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MATERNAL ATOPY DIATHESIS ON THE NEWBORN'S SKIN ACIDITY AND HYDRATION

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Abstract

Background: *Atopic diathesis, a hereditary predisposition to allergic disorders such as atopic dermatitis, asthma, and allergic rhinitis, is more strongly transmitted maternally. Maternal atopy may influence neonatal skin barrier development, but evidence on its effect on neonatal skin pH and hydration is limited.* ***Methods:*** *This cross-sectional study was conducted at Dr. Moewardi General Hospital, Surakarta, Indonesia, between March–April 2025. Neonates (28–41 weeks gestation), <24 hours old, and delivered by cesarean section were included. Skin pH was measured on the volar forearm and axilla using a calibrated pH meter, and hydration (water and oil content) was assessed with a Skin Tester. Maternal atopy diathesis was classified by the Erlangen Atopy Score (EAS).* ***Results:*** *Twenty-nine neonates were enrolled, comprising 12 with and 17 without maternal atopy. No significant association was found between maternal atopy and neonatal hydration (water: p = 0.460; oil: p = 0.997) or skin pH (p = 0.876).* ***Conclusion:*** *Maternal atopy diathesis was not associated with neonatal skin pH or hydration in the first 24 hours of life. Early neonatal skin physiology appears to be influenced more by intrinsic maturation than maternal atopic status. Longitudinal studies are needed to assess potential delayed effects.*

Keywords**:** *newborn's skin acidity, newborn's skin hidration, maternal atopy diathesis***.**

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INTRODUCTION

Atopic diathesis refers to a constitutional predisposition to develop allergic disorders such as atopic dermatitis, asthma, and allergic rhinitis, often linked to elevated IgE levels and a skewed Th2 immune response (Erdem *et al*., 2024; Kridin *et al*., 2020). Atopic diathesis defined as a hereditary predisposition to produce IgE against environmental allergens. This condition often transmitted more strongly through the maternal than paternal line (Wu *et al*., 2012 Papapostolou *et al*., 2022). Infants born to mothers with atopic conditions, such as atopic dermatitis, allergic rhinitis, or asthma, are more likely to exhibit early skin barrier dysfunction, manifested as elevated trans-epidermal water loss (TEWL) and dry or eczematous skin, which in turn significantly increases their risk for allergic sensitization during the first months of life (Simpson *et al*., 2014; Yonezawa & Haruna, 2019; Rehbinder *et al*., 2020; Wärnberg Gerdin *et al*., 2022). Maternal IgE transferred across the placenta, together with maternal cytokines and intrauterine environmental factors, such as diet or inflammation, is thought to epigenetically program immune cells and possibly skin-barrier development in the fetus and neonate (Marsh *et al*., 2011; Dwyer & Boyce, 2021; Fernandes & Lim, 2024; Balla *et al*., 2025). A protective acidic skin surface, also known as skin acid mantle, is essential for enzymatic lipid processing, microbial balance, and epidermal cohesion. Neonatal skin, however, is more alkaline, with incomplete barrier maturation and lower natural moisturizing factor (NMF), rendering it susceptible to TEWL (Visscher *et al*., 2015; Darlenski & Fluhr, 2023).

Newborn skin hydration undergoes dynamic changes immediately after birth. Although full-term infants gradually achieve hydration levels that can exceed those of adults during the first weeks to months of life, their stratum corneum still exhibits limited water-holding capacity and rapid sorption desorption cycles (Oranges *et al*., 2015). Vernix caseosa, proteins and antimicrobial peptides (AMP), contributes to a lower skin pH and improved hydration in the first days of life, whereas its absence correlates with higher skin pH, greater TEWL, and risk of barrier impairment (Darlenski & Fluhr, 2023). These intrinsic features of neonatal skin may be further influenced by maternal atopic status, yet data directly linking maternal atopy to newborn skin pH and moisture remain scarce.

Understanding the associaation between maternal atopy and neonatal skin acidity and hydration has practical implications. If maternal atopic diathesis indeed shifts neonatal skin toward higher pH and suboptimal hydration, these infants may be at elevated risk of barrier breakdown, microbial dysbiosis, and early onset eczema. Clarifying this link could inform tailored neonatal skincare strategies, for example, early application of pH-balanced emollients or interventions that support NMF levels, to reinforce barrier integrity and possibly reduce progression to atopic dermatitis (Chalmers *et al*., 2017). Thus, investigating the influence of maternal atopy on newborn skin properties may provide an evidence base for preventive dermatologic care beginning immediately after birth.

