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Are Families Ready for Disease X? Disparities in Household Outbreak Preparedness in a High-Density State in Malaysia

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ABSTRACT:
Household preparedness for outbreaks, including those caused by novel threats, is an important component of disaster risk reduction. However, evidence from Malaysia remains limited. This study aimed to assess household preparedness for Disease X and outbreaks and identify the associated factors in a selected high-density state in Malaysia.
A cross-sectional survey was conducted among 566 households using a validated questionnaire. Preparedness was assessed as a continuous score and examined using a preparedness matrix incorporating cognitive preparedness and preparedness behaviour.
The mean household outbreak preparedness score was 57.4 out of 100 (SD=16.8), indicating a moderate level of preparedness. In the multivariable general linear model, Indigenous Orang Asli respondents had lower preparedness scores than Malay respondents, while respondents with secondary education had higher preparedness scores than those with no formal education. Respondents residing at their current address for 4 to 6 years had lower preparedness scores than those residing there for 3 years and below. The preparedness matrix showed clustering in the Prepared and Aware quadrants, suggesting that cognitive preparedness may not always translate into preparedness behaviour.
These findings indicate the need for community-based strategies that support households in translating preparedness knowledge into practical action, particularly among vulnerable and marginalised groups.

Keywords: household preparedness, outbreak preparedness, public health, survey, Malaysia

1. Introduction

In today's increasingly interconnected and urbanising world, urban expansion, environmental change, and human encroachment into forested areas are creating conditions that favour the emergence and re-emergence of infectious diseases (Morens & Fauci, 2020; Neiderud, 2015). These changes, coupled with global interconnectedness,

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have heightened concern over outbreaks caused not only by known pathogens, but also by the possibility of future pandemics driven by unknown threats.

The COVID-19 pandemic highlighted that novel infectious threats will continue to emerge, including the possibility of Disease X (Morens & Fauci, 2020). Disease X refers to a currently unidentified pathogen with pandemic potential and has been recognised by the World Health Organization (WHO) as a priority for preparedness research and development (Possas et al., 2024; Simpson et al., 2020; World Health Organization, 2018). Notably, the term was introduced in 2018, prior to the COVID-19 pandemic. Despite this early recognition, the pandemic exposed how inadequately prepared the world was to respond to a novel and rapidly spreading infectious threat (Moradi et al., 2025). This underscores the need for preparedness that extends beyond known diseases to include uncertain future outbreaks (Fauci & Folkers, 2023; Simpson et al., 2020).

As shown by previous epidemics and pandemics, infectious disease threats can emerge and spread rapidly across populations. In a highly connected world, an outbreak can spread from a remote village to major cities on six continents in less than 36 hours (Centers for Disease Control and Prevention, 2025). Inadequate preparedness, particularly in response to a novel pathogen, can result in substantial morbidity and mortality, severe strain on healthcare systems, and major economic disruption (Breiman et al., 2025).

Preparedness refers to actions taken in advance to anticipate, respond to, and reduce the negative impacts of outbreaks. It is a key component of disaster risk reduction because it can reduce loss of life, minimise harm, and support more effective response and recovery. It is recognised as one of the four priority areas of the Sendai Framework for Disaster Risk Reduction 2015–2030 (United Nations Office for Disaster Risk Reduction, 2016). However, preparedness efforts have often focused on top-down systems and planning at higher administrative levels, with less emphasis on community participation and lower-level readiness (Levac et al., 2012; Lorenzoni et al., 2022). The COVID-19 pandemic exposed weaknesses in this approach, as many systems were insufficiently prepared to translate broad preparedness principles into practical action for a novel pathogen (Moradi et al., 2025).

This limitation is important because outbreaks are first experienced not only by institutions, but by people within households and communities. During the early phase of an outbreak, delays in recognition and external support may worsen health outcomes (Wang et al., 2024). Actions taken at the household level before professional help arrives may therefore be crucial (Kim & Kang, 2010). Household preparedness has been shown to reduce the negative consequences of emergency events and reliance on delayed external assistance (Levac et al., 2012). Household-level preparedness refers to the cognitive and behavioural dimensions of readiness adopted by individuals and families before an emergency. It includes knowledge, awareness, and attitudes, together with tangible capacities and practices that support timely response, reduce exposure, and minimise adverse outcomes (Nelson et al., 2007; Nojang & Jensen, 2020; United Nations Office for Disaster Risk Reduction, 2016). At the household level, this may include emergency planning, stockpiling essential supplies, and other protective measures (Diyana, 2022; Heidenstrøm & Kvarnlöf, 2018; Sadeka et al., 2020; Tam et al., 2018).

