Avoidable mortality pattern in a Chinese population—Hong Kong, China

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Background: We examined the avoidable mortality pattern in Hong Kong, and the influence of age and gender. Comparison with Paris, Inner London and Manhattan was performed, and we discussed the findings in terms of prevention programmes, ethnicity and lifestyles. Methods: Mortality and population data by age and gender were obtained from vital statistics sources. Two periods, 1999–2003 and 2004–06, were selected for analysis. Negative binomial regression and logistic regression were used to model, respectively, the number and proportion of avoidable mortality, in relation to age and gender. Results: The standardized total mortality rates (per 1000 population) were 2.51 in the period 1999–2003 and 2.25 in the period 2004–06, whereas the standardized avoidable mortality rates (per 1000 population) were 0.85 and 0.77 for the two periods, respectively. Cerebrovascular disease (stroke) was the leading cause of avoidable mortality. Women in the age range of 65–74 years had the highest avoidable mortality proportion. In 1999–2003, Hong Kong had the second lowest standardized avoidable mortality rate among the four cities compared, whereas the avoidable mortality proportion was the highest. Conclusion: There might be room for improvement in the primary care system in Hong Kong, particularly in the development of effective prevention programmes targeting the leading causes of avoidable mortality.

Keywords: avoidable mortality, Hong Kong, primary care

Introduction

Rutstein \textit{et al.} introduced the concept of avoidable mortality as ‘unnecessary untimely deaths’ which built on the assumption that certain causes of death are avoidable given effective health-care systems.\textsuperscript{3} Various researchers compared avoidable mortality across nations having different health-care systems.\textsuperscript{2,3} Some researchers extended the definition of avoidable mortality to deaths that could be prevented by effective health policies.\textsuperscript{6–8} Here, we adopted the original definition that avoidable mortality is a reflection of effective health-care systems. In particular, differences in primary care systems, which cover prevention programmes, have been shown to affect health outcomes, including mortality from heart disease, stroke and cancers.\textsuperscript{9}

In addition, ethnic and lifestyle differences may also contribute to differences in avoidable mortality. Studies showed that avoidable mortality rates varied among different ethnic groups within the same country. For example, in New Zealand, Pacific residents have higher avoidable mortality rates than European residents\textsuperscript{6} and in Singapore, Chinese residents have lower avoidable mortality rates than Malays residents.\textsuperscript{10} However, few studies examined variations across countries of different ethnic origins.

Hong Kong, situated in the southeast coast of China, has a population of 7 million in 2006, with 95% being Chinese.\textsuperscript{11} The primary care structure is weak and is provided mainly by general practitioners (GPs) in the private sector.\textsuperscript{12} This unique primary care setting may be expected to be reflected by higher avoidable mortality rates than places with stronger primary care.

Paris, Inner London and Manhattan, which were shown to have different avoidable mortality patterns,\textsuperscript{13} are good candidates for comparison with Hong Kong, since they are centres of the global economy and have significant medical resources, yet they have different primary care systems. Furthermore, the Hong Kong population is mainly Chinese, whilst the populations in these Western cities are less homogeneous.

Despite the ageing population, the crude death rate in Hong Kong fluctuated at \textasciitilde{}5 per 1000 population for the past decades, which was lower than other economies.\textsuperscript{14} If analysis on avoidable mortality is based on the absolute rate, some of the important observations may be masked. Hence, we propose avoidable mortality proportion as an alternative measure.

