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Introduction

Malaysia has one of the lowest crude death rates in the world at 4.97 per thousand persons in 2002 (WHO Mortality Database). However, standardizing on the WHO global standard population, the death rate in the same year was 8.32 per thousand persons, and compared to, say, France's age-standardized rate of 4.43 or Singapore's age-standardized rate of 4.60, suggests that there is need for further improvement. Over time, males have registered lower declines in the death rate than females, and the mortality rate of Chinese community has declined more rapidly than that of the Indian or Malay communities (Tey and Balakrishnan, forthcoming). Age-gender-ethnic differentials are pronounced. While the mortality rate for the Chinese males has been declining steadily for all age groups, Malay males aged 20-29 and Indian males aged 15-34 registered an increase in the death rate between 1970 and 2000.

Higher mortality rates among males are in fact a common occurrence across cultures, countries and even in the animal kingdom (Kalben, 2002). While it may be well known that mortality rates are generally higher for males (except for specific causes), what is less clear is why these differentials exist. This paper examines male-female differentials in mortality by studying changes in the leading causes of death across the three main ethnic groups in Malaysian society. The Malaysian experience provides a unique opportunity to evaluate differences between groups in a population whose health is monitored and maintained by a national healthcare system.

The next section of the paper considers the issue of assessing mortality in sub-populations. The use of the terms sex and gender, and race and ethnicity, as well as measurement and comparisons across sub-groups are addressed. The third section discusses male-female differentials in mortality by ethnicity for the period 1970 - 2004. This is followed by a discussion of the changes in the leading causes of death between 1971 and 2002, and then by a comparison of causes of death that distinguishes male death rates from female death rates for 2002 across ethnic groups. The final section concludes the paper with a discussion.

Methodological Issues

This paper attempts to explain mortality differentials between males and females across ethnic groups using a variety of mortality measures. Previous research has sought to assess the differences in mortality levels across sub-groups of a population. The categorisations have included male and female, race or ethnicity, age, educational level, religion, marital status, and in studies across countries, level of development (Acemoglu & Johnson, 2006; Caldwell, 1990; Case & Paxson, 2005; Houweling, Caspar, Looman, & Mackenbach, 2005; Khang, Lynch, & Kaplan, 2004; Nathanson, 1984; Singh & Hiatt, 2006). Of concern to this paper are the two groupings, sex/ gender and race/ethnicity and whether the findings on differences in mortality provide information across 'sex' or 'gender', and 'race' or 'ethnicity', respectively.

There is evidence that the causes of the observed higher male mortality relative to females can be biological as well as social in nature. However, as Kalben (2002) observes, studies seldom deal with both aspects. Nathanson (1984) argues that the direction of research is guided by the interests or orientation of the researcher so that "the biologist sees hormones; the epidemiologist, risk factors; and the sociologist, social roles and structural constraints." He ascribes this to the "uniquely protean quality of sex as a conceptual category." Not surprisingly then, the terms used to denote male-female categories in the scientific literature is the biological term 'sex' (something that cannot ordinarily change), while that in the social science literature is the behavioural term 'gender' (encompassing roles and behaviours that can change over life, time and place). Phillips (2005) contends that since the health of an individual is affected by biological and socio-economic circumstances, it is time that gender is recognized as a social determinant of health of both men and women. Indeed, she finds that the term 'gender' encompasses both "sex differences and the social constructs that give rise to gender differences."

The terms 'race' and 'ethnicity' have been similarly distinguished in the literature, the former used to denote biological (usually physical) attributes (as in Muhuri et al., 2004) and the latter to denote the cultural and social behaviours ascribed to a group (as in Panis and Lillard, 1995). However, here the understanding of the term 'race' as an unchanging biological characteristic is

less clear, since it is difficult to define the 'purity' of a race in terms of origin unlike as in the case generally for male or female. Indeed, the very use of racial categories in assessing health has been called into question: the 2007 issue of PloS Medicine has several papers devoted to the topic (Braun, 2007; Brown, 2007; Ellison, 2007). Braun et al. (2007) argue that racial categories are historically and nationally specific. They therefore caution against its use in a biological or attributive sense in the clinical environment, but accept that it could be used in a descriptive sense to document the health status of sub-groups in a population. On the other hand, Ellison et al. (2007) argue that a consensus on operationalisation of race or ethnicity in specific contexts is first needed in order to make clear the distinction between the attributive and descriptive nature of race. In an editorial on these papers, Brown et al. conclude that while much can be done to define more clearly the sub-divisions, the use of these "ways of categorizing humans are here to stay".

The annual Vital Statistics publications for Malaysia report deaths by sex and ethnicity. 'Sex' denotes male/female categories while 'Ethnicity', as defined by the decennial Census, captures groups "bound by a common language/ dialect, religion and customs" (Nagaraj et al., 2007). Malaysia's multi-ethnic society permits a comparative analysis of the health status, as measured by mortality rates and causes of death, of males and females across ethnic groups within one country that has a central healthcare delivery system. The analysis in this paper takes the position that these categories provide information on social and cultural nuances of male-female mortality differentials. It is in this regard that the term gender and ethnicity are used in this paper. Gender is used in the sense of Phillips (2005) and ethnicity is taken in its descriptive sense to be imbued by cultural and social dimensions. The term 'Malays' to refer both to 'Malays' and other indigenous groups referred to as 'Other *Bumiputera*'[1]. The *Vital Statistics* publications use the single category 'Malay' to refer to both 'Malays' and 'Other *Bumiputera*' up till 1990, and then subsequently provide information separately and jointly for 'Malay' and 'Other *Bumiputera*' since 1991. In 2000, 'Malays and Other *Bumiputera*' comprised 61.2 per cent of the

[1] A Malay word meaning "sons of the soil". The *Bumiputera* community comprises mostly people of Malay origin but also minority groups such as the Aborigines of Peninsular Malaysia and indigenous tribes of Sabah and Sarawak.

population, 'Chinese' 25.1 per cent and 'Indians' 7.2 per cent. The rest of the populations were made up of 'Other Malaysians' and 'Non-Malaysians'.