These concerns are particularly relevant in Selangor, Malaysia, due to its large population, high density, substantial mobility, and continuing vulnerability to infectious

disease outbreaks (Aw et al., 2021; Department of Statistics Malaysia, 2023; Ganasegeran et al., 2021; Ministry of Health Malaysia, 2026). Selangor also recorded the highest COVID-19 burden in Malaysia and continues to report high numbers of other infectious diseases, including dengue and hand, foot and mouth disease (Abdul Shakor et al., 2023; Ministry of Health Malaysia, 2026). Yet evidence on household outbreak preparedness in this setting remains limited, especially in low- and middle-income countries where related evidence is still scarce (Levac et al., 2012; Lorenzoni et al., 2022; Morris et al., 2025).

Therefore, this study aimed to assess the level of household preparedness for Disease X and other potential outbreaks, and to identify the sociodemographic factors associated with preparedness among households in Selangor, Malaysia. The findings may provide local evidence on preparedness gaps and population groups requiring greater support, which can inform more targeted household-level risk communication, preparedness interventions, and outbreak preparedness planning.

2. Material and Methods

2.1 Study design and study population

A cross-sectional survey was conducted in Selangor, a high-density state in Malaysia, from December 2024 to January 2025. Eligible respondents were Malaysian citizens aged 18 years and above who were able to understand Malay and willing to provide informed consent. One adult respondent was recruited from each household.

2.2 Sample size and sampling method

Sample size was calculated using OpenEpi for a population survey, based on an expected frequency of 44% derived from a previous local flood preparedness study (Diyana, 2022), with a 95% confidence level, 5% precision, and a design effect of 1.0. The calculated minimum sample size was 379 households. Within the study period, respondents were recruited using convenience sampling from a public university and a public health facility in Selangor, resulting in a final sample of 566 households, which was higher than the required sample size.

2.3 Data collection and outcome measures

Data were collected using the Household Outbreak Preparedness Evaluation (HOPE) questionnaire, a validated Malay-language instrument for assessing household outbreak preparedness (Abdul Shakor et al., 2026). The questionnaire includes 30 items: 18 items in the Cognitive Preparedness (COG) domain and 12 items in the Preparedness Behaviour (BEH) domain. The COG domain assesses knowledge of Disease X, outbreaks, and preparedness, as well as perceived threat and perceived barriers. The BEH domain assesses household planning, outbreak kit preparation, and practical skills related to outbreak preparedness.

Following the established scoring approach described by Sumaja (2018), Household Outbreak Preparedness (PREP) was assessed using both a continuous score and a preparedness matrix. This approach also reflects the conceptualisation of preparedness as encompassing both cognitive and behavioural dimensions (Nojang &

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Jensen, 2020). PREP was operationalised as a continuous outcome variable and calculated using Equation 1:

$$PREP = 0.5(COG) + 0.5(BEH) \quad \text{(Equation 1)}$$

The PREP score ranged from 0 to 100, with higher scores indicating greater household outbreak preparedness. For the preparedness matrix, COG and BEH scores were standardised to a scale ranging from 0 to 1. COG was represented on the x-axis, while BEH was represented on the y-axis. A cutoff value of 0.5 on both axes was used to divide the matrix into four quadrants: Prepared, Committed, Aware, and Unprepared. The matrix was used to support graphical interpretation of household outbreak preparedness.

2.4 Statistical analysis

Descriptive statistics were used to summarise study variables. Sociodemographic characteristics were presented as frequencies and percentages, while PREP, COG, and BEH scores were summarised using mean and standard deviation. Univariable analysis using one-way analysis of variance (ANOVA) was performed to compare mean preparedness scores across categories of each sociodemographic variable. Variables with $p<0.25$ were included in the multivariable analysis to avoid excluding potentially important variables at the preliminary screening stage. Multivariable analysis was conducted using the general linear model to identify sociodemographic factors independently associated with preparedness score. Model assumptions assessed included normality of residuals assessed through visual inspection of Q-Q plots, homoscedasticity using Levene's test, independence of observations through independent household sampling, and multicollinearity through examination of inter-correlations among categorical predictors. Results were presented as regression coefficients, 95% confidence intervals, and p-values. All analyses were performed using IBM SPSS Statistics version 29. The preparedness matrix was generated using a scatter plot in Microsoft Excel.

