

**PREVALENCE AND FACTORS ASSOCIATED
WITH PREVENTABLE UNDER-FIVE
MORTALITY IN KELANTAN, MALAYSIA FROM
2018-2021**

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by

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LIST OF ABBREVIATIONS

U5MR	Under-five Mortality Rate
CIPD	Certain infectious and parasitic disease
CM-CNS	Congenital malformations of the central nervous system
CRS	Child restraint system
GAPPD	Global Action Plan for Pneumonia and Diarrhoea
HIE	Hypoxic Ischaemic Encephalopathy
IMCI	Integrated Management Childhood Illness
MAS	Meconium Aspiration Syndrome
NIP	National Immunization Programme
NTDs	Neural tube defects
PDA	Patent Ductus Arteriosus
SDGs	Sustainable Development Goals
SU5MR	Stillbirth and Under-five Mortality
TGA	Transposition of Great Arteries
UCOD	Underlying Cause Of Death
VSD	Ventricular Septal Defect

ABSTRAK

PREVALEN DAN FAKTOR-FAKTOR BERKAITAN DENGAN KEMATIAN BAWAH LIMA TAHUN YANG BOLEH DICEGAH DI KELANTAN, MALAYSIA DARI 2018-2021

Latar Belakang Kajian: Matlamat Pembangunan Mampan (SDG) menasaskan untuk menamatkan kematian bayi baru lahir dan kanak-kanak bawah lima tahun yang boleh dicegah menjelang 2030, dimana semua negara menasaskan untuk mengurangkan kematian bawah lima tahun kepada sekurang-kurangnya serendah 25 bagi setiap 1,000 kelahiran hidup. Kadar Kematian Bawah Lima Tahun ialah penunjuk penting untuk kesihatan dan kesejahteraan kanak-kanak, dan mencerminkan perkembangan sosial dan ekonomi.

Objektif: Kajian ini bertujuan untuk menentukan prevalens, sebab-sebab kematian yang boleh dicegah dan faktor-faktor berkaitan dengan kematian bawah lima tahun yang boleh dicegah di Kelantan dari 2018-2021

Metodologi: Kajian keratan rentas telah dijalankan antara Disember 2022 hingga Jun 2023 di kalangan kematian kanak-kanak di bawah lima tahun dari sepuluh daerah di Kelantan yang dilaporkan kepada Jabatan Kesihatan Negeri Kelantan dari tahun 2018 hingga 2021. Kajian ini menggunakan data sekunder yang diperolehi dari Sistem Pemberitahuan *Stilbirth* dan Kematian Kanak-kanak di bawah Lima Tahun dan Borang Siasatan *Stilbirth* dan Kematian Kanak-kanak di bawah Lima Tahun. Kaedah persempelan rawak mudah menggunakan Microsoft excel telah digunakan untuk memilih 904 kematian

daripada semua kes. Analisis deskriptif, regresi logistik mudah, dan regresi logistik berganda telah digunakan.

Keputusan: Sebanyak 904 subjek kematian bawah lima tahun yang memenuhi kriteria inklusi dan eksklusi telah dikaji. Kajian ini menunjukkan bahawa 46.7% kematian bawah lima tahun boleh dicegah. Analisis lanjut menunjukkan bahawa kematian bawah lima tahun yang boleh dicegah secara signifikan dikaitkan dengan ibu berumur 14-19 tahun (Adj. OR 2.69, 95% CI: 1.24,5.83; $p=0.012$), pendapatan isi rumah kurang daripada RM3000 (Adj. OR 1.55, 95% CI 1.05,2.31; $p=0.030$), umur kanak-kanak (Adj. OR 0.19, 95% CI 0.12,0.31; $p <0.001$), kanak-kanak tanpa komorbiditi (Adj. OR 3.26, 95% CI 2.37,4.49; $p <0.001$); kekurangan kualiti penjagaan (Adj. OR 7.02, 95% CI 4.23,11.65; $p <0.001$)

Kesimpulan: Bilangan kematian bawah lima tahun yang boleh dicegah adalah berkaitan dengan faktor berkaitan keluarga, faktor berkaitan kanak-kanak dan faktor berkaitan perkhidmatan kesihatan. Faktor-faktor seperti ibu yang berumur 14 -19 tahun, pendapatan isi rumah kurang daripada RM3000, umur kanak-kanak, kanak-kanak tanpa komorbiditi dan kekurangan kualiti penjagaan adalah signifikan dikaitkan dengan kematian bawah lima tahun yang boleh dicegah. Pengenalpastian faktor-faktor yang berkaitan ini boleh membantu pengamal perubatan dan kesihatan untuk menambah baik strategi dan intervensi masa hadapan dan memperbaiki mutu perkhidmatan untuk menamatkan kematian bawah lima tahun yang boleh dicegah dan mencapai SDG menjelang 2030.

