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ORIGINAL ARTICLE

Climate Factors Contribute to Irritant Contact Dermatitis Among Farmers: A Study in East Java, Indonesia

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ABSTRACT

Introduction: Irritant contact dermatitis is a common occupational disease among farmers, often triggered by environmental stressors. In Indonesia, particularly in Jember and Wuluhan District, over 70% of the population is engaged in farming, increasing vulnerability to climate-related health issues. This study aimed to examine the association between climate variables and the incidence of irritant contact dermatitis among farmers in Wuluhan District, East Java. **Methods:** A retrospective study was conducted using outpatient records from Lojejer Primary Healthcare Facility from July 2022 to December 2024. Included cases were farmers aged ≥17 years diagnosed with irritant contact dermatitis. A total of 462 dermatitis cases were recorded. Climate data—temperature, humidity, and wind flow—were obtained from the World Weather Satellite. Multiple linear regression assessed the relationship between monthly dermatitis cases and climate variables. Significance was set at $p < 0.05$. **Results:** Humidity was significantly associated with increased dermatitis incidence ($p = 0.047$; 95% CI: 1.464 to 0.011; $R^2 = 0.369$), suggesting a moderate predictive value. In contrast, temperature ($p = 0.274$) and wind flow ($p = 0.624$) were not significant. **Conclusions:** Humidity significantly contributes to irritant contact dermatitis among farmers, likely due to prolonged skin exposure and barrier dysfunction. These findings underscore the need for climate-responsive occupational health strategies, such as improved protective equipment and work schedule adaptations, to safeguard farmer health amid changing environmental conditions.

Keywords: climate, dermatitis, farmers, humidity, Indonesia, occupational diseases

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INTRODUCTION

Irritant contact dermatitis (ICD) represents a major occupational health issue globally, with agricultural workers among the most affected groups (Jacobsen *et al*., 2022). Estimates suggest that the prevalence of ICD in this workforce ranges between 10% and 30%, depending on geographical and methodological differences (Bains, Nash and Fonacier, 2019; Li and Li, 2021). In the Indonesian context, however, the condition often goes underdiagnosed and insufficiently addressed, despite being a common complaint among rural agricultural communities(Wulandari, 2023). Notably, from July 2022 to December 2024, the Lojejer Primary Healthcare Facility in Wuluhan District, East Java, documented 462 cases of ICD among local farmers. This figure reflects a concerning rise in cases and highlights the occupational risks faced by a population in which more than 70% rely on farming as their primary livelihood (BPS, 2024).

ICD has effects that go beyond simple skin discomfort. Redness, scaling, fissuring, and persistent itching are some of the symptoms that can result from the skin's natural defense mechanisms being harmed by constant exposure to irritants. These symptoms can have a major impact on a person's capacity to work effectively, and they are frequently made worse by limited access to healthcare and little use of protective gear. This could eventually result in lower income, heightened vulnerability to infections, or even chronic impairment that could

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prevent long-term work. (Milam *et al*., 2020; Patel and Nixon, 2022).

Various environmental elements can significantly influence the onset and progression of irritant contact dermatitis (ICD), especially in outdoor work environments like farming. Conditions such as high humidity, temperature extremes, and wind exposure are key contributors. Excessive humidity can cause the skin to remain overly moist, weakening its natural protective barrier and increasing susceptibility to harmful substances like soil particles and agricultural chemicals. On the other hand, high temperatures can compromise the skin's resilience, while wind may disperse irritants such as dust and pesticide residues, enhancing exposure risks. These environmental stressors, when paired with the routine chemical and physical exposures typical in agricultural work, can heighten the likelihood of skin disorders. Moreover, the effects of climate change, marked by erratic weather patterns, more intense rainy periods, prolonged heatwaves, and humidity surges, are further complicating these risks. Farmers, who often spend long hours outdoors, are particularly vulnerable to these changes. Despite these growing concerns, research specifically investigating how evolving climatic conditions affect ICD among Indonesian farming communities remains limited and underdeveloped. (Kantor and Silverberg, 2017; Novak-Bilić *et al*., 2018).

This study was conducted in Wuluhan District, East Java, Indonesia, an agricultural hub within Jember Regency, where farming constitutes the primary livelihood for the majority of residents. The region experiences a tropical monsoon climate, characterized by high humidity and fluctuating temperatures, especially during peak agricultural periods. These environmental conditions, combined with frequent contact with soil, fertilizers, pesticides, and other irritants, create a high-risk setting for the development of ICD. From 2022 to 2024, an extraordinary surge in ICD cases was observed, with 462 documented cases among farmers reported by Lojejer Primary Healthcare Facility, a number substantially higher than typically reported in similar settings. This rise underscores the urgent need to explore local environmental determinants of ICD.

