Trends in ischaemic heart disease hospitalisation and case-fatality in the Hong Kong Chinese population, 2000–2009

Journal:	*BMJ Open*
Manuscript ID:	bmjopen-2013-002963
Article Type:	Research
Date Submitted by the Author:	28-Mar-2013
Complete List of Authors:	Chau, PH; The University of Hong Kong, School of Nursing Wong, Moses; The Chinese University of Hong Kong, Medicine and Therapeutics Woo, J; The Chinese University of Hong Kong, Medicine and Therapeutics
Primary Subject Heading:	Epidemiology
Secondary Subject Heading:	Epidemiology, Public health
Keywords:	Ischaemic heart disease , epidemiology, Trends, Hong Kong, incidence , case-fatality

SCHOLARONE™ Manuscripts

Trends in ischaemic heart disease hospitalisation and case-fatality in the Hong Kong Chinese population, 2000–2009

Chau PH[1], Wong M[2], Woo J[2]

[1]School of Nursing, The University of Hong Kong, Pokfulam, Hong Kong S. A. R.

[2]Department of Medicine and Therapeutics, The Chinese University of Hong Kong, Shatin, Hong Kong S. A. R.

<u>Address for Correspondence</u>

Dr Chau PH

School of Nursing, The University of Hong Kong, Pokfulam, Hong Kong.

Tel: +852 2819 2626

Fax: +852 2872 6079

Email: phchau@graduate.hku.hk

Keywords: Ischaemic heart disease, incidence, case-fatality, hospitalisation, Hong Kong

Word Count: 3,000 (excluding title page, abstract, references, figures and tables)

Abstract

Background The incidence of ischaemic heart disease (IHD) and its associated mortality and case-fatality rates differ substantially in different populations. Hong Kong has historically had a low prevalence of IHD and IHD-associated mortality. However, the incidences of some cardiovascular risk factors appear to be increasing.

Objectives This study examines the recent trends in IHD incidence and case-fatality in Hong Kong, and explores the possible risk factors.

Design/Setting Secondary data analysis based on records of IHD inpatients aged ≥15 years admitted to hospitals under Hong Kong Hospital Authority during 2000–2009.

Outcome measures Incidence rate was defined as the number of hospital admission episodes divided by the size of the corresponding population. Short-term and long-term case-fatality rate was defined as deaths from all causes occurring within 30 and 31–365 days, respectively, divided by the number of hospital admission episodes among the corresponding population.

Methods Poisson and logistic regression models were used to examine the IHD incidence and short-term/long-term case-fatality trends, respectively, for different age and sex groups.

Results IHD incidence was stable in most age groups. However, men aged 15–24, 35–44, and >85 years had an increasing trend, whereas men aged 55–64 years and women aged 35–74 years had a decreasing trend. Overall short-term/long-term case-fatality were unchanged over time for both sexes; some groups (men aged 75–84 years and women aged 45–54 and >65 years) even showed an increasing trend.

Conclusion Hong Kong trends resembled those in the US, England, and Wales, showing decelerating decline in IHD rates, although an increasing trend was observed for some age groups, particularly young adults. Public health promotion efforts should focus on reducing cardiovascular risk factors, such as hypertension prevalence.

Article Summary

Article Focus

- IHD incidence and case-fatality show diverse trends in different populations, with a decelerating decline in the US and an increasing trend among certain age groups in England and Wales.
- With some unfavourable trends in risk factors, it is uncertain if IHD trends in the Hong Kong Chinese population will follow those of Caucasian populations.
- This study examines the recent trends in IHD incidence and case-fatality in the Hong Kong population aged 15 and above, and explores the possible risk factors related to such trends.

Key Messages

- Based on inpatient data, there was no overall decline in IHD incidence. However, the incidence for men aged 15–24, 35–44, and ≥85 years increased; whereas, that for men aged 55–64 years and women aged 35–74 years decreased.
- Overall, both short-term and long-term case-fatality rates were unchanged over time for both sexes; some age groups (men aged 75–84 years and women aged 45–54 and ≥65 years) showed an increasing trend.
- The increasing prevalence of hypertension may account for this observation which highlights the needs for directing the public health promotion efforts towards measures such as reducing salt intake to reduce hypertension prevalence.

Strengths and Weaknesses of This Study

- The strength of this study is the use of a territory-wide database which captures about 90% of all IHD inpatients in Hong Kong, and reliable death status enables the investigation of case-fatality. Furthermore, the long time series allows examination IHD trends over a decade.
- This study is limited by the fact that secondary data analysis does not allow examination of risk factors of the individuals. Also, the trends in the incidence and case-fatality of the patients who died before hospital arrival, in the accident and emergency department, or before inpatient admission could not be captured.

Trends in ischaemic heart disease hospitalisation and case-fatality in the Hong Kong Chinese population, 2000–2009

INTRODUCTION

According to the World Health Organization (WHO), ischaemic heart disease (IHD) is the leading cause of mortality globally, accounting for 12.8% of deaths.[1] The Global Burden of Disease Study 2010 reported that IHD was the leading cause of death in 2010.[2] The American Heart Association noted that the decline in cardiovascular diseases (CVD) mortality being faster than incidence would imply a stable high burden of disease.[3]

Risk factors for IHD include tobacco smoking, hypertension, diabetes, overweight, sedentary lifestyle, and unhealthy diet. When the risk factors are controlled properly, IHD can largely be prevented. In analysing avoidable mortality, it is assumed that half of the IHD deaths are avoidable.[4] When Hong Kong was compared with Western cities (Paris, Inner London, and Manhattan), it was found that IHD ranked first for avoidable mortality among the Western cities, but only fourth in Hong Kong. It was speculated that Hong Kong had lower IHD mortality rates because of lower prevalences of smoking and overweight; the effects of ethnic differences on susceptibility to IHD may also play a role. However, there was evidence that risk factors for IHD are becoming more common in the Hong Kong population, as reflected by daily consumption of fewer than 5 servings of fruits and vegetables and adoption of a more sedentary lifestyle with little or no leisure-time exercise. If such unhealthy lifestyles continue, IHD mortality in Hong Kong may increase in the future.

The incidence of IHD and its associated mortality and case-fatality rates differ substantially in different populations.[5] Even within China, both increasing and decreasing trends in IHD incidence and associated mortality were observed in different populations.[6] In Denmark, the first-time hospitalisation and case-fatality rates for myocardial infarction declined between 1984 and 2008.[7] Similarly, in the United Kingdom (UK), the incidence of acute myocardial infarction declined between 2002 and 2010.[8] Meanwhile, some studies have shown that the decline did not apply to all population subgroups. In England and Wales, IHD mortality among men aged 35–44 years increased from 1984 to 2004, and the declines among the overall population aged 45–54 years slowed down.[9] In a US study, it was shown that the decline in IHD mortality rate also slowed down among young adults aged 35–54 years between 2000 and 2002.[10] Based on the diverse trends observed in the literature, it is difficult to predict the IHD trends in the Chinese population in Hong Kong. If the trends in Hong Kong are to resemble and follow those of the US, IHD incidence in Hong Kong may increase, followed by a decline with a decelerating rate. Further, different age groups may show different trends, as did in the study from England and Wales. The objectives of this study were to examine the recent trends in IHD incidence and case-fatality in the Hong Kong population, and explore the possible risk factors related to such trends.

METHODS

Data

IHD incidence and case-fatality data from the Hong Kong population aged ≥15 years during 2000–2009 were obtained from the Hong Kong Hospital Authority (HA) database, which recorded inpatient data based on the Clinical Management System and the death status (as of mid-2010) based on linked data identified from patients' Hong Kong Identity Card numbers. Information on age, sex, principal diagnosis, as well as dates of admission, discharge, and death were available from the database. The diagnoses for hospital admission were coded according to the International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) and verified by experts in the HA. IHD cases were identified by ICD-9-CM codes 410-414 in the principal diagnosis for admission. The current data covered nearly all hospital admissions for IHD in Hong Kong, since 88–94% of these admissions were made to public hospitals (www.ha.org.hk). Because discharged patients might be readmitted for the same episode of IHD, hospital admissions within 30 days of discharge were regarded as the same episode. Death occurring within 30 days (short-term case fatality) and 31–365 days (long-term case fatality) of hospital admission were identified by the date of death available in the database. For analysis of long-term case-fatality, only admissions on or before 30 June 2009 were included, to allow at least 1 year of follow-up to be available. Population statistics were obtained from the Hong Kong Census and Statistics Department (www.censtatd.gov.hk). Ethics approval was obtained from The University of Hong Kong and The Chinese University of Hong Kong.

Statistical analysis

Age- and sex-specific IHD incidence rates were defined as the number of hospital admission episodes divided by the size of the corresponding population. Age- and sex-specific short-term and long-term case-fatality rates were the number of deaths from all causes occurring within 30 days and 31–365 days of hospital admission, respectively, divided by the number of IHD episodes of the corresponding population. Age-standardised incidence rates were calculated by a direct method using statistics from the 2009 Hong Kong population. Age-standardised case-fatality rates were calculated by a direct method using the total number of IHD episodes in 2000–2009 as the standard. Eight age groups (15–24, 25–34, 35–44, 45–54, 55–64, 65–74, 75–84, and ≥85 years) were classified for this study.

Age- and sex-specific IHD incidence rates and case-fatality rates were plotted against time. Since there were diverging trends in the age- and sex-specific rates, modelling of the trends was conducted for these groups separately. Poisson and logistic regression models were used to examine the trends in IHD incidence and case-fatality, respectively, with year of admission as the independent variable. In the Poisson model, the age- and sex-specific population was used as the offset population. Data analysis was performed using SPSS version 20.0 (SPSS Inc., Chicago, IL, USA). A significance level of 5% was adopted.

RESULTS

In total, 179,769 IHD episodes were identified during 2000–2009 among the Hong Kong population aged ≥15 years, and 61.8% of these episodes occurred in men. Approximately 9% of the hospital admission episodes resulted in subsequent death within 30 days of hospital admission, and another 9% resulted in subsequent death 31–365 days after hospital admission.

The age-standardised IHD incidence rate (per 100,000 population) for men aged ≥15 years remained stable at 460.9 in 2000 and 477.9 in 2009, whereas that for women declined from 290.7 to 251.1. Figure 1 shows the age and sex-specific IHD incidence rates. Poisson regression showed that the incidence rates of IHD increased significantly among men aged 15–24 years ($p = 0.023$), 35–44 years ($p < 0.001$), and ≥85 years ($p = 0.002$), despite the overall stable trend. The increase in the incidence rate was as high as 10.7% per year for men aged 15–24 years. For women, the incidence rates decreased significantly among those aged 35–74 years ($p = 0.017$ for age group 35–44 years and $p < 0.001$ for the age group 45–74 years), but remained stable for the youngest and oldest age groups. Table 1 provides a summary of the trends analysis.

The age-standardised short-term case-fatality rates remained stable for both men and women. In 2009, the age-standardised short-term case-fatality rates for men and women aged ≥15 years were 7.0% and 10.8%, respectively. Figure 2 shows the age- and sex-specific short-term case-fatality rate for IHD. Results from the logistic regression analysis (Table 1) showed that the short-term IHD case-fatality rate for men aged 55–64 years decreased significantly by 2.7% per year ($p = 0.030$), and remained stable for other age groups. For women, the rates increased significantly by 2.9% per year for those aged 65–74 years ($p = 0.006$), and by 3.4% per year for those aged ≥85 years ($p < 0.001$), in the context of the overall stable trend.

The age-standardised long-term case-fatality rate for men aged ≥15 years increased from 7.0% in 2000 to 8.6% in 2009, whereas that for women increased from 10.1% in 2000 to 11.5% in 2009. However, when analysed by age and sex, results from the logistic regression analysis (Table 1) showed that the significant increase was only observed among men aged 75–84 years ($p < 0.001$) and women aged 45–54 years ($p = 0.042$), 75–84 years ($p = 0.002$), and ≥85 years ($p = 0.004$). Figure 3 shows the age- and sex-specific long-term IHD case-fatality rates.

DISCUSSION

Based on inpatient data from Hong Kong, this study examined the trends of IHD incidence and case-fatality among the population aged ≥15 years. While the overall trends in incidence rates for men and women were stable, trends for different age groups among men and women differed. Men aged 15–24, 35–44, and ≥85 years had an increasing trend; men and women aged 55–64 and 35–74 years, respectively, had decreasing trends. The trends in short-term and long-term case-fatality rates for both men and women remained stable overall, although men aged 55–64 years had a decreasing trend in short-term case-fatality rate. Some age groups even showed an increasing trend in short-term case-fatality (women aged 65–74 and ≥85 years) and/or long-term case-fatality (men aged 75–84 years and women aged 45–54, 75–84, and ≥85 years).

Our findings resemble those from the England and Wales IHD mortality study, in that unfavourable increasing trends were observed for young adult men.[9] The stable trends found in our study are similar to the levelling of IHD mortality rates among younger adults in the US.[10] Both the UK and the US studies suggested that the increasing IHD mortality rates among young adults may be due to unfavourable trends in risk factors, particularly obesity, diabetes, and hypertension. An impact model suggested that improvements in medical treatment contributed to the declining mortality from IHD during 1989 to 2001 in Hong Kong more than risk factor reduction.[11] However, this explanation may not be applicable to our study in which case-fatality included deaths from all causes. Here, we explore possible explanations for our findings.

The prevalence rate of daily cigarette smoking for men aged ≥15 years declined steadily from 39.7% in 1982 to 20.8% in 2009; that for women declined from 5.6% in 1982 to 2.6% in 1990, but increased again to 4% in 2005 (http://www.tco.gov.hk/). Studies have shown that the reduction in CVD risk becomes apparent within 5 years of smoking cessation.[12, 13] Therefore, if changes in smoking prevalence have contributed to the IHD trends, we would expect the male population to have experienced a larger reduction in IHD incidence than their female counterparts. However, women aged 35–74 years, and not men, had a significant decline in IHD incidence. Thus, risk factors other than smoking (which may not have shown decreasing trends) may have affected the IHD incidence.

Three local health surveys provided information on various cardiovascular risk factors including hypertension, overweight, high cholesterol, diabetes mellitus, and physical activities.[14-16] Inconsistent trends were found for these risk factors. Despite the age differences among the survey respondents, both men and women appeared to have decreased prevalence of overweight, high cholesterol, and diabetes mellitus, with greater decreases seen among women than men. The proportion of men and women who did not perform exercise in a month declined slightly, from over half to below half. In contrast, the prevalence of hypertension increased markedly for both sexes. In 1995–1996, 18.5% of men and 17.5% of women aged 25–74 years had hypertension; in 2003–2004, 30.1% of men and 24.9% of women aged ≥15 years had hypertension. Moreover, the proportion of men with hypertension tended to increase faster than that of women. Hypertension is a major risk factor for CVD, contributing to IHD in 49% of cases.[17] Hypertension also contributed to 41% of CVD mortality, compared with 14% for smoking, 13% for poor diet, 12% for insufficient physical activity, and 9% for abnormal glucose levels.[3] It is possible that the unfavourable trend in prevalence of hypertension outweighed the beneficial effects of the favourable trends in other risk factors including smoking.

Extreme environmental temperatures may also hasten IHD, with the elderly population being more vulnerable,[18, 19] as observed in the Hong Kong population. [20, 21] The trends in IHD incidence and case-fatality observed in our study may partly be explained by trends in temperature extremes. The Hong Kong Observatory data (www.hko.gov.hk) reveals that the annual numbers of days with extreme hot or cold temperatures have been generally increasing, although such increases are not statistically significant. This phenomenon may explain the non-decreasing trends among the older age groups. However, since the younger populations are less likely to be affected by extreme temperatures, temperature is unlikely to have contributed to IHD trends in those groups. Further, air pollution (reflected by decreased visibility) was associated with increased mortality, respiratory and CVD in particular.[22] The number of invisible days in Hong Kong (www.hko.gov.hk) increased sharply in 2000–2009, which may partly contribute to the unfavourable IHD trends.

Another potential IHD risk factor is chronic stress. A recent review found that chronic stress predicted the occurrence of IHD.[23] Both short-term and long-term stresses were related to an increased risk of heart disease and mortality. Work-related stress is one of the sources of stress for employees. In Hong Kong, men in particular face stress due to work and financial issues, with their situations being worsened by their concept of masculinity, lack of gender-specific support services for men, and their reluctance to seek help.[24] The oldest men tend to be more susceptible to socioeconomic and political stressors than women, a concept supported by an association between their mortality rates and environmental stressors.[25] Further, a higher level of socioeconomic status was associated with higher risk of death from IHD.[26] Furthermore, growing up in an economically developed environment increased the risk of IHD among men more than women.[27] These factors may at least partly explain the increasing IHD incidence among the younger and older old men, but not women.

With respect to the provision of services for IHD, survival of out-of-hospital cardiac arrest patients depends on resuscitation guidelines and practices, as well as response time.[28, 29] In Hong Kong, the outcomes of out-of-hospital cardiac arrest are poor.[30] Knowledge of cardiopulmonary resuscitation (CPR) techniques among the public is also poor.[31] Most cardiac arrests occur at home, but fewer than 16% receive bystander CPR and fewer than 15% have return of spontaneous circulation.[32] Overall, there is insufficient information relating to out-of-hospital survival for IHD patients. We are uncertain if the non-decreasing IHD incidence may be related to improvement in out-of-hospital survival for IHD patients, and hence increasing hospital admissions.

This study has certain limitations. Our dataset does not capture 100% of IHD cases in Hong Kong, since some patients have been treated in the private sector. From 2000 to 2009, the proportion of IHD patients admitted to public hospitals slightly decreased, from 93% to 88% (www.ha.org.hk). However, since the shift from the public to the private system was slow, the effect should not be greatly influential. We believe that the increase in IHD incidence observed in our study may have been slightly greater if patients utilising the private sector were considered; for decreasing trends, the extent of decline may have been slightly smaller than observed. Using inpatient records for secondary data analysis does not allow examination of trends in underlying risk factors of the individuals. Further, the trends in the incidence and case-fatality of the patients who died before hospital arrival, in the accident and emergency department, or before inpatient admission could not be captured. Nevertheless, we were able to use a territory-wide database covering a decade to examine IHD trends. We further examined the IHD mortality rates based on the data available from the website of the Department of Health (www.healthyhk.gov.hk). It was found (results not shown) that the mortality rates from IHD for most age groups, both male and female, did not decrease over the past decade, although those for men aged 65–74 years and women aged 55–74 years did decrease. These data were consistent with our findings that unfavourable trends were observed despite favourable trends being reported in the Western literature.

Although we cannot determine the exact underlying factor(s) contributing to the unfavourable trends in the incidence and case-fatality of IHD, we are able identify some of the possible modifiable factors, the most obvious being better population control of blood pressure. Salt intake reduction is known to be an effective non-pharmacological intervention for reducing blood pressure.[33, 34] The diversity and strength of the evidence for the effect of high salt intake on rising blood pressure was far greater than that for other risk factors such as low consumption of fruit and vegetables, overweight, excess alcohol intake, and low physical activity level.[17] In a local study in 1998–2000, it was shown that ambulatory blood pressure decreased significantly with salt intake reduction.[35] However, salt intake reduction has been given less attention in Hong Kong compared with other health promotion programmes (such as smoking cessation). A local population nutrition survey showed that 78% of adults had a sodium intake over 2300 mg/day, a value considered to be associated with an age-related elevation in blood pressure.[36] The average salt intake increased from 8.0 g/day to 9.9 g/day from 1989–1991 to 2000–2002,[37] far exceeding the maximum daily intake of 5 g/day recommended by the WHO.[38] Reducing salt intake involves behavioural change which can be difficult achieve, particularly because such change has to be sustained. Social learning theory and behavioural approaches have been adopted to achieve salt intake reduction.[39] Lifestyle modification programmes, which have been effective in weight maintenance,[40] may be provide practical approaches to promote reduced salt intake in the diet.

An increasing IHD incidence in terms of inpatient admission combined with a stable case-fatality rate will result in increasing healthcare expenditure. The increasing trend in short-term case-fatality rate for women is of concern, and further analysis is required to determine whether this can be explained by gender differences in delayed diagnoses, reduced accessibility to interventional procedures, or genuinely poorer outcomes of IHD for women. Risk factor reduction among IHD survivors remains an important strategy in controlling IHD disease burden.

Acknowledgements

The authors would like to acknowledge the Strategy and Planning Division of the Hospital Authority for the provision of data for this study.

Competing interests
None declared.

Funding
This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

Contributorship Statement
PC and JW participated in the conception and design of the study and interpretation of the findings. PC and MW participated in literature review and data analysis. All authors wrote the article.

Data Sharing Statement
no additional data available.

Table 1. Fitted annualised percentage change in the incidence rate of IHD and subsequent risk of short- and long-term mortality based on Poisson regression and logistic regression, respectively

	Incidence		Short-term mortality		Long-term mortality	
Age (years)	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
	% change in rate per year		**% change in risk per year**			
15–24	10.7%	--	--	N/A	N/A	N/A
25–34	--	--	--	--	--	--
35–44	2.2%	-3.0%	--	--	--	--
45–54	--	-5.2%	--	--	--	2.7%
55–64	-1.5%	-6.7%	-2.7%	--	--	--
65–74	--	-4.0%	--	2.9%	--	--
75–84	--	--	--	--	2.7%	2.2%
85+	4.1%	--	--	3.4%	--	2.4%

Remarks: N/A, not available as no death occurred during the study period

--, insignificant trend (p-value > 0.05)

References

1 World Health Organization. The top 10 causes of death. 2011. http://www.who.int/mediacentre/factsheets/fs310/en/ (accessed 11 Jan 2013).

2 Lozano R, Naghavi M, Foreman K*, et al.* Global and regional mortality from 235 causes of death for 20 age groups in 1990 and 2010: a systematic analysis for the Global Burden of Disease Study 2010. doi: 10.1016/S0140-6736(12)61728-0. *Lancet* 2012;**380**:2095-128.

3 Go AS, Mozaffarian D, Roger VL*, et al.* Heart Disease and Stroke Statistics--2013 Update: A Report From the American Heart Association. *Circulation* 2013;**127**:e6-e245.

4 Chau PH, Woo J, Chan KC*, et al.* Avoidable mortality pattern in a Chinese population--Hong Kong, China. *Eur J Public Health* 2011;**21**:215-20.

5 Truelsen T, Mahonen M, Tolonen H*, et al.* Trends in stroke and coronary heart disease in the WHO MONICA Project. *Stroke* 2003;**34**:1346-52.

6 Wu Z, Yao C, Zhao D*, et al.* Sino-MONICA project: a collaborative study on trends and determinants in cardiovascular diseases in China, Part i: morbidity and mortality monitoring. *Circulation* 2001;**103**:462-8.

7 Schmidt M, Jacobsen JB, Lash TL*, et al.* 25 year trends in first time hospitalisation for acute myocardial infarction, subsequent short and long term mortality, and the prognostic impact of sex and comorbidity: a Danish nationwide cohort study. *BMJ* 2012;**344**:e356.

8 Smolina K, Wright FL, Rayner M*, et al.* Determinants of the decline in mortality from acute myocardial infarction in England between 2002 and 2010: linked national database study. *BMJ* 2012;**344**:d8059.

9 O'Flaherty M, Ford E, Allender S*, et al.* Coronary heart disease trends in England and Wales from 1984 to 2004: concealed levelling of mortality rates among young adults. *Heart* 2008;**94**:178-81.

10 Ford ES, Capewell S. Coronary heart disease mortality among young adults in the U.S. from 1980 through 2002: concealed leveling of mortality rates. *Journal of the American College of Cardiology* 2007;**50**:2128-32.

11 McGhee SM, So JC, Thomas GN. Explaining coronary heart disease trends in Hong Kong: creation of a model for policy and planning. *Hong Kong Med J* 2009;**15 Suppl 2**:22-5.

12 Meade TW, Imeson J, Stirling Y. Effects of changes in smoking and other characteristics on clotting factors and the risk of ischaemic heart disease. *Lancet* 1987;**2**:986-8.

13 Bakhru A, Erlinger TP. Smoking cessation and cardiovascular disease risk factors: results from the Third National Health and Nutrition Examination Survey. *PLoS Med* 2005;**2**:e160.

14 Janus ED, Cockram CS, Fielding R*, et al. Hong Kong Cardiovascular Risk Factor Prevalence Study 1995 - 1996*. Hong Kong: Department of Clinical Biochemistry, Queen Mary Hospital of Hong Kong. 1997.

15 Department of Health. Report on Population Health Survey 2003 / 2004. http://www.chp.gov.hk/files/pdf/Heart_Health_Survey_en_20071109.pdf (accessed 11 Jan 2013). Hong Kong: Department of Health of Hong Kong Special Administrative Region and Department of Community Medicine of The University of Hong Kong. 2005.

16 Department of Health. Heart Health Survey 2004 / 2005. 2007. http://www.chp.gov.hk/files/pdf/Heart_Health_Survey_en_20071109.pdf. (accessed 11 Jan 2013). Hong Kong: Department of Health.

17 He FJ, MacGregor GA. Reducing population salt intake worldwide: from evidence to implementation. *Prog Cardiovasc Dis* 2010;**52**:363-82.

18 Basu R, Samet JM. Relation between elevated ambient temperature and mortality: a review of the epidemiologic evidence. *Epidemiol Rev* 2002;**24**:190-202.

19 Barnard LF, Baker MG, Hales S*, et al.* Excess winter morbidity and mortality: do housing and socio-economic status have an effect? *Rev Environ Health* 2008;**23**:203-21.
20 Yan YY. The influence of weather on human mortality in Hong Kong. *Soc Sci Med* 2000;**50**:419-27.
21 Chau PH, Chan KC, Woo J. Hot weather warning might help to reduce elderly mortality in Hong Kong. *International Journal of Biometeorology* 2009;**53**:461-8.
22 Thach TQ, Wong CM, Chan KP*, et al.* Daily visibility and mortality: assessment of health benefits from improved visibility in Hong Kong. *Environ Res* 2010;**110**:617-23.
23 Steptoe A, Kivimaki M. Stress and cardiovascular disease. *Nat Rev Cardiol* 2012;**9**:360-70.
24 Leung LC, Chan KW. Understanding the Masculinity Crisis: Implications for Men's Services in Hong Kong. doi:10.1093/bjsw/bcs122. *British Journal of Social Work* 2012.
25 Chau PH, Yen E, Morley JE*, et al.* The effects of environmental stressors on the mortality of the oldest old male population in Hong Kong, 1977-2006. *Aging Male* 2008;**11**:179-88.
26 Wong SL, Donnan SP. Influence of socioeconomic status on cardiovascular diseases in Hong Kong. *J Epidemiol Community Health* 1992;**46**:148-50.
27 Schooling CM, Lam TH, Thomas GN*, et al.* Growth environment and sex differences in lipids, body shape and diabetes risk. *PLoS One* 2007;**2**:e1070.
28 Vukmir RB. Survival from prehospital cardiac arrest is critically dependent upon response time. *Resuscitation* 2006;**69**:229-34.
29 Kudenchuk PJ, Redshaw JD, Stubbs BA*, et al.* Impact of changes in resuscitation practice on survival and neurological outcome after out-of-hospital cardiac arrest resulting from nonshockable arrhythmias. *Circulation* 2012;**125**:1787-94.
30 Leung LP, Lo CM, Tong HK. Prehospital resuscitation of out-of-hospital cardiac arrest in Queen Mary Hospital. *Hong Kong Journal of Emergency Medicine* 2000;**7**:191-6.
31 The University of Hong Kong Cardiopulmonary Resuscitation Knowledge Study Group. Knowledge of cardiopulmonary resuscitation among the public in Hong Kong: telephone questionnaire survey. *Hong Kong Med J* 2003:323-8.
32 Chung CH, Wong PCY. A six-year prospective study of out-of-hospital cardiac arrest managed by a voluntary ambulance organisation. *Hong Kong Journal of Emergency Medicine* 2005;**12**:140-7.
33 Dickinson HO, Mason JM, Nicolson DJ*, et al.* Lifestyle interventions to reduce raised blood pressure: a systematic review of randomized controlled trials. *J Hypertens* 2006;**24**:215-33.
34 Sacks FM, Svetkey LP, Vollmer WM*, et al.* Effects on blood pressure of reduced dietary sodium and the Dietary Approaches to Stop Hypertension (DASH) diet. DASH-Sodium Collaborative Research Group. *N Engl J Med* 2001;**344**:3-10.
35 Cheung BMY, McGhee SM, Lau CP*, et al.* Cost-effectiveness of low-salt diet for lowering blood pressure in Hong Kong Chinese population. *Hong Kong Med J* 2007;**13**:32-6.
36 Woo J, Leung SS, Ho SC*, et al.* Dietary intake and practices in the Hong Kong Chinese population. *J Epidemiol Community Health* 1998;**52**:631-7.
37 The Chinese University of Hong Kong. Increasing Salt Intake Predisposes Hong Kong People to Hypertension and Its Complications. 2005. http://www.cuhk.edu.hk/cpr/pressrelease/050511e.htm (accessed 11 Jan 2013).
38 World Health Organization. Prevention of cardiovascular disease: guidelines for assessment and management of total cardiovascular risk. Geneva: World Health Organization. 2007.
39 Appel LJ, Espeland MA, Easter L*, et al.* Effects of reduced sodium intake on hypertension control in older individuals: results from the Trial of Nonpharmacologic Interventions in the Elderly (TONE). *Archives of Internal Medicine* 2001;**161**:685-93.

40 Woo J, Sea MM, Tong P, *et al.* Effectiveness of a lifestyle modification programme in weight maintenance in obese subjects after cessation of treatment with Orlistat. *J Eval Clin Pract* 2007;**13**:853-9.