Kata kunci: Kematian bawah lima tahun, dicegah, faktor berkaitan

ABSTRACT

PREVALENCE AND FACTORS ASSOCIATED WITH PREVENTABLE UNDER-FIVE MORTALITY IN KELANTAN, MALAYSIA FROM 2018-2021

Background of study: The Sustainable Development Goals (SDG) target to end the preventable deaths of newborns and children under-five years of age by 2030, with all countries aiming to reduce under-five mortality to at least as low as 25 per 1,000 live births. Under-five Mortality Rates is an important indicator for child health and well-being, and reflects the social and economic development.

Objective: The aim of the study was to determine the prevalence, causes and factors associated with preventable under-five mortality in Kelantan from 2018-2021.

Methodology: A cross sectional study was conducted between December 2022 till June 2023 among under-five deaths from ten districts in Kelantan notified to Kelantan State Health Department from 2018 to 2021. The study used secondary data derived from Stillbirth and Under-five Notification System and Stillbirth and Under-five Mortality Investigation Form. A simple random sampling method using Microsoft Excel was applied to select 904 deaths from all cases. The descriptive, simple logistic regression and multiple logistic regression analysis were applied.

Results: A total of 904 under-five deaths who fulfill the inclusion and exclusion criteria were studied. This study showed that 46.7% of under-five deaths was preventable. Further analysis showed that preventable under-five deaths was significantly associated with

maternal aged 14-19 (Adj. OR 2.69, 95% CI: 1.24,5.83; p=0.012), household income less than RM3000 (Adj. OR 1.55, 95% CI 1.05,2.31; p=0.030), child age (Adj. OR 0.19, 95% CI 0.12,0.31; p <0.001), child without comorbidities (Adj. OR 3.26, 95% CI 2.37,4.49; p<0.001) and shortfall of quality of care (Adj. OR 7.02, 95% CI 4.23,11.65; p<0.001).

Conclusion: The number of preventable under-five deaths is substantiate and it was associated with family related factor, child related factor and health service related factor. Factors such as maternal aged 14-19, household income less than RM3000, child age, child without comorbidities and shortfall of quality of care were significantly associated with preventable under-five deaths. Recognition of these associated factors hence may guide healthcare providers for improvisation of strategy and future intervention in order to end the preventable under-five deaths and achieve the SDG by 2030.

Key words: Under-five mortality, preventable, associated factor

CHAPTER 1

INTRODUCTION

1.1 Background of the study

The Under-five Mortality Rate (U5MR) is an important indicator for children's health and well-being, as well as of broader social and economic development (Ministry of Health, 2022c). It reflects the degree to which children have access to essential health interventions like immunization, adequate nutrition and treatment care in developing countries and poses a serious public health concern. In accordance with the Sustainable Development Goals (SDGs), our goal is to improve child survival by 2030 by eliminating preventable infant and child deaths, with every nation aiming to lower under-five mortality to a minimum of 25 per 1,000 live births (UK, 2021).

Under-five mortality encompasses all deaths that occur in children aged 0 days up to five years, which is one of the important components of a population. Infant deaths are deaths occurring at less than one year of life. Early neonatal deaths refer to deaths that occur at the first week after delivery. Late neonatal death are defined as deaths that arise between seven and 28 days after delivery while post-neonatal deaths defined as deaths that occur between 28 days and one year of age (Department of Statistics, 2021; WHO, 2021).

Preventable death is death that can be prevented through medical and non-medical intervention. Medically treatable refers to conditions potentially preventable by medical

intervention like delay referral to healthcare facilities, inappropriate diagnosis and treatment care, inadequate resuscitation which lead to death meanwhile non-medical intervention is conditions that potentially be prevented through public healthcare policies or interventions, social factors or patient factors (Ministry of Health, 2016).

Globally, approximately 70% of deaths among children and youth occurred in children under the age of five, with almost half of these mortality being infants whose lives can be saved through various fundamental healthcare approaches. These methods include ensuring wider access to good quality of antenatal treatment care, preventing premature delivery, providing high quality of services during childbirth, offering healthcare services both mothers and infants after delivery, and attending to the needs of small and sick newborns (Omar, 2020). Over the years, there has been a significant decline in the global U5MR from 93 of deaths per 1000 live births in 1990, reduced to 37 deaths in 2020, marking a remarkable 61% reduction (WHO, 2021; Yemane, 2022).

The U5MR in Malaysia has significantly decreased, falling from 16.8 deaths per 1000 live births in 1990, reduce to 6.9 deaths in 2020, a 46% decrease (Nurul N. M. *et al.*, 2021). Since then, the U5MR in Malaysia have plateaued for 2 decades ranging from of 8-9 deaths per 1000 live birth (JKNK, 2022; Ministry of Health, 2016).

