

# Effects of Delivery Method on Skin Diseases and Allergy Status: A Cross-Sectional Study

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## Abstract

**Background:** Recent data support a relationship between gut microbiota and various chronic diseases, with emerging evidence indicating a similar association with skin microbiota. **Objective:** This study aimed to examine the impact of the delivery method on skin microbiota and explore its effects on skin diseases and allergies. Sociodemographic characteristics, which are potential factors impacting skin microbiota, were also considered to investigate this relationship. **Methods:** A cross-sectional study was conducted with 285 pediatric patients. The delivery method, allergy status, age, gender, consanguineous marriage, and parental smoking exposure (PSE) factors were questioned. The present diagnoses of the patients were also recorded. Categorical variables were analyzed using Chi-square analysis. **Results:** An increased risk of infectious skin diseases (ISDs) (viral, bacterial, fungal) and allergies has been observed in cesarean section (CS) ( $P < 0.001$ ,  $P = 0.057$ ). The risk of scabies was higher in normal delivery ( $P = 0.032$ ). There was no significant relationship between the method of delivery and atopic or non-atopic dermatitis. For children born by CS, PSE, and allergies were identified as factors increasing the risk of atopic dermatitis ( $P = 0.045$ ,  $P = 0.018$ ). Allergic children born by CS exhibited a lower prevalence of ISD ( $P = 0.037$ ). In addition, a decrease in ISDs from 21.2% to 10.3% was observed after 3 years of age in normal births ( $P = 0.139$ ). **Conclusion:** Minimizing sociodemographic risk factors and creating a balanced and healthy microbiota, especially in early life, through personal and environmental measures, will be an important part of the treatment of skin diseases and allergies.

**Keywords:** Allergy, cesarean section, delivery method, microbiota, skin diseases

## INTRODUCTION

The rise in cesarean deliveries and evolving disease patterns necessitate comparing conditions in individuals born through normal vaginal delivery (NVD) and cesarean section (CS). The shift in delivery preferences has prompted recent research, particularly in the past few decades, exploring the connection between the increased occurrence of atopic and allergic diseases and the chosen method of delivery.

Multiple studies have examined the link between delivery method and atopic-allergic diseases (e.g., asthma, allergic rhinitis, atopic dermatitis (AD), food allergy). CS is commonly identified as a risk factor for them.<sup>[1,2]</sup>

Additionally, some studies propose that CS could also increase the risk of immune-related conditions like inflammatory bowel diseases, immune deficiencies, and connective tissue disorders.<sup>[3]</sup>

Various factors, including maternal and infant stress, variations in physiological and neurological pathways, and the activation of distinct hormonal pathways based on the delivery method, undoubtedly have diverse effects on the newborn's health. However, in addition to these factors, the microbiota variances attributed to the method of delivery hold distinct and paramount importance concerning newborn health. Recent studies

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**Table 3: Comparisons of atopic dermatitis status in normal and cesarean delivery groups according to sociodemographic characteristics**

Characteristics		Normal delivery					Cesarean delivery				
		Atopic dermatitis					Atopic dermatitis				
		has		not		P value	Has		not		P value
		n	%	n	%		n	%	n	%	
Gender	Female	13	21.3%	48	78.7%	0.260	24	31.2%	53	68.8%	0.221
	Male	19	30.2%	44	69.8%		19	22.6%	65	77.4%	
Age	0-3	19	22.4%	66	77.6%	0.194	34	28.3%	86	71.7%	0.425
	>3	13	33.3%	26	66.7%		9	22%	32	78%	
CM	Yes	8	29.6%	19	70.4%	0.608	4	21.1%	15	78.9%	0.553
	No	24	24.7%	73	75.3%		39	27.5%	103	72.5%	
PSE	Yes	19	29.7%	45	70.3%	0.308	27	33.8%	53	66.2%	0.045
	No	13	21.7%	47	78.3%		16	19.8%	65	80.2%	
Allergy	has	6	46.2%	7	53.8%	0.076	18	40%	27	60%	0.018
	not	26	23.4%	85	76.6%		25	21.6%	91	78.4%	

CM = consanguineous marriage, PSE = parental smoking exposure

**Table 4: Comparisons of non-atopic dermatitis status in normal and cesarean delivery groups according to sociodemographic characteristics**