Despite growing awareness of both ICD and the impacts of climate change, research linking specific climate variables to ICD incidence in Indonesian agricultural settings remains scarce. This study aims to examine the association between temperature, humidity, and wind flow and the incidence of irritant contact dermatitis among farmers in Wuluhan District from July 2022 to December 2024.

METHODS

Study Design and Setting

This retrospective ecological time-series study was conducted in Wuluhan District, a predominantly agricultural area in Jember Regency, East Java, Indonesia. The region experiences a tropical monsoon climate with significant seasonal variation in temperature, humidity, and wind flow, environmental conditions that may influence the incidence of skin-related diseases among outdoor workers, such as farmers. Notably, an outbreak of irritant contact dermatitis (ICD) occurred between July 2022 and December 2024, with a substantial surge in reported cases, emphasizing the urgency to investigate environmental determinants contributing to this occupational health issue.

Health Data Collection

Outpatient medical records were reviewed from the Lojejer Primary Healthcare Facility for the period July 2022 to December 2024. The inclusion criteria were as follows:

1. Individuals aged ≥17 years,
2. Professionally identified as farmers, and

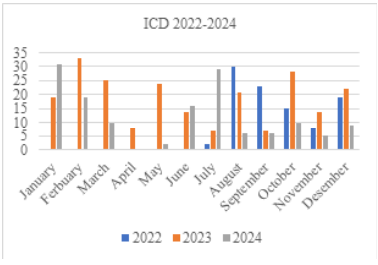

Figure 1. ICD March 2022 - December 2024

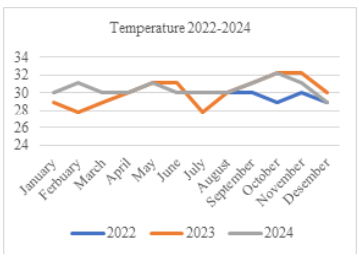

Figure 2. Temperature March 2022 - December 2024

3. Diagnosed with irritant contact dermatitis (ICD) by a certified medical doctor.

Cases with incomplete records, non-occupational dermatitis, or other dermatological diagnoses such as allergic contact dermatitis were excluded. Based on these criteria, a total of 462 ICD cases were documented during the study period. Monthly case counts were aggregated for subsequent analysis.

Climate Data Collection

Monthly climate data, including average temperature (°C), relative humidity (%), and wind flow (m/s), were obtained from the World Weather Satellite database to ensure spatial relevance and accuracy in local environmental exposure estimation.

Data Analysis

Descriptive statistics were used to summarize ICD case counts and climate trends across the 30-month period. Temporal patterns were visualized using line graphs to examine fluctuations in disease incidence relative to environmental conditions.

To investigate the relationship between climate variables and ICD incidence, multiple linear regression analysis was performed, using monthly ICD case numbers as the outcome variable. All three climate parameters were entered simultaneously into the model. The level of statistical significance was set at $p < 0.05$, and multicollinearity was evaluated using the variance inflation factor (VIF). Results are reported as beta coefficients, 95% confidence intervals, and p-values.

Ethical Considerations

This study received ethical approval from the Health Research Ethics Committee, Faculty of Dentistry, University of Jember (Approval Number:3139/UN25.8/KEPK/DL/2025). All patient information was anonymized prior to analysis to protect confidentiality.

RESULTS

From July 2022 to December 2024, a total of 462 cases of irritant contact dermatitis (ICD) were reported among farmers in Wuluhan District. The monthly distribution revealed clear seasonal patterns, particularly in 2023 and 2024. In 2023, peaks occurred in February (33 cases), March (27 cases), and October (28 cases), while in 2024 the highest counts were observed in January (34 cases), July (29 cases), and February (20 cases). These high-incidence months often coincided with elevated humidity; for example, March 2023 reached 85% and January 2024 reached 86% aligning with increased ICD occurrence. While this supports a link between high humidity and dermatitis risk, these same months also correspond to intensive farming activities such as planting, weeding, and pesticide spraying, which increase prolonged skin contact with wet soil and agrochemicals. This suggests that both climatic conditions and seasonal agricultural practices likely contribute to the observed peaks. Overall, monthly case counts ranged from 0 to 33, with an average of 15.40 cases per month (SD = 9.62) (Figure 1). During the same period, environmental measurements showed average monthly temperatures between 27.78°C and 32.22°C (mean = 30.15°C, SD = 1.26), humidity between 66% and 90% (mean = 83.03%, SD = 4.80), and wind flow between 1.60 and 90.00 (mean = 86.27, SD = 2.08) (Figures 2–4, Table 1).

