognitive and neurobehavioral disorders that affect the development of communication and social skills, as well as involve restricted and repetitive patterns of behavior.[6] Detection and diagnosis of ASD as early as possible are necessary to help ASD individuals obtain the earliest possible intervention so that delays in communication, social, and behavioral development can be overcome immediately.[7]

Fingerprint patterns have the potential to be a component of early screening for ASD because fingerprints are a reflection of genetic disorders, aligning with the genetic basis of ASD as a brain development disorder.[8] The brain and fingerprints develop during the same gestational period, namely in the second trimester of pregnancy.[4,9] Van in Bhat[3] stated that the skin and brain develop from the same ectoderm so that fingerprint patterns can inform early developmental disorders in the brain.

Findings in previous studies reinforce the association of fingerprint patterns with ASD. Research by Suciandari[9] reported that the loop pattern has the highest frequency in people with ASD at 57.2%, while the arch pattern has the lowest number at 3.7%. Study by Kazemi[10] compared the fingerprint patterns of ASD individuals with a control group and reported that the fingerprint patterns on the left thumb and left forefinger had a significantly higher number of loop patterns in people with ASD.

Several other studies have different results, stating that arch patterns are more frequent in people with ASD. Research by Stošljevic and Adamovic[4] divulged that ASD patients had a significantly higher number of arches (9.17%) than the control group (4.34%). Gabriel et al[13] also reported that people with ASD in Nigeria have a frequency of arch (49.5%), whorl (18.5%), ulnar loop (28.5%), and radial loop (3.5%), while the control group has a frequency of ulnar loop (44%), arch (25.5%), whorl (22%), and radial loop (8.5%).

Fingerprint patterns hold promise as an alternative early diagnostic tool for ASD, given that they can be identified at birth, allowing for earlier identification and intervention in babies at high risk. Notably, no previous systematic review has comprehensively addressed this topic, highlighting the need for further exploration. Building on the observations described above, this study aims to investigate the potential of loop handprint patterns as a component of ASD risk screening.

Methods

This systematic review adjusted Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols (PRISMA-P) 2020 checklist was used.[11] Guidelines from the Cochrane Handbook for Systematic Reviews of Interventions were also used to carry out the systematic review steps.[12]

Research Questions

The determined research question is can loop pattern handprints be a component of ASD risk screening?

Eligibility Criteria

Inclusion criteria were patients with ASD based on DSM diagnosis criteria IV-V and/or ICD 10-11, or the article mentions that the patient has been diagnosed with ASD by a general practitioner, psychiatrist, pediatrician, or the hospital. There were no age restrictions for patients. The intervention involves identifying loop, whorl, and arch pattern handprints using a fingerprint scanner or ink stamp method taken on the fingertips of the right and/or left hand. The comparison group consisted of individuals without ASD. Eligible studies were limited to case-control and cohort designs, with publications between 2012 and 2022. Articles must be written in English or Indonesian, with no restrictions on study location, and must be available as open-access publications.

Literature Search Strategy

Pubmed, SpringerLink, Epistemonikos, Nature, and ScienceDirect databases were used. Three strategies were used in searching articles to expand the coverage of the number of articles, namely database searching, manual handsearching, and citation searching. Manual handsearching is the task of searching through medical journals or conference publications for reports of controlled trials which are not indexed in the major electronic databases.[12] Manual handsearching searching was done by freely searching for relevant articles outside of the five databases that have been determined. Citation searching was done by searching for relevant articles in the bibliography section of a research article with similar topics. In the database search, the following keywords were used: (((Dermatoglyphics) OR (Fingerprints)) OR (Fingerprints)) AND ((((((((((Autism Spectrum Disorder) OR (Autism Spectrum Disorders)) OR (Autistic Spectrum Disorders)) OR (Autistic Spectrum Disorders)) OR (Disorder, Autistic Spectrum)) OR (Autistic Disorder)) OR (Asperger Syndrome)) OR (Asperger Disease)) OR (Asperger Disorder)) OR (Rett Syndrome)) OR (Rett Disorder)).

