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Trend Analysis of Under-Five Mortality Rate in Malaysia by Gender and States

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ABSTRACT

The mortality rate especially among children is a prime barometer of the overall status of a country. Malaysia has taken the initiative to reduce and remain the low mortality rate among children under-five as emphasized by United Nations in Sustainable Development Goal. This paper presented the trend of mortality rates among children under-five in Malaysia, using yearly national death data recorded from the Department of Statistics Malaysia (DOSM) from 1980 to 2018 across gender and sub-national unit (states). We used descriptive analysis and time series plot to observe the under-five mortality trend across gender, while the filled map function was used to examine the U5MR trend across states (sub-national unit) in Malaysia. As a result, we found a decreasing trend of U5MR for both male and female children across the years. Besides that, the mortality rate among male children was consistently higher compared to female children. Although the U5MR in Malaysia has shown a decreasing trend throughout the year, there was still a visible difference in U5MR across the states. Throughout the whole period of the study, the highest mortality rate was found in rural or underdeveloped states which were mainly on the East coast of the Peninsular and the Borneo part of Malaysia. This trend analysis can be used as a reference for the demographers and entitled legislator in Malaysia to draft a suitable policy to ensure the mortality rate among children can be reduced and achieve the thin gap of mortality rate across gender and states in comparison to the other developing countries. This study may also become a guideline for the health department to channel a practical approach focusing on the underdeveloped states to equally disperse Malaysia's U5MR across the states in the near future.

Keywords: filled map, time series plot, trend analysis, under-five mortality rates, U5MR Malaysia

1 INTRODUCTION

Child well-being has become one of the substantial popular topics in most developing countries. For a low and middle-income country like Malaysia, child health is a sensitive issue as it is one of the key indicators of an overall status such as population health and socio economic [1]. Following the end of Millennium development Goal (MDG), United Nations (UN) with the pledge of 'no one will be left behind' had adopted a far border Sustainable Development Goal (SDG), with one of its goal to develop a good health and well-being among children. The SDG number 3 (SDG-3) has pinpointed that every

country had to reduce the mortality rate among children under-five years old to as low as 25 per 1000 livebirths and neonatal death to at least 12 deaths in 1000 livebirths by the year 2030.

The under-five mortality rate (U5MR) is defined as the probability of a child dying in 1,000 live births before reaching their fifth birthdays [2]. In pertaining to the SDG adopted by the UN, reducing U5MR has come to be a central goal globally. U5MR is said to be a vital measure for a whole population development status, a key pointer for social and financial progress [3]. Like any other nation, Malaysia has also implemented the SDG-3 by enforcing a wide range of policies and programs in controlling the infectious and preventable diseases since it has reported that an approximate of 5.2 million children under the age of 5 died in 2019, many from preventable and treatable causes [3]. One of the efforts that the Ministry of Health Malaysia (MOH) had carried out was Immunise4life program which intended to promote immunization and free administration of vaccines against several leading childhood diseases to Malaysian children [5].

Currently, Malaysia is one of the few countries that have remarkable achievement in reducing U5MR. According to the Department of Statistics Malaysia (DOSM), Malaysia has already achieved SDG-3 since 1984, and has proved to continue its outstanding performance when it was reported that Malaysia's U5MR in 2019 improved to as low as 9 deaths per 1,000 live births [5][6]. However, this progress is not equally scattered across its sub-national unit. This can be seen from the 2018 annual health report of U5MR in 2016 across the states which was not proportionate as some of the states were above the national average while the others were below the national average [7]. Additionally, U5MR is vital in many application areas, especially in government planning due to health care and education program, hence it is important to study the trend performance of U5MR across sub-national unit such as the state.

Previously, a number of studies were done globally on U5MR, such as in Indonesia [8], Africa [9], Kenya [10], China [11][12], Chile [13]. In addition, among these studies, several researchers focused on estimating and forecasting trend of U5MR [8][12][14][15]. In the case of Malaysia, there is limited study found on U5MR specifically. Most of the studies focused more on mortality rate for all ages [3][16][17][18][19]. Currently, there are studies by [1][1] and [20] which focused on analyzing the trend and forecasting U5MR in Malaysia. However, these studies used the total U5MR that spanned from 1980 to 2016 in Peninsular Malaysia (West Malaysia). These studies did not cover East Malaysia (Borneo) and did not cater specifically U5MR for each state in Malaysia. As highlighted by [21], it is important to study the mortality rates across the states since the socially advantaged districts have much better mortality rates compared to the socially disadvantaged districts. Therefore, it is significant to conduct this study to observe and examine the updated trend of U5MR across the states and gender so that prominent actions can be taken towards the states or districts that have a higher rate. Hence, this study was done to analyze and examine the progress of U5MR trend in Malaysia throughout the year 1980 to 2018 across the gender and state.

2 METHODOLOGY

This study examined the trend of under-five mortality rates (U5MR) across gender and states in Malaysia by using the time series data that spanned for 39 years. Malaysia is divided into West Malaysia and East Malaysia. The west part of the country is also known as Peninsular Malaysia which consists of eleven (11) states, while the East or Borneo part has two (2) states with a total of three (3) federal territories. The national death records among the children under-five years old were obtained from the Department of Statistics Malaysia (DOSM) for this study. The data consisted of the parameter counts of death, mortality rate (per 1,000 live birth), gender, states, and year. The overall study period of 1980 to 2018 was chosen due to the availability of the data at the time of conducting the study. However, due to the constitutional act, some of the mortality data of federal territories were incomplete. In this case, the study was conducted using the U5MR data span from 1991 to 2018 for Federal Territory of Labuan, while Federal Territory of Putrajaya data span was from 2010 to 2018. Before those periods, the U5MR data in Labuan was included in Sabah, and Putrajaya was included in Selangor.