A multiple linear regression analysis was conducted to evaluate the association between monthly ICD cases and the climate variables of temperature, humidity, and wind flow. The analysis revealed that humidity was a statistically significant predictor of ICD incidence. The positive coefficient ($R^2 = 0.369$) and confidence interval (95% CI: 0.011–1.464) suggest that increases in ambient

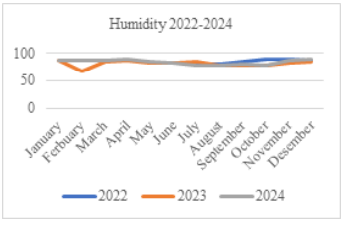

Figure 3. Humidity March 2022 - December 2024

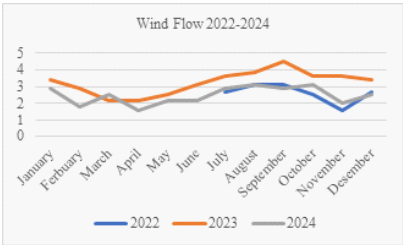

Figure 4. Humidity March 2022 - December 2024

humidity are associated with a higher number of ICD cases among farmers.

In contrast, temperature and wind flow did not show statistically significant associations with ICD incidence. Although the temperature had a negative coefficient (R^2 = -0.201), the wide confidence interval (-2.633 to 0.780) and p-value of 0.274 suggest a weak and non-significant relationship. This may indicate that temperature variations within the study period were not extreme enough to affect skin integrity substantially. Similarly, wind flow also demonstrated a non-significant association (R^2 = 0.103, p = 0.624), with a broad confidence interval (-4.577 to 7.489), suggesting limited influence on ICD cases.

DISCUSSION

This study provides evidence that environmental conditions, particularly humidity, are significantly associated with the incidence of irritant contact dermatitis among farmers in Wuluhan District, East Java. Our findings highlight the role of climate in occupational skin diseases, especially in tropical, agriculture-dependent regions. While temperature and wind flow were not statistically associated with ICD incidence, the significant association with humidity underscores the importance of localized environmental monitoring in understanding occupational health risks (Houle, Holness and DeKoven, 2021; Suryani and Shofwati, 2023).

The observed relationship between humidity and ICD is consistent with the pathophysiological understanding of how moisture affects the skin. High humidity levels can lead to prolonged skin dampness and maceration, compromising the skin barrier and increasing its permeability to irritants such as soil, pesticides, and fertilizers. For outdoor agricultural workers who often wear occlusive clothing and have limited access to hygiene facilities, elevated humidity may create a sustained environment of moisture exposure, thereby accelerating the onset or worsening of ICD (Cohen, 2017; Brans, John and Frosch, 2021).

Although temperature did not show a statistically significant link to ICD in this study, it remains an important factor to consider for skin health. One possible reason for the lack of association is the relatively narrow fluctuation in temperature throughout the year in Wuluhan District, which may not provide enough contrast to reveal its impact. Furthermore, local farmers may have adapted to heat exposure by modifying their routines, for instance, working earlier in the morning or taking breaks during peak sunlight hours. It's also worth noting that temperature could indirectly impact the skin through interactions with elements not covered in this study, such as UV radiation or perspiration. These possibilities suggest that broader investigations are needed to uncover the more complex or indirect ways in which heat may influence the development of skin disorders like ICD (Bains, Nash and Fonacier, 2019; Suaini *et al*., 2021).

Similarly, wind flow was not found to be a significant determinant of ICD in this context. This could be attributed to the relatively low and stable wind speeds observed during the study period, which may not have been sufficient to significantly alter the dispersion of airborne irritants like dust or pesticide particles (Patella *et al*., 2020; Xiong *et al*., 2024). Furthermore, the direct contact nature of most agricultural tasks in East Java likely exposes workers more to soil and chemical substances through tactile means than through airborne routes (Diah, 2024). As such, in contrast to drier or dustier regions, wind might have a minimal influence on dermatitis occurrence in this specific environment (Zhang *et al*., 2018).

Given these findings, there is a pressing need to develop occupational health interventions tailored to the climatic realities of farming communities. Prioritizing health education and outreach during periods of high humidity may help mitigate the effects of environmental exposure. Farmers should be encouraged to adopt practical measures, such as using breathable protective clothing, practicing

Table 1. Descriptive table of the variables

Variable	Minimum	Maximum	Mean	Std. Deviation
ICD	0	33	15.40	9.62
Temperature	27.78	32.22	30.15	1.26
Humidity	66	90	83.03	4.80
Wind Flow	1.60	90.00	86.27	2.08

Table 2. Multiple liniar regression of predictors

Covariate	R2	95%CI	P value
Temperature	-0.201	-2.633-0.780	0.274
Humidity	0.369	1.464-0.011	0.047*
Wind Flow	0.103	-4.577-7489	0.624

regular handwashing, and taking scheduled rest periods during peak climate stress. In addition, incorporating weather surveillance into public health frameworks could help anticipate spikes in skin-related health issues.

