

ORIGINAL ARTICLE

Associations Between Household Characteristics, Building Occupants' Daily Activities, and Their Atopic Diseases: A Cross-Sectional Study in Kampar

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ABSTRACT

Introduction: Atopic diseases can be influenced by environmental factors. Malaysia's humid tropical climate promotes the proliferation of mould and dust mites, potentially triggering sensitisation. This study aims to fill the research gap by investigating the relationships between household characteristics, occupants' activities and atopic diseases (asthma, eczema, rhinitis) among adults in Kampar town, Malaysia. **Materials and Methods:** A cross-sectional survey (n=231) was conducted in Kampar from January 2023 to August 2024. Socio-demographic data, household characteristics, daily activities, and atopic diseases of the respondents were recorded. Multilevel logistic regression (STATA 18.0) was performed to analyze the associations between study variables and atopic diseases. **Results:** Floor sweeping (OR: 0.669) and frequency of air conditioner usage (OR: 0.592) showed significant negative associations with asthma, whereas frequency of air purifier usage showed a positive association (OR: 1.464) with asthma. Home renovation in the past 12 months (OR: 2.709) and any signs of home dampness (OR: 2.292) were positively associated with rhinitis, whereas cleaning activities (ORs range: 0.762-0.860) were negatively associated with rhinitis. The presence of cockroaches (OR: 1.813), frequent pan-frying (OR: 1.558), and indoor dampness conditions (ORs range: 2.671-3.297) were significantly associated with eczema ($p < 0.05$). **Conclusion:** Household cleaning and ventilation mitigate risks of asthma and rhinitis, while adverse indoor conditions, including dampness and pests, elevate the likelihood of atopic diseases. Future research could explore additional variables, such as isolated kitchens and footwear habits, to further clarify these associations.

Malaysian Journal of Medicine and Health Sciences (2026) 22(s8):161-166.doi:10.47836/mjmhs.22.s8.22

Keywords: Atopic diseases, House characteristics, Daily activities, Home environment, Dampness

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INTRODUCTION

Atopic diseases, specifically asthma, rhinitis, and eczema, are allergic reactions caused by an exaggerated immune response, which can be worsened by environmental factors and daily activities. Human activities such as smoking produce environmental tobacco smoke (ETS), while home renovation and painting release indoor air pollutants that aggravate

respiratory symptoms [1]. Airborne pollutants can induce oxidative stress and inflammation. Thereby increasing the permeability of epithelial barriers in the respiratory tract, causing sensitisation and trigger airway hyperreactivity. Malaysia's hot, humid climate provides an optimum environment for mould growth and dust mite proliferation. A humid environment allows mould spores to germinate, indirectly increasing sensitisation risks [2].

Globally, the prevalence of asthma among adults is estimated at 4.3%, compared to 6.2% in Malaysia [3]. The prevalence of allergic rhinitis is 8.7% in the Asia-Pacific region and 7.1% in Malaysia [4]. These atopic conditions pose a substantial burden on public health

and can significantly affect individuals' quality of life, productivity and overall well-being. Thus, understanding the risk factors associated with atopic conditions is essential for developing effective prevention and management strategies. Previous research conducted in classrooms [5] and office settings [2][6][7] have identified personal factors, dampness problems, building-related activities, and exposure to air pollutants may exacerbate atopic diseases. However, most existing indoor air quality studies in tropical climates have primarily focused on institutional or workplace environments, while comparatively limited research has examined these risk factors within household settings [8], where individuals typically spend a substantial portion of their time. The household environment may present unique exposure patterns and environmental conditions that could influence the development or aggravation of atopic diseases. Therefore, this study aims to examine the associations between household characteristics, daily living habits, and the prevalence of atopic diseases among adults in Kampar town. This study is important because it would contribute to a better understanding of Malaysian household-related exposures and support the development of targeted, effective interventions to improve indoor environmental quality and reduce the burden of atopic diseases in the community.

