ANALYSIS OF MALAYSIAN MORTALITY RATES BY SPECIFIC ETHNICS, AGE GROUPS AND GENDER BEFORE AND DURING COVID-19 PANDEMIC
(Analisis Kadar Kematian Mengikut Spesifik Etnik, Kumpulan Umur dan Jantina Sebelum dan Semasa Pandemik COVID-19)

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ABSTRACT

Malaysia has been one of the Western Pacific region's nations that has been adversely affected by the COVID-19 pandemic with over 32,000 deaths linked to COVID-19 over three major epidemic waves, and a cumulative case count of over six hundred million worldwide. The study aims to investigate the trend of mortality rates for the three major ethnic groups in Malaysia, which are Bumiputera, Chinese, and Indians for the age groups of adults, middle age, and elderly for both genders. Since data on mortality rates in Malaysia is only accessible for age groups such as 1–4, 5–9, 10–14, 15–19, and so on, a distributional or interpolation approach was required to expand it to the individual ages. Thus, the Lagrangian interpolation is used to estimate the values of mortality for each individual age. The study also intends to identify which ethnic, age groups and gender that were most affected during the pandemic. Overall, it was found that the trend is decreasing for all age groups and gender for years before the pandemic. The ethnic group that most affected during the pandemic was Chinese females aged 24 to 39 with a 13.89 percent increment in 2021. However, there are some deviations from the pattern observed during the COVID-19 pandemic. Also, mortality rates for females are consistently lower than males across all age groups. Surprisingly, for the elderly, mortality rates are consistently lower, even during the pandemic for both males and females. This happened due to the ageing population process whereby the proportion of the elderly increased significantly as Malaysia is expecting to be an ageing population country by year 2030.

Keywords: ageing population; Lagrangian interpolation; mortality rates; mortality trend

ABSTRAK

Malaysia telah menjadi salah satu negara di rantau Pasifik Barat yang terjejas teruk disebabkan oleh pandemik COVID-19 dengan lebih 32,000 kematian berkaitan COVID-19 dalam tiga gelombang wabak utama dan jumlah kes terkumpul melebihi enam ratus juta di seluruh dunia. Tujuan kajian ini adalah mengkaji trend kadar kematian bagi tiga kumpulan etnik utama di Malaysia, iaitu Bumiputera, Cina, dan India bagi kumpulan umur dewasa, pertengahan umur dan warga emas bagi kedua-dua jantina. Memandangkan data kadar kematian di Malaysia hanya boleh diakses untuk kumpulan umur 1-4, 5-9, 10-14, 15-19, dan seterusnya, beberapa pendekatan pengagihan atau interpolasi diperlukan untuk mengembangkannya kepada peringkat umur individu. Oleh itu, interpolasi Lagrangian digunakan untuk menganggar nilai kadar kematian bagi setiap umur individu. Di samping itu, kajian ini juga ingin mengenal pasti etnik, kumpulan umur dan jantina yang paling terjejas semasa pandemik. Secara keseluruhannya, ia mendapati trend menurun untuk semua kumpulan umur dan jantina untuk tahun-tahun sebelum wabak. Etnik yang paling terjejas semasa wabak adalah wanita Cina dalam lingkungan umur 24 hingga 39 tahun dengan kenaikan sebanyak 13.89 peratus pada 2021. Walau bagaimanapun, terdapat beberapa perubahan daripada corak trend semasa pandemik COVID-19. Di samping itu, kadar kematian bagi perempuan lebih rendah secara konsisten daripada lelaki untuk semua kumpulan umur. Selain itu, bagi warga tua, kadar kematian lebih rendah secara konsisten walaupun semasa

wabak untuk lelaki dan perempuan. Ini berikutan proses penuaan penduduk di mana nisbah warga tua telah meningkat dengan ketara kerana Malaysia dijangka menjadi negara yang semakin menua pada tahun 2030.

Kata kunci: populasi menua; interpolasi Lagrangian; kadar kematian; trend kematian

1. Introduction

Mortality rates is one of essential factors that affect demographers, legislators, government as well as insurance companies. Inaccurate mortality rates estimation can bring severe consequences to stakeholders and society as it leads to undermestimation of premium and reserves for annuity and pension products, leaving annuity and pension providers with financial loss. Tsai and Cheng (2021) stated that overpriced premiums may cause insurance companies to experience catastrophic losses, rendering low-income policyholders to be unable to receive protection to cover themselves. Hence, to maintain the greatest level of service and deliver the finest resources for future planning, all stakeholders should be aware of changes in mortality rates (Edrus *et al.* 2022).

In addition, a population's age and gender distribution also can be represented using a population pyramid. Figure 1 shows population pyramid estimated in Malaysia for year 2021 and 2030.
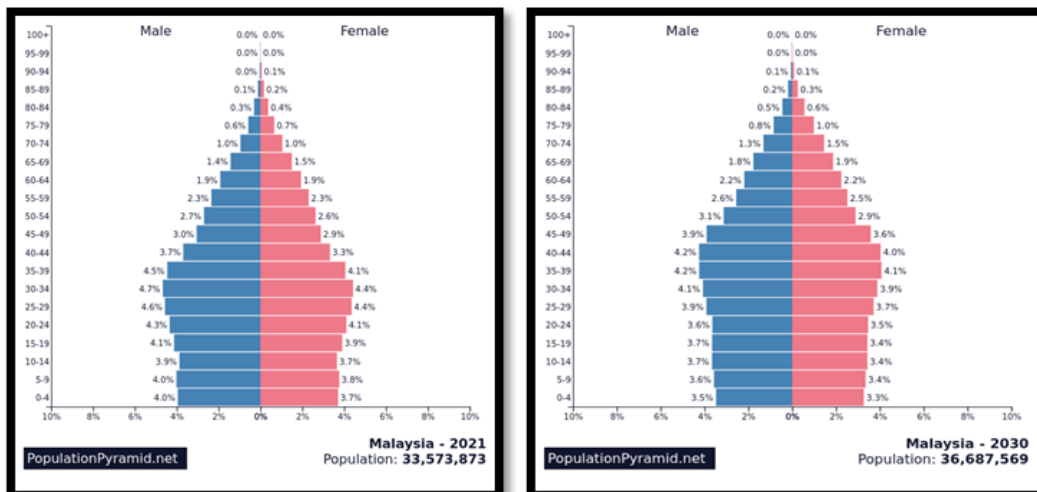

Figure 1: Population pyramids of Malaysia in year 2021 and 2030 (PopulationPyramid.Net 2019)

Based on Figure 1, Pyramid Malaysian Population in year 2021 states that the population for males' adult (age 20-39 years) make up about 18.2% population, and females' adult (age 20-39 years) consists of 16.9%. Middle-aged adult (age 40-59 years) comprise about 11.5% of population for males. While the proportion for females middle age is about 10.8%. As for elderly group (age 60 years and above), it makes up the most at about 11.4% of the population for the total of both genders. However, according to Mutalib *et al.* (2020), Malaysia is expected to be a country with an ageing population as this elderly group is estimated to increase up to 15% from 11.4% of the total population in the year 2021 to 2030. Ageing population happens when fatality rates is low and that contributes to a lower proportion of younger population and higher proportion of the elderly from time to time. This can be seen in Figure 1 where the base layer of the pyramid population shrinks while the top layer of the pyramid gets bigger from the year 2021 to 2030.