METHODS

Study Design and Criteria

This research employed an observational analytic approach using a cross-sectional design. It was carried out in the neonatal ward and microbiology laboratory of Dr. Moewardi General Hospital, Surakarta, Indonesia, over a two-month period from March to April 2025. The study population comprised neonates delivered at the hospital during this timeframe, encompassing both term and preterm infants. Eligibility criteria included a gestational age at birth between 28 and 41 weeks, determined from the last menstrual period or ultrasound findings documented in the medical record, an age of less than 24 hours at the time of enrollment, stable vital parameters, an APGAR score of ≥7 at five minutes, and delivery via cesarean section for either absolute or relative indications. Infants were excluded if they experienced fetal distress, had evidence of intrauterine infection, or presented with major congenital anomalies. Ethical clearance was obtained from the Health Research Ethics Committee of Dr. Moewardi General Hospital, Surakarta. Written informed consent was secured from the parents of all neonates prior to participation.

Skin pH and Hydration Measurement

Before assessment, all neonates underwent a 20-minute acclimatization period at room temperature (20–22 °C). Measurements were taken at two anatomical sites: the volar forearm and the axilla. Skin surface pH was determined using a calibrated skin pH meter (Horiba Laqua PH210-

K). During measurement, infants were positioned as close as possible to a neutral anatomical posture. The selected skin area was gently wiped with a dry, additive-free tissue to remove surface residues. Prior to application, the electrode was lightly moistened with distilled water, then placed perpendicular to the skin with minimal pressure to maintain reliable contact without affecting hydration status. Readings were recorded once stabilized, and each site was assessed three times. The average value of the three measurements was used for subsequent analysis. The pH of neonatal skin is categorized as acidic or alkaline. Skin pH is categorized based on median values, with skin pH of 6.7-7.32 categorized as alkaline and skin pH of 6.1-6.63 categorized as acidic.

Neonatal skin hydration was assessed using the Skin Tester SK-8 (Vcare, Shenzhen, China), a non-invasive capacitance-based hydrometer that provides an index of stratum corneum water content as a percentage. Measurements were taken at the dorsal hand, with the device's flat sensor gently touching the skin surface following a minor dry cleaning of the area. Three consecutive readings were obtained per site, allowing sensor stabilization between measurements, and the mean value of the triplicate readings was computed and used for analysis. Ambient environmental conditions were recorded contemporaneously to ensure data reliability.

Maternal Atopy Diathesis Assessment

Maternal atopic diathesis was determined using the Erlangen Atopy Score (EAS), a validated diagnostic tool that combines personal and family history of atopic disorders with characteristic clinical signs to quantify atopic diathesis (Novak *et al*., 2021). The scoring system includes major criteria (such as atopic dermatitis, allergic rhinitis, and bronchial asthma) and minor criteria (including xerosis, cheilitis, and a positive family history), each weighted according to diagnostic relevance. Based on the EAS interpretation, mothers were classified into two categories, with maternal atopy diathesis (EAS ≥10, indicating a high probability of atopic constitution) or without maternal atopy diathesis (EAS <10, indicating no significant atopic tendency). This categorical classification was used to stratify the neonatal subjects for further analysis of skin acidity and hydration outcomes.

Statistical Analysis

Data were analyzed using IBM SPSS version 26. Continuous variables were summarized as mean ± SD or median values, while categorical variables were presented as frequencies and percentages. Associations between maternal atopy diathesis and skin pH and hydration using the Eta correlation test and Chi-Square test. Statistical significance was defined as $p < 0.05$.

RESULTS AND DISCUSSION

Subject's Baseline Characteristics

There were 29 neonates in this study. Several characteristics were presented, namely maternal age, gestational age, gender, birth weight, maternal atopy history, skin pH, and skin hydration. The basic characteristics of the research subjects can be seen in Table 1.

Table 1. Baseline Characteristics

Characteristics	N/ Mean ± SD	Percentage / median (min-max)
Mother' age	30.72 ±5.00	31.00 (20-40)
Gestational Age		
Preterm	16	55.2%
Full-term	13	44.8%
Sex		
Male	12	41.4%
Female	17	58.6%
Birth weight		
Low weight	13	44.8%
Normal weight	16	55.2%
Maternal atopy diathesis		
Present	12	41.4%
Absent	17	58.6%
Skin pH	6.72 ± 0.32	6.82 (6.16-7.23)
Alkaline	15	51.7%
Acid	14	48.3%
Skin hydration (water)	15.93 ±7.65	13.50 (10.20- 46.90)

Characteristics	N/ Mean ± SD	Percentage / median (min-max)
Skin hydration (Oil)	7.66 ± 3.87	6.30 (4.30-21.10)

Maternal Atopy Diathesis Association with Skin Hydration

There were 12 subjects with maternal atopy diathesis and 17 without maternal atopy diathesis. The results of the analysis showed that maternal atopy diathesis was not associated with skin hydration, both skin hydration (water) and skin hydration (oil). However, subjects with maternal atopy diathesis tended to have lower skin hydration (water), meanwhile it relatively similar in skin hydration (oil). The results of the analysis of the association between maternal atopy diathesis and skin hydration can be seen in Tables 2 and 3.

