Tropical Biomedicine 42(4): 415-421 (2025)
https://doi.org/10.47665/tb.42.4.007

RESEARCH ARTICLE

Factors associated with melioidosis mortality in Pahang from 2020-2024: data analysis using melioidosis registry from Pahang State Health Department

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ARTICLE HISTORY

Received: 15 July 2025
Revised: 12 September 2025
Accepted: 20 October 2025
Published: 31 December 2025

ABSTRACT

Melioidosis is a severe infection caused by *Burkholderia pseudomallei* and is endemic in tropical regions, such as Southeast Asia. Favourable climate and substantial agricultural sectors contribute to a high incidence of melioidosis in Pahang, Malaysia. This study aims to identify factors associated with melioidosis mortality in Pahang from 2020 to 2024, with an emphasis on sociodemographic, occupational, clinical, and environmental determinants. A retrospective cohort study was conducted using the state-driven melioidosis registry. All confirmed cases between 2020 and 2024 were included in the analysis. All variables were extracted and analysed using simple and multiple logistic regression to identify the risk factors for melioidosis mortality. Out of 466 confirmed cases, 68 (14.6%) died from melioidosis. The median age was 48 years (IQR: 34–60), with the majority being male (76%) and originating from rural areas (71%). The incidence, mortality and case fatality rates fluctuated over the study period. The final regression model analysis identified three risk factors for mortality which include non-Malaysian ethnicity (aOR 3.27; 95% CI: 1.43–7.51), chronic obstructive pulmonary disease (COPD) (aOR 8.71; 95% CI: 1.11–68.39), and intensive care unit (ICU) admission (aOR 3.44; 95% CI: 1.91–6.17). In contrast, diabetes mellitus, which is often associated with increased risk of mortality, was not found to be significant in this study, nor was the level of monthly rainfall. These study findings highlight the need to address social determinants of health among vulnerable populations and to prioritise early recognition and management, especially for patients with COPD.

Keywords: Melioidosis; *Burkholderia pseudomallei*; Pahang; mortality; risk factor.

INTRODUCTION

Melioidosis is a severe infectious disease caused by the gram-negative bacterium, *Burkholderia pseudomallei,* which is commonly found in soil and water (Fong *et al*., 2021; Wiersinga *et al*., 2018). It is also known as Whitmore's disease, as it was first discovered by Whitemore and Krishnaswami in Rangoon, Myanmar, back in 1911 (Mardhiah & Nursyahiyatul-Anis, 2024). Melioidosis is endemic to tropical regions, particularly in Southeast Asia and northern Australia. However, the disease has also been detected in other regions of the world, including Africa, South Asia, and the United States of America (Birnie *et al*., 2022). The mode of transmission is usually direct contact through percutaneous inoculation, inhalation, or ingestion of the contaminated soil or water (Mohapatra & Mishra, 2022). The disease is infamously known as 'the great mimicker' due to its vast spectrum of clinical manifestations, which range from fever, localised abscesses, and mild pneumonia to a fulminant septic shock and death (Hussin *et al*., 2023; Nathan *et al*., 2018). This clinical ambiguity presents a significant diagnostic challenge for clinicians and often results in delayed or incorrect treatment, which contributes to its high fatality rate.

The importance of melioidosis as a public health threat is substantial and yet frequently underestimated. It is considered a major neglected tropical disease with a global burden estimated at 165,000 cases and 89,000 deaths annually (Gassiep *et al*., 2020). In Malaysia, the problem is predominantly crucial due to the country's favourable climate and large agricultural sector, which allows the pathogen to thrive. However, since melioidosis is not a mandatory notifiable disease, the true incidence remained unknown and likely underreported (Md Hanif *et al*., 2024). Despite this, the regional data indicate high case fatality rates, sometimes exceeding 50% (Nathan *et al*., 2018). The state of Pahang, the largest state on the Malaysian peninsula, has been identified as having the highest incidence in Malaysia, underscoring the need to understand and address the disease in this specific high-risk area (Arushothy *et al*., 2024).

