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A Comparative Analysis of Malaysian Ethnic Mortality Risk Disparities using the Heligman-Pollard Model

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Malaysia is characterised by a unique multiethnic demographic profile that influences the national mortality landscape. However, relying on national population mortality data often leads to actuarial valuation inaccuracies because it fails to reflect actual ethnic mortality disparities. To address this issue, the study analyses the mortality risk disparities across the Bumiputera, Chinese and Indian groups relative to the national population. Since a detailed analysis across all ages required complete life tables, this study employed the Heligman-Pollard model to expand abridged life tables. Long term mortality trends from 1970 to 2020 showed that the Chinese group consistently recorded the lowest mortality risk whereas the Indian group faced the highest rates. Furthermore, age specific analysis for 2020 highlighted that these mortality gaps changed throughout different life stages. This study shows that national mortality data is misleading since it fails to represent the actual mortality risks faced by different ethnic groups. To ensure financial fairness and sustainability, these findings recommend that actuaries and policymakers adopt ethnic specific mortality tables. This study contributes to improving the financial models for Malaysia as well as other multiethnic countries with diverse mortality profiles.

Keywords: mortality disparities; mortality risk; ethnic groups; Heligman-Pollard model; actuarial valuation; mortality rate ratio

I. INTRODUCTION

Mortality studies are crucial for actuarial science for risk assessment and financial management of life insurance and pension providers. These studies provide the empirical mortality data for estimation of future liabilities and adequacy of reserves for insurers and retirement funds. This information is important for actuaries to evaluate population mortality trends that are critical for proper pricing of premiums, estimation of pension liabilities, and development of long-term investment strategies. Mortality trends reflect demographic changes, for example, a continuous increase in life expectancy or the emergence of uncertainty in mortality. This is important in the management of longevity risk where an unexpected acceleration in mortality decline may have financial implications for annuity schemes and pension funds. A thorough comprehension of these trends is necessary for a sustainable implementation of financial planning. This can have a negative impact on the financial stability and solvency of the insurance and pension sectors. Fehr *et al.* (2012) show that demographic changes are a key driver of long-run levels of pension benefits. Wahab *et al.* (2012) also argued that demographic changes are making the evaluation of pension schemes more urgent as the existing systems are facing sustainability issues. Bielecki *et al.* (2016) further explained that the falling mortality rates have an impact on

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pension schemes as pensioners live longer. Moreover, demographic uncertainty has an impact on long term benefits as mentioned by Wang *et al.* (2019). Furthermore, De Wind *et al.* (2016) and Engels *et al.* (2017) suggested increasing the retirement age to strengthen the pay as you go pension system and overcome these challenges.

Accurate mortality data are essential for the actuarial valuation of life insurance and pension products. The mortality data is a key primary input into the systematic mathematical and actuarial modelling. These data enable actuaries to convert raw death data into statistical probabilities (q_x) which are the basic method for constructing life tables. However, there is a challenge in a diverse country like Malaysia where national mortality data is often the main basis for the actuarial modelling. The demographic composition of the Malaysian population has changed over the last twenty-five years. According to the Department of Statistics Malaysia (DOSM) data, the Bumiputera community accounted for 69.6 per cent of the population, while the Chinese, Indian and other groups made up 22.6, 6.8 and 1 per cent respectively (DOSM, 2020). However, the Current Population Estimates Malaysia 2025 report (DOSM, 2025) reveals that the Bumiputera community now makes up around 70.5 per cent of the total population. This expansion reflects the important role the Bumiputera community plays in defining the social, cultural and political identity of the nation. The Chinese community is estimated to be about 22.2 per cent of the population and remains a major contributor to the economic, cultural and urban development. Meanwhile, Indians account for around 6.5 per cent of the population and have strong roots in trade, labour migration and professional sectors that continue to shape the multicultural identity of the nation today. These changes highlight the crucial need for ethnic specific mortality data as the national population no longer reflects every group. In the insurance industry, it leads to the mispricing of annuity products. In the case of pensions, it leads to inaccurate estimation of current pension funds and future payments required by retirees. Furthermore, there are very few studies that look at these mortality gaps over a long time period and across different ages. Failing to identify these gaps makes risk management too generalised and increases financial uncertainty due to unexpected demographic shifts. Therefore, relying on such data as a single baseline can be inaccurate because mortality risks are not uniform across the ethnicity.

In view of this, the primary objective of this research is to examine mortality risk disparities among the three major ethnic groups relative to the national population. The study first analyses long term mortality trends from 1970 to 2020 for the national population and each ethnic group. Then, the mortality gap varies across life stages, including young adulthood, middle age and the older population for the year 2020 is examine. Finally, the study determines the relative risk of mortality at specific ages to measure the extent of these differences. These findings are expected to contribute toward more precise actuarial modelling in the insurance and pension sectors for Malaysia's multiethnic population as well as other multiethnic countries with diverse mortality profiles. This will help with more accurate annuity pricing and help pension funds to be sustainable in the long term by efficient management of mortality risk.