MATERIALS AND METHODS

This cross-sectional study was carried out between January 2023 and August 2024 in Kampar, Malaysia. It used a self-administered questionnaire (adapted from previous published studies [2], [9], [10]), covering a total of four sections, Section A: socio-demographics, Section B: household characteristics, Section C: daily activities, and Section D: atopic diseases (asthma, rhinitis, and eczema). The questions regarding the atopic diseases, with 'yes' or 'no' options, were as follows: "Have you been diagnosed by doctor with the following diseases?" 1) Asthma; 2) Nasal allergies (rhinitis); 3) Skin allergies (eczema). Another question "Have you ever had a problem with sneezing, or a runny nose or a blocked nose when you did not have a cold or flu in the last 12 months", with options 'yes' or 'no', was used to verify rhinitis. Eligible participants were identified by using a community-based household survey approach. The questionnaire content was reviewed by the researchers, who are experts in the indoor air quality field, and the questionnaire was pretested before distribution to the study respondents (Cronbach's $\alpha = 0.73$) [11]. A total of 231 residents (aged 13-64), who resided in terrace houses, apartments, or condominiums, were randomly selected to participate in the survey questionnaires. Exclusions included COVID-19 infection within two weeks or residency in shop lots, industrial buildings, or homestays. Descriptive analysis was performed to analyse the prevalence of atopic diseases, frequency of house characteristics, daily activities and habits of respondents. Chi-square test (Statistical Package for

the Social Sciences version 28.0) was performed to determine the associations of household characteristics with any atopic diseases. Multilevel logistic regression (STATA 18.0) was performed to analyse the associations between household characteristics, daily activities, and atopic diseases, adjusted for confounders such as age, gender, and exposure to cigarette smoke. All tests were conducted at a 95% confidence interval, with a significance level of $p < 0.05$.

ETHICAL CLEARANCE

This study was approved by Universiti Tunku Abdul Rahamn Scientific and Ethical Review Committee (Ref: U/SERC/22/2023).

RESULTS

A total of 231 respondents participated in this study, with 51.1% ($n=181$) females. The mean age of the respondents was 30 years (range 13-64 years), with a majority of Chinese (50.7%, $n=117$), followed by Malay (38.8%, $n=89$) and Indians (10.2%, $n=23$). Most of the respondents with a mean weight of 61 kg (standard deviation = 12.35 kg). The prevalence of asthma, rhinitis and eczema were 6.1% ($n=14$), 57.6% ($n=133$) and 13.4% ($n=31$), respectively (**Table I**). This study found that houses renovated in the last 12 months ($p=0.037$) and the presence of damp stain ($p=0.013$) were associated with atopic diseases. More than half of the respondents 65.4% ($n=151$) lived near busy or main roads; 54.1% ($n=125$) observed home damp stains, 43.3% ($n=100$) observed visible mould spots at home, and 22.1% ($n=51$) were smokers or exposed to second-hand tobacco smoke (**Table II**). Besides, 30.3% ($n=70$) raised furry pets in their indoor house, and 58.0% ($n=134$) were using LPG as cooking fuel. Pest infestation was commonly reported among the respondents' households. Approximately 51.1% ($n=118$) reported occasional ('sometimes') presence of cockroaches in their homes, 46.3% ($n=107$) reported the occasional ('sometimes') presence of houseflies or mosquitoes, while 27.7% ($n=64$) reported rare presence of mice or rats in their households.

For the daily living habits, half of the respondents (50.6%, $n=117$) always switched on air conditioning, while only 5.6% ($n=13$) always used an air purifier (**Table III**). Home cooking was common (60.2%, $n=139$), primarily using boiling or steaming (56.7%, $n=131$) and pan frying (54.6%, $n=126$). Multilevel logistic regression with adjustment (exposure to tobacco cigarette smoke, gender, and age) analysis showed house renovation in the past 12 months was positively associated with rhinitis (OR=2.71, $p=0.009$) (**Table IV**). The presence of rats was associated with rhinitis (OR=1.79, $p=0.015$), while cockroach presence was associated with eczema (OR=1.81, $p=0.043$). Household dampness problems showed significant associations, in which damp stains

Table I: Associations between house characteristics and atopic diseases (n=231).

Variable	Frequency, n (%)					(p-value)
	Asthma [n = 14 (6.1%)]	Rhinitis [n = 133 (57.6%)]	Eczema [n = 31 (13.4%)]	With any atopic dis- ease(s) ^b	Without any atopic disease ^b	
Renovated in last 12 months	4 (1.7%)	38 (16.5%)	9 (3.9%)	38 (16.5%)	14 (6.1%)	4.371 (0.037)
<200m from high traffic density road	8 (3.5%)	85 (36.8%)	18 (7.8%)	89 (38.5%)	62 (26.8%)	0.507 (0.477)
Present of visible mould spot ^a	4 (1.7%)	55 (23.8%)	18 (7.8%)	62 (26.8%)	38 (16.5%)	0.144 (0.705)
Present of mould odour ^a	1 (0.4%)	5 (2.2%)	0 (0%)	5 (2.2%)	3 (1.3%)	2.421 (0.298)
Water damage ^a	8 (3.5%)	55 (23.8%)	17 (7.4%)	58 (25.1%)	30 (13.0%)	1.674 (0.196)
Presence of damp stain ^a	10 (4.3%)	79 (34.2%)	23 (10.0%)	85 (36.8%)	40 (17.3%)	6.238 (0.013)
Expose to tobacco cigarettes smoke	8 (3.5%)	28 (12.1%)	9 (3.9%)	33 (14.3%)	18 (7.8%)	0.461 (0.497)
Raise furry pets indoor	3 (1.3%)	38 (16.5%)	12 (5.2%)	42 (18.2%)	28 (12.1%)	0.015 (0.901)