Figure 1. Age- and sex-specific rate of IHD incidence among the population aged ≥ 15 years in Hong Kong for 2000–2009

a. Male

b. Female

Figure 2. Age- and sex-specific, short-term, IHD case-fatality rate among the population aged ≥ 15 years in Hong Kong for 2000–2009

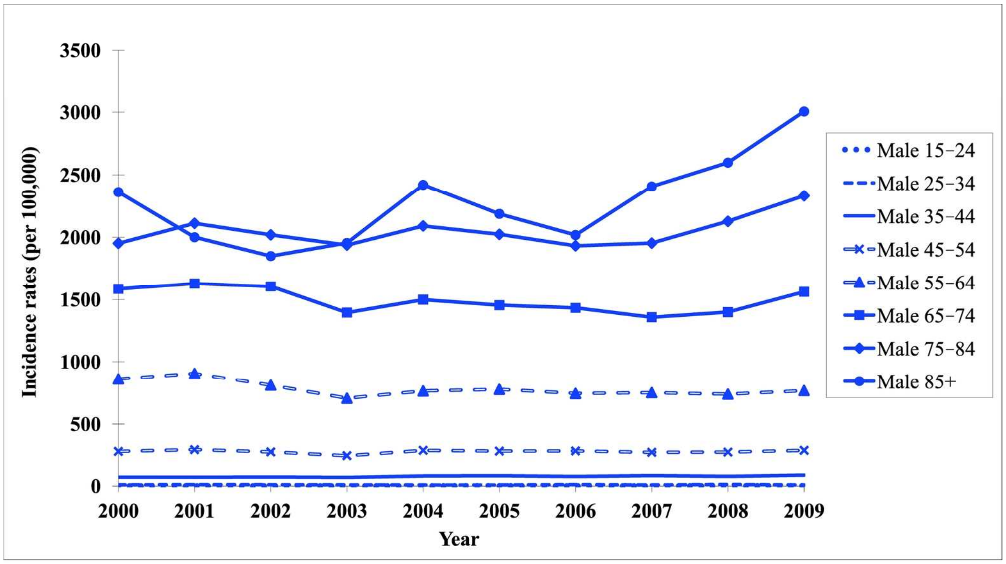
a. Male

b. Female

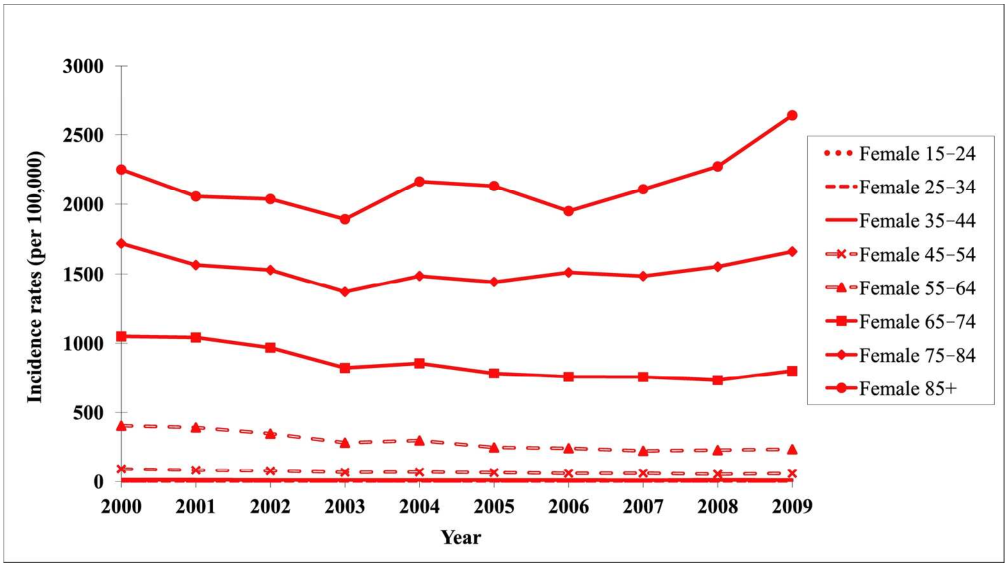
Figure 3. Age- and sex-specific, long-term, IHD case-fatality rate among the population aged ≥ 15 years in Hong Kong for 2000–2009

a. Male

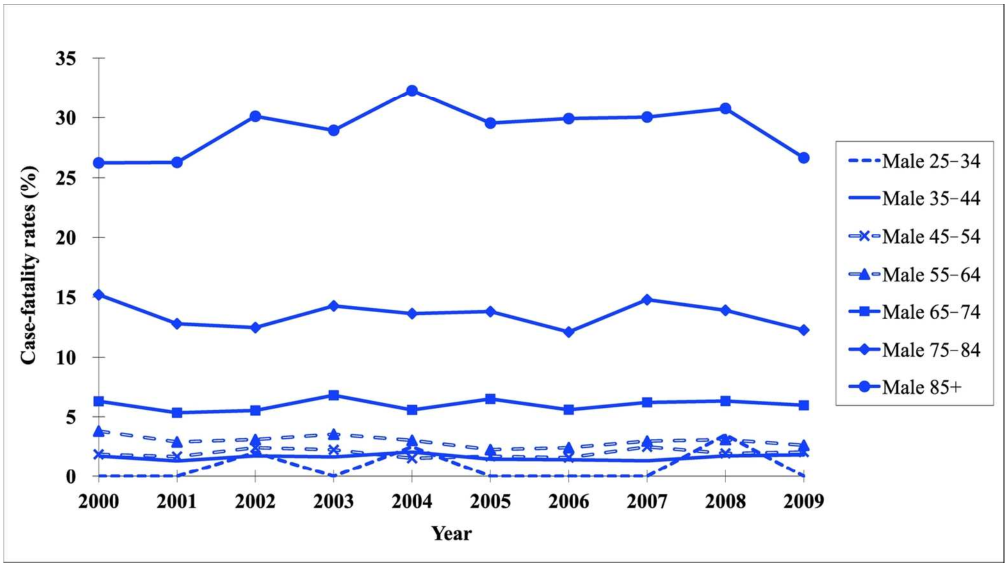
b. Female



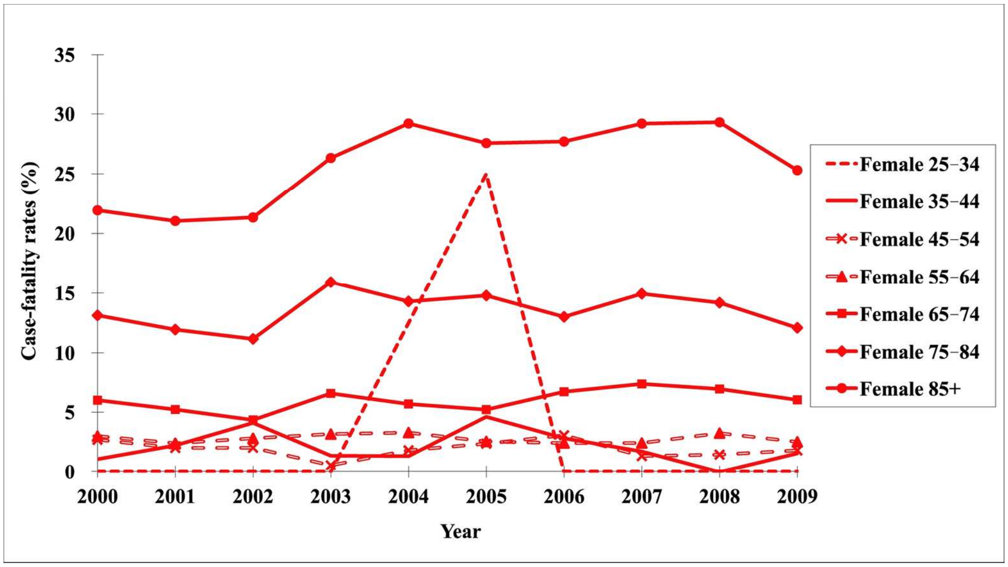
174x98mm (300 x 300 DPI)



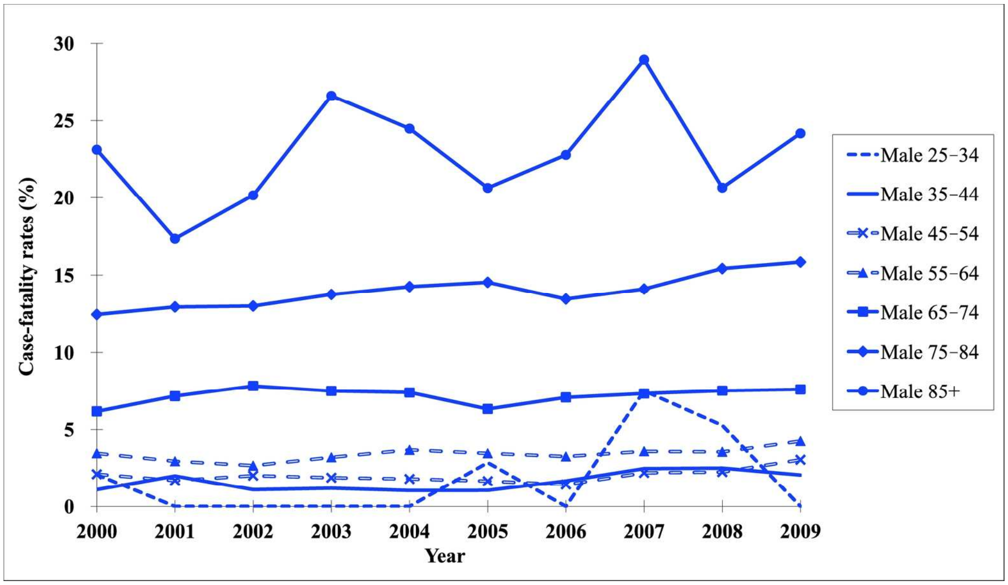
172x96mm (300 x 300 DPI)



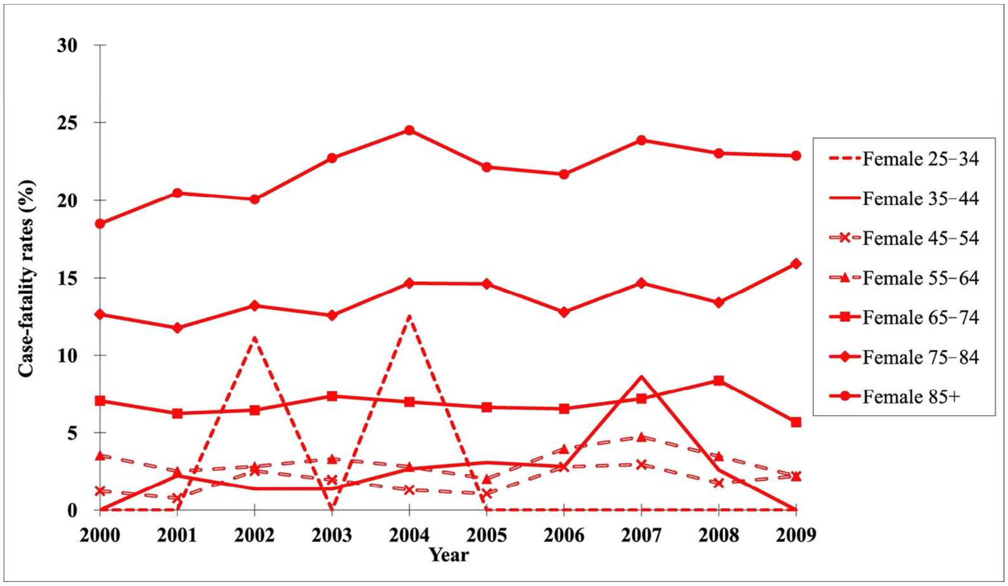
136x76mm (300 x 300 DPI)



172x96mm (300 x 300 DPI)



178x102mm (300 x 300 DPI)



140x81mm (300 x 300 DPI)

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	CHECK
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	Yes
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	Yes
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	Yes
Objectives	3	State specific objectives, including any prespecified hypotheses	Yes
Methods			
Study design	4	Present key elements of study design early in the paper	Yes
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Yes
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	Yes
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	Not Applicable
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	Yes
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Yes

Bias	9	Describe any efforts to address potential sources of bias	Yes
Study size	10	Explain how the study size was arrived at	Yes
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	Yes
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	Yes
		(*b*) Describe any methods used to examine subgroups and interactions	Yes
		(*c*) Explain how missing data were addressed	Not Applicable
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	Yes
		(*e*) Describe any sensitivity analyses	Yes

Continued on next page

Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Not Applicable
		(b) Give reasons for non-participation at each stage	Not Applicable
		(c) Consider use of a flow diagram	Not Applicable
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Yes
		(b) Indicate number of participants with missing data for each variable of interest	Not Applicable
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	Not Applicable
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	Not Applicable
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	Not Applicable
		Cross-sectional study—Report numbers of outcome events or summary measures	Not Applicable
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Yes
		(*b*) Report category boundaries when continuous variables were categorized	Yes
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	Not Applicable
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Yes
Discussion			
Key results	18	Summarise key results with reference to study objectives	Yes
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	Yes
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Yes
Generalisability	21	Discuss the generalisability (external validity) of the study results	Yes
Other information			

Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Not Applicable

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

Trends in ischaemic heart disease hospitalisation and case-fatality in the Hong Kong Chinese population, 2000–2009

Journal:	*BMJ Open*
Manuscript ID:	bmjopen-2013-002963.R1
Article Type:	Research
Date Submitted by the Author:	25-Jun-2013
Complete List of Authors:	Chau, PH; The University of Hong Kong, School of Nursing Wong, Moses; The Chinese University of Hong Kong, Medicine and Therapeutics Woo, J; The Chinese University of Hong Kong, Medicine and Therapeutics
Primary Subject Heading:	Epidemiology
Secondary Subject Heading:	Epidemiology, Public health
Keywords:	Ischaemic heart disease , Epidemiology < TROPICAL MEDICINE, Trends, Hong Kong, incidence , case-fatality

SCHOLARONE™
Manuscripts

Trends in ischaemic heart disease hospitalisation and case-fatality in the Hong Kong Chinese population, 2000–2009

Chau PH[1], Wong M[2], Woo J[2]

[1]School of Nursing, The University of Hong Kong, Pokfulam, Hong Kong S. A. R.

[2]Department of Medicine and Therapeutics, The Chinese University of Hong Kong, Shatin, Hong Kong S. A. R.

Address for Correspondence

Dr Chau PH

School of Nursing, The University of Hong Kong, Pokfulam, Hong Kong.

Tel: +852 2819 2626

Fax: +852 2872 6079

Email: phchau@graduate.hku.hk

Keywords: Ischaemic heart disease, incidence, case-fatality, hospitalisation, Hong Kong

Word Count: 3,485 (excluding title page, abstract, references, figures, and tables)

ABSTRACT

Background The incidence of ischaemic heart disease (IHD) and its associated mortality and case-fatality rates differ substantially in different populations. Hong Kong has historically had a low prevalence of IHD and IHD-associated mortality. However, the incidences of some cardiovascular risk factors appear to be increasing.

Objectives This study examines the recent trends in IHD incidence and case-fatality in Hong Kong, and explores the possible risk factors.

Design/Setting Secondary data analysis was conducted on records of IHD inpatients aged ≥15 years admitted to hospitals under the Hong Kong Hospital Authority during 2000–2009.

Outcome measures Incidence rate was defined as the number of IHD inpatient episodes divided by the size of the corresponding population. Short-term and long-term case-fatality rate was defined as deaths from all causes occurring within 30 and 31–365 days, respectively, divided by the number of IHD inpatient episodes among the corresponding population.

Methods Poisson and logistic regression models were used to examine the IHD incidence and short-term/long-term case-fatality trends, respectively, for different age and sex groups.

Results IHD incidence was stable in most age groups. However, the incidence in men aged 15–24, 35–44, and ≥85 years showed increasing trends, whereas the incidence in men aged 55–64 years and women aged 35–74 years showed decreasing trends. Overall short-term/long-term case-fatality rates were unchanged over time for both sexes. Short-term case-fatality showed increasing trends in women aged 65–74 and ≥85 years, whilst long-term case-fatality in men aged 55–64 and 75–84 years and women aged ≥75 years showed increasing trends.

Conclusion Hong Kong trends resembled those in the US, England, and Wales, showing stable or slow decline in IHD rates, while increasing trends were observed for some age groups, particularly young adults. Public health promotion efforts should focus on reducing cardiovascular risk factors, such as hypertension prevalence.

Article Summary

Article Focus

- Ischaemic heart disease (IHD) incidence and case-fatality rates show diverse trends in different populations, with a slow decline in the US and an increasing trend among certain age groups in England and Wales.
- As unfavourable trends emerge in risk factors, it is uncertain if IHD trends in the Hong Kong Chinese population will follow those of Caucasian populations.
- This study examines the recent trends in IHD incidence and case-fatality rates in the Hong Kong population aged 15 years and above, and explores the possible risk factors related to such trends.

Key Messages

- On the basis of inpatient data, there was no overall decline in IHD incidence. However, the incidence for men aged 15–24, 35–44, and ≥85 years increased, whereas that for men aged 55–64 years and women aged 35–74 years decreased.
- Overall, both short-term and long-term case-fatality rates were unchanged over time for both sexes; some age groups (men aged 55–64 and 75–84 years and women aged ≥65 years) showed an increasing trend.
- The increasing prevalence of hypertension may account for this observation, and this highlights the need for directing public health promotion efforts towards measures such as reducing salt intake to reduce hypertension prevalence.

Strengths and Weaknesses of This Study

- The strength of this study is the use of a territory-wide database that captures approximately 90% of all IHD inpatients in Hong Kong, and the availability of reliable survival data enables the investigation of case-fatality. Furthermore, the longitudinal data allows for examination of IHD trends over a decade.
- This study is limited by the fact that secondary data analysis does not allow for examination of risk factors at individual level. Moreover, the trends in the IHD incidence and case-fatality rates of patients who did not have an overnight hospital stay, and those who died before hospital arrival, in the accident and emergency department, or before inpatient admission, could not be captured.

Trends in ischaemic heart disease hospitalisation and case-fatality in the Hong Kong Chinese population, 2000–2009

INTRODUCTION

According to the World Health Organization, ischaemic heart disease (IHD) is the leading cause of mortality worldwide, accounting for 12.8% of deaths.[1] The Global Burden of Disease Study 2010 reported that IHD was the leading cause of death in 2010.[2] The American Heart Association noted that if there is a decline in cardiovascular disease (CVD) mortality that exceeds CVD incidence, a stable high burden of disease would occur.[3]

Risk factors for IHD include tobacco smoking, hypertension, diabetes, overweight, sedentary lifestyle, and unhealthy diet. When the risk factors are controlled properly, IHD can largely be prevented. In analysing avoidable mortality, it is assumed that half of all IHD deaths are avoidable.[4] When Hong Kong was compared with Western cities (Paris, Inner London, and Manhattan), it was found that IHD ranked first for avoidable mortality among the Western cities, but only fourth in Hong Kong. It was speculated that Hong Kong had lower IHD mortality rates because of a lower prevalence of smoking and overweight; the effects of ethnic differences on susceptibility to IHD may also play a role. However, there was evidence that risk factors for IHD are becoming more common in the Hong Kong population, as reflected by daily consumption of fewer than 5 servings of fruits and vegetables and the adoption of a more sedentary lifestyle with little or no leisure-time exercise. If such unhealthy lifestyles become increasingly common, IHD mortality in Hong Kong may increase in the future.

The incidence of IHD and its associated mortality and case-fatality rates differ substantially in different populations.[5] Even within China, both increasing and decreasing trends in IHD incidence and associated mortality were observed in different populations.[6] In Denmark, the first-time hospitalisation and case-fatality rates for myocardial infarction declined between 1984 and 2008.[7] Similarly, in England, the incidence of acute myocardial infarction declined between 2002 and 2010.[8] Meanwhile, some studies have shown that these declines did not apply to all population subgroups. In England and Wales, IHD mortality among men aged 35–44 years increased from 1984 to 2004, while the decline among the overall population aged 45–54 years slowed down.[9] In a US study, it was shown that the decline in IHD mortality rate also slowed down among young adults aged 35–54 years between 2000 and 2002.[10] On the basis of the diverse trends reported in the literature, it is difficult to predict the IHD trends in the Chinese population in Hong Kong. If the trends in Hong Kong are to resemble and follow those of the US, IHD incidence in Hong Kong may increase, and subsequently decline with a decelerating rate. Furthermore, different age groups may show different trends, as was revealed in the study from England and Wales. The objectives of this study were to examine the recent trends in IHD incidence and case-fatality rates in the Hong Kong population, and to explore the possible risk factors related to such trends.

METHODS

Data

Inpatient discharge data from the Hong Kong population aged ≥15 years during 2000–2009 were obtained from the Hong Kong Hospital Authority (HA) database. Data from the Clinical Management System and information on death status of these inpatients (as of mid-2010) were linked according to patients' Hong Kong Identity Card numbers. Patients who were discharged after 31 December 2009 were not included in this dataset. Information on age, sex, and principal diagnosis, as well as information on date of admission, discharge, and death, were available from the database. The principal diagnoses were coded according to the International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) and verified by experts in the HA. IHD incidence was identified by ICD-9-CM codes 410–414 in the principal diagnosis for hospitalisation. Only inpatients were included in this study, regardless of whether admission occurred via the accident and emergency department or via inpatient/outpatient services. Patients without overnight stay, regardless of the presence of potential IHD symptoms, were not included. The current data covered nearly all IHD inpatients in Hong Kong, since 88–94% of these admissions were made to public hospitals (www.ha.org.hk). Because discharged patients might be readmitted for the same IHD episode, hospital admissions within 30 days from the date of discharge were regarded as the same IHD inpatient episode. Deaths occurring within 30 days (short-term case fatality) and 31–365 days (long-term case fatality) of hospital admission were identified by the date of death available in the database. To allow at least 1 year of follow-up for determining long-term case-fatality, only admissions on or before 30 June 2009 were included for analysis of long-term case-fatality. Population statistics were obtained from the Hong Kong Census and Statistics Department (www.censtatd.gov.hk). Ethics approval was obtained from The University of Hong Kong and The Chinese University of Hong Kong.

Statistical analysis

Age- and sex-specific IHD incidence rates were defined as the number of IHD inpatient episodes divided by the size of the corresponding population. Age- and sex-specific short-term and long-term case-fatality rates were defined as the number of deaths from all causes occurring within 30 days and 31–365 days of hospital admission, respectively, divided by the number of IHD inpatient episodes in the corresponding population. Age-standardised incidence rates were calculated by a direct method using statistics from the 2009 Hong Kong population. Age-standardised case-fatality rates were calculated by a direct method using the total number of IHD episodes in 2000–2009 as the standard. Eight age groups (15–24, 25–34, 35–44, 45–54, 55–64, 65–74, 75–84, and ≥85 years) were classified for this study.

Age- and sex-specific IHD incidence rates and case-fatality rates were plotted against time. Since there were diverging trends in the age- and sex-specific rates, their trends were modelled separately. Poisson and logistic regression models were used to examine the trends in IHD incidence and case-fatality, respectively, with year of admission as the independent variable. In the Poisson model, the age- and sex-specific population was used as the offset population. Data analysis was performed using SPSS version 20.0 (SPSS Inc., Chicago, IL, USA). A significance level of 5% was adopted.

RESULTS

In total, 179,769 IHD inpatient episodes were identified during 2000–2009 among the Hong Kong population aged ≥15 years, and 61.8% of these episodes occurred in men. Approximately 9% of the IHD inpatient episodes resulted in subsequent death within 30 days of hospital admission, and another 9% resulted in subsequent death during 31–365 days after hospital admission (Table 1).

The age-standardised IHD incidence rate (per 100,000 population) for men aged ≥15 years remained stable at 460.9 in 2000 and 477.9 in 2009, whereas that for women declined from 290.7 to 251.1 over the same time period (Table 2). Figure 1 shows the age- and sex-specific IHD incidence rates. Poisson regression analysis showed that the incidence rates of IHD increased significantly by 10.7% per year (95% confidence interval [CI]: 1.4%–20.9%) among men aged 15–24 years, 2.2% per year (95% CI: 1.0%–3.4%) among men aged 35–44 years, and 4.1% per year (95% CI: 1.4%–6.8%) among men aged ≥85 years, despite the overall stable trend. For women, the incidence rates decreased significantly by 3.0% per year (95% CI: 0.5%–5.4%) among those aged 35–44 years, 5.2% per year (95% CI: 4.0%–6.4%) among those aged 45–54 years, 6.7% per year (95% CI: 5.1%–8.4%) among those aged 55–64 years, and 4.0% per year (95% CI: 2.6%–5.4%) among those aged 65–74 years, but remained stable for the youngest and oldest age groups. Table 3 provides a summary of the trends analysis.

The age-standardised short-term case-fatality rates remained stable for both men and women. In 2009, the age-standardised short-term case-fatality rates for men and women aged ≥15 years were 7.0% and 10.8%, respectively (Table 2). Figure 2 shows the age- and sex-specific short-term case-fatality rates for IHD. Logistic regression analysis (Table 3) showed that the short-term IHD case-fatality rate for men aged 55–64 years decreased significantly by 2.7% per year (95% CI: 0.3%–5.1%) while remaining stable for other age groups. For women, the rates increased significantly by 2.9% per year (95% CI: 0.8%–5.0%) for those aged 65–74 years, and by 3.4% per year (95% CI: 1.9%–4.8%) for those aged ≥85 years, in the context of the overall stable trend.

The age-standardised long-term case-fatality rate for men aged ≥15 years increased from 7.0% in 2000 to 8.6% in 2009, whereas that for women increased from 10.1% in 2000 to 11.5% in 2009 (Table 2). However, when analysed by age and sex, the logistic regression analysis (Table 3) showed that significant increases were observed only among a few groups. The long-term case-fatality increased significantly by 2.7% per year (95% CI: 0.1%–5.3%) among men aged 55–64 years, 2.7% per year (95% CI: 1.3%–4.1%) among men aged 75–84 years, 2.2% per year (95% CI: 0.8%–3.7%) among women aged 75–84 years, and 2.4% per year (95% CI: 0.8%–4.1%) among women aged ≥85 years. Figure 3 shows the age- and sex-specific long-term IHD case-fatality rates.

DISCUSSION

This study examined IHD incidence and case-fatality trends among the Hong Kong population aged ≥15 years, using inpatient data. While the overall trends in incidence rates were stable for men and women, trends for different age groups among men and women differed. Men aged 15–24, 35–44, and ≥85 years had an increasing trend; men aged 55–64 years and women aged 35–74 years had decreasing trends. The trends in short-term and long-term case-fatality rates for both men and women remained stable overall, although men aged 55–64 years had a decreasing trend in short-term case-fatality rate. Some age groups even showed an increasing trend in short-term case-fatality (women aged 65–74 and ≥85 years) and long-term case-fatality (men aged 55–64 and 75–84 years, and women aged ≥75 years). It should be noted that owing to the small number of IHD cases among those aged 15–24, the estimated 10.7% increase in annual incidence among men of this age group was imprecise, as reflected by the estimate's wide confidence interval (from 1.4% to 20.9%). Furthermore, the absence of subsequent mortality in this age group also prohibited the examination of case-fatality trends (except short-term case-fatality for men). While the case-fatality rates among those aged 25–34 could be estimated, abrupt peaks resulted (Figures 2 and 3). For example, 1 death among 4 inpatient episodes could result in a case-fatality rate of 25%.

Our findings resembled those from the England and Wales IHD mortality study, in that unfavourable increasing trends were observed for young adult men.[9] The stable trends found in our study are similar to the levelling-off of IHD mortality rates among younger adults in the US.[10] Both the UK and the US studies suggested that the increasing IHD mortality rates observed among young adults may have been due to unfavourable trends in risk factors, particularly obesity, diabetes, and hypertension. An impact model suggested that improvements in medical treatment contributed to Hong Kong's decline in IHD-related mortality from 1989 to 2001 to a greater extent than risk factor reduction.[11] However, this explanation may not be applicable to our study in which case-fatality included death from all causes. Below, we explore possible explanations for our findings.

The prevalence of daily cigarette smoking in men aged ≥15 years declined steadily from 39.7% in 1982 to 20.8% in 2009; meanwhile, that for women declined from 5.6% in 1982 to 2.6% in 1990, but increased again to 4% in 2005 (http://www.tco.gov.hk/). Studies have shown that the reduction in CVD risk becomes apparent within 5 years of smoking cessation.[12, 13] Therefore, if changes in smoking prevalence alone contributed substantially to IHD trends, we would expect a larger reduction in IHD incidence among men than women. However, women aged 35–74 years showed a significant decline in IHD incidence, while men did not. Thus, risk factors other than smoking (which may not have decreasing trends) may have affected the IHD incidence.

Three local health surveys have provided information on the rates of various cardiovascular risk factors including hypertension, overweight, high cholesterol, diabetes mellitus, and physical activity level.[14-16] Inconsistent trends in different population subgroups were found for these risk factors. Despite age differences in the survey respondents, the prevalence of overweight, high cholesterol, and diabetes mellitus appeared to have decreased, with greater decrease among women than men. The proportion of men and women who did not perform exercise in a month declined slightly, from over to below a half of respondents. In contrast, the prevalence of hypertension increased markedly for both sexes for all age groups. In 1995–1996, the prevalence of hypertension among men aged 25–34, 35–44, 45–54, 55–65, and 65–74 years was 3%, 7%, 17%, 37%, and 52%, respectively; in 2003–2004, these rates increased to 11%, 23%, 34%, 50%, and 66%, respectively. For women, the prevalence of hypertension in 1995–1996 for those aged 25–34, 35–44, 45–54, 55–65, and 65–74 years was 1%, 5%, 20%, 40%, and 55% respectively; in 2003–2004, these rates increased to 5%, 14%, 31%, 47%, and 70%, respectively. Those aged ≤44 years had the fastest rate of increase in prevalence of hypertension (ranging from 3-fold to 8-fold). Even among those with the slowest rate of increase (subjects aged ≥55 years), the rates also doubled. Moreover, the proportion of men with hypertension increased faster than that of women (except for those aged 25–34). Hypertension is a major risk factor of CVD, contributing to 49% of IHD cases.[17] Hypertension has also been indicated as a contributing factor to 41% of CVD-related deaths, compared with 14% for smoking, 13% for poor diet, 12% for insufficient physical activity, and 9% for abnormal glucose levels.[3] It is possible that the unfavourable trend in prevalence of hypertension outweighed the beneficial effects of the favourable trends in other risk factors, including smoking.

Extreme environmental temperatures may also hasten the onset of IHD, with the elderly population being more vulnerable,[18, 19] as observed in the Hong Kong population.[20, 21] The trends in IHD incidence and case-fatality rates observed in our study may partly be explained by trends in temperature extremes. Hong Kong Observatory data (www.hko.gov.hk) reveal that the annual number of days with extreme hot or cold temperatures has been generally increasing, although such increase is not statistically significant. This phenomenon may explain the increasing IHD trend among men aged ≥85 years and the non-decreasing trends among all older age groups. However, since younger populations are less likely to be affected by extreme temperatures, temperature is unlikely to have contributed to IHD trends in those groups. Furthermore, air pollution (reflected by reduced visibility) has been associated with increased rates of mortality, respiratory disease, and CVD in particular.[22] The number of “invisible days” in Hong Kong (www.hko.gov.hk) increased sharply from 2000 to 2009, and this may have partly contributed to the unfavourable IHD trends observed.

Another potential IHD risk factor is chronic stress. A recent review found that chronic stress predicted the occurrence of IHD.[23] Both short-term and long-term stresses were related to an increased risk of heart disease and mortality. The workplace is one source of stress for employees. In Hong Kong, men in particular face work- and financial-related stress, and their situations are worsened by the concepts of masculinity held in the society, a lack of gender-specific support services for men, and men’s general reluctance to seek help.[24] This may explain the increasing incidence of IHD among younger men. Meanwhile, elderly men tend to be more susceptible to socioeconomic and political stressors than women, a concept supported by an association between their mortality rates and environmental stressors.[25]

This may explain the increasing incidence of IHD among men aged ≥85 years. Furthermore, a higher socioeconomic status has been associated with a higher risk of death from IHD, [26] and growing up in an economically developed environment increased the risk of IHD among men more than women.[27] These factors may at least partly explain the increasing IHD incidence among younger and older men, but not women. Other reasons for the increasing incidence among those aged ≥85 years may include more adverse early-life experiences or a poorer *in utero* environment, exposure to periods of economic hardship, and poor primary care. However, these reasons apply to both genders, despite a significant increase being found only among men aged ≥85 years.

Survival of out-of-hospital cardiac arrest patients depends on resuscitation guidelines and practices, as well as response time.[28, 29] In Hong Kong, the outcomes for patients with out-of-hospital cardiac arrest are poor.[30] Knowledge of cardiopulmonary resuscitation techniques among the public is also poor.[31] Fewer than 16% of witnessed cardiac arrests received bystander cardiopulmonary resuscitation and only 11% of those received bystander cardiopulmonary resuscitation were discharged alive.[32] Overall, there is insufficient information relating to out-of-hospital survival for IHD patients. We are uncertain if the non-decreasing IHD incidence may be related to improvement in out-of-hospital survival for IHD patients, and hence an increasing prevalence of hospital admissions.

This study has certain limitations. Our dataset does not capture 100% of IHD inpatients in Hong Kong, since some patients are treated in the private sector. From 2000 to 2009, the proportion of IHD patients admitted to public hospitals slightly decreased, from 93% to 88% (www.ha.org.hk). However, since the shift from the public to the private system has been slow, the effect should not be strong. We believe that the increase in IHD incidence observed in our study may have been slightly greater if patients utilising the private sector were considered; for those groups that showed decreasing trends, the extent of decline may have been slightly smaller than observed. Using inpatient records for secondary data analysis does not allow examination of trends in underlying risk factors for each individual. Furthermore, the trends in the incidence and case-fatality rates of patients who did not have an overnight hospital stay, and those who died before hospital arrival, in the accident and emergency department, or before inpatient admission, could not be captured. While the hospitalisation diagnoses were verified by HA experts, no validation study on hospital diagnoses has been published. Since the dataset available did not include the cause of death, deaths subsequent to IHD hospitalisation, and for which IHD was the main cause, could not be examined. Nevertheless, we were able to use a territory-wide database spanning a decade to examine IHD trends. We further examined the IHD mortality rates according to the data available from the website of the Department of Health (www.healthyhk.gov.hk). It was found (results not shown) that the mortality rates from IHD for most age groups, both male and female, did not decrease over the past decade, although those for men aged 65–74 years and women aged 55–74 years did decrease. These data were consistent with our findings of unfavourable trends.

Although we cannot determine the exact underlying factor(s) contributing to the unfavourable trends in the incidence and case-fatality of IHD, we are able identify some of the possible modifiable factors, the most obvious being better population control of blood pressure, even though hypertension does not automatically lead to IHD. Salt intake reduction is known to be an effective non-pharmacological intervention for reducing blood pressure.[33, 34] The diversity and strength of the evidence for the effect of high salt intake on blood pressure is far greater than that for other risk factors, such as low consumption of fruit and vegetables, overweight, excess alcohol intake, and low physical activity level.[17] In a local study in 1998–2000, it was shown that ambulatory blood pressure decreased significantly with salt intake reduction.[35] However, salt intake reduction has been given less attention in Hong Kong compared with other health promotion programmes (such as smoking cessation). A local population nutrition survey showed that 78% of adults had a sodium intake over 2300 mg/day, a value considered to be associated with an age-related elevation in blood pressure.[36] The average salt intake increased from 8.0 g/day to 9.9 g/day from 1989–1991 to 2000–2002,[37] far exceeding the maximum daily intake of 5 g/day recommended by the World Health Organization.[38] Reducing salt intake involves behavioural change that can be difficult to achieve, particularly because such change has to be sustained. Social learning theory and behavioural approaches have been adopted to achieve salt intake reduction.[39] Lifestyle modification programmes, which have been effective in weight maintenance,[40] may also provide practical approaches to reducing salt intake.

An increasing IHD incidence, in terms of inpatient admission, combined with a stable case-fatality rate will lead to increased healthcare expenditure. The increasing trend in short-term case-fatality rate for women is of concern, and further analysis is required to determine whether this can be explained by gender differences in delayed diagnoses, reduced accessibility to interventional procedures, or genuinely poorer outcomes of IHD for women. Risk factor reduction among IHD survivors remains an important strategy in controlling IHD disease burden.

Acknowledgements

The authors would like to acknowledge the Strategy and Planning Division of the Hospital Authority for the provision of data for this study.

Competing interests

None declared.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Contributorship Statement

PC and JW participated in the conception and design of the study and interpretation of the findings. PC and MW participated in literature review and data analysis. All authors contributed to the writing of the article.

Data Sharing Statement

There are no additional data available.

Table 1. Study population characteristics according to IHD inpatient episodes and subsequent mortality, 2000–2009

Age group	Incidence		Short-term mortality		Long-term mortality*	
(years)	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
	(N = 111,112)	**(N = 68,657)**	**(N = 8,250)**	**(N = 7,915)**	**(N = 7,980)**	**(N = 7,114)**
15-24	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
25-34	0.4%	0.1%	0.0%	0.0%	0.1%	0.0%
35-44	4.0%	1.1%	0.9%	0.2%	0.8%	0.2%
45-54	14.1%	5.5%	3.7%	0.9%	3.6%	0.9%
55-64	22.6%	12.2%	9.0%	2.9%	9.9%	3.5%
65-74	31.5%	28.8%	25.4%	14.8%	29.8%	18.2%
75-84	22.0%	34.5%	39.9%	40.5%	39.9%	42.1%
≥85	5.4%	17.8%	21.1%	40.6%	15.8%	35.0%

Note: * Only include 104,076 male IHD inpatients and 64,387 female IHD inpatients who were admitted on or before 30 June 2009.

Table 2. The IHD incidence and case-fatality rates, 2000 and 2009

Age group (years)	Incidence rate (per 100,000 population)				Short-term mortality rate (%)				Long-term mortality rate* (%)			
	Male		Female		Male		Female		Male		Female	
	2000	2009	2000	2009	2000	2009	2000	2009	2000	2009	2000	2009
15-24	0.9	1.8	0.2	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
25-34	9.5	7.7	1.8	1.8	0.0	0.0	0.0	0.0	2.1	0.0	0.0	0.0
35-44	70.8	86.7	13.3	9.6	1.7	1.8	1.1	1.6	1.1	2.1	0.0	0.0
45-54	282.3	290.6	91.5	58.5	1.9	2.1	2.7	1.8	2.1	3.0	1.2	2.2
55-64	860.9	766.5	403.9	234.7	3.8	2.6	3.0	2.5	3.5	4.3	3.5	2.2
65-74	1586.0	1562.1	1049.7	801.1	6.3	5.9	6.0	6.0	6.2	7.6	7.0	5.7
75-84	1951.7	2331.5	1719.1	1661.2	15.2	12.3	13.1	12.1	12.4	15.9	12.6	15.9
≥85	2362.0	3005.7	2250.6	2640.0	26.2	26.7	21.9	25.3	23.1	24.2	18.5	22.9
≥15 (age-adjusted#)	460.9	477.9	290.7	251.1	7.9	7.0	10.7	10.8	7.0	8.6	10.1	11.5

Note: * Only includes IHD inpatients who were admitted on or before 30 June 2009.

The 2009 Hong Kong population and the total number of IHD inpatient episodes in 2000–2009 were used as the standard populations for calculating age-adjusted incidence rates and case-fatality rates, respectively.