There are also methodological issues regarding the analysis of mortality differentials. Besides the limitations inherent in measures like life expectancy and the crude death rate (Pollard, 1982), there are issues in the way comparisons are made across groups for a given measure (Keppel et al., 2005). One basic requirement is to standardise measures for age. However, given data limitations, age in this study is taken into consideration only where possible.

In comparing males and females, we present the male-female differentials as measured by the ratio of the male value to the female value. This is a relative measure which has the value 1 when there is no difference. Keppel et al. (2005) suggest that relative values should be accompanied by absolute values in order to understand the magnitude involved. We therefore also present selected values along with the relative values.

Two aspects are pertinent in examining causes of death. First, we only examine medically certified deaths, i.e. deaths which were certified by health care professionals. In Malaysia, a significant proportion of deaths is certified by lay persons including the police and village heads especially in the rural areas. In 1998, only 44% of the deaths in the country were medically certified (Institute for Public Health, 2004). Researchers who conducted the Malaysian Burden of Disease and Injury Study evaluated the mortality data for 1998 (Institute for Public Health, 2004). They concluded that their analysis provides insufficient evidence to say that the pattern of cause of death for uncertified deaths differs from that for certified deaths although there are reasons to believe that certain causes are more likely to be certified (e.g. injuries) and that deaths in the poor and in rural areas are more likely not to be certified.

The second aspect is classification of causes of death into summary groups to ascertain changes in leading causes over time. While the term used to identify the cause of death of an individual has probably remained the same over the period under study here, 1971-2004, groupings into useful categories has changed, so that the name given to categories and the specific causes entering categories may have changed. The data used in this paper are from the Department of Statistics, Malaysia. Information on the 1971 causes of deaths was obtained from the *Vital Statistics 1971* published by the Department of

Statistics, Malaysia for which causes of death were aggregated into 50 categories based on the Seventh Revision of the International Lists of Diseases and Causes of Death. Information on the 2002 causes of deaths (unpublished data) was obtained directly from the Department of Statistics, Malaysia where causes of death were aggregated into 80 categories based on the Tenth Revision of International Statistical Classification of Diseases and Related Health Problems (ICD 10). Each category is either a single subcategory or an aggregate of several subcategories of related diseases within a particular chapter of ICD 10. In order for some meaningful comparison to be made across the two years, a decision was made by the authors to re-categorise the available data into disease categories which were based on the following criteria:

i. Disease categories which would be reflective of improvement in the delivery of public health.
ii. Disease categories where the contribution to the overall burden of death had been significant.

As an example, the application of the above criteria resulted in the re-classification of all diseases of infective and parasitic origins in the 1971 dataset into a single category labelled "Infectious and parasitic diseases". In the 2002 dataset, all infectious and parasitic diseases (as listed in Chapter 1 of ICD 10) were again re-classified into a single category "Infectious and parasitic diseases" with the exception of septicaemia (Chapter 1 Block A40-41) due to this condition's significant contribution to the burden of death (7.4% of total deaths).

Finally, we highlight the issue of reliability of mortality data for Malaysia, which is uneven across geographical regions and may therefore impinge on data by sex or ethnicity. Past research (Hirschman and Tan, 1971) suggests that coverage is reasonably good for Peninsular Malaysia (formerly West Malaysia). However, Noor Laily et al. (1983) provide evidence for the inadequacy in the measurement of crude death rates for Malay males for their period of study (1957-1979). In assessing the 1998 mortality data, the researchers from the Institute of Public Health (2004) concluded that there was considerable under-registration of mortality in the East Malaysian states of Sabah and Sarawak.

As with any work covering a long time span of about thirty-four years, it is important to be careful in drawing conclusions. Our findings will be appraised with due caution in view of the discussion above.

Mortality Trends

Malaysia has experienced great declines in its mortality levels (Tan et al., 1988; Noor Laily et al., 1983). Most of the mortality indicators for Malaysia are approaching those of developed countries (Tey and Balakrishnan, forthcoming). The low level of mortality has been achieved by all segments of the population, indicating that health programmes and services have played a large part in improving the health status of the Malaysian population (Pathmanathan et al., 2003). However, based on the life expectancy, age standardized death rates and probability of birth surviving to 65, there is still room for further reduction. Moreover, as Malaysia's health expenditure is still relatively low compared to the more developed countries, much more could be done to improve the health status of the population and reduce mortality levels.

Table 1 shows the burden of disease by age-standardised disability-adjusted life years (DALYs)[2] for selected World Health Organisations member countries, the ranks of these countries among the 192 countries covered, and the total health expenditures as a percentage of gross domestic product expenditure on health, for 2002 for selected countries. Malaysia's DALYs is almost twice that of Japan's, the country with the lowest DALYs. On the other hand, Malaysia is ranked at 59 and fares much better than some of its neighbours like Thailand. A comparison of the total expenditure on health as a percentage of gross domestic product suggests that Malaysia's healthcare system is relatively efficient compared to countries like the United States, but not as efficient as, say, Singapore.

[2] The DALY is a health gap measure that extends the concept of potential years of life lost due to premature death to include equivalent years of 'healthy' life lost by virtue of being in states of poor health or disability. One DALY can be thought of as one lost year of 'healthy' life and the burden of disease as a measurement of the gap between current health status and an ideal situation where everyone lives into old age free of disease and disability.

Table 1: Age-Standardised DALYs, Rank among 192 countries and Total Expenditure on Health as a Percentage of Gross Domestic Product, Selected Countries, 2002

Country	Age-Standardised DALYs	Rank of Age-Standardised DALYs Among 192 countries	Total expenditure on health as percentage of gross domestic product
Japan	8178	1	7.9
Sweden	8783	3	9.1
Singapore	9826	7	4.2
United Kingdom	10616	21	7.7
United States of America	12781	36	14.7
China	15149	56	4.8
Malaysia	15477	59	3.7
Vietnam	17307	76	5.1
Thailand	20179	109	3.7
Philippines	20110	108	3
India	27537	140	4.8

Source: WHO Database on Mortality. DALYs are age-standardized to WHO's world standard population.