According to Department of Statistics Malaysia (2021), from the year 2020 to 2021, Malaysia Bumiputera consists of 69.6% to 69.8%, 22.6% to 22.4% of Chinese as well as Indian stays at 6.8% of Malaysia population as shown in Figure 2.
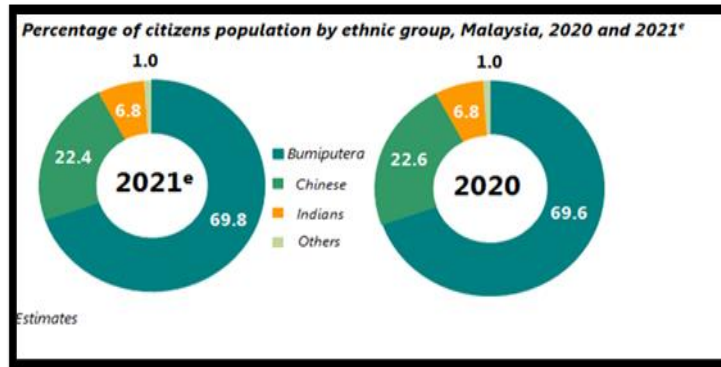

Figure 2: Percentage of citizens population by ethnic group, Malaysia, 2020 and 2021
(Department of Statistics Malaysia 2021)

A virus named Severe Acute Respiratory Syndrome Coronavirus 2 (SARSCoV-2) triggered Coronavirus Disease 2019 (COVID-19). It was originally found in December 2019 in Wuhan, and Hubei in China, and has spread fast throughout Southeast Asia and the rest of the world (Elengoe 2020). On February 5, 2020, Malaysia reported the first local case of the Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) and began to experience the first wave of the COVID-19 virus, which primarily involved Chinese tourists and other imported patients. The second wave began on February 27 in 2020, after an 11-day period without new cases, which then established the local transmission in Malaysia (Din *et al.* 2021). According to the Director General of Health Malaysia (2020), as of 12 June 2020, 122 people had died because of the COVID-19 pandemic and about 67% of them were Malaysian elderlies. After two years of the pandemic, Malaysia has been one of the most severely impacted countries in the Western Pacific area with over 32,000 deaths associated with COVID-19 over three significant epidemic waves and a cumulative case count of over three million (Tan *et al.* 2022).

A study by Elo *et al.* (2022) to evaluate age patterns of COVID-19 mortality by race and ethnicity in the United States for 3 periods (March to June 2020 [first period], November 2020 to February 2021 [second period], and July-October 2021 [third period]), found that age pattern of mortality changed in the third period for all genders and all racial and ethnic groupings. It was found that mortality rates for the elderly decreased at a higher percentage in the third period as compared to younger adults. Hence, reductions in COVID-19 mortality among older populations are remarkable from the second period through the third period in the United States. This is due to mortality rates during COVID-19 increasing, though not as much as declining in mortality rates caused by aging population. A study by Edrus *et al.* (2022) was conducted to determine the excess mortality rate for elderly age group for both genders in Malaysia during COVID-19 by comparing the mortality forecast under normal conditions to the COVID-19 data-based mortality forecast from the year 2020 to 2030, and the result found that for a certain age, particularly at 60 and above, has excess mortality rate. Excess mortality rate happens when the overall mortality number of fatalities during a crisis (such as a global pandemic) is higher than would be anticipated under normal circumstances. When the mortality rate is anticipated for 2019 and 2020 using the COVID-19 mortality data, the men's mortality rate for age group 60 and above showed a decreasing trend after the year 2020 and began to increase after the year 2023 with mortality rates for men aged 60 and up

increased significantly. Women's mortality rates showed short term impact of COVID-19 when the trend only increased until the year 2023 and turned back to normal condition as forecasted. Hence, this study proved that men faced a more severe impact of COVID-19 in terms of mortality.

Ibrahim *et al.* (2020) used the method of central age-specific mortality rates according to genders to analyze death rates between genders in Malaysia. The data for number of deaths and Malaysian population used to determine this central death were obtained from the United Nations websites. Apart from that, this recent study also determines life expectancy improvement using the life table approach. The results are obtained using log central death rates, mortality rates for Malaysian elderlies for female and male increasing consistently in linear pattern by age from the year 1950 to 2010. However, mortality rates for females are lower compared to males. This finding implies that female elderlies had better improvement in mortality compared to male. In view of this, the study aims to expand the Malaysian abridged life tables for three main ethnic groups before and during the COVID-19 pandemic. After expanding the values from the table, this study will analyse mortality rates for specific ethnics which are Bumiputera, Chinese, and Indian for age groups of adults, middle-age as well as the elderly for both genders before and during the COVID-19 pandemic. After analysing the mortality rates, the final objective is to determine which ethnic, age group and gender are affected during COVID-19 based on mortality perspectives.

2. Methodology

2.1 *Expanding an abridged life table*

The life table, commonly referred to as a mortality table, gives information on a population's survival and mortality rates. Usually, data of mortality rate in those developing countries comes with incomplete life table called the abridged life table. For some developed countries such as Singapore, it does not have complete life tables that contain mortality rates for every age group (Li & Chan 2004). Malaysia, which also a developing country, also has abridged life tables that have the mortality data by age intervals. This is due to the phenomena of age heaping, which is caused by age inaccuracies in data registration and the quality of the data, which may prevent computation of a complete life table due to inadequate and inaccurate census data (Ibrahim & Siri 2011). While deaths have gradually escalated at all other ages, they are highly concentrated in the first year of life and the oldest age category, particularly after the age of 65. Therefore, in order to minimize the variability of mortality, the data is typically pooled by age groups; as a result, only abridged life tables are made publicly available in Malaysia (Khaliludin *et al.* 2019).