The simple descriptive statistics and pie chart were used in analyzing U5MR across gender. Mean, standard deviation and variance were used in describing the characteristics of the historical UFMR in Malaysia. The statistics used are mean, variance and standard deviation.

$$\mu = \frac{\sum_{i=1}^{N} x_i}{N} \quad (1)$$

Equation (1) shows the mean formula where $\sum_{i=1}^{N} x_i$ is the sum of all the data values in which for this study, it is the sum of the rates across the years and N is the number of rate values.

$$\sigma^2 = \frac{\sum(x-\mu)^2}{N} \quad (2)$$

$$\sigma = \sqrt{\frac{\sum(x-\mu)^2}{N}} \quad (3)$$

Equation (2) was used to measure the spread out of the data set in this study where the sum of the $(x-\mu)^2$ (μ is the population mean) was divided by the number of rates. Equation (3) shows the formula for standard deviation that was used to measure the variability or dispersion in this study which was basically the square root of the variance in equation (2).

In addition, the trend U5MR was analyzed using time plot where time plots were presented separately for the trends of overall U5MR and U5MR across states. This study also used map chart in using 'filled map' function in Microsoft Excel 360 program (2019 versions) to position U5MR data in a context of geographical location across states. No inferential statistics were done for this paper.

3 RESULTS

3.1 Malaysia's U5MR Trend Analysis by Gender

The result of this study was based on the secondary U5MR data attained from the Department of Statistics Malaysia (DOSM) that spanned from 1980 to 2018. The pie chart in Figure 1 shows the distribution of male and female U5MR across the year 1980 to 2018. The result showed that throughout 39 years of the study period, the male U5MR was consistently higher with 56% compared to the female with the balance of 44%.

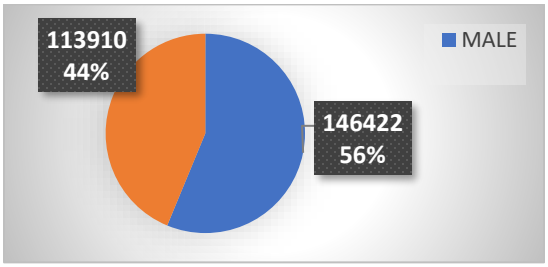


Figure 1: The distribution of male and female U5MR (1980 – 2018).

The result from Figure 1 is supported by the descriptive statistics table as shown in Table 1. The Table 1 shows that the lowest mean score of U5MR was female with the value of 12.2. When compared with three groups, the mean value of the male was much higher than the female and the total rate mean score. The U5MR of the male ranged from 8.3 to 34.3 in comparison to the female U5MR which ranged from 6.9 to 28.5 while the total U5MR ranged between 7.6 to 31.5 per 1000 livebirths.

Table 1: Descriptive analysis table

Statistics	Total Rate	Male	Female
Mean	13.5	14.7	12.2
Standard Deviation	6.5	7.1	5.8
Sample Variance	42.1	50. 7	33.9
Minimum	7.6	8.3	6.9
Maximum	31.5	34.3	28.5
Count	39	39	39

The trend for Malaysia's U5MR that spanned from 1980 to 2018 can be seen in Figure 2. The decreasing trend of U5MR was portrayed in the figure throughout the first 17 years of the study period which was from 1980 to 1996 for both the female and male U5MR as well as the total Malaysia's U5MR. The trend was seen to increase in 1997 and peaked in 1998 before fluctuating drastically in 2000. Throughout those periods, the rate of U5MR among male was constantly higher than the female and the total rate. It was reported an economic crisis had occurred in Malaysia between 1997 to 1998 and this had impacted the health status of the children badly [22]. Consequently, the U5MR trend peaked during those periods. Starting from 2001 to the latest year of 2018, the Malaysia's U5MR had a steady decline trend with the gap of the rate between the male and

female was close to the total U5MR as depicted in Figure 2. The trend of U5MR for male and female gradually approached each other towards 2018 which was a proof of Malaysia's wide range of alliance and teamwork from various policy and approach by the government to ensure that SDG-3 is attained [20]. This result was also supported by previous research in revealing that the "mortality improvement" in Malaysia can be seen when the mortality rates for both genders had decreased by year from 1950 to 2015 [23]. This "mortality improvement" was resulted from the significant number of improvements in public health and Medicare that was emphasize by the Malaysia's government [23].

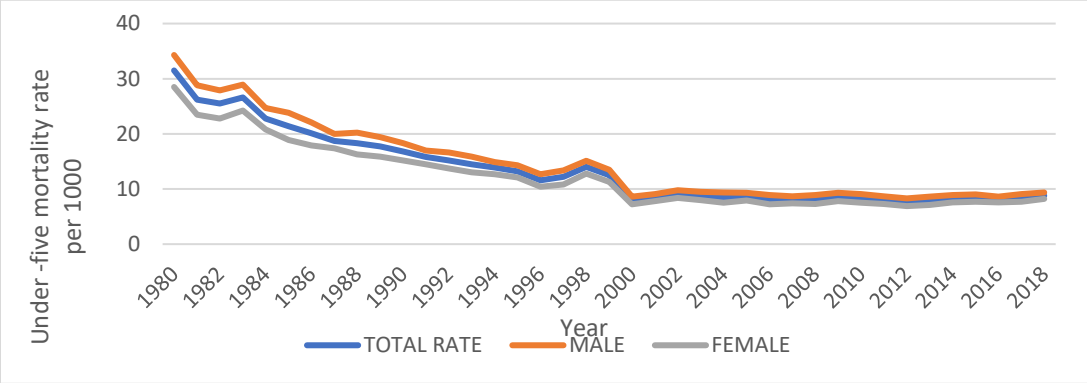


Figure 1: Trend of U5MR in Malaysia from year 1980 to 2018.