1.2 Problem Statements and Rationale of The Study

Despite the reduction in U5MR in Malaysia, the performance of under-five mortality is still not achieved the target of 5.6 per 1000 life birth which was targeted by

Ministry Of Health, Malaysia. Preventable death in Malaysia account for 37.8% of all deaths in year 2019 and Kelantan was among the highest state (Ministry of Health, 2022a).

However, limited study was found on preventable U5MR particularly on its associated factors in Malaysia, especially in Kelantan. Therefore, to reduce the U5MR and to achieve the Sustainable Development Goals, the under-five mortality data was analyzed further to determine the factors associated with preventable under-five mortality that might help us to identify shortfalls in the healthcare so that remedial measures can be implemented at the state and district level. In addition, the study findings may be utilized to ensure the intervention programs are more appropriately targeted and effective to achieve improvement and reduction of under-five mortality rate in Kelantan.

1.3 Research Questions

1. What is the prevalence of preventable under-five deaths in Kelantan?
2. What are the common causes of preventable under-five deaths in Kelantan?
3. What are the factors associated with preventable under-five deaths in Kelantan?

1.4 Objectives

1.4.1 General objective:

To determine the prevalence, causes and factors associated with preventable under-five deaths in Kelantan from 2018-2021

1.4.2 Specific objective:

1. To determine the prevalence of preventable under-five deaths in Kelantan from 2018-2021
2. To describe the common causes of preventable under-five deaths in Kelantan from 2018-2021
3. To determine the factors associated with preventable under-five deaths in Kelantan from 2018-2021

1.5 Research hypothesis

There are significant associations between family related factors, child related factors and health services related factors with preventable under-five deaths in Kelantan.

CHAPTER 2

LITERATURE REVIEW

2.1 Prevalence of preventable under-five deaths

Globally, 5.3 million children died in 2018, with over 50% of deaths were due to diseases that are preventable and treatable that could be addressed through simple and cost-effective interventions (Samnang and Sopheab, 2021). Malaysia already established the target for SDGs indicator 3.2.1 U5MR which is reduction of under-five to 25 per 1,000 live births since 1984. However, the target to end the preventable death is yet to be achieved. About 37.8 % of under-five death in Malaysia were preventable and treatable in 2019 (Ministry of Health, 2022c). A local study conducted in Kedah reported that U5MR was 7.63 per 1000 live births in 2019 and 22.9% were preventable (Omar, 2020). Local study in Sabah reported there was increment of preventable U5MR within 1 year from 1.7% in 2015 to 12.5% in 2016 (Dualis, 2018). Study by Prasetyoputra *et al.* (2022) in Indonesia showed the U5MR was at 32 per 1000 livebirths. Meanwhile, a cohort study in city of Rio de Janeiro Brazil showed 61% out of 426,867 deaths were avoidable (Kale *et al.*, 2019).

2.2 Causes of preventable under-five deaths

According to the Ministry of Health (2022c), there are five main underlying causes of death. The causes are (1) The conditions in perinatal period, (2) Congenital abnormalities,

deformations and abnormal chromosomes, (3) Respiratory diseases, (4) Injuries, poisoning and other external causes, and (5) Parasites and infectious diseases.

According to Dibley *et al.* (2012), perinatal mortality was found to be twice as common among preterm newborns compared to term newborns. The main cause of condition from the perinatal period was severe prematurity (64.6%), hypoxic-ischemic encephalopathy (15.4%) and infections (Harrison and Goldenberg, 2016; Omar, 2020).

Among various types of congenital malformations, abnormalities of the cardiovascular system accounted for 30.4% of cases, followed by the central nervous system at 14.5%, and congenital malformations requiring surgical intervention at 9.8%. Within the cardiovascular system malformations, 50.2% were deemed preventable (Ministry of Health, 2022c). These preventable deaths could have been addressed through surgical and catheter interventions, such as addressing variants like VSD, PDA, and TGA (Ministry of Health, 2022c). Congenital malformations of the central nervous system (CM-CNS) can be divided into non-neural tube defects (NTDs) and NTDs. Notably, half of CM-CNS mortality were attributed to preventable NTDs, which have been shown to be preventable through mandatory implementation of folic acid fortification in various countries (Dibley *et al.*, 2012; Ministry of Health, 2022c). Biliary Atresia were the commonest causes of congenital malformations of the digestive system, followed by Bowel Atresia and Tracheoesophageal fistula. The primary factor contributing to mortality in cases of biliary atresia is the delayed age of surgery. However, this unfortunate outcome can be prevented through early detection and timely surgical intervention (Bocar Wellé *et al.*, 2022).