Besides, creating a complete life table in Malaysia needs extensive study on mortality rates as well as advanced computing techniques that require a lot of complicated and tedious work. Siran *et al.* (2015) also used the method from Heligman and Pollard to expand abridged life tables data from the years 2010 until 2013 for the major ethnic groups for both genders. The study estimates the parameter of this model using the Matrix Laboratory Version 7.0 (MATLAB 7.0) software since the equations from the model were complicated to solve analytically. The overall result showed that males' mortality rates were consistently higher than females' mortality rates across all ethnic groups and age categories. Indian males and females have highest mortality rate followed by Malays. Meanwhile, Chinese recorded the lowest mortality rates. A study of methods to expand an abridged life table by Kostaki and Panousis (2001) stated that, the six term Lagrangian interpolation had been used by (Elandt-Johnson & Johnson 1999). In this method, l_x-values from the abridged life table were applied to find the missing values for age intervals. From the results obtained in this study, at the ages

of 10 to 15 years, the shape of age specific mortality pattern is deformed. However, the Lagrangian interpolation method was proven to be accurate for estimating the age specific mortality rates.

Abridged life table from year 2018 to 2021 were used in this study since we want to analyse the trend two years before and during pandemic in Malaysia. Since data of the abridged life table consist of 5-years ages intervals of 5-9, 10-14, 15-19 and so on are used, except for the first two groups which are 0-1 and 1-4 (Elandt-Johnson & Johnson 1999). Hence the Lagrangian interpolation can be used to expand these abridged life tables by interpolating the five-year age groups or intervals into mortality and survival rates for each individual age. The formula of six-point Lagrangian interpolation is given as below:

$$f_5(x) = \sum_{i=0}^{5} L_i(x) \, f(x_i) \qquad (1)$$

where $f(x_i)$ are tabular values for survivor nearest age x from abridged life table.
The coefficient is calculated using formula as follow:

$$L_i(x) = \prod_{j=0, j \neq i}^{5} \frac{x - x_i}{x_i - x_j} \qquad (2)$$

where $x_0, x_1, \ldots, x_5$ are the tabular ages nearest to x.

In this study, we will use l_x-values from the abridged life table to obtain l_x-values for every age group. Then, we will compute q_x-values by using the formula stated in Table 1.

Table 1: Life table notations and formula

Notation	Definition	Formula
x	Age	-
n	Age intervals	-
l_x	Number of lives at age (x)	-
p_x	Probability that (x) survives in the next year	$\frac{l_{x+1}}{l_x}$
q_x	Probability that (x) dies in the next year	$1 - p_x$
np_x	Probability that (x) survives in the next n years	$\prod_{x}^{x+n-1} p_x$
nq_x	Probability that (x) dies in the next n years	$1 - np_x$

2.2. *Computing percentage difference*

Percentage difference of mortality rates are computed by using the q_x-values from the complete life tables based on these scenarios below.

- Baseline Scenario: Mortality rates in year 2018
- Scenario 1: Mortality rates in year 2019
- Scenario 2: Mortality rates in year 2020
- Scenario 3: Mortality rates in year 2021

Table 2: Percentage difference of scenario

Scenario	Percentage difference
1	$\left(\dfrac{Scenario\ 1-\ Baseline\ Scenario}{Baseline\ Scenario}\right) \times 100$
2	$\left(\dfrac{Scenario\ 2-\ Baseline\ Scenario}{Baseline\ Scenario}\right) \times 100$
3	$\left(\dfrac{Scenario\ 3-\ Baseline\ Scenario}{Baseline\ Scenario}\right) \times 100$

3. Results and Discussion

Figure 3 shows the trend of mortality rates among three main ethnic groups for adult in Malaysia. According to Figure 3, male mortality rates were higher than female mortality rates for the three ethnicities. Ibrahim and Siri (2014) also found the same result where mortality rates for female were higher than male. Furthermore, mortality rates for Indian males had the highest while Chinese female had the lowest. For Bumiputera males and females, there was significant improvement in life expectancy because the mortality rates kept on decreasing from 2018 to 2021. The trend of mortality rates was also similar from 2018 to 2021. However, during the pandemic, the trend of mortality rates showed smaller decrements for males aged 35 to 39 for males as the mortality trend nearly overlapped with mortality trend in 2019 and 2020 at those ages. Females Bumiputeras also showed a higher decline in mortality rates during the COVID-19 pandemic in 2021. This was due to an increase in mortality rate during the COVID-19 pandemic, though not as much as declining in mortality rates that were related to population aging. Apart from that, females Bumiputeras had higher life expectancy improvement as compared to males.

For Chinese males, mortality rates in 2018, 2019 and 2020 exhibited the same pattern in mortality trend. However, in 2021, the trend was quite different. From Figure 3, the trend in the year 2020 showed a significant decrease at age 29 to 35 as compared to the mortality trends in the year 2018 and 2019. Plus, mortality rates between age of 25 until 29 exhibited an overlapping trend with mortality rates in 2020, and were higher in 2021 compared to 2020. Apart from that, Chinese females displayed similar pattern in year 2018 and 2019. Meanwhile, during the time of pandemic in the year 2020, mortality rates were higher compared to the year 2019 at the age group of 25 to 35. Furthermore, compared to 2018, 2019 and 2020, adult aged 24 to 29 experienced a significant increase in mortalitly rates in 2021. This means that, more people at the age range 24 to 29 died during second year of pandemic.