Literature Selection

Article selection was carried out in stages, duplication selection by excluding the same research articles using the Rayyan AI website, selection based on the suitability of the title and abstract using the Rayyan AI website, and selection of article accessibility to include articles that can be accessed open access. The next stage was selection based on eligibility criteria by reading the articles in full text.

Data Extraction

Data extracted from each research article include the author's name, study characteristics, sample characteristics, ASD diagnosis criteria, fingerprint scanning method, and frequency of fingerprint findings.

Results

The total number of articles in the initial stage was 3,883; after selecting articles, three final articles were obtained. The results of the literature selection are shown in Figure 1.

Risk of Bias Assessment

The Newcastle-Ottawa Scale (NOS) was used based on recommendations from the Cochrane Handbook for Systematic Reviews to assess the risk of bias in the case-control study design.[12] The Newcastle-Ottawa Scale conversion to Agency for Healthcare Research and Quality (AHRQ) standards was used to conclude the risk of bias in articles with reasonable, fair, or poor-quality conclusions. The results of the risk of bias assessment on the three articles are shown in Table 1.

Three articles included in this study employed a case-control study design. The domains assessed for case-control studies were selection, comparability, and exposure, with a maximum total score of 9 stars. A star was awarded if an article fulfilled one of the assessment components within the respective domains, comprising 4 components for selection, 2 components for comparability, and 3 components for exposure. All three studies were classified as having good quality. The study by Kazemi et al[10] received a perfect score, earning 4 stars in the selection domain, 2 stars in comparability, and 3 stars in exposure. The studies by Stošljevic and Adamovic[4], and by Lien et al[15], each received 3 stars in the selection domain, 2 stars in comparability, and 3 stars in exposure. The lower score in the selection domain for the studies by Stošljevic and Adamovic[4] and by Lien et al[15] was due to the lack of information on whether the control group had any prior history of ASD.

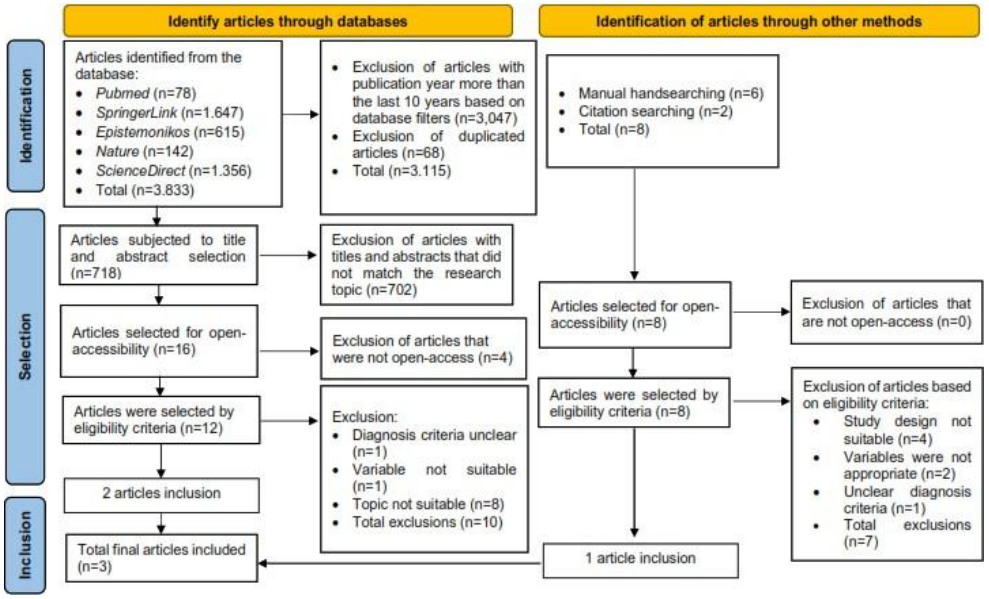

Figure 1. Flow Diagram for Study Selection

Table 1. Risk of Bias Assessment

Author	Assessment Components			Total Score	Conclusion
	Selection	Comparability	Exposure		
Kazemi et al[10]	++++	++	+++	9	Good quality
Stošljevic and Adamovic[4]	+++	++	+++	8	Good quality
Lien et al[15]	+++	++	+++	8	Good quality