Characteristics		Normal delivery					Cesarean delivery				
		Non-atopic dermatitis					Non-atopic dermatitis				
		has		not		P value	Has		not		P value
		n	%	n	%		n	%	n	%	
Gender	Female	14	23%	47	77%	0.593	14	18.2%	63	81.8%	0.486
	Male	12	19%	51	81%		19	22.6%	65	77.4%	
Age	0-3	18	21.2%	67	78.8%	0.933	26	21.7%	94	78.3%	0.529
	>3	8	20.5%	31	79.5%		7	17.1%	34	82.9%	
CM	Yes	4	14.8%	23	85.2%	0.375	4	21.1%	15	78.9%	.1.000*
	No	22	22.7%	75	77.3%		29	20.4%	113	79.6%	
PSE	Yes	9	14.1%	55	85.9%	0.051	14	17.5%	66	82.5%	0.349
	No	17	28.3%	43	71.7%		19	23.5%	62	76.5%	
Allergy	has	1	7.7%	12	92.3%	0.298*	7	15.6%	38	84.4%	0.333
	not	25	22.5%	86	77.5%		26	22.4%	90	77.6%	

\*These have at least 1 cell with an expected count of less than 5. Therefore, the P value obtained from Fisher's Exact Test took precedence over Pearson's chi-square. CM = consanguineous marriage, PSE = parental smoking exposure

in both normal and cesarean deliveries. No significant relationship was found between sociodemographic characteristics and allergy status based on the mode of delivery.

## DISCUSSION

In recent studies, the relationship between delivery methods and atopic-allergic diseases has gained increased attention. Asthma, allergic rhinoconjunctivitis, AD, and food allergies have been extensively studied in this context.<sup>[1,2]</sup> In a meta-analysis conducted by Bager *et al.* with 26 studies, it was observed that CS moderately increases the risk of allergic rhinitis, asthma, and food allergy, but not inhalant atopy or AD.<sup>[12]</sup>

In our study, patients with various allergies were grouped together due to the low number of patients in each subtype. Comparing the delivery method and allergic conditions, it was found that CS birth carried a 3.3 times increased risk of developing allergies [Table 2]. Although the precise mechanisms underlying this relationship are still not clarified, it is clear that the early formation and maturation of the infant microbiome has a significant impact on immune system development and prevention of allergic diseases.

Some studies suggest a link between the delivery method and AD,<sup>[13]</sup> but most studies have not found conclusive evidence to support this association.<sup>[12,14,15]</sup> Of course, factors such as genetics, environment, age, and sociodemographic characteristics may influence this



**Table 5: Comparisons of infectious skin diseases (viral, bacterial, fungal) in normal and cesarean delivery groups according to sociodemographic characteristics**

Characteristics		Normal					Cesarean				
		ISD				P value	ISD				P value
		Has		Not			Has		Not		
n	%	n	%	n	%	n	%				
Gender	Female	10	16.4%	51	83.6%	0.699	18	23.4%	59	76.6%	0.281
	Male	12	19%	51	81%		26	31%	58	69%	
Age	0-3	18	21.2%	67	78.8%	0.139	33	27.5%	87	72.5%	0.934
	>3	4	10.3%	35	89.7%		11	26.8%	30	73.2%	
CM	Yes	6	22.2%	21	77.8%	0.570*	2	10.5%	17	89.5%	0.080
	No	16	16.5%	81	83.5%		42	29.6%	100	70.4%	
PSE	Yes	14	21.9%	50	78.1%	0.213	19	23.8%	61	76.3%	0.311
	No	8	13.3%	52	86.7%		25	30.9%	56	69.1%	
Allergy	has	1	7.7%	12	92.3%	0.461*	7	15.6%	38	84.4%	0.037
	not	21	18.9%	90	81.1%		37	31.9%	79	68.1%	

\*These have at least 1 cell with an expected count of less than 5. Therefore, the *P* value obtained from Fisher's Exact Test took precedence over Pearson's chi-square. ISD = infectious skin diseases, CM = consanguineous marriage, PSE = parental smoking exposure

relationship. In our study, no significant association was found between delivery method and AD ( $P = 0.864$ ) [Table 2].

Sociodemographic characteristics and allergy status were also analyzed in normal and cesarean births separately for their impact on AD [Table 3]. Herein, PSE showed a significant association with increased AD in CS ( $P = 0.045$ ). Literature suggests that active smoking and passive smoke exposure are linked to higher AD prevalence in children and adults.<sup>[16]</sup> Smoking likely contributes to AD indirectly by disrupting the microbiota, in addition to its direct effects on the immune system and skin barrier. Consequently, it can be concluded that PSE in CS-born patients may enhance AD susceptibility by influencing the microbiota, immune system, or underlying mechanisms.