3.2 U5MR Trend Analysis by States

The trend analysis by states in Malaysia was portrayed in the time plot as shown in figure 3. Overall, U5MR for each state showed almost a similar pattern of decreasing trend with the overall Malaysia's U5MR. Most of the states had a random shock in the year 1998 before the trend became fluctuated by the year 2000. Figure 3(a) shows a decreasing trend of U5MR in Johor for both male and female before there was a slight increment trend in 1990. The trend showed a downward movement after that and a random shock of decreasing trend was seen in 1996 before the trend rose upward again and decreased once again in 2000. After 2001, the trend gradually decreased across the years for both male and female.

The trend of U5MR in Kedah (Figure 3(b)) showed a random shock of decreasing trend in 1982 before the trend rose again in 1983 for both male and female. There was a wide gap of rate between the male and female from 1984 to 1990 where the male rate showed a random shock of increment trend in 1986, while the female rate showed a gradual decreasing trend. There was a couple of sudden downward movements throughout the period of this study which were in 1992, 1995 and 2000 for both male and female before a gradual decreasing trend was observed over time.

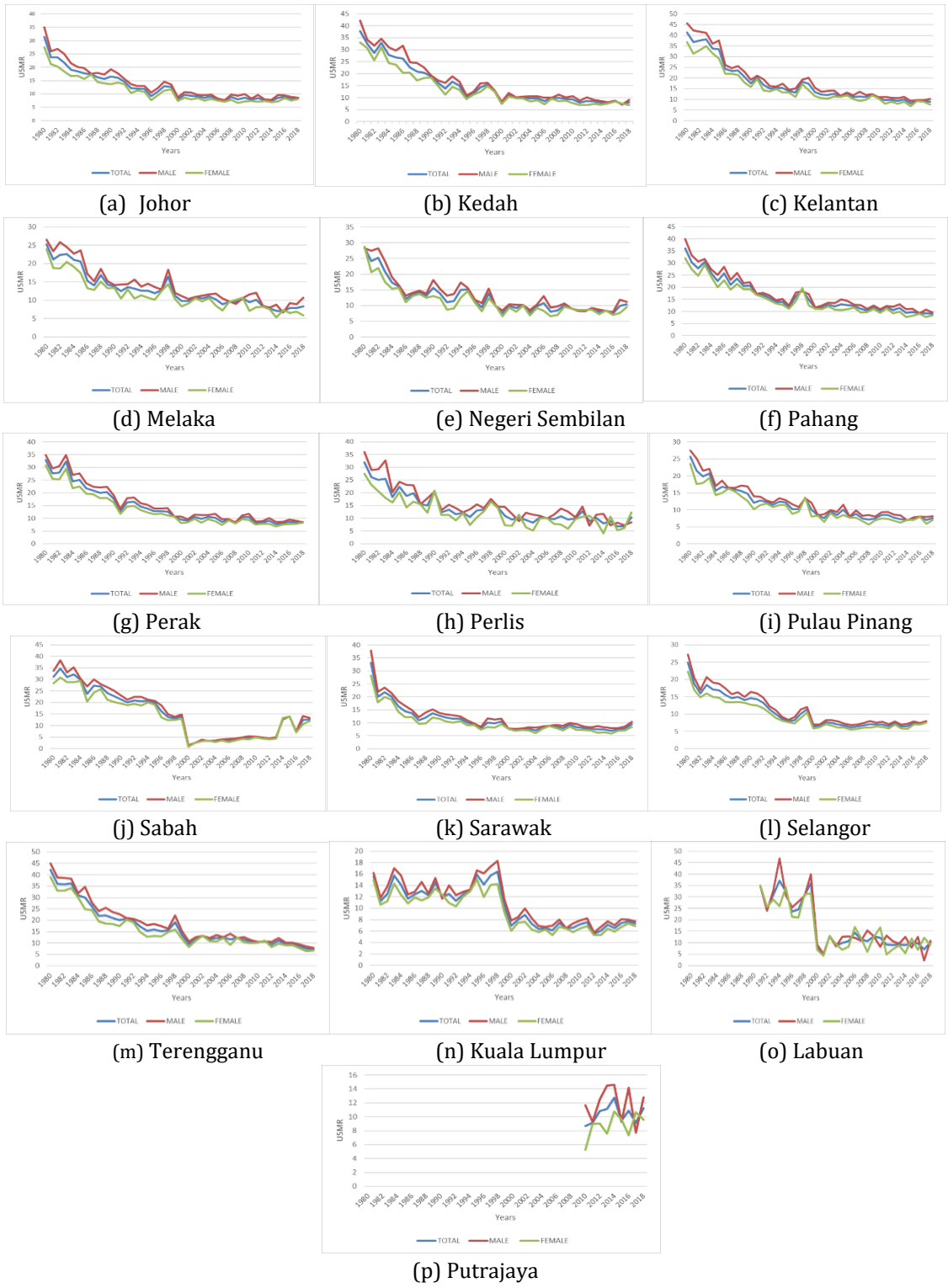
In the case of U5MR in Kelantan (Figure 3(c)), there was a wide gap of rate between the male and female at the beginning of the period of the study before the gap for both genders got narrowed and showed a steady decreasing trend in 1986 onwards. The trend of Kelantan's U5MR increased in 1998 for both male and female and then a steady declining trend was observed over time onwards. However, Melaka (Figure 3(d)) showed an unsteady decreasing trend at the beginning of the period

of this study, before the trend showed a random shock of increase in 1988 and 1998 for both genders. After that, the trend was seen to have a steady decreasing trend over time. At the same time, Negeri Sembilan (Figure 3(e)) also showed a declining trend from 1980 to 1989 where there was a random shock of decreasing trend in 1986 for both male and female. Throughout 1989 to 2000, the seasonal trend was observed in U5MR of Negeri Sembilan before the gradual declining trend. Towards the end of the study, the male U5MR of Negeri Sembilan showed a couple of sudden upward trends which were in 2006 and 2017, while female rate showed a steady downward trend.