2.5 Ethical considerations

Ethical approval was obtained from the National Medical Research Register/Medical Research and Ethics Committee (Ref: NMRR-24-01859-NQ7) and the Universiti Teknologi MARA (UiTM) Research Ethics Committee (Ref: REC/10/2024 [PG/FB/33]). Informed consent was obtained from all participants prior to data collection, and data confidentiality was maintained throughout the study.

3. Results

A total of 566 households were included in the analysis. The sociodemographic characteristics of the respondents are presented in Table 1. The mean PREP score was 57.43 (SD=16.79), indicating a moderate level of household outbreak preparedness. The mean COG score was 65.22 (SD=16.05), also reflecting a moderate level of cognitive preparedness, whereas the mean BEH score was 49.64 (SD=24.93), suggesting comparatively lower preparedness behaviour.

The sample included respondents from all major ethnic groups in Selangor, although Orang Asli respondents constituted a higher proportion (19.8%) than indicated by state population estimates, possibly reflecting the geographic concentration of these communities and the catchment populations of the recruitment settings (Department of Statistics Malaysia, 2023).

Table 1: Sociodemographic characteristics of respondents

Characteristics	Category	N	%
Age group	18 to 24 years old	68	12.0
	25 to 34 years old	165	29.2
	35 to 44 years old	160	28.3
	45 to 64 years old	133	23.5
	65 years old and above	40.0	7.1
Sex	Male	238	42.0
	Female	328	58.0
Ethnicity	Malay	263	46.5
	Orang Asli	112	19.8
	Chinese	82	14.5
	Indian	59	10.4
	Others	50	8.8
Educational level	No formal education	37	6.5
	Primary education	128	22.6
	Secondary education	121	21.4
	Tertiary education	280	49.5
Average monthly household income (MYR)	2500 and below	174	30.7
	2501 to 5000	168	29.7
	5001 to 8000	112	19.8
	8001 to 12000	81	14.3
	More than 12000	31	5.5

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Duration of residence at current address	3 years and below	160	28.3
	4 to 6 years	110	19.4
	7 to 10 years	101	17.8
	More than 10 years	195	34.5
Total household members	1 to 5 individuals	276	48.8
	6 to 10 individuals	283	50.0
	More than 10 individuals	7	1.2

*Note: N, frequency; All monetary values are presented in MYR, and, for reference, the exchange rate was 1.00 EUR to MYR 4.61 on 8 May 2026.

In univariable analysis, ethnicity, educational level, and years of residence met the criterion for inclusion in the multivariable model (Table 2).

Table 2: One-way ANOVA comparing mean household outbreak preparedness scores across respondent characteristics

Characteristics	Category	N	PREP Mean Score (SD)	F statistic (df)	p-value
Age group	18 to 24 years old	68	59.44 (15.76)	0.585 (4, 561)	0.673
	25 to 34 years old	165	57.74 (16.91)		
	35 to 44 years old	160	57.41 (16.84)		
	45 to 64 years old	133	55.82 (17.20)		
	65 years old and above	40	58.19 (16.68)		
Sex	Male	238	57.59 (16.44)	0.035 (1, 564)	0.852
	Female	328	57.32 (17.05)		
Ethnicity	Malay	263	57.97 (17.53)	2.742 (4, 561)	0.028
	Orang Asli	112	53.11 (17.22)		
	Chinese	82	60.51 (15.10)		
	Indian	59	58.75 (13.04)		
	Others	50	57.69 (17.13)		

Educational level	No formal education	37	53.65 (19.47)	1.828 (3, 562)	0.141
	Primary education	128	56.61 (18.14)		
	Secondary education	121	60.16 (15.45)		
	Tertiary education	280	57.13 (16.24)		
Average monthly household income (MYR)	2500 and below	174	58.74 (15.92)	0.796 (4, 561)	0.528
	2501 to 5000	168	57.42 (17.64)		
	5001 to 8000	112	56.06 (17.21)		
	8001 to 12000	81	57.88 (16.69)		
	More than 12000	31	53.95 (15.64)		
Duration of residence at current address	3 years and below	160	58.33 (16.26)	1.862 (3, 562)	0.135
	4 to 6 years	110	54.22 (17.28)		
	7 to 10 years	101	59.13 (16.43)		
	More than 10 years	195	57.62 (17.00)		
Total household members	1 to 5 individuals	276	58.57 (15.98)	1.322 (2, 563)	0.268
	6 to 10 individuals	283	56.41 (17.43)		
	More than 10 individuals	7	53.85 (20.49)		

*Note: N, frequency; All monetary values are presented in MYR, and, for reference, the exchange rate was 1.00 EUR to MYR 4.61 on 8 May 2026.