A considerable number of studies have identified several domains of risk factors that are associated with melioidosis mortality. These include sociodemographic and occupational exposure, which are consistently linked to higher risk and mortality, particularly older age, male gender, and working in the agriculture sector (Siti Maisarah *et al*., 2020). Comorbidities, particularly diabetes mellitus, have shown a significant increase in the risk of severe

disease due to impaired immune function (Nathan *et al*., 2018). Other comorbidities also include chronic obstructive pulmonary disease (COPD), chronic kidney disease, chronic lung disease and hypertension (Md Hanif *et al*., 2024; Menon *et al*., 2021; Selvam *et al*., 2022). Environmental exposure, such as high rainfall amounts and humidity, is also found to be associated with severe melioidosis infection (Cheng & Currie, 2005). On top of that, the clinical and laboratory factors such as bacteraemia status, the requirement for intensive care unit (ICU) and history of intubation are also markers of a poor prognosis (Hussin *et al*., 2023; Mardhiah & Nursyahiyatul-Anis, 2024; Poh *et al*., 2024).

Although the risk factors are well-documented in previous literature, their specific impact within Pahang's distinctive demographic and environmental context remains poorly understood. Most earlier studies in Malaysia primarily focused on other states. In contrast, the state of Pahang has a vast agricultural economy and a substantial rural and indigenous population, suggesting that the primary factors of mortality may differ from those in more urbanised states. To address this critical knowledge gap, this study aims to determine the factors associated with melioidosis mortality in Pahang from 2020 to 2024, with an emphasis on sociodemographic, occupational, clinical, environmental, and individual determinants.

MATERIALS AND METHODS

Study design

This aetiological study utilised a retrospective cohort study design. It used secondary data from the Melioidosis Registry of the Pahang State Health Department. The research was conducted in the State of Pahang, where it is the highest reported prevalence in Malaysia (Arushothy *et al*., 2024). The data encompass all melioidosis cases reported across 11 districts in Pahang.

Study population, sampling, and sample size

The study population consisted of all individuals with confirmed melioidosis diagnoses who were registered in the Pahang State Melioidosis Registry between 2020 and 2024. A universal sampling method was employed for the entire sampling frame to maximise statistical power and ensure comprehensive representation in this study.

The inclusion criterion for this study was all confirmed cases of melioidosis, irrespective of age, while 'suspected' and 'probable' cases registered were excluded. The registry initially contained 480 cases, and the final sample was 466 after excluding 14 probable cases that did not meet the confirmed case definition during the study period. The estimated sample size was 235, when accounting for 20% of data missingness and was calculated using OpenEpi website at (https://www.openepi.com) with alpha set at 5%, power of 80% and by using 54% melioidosis case fatality rate (Nathan *et al*., 2018).

Case definition

The case definition used in this study was based on the *Case Definition of Infectious Diseases in Malaysia, 3rd Edition (2017)* by the Malaysian Ministry of Health (MOH) to ensure consistency with national surveillance practices (Disease Control Division Ministry of Health Malaysia, 2017).

- Confirmed cases: Any suspected case with either a positive culture for *B. pseudomallei* from any clinical specimen, a positive polymerase chain reaction (PCR) test, or a four-fold rise in serological titre between acute and convalescent samples.
- Melioidosis mortality: A death directly resulted from a confirmed case of melioidosis, as determined and recorded in the cause of death by the attending clinician.

Data collection and study variables

Data were extracted from the Pahang State Melioidosis Registry after obtaining permission from the Pahang State Health Department. In order to maintain confidentiality, the data were de-identified and extracted by the Communicable Disease Control (CDC) unit before being provided in Excel format.

Variables obtained from the registry include sociodemographic, comorbidities, and clinical factors such as a history of ICU admission and the time from onset to diagnosis. The environmental data, which include the monthly mean rainfall amount (cm), were obtained from the National Climate Centre of Malaysia (Malaysian Meteorological Department, 2025). In this study, data from the district of Temerloh were analysed, as this district recorded the highest incidence rate of melioidosis in Pahang during the study period.

Data management and statistical analysis

Data cleaning and statistical analyses were performed using the IBM Statistical Package for the Social Sciences (SPSS) software, version 29.0. An assessment of the missing data was conducted. The body mass index (BMI) variable was excluded from the study variable due to a high proportion of missing data (>20%). The 'time of diagnosis' variable had 14.8% missing values, and the Little's missing completely at random (MCAR) test indicated that these values were missing completely at random ($\chi^2 = 45.958$, df = 44, p = 0.391). Hence, the missing values in this variable were imputed using the series mean method. Chronic kidney disease (CKD) and human immunodeficiency virus (HIV) variables were also excluded from the analysis due to zero-cell count in the 2x2 contingency table when cross-tabulated with the outcome.