Table 2. Maternal Atopy Diathesis with Skin Hydration (Water)

	Skin Hydration (Water (%))						
	Mean	**±SD**	**Median**	**Minimum**	**Maximum**	**r**	***p***
Maternal Atopy Diathesis						0.143	0.460
Present	14.65	3.89	13.90	10.60	23.40		
Absent	16.83	9.49	12.40	10.20	46.90		

Table 3. Maternal Atopy Diathesis with Skin Hydration (Oil)

	Skin Hydration (Water (%))						
	Mean	**±SD**	**Median**	**Minimum**	**Maximum**	**r**	***p***
Maternal Atopy Diathesis						0.001	0.997
Present	7.66	3.45	6.35	4.70	15.00		
Absent	7.65	4.25	5.90	4.30	21.10		

Maternal Atopy Diathesis Association with Skin pH

In subjects with a history of maternal atopy diathesis, there were 6 subjects with alkaline skin pH and 6 subjects with acidic skin pH. Meanwhile, in subjects without a history of maternal atopy diathesis, there were 9 subjects with alkaline pH and 8 subjects with acidic pH. Data analysis showed no significant association between maternal atopy diathesis history and neonatal skin pH, with a p-value of 0.876. The results of the data analysis can be seen in Table 4.

Table 4. Maternal Atopy Diathesis with Skin pH

	Skin pH		***p***
	Alkaline	**Acid**	
Maternal Atopy Diathesis			0.876
Present	6	6	
Absent	9	8	

Skin Hydration and Gestational Age

Skin hydration was then categorized into good and poor hydration based on a cut-off value of 12.05%. The cut-off value was obtained after conducting an ROC test. The ROC test results are shown in Figure 1.

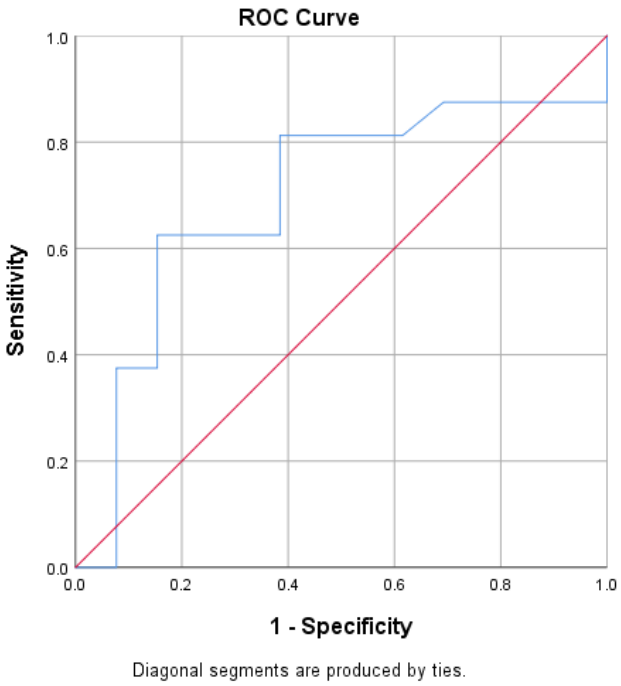

Figure 1. ROC Curve Test for Skin Hydration Category Determination

There were 6 subjects with good skin hydration (water) and 23 with poor hydration, while there were 25 subjects with good skin hydration (oil) and 4 with poor hydration. The analysis results showed no association between skin hydration (water) and gestational age (p=0.183) or skin hydration (oil) and gestational age (p=0.606). The analysis results can be seen in Tables 5 and 6.

Discussion

In our study, we observed no statistically significant association between maternal atopy diathesis, as defined by the EAS, and neonatal skin pH or skin hydration (both water and oil). This finding suggests that maternal atopic propensity may not necessarily modulate early postnatal epidermal barrier properties. Neonatal skin barrier maturation is principally driven by intrinsic processes. Adaptation from the intrauterine alkaline milieu toward an acid mantle, increasing stratum corneum hydration, and functional maturation of eccrine and sebaceous glands (Darlenski & Fluhr, 2023). The lack of difference between groups may reflect that these endogenous maturational trajectories, such as vernix residual effects, NMF synthesis, and acidification dynamics, predominate over maternal atopy influence in the immediate newborn period (Oranges *et al*., 2015; Rahma & Lane, 2022).