By reviewing mortality data in the past decade, we examine the avoidable mortality pattern in Hong Kong and the influence of age and gender. Secondly, we compare the avoidable mortality pattern in Hong Kong with those in Paris, Inner London and Manhattan and discuss the comparisons in terms of prevention programmes, ethnicity and lifestyles. This study informs current health-care planners in Hong Kong on health policy with respect to reduction of avoidable mortality rate, and provides some insight regarding the contribution of different prevention programmes, covered by primary care systems, on avoidable mortality patterns.
Methods

Definitions
Avoidable mortality was assumed to reflect effectiveness of health-care systems by Rutstein et al.\textsuperscript{1} The list of causes of avoidable mortality used by Weisz et al.\textsuperscript{1} for the population in the age range of 1–74 years was adopted (supplementary table). Details about the selection criteria based on previous works were presented elsewhere.\textsuperscript{5,6,13,15,16}

Data
We obtained mortality and population data by age and gender from the Census and Statistics Department of Hong Kong. Causes of death were identified by the International Classification of Diseases (ICD9 and ICD10). Similarly, mortality and population statistics for Paris, Inner London and Manhattan were obtained from respective official statistics agencies as described in Weisz et al.\textsuperscript{13}

Statistical analysis
The total and avoidable mortality rates of Hong Kong were calculated for the periods 1999–2003 and 2004–06. Mortality rates were calculated by dividing the number of deaths by the population. The rates were standardized by age and gender using the direct method with the US 2000 population as the standard population.\textsuperscript{17} For international comparison, such standardized rates for 1999–2003 were also calculated for the Western cities.

Comparisons of avoidable mortality were commonly based on the magnitude of the rate—the lower the better. However, comparison of avoidable mortality rate may subject to the ‘ceiling effect’ of the total mortality rate of a region, which possibly is due to ethnic and lifestyle differences other than attributed to prevention programmes. A hypothetical scenario is that the total mortality rate of a region is very low, but avoidable mortality constitutes 100% of it. This would imply that all deaths in that region should have been avoided, and the low avoidable mortality rate might only be due to the low background mortality risk. Hence, we propose to use the proportion of avoidable mortality among total mortality for comparisons across populations or population subgroups with different background mortality risk. We propose that the higher the proportion, the more room for improvement in prevention programmes.

Demographic variation in terms of age and gender were investigated by statistical models. As avoidable death is a rare event which is assumed to follow Poisson distribution with over-dispersion, negative binomial regression models can be used to compare the incidence rates of different subgroups in terms of incidence rate ratio (IRR). The number of avoidable deaths was used as response variable, and age and gender were used as independent variables, offset by the corresponding population. Given the total number of deaths that occurred, the proportion of avoidable mortality follows binomial distribution. Hence, logistic regression models can be used to compare the probability of avoidable mortality among total mortality of different subgroups in terms of odds ratio (OR). The odds of a death being avoidable given that a death occurred was used as a response variable, and age and gender district were used as independent variables. An IRR or an OR being statistically >1, indicated by the 95% confidence interval (CI), implies that the corresponding level of that factor is associated with greater risk as compared to the reference level. Statistical analysis was performed using Statistical Analysis Software (SAS) version 9.1.\textsuperscript{18}

Results

Rate and proportion of avoidable mortality
In 1999–2003, the crude total and avoidable mortality rates (per 1000) of the Hong Kong population in the age range of 1–74 were 2.56 and 0.86, respectively. The corresponding rates (per 1000) declined slightly to 2.45 and 0.83, respectively, in 2004–06. After standardization, the total and avoidable mortality rates (per 1000) were 2.51 and 0.85, respectively, in 1999–2003 and the corresponding rates declined to 2.25 and 0.77 in 2004–06. Based on the standardized population, the proportion of avoidable mortality was similar in the two periods, being 33.8% in 1999–2003 and 34.2% in 2004–06.

Leading causes of avoidable mortality
In 1999–2003, cerebrovascular disease (stroke) contributed over one-fifth of avoidable mortality, followed by malignancy of colon and rectum, pneumonia and ischaemic heart disease (IHD; table 1). Stroke topped the list, with little gender difference. Pneumonia ranked the second among men and contributed 16.7% to all avoidable mortality, but it only contributed 8.6% to the avoidable mortality among women. Malignancy of breast and malignancy of cervix and uterus together contributed 18.6% of the avoidable mortality among women, which exceeded the contribution from malignancy of colon and rectum. The pattern of leading avoidable mortality causes was similar in 2004–06. It should be noted that malignancy of breast and malignancy of cervix and uterus together contributed about 21.1% of all avoidable mortality among women, which exceeded the contribution from stroke.