In terms of analysis, the annual incidence rate, mortality rate, and case fatality rate of melioidosis in Pahang were calculated using the standard epidemiological formula with the population estimates obtained from the Department of Statistics Malaysia as the denominator.

$$\text{Incidence Rate} = \frac{\textit{Number of new cases in specified year}}{\textit{Number of person at risk in the specified year}} \times 100\,000$$

$$\text{Melioidosis Mortality Rate} = \frac{\textit{Number of individual dying due to melioidosis}}{\textit{Total population}} \times 100\,000$$

$$\text{Case Fatality Rate} = \frac{\textit{Number of individual dying during specified period after onset/diagnosis}}{\textit{Total number of individual with that disease}} \times 100\,000$$

Descriptive statistics were employed to summarise the characteristics of the study sample. The association between the independent variables and mortality was assessed using simple logistic regression to calculate crude odds ratios (OR) with 95% confidence intervals (CI). Variables with a p-value of less than 0.25 in the univariate analysis were then selected for inclusion in a multivariable logistic regression model. A backward stepwise selection method was utilised to construct the final model, which identified the independent predictors of melioidosis mortality while controlling for confounders (Hosmer, 2013).

RESULTS

A total of 466 confirmed cases of melioidosis registered in the Pahang State Melioidosis Registry from 1st January 2020 until 31st December 2024 were included in the final analysis.

Trend, Incidence and Mortality of Melioidosis

Over the 5-year study period, the incidence rate (IR) of melioidosis in Pahang fluctuated. The lowest rate observed was in 2020 (1.54 per 100 000 population) and the highest in 2022 (3.61 per 100 000 population). Among the districts in Pahang, Temerloh showed the highest incidence rate of melioidosis in 2024 (1.8 per 100 000 population). In terms of mortality, the highest mortality rate observed was in 2024 (0.11 per 100 000 population). No death was recorded in 2020. The case fatality rate (CFR) also showed a fluctuating trend, peaking at 19.76% in 2021 before declining and then rising again to 16.81% in 2024. The annual rates are detailed in Tables 1 and 2.

In terms of environmental data, there was no statistical correlation between monthly rainfall and the number of cases (Pearson's r = 0.186, p = 0.154), as illustrated in Figure 1.

Characteristics of the study cohort

Out of 466 confirmed registered melioidosis cases, 68 (14.6%) have died due to meliodosis. The median age of the cohort was 48 years (IQR 34 - 60). Most of the patients were male (76%) and came from Malay ethnicity (77.3%). In terms of geographical setting, the majority of the patients came from rural areas (71%). Among those cases, many were unemployed or retired (37.3%) and worked in the agriculture sector (27.7%). Diabetes mellitus was the most common comorbidity, which was present in 62.4% of all patients. A detailed univariate analysis and the comparison of the characteristics between those who died and those who survived are presented in Table 3.

Factors associated with melioidosis mortality

The final regression model identified three independent factors associated with melioidosis mortality, which were non-Malaysian ethnicity, presence of COPD and a history of ICU admission. Patients of non-Malaysian ethnicity had over three times the odds of mortality compared to Malay ethnicity patients (aOR 3.27: 95% CI 1.43–7.51). From this study, patient with COPD has the highest odds of fatal outcomes with aOR of 8.71 (95% CI: 1.11–68.39). A history of

Table 1. Annual incidence rate of melioidosis in Pahang from 2020 to 2024

	Year				
	2020	2021	2022	2023	2024
Incidence Rate, IR (per 100 000 population)					
	1.54	1.87	3.61	3.11	3.32
IR by District in Pahang (per 100 000 population)					
Bentong	0	0.09	0	0	0.5
Bera	0.2	0.31	0.51	1	0.99
Cameron Highland	0	0	0.26	0.24	0
Jerantut	0.21	0.1	0.41	0.91	1
Kuantan	0.11	0.47	0.56	0.37	0.44
Lipis	0	0.41	0.2	0.1	0.2
Maran	0.09	0	0.78	1.2	0.59
Pekan	0.41	0.82	1.7	0.71	1.25
Raub	0	0	0	0	0.1
Rompin	1.63	0.8	1.49	0.89	0.39
Temerloh	0.83	0.47	1.75	1.72	1.8