Table 3. Fitted annualised **percentage change in the incidence of IHD and subsequent risk of short- and long-term mortality based on Poisson regression and logistic regression, respectively**

Age group (years)	Incidence		Short-term mortality		Long-term mortality	
	Male	Female	Male	Female	Male	Female
	% change in rate per year		% change in risk per year			
15–24	10.7% (1.4%–20.9%)	--	--	N/A	N/A	N/A
25–34	--	--	--	--	--	--
35–44	2.2% (1.0%–3.4%)	-3.0% (-5.4%– -0.5%)	--	--	--	--
45–54	--	-5.2% (-6.4%– -4.0%)	--	--	--	--
55–64	-1.5% (-2.8%– -0.3%)	-6.7% (-8.4%– -5.1%)	-2.7% (-5.1%– -0.3%)	--	2.7% (0.1%–5.3%)	--
65–74	--	-4.0% (-5.4%– -2.6%)	--	2.9% (0.8%–5.0%)	--	--
75–84	--	--	--	--	2.7% (1.3%–4.1%)	2.2% (0.8%–3.7%)
85+	4.1% (1.4%–6.8%)	--	--	3.4% (1.9%–4.8%)	--	2.4% (0.8%–4.1%)

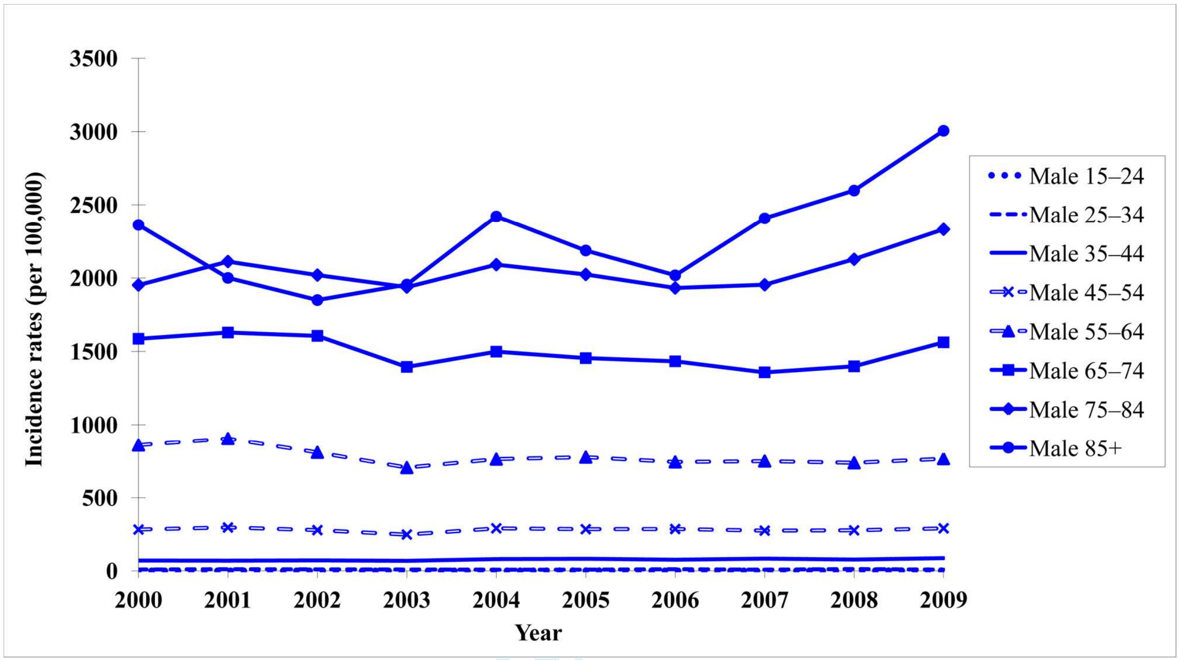
Remarks: N/A, not available as no death occurred during the study period.

Figures in brackets are 95% confidence intervals.

--, insignificant trend (p-value > 0.05).

Figure 1. Age- and sex-specific IHD incidence rates among the population aged ≥15 years in Hong Kong for 2000–2009

a. Male



b. Female

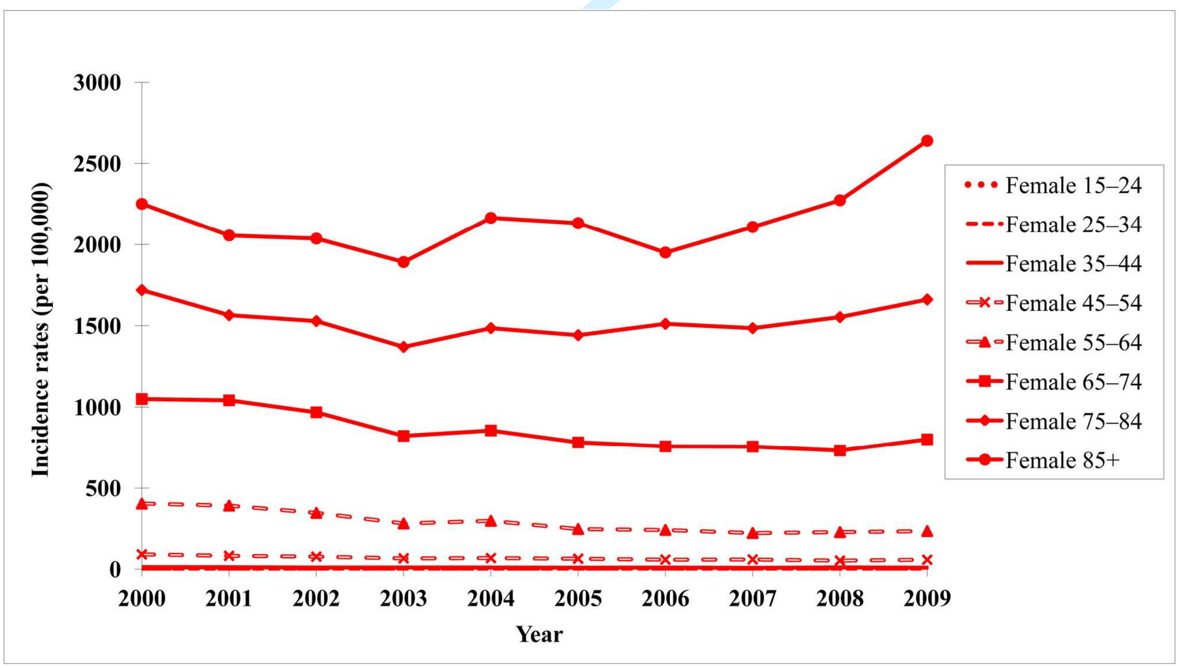
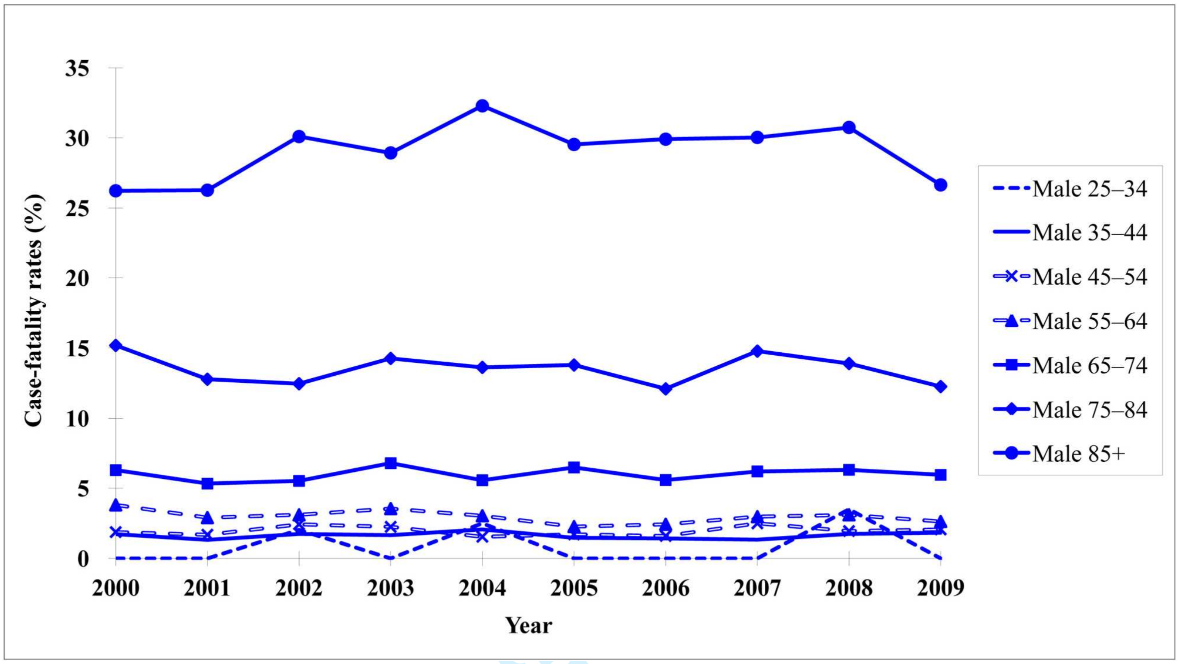


Figure 2. Age- and sex-specific short-term IHD case-fatality rates among the population aged ≥15 years in Hong Kong for 2000–2009

a. Male



b. Female

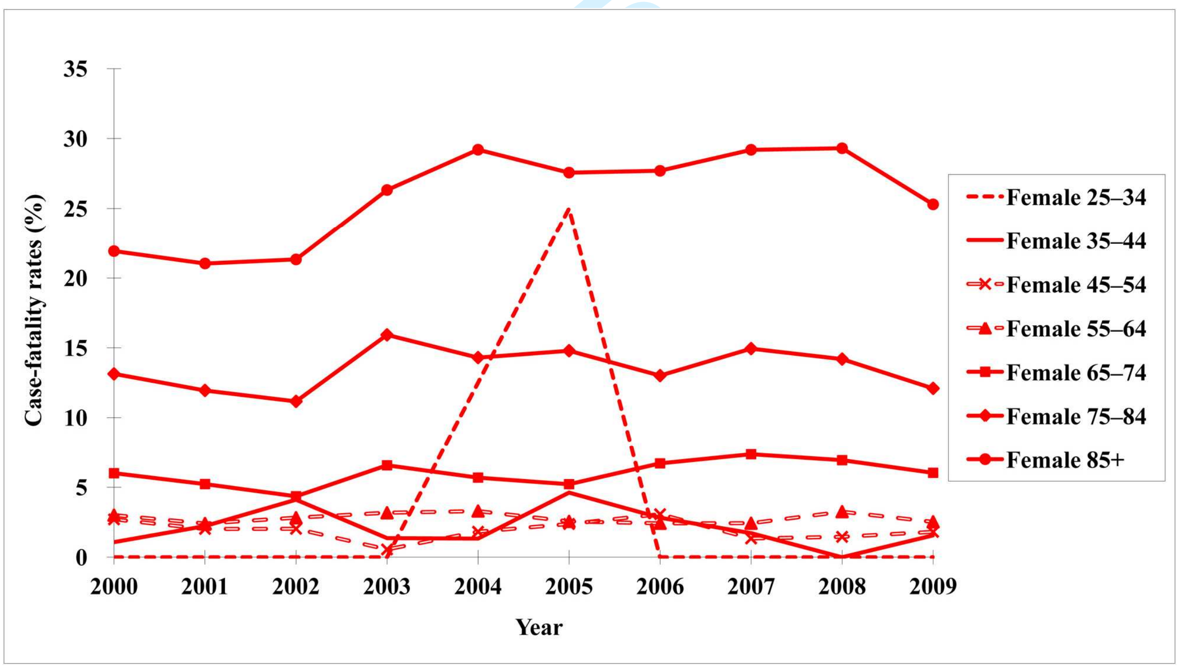
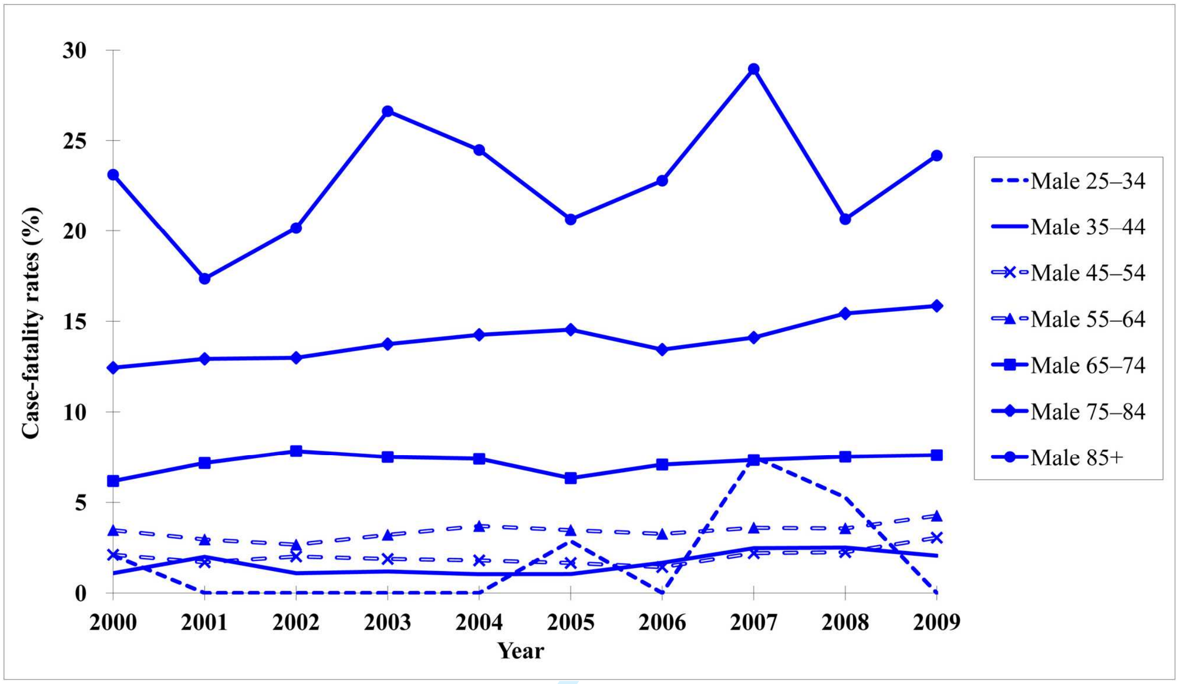
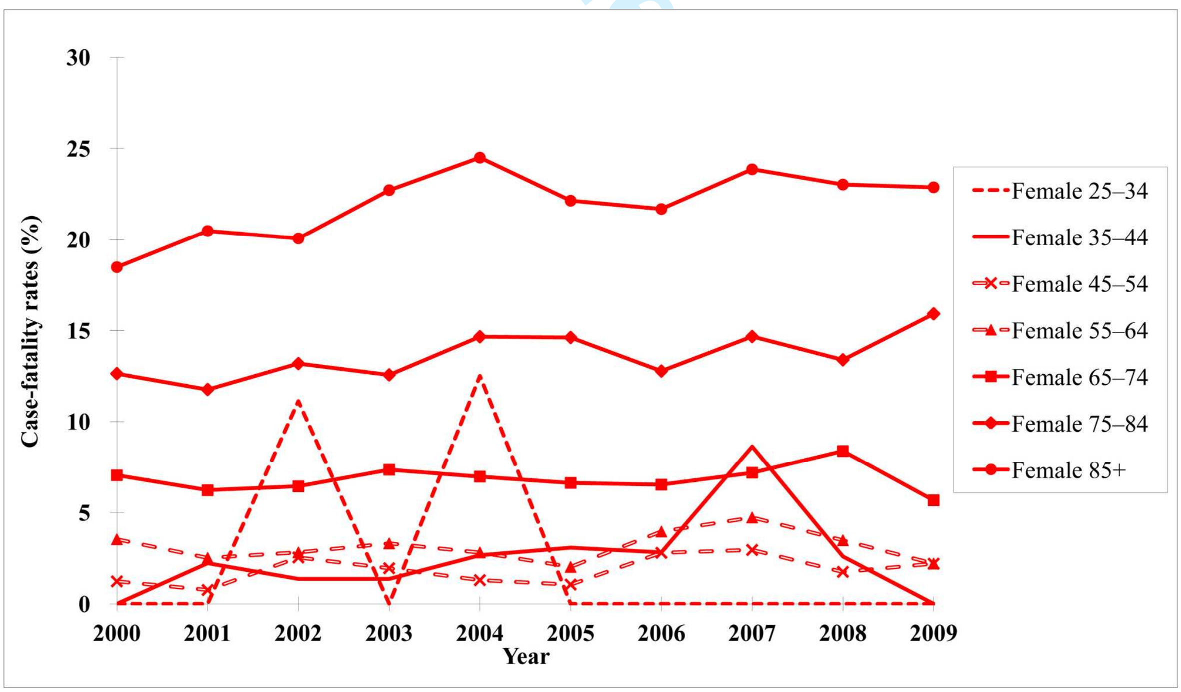


Figure 3. Age- and sex-specific long-term IHD case-fatality rates among the population aged ≥15 years in Hong Kong for 2000–2009

a. Male



b. Female



References

1 World Health Organization. The top 10 causes of death. 2011. http://www.who.int/mediacentre/factsheets/fs310/en/ (accessed 11 Jan 2013).

2 Lozano R, Naghavi M, Foreman K*, et al.* Global and regional mortality from 235 causes of death for 20 age groups in 1990 and 2010: a systematic analysis for the Global Burden of Disease Study 2010. doi: 10.1016/S0140-6736(12)61728-0. *Lancet* 2012;**380**:2095-128.

3 Go AS, Mozaffarian D, Roger VL*, et al.* Heart Disease and Stroke Statistics--2013 Update: A Report From the American Heart Association. *Circulation* 2013;**127**:e6-e245.

4 Chau PH, Woo J, Chan KC*, et al.* Avoidable mortality pattern in a Chinese population--Hong Kong, China. *Eur J Public Health* 2011;**21**:215-20.

5 Truelsen T, Mahonen M, Tolonen H*, et al.* Trends in stroke and coronary heart disease in the WHO MONICA Project. *Stroke* 2003;**34**:1346-52.

6 Wu Z, Yao C, Zhao D*, et al.* Sino-MONICA project: a collaborative study on trends and determinants in cardiovascular diseases in China, Part i: morbidity and mortality monitoring. *Circulation* 2001;**103**:462-8.

7 Schmidt M, Jacobsen JB, Lash TL*, et al.* 25 year trends in first time hospitalisation for acute myocardial infarction, subsequent short and long term mortality, and the prognostic impact of sex and comorbidity: a Danish nationwide cohort study. *BMJ* 2012;**344**:e356.

8 Smolina K, Wright FL, Rayner M*, et al.* Determinants of the decline in mortality from acute myocardial infarction in England between 2002 and 2010: linked national database study. *BMJ* 2012;**344**:d8059.

9 O'Flaherty M, Ford E, Allender S*, et al.* Coronary heart disease trends in England and Wales from 1984 to 2004: concealed levelling of mortality rates among young adults. *Heart* 2008;**94**:178-81.

10 Ford ES, Capewell S. Coronary heart disease mortality among young adults in the U.S. from 1980 through 2002: concealed leveling of mortality rates. *Journal of the American College of Cardiology* 2007;**50**:2128-32.

11 McGhee SM, So JC, Thomas GN. Explaining coronary heart disease trends in Hong Kong: creation of a model for policy and planning. *Hong Kong Med J* 2009;**15 Suppl 2**:22-5.

12 Meade TW, Imeson J, Stirling Y. Effects of changes in smoking and other characteristics on clotting factors and the risk of ischaemic heart disease. *Lancet* 1987;**2**:986-8.

13 Bakhru A, Erlinger TP. Smoking cessation and cardiovascular disease risk factors: results from the Third National Health and Nutrition Examination Survey. *PLoS Med* 2005;**2**:e160.

14 Janus ED, Cockram CS, Fielding R*, et al. Hong Kong Cardiovascular Risk Factor Prevalence Study 1995 - 1996*. Hong Kong: Department of Clinical Biochemistry, Queen Mary Hospital of Hong Kong. 1997.

15 Department of Health. Report on Population Health Survey 2003 / 2004. http://www.chp.gov.hk/files/pdf/Heart_Health_Survey_en_20071109.pdf (accessed 11 Jan 2013). Hong Kong: Department of Health of Hong Kong Special Administrative Region and Department of Community Medicine of The University of Hong Kong. 2005.

16 Department of Health. Heart Health Survey 2004 / 2005. 2007. http://www.chp.gov.hk/files/pdf/Heart_Health_Survey_en_20071109.pdf. (accessed 11 Jan 2013). Hong Kong: Department of Health.

17 He FJ, MacGregor GA. Reducing population salt intake worldwide: from evidence to implementation. *Prog Cardiovasc Dis* 2010;**52**:363-82.

18 Basu R, Samet JM. Relation between elevated ambient temperature and mortality: a review of the epidemiologic evidence. *Epidemiol Rev* 2002;**24**:190-202.

19 Barnard LF, Baker MG, Hales S*, et al.* Excess winter morbidity and mortality: do housing and socio-economic status have an effect? *Rev Environ Health* 2008;**23**:203-21.

20 Yan YY. The influence of weather on human mortality in Hong Kong. *Soc Sci Med* 2000;**50**:419-27.

21 Chau PH, Chan KC, Woo J. Hot weather warning might help to reduce elderly mortality in Hong Kong. *International Journal of Biometeorology* 2009;**53**:461-8.

22 Thach TQ, Wong CM, Chan KP*, et al.* Daily visibility and mortality: assessment of health benefits from improved visibility in Hong Kong. *Environ Res* 2010;**110**:617-23.

23 Steptoe A, Kivimaki M. Stress and cardiovascular disease. *Nat Rev Cardiol* 2012;**9**:360-70.

24 Leung LC, Chan KW. Understanding the Masculinity Crisis: Implications for Men's Services in Hong Kong. doi:10.1093/bjsw/bcs122. *British Journal of Social Work* 2012.

25 Chau PH, Yen E, Morley JE*, et al.* The effects of environmental stressors on the mortality of the oldest old male population in Hong Kong, 1977-2006. *Aging Male* 2008;**11**:179-88.

26 Wong SL, Donnan SP. Influence of socioeconomic status on cardiovascular diseases in Hong Kong. *J Epidemiol Community Health* 1992;**46**:148-50.

27 Schooling CM, Lam TH, Thomas GN*, et al.* Growth environment and sex differences in lipids, body shape and diabetes risk. *PLoS One* 2007;**2**:e1070.

28 Vukmir RB. Survival from prehospital cardiac arrest is critically dependent upon response time. *Resuscitation* 2006;**69**:229-34.

29 Kudenchuk PJ, Redshaw JD, Stubbs BA*, et al.* Impact of changes in resuscitation practice on survival and neurological outcome after out-of-hospital cardiac arrest resulting from nonshockable arrhythmias. *Circulation* 2012;**125**:1787-94.

30 Leung LP, Lo CM, Tong HK. Prehospital resuscitation of out-of-hospital cardiac arrest in Queen Mary Hospital. *Hong Kong Journal of Emergency Medicine* 2000;**7**:191-6.

31 The University of Hong Kong Cardiopulmonary Resuscitation Knowledge Study Group. Knowledge of cardiopulmonary resuscitation among the public in Hong Kong: telephone questionnaire survey. *Hong Kong Med J* 2003:323-8.

32 Chung CH, Wong PCY. A six-year prospective study of out-of-hospital cardiac arrest managed by a voluntary ambulance organisation. *Hong Kong Journal of Emergency Medicine* 2005;**12**:140-7.

33 Dickinson HO, Mason JM, Nicolson DJ*, et al.* Lifestyle interventions to reduce raised blood pressure: a systematic review of randomized controlled trials. *J Hypertens* 2006;**24**:215-33.

34 Sacks FM, Svetkey LP, Vollmer WM*, et al.* Effects on blood pressure of reduced dietary sodium and the Dietary Approaches to Stop Hypertension (DASH) diet. DASH-Sodium Collaborative Research Group. *N Engl J Med* 2001;**344**:3-10.

35 Cheung BMY, McGhee SM, Lau CP*, et al.* Cost-effectiveness of low-salt diet for lowering blood pressure in Hong Kong Chinese population. *Hong Kong Med J* 2007;**13**:32-6.

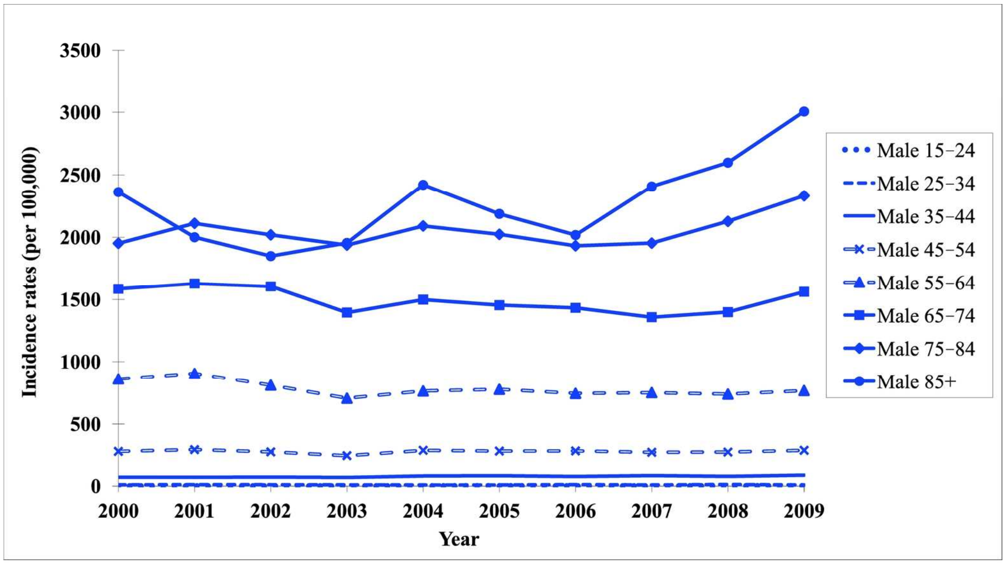
36 Woo J, Leung SS, Ho SC*, et al.* Dietary intake and practices in the Hong Kong Chinese population. *J Epidemiol Community Health* 1998;**52**:631-7.

37 The Chinese University of Hong Kong. Increasing Salt Intake Predisposes Hong Kong People to Hypertension and Its Complications. 2005. http://www.cuhk.edu.hk/cpr/pressrelease/050511e.htm (accessed 11 Jan 2013).

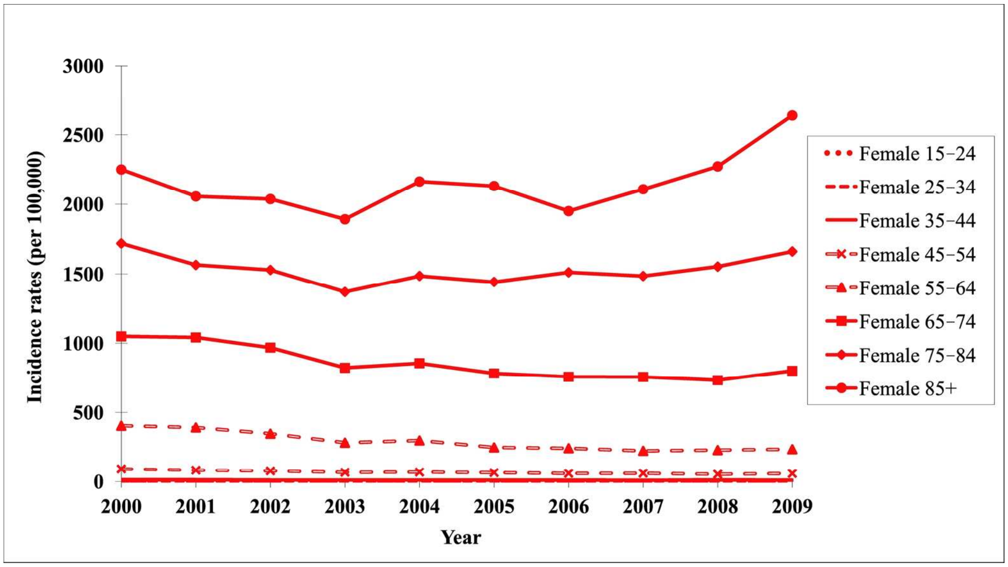
38 World Health Organization. Prevention of cardiovascular disease: guidelines for assessment and management of total cardiovascular risk. Geneva: World Health Organization. 2007.

39 Appel LJ, Espeland MA, Easter L*, et al.* Effects of reduced sodium intake on hypertension control in older individuals: results from the Trial of Nonpharmacologic Interventions in the Elderly (TONE). *Archives of Internal Medicine* 2001;**161**:685-93.

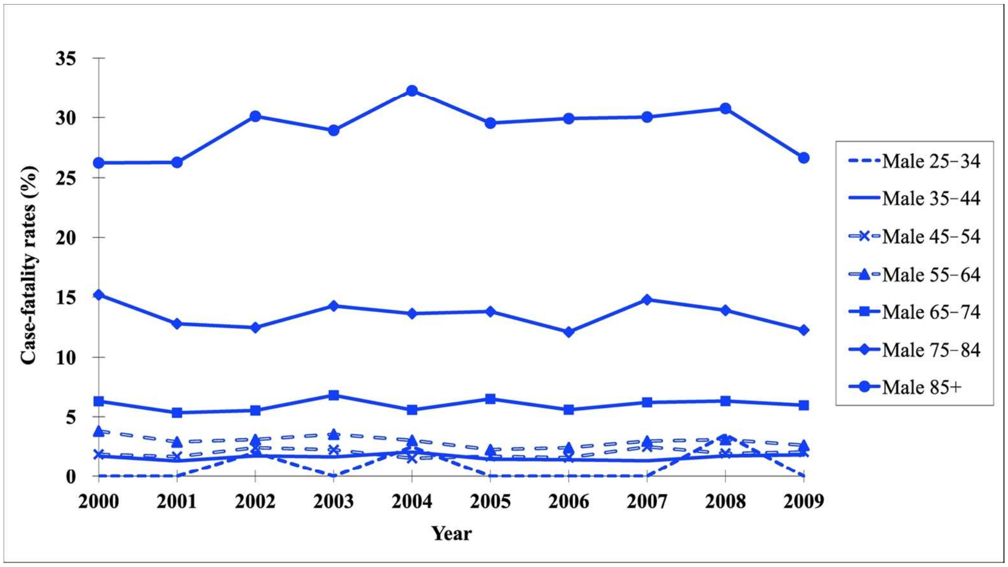
40 Woo J, Sea MM, Tong P*, et al.* Effectiveness of a lifestyle modification programme in weight maintenance in obese subjects after cessation of treatment with Orlistat. *J Eval Clin Pract* 2007;**13**:853-9.



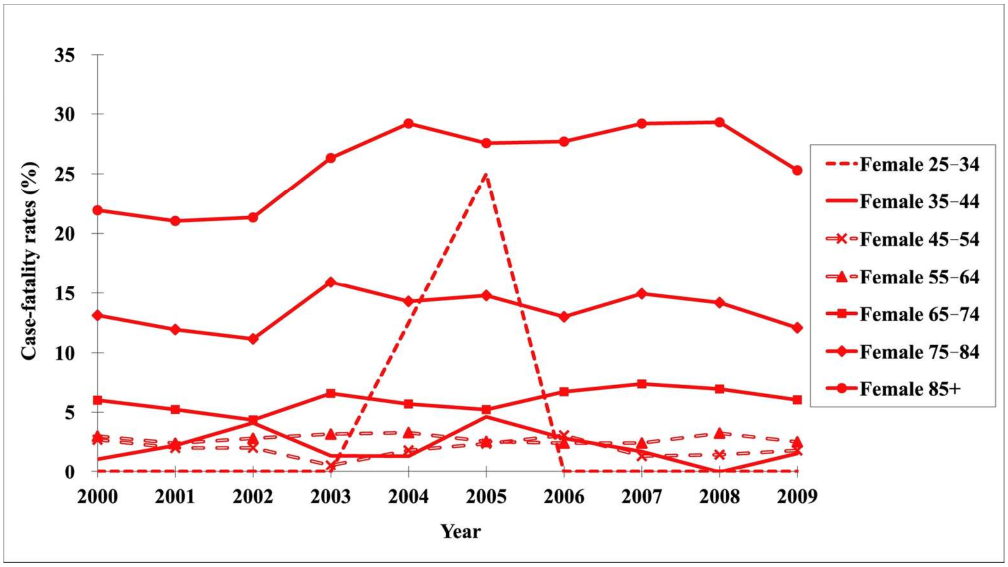
174x98mm (300 x 300 DPI)



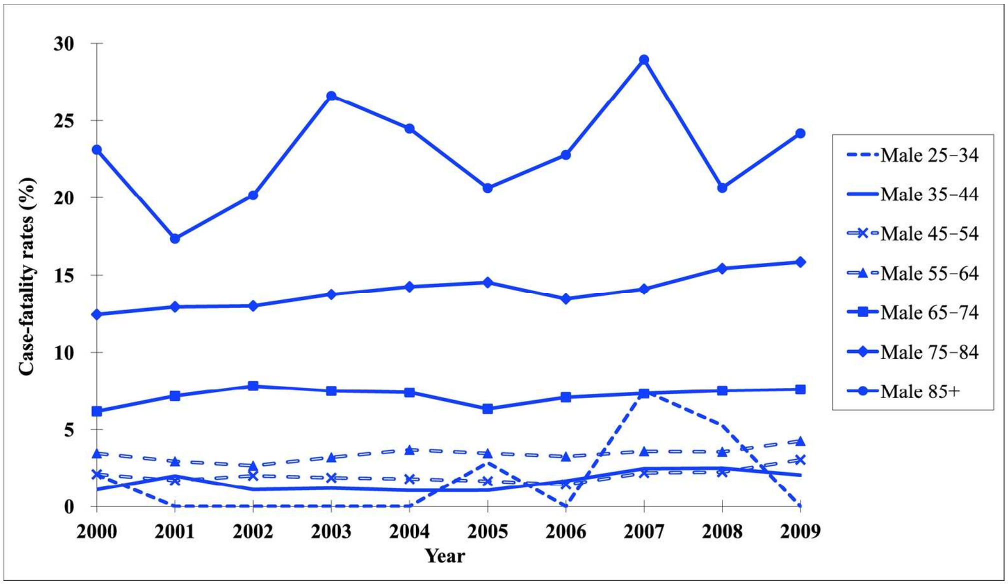
172x96mm (300 x 300 DPI)



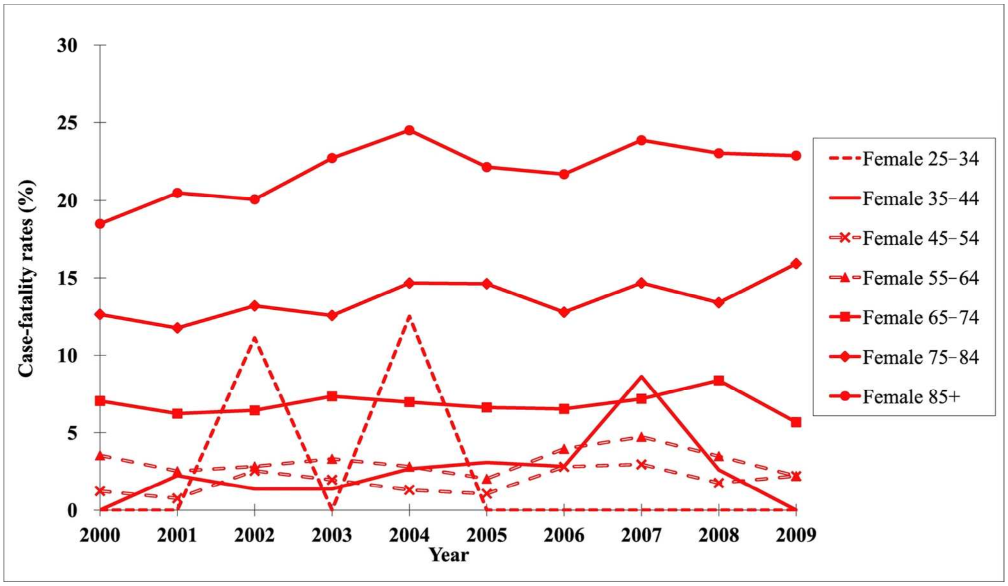
136x76mm (300 x 300 DPI)



172x96mm (300 x 300 DPI)



178x102mm (300 x 300 DPI)



140x81mm (300 x 300 DPI)

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	CHECK
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	Yes
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	Yes
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	Yes
Objectives	3	State specific objectives, including any prespecified hypotheses	Yes
Methods			
Study design	4	Present key elements of study design early in the paper	Yes
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Yes
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	Yes
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	Not Applicable
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	Yes
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Yes

Bias	9	Describe any efforts to address potential sources of bias	Yes
Study size	10	Explain how the study size was arrived at	Yes
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	Yes
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	Yes
		(*b*) Describe any methods used to examine subgroups and interactions	Yes
		(*c*) Explain how missing data were addressed	Not Applicable
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	Yes
		(*e*) Describe any sensitivity analyses	Yes

Continued on next page

Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Not Applicable
		(b) Give reasons for non-participation at each stage	Not Applicable
		(c) Consider use of a flow diagram	Not Applicable
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Yes
		(b) Indicate number of participants with missing data for each variable of interest	Not Applicable
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	Not Applicable
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	Not Applicable
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	Not Applicable
		Cross-sectional study—Report numbers of outcome events or summary measures	Not Applicable
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Yes
		(*b*) Report category boundaries when continuous variables were categorized	Yes
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	Not Applicable
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Yes
Discussion			
Key results	18	Summarise key results with reference to study objectives	Yes
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	Yes
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Yes
Generalisability	21	Discuss the generalisability (external validity) of the study results	Yes

Other information

Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Not Applicable

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

Trends in ischaemic heart disease hospitalisation and case-fatality in the Hong Kong Chinese population, 2000–2009

Chau PH[1], Wong M[2], Woo J[2]

[1]School of Nursing, The University of Hong Kong, Pokfulam, Hong Kong S. A. R.