Assessment of model assumptions indicated that Levene's test was non-significant ($p=0.079$), indicating homoscedasticity. No substantial multicollinearity was detected among the categorical predictors. In the multivariable general linear model, the overall effects of ethnicity ($F=5.680$, $p<0.001$), educational level ($F=2.672$, $p=0.047$), and years of residence ($F=3.676$, $p=0.012$) were significantly associated with household outbreak preparedness. As shown in Table 3, the Indigenous Orang Asli respondents had significantly lower preparedness scores than Malay respondents ($B=-10.19$, 95% CI: -14.96, -5.41; $p<0.001$). Respondents with secondary education had significantly higher preparedness scores than those with no formal education ($B=7.52$, 95% CI: 1.40, 13.64; $p=0.016$). Respondents who had lived in their current residence for 4 to 6 years had significantly lower preparedness scores than those who had lived there for 3 years and below ($B=-4.26$, 95% CI: -8.28, -0.25; $p=0.038$).

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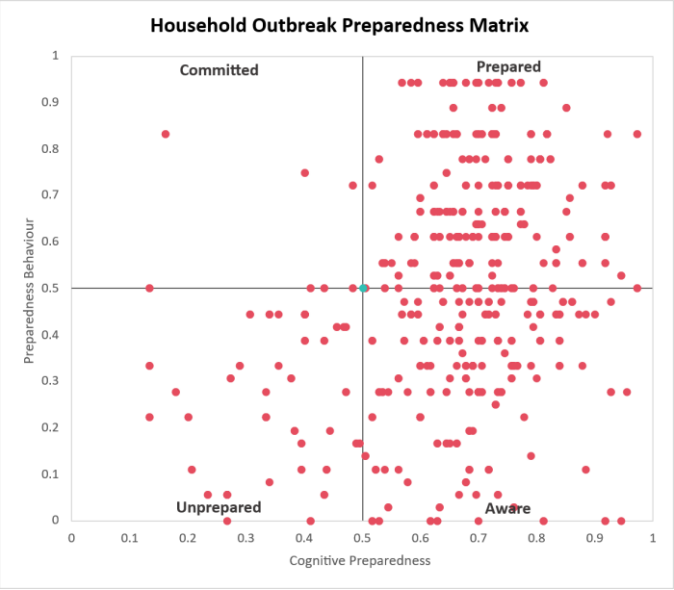
Table 3: Multivariable general linear model of factors associated with household outbreak preparedness

Characteristics	Category	Adjusted mean (SE)	Adjusted coefficient, B (95% CI)	p-value
Ethnicity	Malay	58.65 (1.29)	Reference	—
	Orang Asli	48.46 (2.07)	-10.19 (-14.96, -5.41)	<0.001*
	Chinese	61.07 (1.96)	2.42 (-1.67, 6.52)	0.246
	Indian	59.76 (2.25)	1.12 (-3.55, 5.79)	0.639
	Others	52.84 (2.68)	-5.81 (-11.65, 0.03)	0.051
Educational level	No formal education	52.48 (2.79)	Reference	—
	Primary education	56.95 (1.61)	4.47 (-1.60, 10.55)	0.149
	Secondary education	60.00 (1.66)	7.52 (1.40, 13.64)	0.016*
	Tertiary education	55.19 (1.27)	2.71 (-3.13, 8.55)	0.362
Duration of residence at current address	3 years and below	56.15 (1.67)	Reference	—
	4 to 6 years	51.88 (1.91)	-4.26 (-8.28, -0.25)	0.038*
	7 to 10 years	56.64 (1.92)	0.49 (-3.62, 4.61)	0.814
	More than 10 years	59.95 (1.47)	3.81 (-0.62, 8.23)	0.092

*Note: Adjusted coefficients were obtained from the multivariable general linear model, and adjusted means were estimated marginal means from the same model. SE, standard error; CI, confidence interval; model fit indices: $R^2=0.057$, adjusted $R^2=0.040$, $F(10,555)=3.353$, and $p<0.001$; * indicates statistical significance at $p<0.05$.