Table 2. Study and Participants Characteristics

Author	Title	Publication Year	Language	Location	Study Design	Group	Sample Quantity	Gender	Age (Years)
Kazemi et al[10]	Comparative Dermatoglyphic Study between Autistic Patients and Normal People in Iran	2017	English	Iran	Case-control	Case	104	88 males and 16 females	5–15
						Control	102	86 males and 16 females	6–25
Stošljevic and Adamovic[4]	Dermatoglyphic Characteristics of Digito-palmar Complex in Autistic Boys in Serbia	2013	English	Serbia	Case-control	Case	182	Male	5–15
						Control	182	Male	30–50
Lien et al[1]	Special Dermatoglyphic Features Can be Used as Screening Tools for Autism and Mental Retardation	2021	English	China	Case-control	Case	141	119 males and 22 females	-
						Control	135	-	-

Study Characteristics and Research Sample

Details of the studies and participants characteristics in the three research articles are shown in Table 2. The three selected articles utilized a case-control study design and were written in English. The study by Kazemi et al[10] was conducted in Iran and published in 2017. The article by Stošljevic and Adamovic[4] was carried out in Serbia and published in 2013. Meanwhile, the study by Lien et al[15] was conducted in China and published in 2021. Regarding the study samples, Kazemi et al[10] included 104 participants in the case group, aged between 5 and 15 years, and 102 participants in the control group, aged between 6 and 25 years. The study by Stošljevic and Adamovic[4] involved 182 individuals in the case group (aged 5–15 years) and 182 individuals in the control group (aged 30–50 years). The study by Lien et al[15] comprised 141 participants in the case group and 135 participants in the control group, although the age ranges of the participants were not specified in the article.

Table 3. Research Methods of Three Articles

Author	ASD Diagnostic Criteria	Fingerprint Scanning Method	Type of finger
Kazemi et al[10]	DSM-V, diagnosed by a psychiatrist	Digital Fingerprint Scanner	Right-left thumb and index finger
Stošljevic and Adamovic[4]	DSM-IV	Digital Fingerprint Scanner (using the Cummins Midlo and Penrose protocols)	All fingers of the right-left hand (10 fingers)
Lien et al[15]	Hospital diagnosis	Using the Penrose protocol	All fingers of the right-left hand (10 fingers)

Data Extraction

The research methods in the three articles are shown in Table 3. The data extraction findings in the three research articles characteristics are shown in Table 4. Kazemi et al[10] study had a sample of 104 subjects in the ASD case group and 102 subjects in the control group. The diagnosis criteria in this study were based on DSM-V, and a psychiatrist carried out the diagnosis. The fingerprint scanning method in this study uses the digital fingerprint scanner method using the Futronic-FS-80 scanner. Thumb and index finger fingerprints on the right and left hands were scanned. The study used quantitative data analysis using the binomial distribution test. The results stated a significant difference in the loop patterns on the L1 (left thumb) and L2 (left index) fingers. The ASD group had a significantly higher number of loop patterns than the control group on the L1 and L2 fingers. The loop pattern on finger L1 had a frequency of 55.7% in the ASD group, while the control group had a frequency of 36.27%. The loop pattern on the L2 finger had a frequency of 51.92% in the ASD group, while the control group had a frequency of 33.34%. This study also reported that there was a significant difference in the arch pattern on the L1 finger between the ASD group and the control group; the ASD group had a lower arch pattern with a frequency of 3.85%, while the control group had a frequency of 15.69%.