[2]Department of Medicine and Therapeutics, The Chinese University of Hong Kong, Shatin, Hong Kong S. A. R.

Address for Correspondence

Dr Chau PH

School of Nursing, The University of Hong Kong, Pokfulam, Hong Kong.

Tel: +852 2819 2626

Fax: +852 2872 6079

Email: phchau@graduate.hku.hk

Keywords: Ischaemic heart disease, incidence, case-fatality, hospitalisation, Hong Kong

Word Count: 3,485 (excluding title page, abstract, references, figures, and tables)

ABSTRACT

Background The incidence of ischaemic heart disease (IHD) and its associated mortality and case-fatality rates differ substantially in different populations. Hong Kong has historically had a low prevalence of IHD and IHD-associated mortality. However, the incidences of some cardiovascular risk factors appear to be increasing.

Objectives This study examines the recent trends in IHD incidence and case-fatality in Hong Kong, and explores the possible risk factors.

Design/Setting Secondary data analysis was conducted on records of IHD inpatients aged ≥15 years admitted to hospitals under the Hong Kong Hospital Authority during 2000–2009.

Outcome measures Incidence rate was defined as the number of IHD inpatient episodes divided by the size of the corresponding population. Short-term and long-term case-fatality rate was defined as deaths from all causes occurring within 30 and 31–365 days, respectively, divided by the number of IHD inpatient episodes among the corresponding population.

Methods Poisson and logistic regression models were used to examine the IHD incidence and short-term/long-term case-fatality trends, respectively, for different age and sex groups.

Results IHD incidence was stable in most age groups. However, the incidence in men aged 15–24, 35–44, and ≥85 years showed increasing trends, whereas the incidence in men aged 55–64 years and women aged 35–74 years showed decreasing trends. Overall short-term/long-term case-fatality rates were unchanged over time for both sexes. Short-term case-fatality showed increasing trends in women aged 65–74 and ≥85 years, whilst long-term case-fatality in men aged 55–64 and 75–84 years and women aged ≥75 years showed increasing trends.

Conclusion Hong Kong trends resembled those in the US, England, and Wales, showing stable or slow decline in IHD rates, while increasing trends were observed for some age groups, particularly young adults. Public health promotion efforts should focus on reducing cardiovascular risk factors, such as hypertension prevalence.

Article Summary

Article Focus

- Ischaemic heart disease (IHD) incidence and case-fatality rates show diverse trends in different populations, with a slow decline in the US and an increasing trend among certain age groups in England and Wales.
- As unfavourable trends emerge in risk factors, it is uncertain if IHD trends in the Hong Kong Chinese population will follow those of Caucasian populations.
- This study examines the recent trends in IHD incidence and case-fatality rates in the Hong Kong population aged 15 years and above, and explores the possible risk factors related to such trends.

Key Messages

- On the basis of inpatient data, there was no overall decline in IHD incidence. However, the incidence for men aged 15–24, 35–44, and ≥85 years increased, whereas that for men aged 55–64 years and women aged 35–74 years decreased.
- Overall, both short-term and long-term case-fatality rates were unchanged over time for both sexes; some age groups (men aged 55–64 and 75–84 years and women aged ≥65 years) showed an increasing trend.
- The increasing prevalence of hypertension may account for this observation, and this highlights the need for directing public health promotion efforts towards measures such as reducing salt intake to reduce hypertension prevalence.

Strengths and Weaknesses of This Study

- The strength of this study is the use of a territory-wide database that captures approximately 90% of all IHD inpatients in Hong Kong, and the availability of reliable survival data enables the investigation of case-fatality. Furthermore, the longitudinal data allows for examination of IHD trends over a decade.
- This study is limited by the fact that secondary data analysis does not allow for examination of risk factors at individual level. Moreover, the trends in the IHD incidence and case-fatality rates of patients who did not have an overnight hospital stay, and those who died before hospital arrival, in the accident and emergency department, or before inpatient admission, could not be captured.

Trends in ischaemic heart disease hospitalisation and case-fatality in the Hong Kong Chinese population, 2000–2009

INTRODUCTION

According to the World Health Organization, ischaemic heart disease (IHD) is the leading cause of mortality worldwide, accounting for 12.8% of deaths.[1] The Global Burden of Disease Study 2010 reported that IHD was the leading cause of death in 2010.[2] The American Heart Association noted that if there is a decline in cardiovascular disease (CVD) mortality that exceeds CVD incidence, a stable high burden of disease would occur.[3]

Risk factors for IHD include tobacco smoking, hypertension, diabetes, overweight, sedentary lifestyle, and unhealthy diet. When the risk factors are controlled properly, IHD can largely be prevented. In analysing avoidable mortality, it is assumed that half of all IHD deaths are avoidable.[4] When Hong Kong was compared with Western cities (Paris, Inner London, and Manhattan), it was found that IHD ranked first for avoidable mortality among the Western cities, but only fourth in Hong Kong. It was speculated that Hong Kong had lower IHD mortality rates because of a lower prevalence of smoking and overweight; the effects of ethnic differences on susceptibility to IHD may also play a role. However, there was evidence that risk factors for IHD are becoming more common in the Hong Kong population, as reflected by daily consumption of fewer than 5 servings of fruits and vegetables and the adoption of a more sedentary lifestyle with little or no leisure-time exercise. If such unhealthy lifestyles become increasingly common, IHD mortality in Hong Kong may increase in the future.

The incidence of IHD and its associated mortality and case-fatality rates differ substantially in different populations.[5] Even within China, both increasing and decreasing trends in IHD incidence and associated mortality were observed in different populations.[6] In Denmark, the first-time hospitalisation and case-fatality rates for myocardial infarction declined between 1984 and 2008.[7] Similarly, in England, the incidence of acute myocardial infarction declined between 2002 and 2010.[8] Meanwhile, some studies have shown that these declines did not apply to all population subgroups. In England and Wales, IHD mortality among men aged 35–44 years increased from 1984 to 2004, while the decline among the overall population aged 45–54 years slowed down.[9] In a US study, it was shown that the decline in IHD mortality rate also slowed down among young adults aged 35–54 years between 2000 and 2002.[10] On the basis of the diverse trends reported in the literature, it is difficult to predict the IHD trends in the Chinese population in Hong Kong. If the trends in Hong Kong are to resemble and follow those of the US, IHD incidence in Hong Kong may increase, and subsequently decline with a decelerating rate. Furthermore, different age groups may show different trends, as was revealed in the study from England and Wales. The objectives of this study were to examine the recent trends in IHD incidence and case-fatality rates in the Hong Kong population, and to explore the possible risk factors related to such trends.

METHODS

Data

Inpatient discharge data from the Hong Kong population aged ≥15 years during 2000–2009 were obtained from the Hong Kong Hospital Authority (HA) database. Data from the Clinical Management System and information on death status of these inpatients (as of mid-2010) were linked according to patients' Hong Kong Identity Card numbers. Patients who were discharged after 31 December 2009 were not included in this dataset. Information on age, sex, and principal diagnosis, as well as information on date of admission, discharge, and death, were available from the database. The principal diagnoses were coded according to the International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) and verified by experts in the HA. IHD incidence was identified by ICD-9-CM codes 410–414 in the principal diagnosis for hospitalisation. Only inpatients were included in this study, regardless of whether admission occurred via the accident and emergency department or via inpatient/outpatient services. Patients without overnight stay, regardless of the presence of potential IHD symptoms, were not included. The current data covered nearly all IHD inpatients in Hong Kong, since 88–94% of these admissions were made to public hospitals (www.ha.org.hk). Because discharged patients might be readmitted for the same IHD episode, hospital admissions within 30 days from the date of discharge were regarded as the same IHD inpatient episode. Deaths occurring within 30 days (short-term case fatality) and 31–365 days (long-term case fatality) of hospital admission were identified by the date of death available in the database. To allow at least 1 year of follow-up for determining long-term case-fatality, only admissions on or before 30 June 2009 were included for analysis of long-term case-fatality. Population statistics were obtained from the Hong Kong Census and Statistics Department (www.censtatd.gov.hk). Ethics approval was obtained from The University of Hong Kong and The Chinese University of Hong Kong.

Statistical analysis

Age- and sex-specific IHD incidence rates were defined as the number of IHD inpatient episodes divided by the size of the corresponding population. Age- and sex-specific short-term and long-term case-fatality rates were defined as the number of deaths from all causes occurring within 30 days and 31–365 days of hospital admission, respectively, divided by the number of IHD inpatient episodes in the corresponding population. Age-standardised incidence rates were calculated by a direct method using statistics from the 2009 Hong Kong population. Age-standardised case-fatality rates were calculated by a direct method using the total number of IHD episodes in 2000–2009 as the standard. Eight age groups (15–24, 25–34, 35–44, 45–54, 55–64, 65–74, 75–84, and ≥85 years) were classified for this study.

Age- and sex-specific IHD incidence rates and case-fatality rates were plotted against time. Since there were diverging trends in the age- and sex-specific rates, their trends were modelled separately. Poisson and logistic regression models were used to examine the trends in IHD incidence and case-fatality, respectively, with year of admission as the independent variable. In the Poisson model, the age- and sex-specific population was used as the offset population. Data analysis was performed using SPSS version 20.0 (SPSS Inc., Chicago, IL, USA). A significance level of 5% was adopted.

RESULTS

In total, 179,769 IHD inpatient episodes were identified during 2000–2009 among the Hong Kong population aged ≥15 years, and 61.8% of these episodes occurred in men. Approximately 9% of the IHD inpatient episodes resulted in subsequent death within 30 days of hospital admission, and another 9% resulted in subsequent death during 31–365 days after hospital admission (Table 1).

The age-standardised IHD incidence rate (per 100,000 population) for men aged ≥15 years remained stable at 460.9 in 2000 and 477.9 in 2009, whereas that for women declined from 290.7 to 251.1 over the same time period (Table 2). Figure 1 shows the age- and sex-specific IHD incidence rates. Poisson regression analysis showed that the incidence rates of IHD increased significantly by 10.7% per year (95% confidence interval [CI]: 1.4%–20.9%) among men aged 15–24 years, 2.2% per year (95% CI: 1.0%–3.4%) among men aged 35–44 years, and 4.1% per year (95% CI: 1.4%–6.8%) among men aged ≥85 years, despite the overall stable trend. For women, the incidence rates decreased significantly by 3.0% per year (95% CI: 0.5%–5.4%) among those aged 35–44 years, 5.2% per year (95% CI: 4.0%–6.4%) among those aged 45–54 years, 6.7% per year (95% CI: 5.1%–8.4%) among those aged 55–64 years, and 4.0% per year (95% CI: 2.6%–5.4%) among those aged 65–74 years, but remained stable for the youngest and oldest age groups. Table 3 provides a summary of the trends analysis.

The age-standardised short-term case-fatality rates remained stable for both men and women. In 2009, the age-standardised short-term case-fatality rates for men and women aged ≥15 years were 7.0% and 10.8%, respectively (Table 2). Figure 2 shows the age- and sex-specific short-term case-fatality rates for IHD. Logistic regression analysis (Table 3) showed that the short-term IHD case-fatality rate for men aged 55–64 years decreased significantly by 2.7% per year (95% CI: 0.3%–5.1%) while remaining stable for other age groups. For women, the rates increased significantly by 2.9% per year (95% CI: 0.8%–5.0%) for those aged 65–74 years, and by 3.4% per year (95% CI: 1.9%–4.8%) for those aged ≥85 years, in the context of the overall stable trend.

The age-standardised long-term case-fatality rate for men aged ≥15 years increased from 7.0% in 2000 to 8.6% in 2009, whereas that for women increased from 10.1% in 2000 to 11.5% in 2009 (Table 2). However, when analysed by age and sex, the logistic regression analysis (Table 3) showed that significant increases were observed only among a few groups. The long-term case-fatality increased significantly by 2.7% per year (95% CI: 0.1%–5.3%) among men aged 55–64 years, 2.7% per year (95% CI: 1.3%–4.1%) among men aged 75–84 years, 2.2% per year (95% CI: 0.8%–3.7%) among women aged 75–84 years, and 2.4% per year (95% CI: 0.8%–4.1%) among women aged ≥85 years. Figure 3 shows the age- and sex-specific long-term IHD case-fatality rates.

DISCUSSION

This study examined IHD incidence and case-fatality trends among the Hong Kong population aged ≥15 years, using inpatient data. While the overall trends in incidence rates were stable for men and women, trends for different age groups among men and women differed. Men aged 15–24, 35–44, and ≥85 years had an increasing trend; men aged 55–64 years and women aged 35–74 years had decreasing trends. The trends in short-term and long-term case-fatality rates for both men and women remained stable overall, although men aged 55–64 years had a decreasing trend in short-term case-fatality rate. Some age groups even showed an increasing trend in short-term case-fatality (women aged 65–74 and ≥85 years) and long-term case-fatality (men aged 55–64 and 75–84 years, and women aged ≥75 years). It should be noted that owing to the small number of IHD cases among those aged 15–24, the estimated 10.7% increase in annual incidence among men of this age group was imprecise, as reflected by the estimate's wide confidence interval (from 1.4% to 20.9%). Furthermore, the absence of subsequent mortality in this age group also prohibited the examination of case-fatality trends (except short-term case-fatality for men). While the case-fatality rates among those aged 25–34 could be estimated, abrupt peaks resulted (Figures 2 and 3). For example, 1 death among 4 inpatient episodes could result in a case-fatality rate of 25%.

Our findings resembled those from the England and Wales IHD mortality study, in that unfavourable increasing trends were observed for young adult men.[9] The stable trends found in our study are similar to the levelling-off of IHD mortality rates among younger adults in the US.[10] Both the UK and the US studies suggested that the increasing IHD mortality rates observed among young adults may have been due to unfavourable trends in risk factors, particularly obesity, diabetes, and hypertension. An impact model suggested that improvements in medical treatment contributed to Hong Kong's decline in IHD-related mortality from 1989 to 2001 to a greater extent than risk factor reduction.[11] However, this explanation may not be applicable to our study in which case-fatality included death from all causes. Below, we explore possible explanations for our findings.

The prevalence of daily cigarette smoking in men aged ≥15 years declined steadily from 39.7% in 1982 to 20.8% in 2009; meanwhile, that for women declined from 5.6% in 1982 to 2.6% in 1990, but increased again to 4% in 2005 (http://www.tco.gov.hk/). Studies have shown that the reduction in CVD risk becomes apparent within 5 years of smoking cessation.[12, 13] Therefore, if changes in smoking prevalence alone contributed substantially to IHD trends, we would expect a larger reduction in IHD incidence among men than women. However, women aged 35–74 years showed a significant decline in IHD incidence, while men did not. Thus, risk factors other than smoking (which may not have decreasing trends) may have affected the IHD incidence.

Three local health surveys have provided information on the rates of various cardiovascular risk factors including hypertension, overweight, high cholesterol, diabetes mellitus, and physical activity level.[14-16] Inconsistent trends in different population subgroups were found for these risk factors. Despite age differences in the survey respondents, the prevalence of overweight, high cholesterol, and diabetes mellitus appeared to have decreased, with greater decrease among women than men. The proportion of men and women who did not perform exercise in a month declined slightly, from over to below a half of respondents. In contrast, the prevalence of hypertension increased markedly for both sexes for all age groups. In 1995–1996, the prevalence of hypertension among men aged 25–34, 35–44, 45–54, 55–65, and 65–74 years was 3%, 7%, 17%, 37%, and 52%, respectively; in 2003–2004, these rates increased to 11%, 23%, 34%, 50%, and 66%, respectively. For women, the prevalence of hypertension in 1995–1996 for those aged 25–34, 35–44, 45–54, 55–65, and 65–74 years was 1%, 5%, 20%, 40%, and 55% respectively; in 2003–2004, these rates increased to 5%, 14%, 31%, 47%, and 70%, respectively. Those aged ≤44 years had the fastest rate of increase in prevalence of hypertension (ranging from 3-fold to 8-fold). Even among those with the slowest rate of increase (subjects aged ≥55 years), the rates also doubled. Moreover, the proportion of men with hypertension increased faster than that of women (except for those aged 25–34). Hypertension is a major risk factor of CVD, contributing to 49% of IHD cases.[17] Hypertension has also been indicated as a contributing factor to 41% of CVD-related deaths, compared with 14% for smoking, 13% for poor diet, 12% for insufficient physical activity, and 9% for abnormal glucose levels.[3] It is possible that the unfavourable trend in prevalence of hypertension outweighed the beneficial effects of the favourable trends in other risk factors, including smoking.

Extreme environmental temperatures may also hasten the onset of IHD, with the elderly population being more vulnerable,[18, 19] as observed in the Hong Kong population.[20, 21] The trends in IHD incidence and case-fatality rates observed in our study may partly be explained by trends in temperature extremes. Hong Kong Observatory data (www.hko.gov.hk) reveal that the annual number of days with extreme hot or cold temperatures has been generally increasing, although such increase is not statistically significant. This phenomenon may explain the increasing IHD trend among men aged ≥85 years and the non-decreasing trends among all older age groups. However, since younger populations are less likely to be affected by extreme temperatures, temperature is unlikely to have contributed to IHD trends in those groups. Furthermore, air pollution (reflected by reduced visibility) has been associated with increased rates of mortality, respiratory disease, and CVD in particular.[22] The number of "invisible days" in Hong Kong (www.hko.gov.hk) increased sharply from 2000 to 2009, and this may have partly contributed to the unfavourable IHD trends observed.

Another potential IHD risk factor is chronic stress. A recent review found that chronic stress predicted the occurrence of IHD.[23] Both short-term and long-term stresses were related to an increased risk of heart disease and mortality. The workplace is one source of stress for employees. In Hong Kong, men in particular face work- and financial-related stress, and their situations are worsened by the concepts of masculinity held in the society, a lack of gender-specific support services for men, and men's general reluctance to seek help.[24] This may explain the increasing incidence of IHD among younger men. Meanwhile, elderly men tend to be more susceptible to socioeconomic and political stressors than women, a concept supported by an association between their mortality rates and environmental stressors.[25]

This may explain the increasing incidence of IHD among men aged ≥85 years. Furthermore, a higher socioeconomic status has been associated with a higher risk of death from IHD, [26] and growing up in an economically developed environment increased the risk of IHD among men more than women.[27] These factors may at least partly explain the increasing IHD incidence among younger and older men, but not women. Other reasons for the increasing incidence among those aged ≥85 years may include more adverse early-life experiences or a poorer *in utero* environment, exposure to periods of economic hardship, and poor primary care. However, these reasons apply to both genders, despite a significant increase being found only among men aged ≥85 years.

Survival of out-of-hospital cardiac arrest patients depends on resuscitation guidelines and practices, as well as response time.[28, 29] In Hong Kong, the outcomes for patients with out-of-hospital cardiac arrest are poor.[30] Knowledge of cardiopulmonary resuscitation techniques among the public is also poor.[31] Fewer than 16% of witnessed cardiac arrests received bystander cardiopulmonary resuscitation and only 11% of those received bystander cardiopulmonary resuscitation were discharged alive.[32] Overall, there is insufficient information relating to out-of-hospital survival for IHD patients. We are uncertain if the non-decreasing IHD incidence may be related to improvement in out-of-hospital survival for IHD patients, and hence an increasing prevalence of hospital admissions.

This study has certain limitations. Our dataset does not capture 100% of IHD inpatients in Hong Kong, since some patients are treated in the private sector. From 2000 to 2009, the proportion of IHD patients admitted to public hospitals slightly decreased, from 93% to 88% (www.ha.org.hk). However, since the shift from the public to the private system has been slow, the effect should not be strong. We believe that the increase in IHD incidence observed in our study may have been slightly greater if patients utilising the private sector were considered; for those groups that showed decreasing trends, the extent of decline may have been slightly smaller than observed. Using inpatient records for secondary data analysis does not allow examination of trends in underlying risk factors for each individual. Furthermore, the trends in the incidence and case-fatality rates of patients who did not have an overnight hospital stay, and those who died before hospital arrival, in the accident and emergency department, or before inpatient admission, could not be captured. While the hospitalisation diagnoses were verified by HA experts, no validation study on hospital diagnoses has been published. Since the dataset available did not include the cause of death, deaths subsequent to IHD hospitalisation, and for which IHD was the main cause, could not be examined. Nevertheless, we were able to use a territory-wide database spanning a decade to examine IHD trends. We further examined the IHD mortality rates according to the data available from the website of the Department of Health (www.healthyhk.gov.hk). It was found (results not shown) that the mortality rates from IHD for most age groups, both male and female, did not decrease over the past decade, although those for men aged 65–74 years and women aged 55–74 years did decrease. These data were consistent with our findings of unfavourable trends.

Although we cannot determine the exact underlying factor(s) contributing to the unfavourable trends in the incidence and case-fatality of IHD, we are able identify some of the possible modifiable factors, the most obvious being better population control of blood pressure, even though hypertension does not automatically lead to IHD. Salt intake reduction is known to be an effective non-pharmacological intervention for reducing blood pressure.[33, 34] The diversity and strength of the evidence for the effect of high salt intake on blood pressure is far greater than that for other risk factors, such as low consumption of fruit and vegetables, overweight, excess alcohol intake, and low physical activity level.[17] In a local study in 1998–2000, it was shown that ambulatory blood pressure decreased significantly with salt intake reduction.[35] However, salt intake reduction has been given less attention in Hong Kong compared with other health promotion programmes (such as smoking cessation). A local population nutrition survey showed that 78% of adults had a sodium intake over 2300 mg/day, a value considered to be associated with an age-related elevation in blood pressure.[36] The average salt intake increased from 8.0 g/day to 9.9 g/day from 1989–1991 to 2000–2002,[37] far exceeding the maximum daily intake of 5 g/day recommended by the World Health Organization.[38] Reducing salt intake involves behavioural change that can be difficult to achieve, particularly because such change has to be sustained. Social learning theory and behavioural approaches have been adopted to achieve salt intake reduction.[39] Lifestyle modification programmes, which have been effective in weight maintenance,[40] may also provide practical approaches to reducing salt intake.

An increasing IHD incidence, in terms of inpatient admission, combined with a stable case-fatality rate will lead to increased healthcare expenditure. The increasing trend in short-term case-fatality rate for women is of concern, and further analysis is required to determine whether this can be explained by gender differences in delayed diagnoses, reduced accessibility to interventional procedures, or genuinely poorer outcomes of IHD for women. Risk factor reduction among IHD survivors remains an important strategy in controlling IHD disease burden.

Acknowledgements

The authors would like to acknowledge the Strategy and Planning Division of the Hospital Authority for the provision of data for this study.

Competing interests

None declared.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Contributorship Statement

PC and JW participated in the conception and design of the study and interpretation of the findings. PC and MW participated in literature review and data analysis. All authors contributed to the writing of the article.

Data Sharing Statement

There are no additional data available.

Table 1. Study population characteristics according to IHD inpatient episodes and subsequent mortality, 2000–2009

Age group	Incidence		Short-term mortality		Long-term mortality*	
(years)	Male (N = 111,112)	Female (N = 68,657)	Male (N = 8,250)	Female (N = 7,915)	Male (N = 7,980)	Female (N = 7,114)
15-24	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
25-34	0.4%	0.1%	0.0%	0.0%	0.1%	0.0%
35-44	4.0%	1.1%	0.9%	0.2%	0.8%	0.2%
45-54	14.1%	5.5%	3.7%	0.9%	3.6%	0.9%
55-64	22.6%	12.2%	9.0%	2.9%	9.9%	3.5%
65-74	31.5%	28.8%	25.4%	14.8%	29.8%	18.2%
75-84	22.0%	34.5%	39.9%	40.5%	39.9%	42.1%
≥85	5.4%	17.8%	21.1%	40.6%	15.8%	35.0%

Note: * Only include 104,076 male IHD inpatients and 64,387 female IHD inpatients who were admitted on or before 30 June 2009.

Table 2. The IHD incidence and case-fatality rates, 2000 and 2009

Age group (years)	Incidence rate (per 100,000 population)				Short-term mortality rate (%)				Long-term mortality rate* (%)			
	Male		Female		Male		Female		Male		Female	
	2000	2009	2000	2009	2000	2009	2000	2009	2000	2009	2000	2009
15-24	0.9	1.8	0.2	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
25-34	9.5	7.7	1.8	1.8	0.0	0.0	0.0	0.0	2.1	0.0	0.0	0.0
35-44	70.8	86.7	13.3	9.6	1.7	1.8	1.1	1.6	1.1	2.1	0.0	0.0
45-54	282.3	290.6	91.5	58.5	1.9	2.1	2.7	1.8	2.1	3.0	1.2	2.2
55-64	860.9	766.5	403.9	234.7	3.8	2.6	3.0	2.5	3.5	4.3	3.5	2.2
65-74	1586.0	1562.1	1049.7	801.1	6.3	5.9	6.0	6.0	6.2	7.6	7.0	5.7
75-84	1951.7	2331.5	1719.1	1661.2	15.2	12.3	13.1	12.1	12.4	15.9	12.6	15.9
≥85	2362.0	3005.7	2250.6	2640.0	26.2	26.7	21.9	25.3	23.1	24.2	18.5	22.9
≥15 (age-adjusted#)	460.9	477.9	290.7	251.1	7.9	7.0	10.7	10.8	7.0	8.6	10.1	11.5

Note: * Only includes IHD inpatients who were admitted on or before 30 June 2009.

The 2009 Hong Kong population and the total number of IHD inpatient episodes in 2000–2009 were used as the standard populations for calculating age-adjusted incidence rates and case-fatality rates, respectively.

Table 3. Fitted annualised **percentage change in the incidence of IHD and subsequent risk of short- and long-term mortality based on Poisson regression and logistic regression, respectively**

Age group (years)	Incidence		Short-term mortality		Long-term mortality	
	Male	Female	Male	Female	Male	Female
	% change in rate per year		% change in risk per year			
15–24	10.7% (1.4%–20.9%)	--	--	N/A	N/A	N/A
25–34	--	--	--	--	--	--
35–44	2.2% (1.0%–3.4%)	-3.0% (-5.4%– -0.5%)	--	--	--	--
45–54	--	-5.2% (-6.4%– -4.0%)	--	--	--	--
55–64	-1.5% (-2.8%– -0.3%)	-6.7% (-8.4%– -5.1%)	-2.7% (-5.1%– -0.3%)	--	2.7% (0.1%–5.3%)	--
65–74	--	-4.0% (-5.4%– -2.6%)	--	2.9% (0.8%–5.0%)	--	--
75–84	--	--	--	--	2.7% (1.3%–4.1%)	2.2% (0.8%–3.7%)
85+	4.1% (1.4%–6.8%)	--	--	3.4% (1.9%–4.8%)	--	2.4% (0.8%–4.1%)

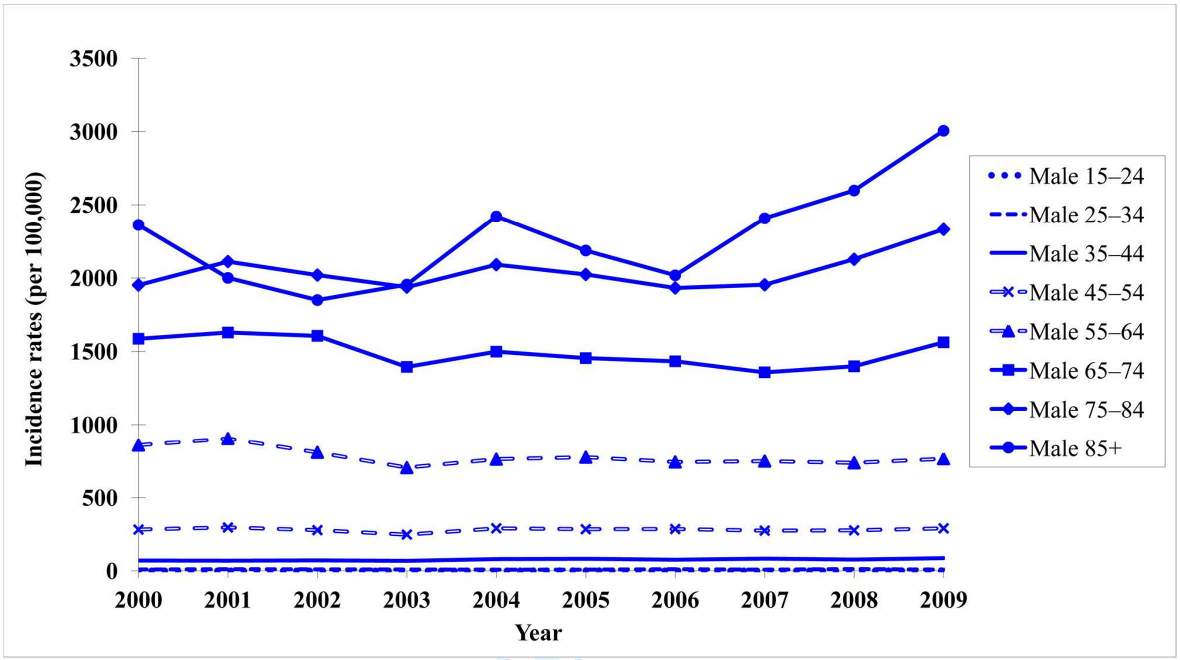
Remarks: N/A, not available as no death occurred during the study period.

Figures in brackets are 95% confidence intervals.

--, insignificant trend (p-value > 0.05).