Most of the previous work on mortality in Malaysia has focused on the national dimension. However, relatively few studies have targeted specific ethnic groups in their investigation of mortality trends. Even though this is the case, previous studies have shown that mortality rates vary significantly across the main ethnic groups of Malaysia (Hamzah & Ibrahim, 2023). Nagaraj *et al.* (2008) studied mortality patterns in Malaysia from 1970 to 2004 and established that mortality had declined during this period. Among different ethnic groups, the Chinese population recorded the lowest mortality rates. In contrast, Bumiputera recorded the slowest decline in mortality between 1990 and 2004. One important finding from their study showed that each age category made progress at different rates. Indeed, it was noted that while mortality decreased significantly for infants and older people, the working population was vulnerable to death. This information clearly indicates that some age groups benefited from improvements in health conditions more than others over decades. In another study conducted by Ibrahim and Siri (2014), mortality trends for these main ethnic segments were examined between 1970 and 2010. It was discovered that death rates for all ethnic groups decreased steadily throughout the forty-year period. However, male mortality remained consistently higher than

female mortality across all ages and ethnicities. Moreover, they stated that the death rates for adolescent and women were somewhat identical within the three examined ethnicities. However, the patterns in death rates of adolescent and men between Bumiputera and Indians were different from the Chinese people. It has also been noted that deaths were at their highest among the old people, the second highest among middle-aged people and adults. Moreover, Ishak *et al.* (2019) conducted another research on the death rates within the period of the years between 1991 and 2011. The findings of this study indicated the death rates for all groups kept on decreasing during these twenty years. The death rates in the Chinese community were less than those of Bumiputera and Indians in all age groups. However, the finding revealed that the decrease in death rates was different in speed across different ethnicities. For example, Bumiputera males had the lowest rate of falling death rates among males. On the contrary, the death rates of Indian females lowered much faster than those of Bumiputera and Chinese females.

It is necessary to go beyond the use of general abridged tables in order to assess the specific patterns of mortality among these groups. Thus, different mathematical methods for converting abridged life tables into complete life tables can be explored. Many methods have been proposed in various studies of the past, such as the King interpolation method (King, 1914) and the 6-point Lagrangian method (Elandt & Johnson, 1980). Kostaki and Panousis (2001) analysed different approaches for the conversion of such tables and focused on the 6-point Lagrangian method by Elandt Johnson and Johnson (1999). According to the approach, data of the l_x-values were used to close the gaps in the statistics of mortality attributed to certain age groups. The results indicated abnormalities in the mortality rates of the individuals aged 10-15. However, the method of Lagrangian interpolation is still deemed valid. Though traditional methods are popularly used to derive mortality figures, some studies have introduced advanced analytical methods. According to Hartmann (1987), in his opinion, the model of Heligman and Pollard (1980) represents the best model for analysis of mortality. This simple analytical expression showed a great versatility in various countries like in US according to Mode and Busby (1982) and in Sweden as per Hartmann (1987). Further studies of Kostaki (1991 and 2000) showed that Heligman Pollard method is rightly used for modelling age specific mortality. This method allows calculating the complete life tables from abridged data for the effective demographic analysis. Subsequently, the research conducted by Ozeki (2005) used four mortality models including the Heligman-Pollard and Lee-Carter models and compared the aforementioned models using Japan life table. He pointed out that the Heligman-Pollard model is easy to grasp for actuaries as it incorporates the well-known Gompertz law along with parameters related to other two components. The results indicated that the Heligman-Pollard model offered good fit since the difference between the observed and fitted mortalities remained below 10% for people aged 50 years and older. Later research by Wel (2015) involved the usage of cross-validation methods with Dutch data for the purpose of comparing the Heligman-Pollard model to the Lee Carter model. From the calculations made based on the Mean Absolute Percentage Errors (MAPE), it was evident that there was a better fit between the Heligman-Pollard model and the actual data, even though there existed some noticeable errors at the extremes of the ages of 0 and 110.

II. MATERIALS AND METHOD

A. Data Collection

The mortality data collection process started with the Department of Statistics Malaysia (DOSM) where the mortality data collected was the abridged life tables. These tables were collected for the years 1970, 1980, 1990, 2000, 2010, and 2020, covering a total period of 50 years at 10-year intervals and analysed using Microsoft Excel. To ensure the study captured a complete picture of the nation, the data included both the national population and the three major ethnic groups consisting of the Bumiputera, Chinese, and Indian groups, with each category further subdivided by gender.

B. The Heligman-Pollard Model

Since these datasets are only available in five-year age groups such as 0 - 4, 5 - 9, 10 - 14, 15 – 19 and so on, an estimation technique is required to obtain mortality rates for

individual ages. This study applied the Heligman-Pollard model as this model is a well-known mathematical model used to describe the entire mortality curve and for generating complete life tables. The original model consists of eight positive parameters, which are divided into three distinct components to capture the different stages of human life. The complete model is expressed as:

$$\frac{q_x}{1-q_x} = A^{(x+B)^C} + D\left\{\exp\left\{-E\left[\ln\left(\frac{x}{F}\right)\right]^2\right\}\right\} + G\,H^x \qquad (1)$$

where, q_x represents the probability that an individual at age x will die within one year. The positive parameters A, B and C are responsible for describing the infant and early childhood mortality stage. The second part, involving positive parameters D, E, and F, represents the "accident hump" typically seen in adult ages, while the last component with positive parameters G and H captures the exponential increase in mortality for ages greater than 40 years old.