Stošljevic and Adamovic[4] study had a sample of 182 subjects in the ASD case group and 182 subjects in the control group. The criteria for diagnosis in this study were based on DSM-IV. This study used the digital fingerprint scanner with the Cummins Midlo and Penrose protocols to scan the fingerprints. Fingerprints on all fingers on the right and left hands were scanned using a Canon 9000F scanner. Qualitative analysis was done by displaying the percentage frequency of each fingerprint pattern. The results showed that there was a significant difference in the frequency of loop patterns and arch patterns on the total fingers of the right and left hands between the ASD group and the control group, where the frequency of loop patterns in the ASD group is lower, and the frequency of arch patterns in the ASD group is higher than the control group. The loop fingerprint pattern in the ASD group showed a frequency of 28.40%, while the control group had a higher frequency of 32.42%. This study also reported that the arch pattern had a significantly higher frequency in the ASD group (9.17%) than in the control group (4.34%).

Table 4. Data Extraction

Author	Fingerprint Frequency (%)												Type of Data Analysis
	Group	*Loop*				*Arch*				*Whorl*				
		R1	R2	L1	L2	R1	R2	L1	L2	R1	R2	L1	L2	
Kazemi et al[10]	Case	55.77	50.96	55.77 ++	51.92 ++	5.77	7.69	3.85 ++	7.69	38.46	41.35	40.38	40.39	Quantitative (Binomial Distribution Test)
	Control	39.22	35.29	36.27	33.34	11.76	10.79	15.69	6.86	49.02	53.92	48.04	59.80	
	Group	Loop			Arch			Whorl						
		R1-R5	L1-L5	Total	R1-R5	L1-L5	Total	R1-R5	L1-L5	Total				
Stošljevic and Adamovic[4]	Case	25.05	31.75	28.40	9.56	8.79	9.17	65.38	59.45	62.41				Qualitative
	Control	29.45	35.38	32.42	4.17	4.50	4.34	66.37	60.10	63.24				
	Group	*Radial Loop*		*Ulnar Loop*				**Arch**		*Whorl*				
		R2	L2	R2	R3	R4	R5	L3	-	R2	R3	R4	R5	L2	L3	L4
Lien et al[15]	Case	7.1 ++	8.5 +	38.3	60.3	34	55.3	56	-	31.2	22.7	56	32.6	25.5 ++	20.6	46.1
	Control	3.7	4.4	42.2	61.5	33.3	60.7	49.6	-	30.4	23	58.5	28.9	31	28.9	48.1

+: p-value <0.01; ++: p-value <0.05; R: Right hand; L: Left hand

The Lien et al[15] study had a sample of 141 subjects in the ASD case group and 135 subjects in the control group. The criteria for diagnosis in this study were based on the hospital diagnosis. This study used the Penrose protocol to scan the fingerprints on all fingers on the right and left hands. Quantitative data analysis was used, but the type of statistical test was not mentioned in the research article. The results of the study from Lien et al[15] stated that there were statistically significant differences between the ASD group and the control group in the radial loop pattern on the R2 (right index) finger with a p-value <0.05, radial loop pattern on the L2 finger with a p-value <0.01, and whorl pattern on the L2 finger with a p-value <0.05. The radial loop fingerprint pattern on finger R2 of the ASD group showed a higher frequency of 7.1%, while the control group had a low frequency of 3.7%. The radial loop fingerprint pattern on the L2 finger of the ASD group showed a higher frequency of 8.5%, while the control group had a low frequency of 4.4%. The whorl fingerprint pattern on the L2 finger of the ASD group showed a lower frequency of 25.5%, while the control group had a higher frequency of 31%.

The findings of two research articles from Kazemi et al[10] and from Lien et al[15], reported that the loop pattern has a significantly higher frequency in the ASD group compared to the control group based on statistical analysis. Both articles reported a higher loop pattern on the L2 finger. Meanwhile, research by Stošljevic and Adamovic[4] reported that the ASD group had a significantly lower frequency of loop patterns on the total of all fingers of the right and left hands based on qualitative data analysis, and instead stated that arch patterns had a significantly higher frequency on the total of all fingers of the right and left hands of the ASD group.