The commonest causes of death for age 1-5 years were injuries, poisoning and external causes in which 34.7% were from motor vehicle accident, 22.1% were from drowning, 15.3% from assault and 13.6% were from asphyxia (Ministry of Health, 2022c). The risk of drowning is greatest for children under the age of five, with 48.5% of fatal drowning incidents taking place close to their homes. Notably, all cases of home drowning involved children under the age of four, supporting the World Health Organization's statement that children below the age of four are most vulnerable to drowning (WHO, 2017). Physical abuse accounted for 93.6% of reported cases of non-accidental injuries, while neglect and physical & sexual abuse made up 4.3% and 2.2%, respectively. Family members and caregivers were identified as the main perpetrators (Ministry of Health, 2022c). Milk aspiration was commonly identified as the cause of death especially in cases where infants passed away within their homes. It is notable that among the deaths attributed to milk aspiration, 88.5% of them affected children who were under six months of age (Moon *et al.*, 2007).

Around 90.7% of deaths related to respiratory systems were attributed to pneumonia, accounting for 5.1% of all mortality among children less than five years old (WHO, 2021). Among preventable deaths caused by respiratory diseases, 42.8% occurred outside of hospital settings. Additionally, infectious diseases, particularly sepsis and acute gastroenteritis (AGE), remained significant causes of death among children less than five years of age. Sepsis accounted for 60.3% of deaths, while acute gastroenteritis accounted for 21.5% (Ministry of Health, 2022c). Poverty and malnutrition cause about 35%-42% of mortality attributed to HIV, tuberculosis, and AGE. Delayed treatment care and low level

of awareness regarding the illness severity were responsible between 50% and 35% of the mortality (Sanyang, 2019).

2.3 Factors associated with preventable under-five deaths

Many studies reported on factors associated with under-five deaths in general. To our knowledge, there were very limited studies looking specifically at preventable under-five deaths and its associated factors. However, there were a few studies reported on the factors associated with common causes of preventable under-five deaths.

2.3.1 Family related factors

In general, studies reported that under-five mortality was associated with family and child factors, in which younger (<19 years old) and advanced maternal age are higher risk for under-five mortality (Hussein *et al.*, 2021; Sinha, 2017). Studies found that unmarried mothers have a higher risk of U5MR compared to married mothers (Hussein *et al.*, 2021; Patel and Olickal, 2021). Furthermore, the mortality rate among children under five years old was 1.22 times higher for mothers who did not attend school and 1.16 times higher for mothers who only completed primary education, in comparison to mothers who had secondary and tertiary education (Andegiorgish *et al.*, 2022). The risk of death in children in rural areas was 1.84 times more than children in urban areas (Pal *et al.*, 2021). In Malaysia, U5MR was more in the rural or underdeveloped states, mainly the east coast region of the peninsular Malaysia and the Borneo (Nurul N. M. *et al.*, 2021). Household income influences the U5MR as well. Those with low household income had three times more under-five mortality than those who were rich (Edmund W.K. *et al.*, 2014;

Ekholuenetale *et al.*, 2020). This statement is related to fact that the lowest income family had poor housing condition, poor nutrition and can't afford for better medical attention. The deaths among male children were consistently higher as 56% compared to the female (Sawyer, 2012; Yemane, 2022).

2.3.2 Child related factors

There were a few studies reported on the factors associated with common causes of preventable under-five mortality. The common causes include prematurity, infectious disease, congenital malformation and malnutrition.

Premature newborns were found to be twice as likely to experience perinatal mortality compared to term newborns (Dibley *et al.*, 2012). Studies have indicated that mortality rates were higher among smaller infants with a birth weight below 1000 grams and extreme prematurity under 32 weeks (Silverberg *et al.*, 2018). Nosocomial infection primarily affects premature babies born at less or at 31 weeks (84.9%) and babies with a birth weight of less than 1500 grams (78.1%). Infants born prematurely or with low birth weight had four-times the risk of Sudden Infant Death Syndrome (SIDS) compared to full-term infants (Rohana *et al.*, 2018). Both adolescent pregnancies and pregnancies in advanced maternal has 0.50 times increased odds of preterm birth (Li *et al.*, 2022; Vogel *et al.*, 2018). Nulliparous women less 18 years old had 1.52 times the odds of preterm birth in comparison to other parity and age categories. Additionally, mothers with low level of education has higher risk of preterm birth. History of preterm birth and twin pregnancy, less than six months of interval between pregnancies, and a previous history of multiple miscarriages are strong risk factors for premature birth in subsequent pregnancies

(Barfield, 2018). Female newborns are lower risk of premature birth compare to male newborns. Furthermore, other maternal conditions that can complicate pregnancy and increase risk of premature birth include infections, pre-eclampsia, gestational and pre-gestational diabetes, cervical incompetence, periodontal related disease, anemia in pregnancy, maternal obesity, mother with short stature, and mother with low levels of vitamin D (Li *et al.*, 2022).