Table 2. Annual mortality rate and case fatality rate of melioidosis in Pahang (2020-2024)

	Year				
	2020	2021	2022	2023	2024
Mortality Rate, MR (per 100 000 population)					
	0	0.07	0.08	0.07	0.11
MR by District in Pahang (per 100 000 population)					
Bentong	0	0.09	0	0	0.08
Bera	0	0.1	0	0.1	0.5
Cameron Highland	0	0	0	0	0
Jerantut	0	0.1	0	0	0
Kuantan	0	0.09	0.02	0.05	0.07
Lipis	0	0	0.1	0.1	0.1
Maran	0	0	0.17	0.09	0
Pekan	0	0.16	0.32	0.16	0.31
Raub	0	0	0	0	0
Rompin	0	0.1	0.3	0	0
Temerloh	0	0.06	0.12	0.17	0.22
Case Fatality Rate, CFR (%)					
Pahang	0	19.67	11.02	10.58	16.81

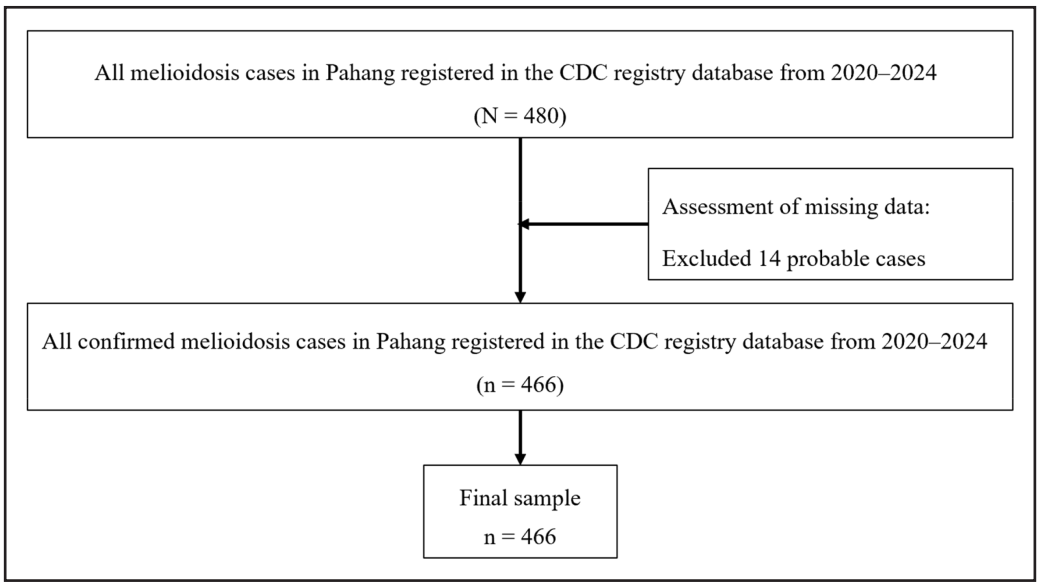

Figure 1. Flowchart of data extraction from melioidosis registry (2020–2024).

Table 3. Crosstabulation of sociodemographic data and factors associated with melioidosis mortality in Pahang (2020-2024)