Similar to Negeri Sembilan, there was also a decreasing trend of U5MR in Pahang (Figure 3f) before the trend showed a seasonal trend in the years 1982 till 1990, then it showed a regular declining trend. The random shock of increase was seen in 1998 before the steady trend of decrease over time was observed. Meanwhile, Perak (Figure 3(g)) showed a steady decreasing trend towards the end of the period of this study except there was a random shock of increase in 1984 and random shock of decreasing trend in 1991 for both male and female. Otherwise, Perlis (Figure 3(h)) showed an unsteady trend with seasonal component throughout this period of the study with several random shocks of increase in 1983, 1990, 1998 and 2011, and a couple of sharp decreasing trends in 1984 and 1988. In Figure 3(i), Pulau Pinang showed a gradual declining trend over time for both male and female except there was a sudden increment in 1998. The trend onwards showed a slight increase in 2004 before the trend showed a steady decreasing trend again throughout the end of the period of this study.

Figure 3(j) presents the trend of U5MR in Sabah which had a gradual decreasing trend except there was a random shock of decreasing trend in 1985 while in 2000, the U5MR in Sabah stayed at the low rates from 2000 to 2013 before the trend showed a sudden sharp of increment in 2014 and declined again in 2016. Figure 3(k) shows Sarawak had a steady declining trend throughout the period of this study with a couple of sudden decreasing trends which were in 1981, 1996 and 2000 for both male and female. Figure 3(l) displays a decreasing trend of U5MR in Selangor before the trend showed a sudden increment of rates in 1983 and 1999. The trend of Selangor continued to show a slow decreasing trend onwards towards the end of the period of this study. Trend of U5MR in Terengganu as presented in Figure 3(m) also showed a decreasing trend throughout the period of this study with a couple of increments which were in 1985 and 1998. Besides, the Federal Territories of Kuala Lumpur as in Figure 3(n) showed a seasonal trend at the beginning of this study before a sudden shock of decreasing trend was observed in 2000. The trend of Kuala Lumpur showed a slow decreasing trend with a couple of slight rises in trend towards the end of this study.

Due to the availability of the data, the trend of U5MR in the Federal Territories of Labuan was only observed starting from 1991 onwards, while the Federal Territories of Putrajaya started in 2010 onwards. U5MR in Federal Territories of Labuan as presented in Figure 3(o) showed a seasonal trend at the beginning of the study with a sharp increment in 1994 and 1999. A random shock of decreasing trend was observed in 2000 before a seasonal trend was once again observed throughout the end of this study. Lastly, Figure 3(p) shows the trend for Federal Territories of Putrajaya which had an increment of U5MR trend at the beginning of the study before the decreasing trend was observed with a couple of slight rises in 2016 and 2018. Throughout this study, the male and female rates were shown to have a wide gap with a couple of conflicting trends, such as in 2011, the male showed a declining trend while the female showed an upward trend. Other than that, in 2013 and 2016, the U5MR trend of the male showed an upward trend, while the female was observed to have a decreasing trend.



(a) Johor (b) Kedah (c) Kelantan

(d) Melaka (e) Negeri Sembilan (f) Pahang

(g) Perak (h) Perlis (i) Pulau Pinang

(j) Sabah (k) Sarawak (l) Selangor

(m) Terengganu (n) Kuala Lumpur (o) Labuan

(p) Putrajaya

Figure 3: Trend of U5MR for each state in Malaysia.

3.3 Map Charts for U5MR across the States

Using the map chart, the U5MR trend was observed geographically across the states. Figure 4 to Figure 12 show the U5MR of 10 states and 3 federal territories of Malaysia in every five years including the first and the last observation year which were in 1980, 1985, 1990, 1995, 2000, 2005, 2010, 2015, and 2018. The generated map was filled with 3 colors: red, yellow, and blue. States that were in red means that the U5MR in that state and year was high, yellow represents intermediate and blue represents low rate.

In 1980 (Figure 4), the U5MR ranged between 15.6 and 42.1 with the highest rate focusing on the east coast of peninsular Malaysia, Terengganu, and Kelantan, while the lowest rate was in federal territories of Kuala Lumpur. The gap between the highest and the lowest was almost three times. Then, the U5MR trend declined in 1985 (Figure 5) when the highest rate was in Kelantan (33.5 per 1000 livebirths) while the lowest was in federal territories of Kuala Lumpur (11.7 per 1000 livebirths) and the gap between those two values was in fact increasing compared to the gap in 1980.

Approaching 90's, the Malaysia's U5MR steadily declined as well as the U5MR across the states since the gap was getting narrower as seen in Figure 6 (1990) and Figure 7 (1995). In 1990, Sabah U5MR had the highest value of 21.4 deaths per 1000 livebirths and the lowest was only 12 deaths among 1000 livebirths in Kuala Lumpur. Although the Malaysia's U5MR has continuously showed an improvement, yet the gap among the states was growing bigger in 1995. The gap between the highest U5MR and the lowest one was almost four times with the highest being 32.5 death per 1,000 livebirths in federal territories of Labuan and the lowest was 8.7 deaths per 1,000 livebirths in Selangor. Almost every state in 1995 was in the low-rate area with only Sabah and Labuan were in the medium and high-rate states, respectively.