Demographic variation
In 1999–2003, the standardized avoidable mortality rates (per 1000) for men and women were 0.93 and 0.77, respectively (IRR = 1.25, 95% CI: 1.19–1.33). However, only 28.8% of deaths among men were avoidable as compared with 42.6% among women. For any given death, death from men had about half the risk of being avoidable as compared with women (OR = 0.55, 95% CI: 0.53–0.57). In 2004–06, the standardized avoidable mortality rate (per 1000) declined slightly both in men (0.86) and women (0.68), with IRR being 1.31 (95% CI: 1.23–1.40). However, the avoidable mortality proportion remained unchanged, being 29.6% for men and 42.3% for women (OR = 0.56, 95% CI: 0.54–0.59).

The avoidable mortality rates increased exponentially with age group (except those in the age range: 1–4; figure 1). The avoidable mortality rates (per 1000) for those in the age range of 65–74 were 6.81 in 1999–2003 and 6.21 in 2004–06. IRR for those in the age range of 65–74 compared with those in the age range of 55–64 was 3.31 (95% CI: 3.07–3.57) in 1999–2003 and 3.54 (95% CI: 3.23–3.89) in 2004–06. Meanwhile, the proportions of avoidable mortality showed a U shape (figure 1). Those in the age range of 15–24 had the smallest proportion of avoidable mortality (11.5%), while those between 65 and 74 years of age had the highest (39.6%) in 2004–06. Compared with those in the age range of 55–64, death from those in the age range of 65–74 had ~30% higher risk of being avoidable. The OR was 1.33 (95% CI: 1.28–1.38) in 1999–2003 and 1.32 (95% CI: 1.26–1.39) in 2004–06.

International comparison
In 1999–2003, Hong Kong had the lowest standardized total mortality rate among those in the age range of 1–74 when
compared with Paris, Inner London and Manhattan. However, Paris had the lowest avoidable mortality rate followed by Hong Kong (table 2). Nevertheless, the avoidable mortality proportion in Hong Kong was the highest, with Paris being the lowest.

We found differences in the leading causes of avoidable mortality. IHD ranked first in Western cities, but was the fourth in Hong Kong; while malignancy of colon, rectum, breast and cervix together had the largest share in Hong Kong. If IHD was excluded, Paris still had the lowest avoidable mortality rate, followed by Hong Kong (table 2). In this scenario, Hong Kong had just slightly lower avoidable mortality rate than Manhattan and Inner London.

For all four cities, men had higher avoidable mortality rate than women, but the reverse was true for avoidable mortality proportion. The gender difference in rate was reduced if IHD was excluded. In Paris, the rate in men was even lower than in women. However, the large gender difference in proportion remained unchanged (table 2).
Table 2 Total and avoidable mortality rate\(^a\) (per 1000 population) among the population aged 1–74 years in Hong Kong, Paris, Inner London and Manhattan, 1999–2003

<table>
<thead>
<tr>
<th>World City</th>
<th>Total mortality rate</th>
<th>Avoidable Mortality rate</th>
<th>Avoidable mortality rate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
<td>Overall</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hong Kong</td>
<td>3.22</td>
<td>1.81</td>
<td>2.51</td>
</tr>
<tr>
<td>Paris</td>
<td>3.83</td>
<td>1.90</td>
<td>2.80</td>
</tr>
<tr>
<td>Inner London</td>
<td>5.10</td>
<td>2.82</td>
<td>3.86</td>
</tr>
<tr>
<td>Manhattan</td>
<td>4.47</td>
<td>2.49</td>
<td>3.40</td>
</tr>
</tbody>
</table>

\(\text{a: Rates were standardized by the US 2000 Standard Population.}\)

Discussion

This is the first study to examine the avoidable mortality pattern in a Chinese city—Hong Kong, and compare with Paris, Inner London and Manhattan. To increase the comparability, international comparisons were based on raw data and followed exactly the same methodology in each city. Our study is subject to limitations. First, mortality is a complex process and primary care system is not the sole factor contributing to variations in avoidable mortality. Second, accuracy and completeness of the mortality statistics is always subject to the recording and coding errors. As only the principal cause of death is available to us on death certificates, we cannot control for multi-morbidity, which may affect the mortality risk. By using secondary data analysis, we can only interpret the results based on our conceptual framework, rather than from controlled studies.