Figure 1. Age- and sex-specific IHD incidence rates among the population aged ≥15 years in Hong Kong for 2000–2009

a. Male



b. Female

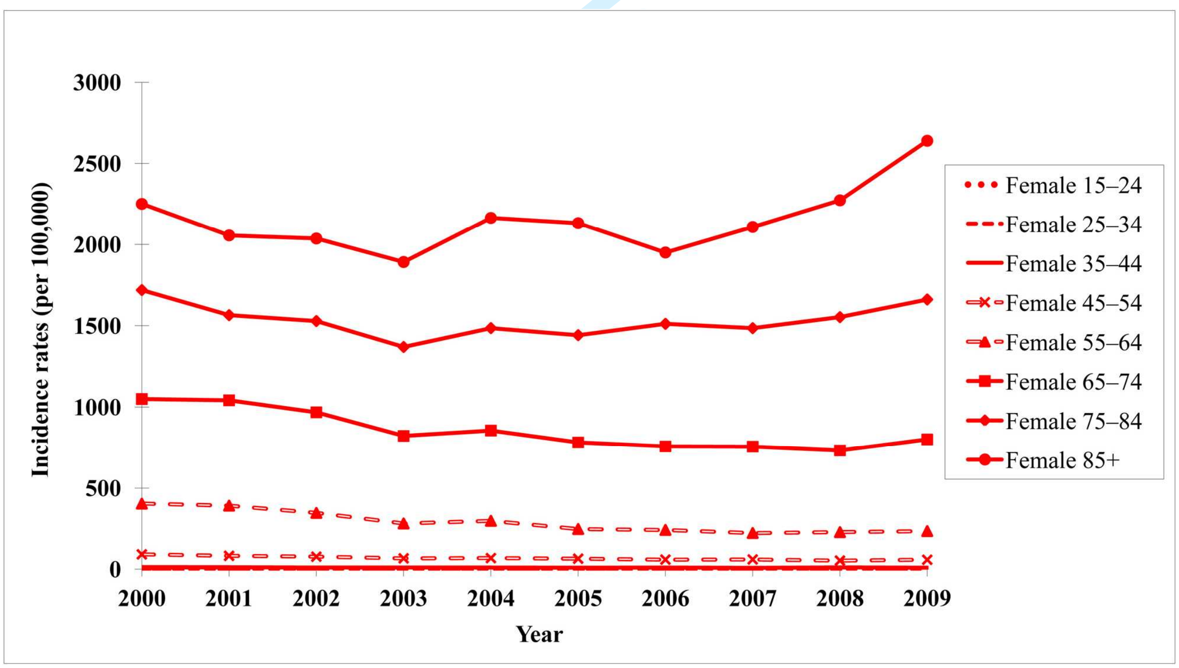
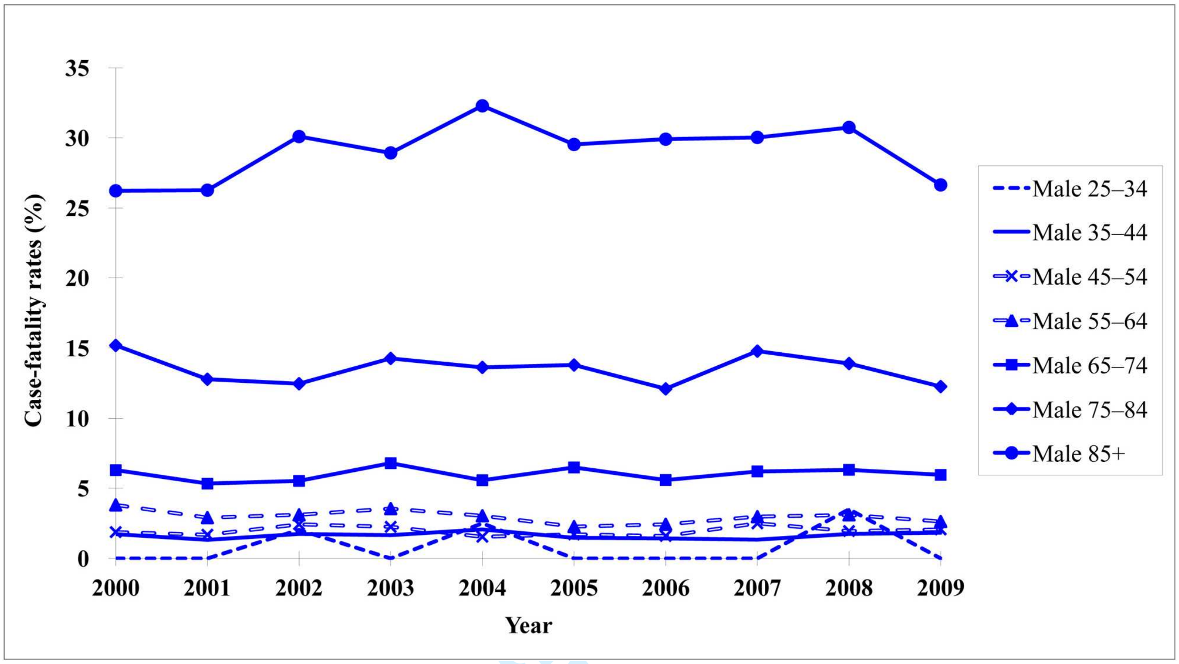


Figure 2. Age- and sex-specific short-term IHD case-fatality rates among the population aged ≥15 years in Hong Kong for 2000–2009

a. Male



b. Female

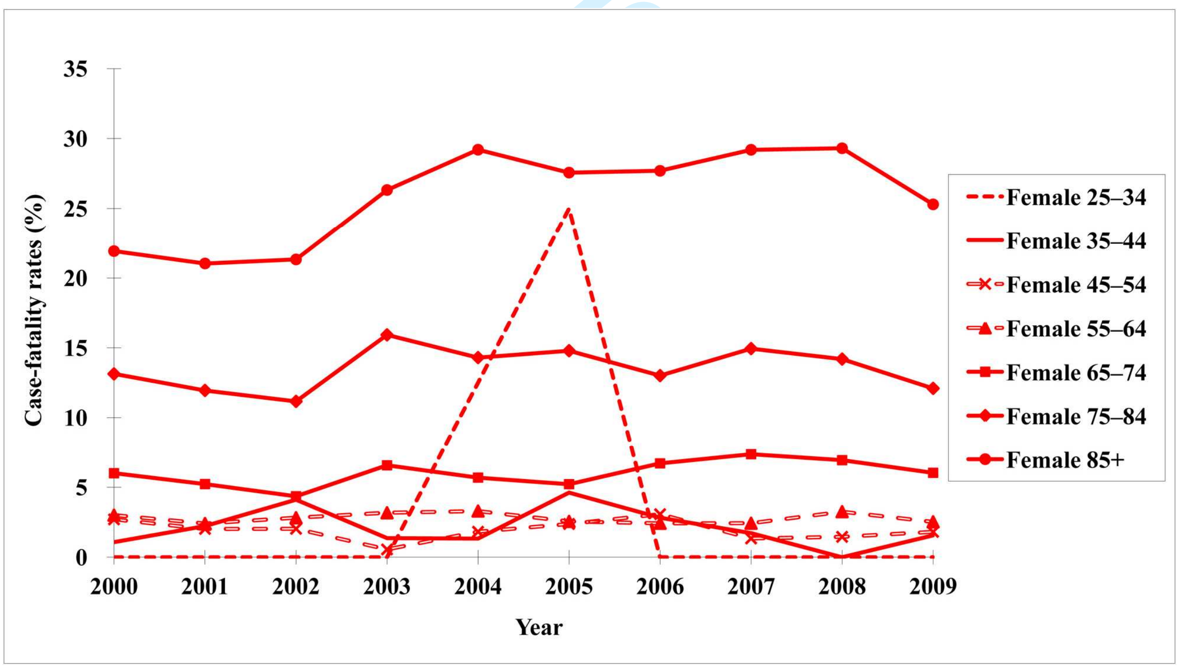
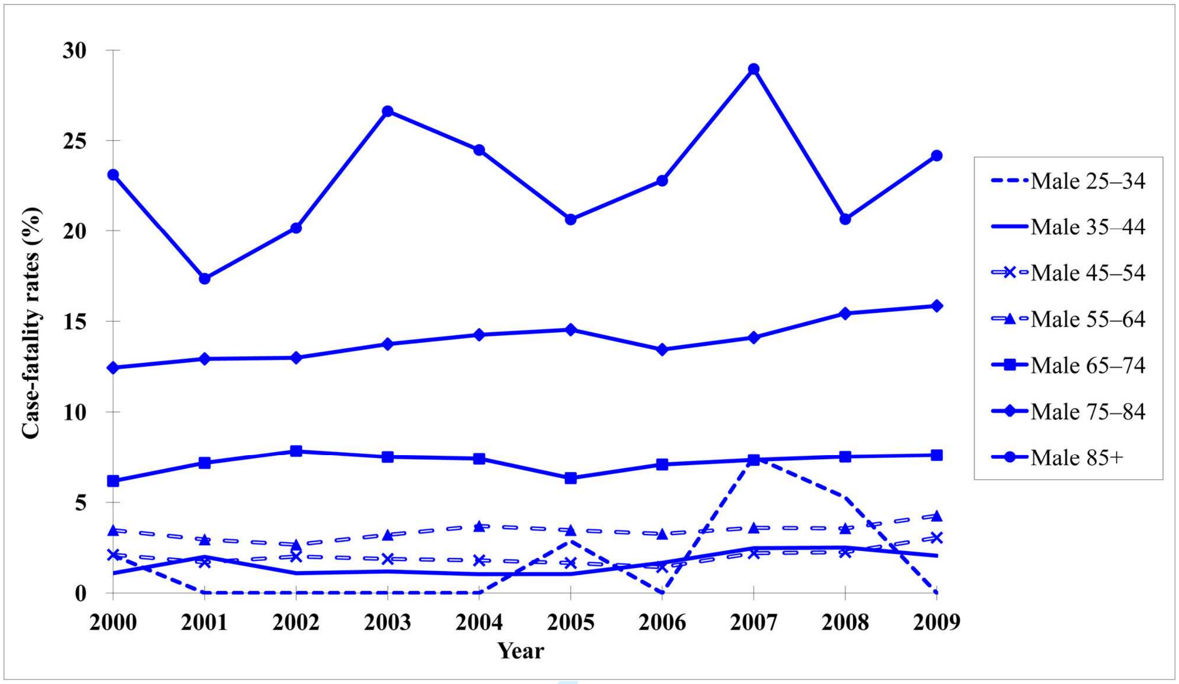
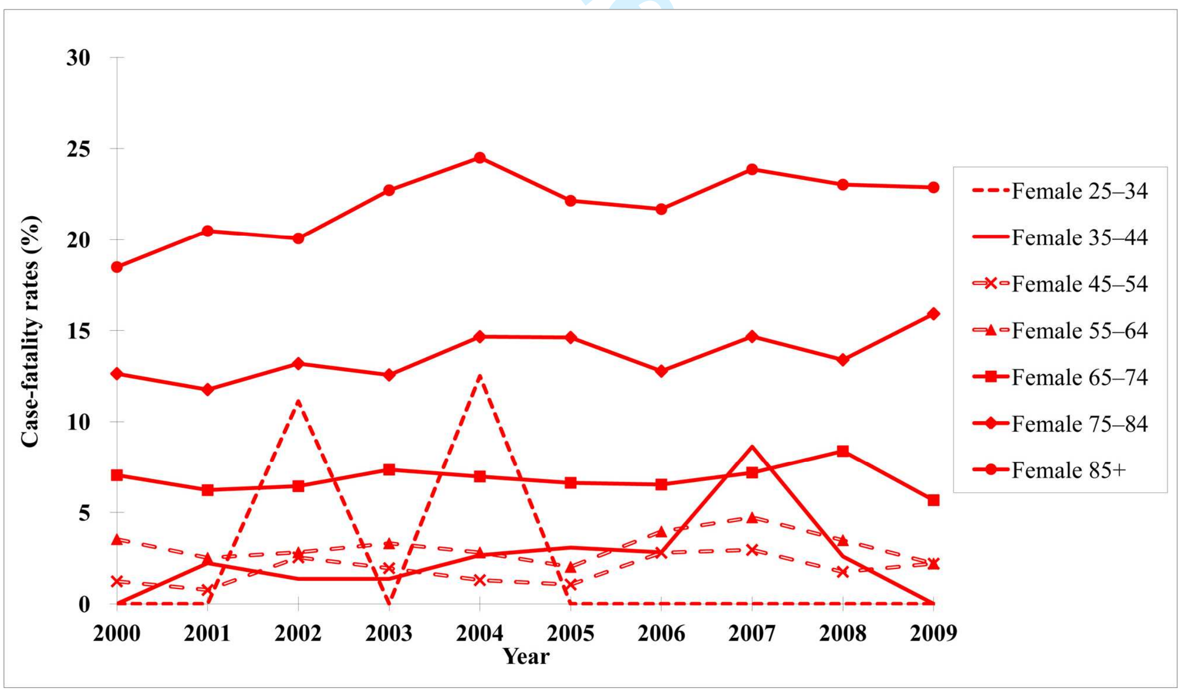


Figure 3. Age- and sex-specific long-term IHD case-fatality rates among the population aged ≥15 years in Hong Kong for 2000–2009

a. Male



b. Female



References

1 World Health Organization. The top 10 causes of death. 2011. http://www.who.int/mediacentre/factsheets/fs310/en/ (accessed 11 Jan 2013).
2 Lozano R, Naghavi M, Foreman K, *et al.* Global and regional mortality from 235 causes of death for 20 age groups in 1990 and 2010: a systematic analysis for the Global Burden of Disease Study 2010. doi: 10.1016/S0140-6736(12)61728-0. *Lancet* 2012;**380**:2095-128.
3 Go AS, Mozaffarian D, Roger VL, *et al.* Heart Disease and Stroke Statistics--2013 Update: A Report From the American Heart Association. *Circulation* 2013;**127**:e6-e245.
4 Chau PH, Woo J, Chan KC, *et al.* Avoidable mortality pattern in a Chinese population--Hong Kong, China. *Eur J Public Health* 2011;**21**:215-20.
5 Truelsen T, Mahonen M, Tolonen H, *et al.* Trends in stroke and coronary heart disease in the WHO MONICA Project. *Stroke* 2003;**34**:1346-52.
6 Wu Z, Yao C, Zhao D, *et al.* Sino-MONICA project: a collaborative study on trends and determinants in cardiovascular diseases in China, Part i: morbidity and mortality monitoring. *Circulation* 2001;**103**:462-8.
7 Schmidt M, Jacobsen JB, Lash TL, *et al.* 25 year trends in first time hospitalisation for acute myocardial infarction, subsequent short and long term mortality, and the prognostic impact of sex and comorbidity: a Danish nationwide cohort study. *BMJ* 2012;**344**:e356.
8 Smolina K, Wright FL, Rayner M, *et al.* Determinants of the decline in mortality from acute myocardial infarction in England between 2002 and 2010: linked national database study. *BMJ* 2012;**344**:d8059.
9 O'Flaherty M, Ford E, Allender S, *et al.* Coronary heart disease trends in England and Wales from 1984 to 2004: concealed levelling of mortality rates among young adults. *Heart* 2008;**94**:178-81.
10 Ford ES, Capewell S. Coronary heart disease mortality among young adults in the U.S. from 1980 through 2002: concealed leveling of mortality rates. *Journal of the American College of Cardiology* 2007;**50**:2128-32.
11 McGhee SM, So JC, Thomas GN. Explaining coronary heart disease trends in Hong Kong: creation of a model for policy and planning. *Hong Kong Med J* 2009;**15 Suppl 2**:22-5.
12 Meade TW, Imeson J, Stirling Y. Effects of changes in smoking and other characteristics on clotting factors and the risk of ischaemic heart disease. *Lancet* 1987;**2**:986-8.
13 Bakhru A, Erlinger TP. Smoking cessation and cardiovascular disease risk factors: results from the Third National Health and Nutrition Examination Survey. *PLoS Med* 2005;**2**:e160.
14 Janus ED, Cockram CS, Fielding R, *et al. Hong Kong Cardiovascular Risk Factor Prevalence Study 1995 - 1996*. Hong Kong: Department of Clinical Biochemistry, Queen Mary Hospital of Hong Kong. 1997.
15 Department of Health. Report on Population Health Survey 2003 / 2004. http://www.chp.gov.hk/files/pdf/Heart_Health_Survey_en_20071109.pdf (accessed 11 Jan 2013). Hong Kong: Department of Health of Hong Kong Special Administrative Region and Department of Community Medicine of The University of Hong Kong. 2005.
16 Department of Health. Heart Health Survey 2004 / 2005. 2007. http://www.chp.gov.hk/files/pdf/Heart_Health_Survey_en_20071109.pdf. (accessed 11 Jan 2013). Hong Kong: Department of Health.
17 He FJ, MacGregor GA. Reducing population salt intake worldwide: from evidence to implementation. *Prog Cardiovasc Dis* 2010;**52**:363-82.
18 Basu R, Samet JM. Relation between elevated ambient temperature and mortality: a review of the epidemiologic evidence. *Epidemiol Rev* 2002;**24**:190-202.

19 Barnard LF, Baker MG, Hales S*, et al.* Excess winter morbidity and mortality: do housing and socio-economic status have an effect? *Rev Environ Health* 2008;**23**:203-21.
20 Yan YY. The influence of weather on human mortality in Hong Kong. *Soc Sci Med* 2000;**50**:419-27.
21 Chau PH, Chan KC, Woo J. Hot weather warning might help to reduce elderly mortality in Hong Kong. *International Journal of Biometeorology* 2009;**53**:461-8.
22 Thach TQ, Wong CM, Chan KP*, et al.* Daily visibility and mortality: assessment of health benefits from improved visibility in Hong Kong. *Environ Res* 2010;**110**:617-23.
23 Steptoe A, Kivimaki M. Stress and cardiovascular disease. *Nat Rev Cardiol* 2012;**9**:360-70.
24 Leung LC, Chan KW. Understanding the Masculinity Crisis: Implications for Men's Services in Hong Kong. doi:10.1093/bjsw/bcs122. *British Journal of Social Work* 2012.
25 Chau PH, Yen E, Morley JE*, et al.* The effects of environmental stressors on the mortality of the oldest old male population in Hong Kong, 1977-2006. *Aging Male* 2008;**11**:179-88.
26 Wong SL, Donnan SP. Influence of socioeconomic status on cardiovascular diseases in Hong Kong. *J Epidemiol Community Health* 1992;**46**:148-50.
27 Schooling CM, Lam TH, Thomas GN*, et al.* Growth environment and sex differences in lipids, body shape and diabetes risk. *PLoS One* 2007;**2**:e1070.
28 Vukmir RB. Survival from prehospital cardiac arrest is critically dependent upon response time. *Resuscitation* 2006;**69**:229-34.
29 Kudenchuk PJ, Redshaw JD, Stubbs BA*, et al.* Impact of changes in resuscitation practice on survival and neurological outcome after out-of-hospital cardiac arrest resulting from nonshockable arrhythmias. *Circulation* 2012;**125**:1787-94.
30 Leung LP, Lo CM, Tong HK. Prehospital resuscitation of out-of-hospital cardiac arrest in Queen Mary Hospital. *Hong Kong Journal of Emergency Medicine* 2000;**7**:191-6.
31 The University of Hong Kong Cardiopulmonary Resuscitation Knowledge Study Group. Knowledge of cardiopulmonary resuscitation among the public in Hong Kong: telephone questionnaire survey. *Hong Kong Med J* 2003:323-8.
32 Chung CH, Wong PCY. A six-year prospective study of out-of-hospital cardiac arrest managed by a voluntary ambulance organisation. *Hong Kong Journal of Emergency Medicine* 2005;**12**:140-7.
33 Dickinson HO, Mason JM, Nicolson DJ*, et al.* Lifestyle interventions to reduce raised blood pressure: a systematic review of randomized controlled trials. *J Hypertens* 2006;**24**:215-33.
34 Sacks FM, Svetkey LP, Vollmer WM*, et al.* Effects on blood pressure of reduced dietary sodium and the Dietary Approaches to Stop Hypertension (DASH) diet. DASH-Sodium Collaborative Research Group. *N Engl J Med* 2001;**344**:3-10.
35 Cheung BMY, McGhee SM, Lau CP*, et al.* Cost-effectiveness of low-salt diet for lowering blood pressure in Hong Kong Chinese population. *Hong Kong Med J* 2007;**13**:32-6.
36 Woo J, Leung SS, Ho SC*, et al.* Dietary intake and practices in the Hong Kong Chinese population. *J Epidemiol Community Health* 1998;**52**:631-7.
37 The Chinese University of Hong Kong. Increasing Salt Intake Predisposes Hong Kong People to Hypertension and Its Complications. 2005. http://www.cuhk.edu.hk/cpr/pressrelease/050511e.htm (accessed 11 Jan 2013).
38 World Health Organization. Prevention of cardiovascular disease: guidelines for assessment and management of total cardiovascular risk. Geneva: World Health Organization. 2007.
39 Appel LJ, Espeland MA, Easter L*, et al.* Effects of reduced sodium intake on hypertension control in older individuals: results from the Trial of Nonpharmacologic Interventions in the Elderly (TONE). *Archives of Internal Medicine* 2001;**161**:685-93.

40 Woo J, Sea MM, Tong P, *et al.* Effectiveness of a lifestyle modification programme in weight maintenance in obese subjects after cessation of treatment with Orlistat. *J Eval Clin Pract* 2007;**13**:853-9.

Trends in ischaemic heart disease hospitalisation and case-fatality in the Hong Kong Chinese population, 2000–2009

Journal:	*BMJ Open*
Manuscript ID:	bmjopen-2013-002963.R2
Article Type:	Research
Date Submitted by the Author:	11-Jul-2013
Complete List of Authors:	Chau, PH; The University of Hong Kong, School of Nursing Wong, Moses; The Chinese University of Hong Kong, Medicine and Therapeutics Woo, J; The Chinese University of Hong Kong, Medicine and Therapeutics
Primary Subject Heading:	Epidemiology
Secondary Subject Heading:	Cardiovascular medicine, Public health
Keywords:	Ischaemic heart disease , Epidemiology < TROPICAL MEDICINE, Trends, Hong Kong, incidence , case-fatality

SCHOLARONE™
Manuscripts

Trends in ischaemic heart disease hospitalisation and case-fatality in the Hong Kong Chinese population, 2000–2009

Chau PH[1], Wong M[2], Woo J[2]

[1]School of Nursing, The University of Hong Kong, Pokfulam, Hong Kong S. A. R.

[2]Department of Medicine and Therapeutics, The Chinese University of Hong Kong, Shatin, Hong Kong S. A. R.

Address for Correspondence

Dr Chau PH

School of Nursing, The University of Hong Kong, Pokfulam, Hong Kong.

Tel: +852 2819 2626

Fax: +852 2872 6079

Email: phchau@graduate.hku.hk

Keywords: Ischaemic heart disease, incidence, case-fatality, hospitalisation, Hong Kong

Word Count: 3,517 (excluding title page, abstract, references, figures, and tables)

ABSTRACT

Background The incidence of ischaemic heart disease (IHD) and its associated mortality and case-fatality rates differ substantially in different populations. Hong Kong has historically had a low prevalence of IHD and IHD-associated mortality. However, the incidences of some cardiovascular risk factors appear to be increasing.

Objectives This study examines the recent trends in IHD incidence and case-fatality in Hong Kong, and explores the possible risk factors.

Design/Setting Secondary data analysis was conducted on records of IHD inpatients aged ≥15 years admitted to hospitals under the Hong Kong Hospital Authority during 2000–2009.

Outcome measures Incidence rate was defined as the number of IHD inpatient episodes divided by the size of the corresponding population. Short-term and long-term case-fatality rate was defined as deaths from all causes occurring within 30 and 31–365 days, respectively, divided by the number of IHD inpatient episodes among the corresponding population.

Methods Poisson and logistic regression models were used to examine the IHD incidence and short-term/long-term case-fatality trends, respectively, for different age and sex groups.

Results IHD incidence was stable in most age groups. However, the incidence in men aged 15–24, 35–44, and ≥85 years showed increasing trends, whereas the incidence in men aged 55–64 years and women aged 35–74 years showed decreasing trends. Overall short-term/long-term case-fatality rates were unchanged over time for both sexes. Short-term case-fatality showed increasing trends in women aged 65–74 and ≥85 years, whilst long-term case-fatality in men aged 55–64 and 75–84 years and women aged ≥75 years showed increasing trends.

Conclusion Hong Kong trends resembled those in the US, England, and Wales, showing stable or slow decline in IHD rates, while increasing trends were observed for some age groups, particularly young adults. Public health promotion efforts should focus on reducing cardiovascular risk factors, such as hypertension prevalence.

Article Summary

Article Focus

- Ischaemic heart disease (IHD) incidence and case-fatality rates show diverse trends in different populations, with a slow decline in the US and an increasing trend among certain age groups in England and Wales.
- As unfavourable trends emerge in risk factors, it is uncertain if IHD trends in the Hong Kong Chinese population will follow those of Caucasian populations.
- This study examines the recent trends in IHD incidence and case-fatality rates in the Hong Kong population aged 15 years and above, and explores the possible risk factors related to such trends.

Key Messages

- On the basis of inpatient data, there was no overall decline in IHD incidence. However, the incidence for men aged 15–24, 35–44, and ≥85 years increased, whereas that for men aged 55–64 years and women aged 35–74 years decreased.
- Overall, both short-term and long-term case-fatality rates were unchanged over time for both sexes; some age groups (men aged 55–64 and 75–84 years and women aged ≥65 years) showed an increasing trend.
- The increasing prevalence of hypertension may account for this observation, and this highlights the need for directing public health promotion efforts towards measures such as reducing salt intake to reduce hypertension prevalence.

Strengths and Weaknesses of This Study

- The strength of this study is the use of a territory-wide database that captures approximately 90% of all IHD inpatients in Hong Kong, and the availability of reliable survival data enables the investigation of case-fatality. Furthermore, the longitudinal data allows for examination of IHD trends over a decade.
- This study is limited by the fact that secondary data analysis does not allow for examination of risk factors at individual level. Moreover, the trends in the IHD incidence and case-fatality rates of patients who did not have an overnight hospital stay, and those who died before hospital arrival, in the accident and emergency department, or before inpatient admission, could not be captured.

Trends in ischaemic heart disease hospitalisation and case-fatality in the Hong Kong Chinese population, 2000–2009

INTRODUCTION

According to the World Health Organization, ischaemic heart disease (IHD) is the leading cause of mortality worldwide, accounting for 12.8% of deaths.[1] The Global Burden of Disease Study 2010 reported that IHD was the leading cause of death in 2010.[2] The American Heart Association noted that if there is a decline in cardiovascular disease (CVD) mortality that exceeds CVD incidence, a stable high burden of disease would occur.[3]

Risk factors for IHD include tobacco smoking, hypertension, diabetes, overweight, sedentary lifestyle, and unhealthy diet. When the risk factors are controlled properly, IHD can largely be prevented. In analysing avoidable mortality, it is assumed that half of all IHD deaths are avoidable.[4] When Hong Kong was compared with Western cities (Paris, Inner London, and Manhattan), it was found that IHD ranked first for avoidable mortality among the Western cities, but only fourth in Hong Kong. It was speculated that Hong Kong had lower IHD mortality rates because of a lower prevalence of smoking and overweight; the effects of ethnic differences on susceptibility to IHD may also play a role. However, there was evidence that risk factors for IHD are becoming more common in the Hong Kong population, as reflected by daily consumption of fewer than 5 servings of fruits and vegetables and the adoption of a more sedentary lifestyle with little or no leisure-time exercise. If such unhealthy lifestyles become increasingly common, IHD mortality in Hong Kong may increase in the future.

The incidence of IHD and its associated mortality and case-fatality rates differ substantially in different populations.[5] Even within China, both increasing and decreasing trends in IHD incidence and associated mortality were observed in different populations.[6] In Denmark, the first-time hospitalisation and case-fatality rates for myocardial infarction declined between 1984 and 2008.[7] Similarly, in England, the incidence of acute myocardial infarction declined between 2002 and 2010.[8] Meanwhile, some studies have shown that these declines did not apply to all population subgroups. In England and Wales, IHD mortality among men aged 35–44 years increased from 1984 to 2004, while the decline among the overall population aged 45–54 years slowed down.[9] In a US study, it was shown that the decline in IHD mortality rate also slowed down among young adults aged 35–54 years between 2000 and 2002.[10] On the basis of the diverse trends reported in the literature, it is difficult to predict the IHD trends in the Chinese population in Hong Kong. If the trends in Hong Kong are to resemble and follow those of the US, IHD incidence in Hong Kong may increase, and subsequently decline with a decelerating rate. Furthermore, different age groups may show different trends, as was revealed in the study from England and Wales. The objectives of this study were to examine the recent trends in IHD incidence and case-fatality rates in the Hong Kong population, and to explore the possible risk factors related to such trends.

METHODS

Data

Inpatient discharge data from the Hong Kong population aged ≥15 years during 2000–2009 were obtained from the Hong Kong Hospital Authority (HA) database. Data from the Clinical Management System and information on death status of these inpatients (as of mid-2010) were linked according to patients' Hong Kong Identity Card numbers. Patients who were discharged after 31 December 2009 were not included in this dataset. Information on age, sex, and principal diagnosis, as well as information on date of admission, discharge, and death, were available from the database. The principal diagnoses were coded according to the International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) and verified by experts in the HA. IHD incidence was identified by ICD-9-CM codes 410–414 in the principal diagnosis for hospitalisation. Only inpatients were included in this study, regardless of whether admission occurred via the accident and emergency department or via inpatient/outpatient services. Patients without overnight stay, regardless of the presence of potential IHD symptoms, were not included. The current data covered nearly all IHD inpatients in Hong Kong, since 88–94% of these admissions were made to public hospitals (www.ha.org.hk). Because discharged patients might be readmitted for the same IHD episode, hospital admissions within 30 days from the date of discharge were regarded as the same IHD inpatient episode. Deaths occurring within 30 days (short-term case fatality) and 31–365 days (long-term case fatality) of hospital admission were identified by the date of death available in the database. To allow at least 1 year of follow-up for determining long-term case-fatality, only admissions on or before 30 June 2009 were included for analysis of long-term case-fatality. Population statistics were obtained from the Hong Kong Census and Statistics Department (www.censtatd.gov.hk). Ethics approval was obtained from The University of Hong Kong and The Chinese University of Hong Kong.

Statistical analysis

Age- and sex-specific IHD incidence rates were defined as the number of IHD inpatient episodes divided by the size of the corresponding population, and multiplied by 100,000 to give a unit of "per 100,000 population". Age- and sex-specific short-term and long-term case-fatality rates were defined as the number of deaths from all causes occurring within 30 days and 31–365 days of hospital admission, respectively, divided by the number of IHD inpatient episodes in the corresponding population, and multiplied by 100% to give percentage as the unit. Age-standardised incidence rates were calculated by a direct method using statistics from the 2009 Hong Kong population. Age-standardised case-fatality rates were calculated by a direct method using the total number of IHD episodes in 2000–2009 as the standard. Eight age groups (15–24, 25–34, 35–44, 45–54, 55–64, 65–74, 75–84, and ≥85 years) were classified for this study.

Age- and sex-specific IHD incidence rates and case-fatality rates were plotted against time. Since there were diverging trends in the age- and sex-specific rates, their trends were modelled separately. Poisson and logistic regression models were used to examine the trends in IHD incidence and case-fatality, respectively, with year of admission as the independent variable. In the Poisson model, the age- and sex-specific population was used as the offset population. Data analysis was performed using SPSS version 20.0 (SPSS Inc., Chicago, IL, USA). A significance level of 5% was adopted.

RESULTS

In total, 179,769 IHD inpatient episodes were identified during 2000–2009 among the Hong Kong population aged ≥15 years, and 61.8% of these episodes occurred in men. Approximately 9% of the IHD inpatient episodes resulted in subsequent death within 30 days of hospital admission, and another 9% resulted in subsequent death during 31–365 days after hospital admission (Table 1).

The age-standardised IHD incidence rate (per 100,000 population) for men aged ≥15 years remained stable at 460.9 in 2000 and 477.9 in 2009, whereas that for women declined from 290.7 to 251.1 over the same time period (Table 2). Figure 1 shows the age- and sex-specific IHD incidence rates. Poisson regression analysis showed that the incidence rates of IHD increased significantly by 10.7% per year (95% confidence interval [CI]: 1.4%–20.9%) among men aged 15–24 years, 2.2% per year (95% CI: 1.0%–3.4%) among men aged 35–44 years, and 4.1% per year (95% CI: 1.4%–6.8%) among men aged ≥85 years, despite the overall stable trend. For women, the incidence rates decreased significantly by 3.0% per year (95% CI: 0.5%–5.4%) among those aged 35–44 years, 5.2% per year (95% CI: 4.0%–6.4%) among those aged 45–54 years, 6.7% per year (95% CI: 5.1%–8.4%) among those aged 55–64 years, and 4.0% per year (95% CI: 2.6%–5.4%) among those aged 65–74 years, but remained stable for the youngest and oldest age groups. Table 3 provides a summary of the trends analysis.

The age-standardised short-term case-fatality rates remained stable for both men and women. In 2009, the age-standardised short-term case-fatality rates for men and women aged ≥15 years were 7.0% and 10.8%, respectively (Table 2). Figure 2 shows the age- and sex-specific short-term case-fatality rates for IHD. Logistic regression analysis (Table 3) showed that the short-term IHD case-fatality rate for men aged 55–64 years decreased significantly by 2.7% per year (95% CI: 0.3%–5.1%) while remaining stable for other age groups. For women, the rates increased significantly by 2.9% per year (95% CI: 0.8%–5.0%) for those aged 65–74 years, and by 3.4% per year (95% CI: 1.9%–4.8%) for those aged ≥85 years, in the context of the overall stable trend.

The age-standardised long-term case-fatality rate for men aged ≥15 years increased from 7.0% in 2000 to 8.6% in 2009, whereas that for women increased from 10.1% in 2000 to 11.5% in 2009 (Table 2). However, when analysed by age and sex, the logistic regression analysis (Table 3) showed that significant increases were observed only among a few groups. The long-term case-fatality increased significantly by 2.7% per year (95% CI: 0.1%–5.3%) among men aged 55–64 years, 2.7% per year (95% CI: 1.3%–4.1%) among men aged 75–84 years, 2.2% per year (95% CI: 0.8%–3.7%) among women aged 75–84 years, and 2.4% per year (95% CI: 0.8%–4.1%) among women aged ≥85 years. Figure 3 shows the age- and sex-specific long-term IHD case-fatality rates.

DISCUSSION

This study examined IHD incidence and case-fatality trends among the Hong Kong population aged ≥15 years, using inpatient data. While the overall trends in incidence rates were stable for men and women, trends for different age groups among men and women differed. Men aged 15–24, 35–44, and ≥85 years had an increasing trend; men aged 55–64 years and women aged 35–74 years had decreasing trends. The trends in short-term and long-term case-fatality rates for both men and women remained stable overall, although men aged 55–64 years had a decreasing trend in short-term case-fatality rate. Some age groups even showed an increasing trend in short-term case-fatality (women aged 65–74 and ≥85 years) and long-term case-fatality (men aged 55–64 and 75–84 years, and women aged ≥75 years). It should be noted that owing to the small number of IHD cases among those aged 15–24, the estimated 10.7% increase in annual incidence among men of this age group was imprecise, as reflected by the estimate's wide confidence interval (from 1.4% to 20.9%). Furthermore, the absence of subsequent mortality in this age group also prohibited the examination of case-fatality trends (except short-term case-fatality for men). While the case-fatality rates among those aged 25–34 could be estimated, abrupt peaks resulted (Figures 2 and 3). For example, 1 death among 4 inpatient episodes could result in a case-fatality rate of 25%.

Our findings resembled those from the England and Wales IHD mortality study, in that unfavourable increasing trends were observed for young adult men.[9] The stable trends found in our study are similar to the levelling-off of IHD mortality rates among younger adults in the US.[10] Both the UK and the US studies suggested that the increasing IHD mortality rates observed among young adults may have been due to unfavourable trends in risk factors, particularly obesity, diabetes, and hypertension. An impact model suggested that improvements in medical treatment contributed to Hong Kong's decline in IHD-related mortality from 1989 to 2001 to a greater extent than risk factor reduction.[11] However, this explanation may not be applicable to our study in which case-fatality included death from all causes. Below, we explore possible explanations for our findings.