As shown in Figure 8, Kelantan once again became the state with the highest U5MR in 2000 (13.5 deaths per 1000 livebirths) and this time Sabah had the lowest with the rate of only 1.2 deaths for every 1000 livebirths. Apart from Kelantan and Sabah having the highest and the lowest rate, the other state and federal territories were considered to have a uniform distribution of U5MR which ranged between 6.4 and 11.4 deaths per 1000 livebirths. In 2005 (Figure 9), the state with the high rate was dominated by the east coast of the peninsular Malaysia. Kelantan, Terengganu, and Pahang were all in the red zone with Kelantan and Pahang being tied having the highest U5MR with an estimated of 12.6 childbirth for every 1000 livebirths. Having the U5MR of only 3.8, Sabah became the only state with the low rate, while the other states were all in the yellow zone.

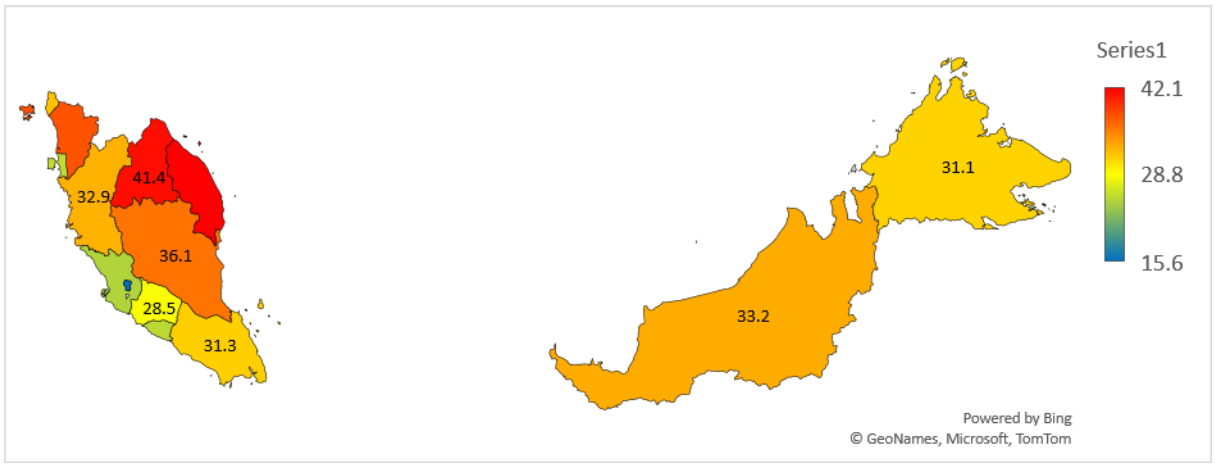


Figure 4: U5MR across the states in 1980.

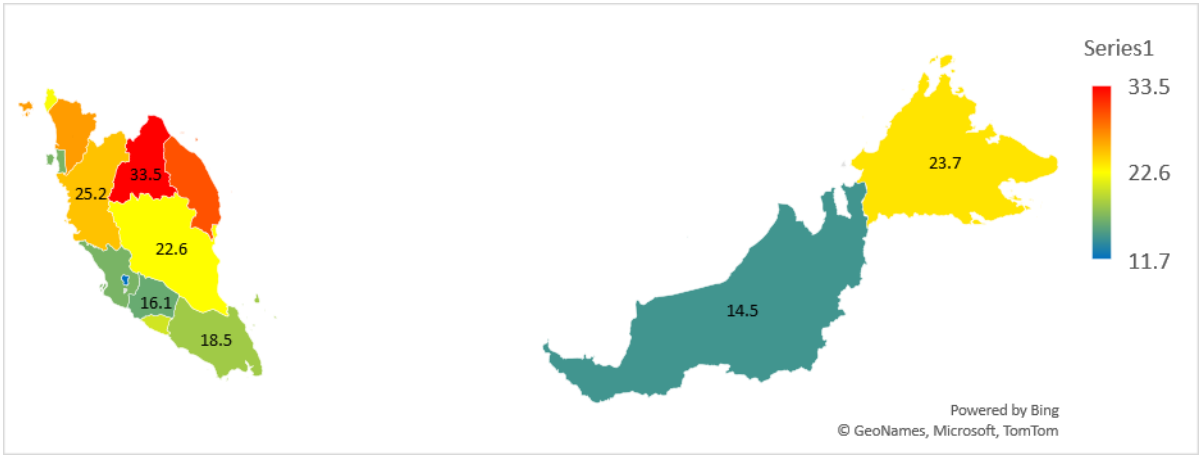


Figure 5: U5MR across states in 1985.