This study showed that the leading causes of avoidable mortality in Hong Kong were stroke and cancers. The impact of primary care on prevention of stroke could include preventive interventions such as lifestyle modification, early detection and treatment of hypertension,\(^9,19\) such that improving primary care may result in a reduction in avoidable mortality.

Mortality due to malignancy of colon and rectum, breast, cervix and uterus could be reduced in the primary care setting through early detection.\(^9\) In Hong Kong, there is no mass screening for colorectal cancer and breast cancer. Although a territory-wide Cervical Screening Programme was launched in 2004, it was not free and the uptake rate was only 36% in 2003–04.\(^20\) As breast cancer incidence is rising,\(^21\) it would be worthwhile to revisit the cost-effectiveness of mass screening in the future.\(^22\) Furthermore, breast self-examination should be further promoted as an alternative. At the same time, factors to increase uptake rate for screening programmes for women’s health need to be identified,\(^23,24\) as the uptake rate is much lower than in Western countries.\(^20\)

Pneumonia was the second largest contributor to avoidable mortality in men. One-fifth of the male population in Hong Kong were daily smokers, as compared with 3.6% among the female population.\(^25\) This may account for increased susceptibility to pneumonia in men,\(^26\) which might be further increased by the year-round circulation of influenza virus in Hong Kong and the difference in microbiology for community-acquired pneumonia between Asia and the West.\(^27,28,29\) The findings support the need for strengthening anti-smoking measures and legislation, in reducing avoidable mortality particularly in men. Primary care through generic preventive interventions could help to reduce risk attributable to smoking.\(^9\)

According to Starfield,\(^29\) primary health care involves equitable distribution of resources; access being independent to financial ability; low or no co-payments; and comprehensiveness of services. The primary health-care system in Hong Kong appears to lag behind the three other cities. The finding that Hong Kong had the second lowest avoidable mortality rate compared with Paris, Inner London and Manhattan is somewhat misleading since Hong Kong had the highest avoidable mortality proportion, which may partly reflect its weak primary care system compared with other countries.

In Hong Kong, primary care is largely provided by doctors in the private sector, where patients pay for consultation, investigations and drugs. Approximately 30% of outpatient episodes were covered by government clinics,\(^12\) where a small fee is charged and can be waived if the patient cannot afford it. However, these clinics mainly consist of brief doctor–patient encounters and are crowded particularly with older patients. The public sector carries out regular health-promotion programmes; however, health screening is not free.

In contrast to the weak primary care system in Hong Kong, the UK National Health System is a very structured primary care system. The first point of contact in seeking health care is the GP that the patient is registered with. If indicated, the patient is referred to specialists in hospitals. Under the GP contract adopted in 2004, there are financial incentives for primary care practices based on ‘146 indicators of quality across seven areas of practice’.\(^30\) For example, GPs can make additional money by meeting certain health targets relating to control of common chronic diseases or screening rates, such as pap smear for women in certain age groups or offering smoking-cessation programmes to patients with hypertension. Consultations are largely free, with the exception of prescription charges, which are not paid by older persons.

The US health-care delivery system is dominated by specialists with less emphasis on primary care than most developed countries. There are comprehensive screening programmes, which are covered by various insurance programmes. Despite the existence of social health insurance for older persons (Medicare) and a federal-state social welfare program (Medicaid) for the very poor, >16% of the population, especially the ‘working poor’, has no health insurance coverage. Virtually all US patients, irrespective of insurance coverage, face substantial out-of-pocket payment for health care. In this respect, Hong Kong and the USA are similar.