In Malaysia, the decline in mortality levels has been uneven across gender and ethnicity. Table 2 shows the life expectancy and the gains in years of life expectancy at birth for these groups between 1970 and 2004. Life expectancy for males increased from 61.6 in 1970 to 70.3 in 2004 (a gain of 8.7 years) while that for the females increased from 65.6 to 75.9 years (gain of 10.3 years) over the same period. The gains in years of life expectancy over the period have been greatest for Indian females (13.8 years) and least for Chinese females (7.2 years). The smaller gain for Chinese females can be explained by the higher life expectancy for this group in 1970; thus gains will be relatively lower. Among the males, the gains in life expectancy between 1970 and 2004 have been smallest for Indian males. However, Indian males gained the least only in the 1970s; the gains across the other years are comparable with the other ethnic groups, especially the Chinese. In contrast, Malay males registered a very small gain between 1990 and 2004. Turning to the females, we note that the life expectancy for the Malays was greater than that for Indians in 1970, but was slightly lower than that for Indians in 2004. The gains for Malay females were

lowest for the period 1990 to 2004, although not as low as that for Malay males. Table 2 also provides the male-female ratios for life expectancy for 1970 and 2004. These show that the ratio declined slightly from 0.94 in 1970 to 0.93 in 2004 for all Malaysians. The ratios by ethnic group for these same years confirm the earlier observation that the relative position of Indian and Malay males has worsened and the relative position of Chinese males has improved. The ratios also indicate that mortality differentials across gender widened the most for the Indians.

Table 2: Life expectancy and gains in life expectancy at birth by ethnicity and sex (years), 1970-2004 Malaysia

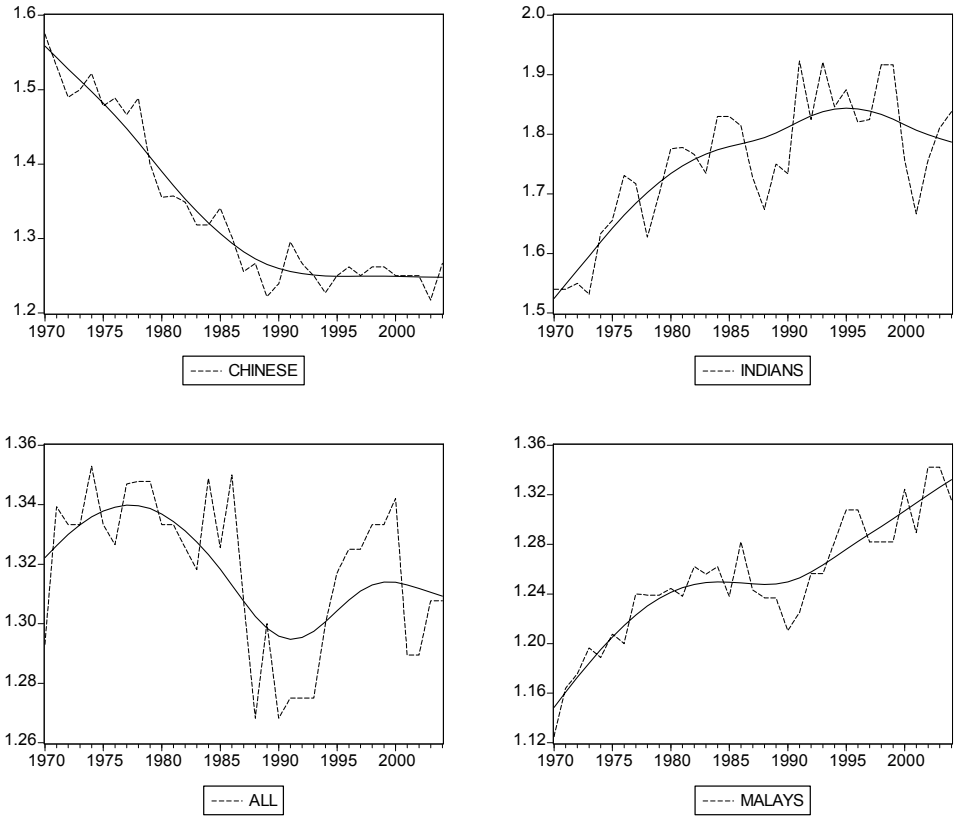
	All		Malays		Chinese		Indians	
	Male	Female	Male	Female	Male	Female	Male	Female
Life expectancy in 1970	61.6	65.6	60.8	62.7	64.0	71.3	59.0	61.3
Male-female ratio, 1970	0.94		0.97		0.90		0.96	
Gains, 1970-1980	4.8	4.9	5.7	6.2	4	2.7	3.1	5.7
Gains, 1980-1990	2.5	3.0	2.5	3.5	2.6	2.3	2.3	3.4
Gains, 1990-2004	1.4	2.4	0.4	2.1	2.7	2.2	2.6	4.7
Gains, 1970-2004	8.7	10.3	8.6	11.8	9.3	7.2	8.0	13.8
Life expectancy in 2004	70.3	75.9	69.4	74.5	73.3	78.5	67.0	75.1
Male-female ratio, 2004	0.93		0.93		0.93		0.89	

Sources: Department of Statistics, Malaysia (1986, 2006b). Figures for 2004 are preliminary.