Characteristic	Death (n=68)	Alive (n=398)	Total (n=466)	Crude Odd Ratio (95% CI)	p-value[a]
Age (years), median (IQR)	46.0 years (IQR: 36.25-60.75)	48.0 years (IQR: 33-60)	48 years (IQR: 34-60)	1.01 (0.99, 1.02)	0.522
Gender, n (%)					
Male	53 (15%)	301 (85.0%)	354 (100%)	1.14 (0.61, 2.11)	0.680
Female	15 (13.4%)	97 (86.6%)	112 (100%)	ref	
Ethnicity, n (%)					
Malay	50 (13.9%)	310 (86.1%)	360 (100%)	ref	
Orang Asli	3 (7.0%)	40 (93.0%)	43 (100%)	0.47 (0.14, 1.56)	0.215
Chinese	2 (16.7%)	10 (83.3%)	12 (100%)	1.24 (0.26, 5.83)	0.785
Indian	2 (11.1%)	16 (88.9%)	18 (100%)	0.78 (0.17, 3.47)	0.739
Others (non-Malaysian)	11 (33.3%)	22 (66.7%)	33 (100%)	**3.10 (1.41, 6.78)**	**0.005***
Geographical Setting, n (%)					
Rural	49 (14.8%)	282 (85.2%)	331 (100%)	1.06 (0.60, 1.88)	0.840
Urban	19 (14.1%)	116 (85.9%)	135 (100%)	ref	
Type of Occupation					
Professional	5 (18.5%)	22 (81.5%)	27 (100%)	ref	
Agriculture	20 (15.5%)	109 (84.5%)	129 (100%)	0.81 (0.27–2.38)	0.698
Mining Industry	1 (50%)	1 (50.0%)	2 (100%)	4.40 (0.23–82.98)	0.323
Factory/ Industry	9 (17.3%)	43 (82.7%)	52 (100%)	0.92 (0.28–3.08)	0.894
Self-employed	12 (14.6%)	70 (85.4%)	82 (100%)	0.75 (0.24–2.38)	0.630
Unemployed/Retiree	21 (12.1%)	153 (87.9%)	174 (100%)	0.60 (0.21–1.77)	0.357
History of ICU admission:					
Yes	26 (29.9%)	61 (70.1%)	87 (100%)	**3.42 (1.96, 5.99)**	**<0.001***
No	42 (11.1%)	337 (88.9%)	379 (100%)	ref	
Exposure Risk Factor:					
Soil related	21 (14.7%)	122 (85.4%)	143 (100%)	ref	0.970
Non-soil Related	47 (14.6%)	276 (85.4%)	323 (100%)	1.01 (0.58, 1.76)	
Comorbidity:					
At least 1 comorbidity	46 (14.5%)	272 (85.5%)	318 (100%)	0.97 (0.56, 1.68)	0.909
No Comorbidities	22 (14.9%)	126 (85.1%)	148 (100%)	ref	
Diabetes Mellitus, n (%)					
Yes	40 (13.7%)	251 (86.3%)	291 (100%)	0.84 (0.50, 1.41)	0.505
No	28 (16.0%)	147 (84.0%%)	175 (100%)	ref	
Hypertension, n (%)					
Yes	16 (14.7%)	93 (85.3%)	109 (100%)	1.01 (0.550, 1.85)	
No	52 (14.6%)	305 (85.4%)	357 (100%)	ref	0.977
Heart Disease, n (%)					
Yes	2 (18.2%)	9 (81.8%)	11 (100%)	1.31 (0.28, 6.20)	
No	66 (14.5%)	389 (85.5%)	455 (100%)	ref	0.734
COPD, n (%)					
Yes	2 (50.0%)	2 (50.0%)	4 (100%)	**6.00 (0.83, 43.34)**	**0.076***
No	66 (14.3%)	396 (85.7%)	463 (100%)	ref	
Time of Diagnosis (Days), median (IQR)	14.50 days (IQR: 8.0-17.78)	17.78 Days (IQR: 10.0-23.0)	17 Days (IQR: 9-22)	**0.98 (0.96, 1.00)**	**0.175***
Distance to Healthcare Facility (km), median (IQR)	4.95 km (IQR: 3.85-6.55)	4.6 km (IQR: 3.6-6.0)	4.7km (IQR: 3.7-6.1)	**1.07 (0.=99, 1.17)**	**0.109***
Rainfall	186.8 mm, IQR (103.8-242.0)	176.2 mm, IQR (116.0-242.0)	185.2 mm, IQR (114.2-242.0)	1.00 (1.00, 1.01)	0.995

[a]Univariate analysis was done using Simple Logistic Regression.
*Factors with a p-value <0.25 were selected for a multivariable.
*ref indicate reference category.