n= number of respondents

^a indicate the dampness conditions on wall/floor or ceiling in last 12 months

^batopic disease = asthma, rhinitis, eczema

Table II: Household characteristics, home dampness and pest issues reported by respondents (n=231).

Variable	Frequency, n (%)	
< 200 m near to highway/ busy road	Yes	151 (65.4)
Renovated in last 12 months	Yes	52 (22.5)
	<500	7 (3.0)
Estimated indoor house size (sqft)	501-1000	24 (10.4)
	1001-1500	178 (77.1)
	>1500	22 (9.5)
Present of visible mould spot ^a	Yes	100 (43.3)
Present of mould odour ^a	Weekly	8 (3.5)
	Sometimes	103 (44.6)
Water damage ^a	Yes	88 (38.1)
Present of damp stain ^a	Yes	125 (54.1)
Expose to tobacco cigarettes smoke	Yes	51 (22.1)
Raise furry pets indoor	Yes	70 (30.3)
Fuel use for cooking	Natural gas	134 (58.0)
	Electricity only	97 (42.0)
	Always	26 (11.3)
	Sometimes	118 (51.1)
Presence of cockroaches	Rarely	79 (34.2)
	Never	8 (3.5)
	Always	2 (0.9)
Presence of mice or rats	Sometimes	19 (8.2)
	Rarely	64 (27.7)
	Never	8 (3.5)
	Always	55 (23.8)
Presence of houseflies or mosquitoes	Sometimes	107 (46.3)
	Rarely	51 (22.1)
	Never	18 (7.8)

^a indicate the dampness conditions on wall/floor or ceiling in last 12 months

were associated with eczema (OR=2.67, p=0.025), and any dampness sign was associated with both rhinitis (OR=2.29, p=0.005) and eczema (OR=3.30, p=0.020). For the cleaning activities, sweeping the floor showed a significant negative association with asthma, indicating a protective effect (OR=0.669, p=0.032) and vacuuming the floor was negatively associated with rhinitis (OR=0.860, p=0.037), similar to sanitising furniture was associated with a lower likelihood of rhinitis (OR=0.762, p=0.004). The use of air conditioning was also negatively associated with asthma (OR=0.592, p=0.005).

In contrast, use of an air purifier was significantly

associated with asthma (OR=1.464, p=0.041) and rhinitis (OR=1.407, p=0.019). The use of insect repellents was also associated with rhinitis (OR=1.392, p=0.021). Regarding cooking activities, cooking frequency was significantly associated with eczema (OR=1.714, p=0.020), while pan frying was also significantly associated with eczema (OR=1.558, p=0.017).

DISCUSSION

Home dampness was significantly associated with eczema and rhinitis. Recent renovation, frequent cooking, insect repellent use, air-conditioning, and

Table III: Frequency of different daily activities reported by the respondents (n=231).

Activity	Frequency, n (%)				
	Always	Often	Sometimes	Rarely	Never
Usage of air-conditioner	117 (50.6%)	40 (17.3%)	32 (13.9%)	11 (4.8%)	31 (13.4%)
Usage of air-purifier	13 (5.6%)	8 (3.5%)	18 (7.8%)	20 (8.7%)	172 (74.5%)
Spray insect repellents / aerosol	6 (2.6%)	26 (11.3%)	78 (33.8%)	65 (28.1%)	56 (24.2%)
Burning incense / light candles / mosquito coils	42 (18.2%)	14 (6.1%)	18 (7.8%)	18 (7.8%)	139 (60.2%)
Open burning activities (include nearby neighbour)	8 (3.5%)	14 (6.1%)	35 (15.2%)	46 (19.9%)	128 (55.4%)
Cooking	82 (35.5%)	57 (24.7%)	56 (24.2%)	23 (10.0%)	13 (5.6%)
Pan frying	57 (24.7%)	69 (29.9%)	43 (18.6%)	30 (13.0%)	32 (13.9%)
Deep frying	4 (1.7%)	43 (18.6%)	42 (18.2%)	70 (30.3%)	72 (31.2%)
Boiling / steaming	58 (25.1%)	73 (31.6%)	61 (26.4%)	27 (11.7%)	12 (5.2%)
Baking	0 (0.0%)	10 (4.3%)	26 (11.3%)	58 (25.1%)	137 (59.3%)
Roasting	2 (0.9%)	12 (5.2%)	24 (10.4%)	48 (20.8%)	145 (62.8%)

n= number of respondents

always= everyday/almost everyday, often= few times per week, sometimes= few times per month, rarely= less than once per month, never= none

Table IV: Adjusted multilevel logistic regression analysis for risk factors of atopic diseases (n = 231).