In our study, it was observed that having allergies increased the rate of AD in both normal and CS delivery, but this risk was significantly 3.1 times higher in CS ( $P = 0.038$ , 95% CI = 1.065–9.139) [Table 3]. The mechanism behind AD is not fully understood, but factors such as gene interactions, skin barrier defects, infectious agents, host environments, and immunological responses are believed to play a role.<sup>[17]</sup> Recent research emphasizes the importance of allergens in AD.<sup>[18]</sup> The skin's immune response to allergens in AD involves complex processes, including both immediate IgE-mediated and delayed T-cell-mediated responses.<sup>[19]</sup> In this intricate mechanism influenced by multiple factors, a balanced microbiota associated with NVD seems to partially mitigate the occurrence of AD in individuals with allergies.

The study found that the delivery method had no effect on NAD similar to AD ( $P = 0.923$ ) [Table 2]. However, unlike AD, allergy did not impact NAD, and NAD cases were less common in normally born children exposed to parental smoke [Table 4]. This unexpected effect of smoking on

NAD contradicts existing literature, which indicates that smoking irritates the skin due to toxic substances and disrupts blood flow and skin oxygenation.<sup>[20]</sup> Although this result may be influenced by the limited number of patients in the study, it is worth investigating the distinct effects of smoking on the microbiota of normal and cesarean-born children through non-atopic pathways.

Although not statistically significant, ISD was more common in patients born by CS (27.3%) compared to NVD (17.7%) ( $P = 0.057$ ) [Table 2]. Conversely, scabies cases were significantly more prevalent in those born by NVD ( $P = 0.032$ ) [Table 2]. The association between the ISD and CS may be linked to disrupted microbiota and compromised immune response. However, distinct factors need to be considered for the scabies group. The higher incidence of scabies in NVD births could be attributed to differences in the mechanism of parasitic diseases or the presence of unique sociodemographic characteristics among those opting for normal birth, potentially leading to living in less hygienic and more crowded environments.

The infection rate in both the 0–3 and 3+ age groups was similar and high in CS, but it decreased from 21.2% to 10.3% in NVD [Table 5]. Studies on the gut microbiota indicate significant changes until the age of 2–3 years.<sup>[21]</sup> Zhu *et al.* demonstrated that the delivery method continues to affect skin microbiota even up to 10 years of age.<sup>[22]</sup> In this study, the decrease in cases of ISD among the 3+ age group born via NVD may be attributed to the gradual development of the microbiome, enhancing its physical and immunological protective functions over time. The elevated ISD rate in CS up to 10 years of age (26.8%) is likely due to the long-term impact of altered microbiota. However, to support these hypotheses, it will be necessary to obtain statistically significant results in more comprehensive studies.

Allergies were found to be associated with a decreased risk of ISD in patients delivered by CS ( $P = 0.037$ ) [Table 5]. The exact immunological mechanism is unknown, but it is worth noting that attentive care provided to allergic children born via CS and their upbringing in a hygienic environment may have contributed to these results. Additionally, although our results were not statistically significant, further studies could examine whether CM has the potential to decrease the risk of ISD in CS ( $P = 0.080$ ). It is important to consider that besides systemic and local factors, genetic and sociodemographic factors, as well as the limited number of patients, may have influenced our results.

Undoubtedly, the method of delivery affects the health of the newborn in the short or long term through microbiota or other pathways. While our study did not reveal a significant difference in both atopic and NAD groups, the result observed in infectious and allergic diseases suggests otherwise. Furthermore, the finding in our study that PSE raises the risk of AD in individuals born via CS underscores the complexity of the underlying pathophysiology. In conclusion, certain compensatory mechanisms may help mitigate the negative effects of the delivery method. Disruption of this compensation by an internal or external factor such as exposure to smoking may contribute to the occurrence of certain diseases. The variability in research findings, with some studies identifying CS birth as a risk for AD while others do not, could be attributed to these internal and external factors.

While we generally attribute the pathology caused by the method of delivery to dysbiosis, it is evident that, regardless of the etiology, the microbiota plays a crucial role in the compensatory mechanism, considering its systemic, local, and immunologic effects. Therefore, in addition to the standard treatments for diseases, establishing a balanced and healthy microbiota, particularly during early childhood, and maintaining its stability through personal and environmental measures will constitute a significant aspect of the treatment.

The present study has limitations. The statistical significance was adversely impacted by the division of patients into smaller groups due to the extensive examination of numerous factors and diseases within the same study. For this reason, diseases were compared in normal and cesarean delivery categories separately. Further studies involving a large number of patients, which will be conducted separately for certain diseases and factors, will yield more significant results.

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### Conflicts of interest

There are no conflicts of interest.

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