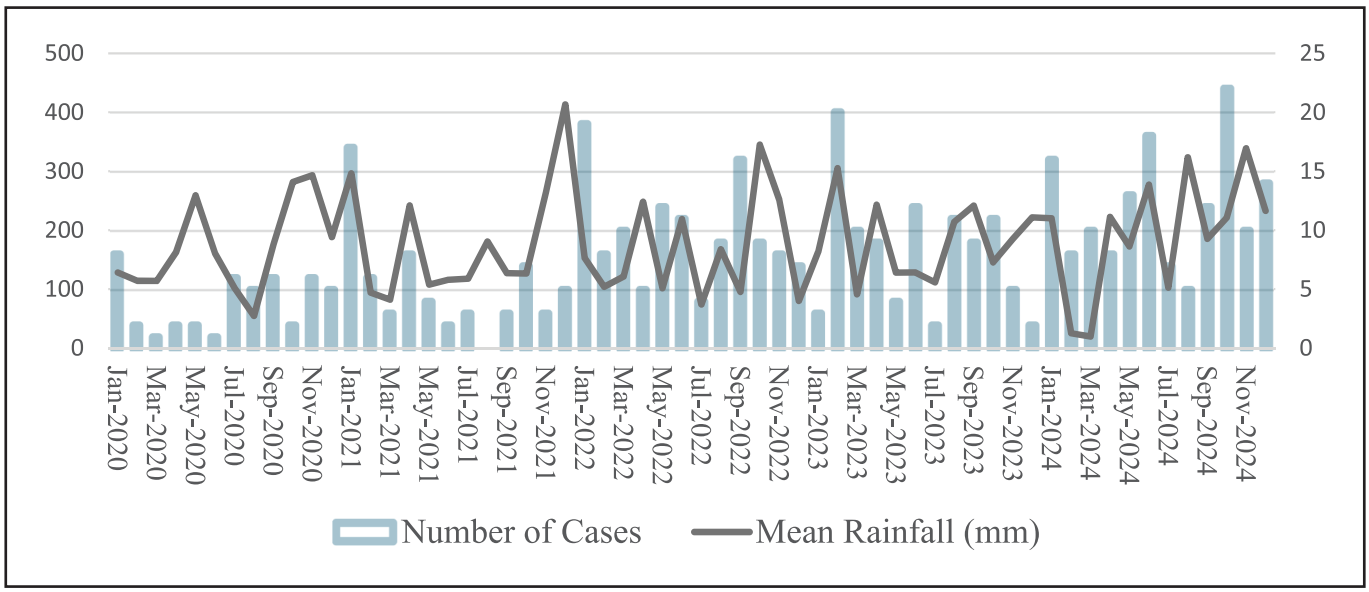

Figure 2. Trends in melioidosis cases and monthly rainfall in Pahang (2020-2024).

Table 4. Factors associated with melioidosis mortality status

Variable	Adjusted OR[a] (95% CI)	Wald, χ^2 (df)	P-value[a]
Ethnicity			
Malay	ref	10.27 (4)	
Orang Asli	0.46 (0.13, 1.57)	1.54 (1)	0.214
Chinese	1.06 (0.20, 5.73)	0.01 (1)	0.945
Indian	0.95 (0.21, 4.40)	0.004 (1)	0.948
Others (non-Malaysian)	**3.27 (1.43, 7.51)**	7.83 (1)	**0.005***
COPD			
Yes	**8.71 (1.11, 68.39)**	4.23 (1)	**0.040***
No	ref		
Distance to Healthcare Facility	1.06 (0.97, 1.16)	1.517 (1)	0.218
ICU admission			
Yes	**3.44 (1.91, 6.17)**	17.081 (1)	**<0.001***
No	ref		
Time of Diagnosis	0.99 (0.96, 1.01)	1.066 (1)	0.302

[a]Multivariable analysis using Multiple Logistic Regression.
*The final regression model demonstrated a good fit (Hosmer-Lemeshow test, p = 0.839) with no interaction or multicollinearity.
*p<0.05 indicates a significant statistical result.

ICU admission was also strongly associated with mortality, with aOR of 3.44 (95% CI: 1.91–6.17). The detailed results of the multivariable analysis are shown in Table 4.

DISCUSSION

There were three significant risk factors identified, which included non-Malaysian ethnicity, history of ICU admission and the presence of chronic obstructive pulmonary disease (COPD).