Variable	Asthma			Rhinitis			Eczema		
	OR	p-value	95% CI	OR	p-value	95% CI	OR	p-value	95% CI
Near to highway/ busy road (< 200 m) ^a	0.875	0.822	0.274 2.796	0.882	0.709	0.458 1.701	0.704	0.390	0.316 1.568
House size ^b	1.478	0.489	0.489 4.463	0.934	0.822	0.516 1.690	0.912	0.789	0.464 1.792
Number of occupants	1.210	0.127	0.947 1.546	1.067	0.381	0.923 1.232	1.035	0.685	0.877 1.221
Renovated in the last 12 months ^a	1.472	0.543	0.424 5.117	2.709	0.009**	1.288 5.697	1.561	0.308	0.663 3.679
Presence of cockroaches ^c	1.139	0.764	0.488 2.659	1.237	0.301	0.827 1.848	1.813	0.043*	1.019 3.228
Presence of rats ^c	1.002	0.995	0.456 2.204	1.794	0.015*	1.119 2.876	0.936	0.818	0.531 1.649
Presence of houseflies or mosquitoes ^c	0.952	0.890	0.473 1.917	1.290	0.138	0.922 1.805	1.072	0.764	0.679 1.694
Presence of any pest ^c	0.295	0.130	0.061 1.435	1.284	0.433	0.688 2.396	0.848	0.702	0.365 1.971
Visible mould spot ^a	0.400	0.147	0.116 1.380	0.791	0.428	0.443 1.413	1.951	0.092	0.897 4.243
Visible mould spot ^a	0.400	0.147	0.116 1.380	0.791	0.428	0.443 1.413	1.951	0.092	0.897 4.243
Presence mould odour ^d	0.998	0.997	0.375 2.655	1.263	0.365	0.762 2.094	1.022	0.949	0.523 2.000
Water damage ^a	1.843	0.293	0.589 5.763	1.457	0.216	0.802 2.646	2.135	0.057	0.978 4.662
Damp stain ^a	1.749	0.372	0.513 5.971	1.725	0.062	0.973 3.056	2.671	0.025*	1.128 6.327
Any dampness sign ^a	1.178	0.794	0.344 4.032	2.292	0.005**	1.280 4.105	3.297	0.020*	1.208 8.998
Sweep floor ^e	0.669	0.032*	0.464 0.966	0.949	0.437	0.833 1.082	0.990	0.908	0.832 1.177
Mop floor ^e	0.913	0.628	0.632 1.319	0.938	0.438	0.797 1.103	0.863	0.256	0.669 1.113
Vacuum floor ^e	1.181	0.174	0.929 1.502	0.860	0.037*	0.745 0.991	1.054	0.562	0.882 1.260
Sanitise furniture ^e	1.111	0.465	0.838 1.472	0.762	0.004**	0.635 0.916	0.892	0.400	0.683 1.165
Switch on air condition ^f	0.592	0.005**	0.411 0.852	1.208	0.067	0.987 1.479	0.912	0.487	0.703 1.182
Air purifier ^f	1.464	0.041*	1.016 2.108	1.407	0.019**	1.058 1.872	0.964	0.834	0.687 1.354
Insect repellents ^f	0.734	0.241	0.438 1.230	1.392	0.021*	1.051 1.844	0.890	0.532	0.617 1.283
Burning incense ^f	0.955	0.814	0.653 1.398	1.207	0.111	0.958 1.520	0.905	0.487	0.684 1.199
Open burning ^f	1.568	0.114	0.897 2.739	1.087	0.570	0.815 1.451	1.066	0.716	0.754 1.508
Cooking ^f	1.280	0.357	0.757 2.167	1.168	0.212	0.915 1.491	1.714	0.020*	1.090 2.693
Use natural gas as cooking fuel ^g	1.130	0.860	0.289 4.428	0.903	0.769	0.457 1.784	0.655	0.344	0.272 1.575
Pan frying ^f	1.009	0.968	0.666 1.527	0.984	0.883	0.798 1.214	1.558	0.017*	1.082 2.243
Deep frying ^f	0.905	0.690	0.553 1.479	1.064	0.625	0.829 1.365	1.322	0.094	0.953 1.833
Boiling ^f	1.040	0.875	0.636 1.702	1.080	0.542	0.843 1.384	1.128	0.498	0.796 1.598
Baking ^f	0.940	0.861	0.473 1.868	1.138	0.459	0.808 1.602	1.300	0.225	0.851 1.986
Roasting ^f	0.759	0.430	0.383 1.504	1.152	0.378	0.841 1.579	1.111	0.598	0.751 1.645
Raise furry pets indoor ^a	0.482	0.289	0.125 1.856	0.804	0.486	0.435 1.485	1.512	0.309	0.682 3.351