However, as the study focuses on mortality rates starting from age 10, the model was simplified by excluding the first component. Thus, only five parameters were estimated using the following simplified model as follows:

$$\frac{q_x}{1-q_x} = D\left\{\exp\left\{-E\left[\ln\left(\frac{x}{F}\right)\right]^2\right\}\right\} + G\,H^x \qquad (2)$$

The MATLAB software was used for the determination of the five parameters through a non-linear least squares method. The Levenberg-Marquardt algorithm, developed by Levenberg (1944) and Marquardt (1963), was employed owing to its efficiency in solving non-linear mortality curves. This particular algorithm is efficient because it employs a combination of the two techniques; the Gauss-Newton method and the gradient descent. Moreover, as it is a damping method, it makes sure that the system is always able to find the best set of parameters when the values of initial parameters are far from the final outputs. The method was initiated with the initial set of parameter values, and the successive iterations continued until either the convergence criterion was achieved or the maximum number of iterations was reached. More information is available according to Ibrahim's (2008) paper. The algorithm is considered as highly efficient when applied to complicated optimisation tasks with a number of parameters. The model has been applied to each population groups, considering the gender aspects as well over period of study. Then, the fitted model was used for obtaining the corresponding age-specific mortality rates.

C. Evaluation of Model Accuracy

Performance of Heligman-Pollard model is measured with Mean Absolute Percentage Error (MAPE) to estimate the precision of the estimated parameters. This statistical indicator determines the average magnitude of the error between the actual and estimated mortality rates. By expressing the prediction accuracy as a percentage, MAPE provides a clear measure of how closely the model fits the data across all age groups.

The process started by taking the single-year probabilities of dying, q_x derived from the model and converting them into single-year survival probabilities using $p_x = 1 - q_x$. Since the original mortality data from DOSM were provided as abridged life tables, these single year values were then converted into estimated n-year survival probabilities, ${}_np_x$ using the product formula as follows:

$${}_np_x = \prod_{i=0}^{n-1} p_{x+i} \qquad (3)$$

Then, the estimated n-year probabilities of dying were calculated using:

$${}_nq_x = 1 - {}_np_x \qquad (4)$$

Finally, the MAPE was calculated to compare these estimated ${}_nq_x$ values with the actual values from the abridged life tables. The formula for MAPE was defined as follows:

$$MAPE = \frac{1}{m}\sum_x \left|\frac{{}_nq_x^{actual} - {}_nq_x^{estimated}}{{}_nq_x^{actual}}\right| \times 100 \qquad (5)$$

where m is the number of age groups.

D. Age-Specific Mortality Comparison

The study estimated the Mortality Rate Ratio (MRR) to determine the relative risk of mortality between each ethnic group and the national population. This measure served as an actuarial tool to identify the extent of mortality risk

deviation for each ethnicity relative to the national population. The MRR was estimated using the formula as follows:

$$MRR = \frac{\text{Mortality Rate of Specific Ethnic Group}}{\text{Mortality Rate of National Population}} \quad (6)$$

The comparison was carried out at ten-year intervals so that the ages would comprise 20, 30, 40, 50, 60, and 70 years. Taking the national population as the benchmark, the mortality risk of a certain group was verified as being either higher or lower than that of the reference group. The value of MRR again obtained at more than 1.0 indicates a higher mortality risk for the ethnic group under review than that of the national population, while the value below 1.0 implies a lower mortality risk relative to that of the reference group. The importance of this approach lies both in establishing the mortality risk inherent in the ethnical diversities in question and in providing a basis for making comparisons across the mortality levels at different age indicators.

III. RESULTS AND DISCUSSION

A. Analysis of Long-Term Mortality Trends

The study first verified how well the Heligman-Pollard model fitted the actual mortality data. Based on the Mean Absolute Percentage Error results, the model showed a high level of accuracy for the national population as well as the Bumiputera and Chinese groups with error rates less than 10 per cent. The Indian group showed slightly higher error values in some years, but the values remained well within the acceptable range of below 15 per cent. Overall, these results indicated that the model was reliable enough to support the analysis of long-term mortality trends and differences between the national and ethnic groups.

This section analysed mortality trends for the national population and the three major ethnic groups in Malaysia from 1970 to 2020. By observing mortality trends at 10- year intervals over these five decades, the analysis highlighted how mortality for each ethnic group differed from the national population for both males and females. Figure 1 illustrates the long-term male mortality trends for the national population and the three main ethnic groups analysed in ten-year intervals from 1970 to 2020.

The findings revealed that the Chinese group consistently recorded the lowest age specific mortality rates compared by the national population. In contrast the Bumiputera and Indian groups experienced relatively higher mortality levels throughout the study period.

By comparing ethnic-specific mortality rates against the national population, it was found that the mortality trends for the Bumiputera group aligned close to the national 2000. These factors allowed the Chinese group to experience a much faster improvement in survival, which increased the disparity with the national population after 2000.

Meanwhile, the Indian male group recorded a different pattern in their mortality rates compared to the national population. While their mortality rates were slightly higher than the national population in the 1970s and the research revealed a clear deviation after year 1990. The findings suggest that Indian males faced a much higher risk of death compared to the national population**.** Although this gap began to narrow after 2010, the findings indicated that their mortality rates still remained higher than the national population.