Figure 1 shows that households were distributed across all four quadrants of the outbreak preparedness matrix. Most households were clustered in the Prepared quadrant (n=248, 43.8%) and the Aware quadrant (n=236, 41.7%), while fewer were in the Unprepared quadrant (n=76, 13.4%) and only a small proportion were in the Committed quadrant (n=6, 1.1%). This pattern suggests that cognitive preparedness was generally higher than preparedness behaviour among many respondents.

Figure 1: Household outbreak preparedness matrix



4. Discussion

This study found that ethnicity, educational level, and years of residence were associated with household outbreak preparedness. In the multivariable model, Orang Asli households had lower preparedness scores than Malay households, respondents with secondary education had higher preparedness scores than those with no formal education, and households residing in the area for 4 to 6 years had lower preparedness scores than those residing there for 3 years and below.

The lower preparedness observed among Orang Asli households is consistent with the broader vulnerabilities experienced by Indigenous communities in Malaysia, shaped by social determinants of health that operate across multiple levels. These include individual-level factors such as low health awareness, poor health-seeking behaviour, and inadequate infection prevention practices; community-level factors such as cultural beliefs and norms and limited community resources; and systemic-level factors such as disparities in healthcare access, socioeconomic disadvantage, geographical isolation, and marginalisation experienced by these communities (Abdullah, 2018; Jamal & Ganapathy, 2021; Mohd Rosman et al., 2020; Rosnon et al., 2022; Sadeka et al., 2020). This finding is also supported by local evidence showing lower levels of flood preparedness among indigenous communities compared with the general population (Diyana, 2022; Sadeka et al., 2020). From a public health perspective, this suggests that preparedness interventions should not rely on uniform approaches, but instead should be tailored to the needs of vulnerable populations, particularly Orang Asli communities. Such efforts should combine culturally appropriate risk communication, outreach through trusted community channels, and practical household-level support to strengthen preparedness actions.

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Educational level was also associated with household outbreak preparedness. This is in keeping with earlier studies showing that higher educational attainment may improve access to information, risk understanding, and adoption of preparedness measures (Chen et al., 2019; Christian et al., 2021). The relationship may also reflect differences in health literacy, which influence how individuals understand health information and act on public health recommendations during emergencies (Nirwan, 2023). This finding suggests that preparedness communication should be designed to be understandable, actionable, and accessible across different educational backgrounds. Public health messaging may therefore need to use simple language, clear behavioural instructions, and repeated reinforcement through accessible communication platforms to support preparedness practices at the household level.

The association between years of residence and preparedness was less straightforward. Households residing in the area for 4 to 6 years had lower preparedness scores than those residing there for 3 years and below, while the other residence categories were not significantly different. Although this pattern should be interpreted cautiously, it may indicate that residential duration alone does not fully explain preparedness. Previous studies suggest that place attachment, neighbourhood tenure, and social connectedness may contribute to preparedness through greater familiarity, self-efficacy, and access to support (Wang et al., 2021). It is possible that other unmeasured contextual factors, such as housing stability, relocation, neighbourhood trust, community participation, mobility patterns, outbreak experience, and access to services, may be more relevant than duration of residence itself.

An important contribution of this study is the use of the preparedness matrix to jointly examine cognitive preparedness and preparedness behaviour. The matrix showed substantial clustering in both the Prepared and Aware quadrants, indicating that many households had moderate cognitive preparedness, whereas preparedness behaviour was more limited. This has important implications for public health practice. Household outbreak preparedness should not be approached solely as a matter of awareness, because knowledge of risk does not necessarily translate into concrete preparedness action (Nipa et al., 2023; Patel et al., 2023). Preparedness programmes should therefore move beyond information provision and include practical guidance, household planning support, and interventions that help households adopt feasible preparedness behaviours. This may be particularly important in the context of Disease X and other emerging outbreaks, where households may need to respond quickly before formal assistance becomes available. More broadly, the findings suggest that preparedness strategies should place greater emphasis on strengthening behavioural preparedness, particularly through practical guidance on household planning, identifying and assembling essential supplies, and developing response skills to cope with outbreaks until support arrives.

Nevertheless, these findings should also be considered in light of the broader literature. As outbreak-specific preparedness evidence remains limited, comparisons with the broader disaster and emergency preparedness literature should be interpreted cautiously, as differences in measures and settings may limit direct comparability of effect sizes.