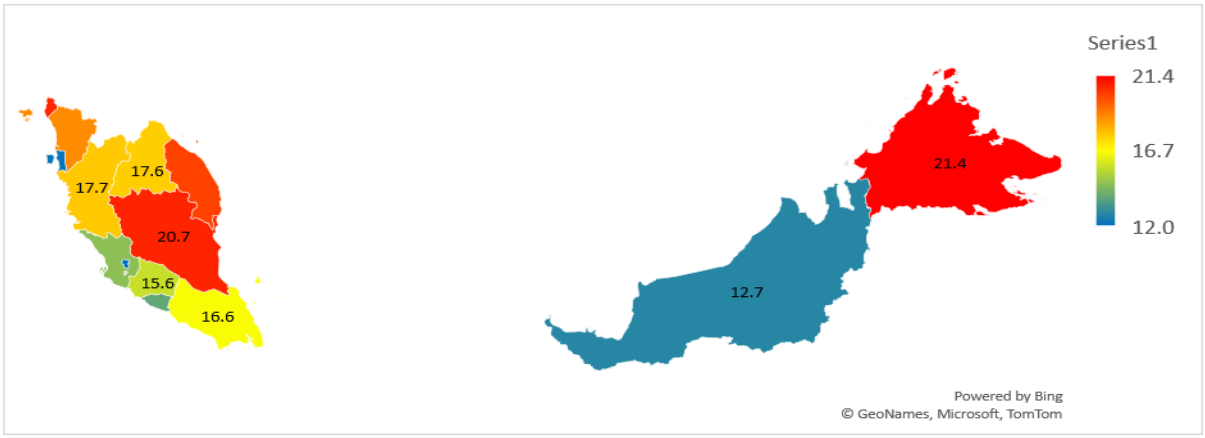


Figure 6: U5MR across states in 1990.

Figure 7: U5MR across states in 1995.

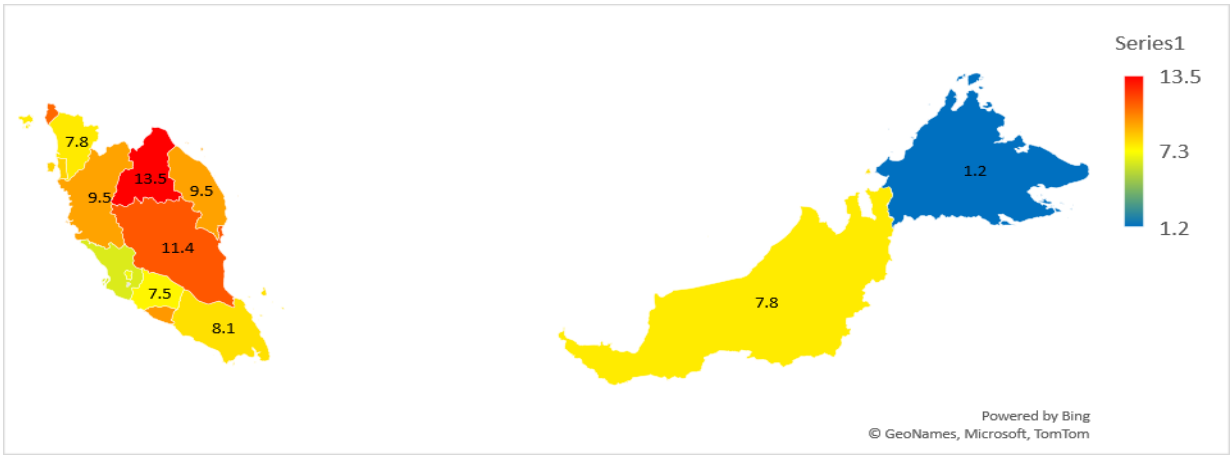


Figure 8: U5MR across states in 2000.

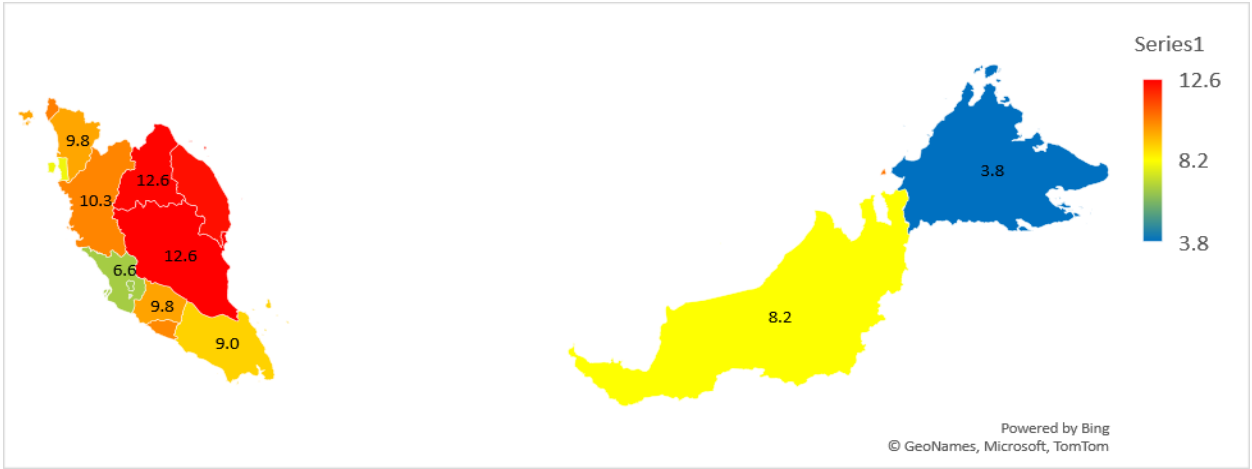


Figure 9: U5MR across states in 2005.