The incidence rate of melioidosis in Pahang from 2020 to 2024 fluctuated, with the lowest in 2020 (1.54 per 100 000 population) and the highest in 2022 (3.61 per 100 000 population). This might be due to changes in how people seek medical care during and after the COVID-19 pandemic, where multiple lockdowns have reduced the public's exposure to contaminated soil or water (Doraiswamy *et al*., 2021). Incidence rates in Pahang are generally lower than those reported in previous studies, such as Arushothy *et al*. (2024), primarily due to the strict inclusion criteria employed. Most studies on melioidosis have been conducted using hospital laboratory findings, whereas this study only utilised the confirmed case definition from the Disease Control Division Ministry of Health Malaysia (2017). There was no mortality in 2020, but the overall case fatality rate (CFR) between 2021 and 2024 was consistently high which range from 10.58% to 19.67%, which is consistent with previous studies in Negeri Sembilan, with a CFR range between 8.7% and 16.7% (Md Hanif *et al*., 2024).

The non-Malaysian ethnicity was found to be a significant risk factor contributing to higher odds of melioidosis mortality with adjusted OR 3.27 (95% CI: 1.43–7.51). This finding aligns with a recent study by Md Hanif *et al*. (2024) in Negeri Sembilan that has also reported a significantly higher mortality rate among non-Malaysians. This risk factor is more likely to represent the broader socioeconomic disadvantages and obstacles to healthcare access in Malaysia, rather than reflecting on innate biological vulnerability (Loganathan *et al*., 2019). In Pahang, the local economy relies heavily on sectors such as agriculture and construction, which employ a large number of migrant workers from neighbouring countries (Department of Statistics Malaysia, 2024). These workers are often assigned to the "3D" jobs (dirty, dangerous, and difficult), which expose them to a greater risk of *B. pseudomallei* infection in soil and water (Saari *et al*., 2025). On top of that, a study done by Loganathan *et al*. (2019) for migrant health also highlights issues such as higher medical costs among non-citizens, fear of job loss, uncertainty of immigration status, language difficulties, and limited social support are all contribute to delayed presentation for medical care. As a result, by the time they seek treatment, their disease is often more severe, and it increases the likelihood of intensive care unit support and death. Hence, addressing these social disparities requires a public health approach that extends beyond the disease itself to promote equitable and affordable access to healthcare for everyone.

In terms of comorbidity, pre-existing diagnosis of chronic obstructive pulmonary disease (COPD) is a significant risk factor for melioidosis mortality. Melioidosis frequently manifests as community-acquired pneumonia, which makes individuals with COPD very susceptible to severe lung infection (Liu *et al*., 2018; Nathan *et al*., 2018). The association between COPD and melioidosis

mortality has been studied in prior studies, although the strength of the association found in this study is particularly high (Domthong *et al*., 2016). In this study, a patient with COPD had over eight times the odds of a fatal outcome (aOR = 8.71, 95% CI: 1.11, 68.39). COPD is characterised by chronic, irreversible airflow obstruction, impaired mucociliary clearance, and immune dysregulation, which compromises the physical defence against inhaled pathogens (Kim & Lee, 2005; Pang & Liu, 2024). COPD also causes structural lung changes such as emphysema and chronic bronchitis, which lead to destruction of lung tissue and airflow obstruction. These changes further compromise the lung's capacity to clear pathogens and may result in a severe lung infection (Kim & Lee, 2005). Moreover, the main medication for COPD is inhaled corticosteroid (ICS), which can suppress the immune response in the long term, making them more susceptible to a severe melioidosis infection (Jo, 2022). The increased risk observed in this study underscores the importance of maintaining a high index of suspicion among clinicians who treat patients with COPD who present with pneumonia symptoms.

Another significant risk factor for melioidosis mortality was a history of intensive care unit (ICU) admission with an adjusted OR of 3.44 (95%CI: 1.91, 6.17). This finding is consistent with previous studies that highlight ICU admission and the need for mechanical ventilation as a critical marker for severe and life-threatening melioidosis infection (Chien *et al*., 2018; Poh *et al*., 2024). Admission to the ICU typically highlights the severity of the disease progression, which generally results from a severe bacterial infection such as acute respiratory distress syndrome (ARDS), septic shock and multiple organ dysfunction (Gascoigne & Bourke, 2013; Poh *et al*., 2024). This finding demonstrates that even with intensive care support, the risk of mortality is exceptionally high among melioidosis patients.