The prevalence of daily cigarette smoking in men aged ≥15 years declined steadily from 39.7% in 1982 to 20.8% in 2009; meanwhile, that for women declined from 5.6% in 1982 to 2.6% in 1990, but increased again to 4% in 2005 (http://www.tco.gov.hk/). Studies have shown that the reduction in CVD risk becomes apparent within 5 years of smoking cessation.[12,13] Therefore, if changes in smoking prevalence alone contributed substantially to IHD trends, we would expect a larger reduction in IHD incidence among men than women. However, women aged 35–74 years showed a significant decline in IHD incidence, while men did not. Thus, risk factors other than smoking (which may not have decreasing trends) may have affected the IHD incidence.

Three local health surveys have provided information on the rates of various cardiovascular risk factors including hypertension, overweight, high cholesterol, diabetes mellitus, and physical activity level.[14-16] Inconsistent trends in different population subgroups were found for these risk factors. Despite age differences in the survey respondents, the prevalence of overweight, high cholesterol, and diabetes mellitus appeared to have decreased, with greater decrease among women than men. The proportion of men and women who did not perform exercise in a month declined slightly, from over to below a half of respondents. In contrast, the prevalence of hypertension increased markedly for both sexes for all age groups. In 1995–1996, the prevalence of hypertension among men aged 25–34, 35–44, 45–54, 55–65, and 65–74 years was 3%, 7%, 17%, 37%, and 52%, respectively; in 2003–2004, these rates increased to 11%, 23%, 34%, 50%, and 66%, respectively. For women, the prevalence of hypertension in 1995–1996 for those aged 25–34, 35–44, 45–54, 55–65, and 65–74 years was 1%, 5%, 20%, 40%, and 55% respectively; in 2003–2004, these rates increased to 5%, 14%, 31%, 47%, and 70%, respectively. Those aged ≤44 years had the fastest rate of increase in prevalence of hypertension (ranging from 3-fold to 8-fold). Even among those with the slowest rate of increase (subjects aged ≥55 years), the rates also doubled. Moreover, the proportion of men with hypertension increased faster than that of women (except for those aged 25–34). Hypertension is a major risk factor of CVD, contributing to 49% of IHD cases.[17] Hypertension has also been indicated as a contributing factor to 41% of CVD-related deaths, compared with 14% for smoking, 13% for poor diet, 12% for insufficient physical activity, and 9% for abnormal glucose levels.[3] It is possible that the unfavourable trend in prevalence of hypertension outweighed the beneficial effects of the favourable trends in other risk factors, including smoking.

Extreme environmental temperatures may also hasten the onset of IHD, with the elderly population being more vulnerable,[18, 19] as observed in the Hong Kong population.[20, 21] The trends in IHD incidence and case-fatality rates observed in our study may partly be explained by trends in temperature extremes. Hong Kong Observatory data (www.hko.gov.hk) reveal that the annual number of days with extreme hot or cold temperatures has been generally increasing, although such increase is not statistically significant. This phenomenon may explain the increasing IHD trend among men aged ≥85 years and the non-decreasing trends among all older age groups. However, since younger populations are less likely to be affected by extreme temperatures, temperature is unlikely to have contributed to IHD trends in those groups. Furthermore, air pollution (reflected by reduced visibility) has been associated with increased rates of mortality, respiratory disease, and CVD in particular.[22] The number of "invisible days" in Hong Kong (www.hko.gov.hk) increased sharply from 2000 to 2009, and this may have partly contributed to the unfavourable IHD trends observed.

Another potential IHD risk factor is chronic stress. A recent review found that chronic stress predicted the occurrence of IHD.[23] Both short-term and long-term stresses were related to an increased risk of heart disease and mortality. The workplace is one source of stress for employees. In Hong Kong, men in particular face work- and financial-related stress, and their situations are worsened by the concepts of masculinity held in the society, a lack of gender-specific support services for men, and men's general reluctance to seek help.[24] This may explain the increasing incidence of IHD among younger men. Meanwhile, elderly men tend to be more susceptible to socioeconomic and political stressors than women, a concept supported by an association between their mortality rates and environmental stressors.[25] This may explain the increasing incidence of IHD among men aged ≥85 years. Furthermore, a higher socioeconomic status has been associated with a higher risk of death from IHD, [26] and growing up in an economically developed environment increased the risk of IHD among men more than women.[27] These factors may at least partly explain the increasing IHD incidence among younger and older men, but not women. Other reasons for the increasing incidence among those aged ≥85 years may include a poorer *in utero* environment or more adverse early-life experiences aggravated by accelerated growth in a later improved living environment, exposure to periods of economic hardship, and poor primary care. [28-31] However, these reasons apply to both genders, despite a significant increase being found only among men aged ≥85 years.

Survival of out-of-hospital cardiac arrest patients depends on resuscitation guidelines and practices, as well as response time.[32, 33] In Hong Kong, the outcomes for patients with out-of-hospital cardiac arrest are poor.[34] Knowledge of cardiopulmonary resuscitation techniques among the public is also poor.[35] Fewer than 16% of witnessed cardiac arrests received bystander cardiopulmonary resuscitation and only 11% of those received bystander cardiopulmonary resuscitation were discharged alive.[36] Overall, there is insufficient information relating to out-of-hospital survival for IHD patients. We are uncertain if the non-decreasing IHD incidence may be related to improvement in out-of-hospital survival for IHD patients, and hence an increasing prevalence of hospital admissions.

This study has certain limitations. Our dataset does not capture 100% of IHD inpatients in Hong Kong, since some patients are treated in the private sector. From 2000 to 2009, the proportion of IHD patients admitted to public hospitals slightly decreased, from 93% to 88% (www.ha.org.hk). However, since the shift from the public to the private system has been slow, the effect should not be strong. We believe that the increase in IHD incidence observed in our study may have been slightly greater if patients utilising the private sector were considered; for those groups that showed decreasing trends, the extent of decline may have been slightly smaller than observed. Using inpatient records for secondary data analysis does not allow examination of trends in underlying risk factors for each individual. Furthermore, the trends in the incidence and case-fatality rates of patients who did not have an overnight hospital stay, and those who died before hospital arrival, in the accident and emergency department, or before inpatient admission, could not be captured. While the hospitalisation diagnoses were verified by HA experts, no validation study on hospital diagnoses has been published. Since the dataset available did not include the cause of death, deaths subsequent to IHD hospitalisation, and for which IHD was the main cause, could not be examined. Nevertheless, we were able to use a territory-wide database spanning a decade to examine IHD trends. We further examined the IHD mortality rates according to the data available from the website of the Department of Health (www.healthyhk.gov.hk). It was found (results not shown) that the mortality rates from IHD for most age groups, both male and female, did not decrease over the past decade, although those for men aged 65–74 years and women aged 55–74 years did decrease. These data were consistent with our findings of unfavourable trends.

Although we cannot determine the exact underlying factor(s) contributing to the unfavourable trends in the incidence and case-fatality of IHD, we are able identify some of the possible modifiable factors, the most obvious being better population control of blood pressure, even though hypertension does not automatically lead to IHD. Salt intake reduction is known to be an effective non-pharmacological intervention for reducing blood pressure.[37, 38] The diversity and strength of the evidence for the effect of high salt intake on blood pressure is far greater than that for other risk factors, such as low consumption of fruit and vegetables, overweight, excess alcohol intake, and low physical activity level.[17] In a local study in 1998–2000, it was shown that ambulatory blood pressure decreased significantly with salt intake reduction.[39] However, salt intake reduction has been given less attention in Hong Kong compared with other health promotion programmes (such as smoking cessation). A local population nutrition survey showed that 78% of adults had a sodium intake over 2300 mg/day, a value considered to be associated with an age-related elevation in blood pressure.[40] The average salt intake increased from 8.0 g/day to 9.9 g/day from 1989–1991 to 2000–2002,[41] far exceeding the maximum daily intake of 5 g/day recommended by the World Health Organization.[42] Reducing salt intake involves behavioural change that can be difficult to achieve, particularly because such change has to be sustained. Social learning theory and behavioural approaches have been adopted to achieve salt intake reduction.[43] Lifestyle modification programmes, which have been effective in weight maintenance,[44] may also provide practical approaches to reducing salt intake.

An increasing IHD incidence, in terms of inpatient admission, combined with a stable case-fatality rate will lead to increased healthcare expenditure. The increasing trend in short-term case-fatality rate for women is of concern, and further analysis is required to determine whether this can be explained by gender differences in delayed diagnoses, reduced accessibility to interventional procedures, or genuinely poorer outcomes of IHD for women. Risk factor reduction among IHD survivors remains an important strategy in controlling IHD disease burden.

Acknowledgements

This study is part of the project entitled "CADENZA: A Jockey Club Initiative for Seniors" funded by The Hong Kong Jockey Club Charities Trust. The authors would like to acknowledge the Strategy and Planning Division of the Hospital Authority for the provision of data for this study.

Competing interests

None declared.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Contributorship Statement

PC and JW participated in the conception and design of the study and interpretation of the findings. PC and MW participated in literature review and data analysis. All authors contributed to the writing of the article.

Data Sharing Statement

There are no additional data available.

Table 1 Characteristics of IHD inpatient episodes by sex, 2000-2009, Hong Kong

		Events in men			Events in women		
Characteristics	**All events**	**All**	**Short-term deaths**	**Long-term deaths#**	**All**	**Short-term deaths**	**Long-term deaths#**
IHD inpatient episode	179,769	111,112	8,250	7,980	68,657	7,915	7,114
Mean (SD) age (years), median	69.3(12.5), 71.0	66.3(12.2), 68.0	75.9(10.7), 77.0	74.7(10.3), 76.0	74.0(11.5), 75.0	81.8(9.3), 83.0	80.6(9.2), 81.0
Age group:							
15-24	56	43	1	0	13	0	0
25-34	543	457	4	8	86	2	2
35-44	5,190	4,451	73	66	739	15	17
45-54	19,401	15,620	306	286	3,781	73	65
55-64	33,442	25,076	741	793	8,366	233	250
65-74	54,812	35,029	2,095	2,381	19,783	1,173	1,295
75-84	48,152	24,473	3,293	3,186	23,679	3,204	2,995
≥85	18,173	5,963	1,737	1,260	12,210	3,215	2,490
Year:							
2000	16,836	9,950	724	651	6,886	661	643
2001	17,405	10,640	669	710	6,765	591	602
2002	17,100	10,442	700	739	6,658	573	652
2003	15,677	9,663	759	747	6,014	717	637
2004	17,713	10,997	817	866	6,716	809	784
2005	17,647	11,127	818	809	6,520	799	744
2006	17,819	11,138	754	816	6,681	809	738
2007	18,361	11,453	939	970	6,908	942	885
2008	19,435	12,138	1,018	1,040	7,297	1,007	913
2009	21,776	13,564	1,052	632	8,212	1,007	516

Note: # Only includes 104,076 male IHD inpatients and 64,387 female IHD inpatients who were admitted on or before 30 June 2009.

Table 2. The IHD incidence and case-fatality rates, 2000 and 2009

Age group (years)	Incidence rate (per 100,000 population) Male		Female		Short-term mortality rate (%) Male		Female		Long-term mortality rate* (%) Male		Female	
	2000	2009	2000	2009	2000	2009	2000	2009	2000	2009	2000	2009
15-24	0.9	1.8	0.2	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
25-34	9.5	7.7	1.8	1.8	0.0	0.0	0.0	0.0	2.1	0.0	0.0	0.0
35-44	70.8	86.7	13.3	9.6	1.7	1.8	1.1	1.6	1.1	2.1	0.0	0.0
45-54	282.3	290.6	91.5	58.5	1.9	2.1	2.7	1.8	2.1	3.0	1.2	2.2
55-64	860.9	766.5	403.9	234.7	3.8	2.6	3.0	2.5	3.5	4.3	3.5	2.2
65-74	1586.0	1562.1	1049.7	801.1	6.3	5.9	6.0	6.0	6.2	7.6	7.0	5.7
75-84	1951.7	2331.5	1719.1	1661.2	15.2	12.3	13.1	12.1	12.4	15.9	12.6	15.9
≥85	2362.0	3005.7	2250.6	2640.0	26.2	26.7	21.9	25.3	23.1	24.2	18.5	22.9
≥15 (age-adjusted#)	460.9	477.9	290.7	251.1	7.9	7.0	10.7	10.8	7.0	8.6	10.1	11.5

Note: * Only includes IHD inpatients who were admitted on or before 30 June 2009.

The 2009 Hong Kong population and the total number of IHD inpatient episodes in 2000–2009 were used as the standard populations for calculating age-adjusted incidence rates and case-fatality rates, respectively.

Table 3. Fitted annualised **percentage change in the incidence of IHD and subsequent risk of short- and long-term mortality based on Poisson regression and logistic regression, respectively**

Age group (years)	**Incidence**		**Short-term mortality**		**Long-term mortality**	
	Male	**Female**	**Male**	**Female**	**Male**	**Female**
	% change in rate per year		**% change in risk per year**			
15–24	10.7% (1.4%–20.9%)	--	--	N/A	N/A	N/A
25–34	--	--	--	--	--	--
35–44	2.2% (1.0%–3.4%)	-3.0% (-5.4%– -0.5%)	--	--	--	--
45–54	--	-5.2% (-6.4%– -4.0%)	--	--	--	--
55–64	-1.5% (-2.8%– -0.3%)	-6.7% (-8.4%– -5.1%)	-2.7% (-5.1%– -0.3%)	--	2.7% (0.1%–5.3%)	--
65–74	--	-4.0% (-5.4%– -2.6%)	--	2.9% (0.8%–5.0%)	--	--
75–84	--	--	--	--	2.7% (1.3%–4.1%)	2.2% (0.8%–3.7%)
85+	4.1% (1.4%–6.8%)	--	--	3.4% (1.9%–4.8%)	--	2.4% (0.8%–4.1%)

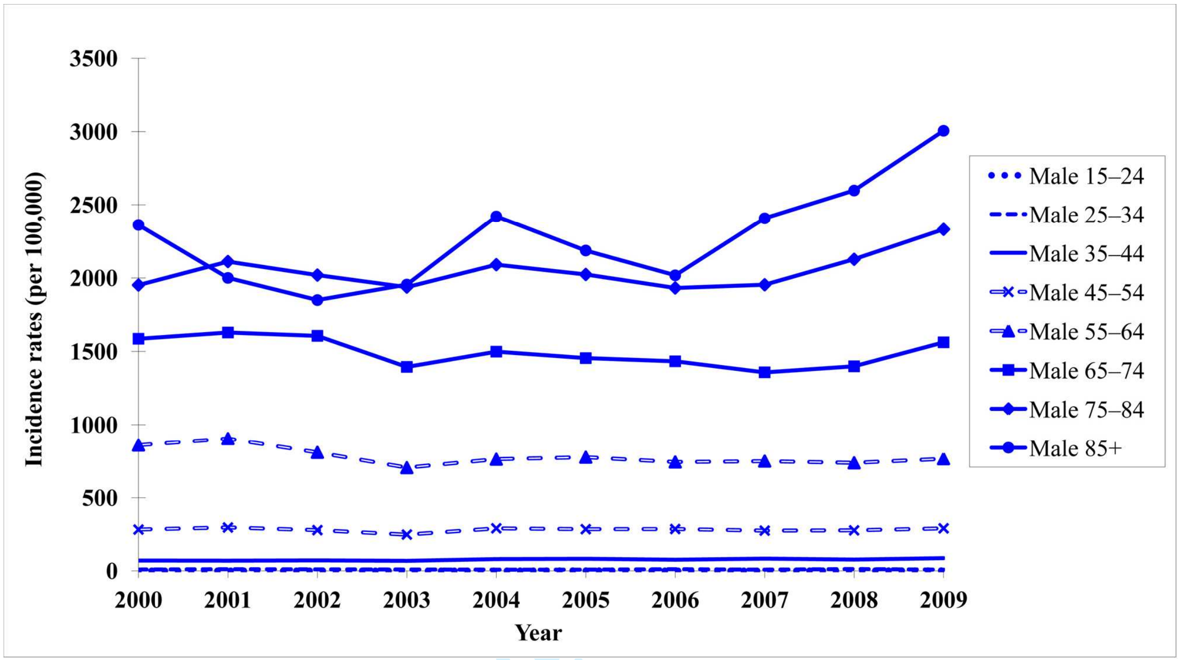
Remarks: N/A, not available as no death occurred during the study period.

Figures in brackets are 95% confidence intervals.

--, insignificant trend (p-value > 0.05).

Figure 1. Age- and sex-specific IHD incidence rates among the population aged ≥15 years in Hong Kong for 2000–2009

a. Male



b. Female

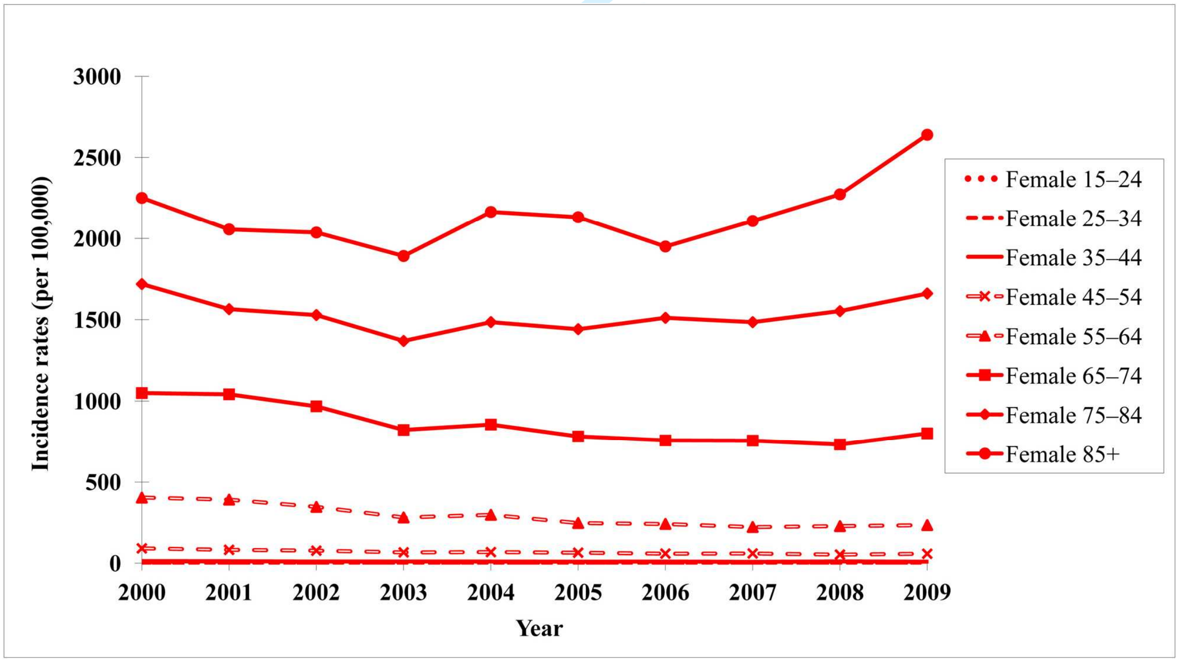
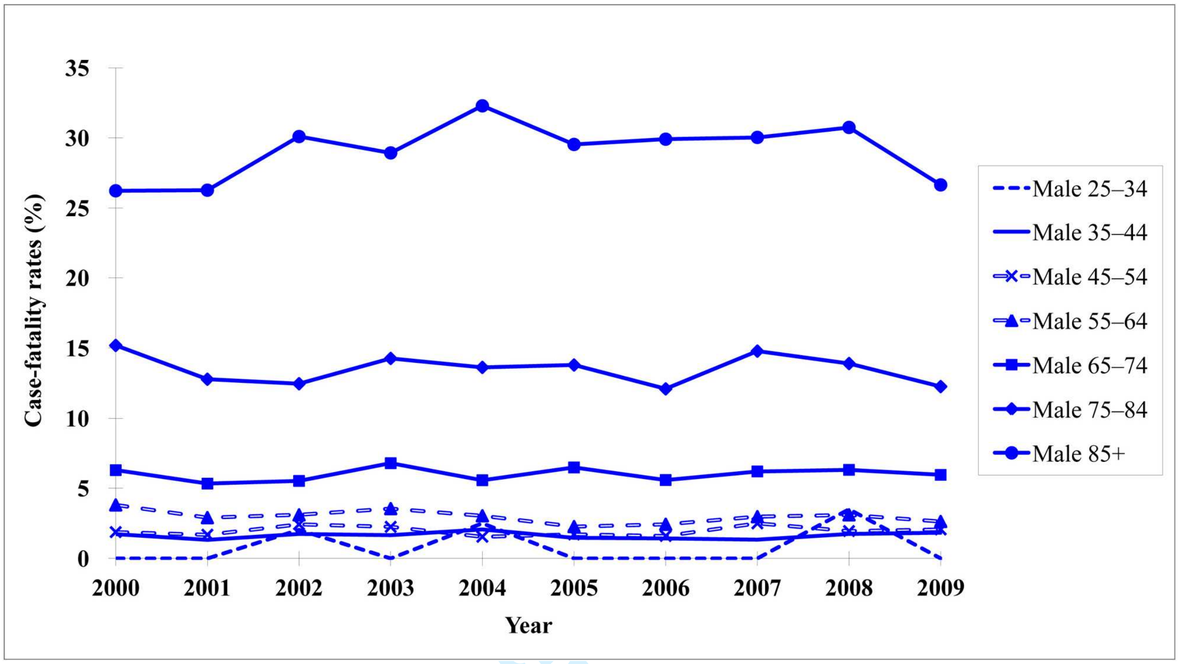


Figure 2. Age- and sex-specific short-term IHD case-fatality rates among the population aged ≥15 years in Hong Kong for 2000–2009

a. Male



b. Female

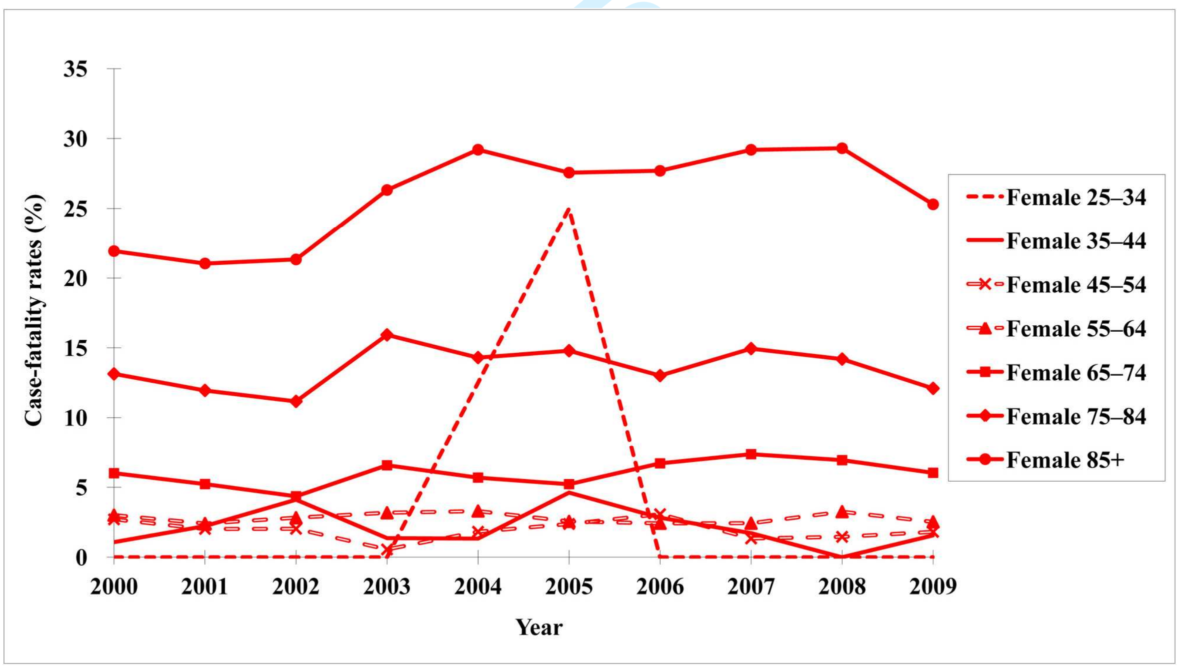
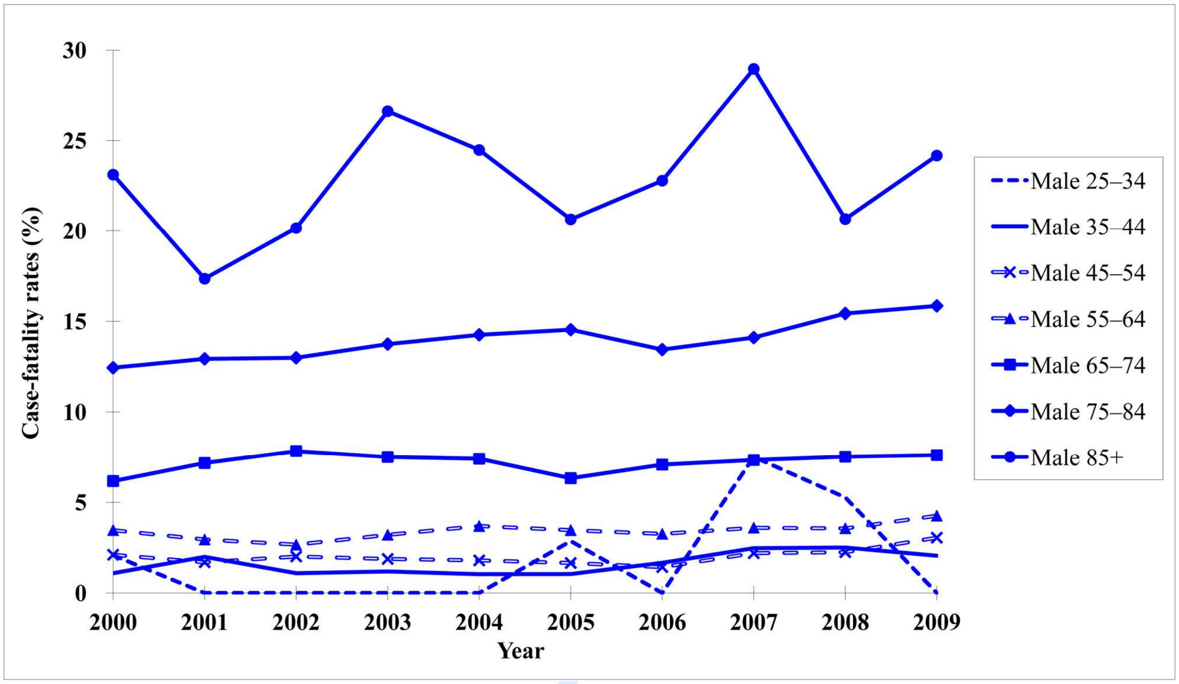
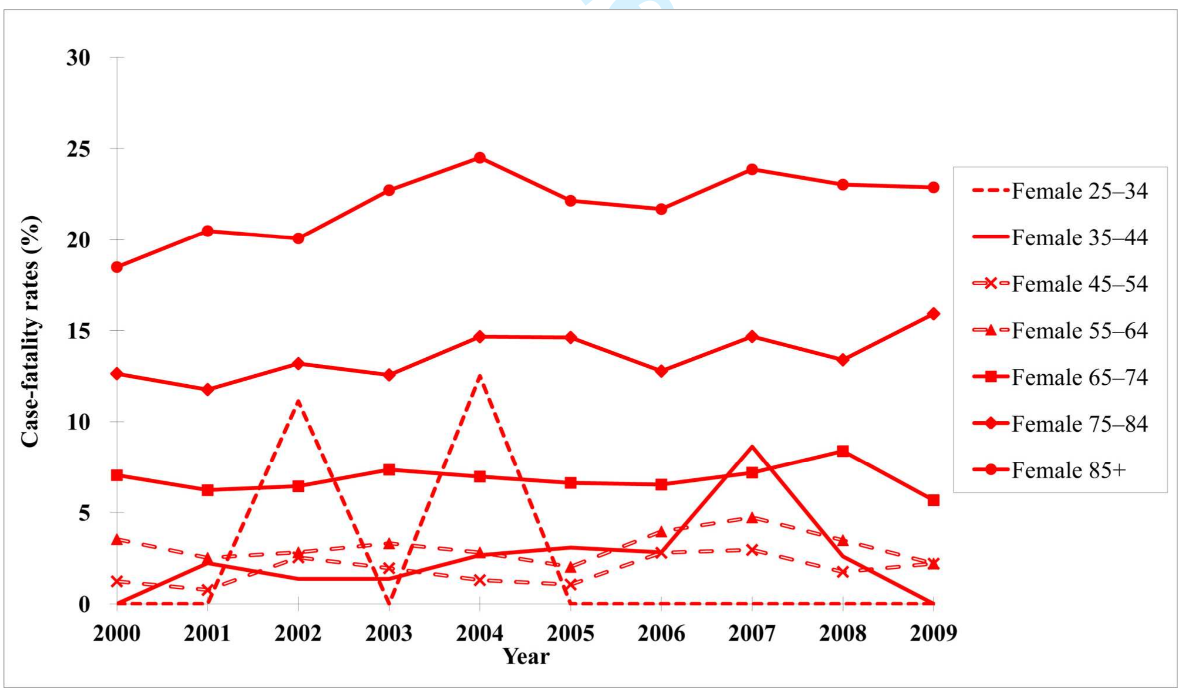


Figure 3. Age- and sex-specific long-term IHD case-fatality rates among the population aged ≥15 years in Hong Kong for 2000–2009

a. Male



b. Female



References

1 World Health Organization. The top 10 causes of death. 2011. http://www.who.int/mediacentre/factsheets/fs310/en/ (accessed 11 Jan 2013).

2 Lozano R, Naghavi M, Foreman K*, et al.* Global and regional mortality from 235 causes of death for 20 age groups in 1990 and 2010: a systematic analysis for the Global Burden of Disease Study 2010. doi: 10.1016/S0140-6736(12)61728-0. *Lancet* 2012;**380**:2095-128.

3 Go AS, Mozaffarian D, Roger VL*, et al.* Heart Disease and Stroke Statistics--2013 Update: A Report From the American Heart Association. *Circulation* 2013;**127**:e6-e245.

4 Chau PH, Woo J, Chan KC*, et al.* Avoidable mortality pattern in a Chinese population--Hong Kong, China. *Eur J Public Health* 2011;**21**:215-20.

5 Truelsen T, Mahonen M, Tolonen H*, et al.* Trends in stroke and coronary heart disease in the WHO MONICA Project. *Stroke* 2003;**34**:1346-52.

6 Wu Z, Yao C, Zhao D*, et al.* Sino-MONICA project: a collaborative study on trends and determinants in cardiovascular diseases in China, Part i: morbidity and mortality monitoring. *Circulation* 2001;**103**:462-8.

7 Schmidt M, Jacobsen JB, Lash TL*, et al.* 25 year trends in first time hospitalisation for acute myocardial infarction, subsequent short and long term mortality, and the prognostic impact of sex and comorbidity: a Danish nationwide cohort study. *BMJ* 2012;**344**:e356.

8 Smolina K, Wright FL, Rayner M*, et al.* Determinants of the decline in mortality from acute myocardial infarction in England between 2002 and 2010: linked national database study. *BMJ* 2012;**344**:d8059.

9 O'Flaherty M, Ford E, Allender S*, et al.* Coronary heart disease trends in England and Wales from 1984 to 2004: concealed levelling of mortality rates among young adults. *Heart* 2008;**94**:178-81.

10 Ford ES, Capewell S. Coronary heart disease mortality among young adults in the U.S. from 1980 through 2002: concealed leveling of mortality rates. *Journal of the American College of Cardiology* 2007;**50**:2128-32.

11 McGhee SM, So JC, Thomas GN. Explaining coronary heart disease trends in Hong Kong: creation of a model for policy and planning. *Hong Kong Med J* 2009;**15 Suppl 2**:22-5.

12 Meade TW, Imeson J, Stirling Y. Effects of changes in smoking and other characteristics on clotting factors and the risk of ischaemic heart disease. *Lancet* 1987;**2**:986-8.

13 Bakhru A, Erlinger TP. Smoking cessation and cardiovascular disease risk factors: results from the Third National Health and Nutrition Examination Survey. *PLoS Med* 2005;**2**:e160.

14 Janus ED, Cockram CS, Fielding R*, et al. Hong Kong Cardiovascular Risk Factor Prevalence Study 1995 - 1996*. Hong Kong: Department of Clinical Biochemistry, Queen Mary Hospital of Hong Kong. 1997.

15 Department of Health. Report on Population Health Survey 2003 / 2004. 2005. http://www.chp.gov.hk/files/pdf/Heart_Health_Survey_en_20071109.pdf (accessed 11 Jan 2013). Hong Kong: Department of Health of Hong Kong Special Administrative Region and Department of Community Medicine of The University of Hong Kong.

16 Department of Health. Heart Health Survey 2004 / 2005. 2007. http://www.chp.gov.hk/files/pdf/Heart_Health_Survey_en_20071109.pdf. (accessed 11 Jan 2013). Hong Kong: Department of Health.

17 He FJ, MacGregor GA. Reducing population salt intake worldwide: from evidence to implementation. *Prog Cardiovasc Dis* 2010;**52**:363-82.

18 Basu R, Samet JM. Relation between elevated ambient temperature and mortality: a review of the epidemiologic evidence. *Epidemiol Rev* 2002;**24**:190-202.

19 Barnard LF, Baker MG, Hales S*, et al.* Excess winter morbidity and mortality: do housing and socio-economic status have an effect? *Rev Environ Health* 2008;**23**:203-21.

20 Yan YY. The influence of weather on human mortality in Hong Kong. *Soc Sci Med* 2000;**50**:419-27.

21 Chau PH, Chan KC, Woo J. Hot weather warning might help to reduce elderly mortality in Hong Kong. *International Journal of Biometeorology* 2009;**53**:461-8.

22 Thach TQ, Wong CM, Chan KP*, et al.* Daily visibility and mortality: assessment of health benefits from improved visibility in Hong Kong. *Environ Res* 2010;**110**:617-23.

23 Steptoe A, Kivimaki M. Stress and cardiovascular disease. *Nat Rev Cardiol* 2012;**9**:360-70.

24 Leung LC, Chan KW. Understanding the Masculinity Crisis: Implications for Men's Services in Hong Kong. doi:10.1093/bjsw/bcs122. *British Journal of Social Work* 2012.

25 Chau PH, Yen E, Morley JE*, et al.* The effects of environmental stressors on the mortality of the oldest old male population in Hong Kong, 1977-2006. *Aging Male* 2008;**11**:179-88.

26 Wong SL, Donnan SP. Influence of socioeconomic status on cardiovascular diseases in Hong Kong. *J Epidemiol Community Health* 1992;**46**:148-50.