Similar to the UK, a large percentage of physicians in France are in primary care, but there is no gatekeeper for specialist care. Ambulatory care is mainly provided by self-employed doctors on a fee-for-service basis, where the fees are regulated by the state. Unlike Hong Kong, there are no long queues for treatment. France relies on a combination of compulsory insurance, supplementary insurance and subsidiary mechanisms, which limits the out-of-pocket expenses for most of the population. For several groups including patients with low incomes and those with chronic
diseases, out-of-pocket fees are waived. There is mass-screening programme for breast cancer and the fees will be reimbursed. However, screening for cervical cancer is opportunistic and mass-screening for colorectal cancer has only been implemented recently.

The differences in avoidable mortality pattern might also be partly explained by the low background mortality risk as a result of lifestyle or ethnic differences. For example, Hong Kong has lower smoking prevalence and lower prevalence of those who are categorized as overweight and obese, yet fewer people consume five servings of fruits and vegetables daily and a higher proportion of people with no leisure-time exercise than New York. The impact of ethnic differences may be ameliorated by primary prevention, such as modifying lifestyle, but the Westernization of diet and lifestyle in Hong Kong has not been helpful. Evidence showed that the traditional Chinese diet may have health benefits and adopting a Western lifestyle was associated with increased risk of IHD. While IHD was not the leading cause of avoidable mortality in Hong Kong (as observed in the Western cities), the opportunity for prevention of this cause of avoidable mortality should not be neglected.

Hong Kong enjoys a relatively low total mortality rate, but the proportion of avoidable mortality is relatively high, a difference that may be partly explained by its weak primary care. Hong Kong had the lowest percentage of health-service expenditure out of gross domestic product (GDP) when compared with other countries, and private doctors accounted for the majority of primary care services. Although these statistics might be impressive for health-care planners in other countries, particularly in the context of containment of health-care expenditure, our findings highlight the possible adverse outcomes of a weak primary care system. This underscores the universal importance of preventive programmes as a key component of public health services. While the population in European countries are more homogeneous, our findings highlighted the need to consider possible effects of ethnic and lifestyle differences on avoidable mortality statistics, which may not be shown by studies conducted within Europe. This study introduces the use of avoidable mortality proportion for comparison between populations with different ethnicity and lifestyle. We demonstrate that, although avoidable mortality is a useful indicator of health-system performance, it is useful to examine the relationship between total and avoidable mortality. The ratio of avoidable mortality to total mortality illustrates the consequences of Hong Kong’s weak primary care system more effectively than an examination of rate alone. While our discussion highlighted the differences in primary care, ethnicity and lifestyle, we acknowledged that these were only some of the contributing factors to avoidable mortality.

To conclude, Hong Kong had the second lowest avoidable mortality rate compared with Paris, Inner London and Manhattan, but avoidable mortality proportion was the highest among the world cities we examined. Furthermore, significant demographic variations in avoidable mortality exist within Hong Kong. Women in the age range of 65–74 had the highest avoidable mortality proportion. Stroke, malignancy of colon, rectum, breast and cervix and pneumonia were the leading causes of avoidable mortality in Hong Kong. Our findings suggest that a strong primary care system, with prevention programmes targeted at these leading causes of avoidable mortality, particularly for older women, should help to lower total mortality rates in Hong Kong.

Supplementary data
Supplementary data are available at EURPUB online.

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Conflicts of interest: None declared.

Key points
- Hong Kong had the second lowest standardized avoidable mortality rate among those in the age range of 1–74 as compared with Paris, Inner London and Manhattan, yet Hong Kong had the largest avoidable mortality proportion.
- Avoidable mortality proportion provided an alternate perspective to the comparison of avoidable mortality across populations with different ethnicity and lifestyles, and hence background mortality risk.
- Cerebrovascular diseases, malignancy of colon, rectum, breast and cervix, as well as pneumonia were the leading causes of avoidable mortality in Hong Kong.
- This study highlights the possible adverse outcomes of a weak primary care system and the importance of preventive programmes as a key component of public health services.

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