How consistent are these gender and ethnic patterns of mortality over the period of study? We now turn an examination of mortality differentials based on the crude death rate. Figure 1 shows the ratio of the male crude death rate to the female crude death rate (with a smoothed trend[3]) from 1970 to 2004. Also shown are the crude death rates for selected years. The crude death rate for males decreased from 7.5 per thousand population in 1970 to 5.1 in 2004 while that for the females decreased from 5.8 per thousand population to 3.9 over the same period. The male-female ratio for the total population increased from about 1.29 in the 1970 to about 1.34 in the late 1980s. It declined to about 1.27 in the early 1990s before increasing again to about 1.31 in 2004. However, the pattern of the ratio for the total population this masks completely different patterns for the three main ethnic groups.. The Chinese ratio follows a declining trend. The ratio, which was about 1.57 in 1970, declined steadily till about the late 1990s when it seems to have levelled off at about 1.25. The improved position of males against females for the Chinese community for 2004 observed earlier in Table 2 is the result of a steady reduction in the crude death rate of males against that of females with most of the gains n the period 1970-1990. However, with the levelling off of the ratio thereafter, it is uncertain whether Chinese males will continue to gain against Chinese females in the future. The Malay ratio, on the other hand, shows an increase from about 1.1 in 1970 to about 1.25 in the period 1985-1990 and then further increasing to about 1.32 in 2004. The steady decline in the position of Malay males against females explains the unfavourable position of Malay males against Malay females observed for 2004 in Table 2. The Indian ratio on the other hand shows an increasing trend till the mid 1990s, and then a decline thereafter. The ratio increases from about 1.5 in 1970 to a peak of 1.9 in 1990s before declining slightly to 1.8 in 2004. That is, although the position of Indian males relative to females was the lowest among ethnic groups in 2004 as observed in Table 2, the position was even worse in the 1990s, and has improved in recent years. The greatest gender differential in mortality observed for the Indian community for 2004 earlier actually indicates an improvement from the mid-1990s.

[3] This is obtained using the Hodrick Prescott filter, which is a non-parametric spline smoother.

Figure 1: Ratio of male to female crude death rates by ethnicity, 1970 – 2004



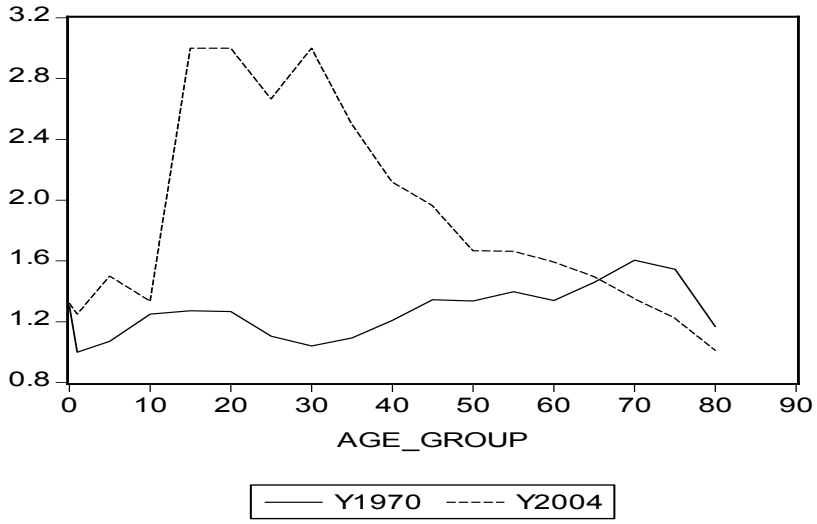
Crude Death Rates	All		Malays		Chinese		Indians	
Year	Male	Female	Male	Female	Male	Female	Male	Female
1970	7.5	5.8	7.2	6.4	7.4	4.7	9.7	6.3
1980	6.0	4.5	5.6	4.5	6.1	4.5	8.7	4.9
1990	5.2	4.1	4.6	3.8	5.7	4.6	7.8	4.5
2004	5.1	3.9	5.3	4.0	5.7	4.5	6.8	3.7

Source: Based on data from Department of Statistics, Malaysia, (2001; 2006b). See Appendix Table 1 for all values.

We now turn to an examination of age-specific death rates. Figure 2 shows the male-female ratio of the age-specific death rate and the age-specific death rates by gender for selected ages for 1970 and 2004. The death rates are greater for males than females at all ages for both 1970 and 2004. The most substantial decline in the age-specific death rate was both males and females at infancy (83% for males, 84%

for females) and the most modest decline for males for ages 15-40 (ages 15-20, 15%; ages 20-35, 21-24%; ages 35-45, 29-30%). These patterns are reflected in the male-female ratios. At all ages, the ratio is above 1 for both years, that is, the male death rates are higher than female death rates. In 1970, the ratio is slightly higher for ages 10-20 and from 45 onwards. The situation for 2004, however, is completely different. The ratio is not just above 1, but is around 3 for ages 15-30, then declining gradually to just over 1.5 at age 50, reducing to just above 1 at older ages. Thus, the slight lowering of the overall position of Malaysian males between 1970 and 2004 observed in Table2 and Figure 1 offsets the considerable widening of gender differentials between ages 15 and 35 against the gains at ages above 65.

Figure 2: Ratio of male to female age-specific death rate for 1970 and 2004



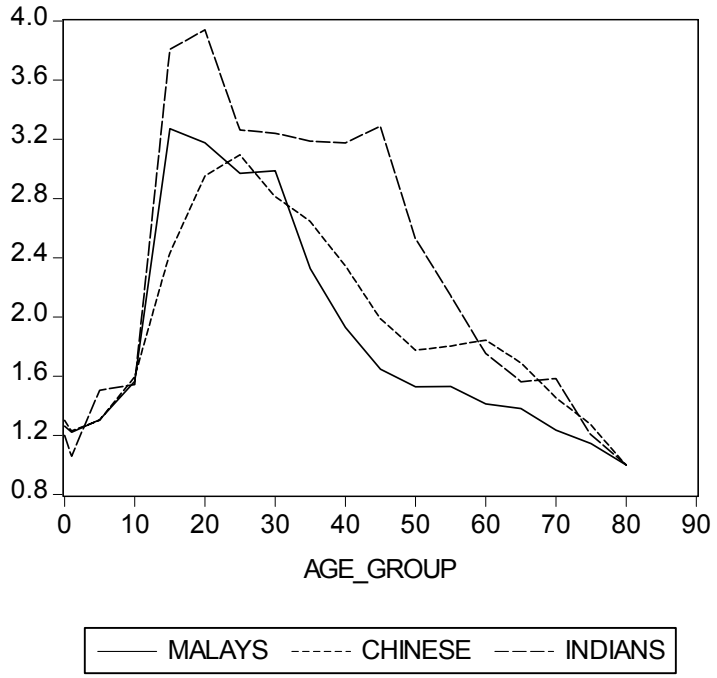
Death Rate	Age	0	10	20	30	40	50	60	70	80
1970	Male	44.4	1	1.9	2.6	5.2	13.9	36.3	95.3	218.6
	Female	34.1	0.8	1.5	2.5	4.3	10.4	27.1	59.4	187
2004	Male	7.4	0.4	1.5	2.1	3.6	7.5	19.9	47.8	145.8
	Female	5.6	0.3	0.5	0.7	1.7	4.5	12.5	35.4	144

Source: For 1970, data are for Peninsular Malaysia (Department of Statistics, Malaysia, 1986). For 2004, data are for Malaysia (Department of Statistics, Malaysia 2006b).