27 Schooling CM, Lam TH, Thomas GN*, et al.* Growth environment and sex differences in lipids, body shape and diabetes risk. *PLoS One* 2007;**2**:e1070.

28 Law CM, Shiell AW, Newsome CA*, et al.* Fetal, infant, and childhood growth and adult blood pressure: a longitudinal study from birth to 22 years of age. *Circulation* 2002;**105**:1088-92.

29 Cheung YF, Wong KY, Lam BC*, et al.* Relation of arterial stiffness with gestational age and birth weight. *Archives of Disease in Childhood* 2004;**89**:217-21.

30 Yi Z, Gu D, Land KC. The association of childhood socioeconomic conditions with healthy longevity at the oldest-old ages in China. *Demography* 2007;**44**:497-518.

31 Chau PH, Woo J, Gusmano MK*, et al.* Access to primary care in Hong Kong, Greater London and New York City. *Health Econ Policy Law* 2013;**8**:95-109.

32 Vukmir RB. Survival from prehospital cardiac arrest is critically dependent upon response time. *Resuscitation* 2006;**69**:229-34.

33 Kudenchuk PJ, Redshaw JD, Stubbs BA*, et al.* Impact of changes in resuscitation practice on survival and neurological outcome after out-of-hospital cardiac arrest resulting from nonshockable arrhythmias. *Circulation* 2012;**125**:1787-94.

34 Leung LP, Lo CM, Tong HK. Prehospital resuscitation of out-of-hospital cardiac arrest in Queen Mary Hospital. *Hong Kong Journal of Emergency Medicine* 2000;**7**:191-6.

35 The University of Hong Kong Cardiopulmonary Resuscitation Knowledge Studt Group. Knowledge of cardiopulmonary resuscitation among the public in Hong Kong: telephone questionnaire survey. *Hong Kong Med J* 2003:323-8.

36 Chung CH, Wong PCY. A six-year prospective study of out-of-hospital cardiac arrest managed by a voluntary ambulance organisation. *Hong Kong Journal of Emergency Medicine* 2005;**12**:140-7.

37 Dickinson HO, Mason JM, Nicolson DJ*, et al.* Lifestyle interventions to reduce raised blood pressure: a systematic review of randomized controlled trials. *J Hypertens* 2006;**24**:215-33.

38 Sacks FM, Svetkey LP, Vollmer WM*, et al.* Effects on blood pressure of reduced dietary sodium and the Dietary Approaches to Stop Hypertension (DASH) diet. DASH-Sodium Collaborative Research Group. *N Engl J Med* 2001;**344**:3-10.

39 Cheung BMY, McGhee SM, Lau CP*, et al.* Cost-effectiveness of low-salt diet for lowering blood pressure in Hong Kong Chinese population. *Hong Kong Med J* 2007;**13**:32-6.

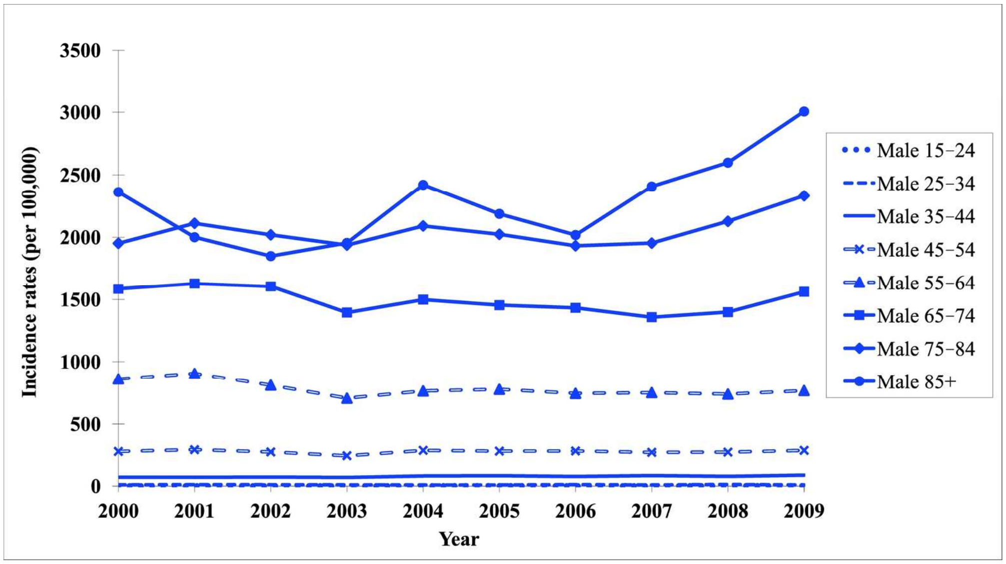
40 Woo J, Leung SS, Ho SC*, et al.* Dietary intake and practices in the Hong Kong Chinese population. *J Epidemiol Community Health* 1998;**52**:631-7.

41 The Chinese University of Hong Kong. Increasing Salt Intake Predisposes Hong Kong People to Hypertension and Its Complications. 2005. http://www.cuhk.edu.hk/cpr/pressrelease/050511e.htm (accessed 11 Jan 2013).

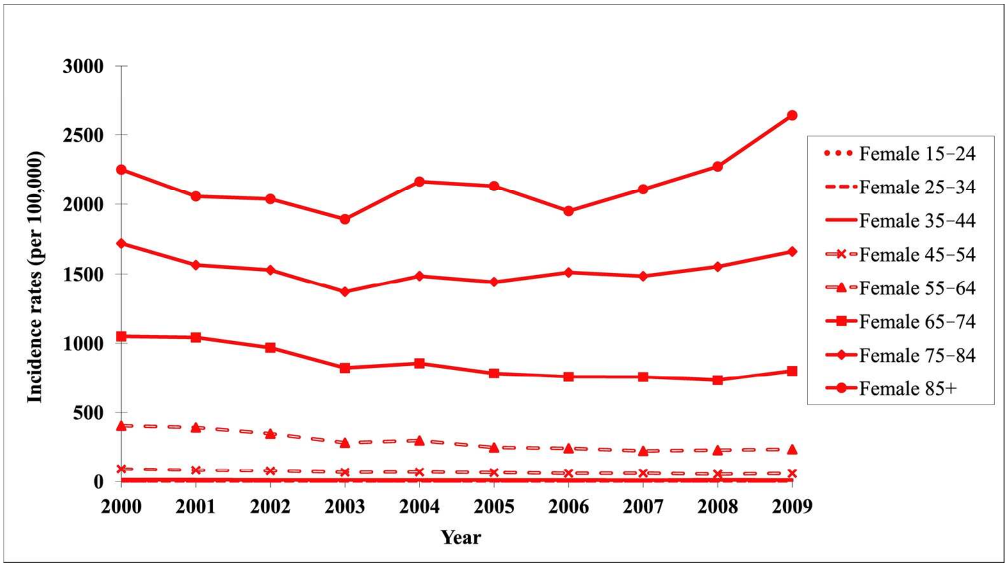
42 World Health Organization. Prevention of cardiovascular disease: guidelines for assessment and management of total cardiovascular risk. Geneva: World Health Organization. 2007.

43 Appel LJ, Espeland MA, Easter L*, et al.* Effects of reduced sodium intake on hypertension control in older individuals: results from the Trial of Nonpharmacologic Interventions in the Elderly (TONE). *Archives of Internal Medicine* 2001;**161**:685-93.

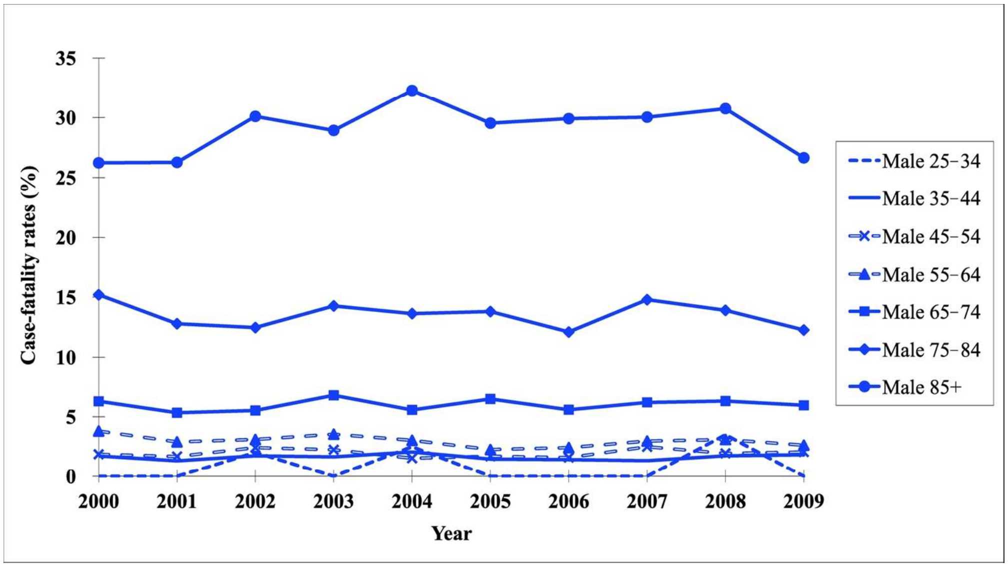
44 Woo J, Sea MM, Tong P*, et al.* Effectiveness of a lifestyle modification programme in weight maintenance in obese subjects after cessation of treatment with Orlistat. *J Eval Clin Pract* 2007;**13**:853-9.



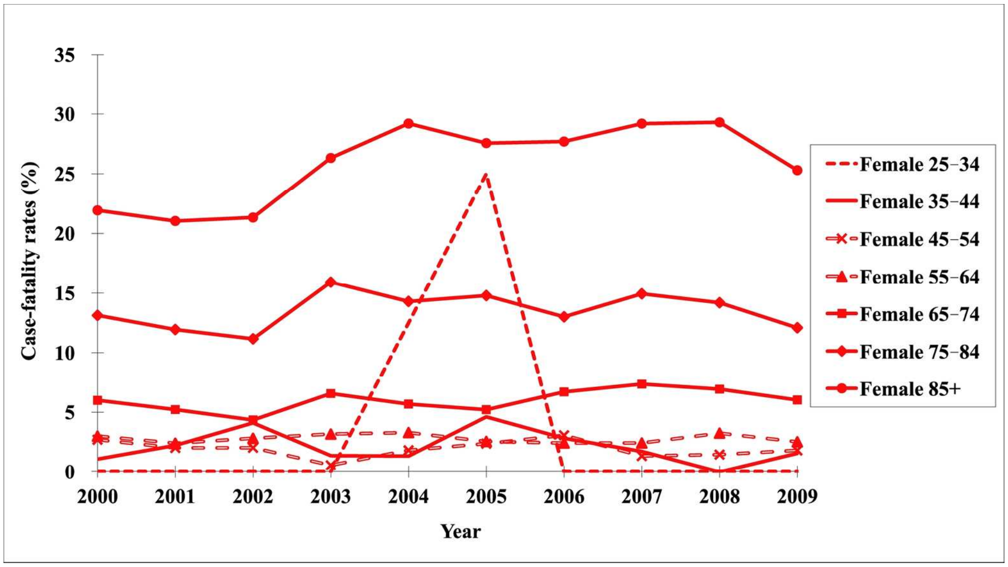
174x98mm (300 x 300 DPI)



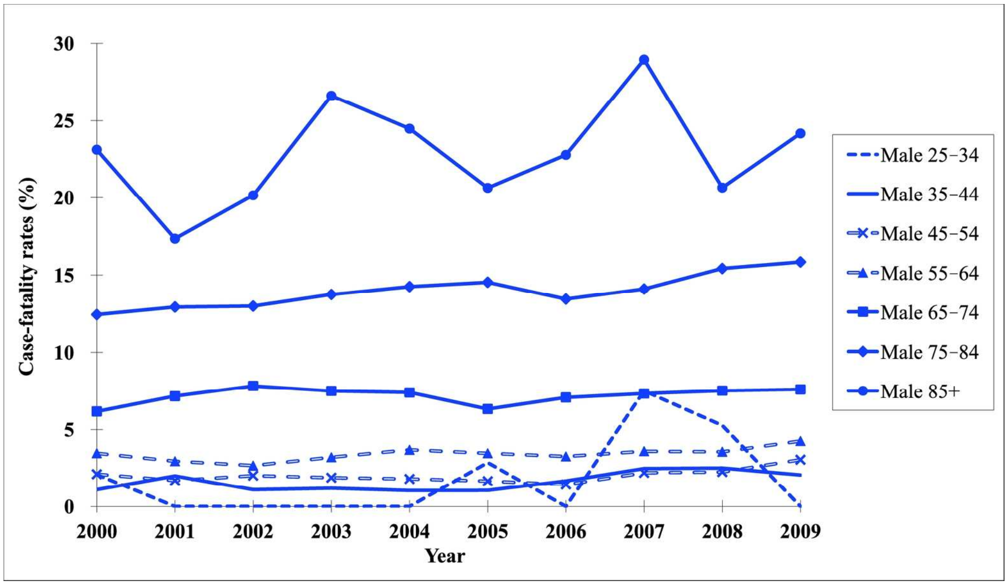
172x96mm (300 x 300 DPI)



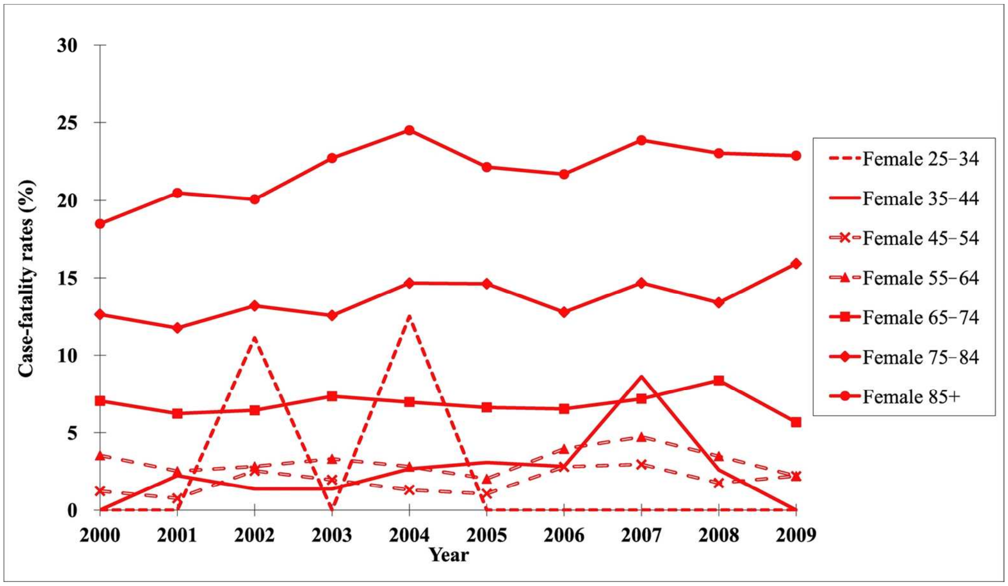
136x76mm (300 x 300 DPI)



172x96mm (300 x 300 DPI)



178x102mm (300 x 300 DPI)



140x81mm (300 x 300 DPI)

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	CHECK
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	Yes
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	Yes
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	Yes
Objectives	3	State specific objectives, including any prespecified hypotheses	Yes
Methods			
Study design	4	Present key elements of study design early in the paper	Yes
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Yes
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	Yes
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	Not Applicable
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	Yes
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Yes

Bias	9	Describe any efforts to address potential sources of bias	Yes
Study size	10	Explain how the study size was arrived at	Yes
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	Yes
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	Yes
		(*b*) Describe any methods used to examine subgroups and interactions	Yes
		(*c*) Explain how missing data were addressed	Not Applicable
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	Yes
		(*e*) Describe any sensitivity analyses	Yes

Continued on next page

Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Not Applicable
		(b) Give reasons for non-participation at each stage	Not Applicable
		(c) Consider use of a flow diagram	Not Applicable
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Yes
		(b) Indicate number of participants with missing data for each variable of interest	Not Applicable
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	Not Applicable
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	Not Applicable
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	Not Applicable
		Cross-sectional study—Report numbers of outcome events or summary measures	Not Applicable
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Yes
		(*b*) Report category boundaries when continuous variables were categorized	Yes
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	Not Applicable
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Yes
Discussion			
Key results	18	Summarise key results with reference to study objectives	Yes
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	Yes
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Yes
Generalisability	21	Discuss the generalisability (external validity) of the study results	Yes

Other information

Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Not Applicable

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

Trends in ischaemic heart disease hospitalisation and case-fatality in the Hong Kong Chinese population, 2000–2009

Chau PH[1], Wong M[2], Woo J[2]

[1]School of Nursing, The University of Hong Kong, Pokfulam, Hong Kong S. A. R.

[2]Department of Medicine and Therapeutics, The Chinese University of Hong Kong, Shatin, Hong Kong S. A. R.

Address for Correspondence

Dr Chau PH

School of Nursing, The University of Hong Kong, Pokfulam, Hong Kong.

Tel: +852 2819 2626

Fax: +852 2872 6079

Email: phchau@graduate.hku.hk

Keywords: Ischaemic heart disease, incidence, case-fatality, hospitalisation, Hong Kong

Word Count: 3,517 (excluding title page, abstract, references, figures, and tables)

ABSTRACT

Background The incidence of ischaemic heart disease (IHD) and its associated mortality and case-fatality rates differ substantially in different populations. Hong Kong has historically had a low prevalence of IHD and IHD-associated mortality. However, the incidences of some cardiovascular risk factors appear to be increasing.

Objectives This study examines the recent trends in IHD incidence and case-fatality in Hong Kong, and explores the possible risk factors.

Design/Setting Secondary data analysis was conducted on records of IHD inpatients aged ≥15 years admitted to hospitals under the Hong Kong Hospital Authority during 2000–2009.

Outcome measures Incidence rate was defined as the number of IHD inpatient episodes divided by the size of the corresponding population. Short-term and long-term case-fatality rate was defined as deaths from all causes occurring within 30 and 31–365 days, respectively, divided by the number of IHD inpatient episodes among the corresponding population.

Methods Poisson and logistic regression models were used to examine the IHD incidence and short-term/long-term case-fatality trends, respectively, for different age and sex groups.

Results IHD incidence was stable in most age groups. However, the incidence in men aged 15–24, 35–44, and ≥85 years showed increasing trends, whereas the incidence in men aged 55–64 years and women aged 35–74 years showed decreasing trends. Overall short-term/long-term case-fatality rates were unchanged over time for both sexes. Short-term case-fatality showed increasing trends in women aged 65–74 and ≥85 years, whilst long-term case-fatality in men aged 55–64 and 75–84 years and women aged ≥75 years showed increasing trends.

Conclusion Hong Kong trends resembled those in the US, England, and Wales, showing stable or slow decline in IHD rates, while increasing trends were observed for some age groups, particularly young adults. Public health promotion efforts should focus on reducing cardiovascular risk factors, such as hypertension prevalence.

Article Summary

Article Focus

- Ischaemic heart disease (IHD) incidence and case-fatality rates show diverse trends in different populations, with a slow decline in the US and an increasing trend among certain age groups in England and Wales.
- As unfavourable trends emerge in risk factors, it is uncertain if IHD trends in the Hong Kong Chinese population will follow those of Caucasian populations.
- This study examines the recent trends in IHD incidence and case-fatality rates in the Hong Kong population aged 15 years and above, and explores the possible risk factors related to such trends.

Key Messages

- On the basis of inpatient data, there was no overall decline in IHD incidence. However, the incidence for men aged 15–24, 35–44, and ≥85 years increased, whereas that for men aged 55–64 years and women aged 35–74 years decreased.
- Overall, both short-term and long-term case-fatality rates were unchanged over time for both sexes; some age groups (men aged 55–64 and 75–84 years and women aged ≥65 years) showed an increasing trend.
- The increasing prevalence of hypertension may account for this observation, and this highlights the need for directing public health promotion efforts towards measures such as reducing salt intake to reduce hypertension prevalence.

Strengths and Weaknesses of This Study

- The strength of this study is the use of a territory-wide database that captures approximately 90% of all IHD inpatients in Hong Kong, and the availability of reliable survival data enables the investigation of case-fatality. Furthermore, the longitudinal data allows for examination of IHD trends over a decade.
- This study is limited by the fact that secondary data analysis does not allow for examination of risk factors at individual level. Moreover, the trends in the IHD incidence and case-fatality rates of patients who did not have an overnight hospital stay, and those who died before hospital arrival, in the accident and emergency department, or before inpatient admission, could not be captured.

Trends in ischaemic heart disease hospitalisation and case-fatality in the Hong Kong Chinese population, 2000–2009

INTRODUCTION

According to the World Health Organization, ischaemic heart disease (IHD) is the leading cause of mortality worldwide, accounting for 12.8% of deaths.[1] The Global Burden of Disease Study 2010 reported that IHD was the leading cause of death in 2010.[2] The American Heart Association noted that if there is a decline in cardiovascular disease (CVD) mortality that exceeds CVD incidence, a stable high burden of disease would occur.[3]

Risk factors for IHD include tobacco smoking, hypertension, diabetes, overweight, sedentary lifestyle, and unhealthy diet. When the risk factors are controlled properly, IHD can largely be prevented. In analysing avoidable mortality, it is assumed that half of all IHD deaths are avoidable.[4] When Hong Kong was compared with Western cities (Paris, Inner London, and Manhattan), it was found that IHD ranked first for avoidable mortality among the Western cities, but only fourth in Hong Kong. It was speculated that Hong Kong had lower IHD mortality rates because of a lower prevalence of smoking and overweight; the effects of ethnic differences on susceptibility to IHD may also play a role. However, there was evidence that risk factors for IHD are becoming more common in the Hong Kong population, as reflected by daily consumption of fewer than 5 servings of fruits and vegetables and the adoption of a more sedentary lifestyle with little or no leisure-time exercise. If such unhealthy lifestyles become increasingly common, IHD mortality in Hong Kong may increase in the future.

The incidence of IHD and its associated mortality and case-fatality rates differ substantially in different populations.[5] Even within China, both increasing and decreasing trends in IHD incidence and associated mortality were observed in different populations.[6] In Denmark, the first-time hospitalisation and case-fatality rates for myocardial infarction declined between 1984 and 2008.[7] Similarly, in England, the incidence of acute myocardial infarction declined between 2002 and 2010.[8] Meanwhile, some studies have shown that these declines did not apply to all population subgroups. In England and Wales, IHD mortality among men aged 35–44 years increased from 1984 to 2004, while the decline among the overall population aged 45–54 years slowed down.[9] In a US study, it was shown that the decline in IHD mortality rate also slowed down among young adults aged 35–54 years between 2000 and 2002.[10] On the basis of the diverse trends reported in the literature, it is difficult to predict the IHD trends in the Chinese population in Hong Kong. If the trends in Hong Kong are to resemble and follow those of the US, IHD incidence in Hong Kong may increase, and subsequently decline with a decelerating rate. Furthermore, different age groups may show different trends, as was revealed in the study from England and Wales. The objectives of this study were to examine the recent trends in IHD incidence and case-fatality rates in the Hong Kong population, and to explore the possible risk factors related to such trends.

METHODS

Data

Inpatient discharge data from the Hong Kong population aged ≥15 years during 2000–2009 were obtained from the Hong Kong Hospital Authority (HA) database. Data from the Clinical Management System and information on death status of these inpatients (as of mid-2010) were linked according to patients' Hong Kong Identity Card numbers. Patients who were discharged after 31 December 2009 were not included in this dataset. Information on age, sex, and principal diagnosis, as well as information on date of admission, discharge, and death, were available from the database. The principal diagnoses were coded according to the International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) and verified by experts in the HA. IHD incidence was identified by ICD-9-CM codes 410–414 in the principal diagnosis for hospitalisation. Only inpatients were included in this study, regardless of whether admission occurred via the accident and emergency department or via inpatient/outpatient services. Patients without overnight stay, regardless of the presence of potential IHD symptoms, were not included. The current data covered nearly all IHD inpatients in Hong Kong, since 88–94% of these admissions were made to public hospitals (www.ha.org.hk). Because discharged patients might be readmitted for the same IHD episode, hospital admissions within 30 days from the date of discharge were regarded as the same IHD inpatient episode. Deaths occurring within 30 days (short-term case fatality) and 31–365 days (long-term case fatality) of hospital admission were identified by the date of death available in the database. To allow at least 1 year of follow-up for determining long-term case-fatality, only admissions on or before 30 June 2009 were included for analysis of long-term case-fatality. Population statistics were obtained from the Hong Kong Census and Statistics Department (www.censtatd.gov.hk). Ethics approval was obtained from The University of Hong Kong and The Chinese University of Hong Kong.

Statistical analysis

Age- and sex-specific IHD incidence rates were defined as the number of IHD inpatient episodes divided by the size of the corresponding population, and multiplied by 100,000 to give a unit of "per 100,000 population". Age- and sex-specific short-term and long-term case-fatality rates were defined as the number of deaths from all causes occurring within 30 days and 31–365 days of hospital admission, respectively, divided by the number of IHD inpatient episodes in the corresponding population, and multiplied by 100% to give percentage as the unit. Age-standardised incidence rates were calculated by a direct method using statistics from the 2009 Hong Kong population. Age-standardised case-fatality rates were calculated by a direct method using the total number of IHD episodes in 2000–2009 as the standard. Eight age groups (15–24, 25–34, 35–44, 45–54, 55–64, 65–74, 75–84, and ≥85 years) were classified for this study.

Age- and sex-specific IHD incidence rates and case-fatality rates were plotted against time. Since there were diverging trends in the age- and sex-specific rates, their trends were modelled separately. Poisson and logistic regression models were used to examine the trends in IHD incidence and case-fatality, respectively, with year of admission as the independent variable. In the Poisson model, the age- and sex-specific population was used as the offset population. Data analysis was performed using SPSS version 20.0 (SPSS Inc., Chicago, IL, USA). A significance level of 5% was adopted.

RESULTS

In total, 179,769 IHD inpatient episodes were identified during 2000–2009 among the Hong Kong population aged ≥15 years, and 61.8% of these episodes occurred in men. Approximately 9% of the IHD inpatient episodes resulted in subsequent death within 30 days of hospital admission, and another 9% resulted in subsequent death during 31–365 days after hospital admission (Table 1).

The age-standardised IHD incidence rate (per 100,000 population) for men aged ≥15 years remained stable at 460.9 in 2000 and 477.9 in 2009, whereas that for women declined from 290.7 to 251.1 over the same time period (Table 2). Figure 1 shows the age- and sex-specific IHD incidence rates. Poisson regression analysis showed that the incidence rates of IHD increased significantly by 10.7% per year (95% confidence interval [CI]: 1.4%–20.9%) among men aged 15–24 years, 2.2% per year (95% CI: 1.0%–3.4%) among men aged 35–44 years, and 4.1% per year (95% CI: 1.4%–6.8%) among men aged ≥85 years, despite the overall stable trend. For women, the incidence rates decreased significantly by 3.0% per year (95% CI: 0.5%–5.4%) among those aged 35–44 years, 5.2% per year (95% CI: 4.0%–6.4%) among those aged 45–54 years, 6.7% per year (95% CI: 5.1%–8.4%) among those aged 55–64 years, and 4.0% per year (95% CI: 2.6%–5.4%) among those aged 65–74 years, but remained stable for the youngest and oldest age groups. Table 3 provides a summary of the trends analysis.

The age-standardised short-term case-fatality rates remained stable for both men and women. In 2009, the age-standardised short-term case-fatality rates for men and women aged ≥15 years were 7.0% and 10.8%, respectively (Table 2). Figure 2 shows the age- and sex-specific short-term case-fatality rates for IHD. Logistic regression analysis (Table 3) showed that the short-term IHD case-fatality rate for men aged 55–64 years decreased significantly by 2.7% per year (95% CI: 0.3%–5.1%) while remaining stable for other age groups. For women, the rates increased significantly by 2.9% per year (95% CI: 0.8%–5.0%) for those aged 65–74 years, and by 3.4% per year (95% CI: 1.9%–4.8%) for those aged ≥85 years, in the context of the overall stable trend.

The age-standardised long-term case-fatality rate for men aged ≥15 years increased from 7.0% in 2000 to 8.6% in 2009, whereas that for women increased from 10.1% in 2000 to 11.5% in 2009 (Table 2). However, when analysed by age and sex, the logistic regression analysis (Table 3) showed that significant increases were observed only among a few groups. The long-term case-fatality increased significantly by 2.7% per year (95% CI: 0.1%–5.3%) among men aged 55–64 years, 2.7% per year (95% CI: 1.3%–4.1%) among men aged 75–84 years, 2.2% per year (95% CI: 0.8%–3.7%) among women aged 75–84 years, and 2.4% per year (95% CI: 0.8%–4.1%) among women aged ≥85 years. Figure 3 shows the age- and sex-specific long-term IHD case-fatality rates.

DISCUSSION

This study examined IHD incidence and case-fatality trends among the Hong Kong population aged ≥15 years, using inpatient data. While the overall trends in incidence rates were stable for men and women, trends for different age groups among men and women differed. Men aged 15–24, 35–44, and ≥85 years had an increasing trend; men aged 55–64 years and women aged 35–74 years had decreasing trends. The trends in short-term and long-term case-fatality rates for both men and women remained stable overall, although men aged 55–64 years had a decreasing trend in short-term case-fatality rate. Some age groups even showed an increasing trend in short-term case-fatality (women aged 65–74 and ≥85 years) and long-term case-fatality (men aged 55–64 and 75–84 years, and women aged ≥75 years). It should be noted that owing to the small number of IHD cases among those aged 15–24, the estimated 10.7% increase in annual incidence among men of this age group was imprecise, as reflected by the estimate's wide confidence interval (from 1.4% to 20.9%). Furthermore, the absence of subsequent mortality in this age group also prohibited the examination of case-fatality trends (except short-term case-fatality for men). While the case-fatality rates among those aged 25–34 could be estimated, abrupt peaks resulted (Figures 2 and 3). For example, 1 death among 4 inpatient episodes could result in a case-fatality rate of 25%.

Our findings resembled those from the England and Wales IHD mortality study, in that unfavourable increasing trends were observed for young adult men.[9] The stable trends found in our study are similar to the levelling-off of IHD mortality rates among younger adults in the US.[10] Both the UK and the US studies suggested that the increasing IHD mortality rates observed among young adults may have been due to unfavourable trends in risk factors, particularly obesity, diabetes, and hypertension. An impact model suggested that improvements in medical treatment contributed to Hong Kong's decline in IHD-related mortality from 1989 to 2001 to a greater extent than risk factor reduction.[11] However, this explanation may not be applicable to our study in which case-fatality included death from all causes. Below, we explore possible explanations for our findings.

The prevalence of daily cigarette smoking in men aged ≥15 years declined steadily from 39.7% in 1982 to 20.8% in 2009; meanwhile, that for women declined from 5.6% in 1982 to 2.6% in 1990, but increased again to 4% in 2005 (http://www.tco.gov.hk/). Studies have shown that the reduction in CVD risk becomes apparent within 5 years of smoking cessation.[12,13] Therefore, if changes in smoking prevalence alone contributed substantially to IHD trends, we would expect a larger reduction in IHD incidence among men than women. However, women aged 35–74 years showed a significant decline in IHD incidence, while men did not. Thus, risk factors other than smoking (which may not have decreasing trends) may have affected the IHD incidence.

Three local health surveys have provided information on the rates of various cardiovascular risk factors including hypertension, overweight, high cholesterol, diabetes mellitus, and physical activity level.[14-16] Inconsistent trends in different population subgroups were found for these risk factors. Despite age differences in the survey respondents, the prevalence of overweight, high cholesterol, and diabetes mellitus appeared to have decreased, with greater decrease among women than men. The proportion of men and women who did not perform exercise in a month declined slightly, from over to below a half of respondents. In contrast, the prevalence of hypertension increased markedly for both sexes for all age groups. In 1995–1996, the prevalence of hypertension among men aged 25–34, 35–44, 45–54, 55–65, and 65–74 years was 3%, 7%, 17%, 37%, and 52%, respectively; in 2003–2004, these rates increased to 11%, 23%, 34%, 50%, and 66%, respectively. For women, the prevalence of hypertension in 1995–1996 for those aged 25–34, 35–44, 45–54, 55–65, and 65–74 years was 1%, 5%, 20%, 40%, and 55% respectively; in 2003–2004, these rates increased to 5%, 14%, 31%, 47%, and 70%, respectively. Those aged ≤44 years had the fastest rate of increase in prevalence of hypertension (ranging from 3-fold to 8-fold). Even among those with the slowest rate of increase (subjects aged ≥55 years), the rates also doubled. Moreover, the proportion of men with hypertension increased faster than that of women (except for those aged 25–34). Hypertension is a major risk factor of CVD, contributing to 49% of IHD cases.[17] Hypertension has also been indicated as a contributing factor to 41% of CVD-related deaths, compared with 14% for smoking, 13% for poor diet, 12% for insufficient physical activity, and 9% for abnormal glucose levels.[3] It is possible that the unfavourable trend in prevalence of hypertension outweighed the beneficial effects of the favourable trends in other risk factors, including smoking.

Extreme environmental temperatures may also hasten the onset of IHD, with the elderly population being more vulnerable,[18, 19] as observed in the Hong Kong population.[20, 21] The trends in IHD incidence and case-fatality rates observed in our study may partly be explained by trends in temperature extremes. Hong Kong Observatory data (www.hko.gov.hk) reveal that the annual number of days with extreme hot or cold temperatures has been generally increasing, although such increase is not statistically significant. This phenomenon may explain the increasing IHD trend among men aged ≥85 years and the non-decreasing trends among all older age groups. However, since younger populations are less likely to be affected by extreme temperatures, temperature is unlikely to have contributed to IHD trends in those groups. Furthermore, air pollution (reflected by reduced visibility) has been associated with increased rates of mortality, respiratory disease, and CVD in particular.[22] The number of "invisible days" in Hong Kong (www.hko.gov.hk) increased sharply from 2000 to 2009, and this may have partly contributed to the unfavourable IHD trends observed.