There are two important causes related to death among term babies in perinatal period which are asphyxia and infection. About 61.8% of deaths reported due to asphyxia among term babies. The main preventable causes of asphyxia are Meconium Aspiration Syndrome (MAS) and Hypoxic Ischaemic Encephalopathy (HIE) (Ministry of Health, 2022c). HIE was responsible for 60.8% of these deaths, followed by Meconium Aspiration Syndrome at 31.6%. Children with meconium-stained amniotic fluid, mother with prolonged second stage of labor and other eventful condition during delivery has significantly associated with HIE (Torbenso *et al.*, 2017). About 27.6% of deaths were associated with infections in term babies. There were sepsis at 77.3%, necrotizing enterocolitis at 7.6% and congenital pneumonia at 15.2%. Mothers with obstetric and medical risk factors were associated with these infections. The risk factors included diabetes mellitus (11.2%), hypertension (7.6%), unbooked and/or unmarried mothers (7.5%), preterm labor (7.2%), anemia (6.3%), and obesity (3.9%) (Perin *et al.*, 2022).

In relation to fatalities resulting from congenital abnormalities, deformations and abnormal chromosomes; abnormalities of the cardiovascular system accounted for 30.4% of the cases, followed by congenital malformations necessitating surgical intervention at 9.8% and the central nervous system at 4.5% (Silverberg *et al.*, 2018). Studies have

indicated that Neural Tube Defects (NTDs) were more prevalent among mothers under the age of 26 (OR=2.92). Mother with diabetes mellitus, obesity, and hypertensive disorders in pregnancy did not show a strong correlation with NTDs. However, with odds ratios of 3.32 and 3.13, respectively, mother with underlying diabetes mellitus and obesity were significant associated with holoprosencephaly (Ministry of Health, 2022c).

About 57.5% of male, and 70.1% of Malay ethnicity children was pronounced deaths due to injury, poisoning, and other external causes. Children below the age of 2 accounted for nearly two-thirds of these deaths. Among the deceased, about 50% had a household income of less than RM3000.00, and 57% of the deaths were a result of motor vehicle accidents (Ministry of Health, 2022c). It is noteworthy that almost 99% of deaths within this group were preventable, with socio-political factors (70.7%) playing a major role, especially adherence to injury preventive measures at 60.5%. Additionally, 16.6% were associated with healthcare factors, primarily as a result of suboptimal quality of care.

Pneumonia emerged as a prominent cause of death within the respiratory system, contributing to 5.1% of all mortalities among children less than 5 years old (WHO, 2021). Majority of childhood pneumonia-related deaths were influenced by familial and patient factors. The main causes of these deaths were predominantly attributed to delays in seeking medical treatment, insufficient awareness of the severity of the illness, and non-adherence or rejection of therapy or immunization (UNICEF, 2016). Mothers with unformal education faced a 5.3 times the risk of child deaths due to respiratory illness. Moreover, 19.7% of under-five mortality are due to incomplete immunization (Ministry of Health, 2022c). Almost 95.7% of preventable deaths are due to shortfall in the quality of care with several risk factors identified, including a failure to detect severe condition of

illnesses, inadequate or delayed therapy, diagnostic errors, delays in referral and a poor of regional retrieval systems.

Many of the deaths attributed to infectious and parasitic diseases (CIPD) involved children who had at least one parent who was a non-citizen. The percentage of non-citizen fathers and mothers was roughly 19% and 24%, respectively. In addition, 31.5% of the parents had only finished elementary school or had no formal education at all. It was observed that children who succumbed to HIV and acute gastroenteritis (AGE) had the highest percentage of parents with low level of educational backgrounds. Additionally, 59% of the children belonged to low household income with a total household income of RM3000 or lesser (Ministry of Health, 2022c).

2.3.3 Health service related factors

To better understand Malaysia's progress in reducing child mortality, it is important to examine the patterns of child deaths and the location of deaths, whether they occur in a hospital or outside a hospital (Omar, 2020). The location of death indicate whether medical care was sought and provided for the child's illnesses were treated medically before they passed away (Ministry of Health, 2016). Even though 77.6% of preventable deaths occurred in hospitals, there were also cases of late arrival to hospital in severe condition and death was unavoidable. In other than hospital settings, most of preventable deaths pronounced at home or in the homes of caregivers (12.2%). In addition, about 4.2 % of children mortality was documented on the way to health facilities, most likely indicate a possible delay in seeking treatment (Ministry of Health, 2022c). Almost half (46.9%) of preventable under-five mortality was associated with health service factors which are shortfall in quality of care. The most common factor was inadequate therapy

(41.7%) for the underlying causes of death in the perinatal group. Failure to recognize the severity of conditions was the primary factor identified for certain infectious diseases and respiratory system diseases (Ministry of Health, 2016; Ministry of Health, 2022c).

2.4 Conceptual Framework

Figure 2.1 shows conceptual framework of factors associated with preventable under-five deaths. Among the family related factors associated with under-five mortality are maternal age, marital status, education, household income, district and ethnicity. Child related factors include gender, child age, immunization status and comorbidities. Health service factors include place of death and shortfall in quality of care. Those mark with * were factors that were not included in this study due to incomplete data.