To examine the age effect on gender differentials in mortality by ethnic group, we consider the probability of dying in 2004. Figure 3 shows with the male-female ratios of the probability of dying between age x and age x+n across ethnic groups. Also shown at the bottom of the graph are these probabilities for selected ages. The Chinese have the lowest mortality rate in all age groups, and this is true for both sexes. Malays have higher infant and child mortality as compared to the other two ethnic groups. The Indians have the highest mortality between ages 15-60, for both males and females. Among males aged 60-70, Indian males have the highest mortality, while among females in the same age group, Malay females have the highest mortality. However, ethnic differentials in the probability of dying almost disappear at ages 70 and over. Moving to gender differentials, the ratios show that for each ethnic group, the probability of dying is greater for males than females at all ages except at age 80. The greatest disparity in the probability of dying between males and females for all ethnic groups is at ages 15 to 50, and is greatest for the Indians.

The analyses above have shown that the mortality level has declined for all sub-groups of the population in Malaysia, whether gender, ethnic or age, between 1970 and 2004. Although both males and females have gained in years of life, the gains have been much greater for females, so that overall the male-female differential has widened. Among ethnic groups, the Chinese community continues to enjoy the highest life expectancy for both males and females. All age groups have also seen a decline in mortality but the most modest decline has been for males aged 15-40. Looking at gender differentials, it is evident that males have higher mortality than females across time, ethnic groups and age groups. Furthermore, young males in the 20-30 age groups are at a much higher risk compared to females, and the risk has increased between 1970 and 2004. Among these, the risk is greatest for Indian males relative to Indian females. Two issues arise here; first in the Malay and Indian communities, the greater gain among females compared to males between the period 1970 and 2004 has implications for an increasing number of widows and single mothers, and for related social and economic issues. Secondly, it appears that the Malay community on the whole has not been able to register the same level of gains as the other communities between 1990 and 2004.

Figure 3: Ratio of male to female probabilities of dying between age x and age x+n across ethnic groups, 2004



	Malays		Chinese		Indians	
Age	Males	Females	Males	Females	Males	Females
0	6.72E-03	5.32E-03	3.67E-03	2.82E-03	5.22E-03	4.35E-03
10	2.30E-03	1.47E-03	1.45E-03	9.10E-04	2.27E-03	1.47E-03
20	8.26E-03	2.60E-03	5.02E-03	1.70E-03	1.51E-02	3.83E-03
30	1.29E-02	4.30E-03	8.72E-03	3.10E-03	1.58E-02	4.87E-03
40	1.88E-02	9.76E-03	1.59E-02	6.77E-03	3.19E-02	1.01E-02
50	3.79E-02	2.48E-02	2.92E-02	1.65E-02	6.42E-02	2.54E-02
60	1.02E-01	7.20E-02	8.07E-02	4.38E-02	1.07E-01	6.13E-02
70	2.44E-01	1.98E-01	1.94E-01	1.34E-01	2.85E-01	1.80E-01
80	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000

Source: Department of Statistics, Malaysia 2006b

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The finding regarding the higher mortality for males is consistent with that of many other studies on mortality. Kalben (2002) points out that in environments where both males and females receive equal treatment, male mortality has been higher than female mortality. The greatest difference is observed around age 22, when the rate is more than 3 times that of females. Most deaths at this age are, Kalben notes, due to accidents, suicide, and

homicide. The higher mortality for males can be attributed to both biological and sociological factors. There is evidence that the primarily female hormone, estrogen, is protective for females, while the primarily male hormone, testosterone, is detrimental. Estrogen lowers harmful cholesterol (low density lipoproteins – LDL) and increases the good ones (high density lipoproteins – HDL). Testosterone does the opposite as well as increases aggression. From the behavioural side, males are more likely to engage in risk-taking behaviours. Kalben also found that the major cause of death that yields the greatest difference in age adjusted death rates between the males and females in the United States in 1998 was suicide, which was 4.3 times greater for males than for females.

For Malaysia, we note that there is considerable variation in the male-female differential between 1970 and 2004, and between ethnic groups. Genetically (and perhaps, sociologically), some ethnic groups may be more prone to certain diseases or causes of death than others. For instance, the Ministry of Health, Malaysia (1996) reported that the prevalence rates for diabetes were much higher among the Indians (11.5%) compared to the Chinese (6.3%) and Malays (5.2%). On the other hand, the differing pattern of changes in gender differentials across ethnic groups between 1970 and 2004 suggest the importance of behavioural, sociological or socio-economic effects in explaining male-female differentials in mortality. Unless genetic differentials arising from ethnicity are different for males and females, the higher mortality particularly the young males across all ethnic groups does imply the effect of risk-taking behaviour which apparently differs across ethnic groups. In the next section, we examine changes in the leading causes of death across gender and ethnicity to explore this question further.

Changes in the Leading Causes of Death, 1971 - 2002

In studying the changes in the leading causes of death, two years 1971 and 2002 were selected. These are the years closest to the two ends of the period 1970-2004 (used to establish patterns of mortality decline in the earlier section) for which data are available. There have been changes in the categories used to summarise deaths by cause between the two years. In order to make a meaningful comparison between the two years, the causes were grouped into

broader categories on a functional basis that are as far as possible similar across the two years 1971 and 2002.