It's also important to acknowledge the role of behavior and socio-environmental context in amplifying climate-related risks. (Heidari and Lawrence, 2023). For instance, many farmers in rural Indonesian areas, including Wuluhan, often continue working in damp or contaminated clothing, particularly during intense agricultural cycles like planting and harvesting. When combined with limited access to clean water or personal hygiene facilities, these habits can increase the likelihood of skin irritation under humid conditions. Therefore, public health interventions must integrate education on behavioral risk factors alongside environmental strategies (Gray, 2018; Garrido *et al*., 2020).

Beyond behavioral factors, the nature of farming practices during the wet season often increases farmers' exposure to skin irritants. Tasks such as pesticide application, hand weeding, and seedling transplantation typically involve frequent and extended contact with damp soil and chemical agents. When performed without proper protective equipment like gloves, these activities can significantly weaken the skin's natural barrier. Understanding how these agricultural routines vary across seasons could help clarify when and why flare-ups of irritant contact dermatitis are more likely to occur. (Steiman *et al*., 2020; Boonupara *et al*., 2023).

These findings emphasize the importance of interdisciplinary cooperation in addressing occupational health issues driven by climate conditions. Integrating climate monitoring data with healthcare information could help researchers and policymakers identify patterns and forecast periods of heightened risk. This would allow for the development of early warning systems tailored to vulnerable populations. In regions with limited access to healthcare, community health workers could play a vital role in distributing timely alerts and preventive advice to farmers. Implementing such integrated strategies has the potential to significantly strengthen public health interventions at the intersection of environmental change and occupational risk. (Rees *et al*., 2019; Yeh *et al*., 2023).

It is also important to consider the implications of climate change on future patterns of occupational skin disease. As global temperatures rise and humidity levels increase in tropical regions like East Java, it is plausible that the burden of ICD and other climate-sensitive diseases will escalate. This study, therefore, not only reflects current challenges but also signals a need for long-term adaptation planning in occupational health policy. Anticipatory frameworks that account for projected environmental shifts will be essential to safeguard vulnerable labor sectors such as agriculture (Montt, Fraga and Harsdorff, 2018)

Lastly, this study contributes to the growing recognition of climate as a social determinant of health. By revealing how environmental factors interact with occupational exposures, it broadens the scope of public health beyond traditional biomedical models. This perspective encourages a more holistic view of health interventions—one that includes infrastructure improvements, worker empowerment, and climate resilience. Investing in research and infrastructure that support healthy working conditions under changing environmental circumstances will be vital for promoting health equity among rural and agricultural populations.

While this study provides valuable insights, it is not without limitations. The ecological design restricts causal inferences, and individual-level data, such as personal protective equipment use, duration of exposure, and comorbidities, were not available. Moreover, other environmental or behavioral factors may confound the relationship between climate and ICD. Future research should incorporate longitudinal individual-level studies, explore additional meteorological variables, and assess the effectiveness of targeted preventive strategies. Nonetheless, this study adds to the growing body of evidence on the health impacts of climate variability in vulnerable working populations.

CONCLUSION

In conclusion, this study highlights the significant influence of climatic conditions, particularly humidity, on the incidence of irritant contact dermatitis (ICD) among farmers in Wuluhan District, East Java, Indonesia. The findings emphasize the heightened vulnerability of agricultural workers to dermatological conditions in tropical, high-humidity environments, where prolonged exposure to moisture and chemical irritants can compromise skin integrity. Although temperature and wind flow were not significantly associated with ICD in this

context, the environmental stressors collectively underscore the importance of integrating climate data into occupational health surveillance and intervention planning. Given the growing impact of climate change on local weather patterns, proactive measures such as improved health education, protective gear usage, and timely medical access are essential to mitigate the burden of ICD in rural farming communities. Future research should explore individual-level risk factors and intervention effectiveness to further enhance the resilience of agricultural populations to climate-sensitive health outcomes.

CONFLICT OF INTEREST

The authors declare that there is no significant competing financial, professional, or personal interests that might have affected the performance

AUTHORS' CONTRIBUTION

KAA: conceptualization, methodology, data analysis, investigation, draft manuscript; RKF: conceptualization, validation, writing-review and editing, supervision, funding acquisition; SA: validation, writing-review and editing

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