This study has several limitations. Its cross-sectional design does not permit causal inference. In addition, convenience sampling from a public university and a public health

facility may have attracted respondents with relatively higher educational attainment and greater engagement with public services, potentially influencing the socioeconomic, educational, ethnic, and preparedness distributions of the sample and limiting the generalisability of the findings to the wider Selangor population. This study also assessed preparedness using self-reported responses, which may be subject to reporting bias. Additionally, the multivariable model explained only a small proportion of variance in preparedness scores, indicating that the identified sociodemographic factors, while statistically significant, do not provide a comprehensive account of household outbreak preparedness. This is consistent with prior research showing that cognitive and behavioural outcomes are inherently difficult to predict, with even well-established theoretical models explaining limited variance (Fish et al., 2022).

Future studies should consider probability-based sampling, include more diverse geographic settings, and further examine how cognitive preparedness is translated into actual preparedness behaviour at the household level. Longitudinal and mixed-methods studies are needed to further examine how these contextual factors shape preparedness across different stages of residential tenure. Qualitative research may also help to better understand the barriers that prevent households from shifting from awareness into action. Additionally, intervention studies are needed to evaluate the effectiveness of community-based preparedness programmes, particularly among vulnerable and marginalised populations such as Orang Asli communities.

5. Conclusion

This study adds to the limited evidence on household outbreak preparedness in Malaysia. Household outbreak preparedness was associated with ethnicity, educational level, and years of residence, with lower preparedness observed among Orang Asli households. The findings also suggest that the majority of households have lower behavioural preparedness compared to cognitive preparedness. Based on these findings, community-based, behaviour-theory-informed strategies may help households shift preparedness knowledge into practical action through accessible, feasible, and responsive approaches, especially for vulnerable and marginalised groups. Further intervention studies are needed to evaluate the effectiveness of such approaches.

Conflict of interest: The authors declare no conflict of interest.

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References

Abdul Shakor, A. S., Mohamad, M., Ibrahim, K., & Mohamad Sayed, I. (2026). Development of X-SIAGA: A disease X and outbreak preparedness intervention for indigenous households in Selangor, Malaysia. PLOS One, 21(3), e0345785. https://doi.org/10.1371/journal.pone.0345785

Abdul Shakor, A. S., Samsudin, E. Z., Chen, X. W., & Ghazali, M. H. (2023). Factors associated with COVID-19 brought-in deaths: A data-linkage comparative cross-sectional study. Journal of Infection and Public Health, 16(12), 2068–2078. https://doi.org/10.1016/j.jiph.2023.10.016

Abdullah, J. (2018). Resettlement of Orang Asli (Aborigines) in Malaysia—Marginalization or demarginalization of an ethnic group. Perspectives on Geographical Marginality (Vol. 3, pp. 145–155). Springer Nature. https://doi.org/10.1007/978-3-319-59002-8_10

Aw, S. B., Teh, B. T., Ling, G. H. T., Leng, P. C., Chan, W. H., & Ahmad, M. H. (2021). The COVID-19 pandemic situation in Malaysia: Lessons learned from the perspective of population density. International Journal of Environmental Research and Public Health, 18(12), 6566. https://doi.org/10.3390/ijerph18126566

Breiman, R. F., Osoro, E., Reithinger, R., Wang, D., Diamond, M., Van Voorhis, W. C., Wasserheit, J. N., Rabinowitz, P. M., Mboup, S., Hemingway-Foday, J. J., de Oliveira, T., Boon, A. C. M., Schieffelin, J. S., Sempowski, G. D., Moody, M. A., Vasilakis, N., Hanley, K. A., Nasimiyu, C., Situma, S., … Njenga, M. K. (2025). Importance of outbreak response research in bridging knowledge gaps on emerging infectious diseases. BMJ Global Health, 10(6), e018297. https://doi.org/10.1136/bmjgh-2024-018297

Centers for Disease Control and Prevention. (2025, January 15). 2024 Global outbreak responses. 2024 Annual Report. https://www.cdc.gov/global-health/annual-report-2024/outbreaks.html

Chen, C. Y., Xu, W., Dai, Y., Xu, W., Liu, C., Wu, Q., Gao, L., Kang, Z., Hao, Y., & Ning, N. (2019). Household preparedness for emergency events: a cross-sectional survey on residents in four regions of China. BMJ Open, 9(11), e032462. https://doi.org/10.1136/bmjopen-2019-032462