The ten leading causes of medically certified deaths based on the reclassification are shown in Table 3a for 1971 and in Table 3b for 2002. **T**here has been a shift in the most important causes of death from early infancy and communicable diseases to non-disease causes and non-communicable diseases like heart diseases. The most important leading causes of death in 1971 was deaths related to early infancy (18%) but this contributed only 3.8 per cent to deaths in 2002. The most important cause in 2002 was all external causes including transport accidents (12.7%), which contributed to 9.5 per cent of deaths in 1971 when it was ranked second most important. Heart diseases contributed to 11.5 per cent of deaths in 1971 (the different categories were ranked 5 and 8) but to 18.9 per cent of deaths in 2002 (the different categories were ranked 2 and 4). Malignant neoplasms or cancers ranked fourth in 1971 and contributed to 7.5 per cent of deaths but were the third most important cause of death contributing to 10.6 per cent of deaths in 2002.

The reduction in infant deaths is a result of improved delivery and access to quality healthcare for mothers and infants (Tan et al., 1988; Tey and Balakrishnan, forthcoming). The increase in certain categories of heart disease like ischaemic heart diseases can be attributed in part to population ageing and to changes in lifestyle. In 1971, population aged 65 or older comprised 3.3 percent of the total population, but this increased to 4.4 percent in 2002. The 65 or older group in 2002 were 1.7 times that in 1971.[4] Of interest is the increase in importance and rank of all external causes. The high number of such causes exceeds the worldwide figure of about 10 per cent found by Murray and Lopez (1998). We have noted in the previous section that one important reason for a high male-female differential in mortality may be the risk-taking behaviour of young males. The proportion of population aged 15-64 increased from 54 per cent of the population in 1971 to 62 per cent in 2002. In absolute trems, there were 1.5 times as many persons between ages 15-64 in 2002 compared to 1971. Hence, the higher male mortality observed previously may be partly explained by the large number of deaths from external causes.

[4] The statistics cited in this paragraph are computed from data in Department of Statistics, Malaysia (2003) and Department of Statistics, Malaysia (

Table 3a: Top ten leading causes of medically certified death, Malaysia, 1971

Rank	Cause	Total Deaths	% of Total Deaths
1.	Diseases peculiar to early infancy, and immaturity including congenital malformations	3836	18.0
2.	All external causes including motor vehicle accidents	2028	9.5
3.	Infectious and parasitic diseases	1810	8.5
4.	Malignant neoplasms including neoplasms of lymphatic and haematopoietic tissues	1598	7.5
5.	Vascular lesions affecting the central nervous system	1380	6.5
6.	Diseases of the heart excluding arterosclerotic and degenerative diseases	1320	6.2
7.	Pneumonia	1090	5.1
8.	Arteriosclerotic and degenerative heart diseases	1067	5.0
9.	Diseases of the gastrointestinal tract excluding malignancies	967	4.5
10.	Nephritis and nephrosis	323	1.5
Total Deaths in 1971		34651	

Note: Not included are two categories, 'senility', and 'other diseases', which are categories that capture causes not elsewhere classified, and which contributed to 21.7% of medically certified deaths.

Table 3a: Top ten leading causes of certified deaths, Malaysia, 2002

Rank	Cause	Total Deaths	% of Total Deaths
1.	All external causes including transport accidents	7308	12.7
2.	Ischaemic heart diseases	6295	10.9
3.	Malignant neoplasms including neoplasms of lymphatic and haematopoietic tissues	6109	10.6
4.	Diseases of heart excluding ischaemic heart diseases	4583	8.0
5.	Septicaemia	4280	7.4
6.	Cerebrovascular diseases	4190	7.3
7.	Pneumonia	2642	4.6
8.	Conditions originating in the perinatal period including congenital malformations	2208	3.8
9.	Infectious and parasitic diseases	2169	3.8
10.	Chronic lower respiratory diseases	1894	3.3
Total Deaths in 2002		57,645	

Note: Not included are two categories, 'symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified' and 'other diseases', which are categories that capture causes not elsewhere classified, and which contributed to 17.9% of medically certified deaths.
Source: based on reclassified causes, data from *Vital Statistics* and Department of Statistics, Malaysia.

Male-Female Differentials in the Leading Causes of Death, 2002

To explain male-female differentials in the causes of death, we focus on the year 2002, and examine differentials across ethnic groups. Data were available for 80 categories (based on ICD 10) were used in the analysis. Not included in the analysis are two categories of death, 'symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified' and 'other diseases', which are categories that capture causes not elsewhere classified, and which contributed to 17.9% of medically certified deaths in 2002.

It is usual to compare the age specific mortality rates by sex for each cause of death (see, for example, Kalben, 2002) to adjust for the effect of differences in the age structure of sub-groups. In this paper, due to limitations in available data, we use the rate per 100000 population which then corrects only for population size. The following measures are used in the analysis:

Percentage of deaths due to cause k =

$$P_k = \frac{N_k}{N} = \frac{Number\ of\ deaths\ due\ to\ cause\ k}{Total\ number\ of\ deaths} \times 100$$

Percentage of deaths due to cause k for subpopulation j =

$$P_{kj} = \frac{N_{kj}}{N_j} = \frac{Number\ of\ deaths\ due\ to\ cause\ k\ for\ subpopulation\ j}{Total\ number\ of\ deaths\ for\ subpopulation\ j} \times 100$$

Rate of death due to cause k for subpopulation j =

$$R_{kj} = \frac{N_{kj}}{Pop_j} = \frac{Number\ of\ deaths\ due\ to\ cause\ k\ for\ subpopulation\ j}{Population\ for\ subpopulation\ j} \times 100000$$

Difference in the male rate and the female rate for cause k

$$D_{kmf} = R_{km} - R_{kf}$$

Total difference in deaths for all causes between males and females:

$$D = \sum_{all\ k} \left| D_{kmf} \right|$$

Percentage of difference in deaths between males and females due to cause k:

$$P_k = \frac{D_{kmf}}{D} \times 100$$

Male risk for cause k or the Male-female ratio for cause k =

$$R_{mf} = \frac{R_{km}}{R_{kf}} = \frac{Rate\ due\ to\ cause\ k\ for\ males}{Rate\ due\ to\ cause\ k\ for\ females}$$

Table 4 shows the top ten leading causes of medically certified deaths, the male rate and the female rate for each cause, and the male-female ratio of these rates for 2002. These ten causes contributed 58.2 per cent of total deaths, 60.4 per cent of male deaths and 54.6 per cent of female deaths in 2002. The last column shows the male-female ratio, a measure of the male risk relative to that of females. For all these causes, the males experience greater mortality except for diabetes where the ratio is just below 1.