In terms of mortality rates, Indian males followed a nearly identical pattern in 2018 and 2019. During the first year of the COVID-19 pandemic, in the year 2020, mortality rates were still lower although the trend exhibited an almost similar pattern with mortality rates in 2018 and 2019. However, between the ages of 35 until 39, the decrement was lower than the period before the pandemic. In 2021, mortality rates recorded significant decrease at the age 20 to 29 while for age 30 to 34, mortality rates overlapped with the mortality trend in 2020. For Indian females, trend of mortality rates showed a different pattern for each year. Yet, mortality rates before COVID-19 pandemic in the year 2019 were higher compared to 2018 for age group 30 to 35. Besides, mortality rates in the year 2020 were still lower than in 2019. This means that Indian females for the middle age group showed improvement in life expectancy even during first year of the pandemic. Nevertheless, at the age of 33 to 37, the mortality trend in the year 2021 was the highest compared to the other years. Hence, it was found that Indian females aged 33 to 37 were affected by COVID-19.
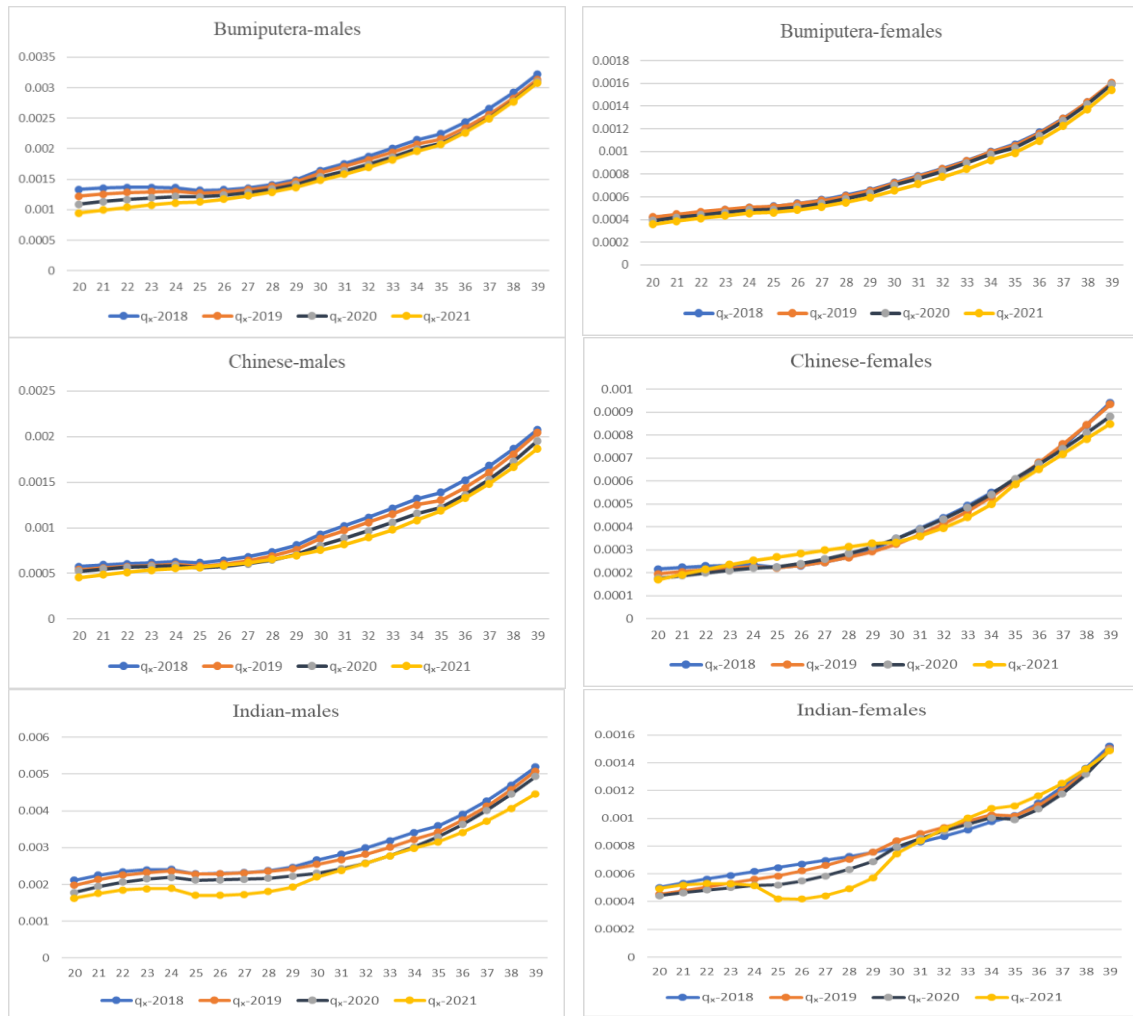
Figure 3: Mortality rates of males and females for adult age group in Malaysia

Figure 4 shows the percentage difference of mortality rates for the adult age group for Scenario 1, 2 and 3. From Figure 4, it shows that the percentage difference in mortality rates for Bumiputera males displayed a significant level of decrement from Scenario 1 to Scenario 3 for each age. Percentage of decrement for Scenario 1, 2 and 3 are 2.41, 7.34, and 8.53 percent in average respectively. Hence, this finding indicates that Bumiputera males for the adult age group were not affected by COVID-19 because it still shows improvement in mortality for Scenario 1 to Scenario 3. For females, there were a slight increment for Scenario 1 for age 20 to 24 and 38 to 39. This means that more people at those age died in year 2019 as compared to 2018. However, during the pandemic, mortality rates also showed a significant level of decrement for both Scenario 2 and 3 that exhibited mortality improvement in the year 2020 and 2021. Thus, this finding implies that Bumiputera females for the adult age group are also not affected by COVID-19.

Apart from that, similar to Bumiputera males, mortality rates for Chinese males also exhibited a significant reduction whereby the mortality rates were reduced by 5.14, 10.00 and 14.30 percent on average respectively for Scenarios 1, 2 and 3. In addition, for Chinese females aged 20 to 22, mortality rates are reduced by 8.70, 15.86, and 14.05 percent on average for Scenarios 1, 2 and 3. Nonetheless, for ages 23 to 29, there was an outstanding

increment in mortality for Scenarios 2 and 3 of about 3.15 and 13.89 percent on average respectively. Yet, the level of increment for Scenario 3 was higher as compared to Scenario 2. This means that many people at this age group died in 2021 than in 2020 due to COVID-19.

Furthermore, mortality rates for Indian males improved with average reduction of 3.4238, 10.0397 and 18.4824 percent respectively for Scenario 1, 2 and 3. This means that Indian males for the adult age group were not affected during the COVID-19 pandemic because the level of percentage decrement decreased significantly between 2019 to 2021. Moreover, mortality rates for Indian females decreased from age 20 until 29, but mortality rates for age 30 to 34 increased by 3.6771 percent on average for scenario 2, while for Scenario 3, mortality rates increased by 4.1646 percent on average for age 31 to 39. As a result, this study discovered that COVID-19 has no effect on Indian males. However, Indian females aged 30 until 39 were affected. In addition, this finding found that more people died in the year 2021 in the second year of the pandemic.
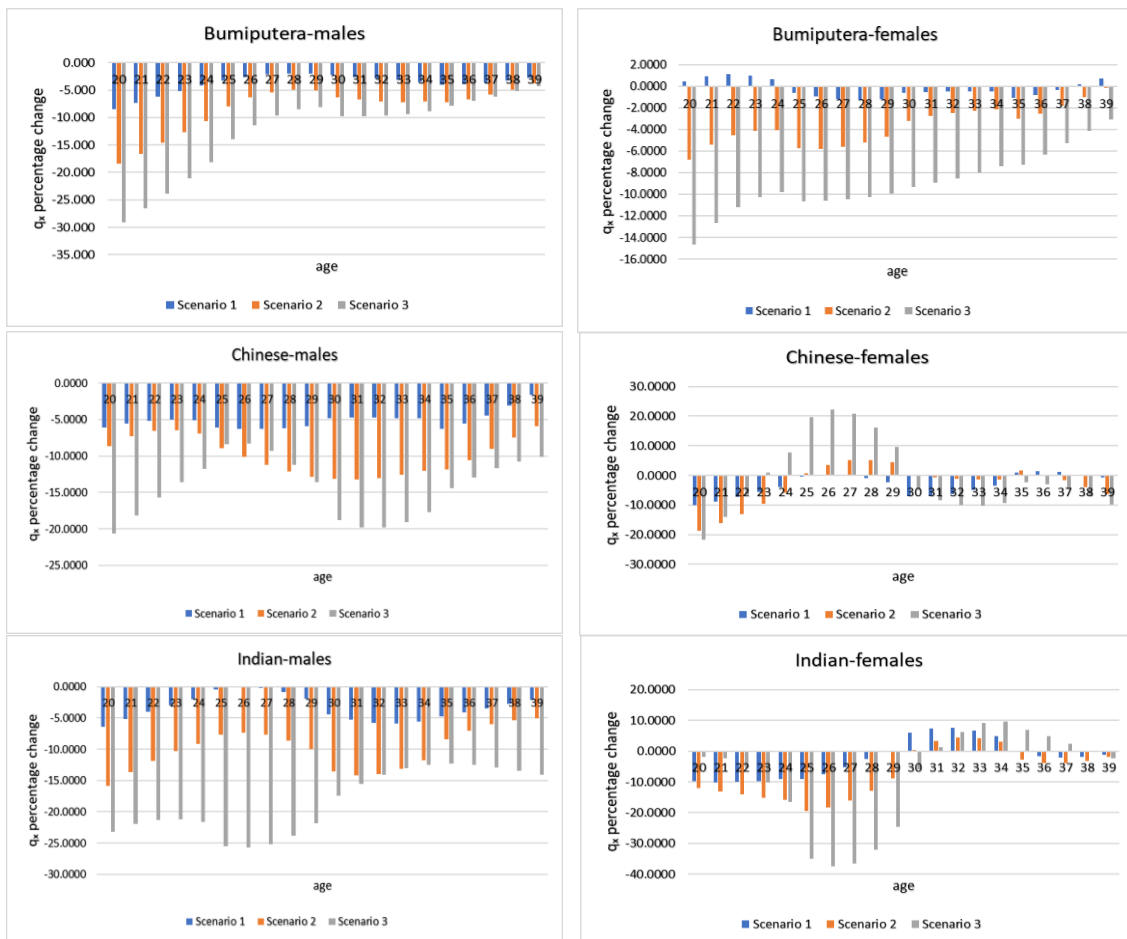