Christian, D. S., Shukla, R. P., Sutariya, H. J., & Patel, Y. R. (2021). Household preparedness for public health emergencies among urban communities of Ahmedabad, Gujarat, India - A community based cross-sectional study. Journal of Evidence Based Medicine and Healthcare, 8(33), 3066–3072. https://doi.org/10.18410/jebmh/2021/559

Department of Statistics Malaysia. (2023, June 30). Jadual penduduk: Negeri. OpenDOSM. https://open.dosm.gov.my/ms-MY/data-catalogue

Diyana, F. A. N. (2022). Attitude and flood preparedness of households in Pasir Mas, Kelantan, Malaysia. IOP Conference Series: Earth and Environmental Science, 1091(1), 012022. https://doi.org/10.1088/1755-1315/1091/1/012022

Fauci, A. S., & Folkers, G. K. (2023). Pandemic preparedness and response: Lessons from COVID-19. The Journal of Infectious Diseases, 228(4), 422–425. https://doi.org/10.1093/infdis/jiad095

Fish, J. A., Prichard, I., Ettridge, K., Grunfeld, E. A., & Wilson, C. (2022). Predicting men's intentions to seek help for cancer symptoms: a comparison of the Theory of Planned Behaviour and the Health Belief Model. Australian Journal of Psychology, 74(1), 1–10. https://doi.org/10.1080/00049530.2022.2039042

Ganasegeran, K., Jamil, M. F. A., Ch'ng, A. S. H., Looi, I., & Pearlasamy, K. M. (2021). Influence of population density for COVID-19 spread in Malaysia: An ecological study. International Journal of Environmental Research and Public Health, 18(18), 9866. https://doi.org/10.3390/ijerph18189866

Heidenstrøm, N., & Kvarnlöf, L. (2018). Coping with blackouts: A practice theory approach to household preparedness. Journal of Contingencies and Crisis Management, 26(2), 272–282. https://doi.org/10.1111/1468-5973.12191

Jamal, M., & Ganapathy, M. (2021). Framing the actors though thematic structures: The case of the Malaysian Orang Asli. Academic Journal of Interdisciplinary Studies, 10(2), 249–258. https://doi.org/10.36941/ajis-2021-0055

Kim, Y., & Kang, J. (2010). Communication, neighbourhood belonging and household hurricane preparedness. Disasters, 34(2), 470–488. https://doi.org/10.1111/j.1467-7717.2009.01138.x

Levac, J., Toal-Sullivan, D., & O'Sullivan, T. L. (2012). Household emergency preparedness: A literature review. Journal of Community Health (Vol. 37, Number 3, pp. 725–733). https://doi.org/10.1007/s10900-011-9488-x

Lorenzoni, N., Kainrath, S., Unterholzner, M., & Stummer, P. H. (2022). Instruments for disaster preparedness evaluation: A scoping review. Australian Journal of Emergency Management, 37(3), 56–64. https://doi.org/10.47389.37.3.56

Ministry of Health Malaysia. (2026). COVID-19 Malaysia. KKMNOW. https://data.moh.gov.my/dashboard/covid-19

Mohd Rosman, M. H. W., Yong, C. L., Azman, M. U., & Mohd Ishar, M. I. (2020). The health issue in Orang Asli community. Malaysian Journal of Social Sciences and Humanities (MJSSH), 5(2), 36–41. https://doi.org/10.47405/mjssh.v5i2.360

Moradi, H., Tavakolifard, N., Haghjooy Javanmard, S., & Vaezi, A. (2025). The imperative of preparedness in navigating health crises with a look at the pandemic of COVID-19. Discover Public Health, 22(1), 509. https://doi.org/10.1186/s12982-025-00911-0

Morens, D. M., & Fauci, A. S. (2020). Emerging pandemic diseases: How we got to COVID-19. Cell, 182(5), 1077–1092. https://doi.org/10.1016/j.cell.2020.08.021

Morris, K., Pasha, A., Li, X., & Qiao, S. (2025). Disaster preparedness of health systems in LMICs in the face of climate change: A systematic mapping review of vulnerabilities and response strategies. BMC Public Health, 26(1), 217. https://doi.org/10.1186/s12889-025-25873-5

Neiderud, C.-J. (2015). How urbanization affects the epidemiology of emerging infectious diseases. Infection Ecology & Epidemiology, 5(1), 27060. https://doi.org/10.3402/iee.v5.27060

Nelson, C., Lurie, N., & Wasserman, J. (2007). Assessing public health emergency preparedness: Concepts, tools, and challenges. Annual Review of Public Health, 28(1), 1–18. https://doi.org/10.1146/annurev.publhealth.28.021406.144054