Table 5 shows the top three leading causes for males and females. Reflecting the status of Malaysia as a country undergoing epidemiological transition, all the top causes for both males and females are non-communicable conditions. Ischaemic heart disease is the most important cause for both males (11.6 of male deaths) and females (9.9% of female deaths). However, an interesting observation is the other two top causes of deaths amongst males. Transport accidents and other external causes combined contributed 15.4% of all male deaths as compared to 5.3% of all female deaths. Examined in the light of our earlier finding of higher mortality among the males aged 15 to 40 years, these two causes of deaths suggest greater risk taking behaviour among males in this age group. In line with this thinking, we find that males are 5.4 times more likely than females to die in transport accidents and 4.2 times more likely than females to die from all other external causes.

Table 4: Top 10 Leading Causes of Death, 2002

Causes of Death	% of Total Deaths	Male Rate	Female Rate	Male/ Female Ratio
Ischaemic heart diseases (I20-25)	10.9	33.4	18.1	1.9
Other heart diseases (I26-I51)	7.7	20.7	15.9	1.3
Septicaemia (A40-A41)	7.4	20.1	15.0	1.4
Cerebrovascular diseases (I60-I69)	7.3	18.3	16.1	1.2
Transport accidents (V01-V99)	6.0	23.6	4.6	5.4
All other external causes (W20-W64, W75-W99, X10-X39, X50-X59, Y10-Y89)	5.6	20.9	5.2	4.2
Pneumonia (J12-J18)	4.6	13.0	8.6	1.6
Chronic lower respiratory diseases (J40-J47)	3.3	10.7	4.7	2.4
Remainder of diseases of the respiratory system (J00-J06, J30-J39, J60-J98)	3.2	9.1	6.1	1.5
Diabetes mellitus (E10-E14)	2.2	4.9	5.6	0.9
Total, top 10 leading causes	58.2	174.7	100.0	1.7
All Deaths	57645	289.0	183.0	1.6

Note: figures in parathesis refer to the block reference in ICD 10.
Source: Based on data from the Department of Statistics, Malaysia

Table 5 Top three leading causes of death for males and females, 2002

Cause of Death	% of deaths	Male-female rate
Males		
Ischaemic heart diseases (I20-25)	11.6	1.9
Transport accidents (V01-V99)	8.2	5.4
All other external causes (W20-W64, W75-W99, X10-X39, X50-X59, Y10-Y89)	7.2	4.2
Total Deaths	35785	
Females		
Ischaemic heart diseases (I20-25)	9.9	1.9
Cerebrovascular diseases (I60-I69)	8.8	1.2
Other heart diseases (I26-I51)	8.7	1.3
Total Deaths	21860	

Note: figures in parathesis refer to the block reference in ICD 10.
Source: Based on data from the Department of Statistics, Malaysia

An investigation of all 80 categories of death found that female mortality was higher only for 14 causes (7 of which were causes pertaining only to females) and which contributed to only 4.6 per cent of all deaths. The highest male-female ratios were for drug abuse (16.0) and HIV (10.9), but both of these contributed only 0.4 per cent of all deaths. High male-female ratios were also observed, in addition to transport accidents and all external causes, for assaults (5.2), drowning (3.5), falls (3.5), poisoning (2.8) and suicides (2.8); these together contribute to 12.6 per cent of all deaths. The largest male-female ratio for a non-behavioural cause is cancer of the larynx (males 4.4 times as likely as females), but other cancers also predominate. These contributed to 4.4 per cent of all deaths.

Which causes of deaths contributed the most to the male-female difference? Table 6 shows the three most important causes of medically certified deaths contributing to the male-female difference in number of deaths. The top three causes are transport accidents, all external causes and ischaemic heart disease, and are the same across all groups albeit with different ranks. These causes contributed to 22.5 per cent of all deaths, and to 47.3 per cent of the total difference in deaths between males and females for the total population. The figures are not that different across ethnic groups, except for Indians, where these three causes contributed 31.3 per cent to all Indian deaths and 52.5 per cent to the male-female difference. For Indians, the rates are greatest for both males and females when compared with other ethnic groups.

The importance of behavioural causes for the male-female differential is explored further in the measures shown for external causes as well as causes related to risky behaviours, namely Human Immunodeficiency Virus (HIV) and deaths caused by use of psychoactive substances in Table 7. These causes contribute about 13.7 per cent of all deaths for Malays, 11.5 per cent of all deaths for Chinese and 18.7 per cent of all deaths for Indians. They explain 36.7 per cent of the male-female difference for Malays, 34.1 per cent for the Chinese and 41.3 per cent for the Indians. The Malay and Indian male is more than five times more likely to die of any of these causes compared to the Malay or Indian female, respectively, while the Chinese male are almost four times as likely to die of these causes as the Chinese female. Furthermore, both Indian males *and* Indian females have much higher rates of death for these causes than males and

females from the other two ethnic groups, respectively. Looking at each cause, Malay males have higher rates for HIV compared to Chinese and Indian males, while Indian males have substantially higher rates for all external causes, transport accidents, assault and abuse of psychoactive substances. It is also interesting to note that Indian females have higher rates for all other external causes, transport accidents and drug abuse.