Figure 4: Percentage difference of mortality rates for adult age group

Figure 5 shows the trend in middle-age mortality rates among Malaysia's three major ethnic groups. This study found that mortality rates for Indian males and females are the highest followed by Bumiputera and Chinese. Based on Figure 5, the trend in mortality rates overlapping for Bumiputera males indicates that mortality rates for these group have not changed significantly. Furthermore, in 2021, which was during pandemic, for age group 45 to

53, there was a slight of increment in mortality rates compared to the other years. For Bumiputera females, the trend of mortality rates overlapped at age group 40 to 50. Hence, there was no remarkable improvement for mortality rates. However, starting from age 51 to 59, mortality rates started to decrease from the year 2018 and 2019 before the pandemic and 2020 to 2021 which is the time during COVID-19 pandemic. The small gap between the trend lines for those ages demonstrates this.

For Chinese males, the trend of mortality rates also overlapped with each other. Hence, there was no significant improvement of mortality rates for Chinese males. Meanwhile, for Chinese females, the trend for mortality rates kept decreasing from 2018 to 2021. Similar to Chinese males, there was no remarkable improvement for Chinese females also. In addition, the trend of mortality rates during COVID-19 in the year 2020 and 2021 were similar as compared to the trend in year before the pandemic.
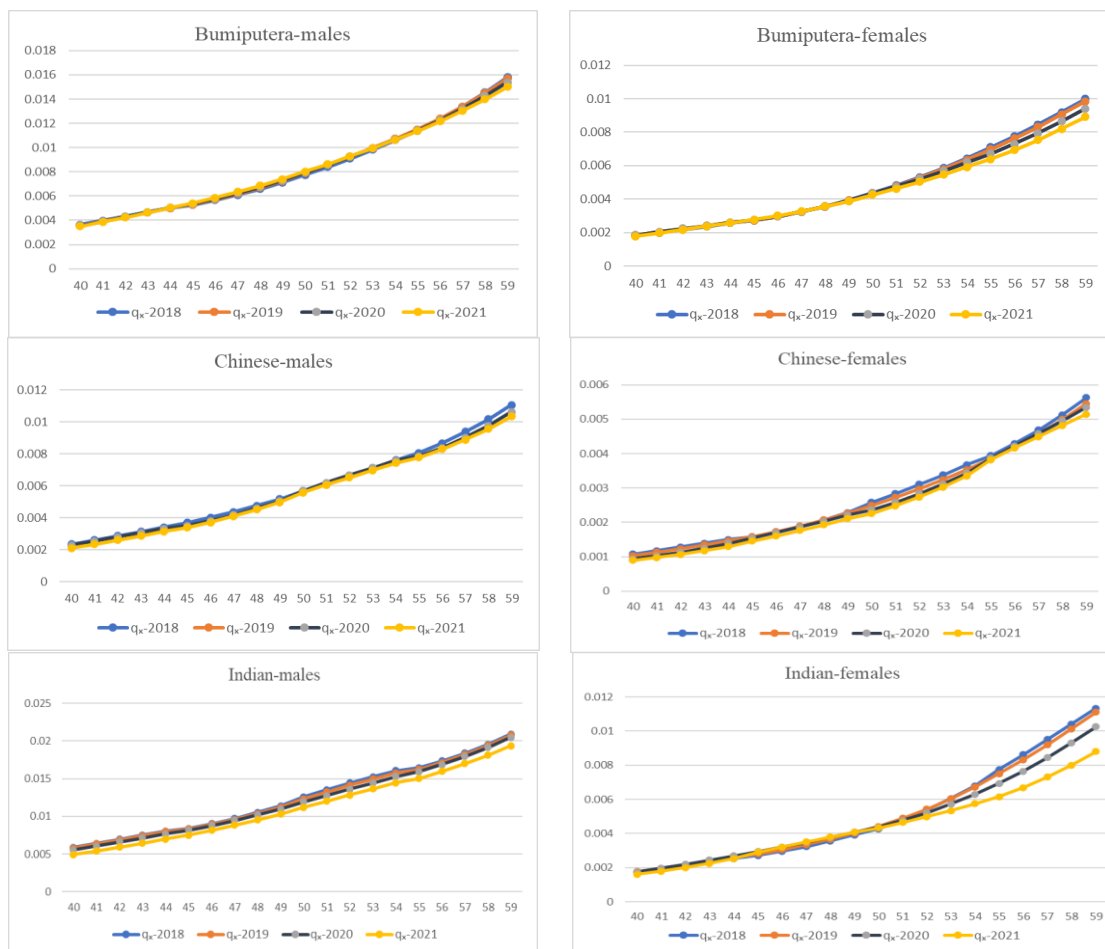

Figure 5: Mortality rates of males and females for middle age group in Malaysia

Next, the trend of mortality rates for Indian males overlapped at the year 2018 to 2020 since there were no gap between the trend lines. Yet, in 2021, mortality rates were lower compared to the year 2020. This finding also shows that there was no noticeable improvement for mortality rates from the year 2018 to 2020. Furthemore, mortality rates for Indian males improved in the second year of the pandemic in 2021, as mortality rates showed a significant gap between the trend line in the year 2020. Thus, it is proven that Indian males were not

impacted during the COVID-19 period. For Indian females, at age 40 to 50, there was an overlapping trend of mortality rates from the year 2018 to 2021 at age 40 to 51. Thus, no remarkable changes were seen in mortality for these age groups. Yet, at age 46 to 49, mortality rates were slightly higher and that implies that people at those ages were affected during the pandemic. Nevertheless, for age 51 and above, there was an overlap in the trend of mortality rates in the year 2018 and 2019. However, in the year 2020 and 2021, there were noticeable decreasing patterns in mortality for those ages, hence, there was improvement of mortality rates for Indian females for age 51 and above for the middle age group since the gap between those lines was getting bigger as the age increased from 51 to 59.