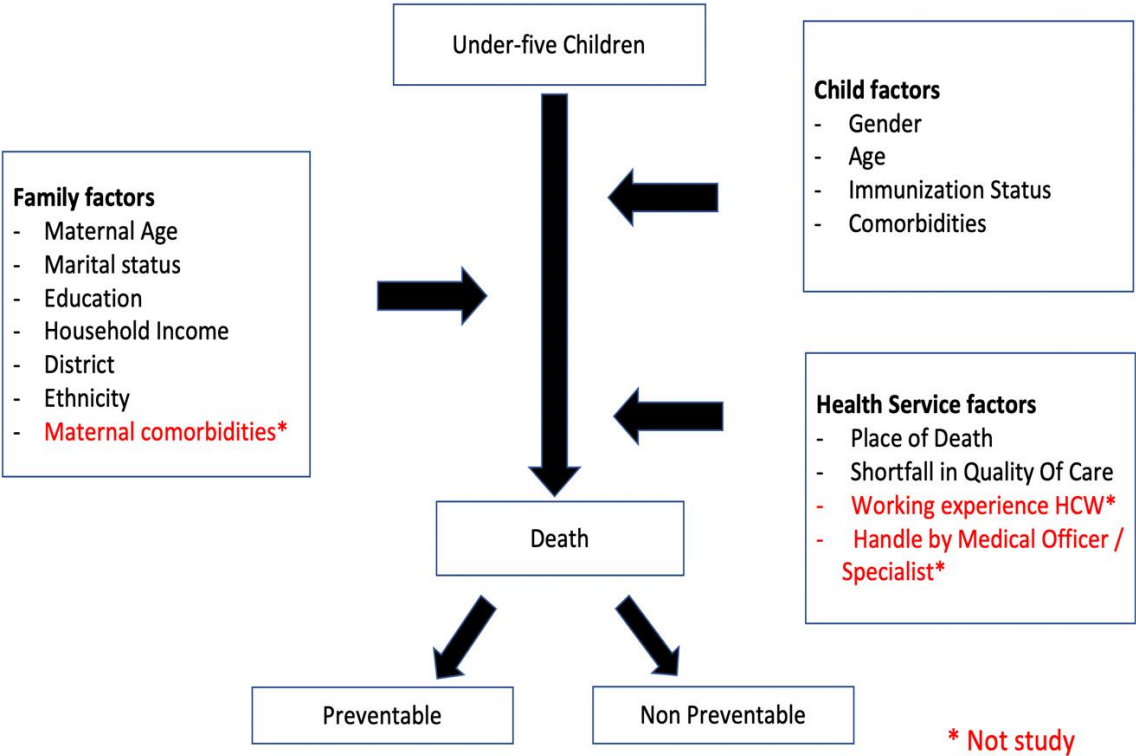


Figure 2.1: Conceptual framework of the study

CHAPTER 3

METHODOLOGY

3.1 Study design

This was a cross sectional study based on retrospective record review of the notified deaths in Stillbirth and Under-five Mortality Notification System (SU5MR System).

3.2 Study duration

This study was conducted between December 2022 till June 2023

3.3 Study location

The study was conducted in Maternal and Child Health Unit, Kelantan State Health Department. The state of Kelantan is located at North-East of Peninsular Malaysia bordered by Thailand in the north, South China Sea in the northeast, Terengganu in the east, Pahang in the south and Perak in the west. Kelantan covers area of 15,040km² and has 10 districts namely Bachok, Gua Musang, Jeli, Kota Bharu, Kuala Krai, Machang, Pasir Mas, Pasir Puteh, Tanah Merah and Tumpat. In 2020, the state's total population was 1.90 million people with a population density of 118.7 per km² (Department of Statistics, 2020). Maternal and Child Health Unit, Kelantan State Health Department received notification and investigation forms from 106 health clinics, private clinics and 15 hospitals in all districts in Kelantan, 9 of which is public, 1 university hospital and 5 were private hospitals.

3.4 Reference population

All deaths under-five years of age in Kelantan

3.5 Source population

All under-five deaths from ten districts in Kelantan notified to Kelantan State Health Department from 2018 to 2021.

3.6 Sampling Frame

All under-five deaths from ten districts notified to Kelantan State Health Department from 2018 to 2021 who fulfilled the inclusion and exclusion criteria.