A possible explanation is that maternal atopic diathesis influences later skin barrier vulnerability, such as the risk for atopic dermatitis, rather than baseline physicochemical parameters at birth. Infant skin physiology evolves rapidly over the first days and weeks post-partum, skin pH drops from alkaline toward adult levels, hydration increases, and sebaceous function gradually develops (Ye *et al*., 2021; Tang *et al*., 2025). If maternal atopy alters skin structure or immune predisposition, such effects may manifest only after environmental exposures or during critical windows of barrier challenge such as in in dry, cold climates or with irritant products (Engebretsen *et al*., 2017; Danby *et al*., 2025). Thus, the null findings in this immediate postnatal context do not invalidate maternal atopy as a risk factor for later atopic outcomes, but rather suggest its impact is not apparent in early skin pH or hydration metrics.

Moreover, variation in skin barrier markers across body sites and gestational maturity might dilute potential group differences. Several studies document anatomical and postnatal age-dependent variation in skin hydration and pH. Higher capacitance on palms and forearms versus lower values at trunk sites, faster maturation in term versus preterm infants and vernix retention influencing hydration locally (Oranges *et al*., 2015; Rahma & Lane, 2022; Darlenski & Fluhr,

2023). If maternal atopy effects are subtle, they may be masked by this physiological heterogeneity unless measured longitudinally or with larger sample sizes. Finally, the instruments used measure superficial parameters at the skin-electrode interface, not the deeper correlates of barrier integrity such as NMF concentration, lipid enzyme function, or immune markers. Maternal atopy could influence these deeper biochemical or immunologic axes without altering surface capacitance or pH readings (Oranges *et al*., 2015; Rahma & Lane, 2022). Thus, more sensitive or molecularly-targeted assessments, or longitudinal follow-up into infancy when atopic phenotypes begin, may be necessary to detect subtle atopy-mediated differences.

Our study also demonstrated that the majority of neonates exhibited poor skin hydration when assessed by water content, while oil-based hydration appeared relatively well-preserved. Importantly, no significant associations were found between gestational age and either water or oil skin hydration, despite prior evidence suggesting that prematurity may be linked to impaired skin barrier function. Previous studies have consistently reported that preterm infants have higher TEWL, reduced NMF, and incomplete lipid organization compared with term infants, leading to increased susceptibility to dehydration and irritant exposure (Darlenski & Fluhr, 2023; Yonezawa & Haruna, 2019; Visscher et al., 2015). However, our findings suggest that, within the first 24 hours of life, differences in stratum corneum hydration between term and preterm neonates may not yet be pronounced or detectable using capacitance-based assessment. Vernix caseosa, which is more abundant in late-gestation neonates, has been shown to enhance surface hydration and reduce TEWL during the immediate neonatal period (Oranges *et al*., 2015). Nonetheless, its variable retention after delivery may confound hydration measurements independent of gestational age. Additionally, the oil content of neonatal skin, largely influenced by sebaceous activity stimulated by maternal androgens, tends to be relatively high in the early postnatal period and may mask subtle differences across gestational groups (Stamatas *et al*., 2010). Taken together, these findings suggest that intrinsic factors governing neonatal hydration dynamics may override gestational differences immediately after birth, while clinically meaningful divergences are more likely to emerge during the subsequent weeks of postnatal skin adaptation. Longitudinal assessment, incorporating biochemical analysis of NMF and lipid composition, would provide more definitive insight into how gestational maturity influences hydration trajectories in neonatal skin.

CONCLUSION

This study found no significant association between maternal atopy diathesis and neonatal skin hydration (both water and oil content) or skin pH within the first 24 hours of life. Similarly, analysis of skin hydration across gestational ages revealed no relationship between gestational maturity and either water-based or oil-based hydration. Interestingly, although most neonates exhibited poor water hydration, the majority demonstrated good oil-based hydration, suggesting that sebaceous activity may remain preserved irrespective of gestational age. These findings indicate that, in the immediate postnatal period, neonatal skin barrier characteristics appear to be shaped more by intrinsic physiological processes of adaptation than by maternal atopic background or gestational maturity.

This study has several limitations that should be acknowledged. First, its cross-sectional design with measurements taken only within the first 24 hours after birth may not capture delayed or cumulative effects of maternal atopy on skin barrier development, which could emerge later in infancy. Second, the parameters assessed, skin surface pH and superficial hydration using capacitance methods, reflect only surface characteristics of the stratum corneum, without evaluating deeper biochemical markers such as natural moisturizing factor levels, lipid metabolism, or cytokine activity, which may be more sensitive to maternal atopic influence. Third, physiological heterogeneity among neonates, including differences in gestational age, body site variability, vernix caseosa retention, and environmental conditions at the time of measurement, may have masked subtle associations. The modest sample size further limits the statistical power to detect small effect sizes.

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