Figure 6 shows percentage difference of mortality rates for the middle age group shown in Scenario 1, 2 and 3. Based on Figure 6, the percentage difference of mortality rates for Bumiputera males for age 44 to 54 increased by 1.40, 1.95 and 2.77 percent in average for Scenario 1, 2 and 3 respectively. This means that there was a small increment in mortality rates from the year 2019 to 2021 for the ethnic group at those age groups. Hence, this result shows that more Bumiputera males ethnic at age 44 to 54 died during COVID-19 pandemic. Apart from that, for Bumiputera females, mortality rates in Scenario 1 and Scenario 2 increased almost in a similar rate for 40 to 46 age groups at about 1.37 and 1.39 percent in average respectively. However, for Scenario 3, mortality rates increased by 0.99 in average for age 43 to 47. Therefore, for the Bumiputera ethnic, this study found that males at age 44 to 54 were affected by COVID-19. For females, more people from this ethnic at age 40 to 46 died in the year 2020, while in the year 2021, Bumiputera females at age 43 to 47 were affected by the pandemic.

For Chinese males, for Scenario 1, mortality rates raised by 1.56 percent in average for age 40 until 44. In the same age category, mortality rates reduced by 2.65 and 8.99 percent in average in Scenario 2 and 3 respectively. Hence, Chinese males at the 40 to 44 age groups were not affected by COVID-19 as they exhibited a decrement in mortality rates in year 2020 and 2021. Moreover, Chinese males at the age of 50 to 53 were affected by COVID-19 in the year 2020 because the rates increased by 0.83 percent in average for Scenario 2. In addition, for Chinese females, mortality rates reduced by 5.84, and 9.75 percent in average for Scenario 2 and 3. Hence, Chinese females for middle age group were not affected by COVID-19 pandemic because there was no increment in mortality rates in the year 2020 and 2021 for this group. However, Chinese males aged 50 to 53 were impacted by COVID-19.

Apart from that, mortality rates for Indian males also had no increment even during the pandemic. Based on Figure 6, the percentage of decrements are 1.30, 3.97, and 10.61 percent in average respectively for Scenario 1, 2 and 3. So, in the year 2021, there was a remarkable improvement in mortality rates for Indian males during the COVID-19 pandemic as compared to 2020 based on the percentage decrement computed. Yet, for Indian females, Scenario 2 showed the increment in mortality rates for age 41 until 50 by 5.22 percent in average while the increment in Scenario 3 from age 45 to 50 by 6.02 percent in average. Therefore, for Indian females, age groups that were affected during the pandemic are from age 41 to 50.

Figure 7 shows the trend of mortality rates among three main ethnic groups for the elderly in Malaysia. Indian and Bumiputera displayed almost the same mortality rates while the lowest was Chinese for both males and females. From Figure 7, for Bumiputera males, there was an insignificant improvement in mortality rates before and during the COVID-19 pandemic. Furthermore, the trend of mortality rates nearly overlapped with each other from the year 2018 to 2021. For Bumiputera females, there was also a slight decrement in mortality rates from the year 2018 to 2020. However, in the year 2021, there was a noticeable improvement in mortality rates as the decrement was higher in this year even during the pandemic.
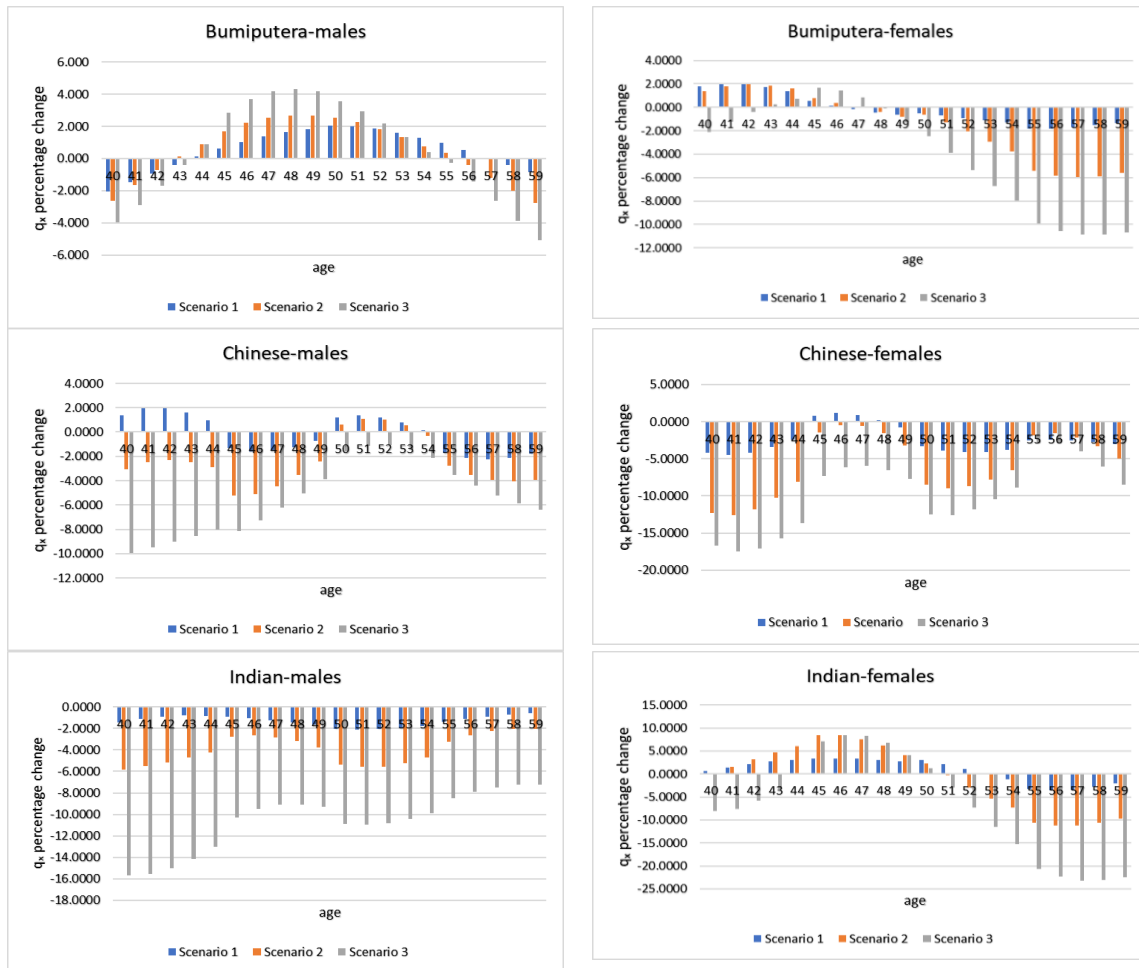
Figure 6: Percentage difference of mortality rates for middle age group