3.7 Study criteria

3.7.1 Inclusion criteria

All under-five deaths includes citizens and non-citizen; who were notified in Kelantan Stillbirth and Under-five Mortality Reporting System (SU5MR System) from 2018 to 2021

3.7.2 Exclusion criteria

Missing data of more than 30% of the interested variables from the database

3.8 Operational definitions

1. Under-five deaths

Death that occurs from the first day of life (day 0) to < 5 years old (1824 completed days) after birth (Ministry of Health, 2018)

2. Preventable Death

Deaths that can be prevented through medical and nonmedical interventions (Ministry of Health, 2016)

3. Non preventable Death

Deaths due to life limiting diseases such as lethal congenital malformation, inborn error of metabolism, severe inoperable congenital heart disease (Ministry of Health, 2016)

4. Maternal age

a. 14-19 years old: refers to teenage pregnancy, the WHO has defined adolescence as being between 10-19 years old (WHO, 2022)

b. > 40 years old: refers to advance maternal age (Ministry of Health, 2022b)

5. Household Income

Household income in this study were <RM1000, RM1001-RM3000, RM3001-RM5000, RM5001-RM7000, above RM7000 and others (on social welfare, no income and unknown status) based on data recorded in

Stillbirth and Under-five Notification System (SU5MR System) and
Stillbirth and Under-five Mortality Investigation Form (SU5MR-1/2012)

6. Having Comorbidities

Comorbidities in this study was defined as comorbidities which were related to deaths which include congenital anomalies, lethal congenital anomalies, perinatal period conditions, cardiac disease, malignancy, lung disease, malnutrition and cerebral palsy. Comorbidities that were not applicable to the mortalities mainly referred to child with present of comorbidities which are not related to deaths.

7. Hospital death

Death of patient who arrived at the hospital with signs of life and had treatment in the hospital whether in the A&E, ward, intensive care etc. before he died. Included deaths occurring in all disciplines in the hospital and included death during ambulance transportation from one hospital to another (Ministry of Health, 2022c)

8. Non-hospital death

Death that occurred outside the hospital which also included brought in dead to the hospital, death while on the way to care/hospital, death in clinic/polyclinic and death at home or elsewhere (Ministry of Health, 2022c)

9. Shortfall in quality of care include inadequate therapy, failure to diagnose, failure to appreciate severity, delay in referral (Ministry of Health, 2022c)

3.9 Sample size determination

3.9.1 Sample size calculation for objective 1

The sample size was calculated to estimate the prevalence of preventable under-five mortality in Kelantan by using single proportion formula (Arifin, 2013). A sample size of 305 was estimated to be sufficient to address the first objective, including an allowance of an additional 10% possibility of missing data (95% confidence, $Z_{\alpha} = 1.96$ and the precision, $d = 0.05$). P is the value of prevalence of preventable under-five mortality. The prevalence of preventable under-five mortality was 23% (Omar, 2020).

Single proportion formula

$$n = \left(\frac{Z_{\alpha}}{d} \right)^2 * P (1 - P)$$

$$\begin{aligned} & \left(\frac{1.96}{0.05} \right)^2 \times 0.23 (1-0.23) \\ & = 1537 \times 0.23 (1-0.23) \\ & = 1537 \times 0.18 + 10\% \text{ possibility of missing data} \\ & = 305 \end{aligned}$$

Therefore, the sample size calculated was 305.

3.9.2 Sample size calculation for objective 3

Sample size was calculated by using PS software (dichotomous). The power of the study is set at 0.8 with $\alpha=0.05$. The calculation was applied to each variable with 10% additional as possibility of missing data.

Table 3.1: Sample size calculation for objective 3

Variables	P ₀	P ₁	m	n	N(nX2)+10% dropout	Literature review
Child Gender (Male)	0.44	0.55	1	324	720	(Ministry of Health, 2022c)
Ethnicity (Malay)	0.10	0.20	1	199	444	(Omar,2020)
Household income (Low)	0.13	0.25	1	167	372	(Andegiorgish <i>et al.</i> , 2022)
Non hospital death	0.17	0.25	1	406	904	(Omar,2020)

P₀= proportion of preventable under-five mortality among unexposed group from the previous study

P₁ = estimated proportion of the preventable under-five mortality among exposed

m: ratio unexposed /exposed

The sample size chosen was 904, which was the biggest sample size calculated for this study.

3.10 Sampling method and subject recruitment

In 2018, there were a total of 310 reported death, followed by 318 cases in 2019, 257 in 2020, and 269 cases in year 2021. A simple random sampling method using Microsoft Excel was applied to select 904 deaths from all cases.

3.11 Data collection and research tools

This study involved secondary data collection. Data collection was done by primary investigator. The data was obtained from Stillbirth and Under-five Mortality Notification System (SU5MR System) (Appendix A) and Stillbirth and Under-five Mortality Investigation Form (SU5MR-1/2012) – (Appendix B) from Maternal and Child Health Unit from Kelantan State Health Department. Stillbirth and Under-five Mortality Notification System (SU5MR System) was established in 2013 by Ministry of Health, Malaysia. This reporting system is to report all under-five deaths including those from private sector and deaths outside hospitals. All deaths are investigated, identified and classified as preventable or otherwise. All under-five deaths (0 - < 5 years old) and stillbirths are notified to District Health Office by filling up the respective Notification form U5MR-N within 24 hours from the time of death. The form is subsequently sent to Kelantan State Health Department within 24 hours from the time of death. Kelantan State Health Department then verify the cases and notify to Ministry of Health within 24 hours. All deaths are investigated and recorded manually in the Stillbirth and Under-five Mortality Investigation Form (SU5MR-1/2012) by hospitals or health clinics. The investigation form is send to the District Health Office within one week from the time

of death before submitting to Kelantan State Health Department and finally to Ministry of Health within 12 weeks from the time of death (Ministry of Health, 2018).