In addition, the long-term female mortality trends across five decades are presented in Figure 2. According to Figure 2, it was found that Chinese females maintained the lowest mortality rates for the entire fifty-year period while the national population stayed slightly above them. Both Bumiputera and Indian groups faced higher mortality risks compared to the others in this analysis.

The findings revealed that Bumiputera females had mortality trends almost similar to the national population from 1970 up to 2010. After this period, the findings revealed that their mortality rates became higher than the national population during the 2010 observation. However, their rates returned to being almost similar to the national population by 2020, which indicated a better mortality trend in the final decade.

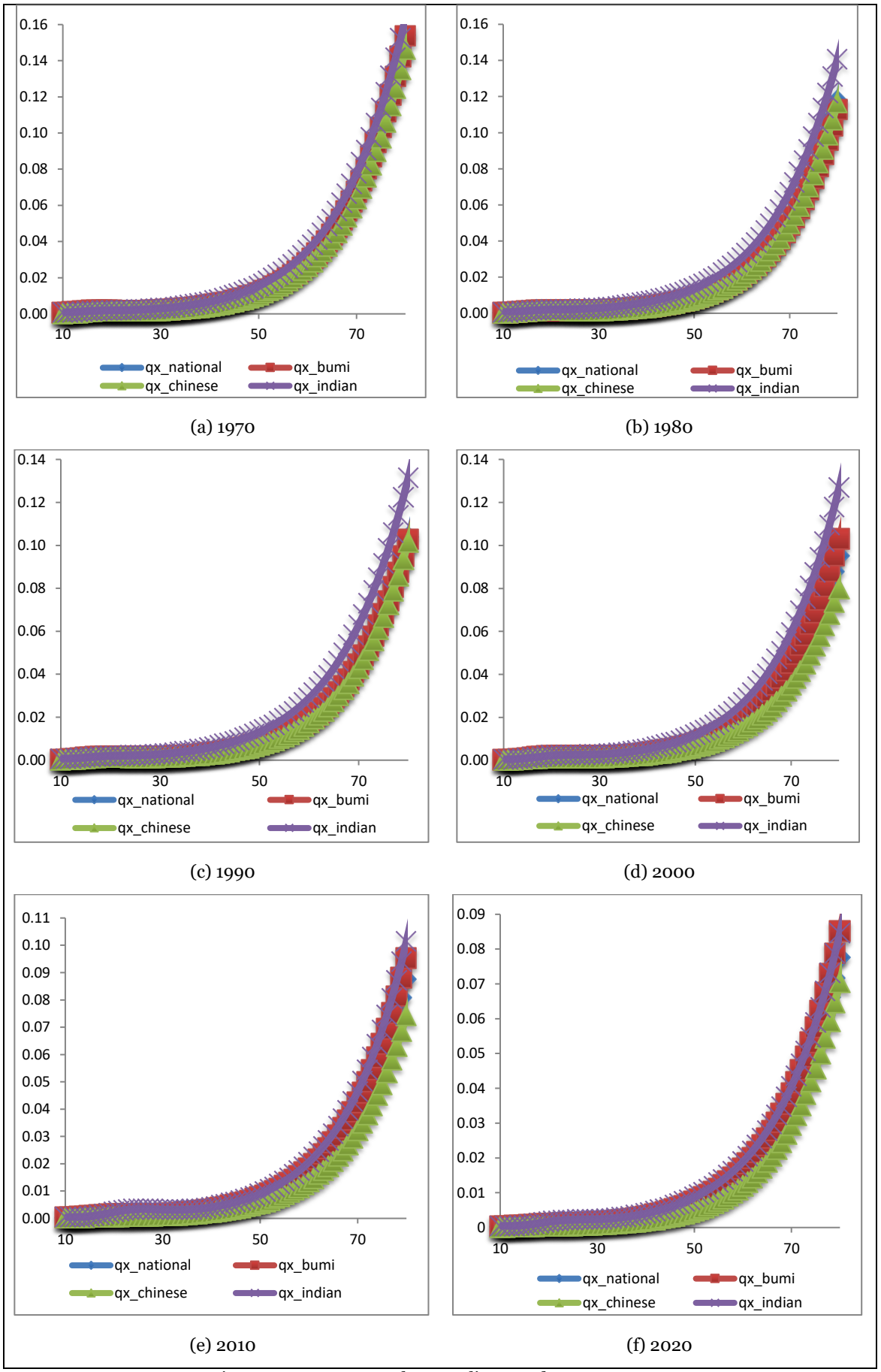


Figure 1. Long Term Male Mortality Trends, 1970 to 2020

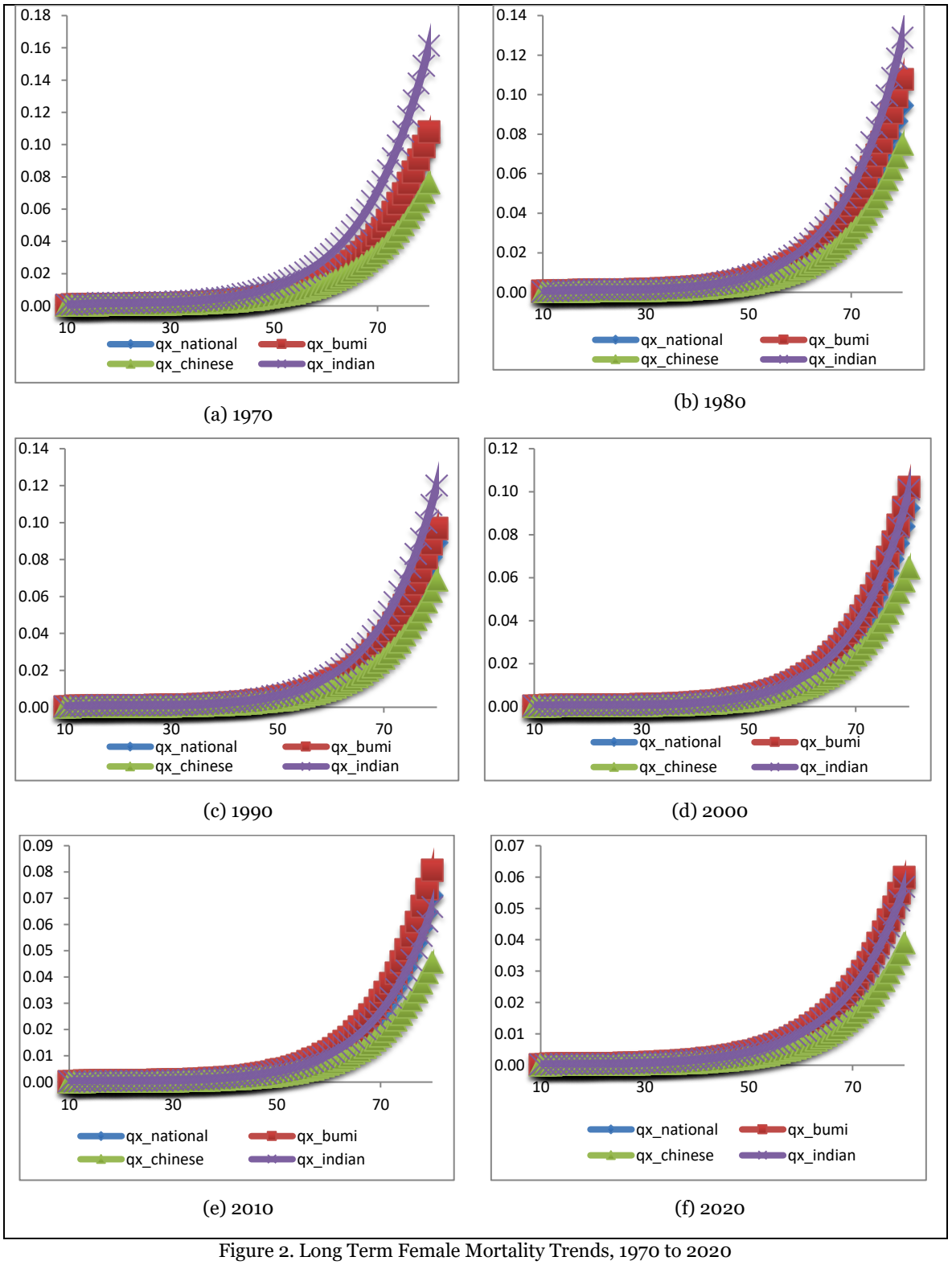


Figure 2. Long Term Female Mortality Trends, 1970 to 2020

Furthermore, the Chinese group consistently showed a mortality trend that remained lower than the national population throughout the entire fifty-year study. This survival advantage grew even stronger over the years as the gap with the national population widened after 2000.