Another potential IHD risk factor is chronic stress. A recent review found that chronic stress predicted the occurrence of IHD.[23] Both short-term and long-term stresses were related to an increased risk of heart disease and mortality. The workplace is one source of stress for employees. In Hong Kong, men in particular face work- and financial-related stress, and their situations are worsened by the concepts of masculinity held in the society, a lack of gender-specific support services for men, and men's general reluctance to seek help.[24] This may explain the increasing incidence of IHD among younger men. Meanwhile, elderly men tend to be more susceptible to socioeconomic and political stressors than women, a concept supported by an association between their mortality rates and environmental stressors.[25] This may explain the increasing incidence of IHD among men aged ≥85 years. Furthermore, a higher socioeconomic status has been associated with a higher risk of death from IHD, [26] and growing up in an economically developed environment increased the risk of IHD among men more than women.[27] These factors may at least partly explain the increasing IHD incidence among younger and older men, but not women. Other reasons for the increasing incidence among those aged ≥85 years may include a poorer *in utero* environment or more adverse early-life experiences aggravated by accelerated growth in a later improved living environment, exposure to periods of economic hardship, and poor primary care. [28-31] However, these reasons apply to both genders, despite a significant increase being found only among men aged ≥85 years.

Survival of out-of-hospital cardiac arrest patients depends on resuscitation guidelines and practices, as well as response time.[32, 33] In Hong Kong, the outcomes for patients with out-of-hospital cardiac arrest are poor.[34] Knowledge of cardiopulmonary resuscitation techniques among the public is also poor.[35] Fewer than 16% of witnessed cardiac arrests received bystander cardiopulmonary resuscitation and only 11% of those received bystander cardiopulmonary resuscitation were discharged alive.[36] Overall, there is insufficient information relating to out-of-hospital survival for IHD patients. We are uncertain if the non-decreasing IHD incidence may be related to improvement in out-of-hospital survival for IHD patients, and hence an increasing prevalence of hospital admissions.

This study has certain limitations. Our dataset does not capture 100% of IHD inpatients in Hong Kong, since some patients are treated in the private sector. From 2000 to 2009, the proportion of IHD patients admitted to public hospitals slightly decreased, from 93% to 88% (www.ha.org.hk). However, since the shift from the public to the private system has been slow, the effect should not be strong. We believe that the increase in IHD incidence observed in our study may have been slightly greater if patients utilising the private sector were considered; for those groups that showed decreasing trends, the extent of decline may have been slightly smaller than observed. Using inpatient records for secondary data analysis does not allow examination of trends in underlying risk factors for each individual. Furthermore, the trends in the incidence and case-fatality rates of patients who did not have an overnight hospital stay, and those who died before hospital arrival, in the accident and emergency department, or before inpatient admission, could not be captured. While the hospitalisation diagnoses were verified by HA experts, no validation study on hospital diagnoses has been published. Since the dataset available did not include the cause of death, deaths subsequent to IHD hospitalisation, and for which IHD was the main cause, could not be examined. Nevertheless, we were able to use a territory-wide database spanning a decade to examine IHD trends. We further examined the IHD mortality rates according to the data available from the website of the Department of Health (www.healthyhk.gov.hk). It was found (results not shown) that the mortality rates from IHD for most age groups, both male and female, did not decrease over the past decade, although those for men aged 65–74 years and women aged 55–74 years did decrease. These data were consistent with our findings of unfavourable trends.

Although we cannot determine the exact underlying factor(s) contributing to the unfavourable trends in the incidence and case-fatality of IHD, we are able identify some of the possible modifiable factors, the most obvious being better population control of blood pressure, even though hypertension does not automatically lead to IHD. Salt intake reduction is known to be an effective non-pharmacological intervention for reducing blood pressure.[37, 38] The diversity and strength of the evidence for the effect of high salt intake on blood pressure is far greater than that for other risk factors, such as low consumption of fruit and vegetables, overweight, excess alcohol intake, and low physical activity level.[17] In a local study in 1998–2000, it was shown that ambulatory blood pressure decreased significantly with salt intake reduction.[39] However, salt intake reduction has been given less attention in Hong Kong compared with other health promotion programmes (such as smoking cessation). A local population nutrition survey showed that 78% of adults had a sodium intake over 2300 mg/day, a value considered to be associated with an age-related elevation in blood pressure.[40] The average salt intake increased from 8.0 g/day to 9.9 g/day from 1989–1991 to 2000–2002,[41] far exceeding the maximum daily intake of 5 g/day recommended by the World Health Organization.[42] Reducing salt intake involves behavioural change that can be difficult to achieve, particularly because such change has to be sustained. Social learning theory and behavioural approaches have been adopted to achieve salt intake reduction.[43] Lifestyle modification programmes, which have been effective in weight maintenance,[44] may also provide practical approaches to reducing salt intake.

An increasing IHD incidence, in terms of inpatient admission, combined with a stable case-fatality rate will lead to increased healthcare expenditure. The increasing trend in short-term case-fatality rate for women is of concern, and further analysis is required to determine whether this can be explained by gender differences in delayed diagnoses, reduced accessibility to interventional procedures, or genuinely poorer outcomes of IHD for women. Risk factor reduction among IHD survivors remains an important strategy in controlling IHD disease burden.

Acknowledgements

This study is part of the project entitled "CADENZA: A Jockey Club Initiative for Seniors" funded by The Hong Kong Jockey Club Charities Trust. The authors would like to acknowledge the Strategy and Planning Division of the Hospital Authority for the provision of data for this study.

Competing interests

None declared.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Contributorship Statement

PC and JW participated in the conception and design of the study and interpretation of the findings. PC and MW participated in literature review and data analysis. All authors contributed to the writing of the article.

Data Sharing Statement

There are no additional data available.

Table 1 Characteristics of IHD inpatient episodes by sex, 2000-2009, Hong Kong

		Events in men			Events in women		
Characteristics	**All events**	**All**	**Short-term deaths**	**Long-term deaths#**	**All**	**Short-term deaths**	**Long-term deaths#**
IHD inpatient episode	179,769	111,112	8,250	7,980	68,657	7,915	7,114
Mean (SD) age (years), median	69.3(12.5), 71.0	66.3(12.2), 68.0	75.9(10.7), 77.0	74.7(10.3), 76.0	74.0(11.5), 75.0	81.8(9.3), 83.0	80.6(9.2), 81.0
Age group:							
15-24	56	43	1	0	13	0	0
25-34	543	457	4	8	86	2	2
35-44	5,190	4,451	73	66	739	15	17
45-54	19,401	15,620	306	286	3,781	73	65
55-64	33,442	25,076	741	793	8,366	233	250
65-74	54,812	35,029	2,095	2,381	19,783	1,173	1,295
75-84	48,152	24,473	3,293	3,186	23,679	3,204	2,995
≥85	18,173	5,963	1,737	1,260	12,210	3,215	2,490
Year:							
2000	16,836	9,950	724	651	6,886	661	643
2001	17,405	10,640	669	710	6,765	591	602
2002	17,100	10,442	700	739	6,658	573	652
2003	15,677	9,663	759	747	6,014	717	637
2004	17,713	10,997	817	866	6,716	809	784
2005	17,647	11,127	818	809	6,520	799	744
2006	17,819	11,138	754	816	6,681	809	738
2007	18,361	11,453	939	970	6,908	942	885
2008	19,435	12,138	1,018	1,040	7,297	1,007	913
2009	21,776	13,564	1,052	632	8,212	1,007	516

Note: # Only includes 104,076 male IHD inpatients and 64,387 female IHD inpatients who were admitted on or before 30 June 2009.

Table 2. The IHD incidence and case-fatality rates, 2000 and 2009

Age group (years)	Incidence rate (per 100,000 population)				Short-term mortality rate (%)				Long-term mortality rate* (%)			
	Male		Female		Male		Female		Male		Female	
	2000	**2009**	**2000**	**2009**	**2000**	**2009**	**2000**	**2009**	**2000**	**2009**	**2000**	**2009**
15-24	0.9	1.8	0.2	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
25-34	9.5	7.7	1.8	1.8	0.0	0.0	0.0	0.0	2.1	0.0	0.0	0.0
35-44	70.8	86.7	13.3	9.6	1.7	1.8	1.1	1.6	1.1	2.1	0.0	0.0
45-54	282.3	290.6	91.5	58.5	1.9	2.1	2.7	1.8	2.1	3.0	1.2	2.2
55-64	860.9	766.5	403.9	234.7	3.8	2.6	3.0	2.5	3.5	4.3	3.5	2.2
65-74	1586.0	1562.1	1049.7	801.1	6.3	5.9	6.0	6.0	6.2	7.6	7.0	5.7
75-84	1951.7	2331.5	1719.1	1661.2	15.2	12.3	13.1	12.1	12.4	15.9	12.6	15.9
≥85	2362.0	3005.7	2250.6	2640.0	26.2	26.7	21.9	25.3	23.1	24.2	18.5	22.9
≥15 (age-adjusted[#])	460.9	477.9	290.7	251.1	7.9	7.0	10.7	10.8	7.0	8.6	10.1	11.5

Note: * Only includes IHD inpatients who were admitted on or before 30 June 2009.

The 2009 Hong Kong population and the total number of IHD inpatient episodes in 2000–2009 were used as the standard populations for calculating age-adjusted incidence rates and case-fatality rates, respectively.

Table 3. Fitted annualised **percentage change in the incidence of IHD and subsequent risk of short- and long-term mortality based on Poisson regression and logistic regression, respectively**

Age group (years)	Incidence		Short-term mortality		Long-term mortality	
	Male	Female	Male	Female	Male	Female
	% change in rate per year		% change in risk per year			
15–24	10.7% (1.4%–20.9%)	--	--	N/A	N/A	N/A
25–34	--	--	--	--	--	--
35–44	2.2% (1.0%–3.4%)	-3.0% (-5.4%– -0.5%)	--	--	--	--
45–54	--	-5.2% (-6.4%– -4.0%)	--	--	--	--
55–64	-1.5% (-2.8%– -0.3%)	-6.7% (-8.4%– -5.1%)	-2.7% (-5.1%– -0.3%)	--	2.7% (0.1%–5.3%)	--
65–74	--	-4.0% (-5.4%– -2.6%)	--	2.9% (0.8%–5.0%)	--	--
75–84	--	--	--	--	2.7% (1.3%–4.1%)	2.2% (0.8%–3.7%)
85+	4.1% (1.4%–6.8%)	--	--	3.4% (1.9%–4.8%)	--	2.4% (0.8%–4.1%)

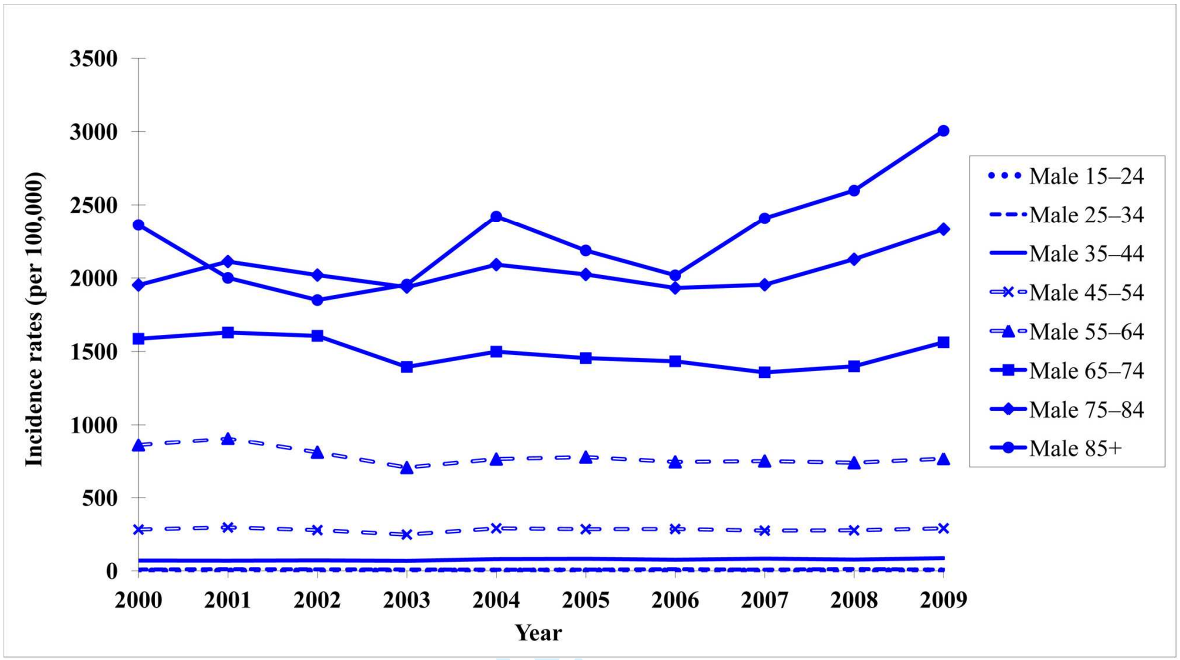
Remarks: N/A, not available as no death occurred during the study period.

Figures in brackets are 95% confidence intervals.

--, insignificant trend (p-value > 0.05).

Figure 1. Age- and sex-specific IHD incidence rates among the population aged ≥15 years in Hong Kong for 2000–2009

a. Male



b. Female

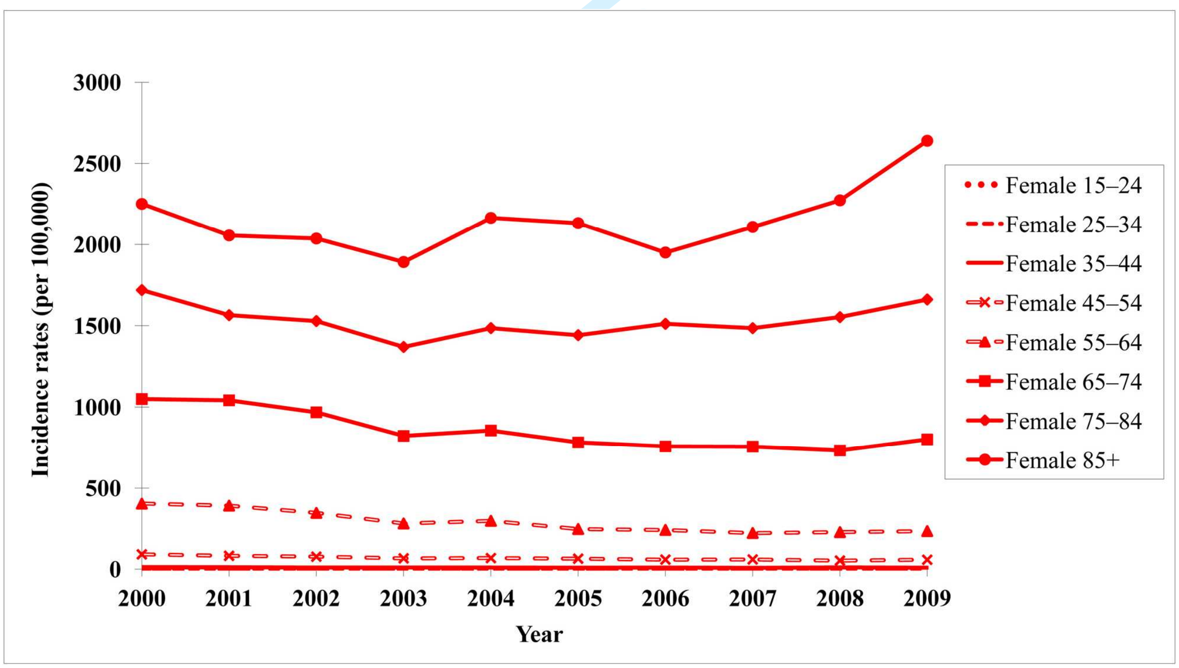
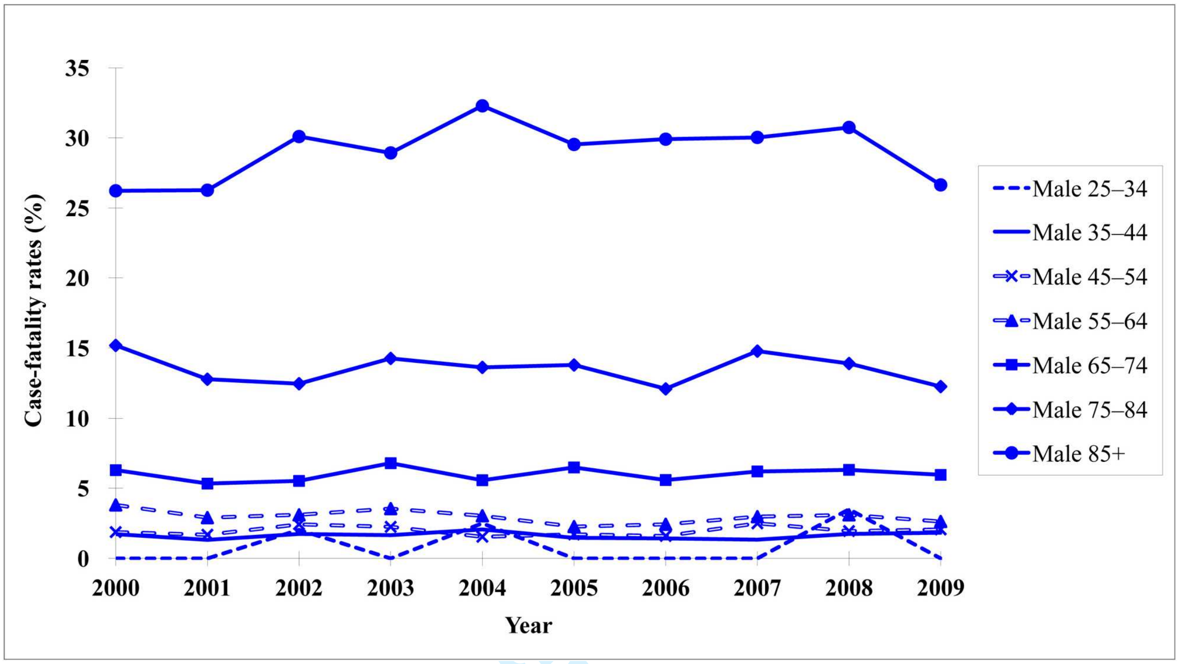


Figure 2. Age- and sex-specific short-term IHD case-fatality rates among the population aged ≥15 years in Hong Kong for 2000–2009

a. Male



b. Female

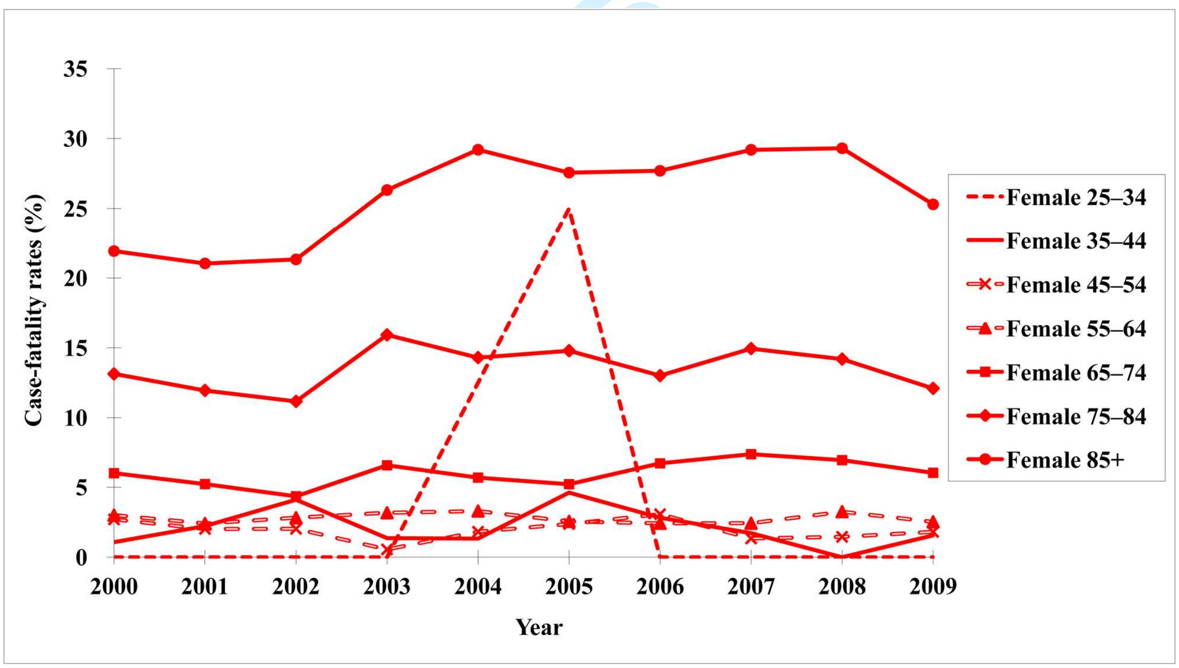
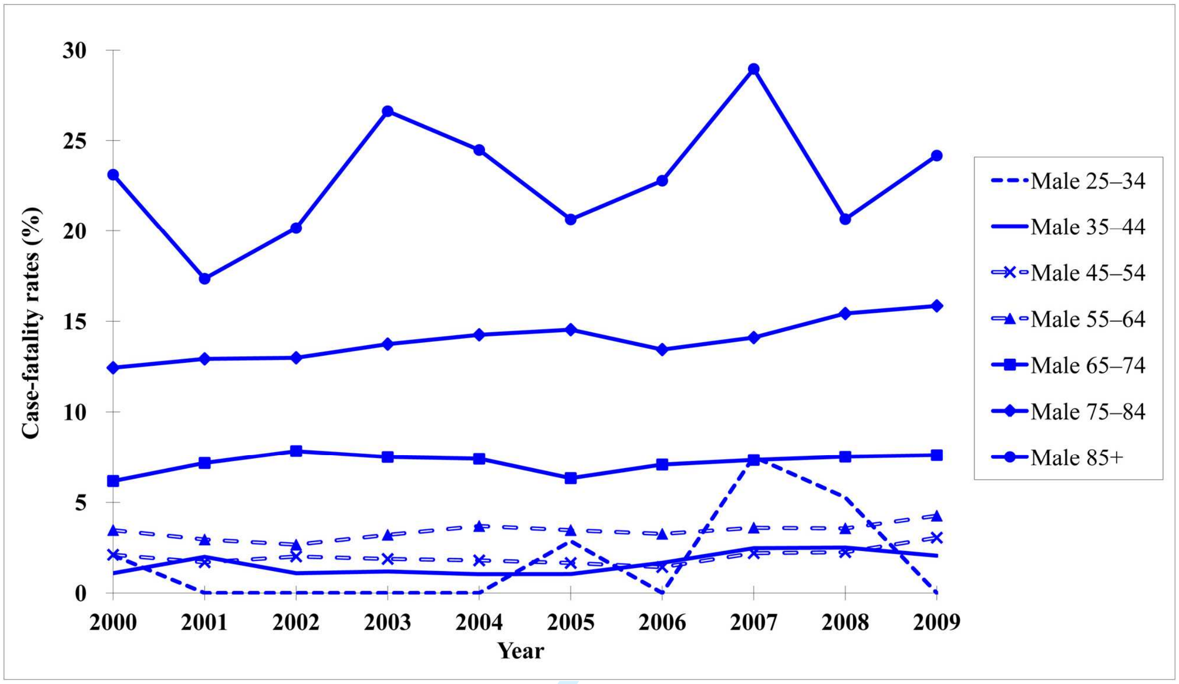
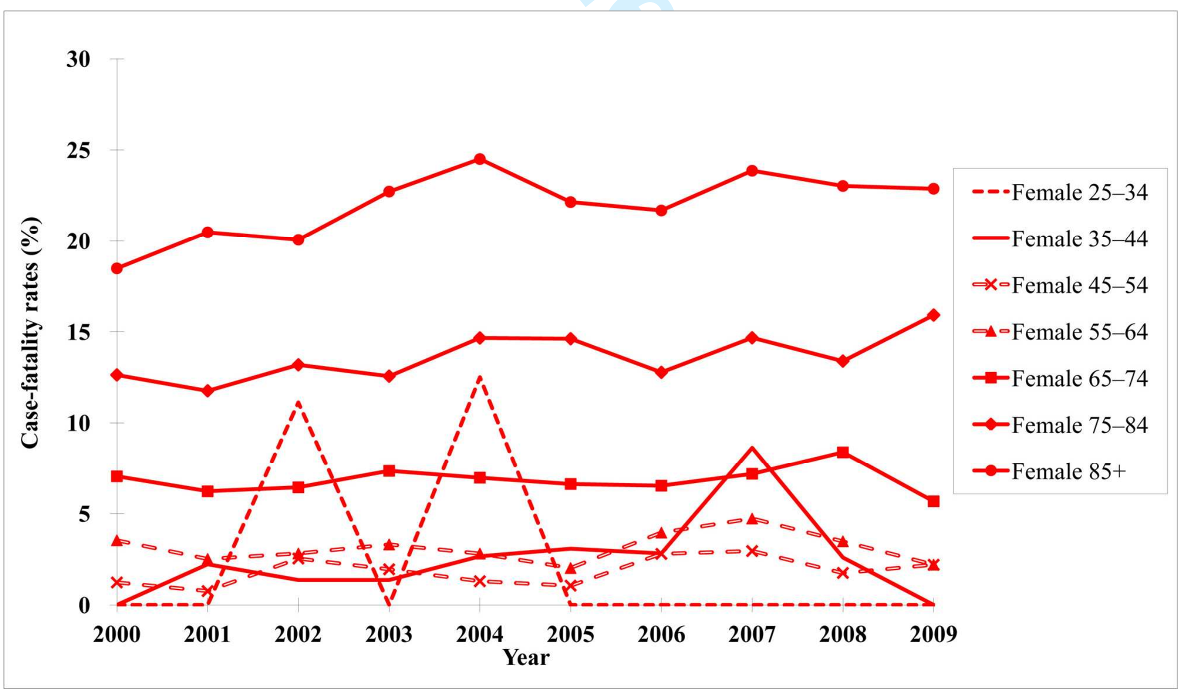


Figure 3. Age- and sex-specific long-term IHD case-fatality rates among the population aged ≥15 years in Hong Kong for 2000–2009

a. Male



b. Female



References

1 World Health Organization. The top 10 causes of death. 2011. http://www.who.int/mediacentre/factsheets/fs310/en/ (accessed 11 Jan 2013).

2 Lozano R, Naghavi M, Foreman K*, et al.* Global and regional mortality from 235 causes of death for 20 age groups in 1990 and 2010: a systematic analysis for the Global Burden of Disease Study 2010. doi: 10.1016/S0140-6736(12)61728-0. *Lancet* 2012;**380**:2095-128.

3 Go AS, Mozaffarian D, Roger VL*, et al.* Heart Disease and Stroke Statistics--2013 Update: A Report From the American Heart Association. *Circulation* 2013;**127**:e6-e245.

4 Chau PH, Woo J, Chan KC*, et al.* Avoidable mortality pattern in a Chinese population--Hong Kong, China. *Eur J Public Health* 2011;**21**:215-20.

5 Truelsen T, Mahonen M, Tolonen H*, et al.* Trends in stroke and coronary heart disease in the WHO MONICA Project. *Stroke* 2003;**34**:1346-52.

6 Wu Z, Yao C, Zhao D*, et al.* Sino-MONICA project: a collaborative study on trends and determinants in cardiovascular diseases in China, Part i: morbidity and mortality monitoring. *Circulation* 2001;**103**:462-8.

7 Schmidt M, Jacobsen JB, Lash TL*, et al.* 25 year trends in first time hospitalisation for acute myocardial infarction, subsequent short and long term mortality, and the prognostic impact of sex and comorbidity: a Danish nationwide cohort study. *BMJ* 2012;**344**:e356.

8 Smolina K, Wright FL, Rayner M*, et al.* Determinants of the decline in mortality from acute myocardial infarction in England between 2002 and 2010: linked national database study. *BMJ* 2012;**344**:d8059.

9 O'Flaherty M, Ford E, Allender S*, et al.* Coronary heart disease trends in England and Wales from 1984 to 2004: concealed levelling of mortality rates among young adults. *Heart* 2008;**94**:178-81.

10 Ford ES, Capewell S. Coronary heart disease mortality among young adults in the U.S. from 1980 through 2002: concealed leveling of mortality rates. *Journal of the American College of Cardiology* 2007;**50**:2128-32.

11 McGhee SM, So JC, Thomas GN. Explaining coronary heart disease trends in Hong Kong: creation of a model for policy and planning. *Hong Kong Med J* 2009;**15 Suppl 2**:22-5.

12 Meade TW, Imeson J, Stirling Y. Effects of changes in smoking and other characteristics on clotting factors and the risk of ischaemic heart disease. *Lancet* 1987;**2**:986-8.

13 Bakhru A, Erlinger TP. Smoking cessation and cardiovascular disease risk factors: results from the Third National Health and Nutrition Examination Survey. *PLoS Med* 2005;**2**:e160.

14 Janus ED, Cockram CS, Fielding R*, et al. Hong Kong Cardiovascular Risk Factor Prevalence Study 1995 - 1996*. Hong Kong: Department of Clinical Biochemistry, Queen Mary Hospital of Hong Kong. 1997.

15 Department of Health. Report on Population Health Survey 2003 / 2004. 2005. http://www.chp.gov.hk/files/pdf/Heart_Health_Survey_en_20071109.pdf (accessed 11 Jan 2013). Hong Kong: Department of Health of Hong Kong Special Administrative Region and Department of Community Medicine of The University of Hong Kong.

16 Department of Health. Heart Health Survey 2004 / 2005. 2007. http://www.chp.gov.hk/files/pdf/Heart_Health_Survey_en_20071109.pdf. (accessed 11 Jan 2013). Hong Kong: Department of Health.

17 He FJ, MacGregor GA. Reducing population salt intake worldwide: from evidence to implementation. *Prog Cardiovasc Dis* 2010;**52**:363-82.

18 Basu R, Samet JM. Relation between elevated ambient temperature and mortality: a review of the epidemiologic evidence. *Epidemiol Rev* 2002;**24**:190-202.

19 Barnard LF, Baker MG, Hales S*, et al.* Excess winter morbidity and mortality: do housing and socio-economic status have an effect? *Rev Environ Health* 2008;**23**:203-21.
20 Yan YY. The influence of weather on human mortality in Hong Kong. *Soc Sci Med* 2000;**50**:419-27.
21 Chau PH, Chan KC, Woo J. Hot weather warning might help to reduce elderly mortality in Hong Kong. *International Journal of Biometeorology* 2009;**53**:461-8.
22 Thach TQ, Wong CM, Chan KP*, et al.* Daily visibility and mortality: assessment of health benefits from improved visibility in Hong Kong. *Environ Res* 2010;**110**:617-23.
23 Steptoe A, Kivimaki M. Stress and cardiovascular disease. *Nat Rev Cardiol* 2012;**9**:360-70.
24 Leung LC, Chan KW. Understanding the Masculinity Crisis: Implications for Men's Services in Hong Kong. doi:10.1093/bjsw/bcs122. *British Journal of Social Work* 2012.
25 Chau PH, Yen E, Morley JE*, et al.* The effects of environmental stressors on the mortality of the oldest old male population in Hong Kong, 1977-2006. *Aging Male* 2008;**11**:179-88.
26 Wong SL, Donnan SP. Influence of socioeconomic status on cardiovascular diseases in Hong Kong. *J Epidemiol Community Health* 1992;**46**:148-50.
27 Schooling CM, Lam TH, Thomas GN*, et al.* Growth environment and sex differences in lipids, body shape and diabetes risk. *PLoS One* 2007;**2**:e1070.
28 Law CM, Shiell AW, Newsome CA*, et al.* Fetal, infant, and childhood growth and adult blood pressure: a longitudinal study from birth to 22 years of age. *Circulation* 2002;**105**:1088-92.
29 Cheung YF, Wong KY, Lam BC*, et al.* Relation of arterial stiffness with gestational age and birth weight. *Archives of Disease in Childhood* 2004;**89**:217-21.
30 Yi Z, Gu D, Land KC. The association of childhood socioeconomic conditions with healthy longevity at the oldest-old ages in China. *Demography* 2007;**44**:497-518.
31 Chau PH, Woo J, Gusmano MK*, et al.* Access to primary care in Hong Kong, Greater London and New York City. *Health Econ Policy Law* 2013;**8**:95-109.
32 Vukmir RB. Survival from prehospital cardiac arrest is critically dependent upon response time. *Resuscitation* 2006;**69**:229-34.
33 Kudenchuk PJ, Redshaw JD, Stubbs BA*, et al.* Impact of changes in resuscitation practice on survival and neurological outcome after out-of-hospital cardiac arrest resulting from nonshockable arrhythmias. *Circulation* 2012;**125**:1787-94.
34 Leung LP, Lo CM, Tong HK. Prehospital resuscitation of out-of-hospital cardiac arrest in Queen Mary Hospital. *Hong Kong Journal of Emergency Medicine* 2000;**7**:191-6.
35 The University of Hong Kong Cardiopulmonary Resuscitation Knowledge Studt Group. Knowledge of cardiopulmonary resuscitation among the public in Hong Kong: telephone questionnaire survey. *Hong Kong Med J* 2003:323-8.
36 Chung CH, Wong PCY. A six-year prospective study of out-of-hospital cardiac arrest managed by a voluntary ambulance organisation. *Hong Kong Journal of Emergency Medicine* 2005;**12**:140-7.
37 Dickinson HO, Mason JM, Nicolson DJ*, et al.* Lifestyle interventions to reduce raised blood pressure: a systematic review of randomized controlled trials. *J Hypertens* 2006;**24**:215-33.
38 Sacks FM, Svetkey LP, Vollmer WM*, et al.* Effects on blood pressure of reduced dietary sodium and the Dietary Approaches to Stop Hypertension (DASH) diet. DASH-Sodium Collaborative Research Group. *N Engl J Med* 2001;**344**:3-10.
39 Cheung BMY, McGhee SM, Lau CP*, et al.* Cost-effectiveness of low-salt diet for lowering blood pressure in Hong Kong Chinese population. *Hong Kong Med J* 2007;**13**:32-6.
40 Woo J, Leung SS, Ho SC*, et al.* Dietary intake and practices in the Hong Kong Chinese population. *J Epidemiol Community Health* 1998;**52**:631-7.

41 The Chinese University of Hong Kong. Increasing Salt Intake Predisposes Hong Kong People to Hypertension and Its Complications. 2005. http://www.cuhk.edu.hk/cpr/pressrelease/050511e.htm (accessed 11 Jan 2013).
42 World Health Organization. Prevention of cardiovascular disease: guidelines for assessment and management of total cardiovascular risk. Geneva: World Health Organization. 2007.
43 Appel LJ, Espeland MA, Easter L, *et al.* Effects of reduced sodium intake on hypertension control in older individuals: results from the Trial of Nonpharmacologic Interventions in the Elderly (TONE). *Archives of Internal Medicine* 2001;**161**:685-93.
44 Woo J, Sea MM, Tong P, *et al.* Effectiveness of a lifestyle modification programme in weight maintenance in obese subjects after cessation of treatment with Orlistat. *J Eval Clin Pract* 2007;**13**:853-9.