Discussion

The selected journals for review strengthen the evidence of an association between the "loop" fingerprint pattern and Autism Spectrum Disorder (ASD). The findings of this systematic review research are 2 out of 3 studies, namely the studies of Kazemi et al.[10] and Lien et al.[15], stated that there was a significant difference in the frequency of loop patterns on the L2 finger between the ASD group and the control group, where the ASD group has a higher frequency of loop patterns.

The study's findings aligned with the research by Suciandari,[9] whom reported that the loop pattern was the pattern with the highest frequency in ASD patients with atotal of 57.2%, while the lowest frequency was the arch pattern, which was 3.7%. De Bruin's research in Suciandari[9] also stated that the loop pattern in ASD individuals has a higher frequency than in normal individuals. This is also supported by Gabriel,[13] whom stated that the loop and arch patterns have the highest frequency in children with ASD in Nigeria, the radial loop pattern had a higher frequency in the ASD group on the left hand (mean = 4.99%) than the control group (mean = 3.35%), and the ulnar loop pattern has a higher frequency in the ASD group on the right hand (mean = 32.89%) than the control group (mean = 26.56%). Sariza[14] also stated that the index finger of the left hand with ASD had the highest frequency in the loop pattern, namely 53.7% (46.7% ulnar loop and 6.7% radial loop), while the frequency of other patterns, namely whorl (40%) and arch (6.7%). The findings from Stošljevic and Adamovic[4] study stated that there was a significant difference in the frequency of arch patterns on the total of all fingers of the right and left hands between the ASD group and the control group based on qualitative data analysis, where the frequency of arch patterns in the ASD group was higher than the control group. The study stated that the arch pattern had a significantly higher frequency in the ASD group (9.17%) than in the control group (4.34%). This finding is supported by previous research by Gabriel,[13] whom stated that arch and loop patterns had the highest frequency in children with ASD in Nigeria; arch patterns had a higher frequency in the ASD group on the left hand (mean=54.32%) than the control group (mean=26.19%). Arch patterns had a higher frequency in the ASD group on the right hand (mean=50.10%) than in the control group (mean=46.41%).

However, the finding of a higher arch pattern in Stošljevic and Adamovic[4] study was also contradicted by the findings of other studies. Suciandari[9] reported that the arch pattern had the lowest number of ASD patients (3.7%). Research by Kazemi[10] also noted that the arch pattern had a significantly lower frequency in the ASD group than in the control group. The findings of de Bruin[2] also stated that the arch pattern had a lower number in the ASD group (mean=1.53%) than in the control group (mean=1.74%).

This study used two articles using Asian populations (Iran and China) and one article using European populations (Serbia). Several studies explain that ethnic differences influence the fingerprint pattern of a population. The variation of fingerprint patterns in ethnicity is influenced by the interaction of several genes that will form a dominant fingerprint pattern in a population where the fingerprint pattern differs from other populations.[9] Research by Temaj in Suciandari[9] stated that there were significant differences in dermatoglyphic patterns between Albanian and Turkish populations; this is due to reproductive isolation, which causes differentiation in each gene in each population, resulting in differences in dermatoglyphic patterns in each ethnicity.

This systematic review study has several limitations. The first limitation is the variation in diagnostic criteria for ASD across the three reviewed studies. Another limitation lies in the differences in data analysis methods; two studies utilized quantitative data analysis, while one employed qualitative analysis. Additionally, there is a limited number of studies in the past ten years examining the relationship between fingerprint patterns and ASD risk. This scarcity of research affects the quality of study findings, which are at best constrained to a case-control study design.

Conclusion

Based on the findings of this systematic review research, it was found that two studies reported that the ASD group had a significantly higher frequency of loop patterns on the left index finger than the control group. In contrast, one study reported that the ASD group had a higher frequency of arch patterns on the total of all fingers of the right and left hands than the control group. This systematic review concludes that the loop fingerprint pattern on the left index finger can be an additional component in screening for ASD risk.

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