Meanwhile, the Indian group recorded a mortality trend with a clear gap relative to the national population starting 1970. This mortality gap remained prominent for several decades before it began to decrease after the year 2000. The mortality trend for this group became almost similar to the national population during the final twenty years. However, their mortality rates still remained higher than the national population throughout the entire period.

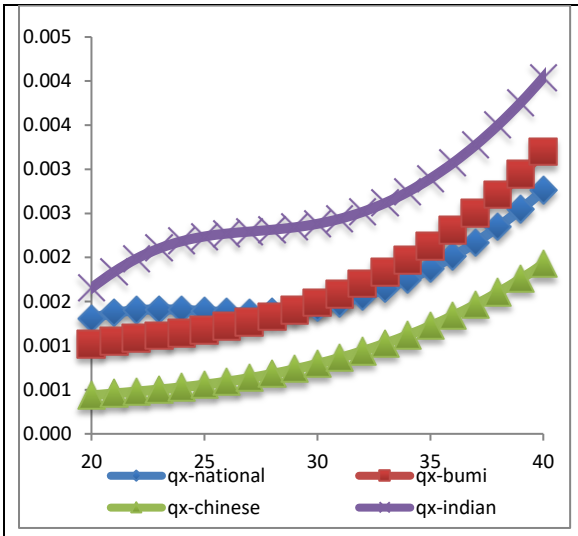
Based on these findings, it suggests that mortality trends for each ethnic group differed from the national population. These findings suggest that relying on a single national population has financial implications specifically for the pension system and insurance industry. Chinese mortality trends remained consistently below the national population, which indicates that this group lives much longer than the general population. This trend causes the pension fund to face a financial shortfall because it must provide benefits for a much longer period than the national estimation. Using the national population to estimate liabilities for the Bumiputera and Indian groups creates a surplus of funds because their actual payout period is shorter. This excess fund indicates a missed chance to earn a profit because the unutilized fund could have been put to better use elsewhere. Managing the various mortality risks effectively will assist in ensuring the pension fund's continuing viability due to better planning of liabilities.