Despite 62.4% of the registered cases having diabetes mellitus (DM), this comorbidity was not found to be significant in this study. Astonishingly, this finding contradicts many previous studies that have proven DM as one of the most important risk factors for melioidosis mortality, particularly due to a weakened immune system (Abu Hassan *et al*., 2019; Hadi *et al*., 2021; Poh *et al*., 2024). This contradiction is possibly due to the similar distribution of diabetic cases between those who died and those who survived in this study cohort. Therefore, the statistical regression model was unable to distinguish its effect from other factors. Secondly, following the National Diabetes Registry Report 2023, it was noted that Pahang had the highest proportion of diabetic patients achieving targeted HbA1c levels in Malaysia (Ministry of Health Malaysia, 2023). Therefore, the better glycaemic control in the Pahang diabetic population may have attenuated the risks of getting severe melioidosis infection.

Melioidosis is an environmentally acquired infection in which soil-related worker are at risk of infection. However, in this study, we found no statistically significant relationship between monthly rainfall amount and melioidosis cases in Pahang (Pearson's r = 0.186, p = 0.154). These results align with recent studies conducted in the states of Sabah and Negeri Sembilan (Hussin *et al*., 2023; Md Hanif *et al*., 2024). It is essential to note that earlier studies, particularly those from Northern Australia, have consistently demonstrated a significant association between rainfall amount and melioidosis incidence and mortality (Cheng & Currie, 2005). Rainfall may contribute to the environmental exposure, but its role as a direct factor for melioidosis incidence and mortality is currently limited (Md Hanif *et al*., 2024). The apparent discrepancy may reflect differences in local climate, environmental conditions, or public health interventions between Pahang and other areas.

Strengths and Limitations

This study has several strengths, including its settings, sampling method, and data source. This study focuses specifically on the state of Pahang, which was known to have the highest incidence rate of melioidosis in Malaysia (Arushothy *et al*., 2024). Selection bias was minimised by using a universal sampling method from the state's official melioidosis registry. By utilising a state-wide registry, we enhanced the generalizability of our findings, particularly to other similar agricultural regions in Southeast Asia.

However, this study also has limitations due to its retrospective design and reliance on secondary data. The data were limited to the variables that are available in the registry. Therefore, other clinical and laboratory parameters associated with mortality, such as bacteraemia status, sepsis scores, or levels of inflammatory markers like C-reactive protein, were not included in this study and may have led to residual confounding.

CONCLUSION

This study identifies non-Malaysian ethnicity, COPD and ICU admission as the risk factors of melioidosis mortality in Pahang from 2020 to 2024. The increased risk among the migrant population suggests the ongoing barriers in accessing healthcare facilities and the need for comprehensive public health strategies. The melioidosis mortality association between COPD and ICU admission highlights the importance of early detection and prompt management. Interestingly, DM and rainfall amount were not found to be significant risk factors, which suggests regional variation or improved glycaemic control in Pahang. From a public health perspective, it is essential to implement a structured health policy to address the social determinants of health among vulnerable groups, particularly migrant workers. Future research should incorporate additional clinical and laboratory parameters to refine the risk assessment. Overall, this study enhanced local understanding of melioidosis mortality and provided evidence to inform public health strategies, resource allocation, and future interventions.

Ethical Approval

The study was conducted in strict adherence to the ethical principles outlined in the Declaration of Helsinki. Ethical approval was granted by the MARA University of Technology (UiTM) Research Ethics Committee (Ref: 100 – FPR (PT.9/19) (FERC-EX-25-03)) and the Medical Research and Ethics Committee (MREC), Ministry of Health Malaysia, via the National Medical Research Register (NMRR) (ID: ID-25-00720-1N6). The administrative approval to access the anonymised data was granted by the Pahang Health State Department.

ACKNOWLEDGMENT

The authors would like to express their sincere appreciation and gratitude to the Pahang State Health Department for granting access to the melioidosis registry data that has been the core element of this study. We are also grateful to all healthcare personnel involved in data collection and management. We are also thankful to the Department of Public Health, Faculty of Medicine, Universiti Teknologi MARA (UiTM), for providing academic support and facilities during this study period. Finally, we would like to thank the Director General of Health Malaysia for his permission to publish this article.

Conflict of Interest

The authors declare that they have no conflict of interests.

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