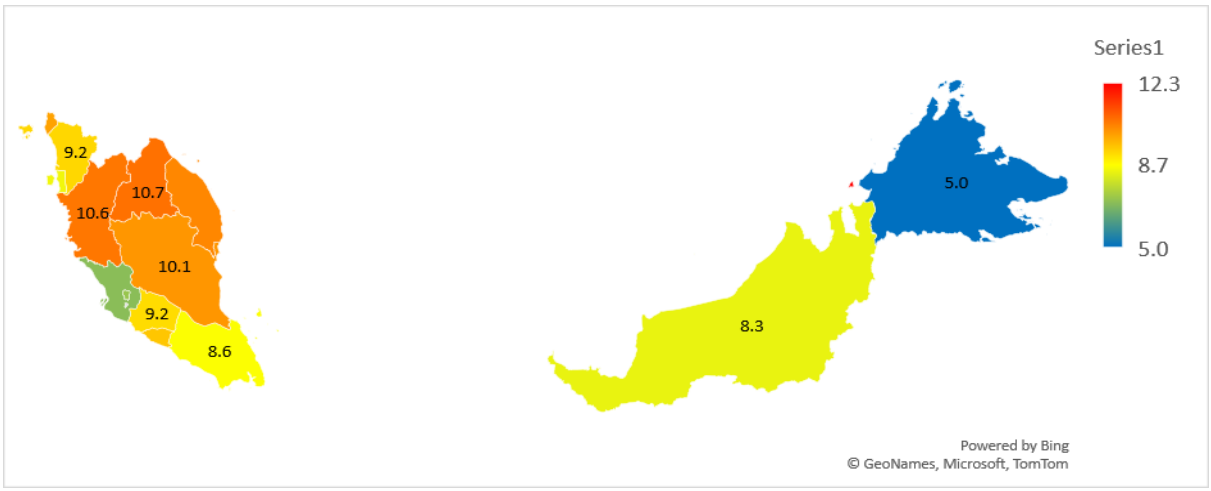


Figure 10: U5MR across states in 2010.

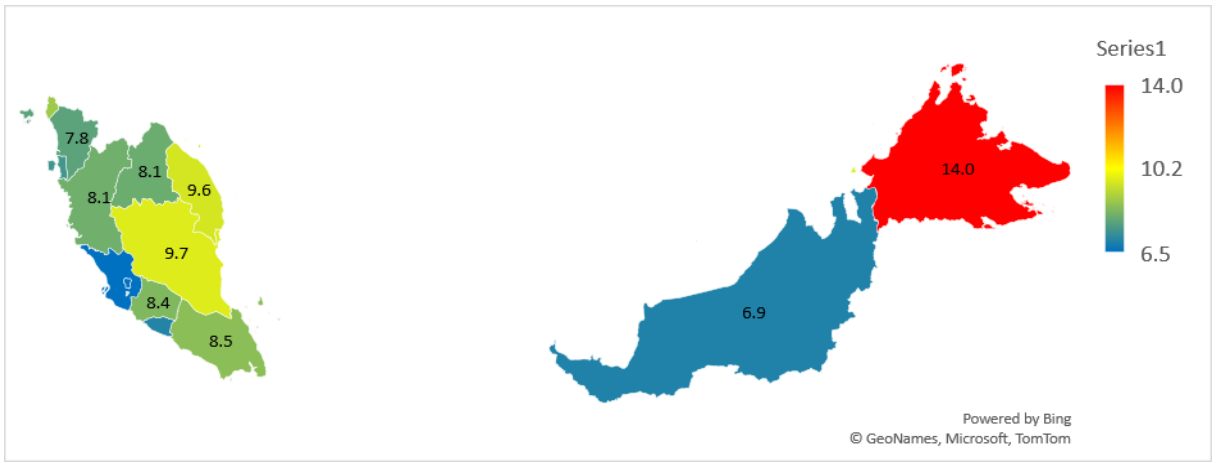


Figure 11: U5MR across states in 2015.

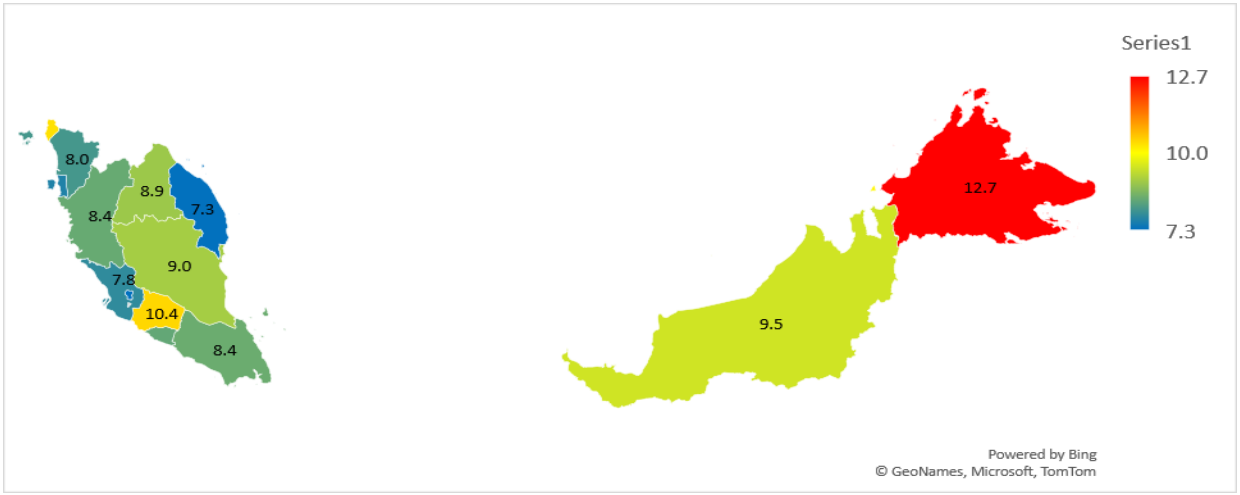


Figure 12: U5MR across states in 2018.