The insurance and takaful sectors experience challenges when applying a uniform price model based on one mortality statistic for all ethnic groups. Although the findings specify that the Bumiputera and Indian groups experience higher death rates, it has been indicated that their risk levels are higher than that of the national population. Hence, the latter causes a lack of premium revenues resulting in the risk of insolvency for insurers in periods of massive payouts. On the other hand, the group with low mortality such as the Chinese are forced to pay premiums based on risk levels that are far higher than those, they possess. Thus, the problem is that the prices charged by insurance companies do not reflect the real mortality risk of each ethnic group. Therefore, it is vital for insurance companies to adopt risk models that reflect the actual mortality experience of populations of every specific ethnic. Nonetheless, mortality patterns among men and women tend to be steady and decrease across ethnicities in all the years researched.

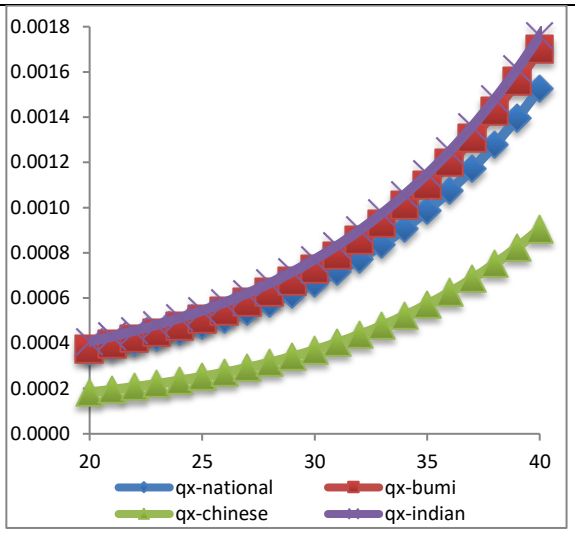
B. Analysis of Age Group-Specific Mortality

Upon analysis of the long-term trends, the study also estimated the mortality gap for the year 2020 segregated into three defined age categories—20 to 40 years, 41 to 60 years, and 61 to 80 years. This section depicts the pattern of mortality gap concerning each ethnic group and the national population during the specified age ranges.

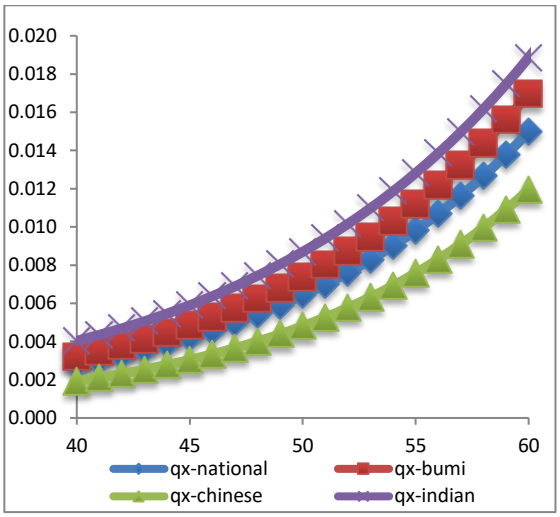
The illustration in Figure 3 shows the death rates for particular age categories among male population in the left-hand section (a, b, c) and among female population in the right-hand section (d, e, f). As indicated in Figure 3(a), male Indians have the highest mortality rates compared to the male Chinese with the lowest rates in the age category of 20 – 40. The findings for the Bumiputera and national male population show that they fit between these two extremes. A noteworthy finding is that crossover takes place in the age category of 29 to 30. In fact, as per the national male rates, their transition male mortality rates were above Bumiputera mortality rates before they reached the age of 30. This regard changes as the national male indicator becomes lower than Bumiputera one after the age of 30. This indicates that Bumiputera males experience mounting death risks after they enter their 30s against the of national population data. Finally, the mortality rates among male Chinese and male Indians against national statistics turn out to be rather clear.