Besides, for Chinese males, the trend of mortality rates was similar with Bumiputera males where there was an overlapping trend from the year 2018 to 2021. Moreover, there was also an insignificant decrement in mortality rates from the year 2018 to 2021. For Chinese females, the trend of mortality rates nearly overlapped with each other from the year 2018 to 2020. Also, in the year 2021, similar with Bumiputera females, there was a noticeable decrement of mortality rates for Chinese females. The gap between the mortality trend lines for the year 2020 and 2021 decreased as age increased. However, the trend nearly overlapped at age 68 and 69. This implies that during the second year of the pandemic, Chinese females had an outstanding mortality improvement.

Next, for Indian males, before pandemic which are in the year 2018 and 2019, the mortality trend was almost similar with an overlapping pattern. In 2020, which is the first year of the pandemic, mortality rates were slightly lower compared to the years before COVID-19. Plus, there was also a remarkable improvement of mortality rates in the year 2021. For Indian females, similar with Indian males, there was an overlapping trend of mortality rates for the year 2018 to 2019 for the elderly age groups. In the year 2020, mortality rates were slightly lower compared to the years before pandemic. Apart from that, there was also significant decrement in the rate of mortality in the year 2021 which is the second year of COVID-19

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pandemic. For the elderly group, since the trend mortality rates were decreasing for the three main ethnicities, older population will increase for the upcoming period. This phenomenon will cause Malaysia to fall under the ageing population group. Furthermore, Elo *et al.* (2022) also found that, reduction in COVID-19 mortality among older populations were remarkable from the second period through the third period in the United States in the year 2021.
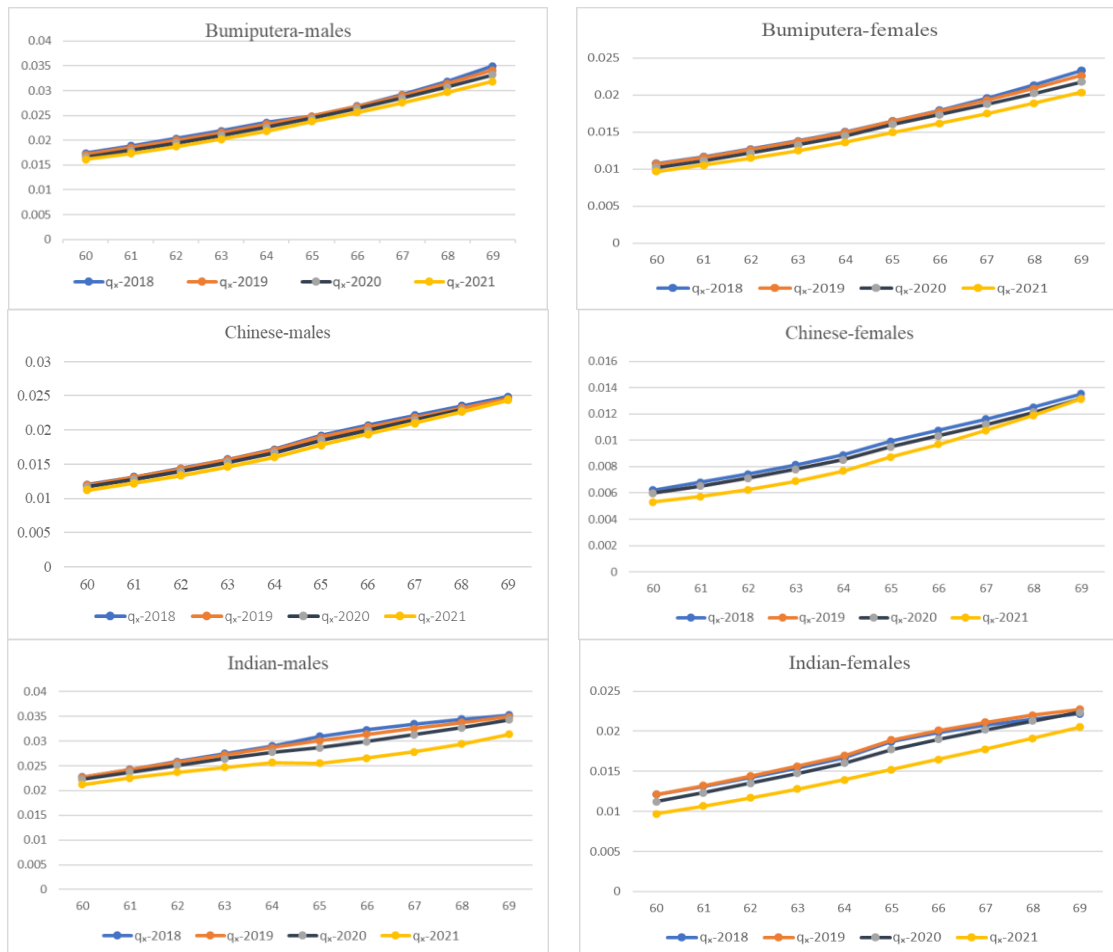

Figure 7: Mortality rates of males and females for elderly age group in Malaysia

Figure 8 shows the percentage difference of mortality rates for the elderly age group shown from Scenario 1, 2 and 3. From Figure 8, it shows that there was no increment of mortality rates for the elderly during pandemic. Although the elderly group bears high risk of COVID-19 mortality, however, the increment of COVID-19 mortality rates did not exceed the mortality rates that decreased due to population aging and had achieved life expectancy improvement due to low mortality rates.