Nipa, T. J., Kermanshachi, S., & Pamidimukkala, A. (2023). Identification of resilience dimensions in critical transportation infrastructure networks. Journal of Legal Affairs and Dispute Resolution in Engineering and Construction, 15(2). https://doi.org/10.1061/JLADAH.LADR-870

Nirwan, M. S. (2023). Health literacy as a public health priority in crisis management: Strategies and policy recommendations. Journal of Health Literacy and Qualitative Research, 3(1), 22–33. https://doi.org/10.61194/jhlqr.v3i1.541

Nojang, E. N., & Jensen, J. (2020). Conceptualizing individual and household disaster preparedness: The perspective from Cameroon. International Journal of Disaster Risk Science, 11(3), 333–346. https://doi.org/10.1007/s13753-020-00258-x

Patel, R. K., Pamidimukkala, A., Kermanshachi, S., & Etminani-Ghasrodashti, R. (2023). Disaster preparedness and awareness among university students: A structural equation analysis. International Journal of Environmental Research and Public Health, 20(5), 4447. https://doi.org/10.3390/ijerph20054447

Possas, C., Marques, E. T. A., Kuchipudi, S. V., Kumar, P., Kim, J. H., & Homma, A. (2024). Disease X in the Tropics, preventing the next pandemic: how to accelerate spillover prevention and vaccine preparedness? Frontiers in Tropical Diseases, 5. https://doi.org/10.3389/fitd.2024.1417065

Rosnon, M. R., Zuhairi, M. H., Abdul Razak, M. A., Jalaludin, M. L., & Ibrahim, R. (2022). Knowledge, attitudes and practice towards COVID-19 among the Orang Asli elderly in Peninsular Malaysia. International Journal of Academic Research in Business and Social Sciences, 12(10). https://doi.org/10.6007/ijarbss/v12-i10/15208

Sadeka, S., Mohamad, M. S., & Sarkar, M. S. K. (2020). Disaster experiences and preparedness of the Orang Asli Families in Tasik Chini of Malaysia: A conceptual framework towards building disaster resilient community. Progress in Disaster Science, 6. https://doi.org/10.1016/j.pdisas.2020.100070

Sadeka, S., Mohamad, M. S., Sarkar, M. S. K., & Al-Amin, A. Q. (2020). Conceptual framework and linkage between social capital and disaster preparedness: A case of orang asli families in Malaysia. Social Indicators Research, 150(2), 479–499. https://doi.org/10.1007/s11205-020-02307-w

Simpson, S., Kaufmann, M. C., Glozman, V., & Chakrabarti, A. (2020). Disease X: Accelerating the development of medical countermeasures for the next pandemic. The Lancet Infectious Diseases, 20(5), e108–e115. https://doi.org/10.1016/S1473-3099(20)30123-7

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Sumaja, K. (2018). Measuring the level of disaster preparedness in Auckland coastal sub-urban areas "Case study Saint Heliers and Mission Bay" [Dissertation, The University of Auckland]. https://www.researchgate.net/publication/359866001

Tam, G., Huang, Z., & Chan, E. Y. Y. (2018). Household preparedness and preferred communication channels in public health emergencies: A cross-sectional survey of residents in an asian developed Urban city. International Journal of Environmental Research and Public Health, 15(8). https://doi.org/10.3390/ijerph15081598

United Nations Office for Disaster Risk Reduction. (2016). Sendai framework terminology on Disaster Risk Reduction. Report of the open-ended intergovernmental expert working group on indicators and terminology relating to disaster risk reduction. http://www.preventionweb.net/drr-framework/open-ended-working-group/

Wang, Y., Lyu, M., & Sun, B. (2024). Emergency resource allocation considering the heterogeneity of affected areas during the COVID-19 pandemic in China. Humanities and Social Sciences Communications, 11(1), 225. https://doi.org/10.1057/s41599-024-02712-3

Wang, Z., Han, Z., Liu, L., & Yu, S. (2021). Place attachment and household disaster preparedness: Examining the mediation role of self-efficacy. International Journal of Environmental Research and Public Health, 18(11), 5565. https://doi.org/10.3390/ijerph18115565

World Health Organization. (2018). Prioritizing diseases for research and development in emergency contexts. Shortlist of Blueprint Priority Diseases. https://www.who.int/activities/prioritizing-diseases-for-research-and-development-in-emergency-contexts