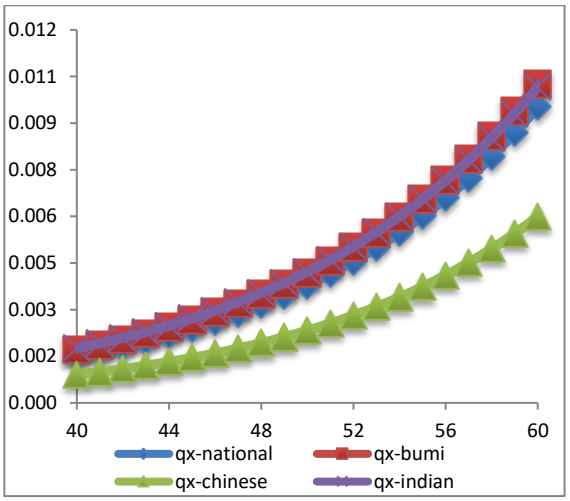
(a) Male: 20–40 years



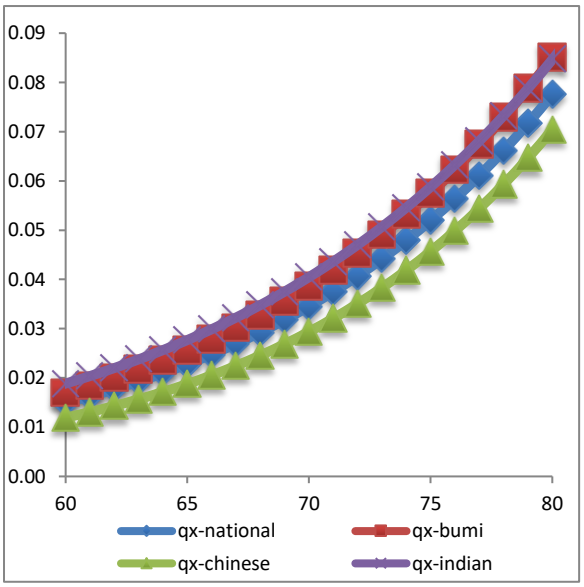
(d) Female: 20–40 years



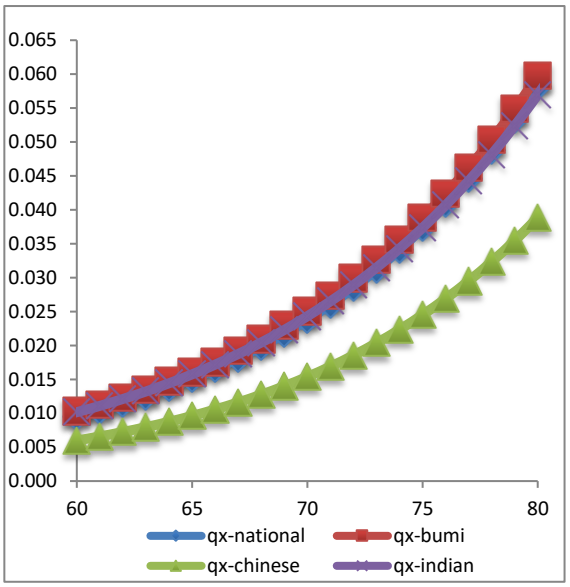
(b) Male: 41–60 years



(e) Female: 41–60 years



(c) Male: 61–80 years



(f) Female: 61–80 years

Figure 3. Comparison of Mortality Rates by Specific Age Groups in 2020

The Indian males observed in Figure 3(b) were those in the age group of 41-60 who showed the highest mortality rate followed by Bumiputeras and the national population respectively. On the other hand, the lowest rate was that of Chinese males. However, the important change witnessed was that the mortality gap of the Bumiputeras now became smaller with respect to the national population. However, the mortalities of the Chinese and Indian males remained comparatively higher although the gap was narrowing down with age.

Figure 3(c) indicates that a similar trend was observed for the age group of 61 to 80 where Indian males recorded the highest mortality rates. A key observation was that the mortality gap for Indian and Bumiputera males compared to the national population became smaller in later life.

Meanwhile the mortality gap for Chinese males remained clear but narrowed compared to the previous age group.

In addition, the mortality gap for females differed slightly from males as shows in Figures 3(d) and 3(e). For the 20 to 40 age group, Bumiputera and Indian females showed almost identical mortality levels at the early stage. However, the mortality gap for these groups widened as age increased. During this stage the national female population recorded lower mortality rates compared to both the Bumiputera and Indian groups. In contrast Chinese females showed a noticeable mortality gap compared to the national population while remaining consistently lower mortality rates. These findings indicated that young Chinese females showed a stronger survival advantage than all other ethnic groups and the national population.

For the age group of 41 to 60, Figure 3(e) illustrates the mortality gap for Bumiputera and Indian females narrowed relative to the national population. Chinese females showed a mortality gap that narrowed compared to the previous age group but remained distinct. This finding highlighted a much lower mortality risk for Chinese females relative to the national population.

Finally for the age group of 61 to 80, only a small difference in mortality risk was observed for the Bumiputera and Indian female populations relative to national population as depicted in Figure 3(f). As they reached older ages their mortality rates became increasingly similar to the national population. However, Chinese females continued to record substantially lower mortality rates even in later life. This consistent advantage in old age demonstrates that, of all the populations examined, Chinese women had the longest lifespans.

In conclusion, it can be seen that the differences in mortality rates apply to specific age cohorts and ethnicities. For the Bumiputera, the mortality gap increases with age more closely to being the same as the national average mortality rate in later years. On the other hand, Indian males had observed a high mortality gap as compared to ages. However, with the passage of time, the gap started narrowing down. The Chinese group was different from the rest of the population groups since they still maintained a wide disparity from the national population in terms of mortality rates. The observed differences in the mortality gap directly affect financial modelling. The use of only national mortality data leads to inaccurate valuation of the pension system and the insurance sector. For pension funds, this means the miscalculation of the life expectancy of the Chinese group resulting in financial loss. For the insurance companies, this leads to the excess income due to the overpricing of the insurance products. On the other hand, because of the high mortality of the Indian group, calculating premiums according to national mortality figures can lead to underinsurance. Therefore, the study recommended using ethnic specific mortality risk models by pension schemes and insurance providers for timely measurements and long-term viability of organisations.