For Bumiputera males, there is an improvement in mortality rates where the percentage change of mortality rates reduced by 1.35, 3.68 and 6.88 percent in average for Scenario 1, 2 and 3 respectively. For Bumiputera females, the mortality rates reduced by 1.12, 4.39, and 10.23 percent in average for Scenario 1, 2 and 3 respectively. Hence, it is proven that Bumiputera males and females are not affected during the pandemic. Moreover, elderly

Bumiputera females faced higher improvement in mortality rates compared to Bumiputera males even during the COVID-19 outbreak.
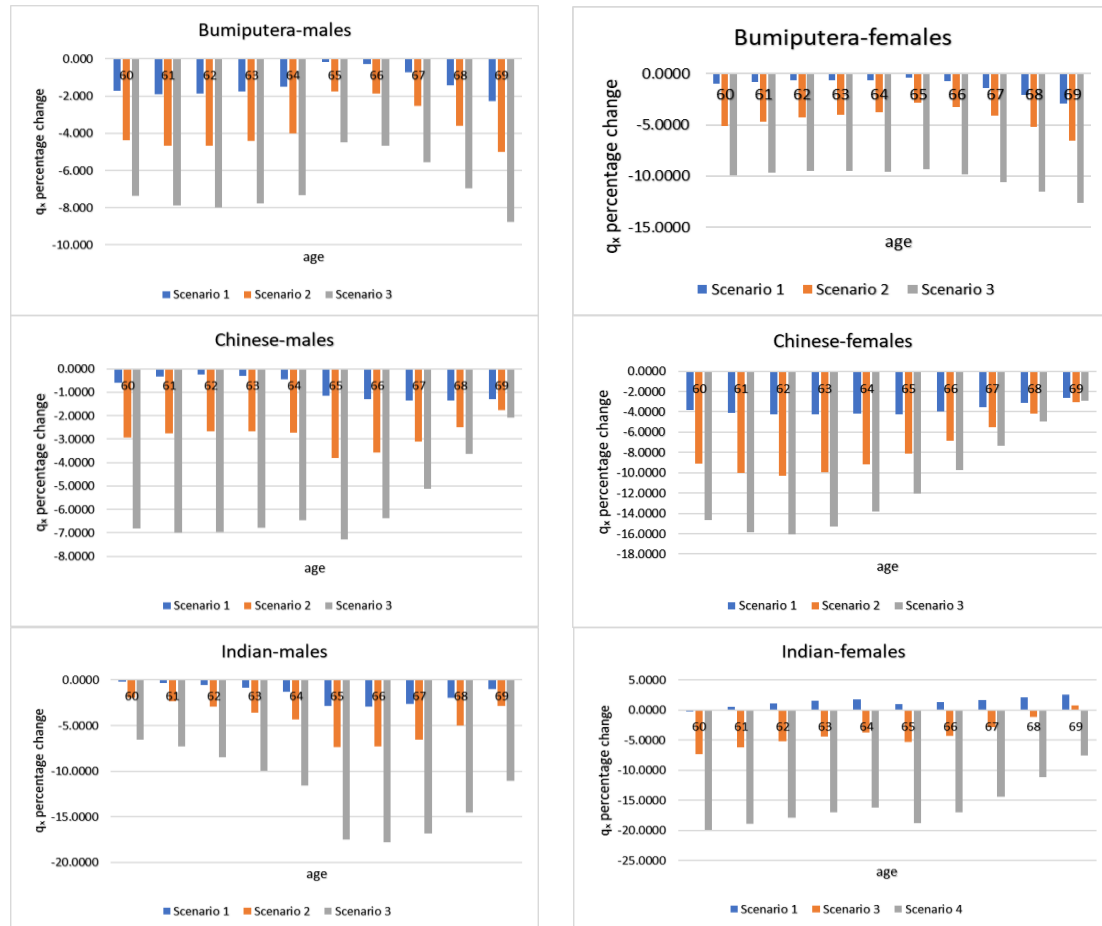

Figure 8: Percentage difference of mortality rates for elderly age group

For Chinese males, in Scenario 1, mortality rates reduced by 0.83 percent in average, while in Scenario 2 and 3 which are during COVID-19 outbreak, mortality rates still exhibited reduction by 2.85 and 5.85 percent in average respectively. For Chinese females, the percentage change of decrement were 3.80, 7.63, and 12.20 in average for Scenario 1, 2 and 3 correspondingly. Mortality rates for Chinese ethnic for both males and females also show higher improvement even in the pandemic. Furthermore, similar to Bumiputera, the percentage of decrement for Chinese females was also higher than males. Edrus *et al.* (2022) also stated that the impact of the COVID-19 mortality rates was higher for males as compared to females.

Besides, for Indian males, there was also improvement in mortality rates where the percentage change of decrement by age were getting higher from Scenario 1 to Scenario 3. Mortality rates reduced by 1.46, 4.44 and 12.16 percent in average for Scenario 1, 2 and 3 respectively. Thus, the mortality rates for the elderly exhibit remarkable improvement during the year of the pandemic. Moreover, for Indian females, in Scenario 1, there was an increment in mortality rates of about 1.35 percent in average from age 61 to 69. Nonetheless,

in the first and second year of the COVID-19 pandemic, there was an improvement in mortality rates where it was reduced by 3.97 and 15.90 accordingly for Scenario 2 and 3. Although the number of deaths related to COVID-19 among the elderly age group was higher than other age groups, the mortality rates exhibited a decreasing trend. Hence, we believe this is happening due to an increase in the rate of death during the pandemic that could not match the rate of ageing population among the elderly in Malaysia. Moreover, Edrus *et al.* (2022) said that Malaysia's population is ageing to the point that the mortality rate from confirmed COVID-19 deaths has not yet been adversely affected by the COVID-19 outbreak.

4. Conclusion

The purpose of this study is to analyse the trend of mortality rates for specific ethnicities, age groups of adults, middle-age as well as the elderly for both genders before and during COVID-19 pandemic, by expanding the abridged life table. Based on the empirical results, it was found that the Six-point Lagrangian interpolation method shows a satisfactory outcome as an error rate of less than 1 percent. The second goal of this study is to identify which ethnicities, age groups and genders were affected by COVID-19 from the perspective of mortality by comparing the mortality rates over a one year period.

Overall, we can conclude that mortality rates had decreased steadily from the year 2018 until 2021 for all ethnicities and age groups for both genders. For all three ethnic groups, females mortality rates were consistently lower than male mortality rates. Plus, it also proven that Chinese mortality rates is persistently the lowest among the three main ethnicities for all age groups. For the adult age group, in 2021 which is second year of the pandemic, there was a pattern disruption in the trend of mortality for Chinese and Indian from the adult age groups for both genders. Apart from that, for the adult age group, Chinese females in between the ages of 24 to 39 was most affected during the COVID-19 pandemic. For the elderly age group, the rates of mortality kept declining even during the pandemic with remarkable improvement in the year 2021. The pattern of mortality rates among ethnic groups before and during COVID-19 pandemic may differ depending on risk factor prevalence, clinical care standards, and healthcare system capability. Hence, this study can be a reference for the public health organization to make a comparison of the trend for mortality rates when the COVID-19 pandemic phase in Malaysia has changed to endemic starting from 1 April 2022.

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