Table 6: Three most important causes of death contributing to the male-female difference in number of deaths, Malaysia, 2002

Cause of Death	% of All Deaths	Male Rate	Female Rate	% of Male - Female Deaths	Male/ Female Ratio
All					
Transport accidents (V01-V99)	6.0	23.6	4.6	18.0	5.4
All other external causes (W20-W64, W75-W99, X10-X39, X50-X59, Y10-Y89)	5.6	20.9	5.2	14.8	4.2
Ischaemic heart diseases (I20-25)	10.9	33.4	18.1	14.5	1.9
Total	22.5	77.9	27.9	47.3	2.8
Malays					
Transport accidents (V01-V99)	6.7	23.6	4.7	19.0	5.1
Ischaemic heart diseases (I20-25)	9.8	27.5	14.3	13.2	2.0
All other external causes (W20-W64, W75-W99, X10-X39, X50-X59, Y10-Y89)	4.8	16.8	3.7	13.2	4.6
Total	21.3	67.9	22.7	45.4	3.0
Chinese					
All other external causes (W20-W64, W75-W99, X10-X39, X50-X59, Y10-Y89)	5.6	25.9	7.9	15.4	3.4
Ischaemic heart diseases (I20-25)	11.4	43.5	25.7	15.2	1.8
Transport accidents (V01-V99)	4.4	21.9	4.7	14.7	4.9
Total	21.4	91.3	38.3	45.3	2.4
Indians					
Transport accidents (V01-V99)	7.5	48.6	5.6	18.9	8.7
All other external causes (W20-W64, W75-W99, X10-X39, X50-X59, Y10-Y89)	9.1	52.0	13.2	17.1	4.0
Ischaemic heart diseases (I20-25)	14.7	71.7	34.1	16.5	2.1
Total	31.3	172.3	52.9	52.5	3.3

Note: figures in parenthesis refer to the block reference in ICD 10.
Source: Based on unpublished data from the Department of Statistics, Malaysia

Table 7: Selected Causes of Death: A Comparison

Causes of Death	% of All Deaths	Male Rate	Female Rate	% of Male - Female Deaths	Male/ Female Ratio
Malays					
Human immunodeficiency virus (HIV) disease (B20-B24)	0.4	1.8	0.1	1.6	13.2
Mental and behavioural disorders due to psychoactive substance use (F10-19)	0.2	0.6	0.0	0.6	45.0
Transport accidents (V01-V99)	6.7	23.6	4.7	19.0	5.1
Falls (W00-W19)	0.5	1.6	0.5	1.1	3.2
Accidental drowning and submersion (W65-W74)	0.2	0.6	0.1	0.4	4.7
Exposure to smoke, fire and flames (X00-X09)	0.0	0.1	0.1	0.1	2.3
Accidental poisoning by and exposure to noxious substances (X40-X49)	0.0	0.1	0.1	0.0	1.8
Intentional self-harm (X60-X84)	0.0	0.1	0.1	0.1	2.0
Assault (X85-Y09)	0.2	0.8	0.1	0.7	5.5
All other external causes (W20-W64, W75-W99, X10-X39, X50-X59, Y10-Y89)	4.8	16.8	3.7	13.2	4.6
Total	13.1	51.1	9.5	36.7	5.4
Chinese					
Human immunodeficiency virus (HIV) disease (B20-B24)	0.2	1.1	0.1	0.8	8.5
Mental and behavioural disorders due to psychoactive substance use (F10-19)	0.1	0.4	0.0	0.3	13.0
Transport accidents (V01-V99)	4.4	21.9	4.7	14.7	4.9
Falls (W00-W19)	0.2	1.0	0.2	0.7	4.4
Accidental drowning and submersion (W65-W74)	0.3	1.2	0.6	0.5	2.1
Exposure to smoke, fire and flames (X00-X09)	0.0	0.1	0.2	0.1	0.6
Accidental poisoning by and exposure to noxious substances (X40-X49)	0.0	0.1	0.0	0.1	4.0
Intentional self-harm (X60-X84)	0.1	0.6	0.2	0.3	3.4
Assault (X85-Y09)	0.4	2.1	0.6	1.2	3.5
All other external causes (W20-W64, W75-W99, X10-X39, X50-X59, Y10-Y89)	5.6	25.9	7.9	15.4	3.4
	11.5	54.4	14.6	34.1	3.7
Indians					
Human immunodeficiency virus (HIV) disease (B20-B24)	0.1	0.9	0.1	0.4	8.0
Mental and behavioural disorders due to psychoactive substance use (F10-19)	0.4	2.5	0.2	1.0	11.0
Transport accidents (V01-V99)	7.5	48.6	5.6	18.9	8.7

Falls (W00-W19)	0.2	1.4	0.2	0.5	6.0
Accidental drowning and submersion (W65-W74)	0.3	1.8	0.1	0.8	16.0
Exposure to smoke, fire and flames (X00-X09)	0.1	0.5	0.2	0.1	2.0
Accidental poisoning by and exposure to noxious substances (X40-X49)	0.0	0.3	0.0	0.2	na
Intentional self-harm (X60-X84)	0.2	0.9	0.3	0.3	2.7
Assault (X85-Y09)	0.8	5.3	0.3	2.2	15.3
All other external causes (W20-W64, W75-W99, X10-X39, X50-X59, Y10-Y89)	9.1	52.0	13.2	17.1	4.0
	18.7	114.3	20.4	41.3	5.7

Note: figures in parathesis refer to the block reference in ICD 10.
Source: Based on data from the Department of Statistics, Malaysia

Conclusion

In almost all societies, male mortality is higher than that of the females. Malaysia is no exception in this regard. The analyses suggest that more than a third of the differential can be explained by risk-taking behaviour and another about half as much by ischaemic heart disease. The evidence suggests that the male-female mortality differential is due to both biological/genetic and environmental/behavioral risk and protective factors. A similar but less clear argument can be made for observed differentials across ethnic groups. Assuming that the biological/ genetic differences are somewhat similar across all males, and across all females, the differences observed across ethnic groups especially for behavioural causes of death provide evidence on the environmental/ behavioural risk factors. The analyses in this paper have shown that males generally are more likely to engage in risk-taking behaviour, and that this varies across ethnic groups. In particular, the differential is greatest for Indians, suggesting that aside from the biological advantages of being female, Indian females have benefited from the efficient and widespread public healthcare system. At the same time, the social environment that has resulted in the greater probability for Indian males of dying from violent causes has also resulted in more deaths for Indian females compared to females from other ethnic groups. It is important to note that the findings are affected by the use of medically certified deaths. In particular, the strong effect of external causes and deaths from HIV and abuse of psychoactive substances may be due to the fact that such causes of death are more likely to be medically certified.

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