C. Analysis of Age-Specific Mortality

Additional assessments were conducted to identify the risk of death in different ethnic groups by calculating the Mortality Rate Ratio (MRR) and comparing it with the national population. The findings obtained for MRR is provided in Table 1 summarisation for both males and females.

According to the Table 1, there are certain differences between the mortality rate based on their ethnicity and gender compared to the mortality rate of the national population. It was found that Indian males had a mortality rate ratio (MRR) more than 1 in every single age category in the range of 1.17 to 1.66 showing that Indian males faced high mortality rate during their entire life cycle relative to

the national population. The mortality rate of Indians reached the maximum level at age 30 with a MRR of more than 66% compared to the national population. Although the difference in the mortality rate decreased to 17% by the age of 70, Indian individuals had a higher mortality rate during the entire life span as compared to the national population.

Initially, at the age of 20, Bumiputera males had a mortality risk that was 23% lower than the national population. However, from the age of 30, their mortality risk started to increase. From that age onward, their mortality risk remains 4% to 16% higher than the national population. In contrast, Chinese males recorded a mortality risk that was about 67% less than that of the national population when they were young, affected by age the only male group that continued to have lower mortality risk than the national population as age increases.

Furthermore, data about females revealed a relatively uniform trend but still gave rise to separate mortality risks. Bumiputera and Indian females always showed the MRR higher than 1.0 ranging from 1.02 to 1.16 for the whole life. Notably, the gap decreased when their mortality risk reached the level of the average population at the age of 70 years, with their risk being only 5% and 2% above the national population correspondingly. However, Chinese females had a consistently lower mortality risk based on MRR values varying from 0.50 to 0.64 at all ages.

In general, these findings indicate that the national mortality rates did not reflect the actual mortality rates of the different ethnic populations. The application of national mortality table for the Chinese population causes an underestimation of liabilities due to the failure to take into account their long-life expectancy. This happens when pension funds do not have sufficient funds to pay for those retirees with the life span larger than that of the national population. On the contrary, due to the higher mortality risks the national data causes overestimation of liabilities for Bumiputera and Indian populations with their life expectancy expected to be less than that of the national population.

Table 1. Summary of Estimated Mortality Rate Ratio (MRR) for Male and Female

Age	**Male**			**Female**		
(*x*)	**Bumiputera**	**Chinese**	**Indian**	**Bumiputera**	**Chinese**	**Indian**
20	0.77393	0.33296	1.26366	1.02331	0.50219	1.11657
30	1.03775	0.55421	1.66284	1.09729	0.55807	1.16244
40	1.15673	0.69665	1.46160	1.11428	0.59308	1.15182
50	1.14657	0.74711	1.35270	1.09847	0.61229	1.11143
60	1.13156	0.79688	1.25926	1.07600	0.62877	1.06646
70	1.11547	0.85052	1.17185	1.05176	0.64627	1.02175

Authors' Estimation

IV. CONCLUSION

In conclusion, the findings of the present study revealed the heterogeneous of mortality risk based on ethnicity in Malaysia. Using the mortality data from 1970 to 2020, the Chinese consistently exhibited the lowest mortality risk, whereas the Indian group had the highest mortality rate. The Bumiputera mortality rates were somewhere between the two extremes. The outcomes of the age specific analysis in 2020 showed that mortality rates evolved across various stages of life. The analysis indicated that young adults in the Indian group had the highest rates of mortality in comparison to their Chinese counterparts. An important finding was the crossover for males in the Bumiputera community at age 30 when their mortality rates started moving in a contrary direction to the national trends. Furthermore, the mortality gap for the Bumiputera and Indian groups narrowed and moved closer to the national population as age increased. The relative risk of mortality analysis showed that the Bumiputera and Indian groups generally maintained risks above the national population. Specifically Indian males recorded the highest relative risk of mortality peaking around 66% above the national population at age 30 while Chinese females remained 50% below it.

These findings suggest that relying on single national mortality data may not fully reflect the differences in mortality patterns between ethnic groups. Such differences may be relevant when considering mortality assumptions for actuarial purposes. However, any application of these findings should take into account the wider context in which mortality data are used, as mortality differences alone may not be sufficient to determine appropriate insurance or pension decisions. Future research should investigate the reasons why mortality rates converge at older ages despite the differences during young adulthood. These discoveries will aid in the development of more precise financial models for Malaysians and other multiethnic nations with a range of mortality rates.

The study too confronts some limitations in terms of interpretation of results. The research relied upon abridged life-table data every 10 years, requiring the application of model-based interpolation to arrive at age-specific mortality estimations. In addition, the investigation omitted socioeconomic and health aspects from consideration, with some uncertainty persisting regarding mortality rates. The forthcoming research can take into consideration more comprehensive mortality data as well as effective socioeconomic and health factors making the differences in mortality among the particular population groups clearer.

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