Data obtained from the investigation forms and notification systems was collected using a proforma checklist (Appendix C) and was identified by a code number. The variables gathered include family related factors: maternal age, marital status, education, household income, district and ethnicity, child related factors: gender, child age, immunization status, comorbidities and congenital anomaly, health service factors: place of death and shortfall in quality of care. The data was transformed into Microsoft Excel and exported into SPSS version 26 software for statistical analysis.

3.12 Statistical analysis

All data were entered and analyzed using SPSS version 26 software. The data were explored, validated and cleaned. A preliminary data description was performed to find any values that were missing. Errors in the data set were verified. Numerical data were presented as mean (SD) or median (IQR) based on their normality distribution. Categorical data were presented as frequency (percentage).

The statistical analysis for objectives 1 and 2 were descriptive analysis. The results were presented as frequency (percentage) for categorical data. Statistical analysis for objective 3 was simple and multiple logistic regression. The independent variables were family related factors (maternal age, marital status, maternal education, household income, district, ethnicity), child related factors (gender, age, immunization status, comorbidities,

congenital anomaly) and health service-related factors (place of death and shortfall in quality of care).

For analysis purposes, variables like district, types of comorbidities, types of shortfall in quality of care were not included in the analysis because of the presence of cells less than 10 count where this problem caused the model to be unstable. This might result in implausibly large b coefficients and very large odd ratio which are not interpretable for the study. Other variables included were marital status, ethnicity, mother education level, household income, immunization status and comorbidities. They were recategorized because there were very small number of the cells for each variables. The dependent (outcome) variable was categorized into 'non-preventable death' and 'preventable death' of under-five death. They were coded as '0' for non-preventable death and '1' for preventable death. Statistical analyses used were simple and multiple logistic regression analysis.

Regression analysis aims to establish a model that is the best fit, parsimonious (simple model), and biologically sound (model that makes sense). Modelling in multiple logistic regressions involved the following steps; (1) univariate analysis, (2) variable selection, (3) check multicollinearity, (4) check two-way interaction term, (5) assess the goodness-of-fit of the model, and (6) establish a final model.

In univariate analysis, a simple logistic regression was used to find factors associated with preventable under-five death in Kelantan. Any significant variables with a p-value < 0.25 were included in the multiple logistic regression model for further analysis. The factors with $p < 0.25$ were (1) 'maternal age', (2) 'mother education level',

(3) 'household income', (4) 'gender', (5) 'child age', (6) 'immunization status', (7) 'comorbidities', (8) 'place of death', and (9) 'shortfall in quality of care'.

The above-mentioned factors were analysed using multiple logistic regression analysis. The variables were selected with forward stepwise selection method by likelihood-ratio test, backward stepwise selection method by likelihood-ratio test and manual selection methods. Multicollinearity was checked by looking into standard error of the variable. Small standard error indicated no multicollinearity. All possible two-way interaction was checked as well. An interaction of variables is considered when p-value is < 0.05 . Preliminary main effect model was obtained. Fitness of the model was tested with Hosmer-Lemeshow goodness of fit test, classification table, and receiver operating characteristic (ROC). The Hosmer-Lemeshow goodness of fit test with a p-value of more than 0.05 indicates that the model was fit. The classification table with the overall correctly classified percentage at 70% and above and ROC curve with an area under the curve of 0.7 and above also indicates that the model was fit. The final model was presented with adjusted odds ratio (Adj. OR), 95% confidence interval (CI) and p-value. The level of significance was set at 0.05 with two-tailed.

3.13 Ethical consideration

Ethical approval was obtained to carry out this research from Ethics Committee, Universiti Sains Malaysia (JEPeM) USM/JEPeM/22110716 (Appendix D), Medical Research and Ethics Committee (MREC) Ministry of Health NMRR ID-22-02812-VR9 (IIR) (Appendix E) and The Kelantan State Health Department (Appendix F). Confidentiality of the data was maintained at the highest level as possible. Patient's name and identification number was not extracted from the database. Every client was kept as anonymous, using a specific identification number. Reported information would not identify individual cases. The researcher who reviewed the patient's data was not involved in the patient's management.

The data were protected through setting of password to access the database, locked in a secured place at all time. Only researcher had access to the data and the data were not passed on to other researchers. The study data will be destroyed after the period of storage.