As presented in Figure 10, the U5MR for the peninsular part of Malaysia in 2010 was all in the yellow zone and much more stable compared to the east or Borneo part as the U5MR of those states ranged between 7 and 10.7 deaths for every 1,000 livebirths. On the other hand, both the lowest and highest rates of U5MR were in the East Malaysia with Sabah having the lowest rate (5 child death per 1000 livebirths) and Labuan having the highest rate of U5MR (12.3 child death for every 1000 livebirths).

U5MR across the states in 2015 was considered to be much more stable compared to the past years as shown in Figure 11. This situation happened because majority of the states fell in the group of states that had low rates with Selangor and Kuala Lumpur being tied to have the lowest rate, which was 6.5, while Sabah was the only state to be in the red zone with an estimated of 14 child deaths in every 1000 livebirths. As a final point, Figure 12 presents the scenario of U5MR in the year 2018 which confirmed that Malaysia has significantly improved the U5MR. The figure shows almost all states were in the low-rate zone which ranged between 7.3 and 12.7 with Terengganu having the lowest rate and Sabah having the highest rate.

4 DISCUSSION

4.1 U5MR Trend across the Gender

Malaysia's U5MR has shown a steady decline over the period of 17 years of this study's period of observation. Nevertheless, from 1997 to 1998, there was a random shock where the rates drastically increased due to the economic crisis during those years. During those periods, the cost of food increased and had a major impact on the population's nutritional and health status, particularly among children [22]. This situation had led the U5MR in Malaysia to escalate quickly before the trend gradually decreased in 1999 onwards.

Throughout the period of this study, both male and female showed decreasing trends with U5MR of the male population being higher compared to the female as shown in Figure 1 and Figure 2 of this study. The rate for the male was constantly above the total average rate, while the female rate was constantly lower than the average rate throughout the whole period of this study. This result was in line with the previous studies [1][16][20] as the death rate among the under-five male was regularly higher than the female. It was revealed that the inequality of the U5MR between the genders was due to them being physically inferior and more vulnerable to infection and premature death [24].

However, over the years the gender gap or the gender inequality of the U5MR had shown an immense improvement as the gap was getting narrowed by years. It was also reported that the neonatal care is greatly attribute to the child survival [25]. A study in Massachusetts had discovered that the gender differential among the infants' mortality had a significant development resulted from the advances in medical treatment [26]. Nevertheless, the fact that Malaysia's U5MR was gradually declining over the years is a great achievement that we can be proud of.

4.2 U5MR Trend across the States

In the view of across the states, U5MR was more concentrated in the rural or underdeveloped states which were mainly in the east coast region of the Peninsular Malaysia and the Borneo part of Malaysia. The highest U5MR was mostly in Kelantan, Sabah, and Labuan, while the lowest was mostly in Selangor and Kuala Lumpur. The results of this study were parallel with the previous study [27]

as it was then highlighted that there were several underdeveloped states such as Kelantan, Pahang, Kedah, and Terengganu which fell in the high-risk category of the infant mortality. A research by [21] revealed that the socioeconomic gradient has affected the mortality among infants and the children under the five years old. It was reported that Kelantan was the most socially disadvantaged district that had poor mortality rate compared to the ones with socially advantaged districts [21].

The result of the study also revealed that there was an imbalance of U5MR across the states. The U5MR inequalities across the states decreased over the period of this study seem coherent with the result of a study that inspected the imbalance of U5MR among 43 developing countries [28]. The disparities of the U5MR across the states can be seen at the early period of the study with the difference between the highest and lowest rates was nearly five times in 2018. Out of all the states, Sabah and Sarawak showed the most imbalance rates with several random shocks and seasonal trends across the years. This may be due to the under-reporting, prohibition of the population which was inaccessible and mobile provincial communities [29]. Although there was a visible difference, the disparities were getting narrower towards the end of the study and it was due to the great collaboration and teamwork of countless policies, strategies, programs, medical advances, and facilities, and more by the government and other bodies in Malaysia.

The west coast of the Peninsular has been more developed and wealthier compared to the east coast as the progress and the industrialization in the west coast has been rapidly growing, while the east coast concentrated more on agricultural as a major source of income [30]. Higher mortality rates in the underdeveloped states were the result of poor infrastructure and better health care in that area. A more developed area tends to have better facilities, healthcare and social services that can lead the population to be less burdened [31].

5 CONCLUSION

This paper studied the trend analysis of U5MR across the states and gender. The U5MR from the year 1980 to 2018 has proven that the child death under the five years old had improved and decreased greatly over the period. This outstanding improvement is from the result of great collaboration and synergy of varieties of programs and policies and cooperation of the government with the other bodies as it can be proven from the increase of hospitals and healthcare for the society across the country.

This study also revealed that the U5MR of male population was constantly higher than the female population which can be a great note for the healthcare researcher to find the root cause of this phenomenon to arise. Besides, the east coast of Peninsular and the Borneo part of Malaysia were proven to have a higher mortality rate among children under-five throughout the whole period of this study with the lowest mortality rate was found in the west coast of the Peninsular Malaysia. An in-depth research should be done with regard to this matter since U5MR was more concentrated on underdeveloped states so that the balance or a uniformly separated rate across the states can be achieved soon.

In conclusion, Malaysia has made an outstanding progress over the years in reducing the U5MR from 1980 to 2018. This study may become a reference for the demographers and entitled legislators in Malaysia to draft a suitable policy to ensure the mortality rate among children can be reduced and achieve the thin gap of mortality rate across gender and states in comparison to the other developing

countries. This study may also become a guideline for the health department to channel practical approach focusing on the underdeveloped states so that Malaysia's U5MR can be equally dispersed across the states in the near future.

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