Two level logistic regression model adjusted with exposure to tobacco cigarettes smoke, gender, age

Bold indicate *p<0.05, **p<0.01, ***p<0.001

^a Response options of No/ Yes, with reference group = No^b Response options of <500/ 501-1000/ 1001-1500/ >1500 ft2, with reference group = < 500 ft2^c Response options of Never/ Rarely/ Sometimes/ Always, with reference group = Never^d Response options of Never/ Sometimes/ Weekly, with reference group = Never^e Response in the Likert scale ranged between 1 to 8 times per week, with reference group = 1 time per week^f Response options of Never/ Rarely/ Sometimes/ Often/ Always, with reference group = Never^g Response options of Do not cook/ Coal or wood/ Electricity/ Natural gas, with reference group = Do not cook

cleaning behaviours are also linked to atopic conditions. Dampness is common in tropical residential buildings, with approximately 50% of houses in southern India reported obvious dampness signs [12], and significant portions of Thai homes were observed with indoor mould (7.1%) and water leakage (28.2%) [13]. **Table IV** shows that exposure to dampness in the Kampar home was significantly associated with atopic conditions. Specifically, living in homes with damp stains increased the likelihood of experiencing eczema by approximately 3 times, while any dampness condition was associated with a 3-fold higher likelihood of eczema. Furthermore, the presence of any dampness signs was linked to a 2-fold increased risk of developing rhinitis. Home dampness increases mould allergen exposure, which may trigger or worsen atopic diseases [2]. In the study conducted by Wang and coresearchers [14], dampness was found to be a significant risk factor for adults' asthma and wheezing.

Non-asthmatic respondents tend to use the air conditioner more frequently. One possible reason for the lower usage among asthma respondents is exposure to cold and dry air from the air-conditioning unit may irritate the airways and potentially trigger asthma symptoms (e.g., coughing, wheezing, shortness of breath) [15]. Conversely, staying in houses that had recently undergone renovation and spraying insect repellents were linked with rhinitis, which could be due to chemical pollutants exposure irritating the respiratory system [1].

The relationship between usage of an air purifier and asthma or rhinitis may be bidirectional, as symptomatic individuals are more likely to use air purifiers. Cleaning activities showed negative associations with the prevalence of asthma and rhinitis, suggesting affected individuals may avoid these tasks to prevent stirring up dust, allergens or chemical irritants that may irritate the airway and trigger respiratory symptoms. Thus, it is important to carry out cleaning activities with proper ventilation to prevent triggering respiratory and allergic symptoms [16].

Cockroach presence was significantly associated with eczema, as cockroach allergens disrupt the skin barrier and activate protease-activated receptor-2 (PAR-2) on skin cells, thereby inducing inflammation [17]. Moreover, frequent cooking and pan-frying also showed significant associations with eczema. Individuals who cook frequently, such as food handler and chefs are commonly affected by dermatitis due to prolonged exposure to heat and moisture [18]. While most of the previous research focused on school and office environments, a primary strength of this study is its focus on the home setting from a tropical perspective. Furthermore, this study identified factors significantly associated with the onset of atopic diseases and potential mitigation factors. However, this research relies on

self-reported data, which may introduce bias if the respondents underreport or overreport their symptoms.

CONCLUSION

In conclusion, household cleaning and proper ventilation practices may mitigate the risk of asthma and rhinitis. Conversely, adverse indoor environmental conditions-such as renovation, dampness, pests, and the use of insect repellents- elevated the likelihood of rhinitis and eczema among adult respondents. Future research could explore other factors, such as ventilation systems, isolated kitchens, indoor footwear habits, and floor carpeting in atopic disease studies.

ACKNOWLEDGEMENT

This research is supported by the Universiti Tunku Abdul Rahman (UTAR), Malaysia, under UTAR Research Fund (UTARRF) (IPSR/RMC/UTARRF/2021-C2/L10). The authors deeply grateful to all the participants for generously dedicating their time and effort to this research, particularly for their assistance with the questionnaire study.

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