Projecting ischaemic heart disease mortality and morbidity in Hong Kong

IOL Wong, BJ Cowling, SV Lo, WYH Chan, CM Schooling *

KEY MESSAGES

1. No ischaemic heart disease (IHD) epidemic is forecast for Hong Kong, despite increasing exposure to risk factors. The IHD morbidity and mortality are projected to decline continuously until at least 2020.
2. Social disparities in IHD mortality are widening, particularly among women, partly because IHD is declining by generation for high-income women but not for low-income women. Differential exposure throughout life contributes to disparities in IHD that may be difficult to reverse in a short-time frame.

Hong Kong Med J 2015;21(Suppl 6):S19-22
HHSRF project number: 08090861

[1] IOL Wong, [1] BJ Cowling, [2] SV Lo, [1] WYH Chan, [1] CM Schooling

[1] *School of Public Health, Li Ka Shing Faculty of Medicine, The University of Hong Kong*
[2] *Hospital Authority Head Office, Hong Kong*

* Principal applicant and corresponding author: cms1@hkucc.hku.hk

Introduction

Ischaemic heart disease (IHD) is becoming a leading cause of morbidity and mortality in Hong Kong. Premature IHD is common in men. This study aimed to assess the relative contribution of age, period of IHD, and birth cohort effects to IHD mortality in women and men by socio-economic status, and to project mortality and morbidity from IHD in Hong Kong until 2020.

Methods

This study was conducted from December 2010 to November 2011. According to the International Classification of Diseases (ICD) codes, IHD is defined as ICD-8 410-414, ICD-9 410-414, and ICD-10 I20-I25. Sex-specific IHD death data and mid-year population figures by small area of residence for years 1976-2006 were obtained from the Hong Kong Death Registry and the Census and Statistics Department, respectively. There are about 280 Tertiary Planning Units (TPUs) in Hong Kong. The TPU boundaries are regularly updated to reflect population dynamics. Sparsely populated TPUs are merged with nearby TPUs so that approximately 200 TPUs are available for analysis.

For each TPU, median household income for 1976-2010 was obtained, as was information on migrant status (born in Hong Kong or elsewhere). All deaths associated with IHD were included. The mortality data were grouped into ten 5-year age-groups from 30-34 years to ≥75 years, and population data were grouped into six 5-year time periods from 1976-1980 to 2001-2005. This classification resulted in 15 birth cohorts.

Aggregated data for sex- and age-specific inpatient bed-days associated with IHD (ICD-9 410-414) from 1999 to 2009 were obtained from the Hospital Authority. The socio-economic status was classified as high- or low-income group based on the above or below median household income per capita of the TPU of residence for each year of observation, rather than using one inflation-adjusted cut-point throughout the period, to avoid classifying most people from early years as low income and most people from later years as high income.

Community burden in women and men associated with IHD by socio-economic status was obtained from population representative studies in Hong Kong, which have asked specifically about doctor-diagnosed IHD, using the Rose angina questionnaire.[1] These include the 1995 Cardiovascular Risk Survey.[1] Given that these cross-sectional studies were conducted over 10 years ago, we examined whether the ratio of IHD mortality to community burden of IHD has changed to take into account improvements in IHD treatment, which may have reduced the IHD case fatality.

Using an age-period-cohort (APC) Poisson model,[2] sex-specific IHD mortality over the past 30 years was decomposed into the effects of age at death, period of IHD at death, and cohort of birth by low/high income group. The effect of each of these components was projected separately in the Hong Kong population to give an overall forecast for IHD mortality from 2006 until 2020. Future hospital bed use and community burden was forecast, using the current ratio of IHD mortality to IHD hospital bed use and to the community burden of IHD. Whether migrant status may affect IHD mortality and morbidity was also investigated.

The second and the penultimate periods and the central birth cohort were used as reference to generate identifiable estimates for birth cohort and

period effects, respectively. Bayesian inference was used to estimate the model parameters, and the fitted model was used to project future mortality in three further 5-year periods up to 2015-2020. For the age, period of IHD, and cohort effects, second-order Gaussian autoregressive priors were specified in the forward direction. These priors specified that the initial expected value of each effect was based on an extrapolation from its two immediate predecessors. Three additional period and cohort effects were extrapolated to enable projections of future incidence. The model parameters were estimated using Markov Chain Monte Carlo simulations with five concurrent chains started at different initial values, because comparison of multiple chains enables discerning of convergence. The parameter estimates and derived rates were summarised in terms of posterior means and 95% confidence intervals.

To examine whether the results differed by socio-economic status or migrant status, we investigated any potential difference in birth cohort, calendar period or chronological age effects for men or women by stratifying our original set of analyses if appropriate by socio-economic status or migrant status.

Age-standardised IHD mortality was projected by sex or socio-economic status in the short to medium term. The uncertainty associated with projections was also assessed. In addition, join point regression was used to evaluate whether there has been any change in the trends in cohort and period effects over time and when change occurs (whenever applicable).[3] The best join point model selection method was based on Bayesian Information Criterion where the best model was selected with the smallest Bayesian Information Criterion.[3]

Future IHD morbidity (as public hospital use and community burden) was estimated in the short- to medium-term, based on the current age- and sex-specific ratios of IHD mortality to IHD hospital bed-use and IHD community burden. Data on private hospital use associated with IHD are difficult to obtain, but public hospitals account for 95% of all bed days in Hong Kong, so that projections based on the public sector only were appropriate and sufficiently accurate for planning purposes. Specifically, a study of acute myocardial infarctions at all hospitals in Hong Kong reported that 96.7% of cases were treated in the public sector.

Results

Age-standardised mortality by income group

The IHD mortality was higher among high-income men than low-income men in the early period and declined faster for the high-income group than the low-income group. From 2006-2010 to 2015-2020, the IHD mortality is projected to decline in the high-income group, but less so for the low-income group (Table).

Age, period, and birth cohort effects on trends in IHD mortality in women and men by socio-economic status

Parameter values of age, period, and cohort components with projections were estimated (Fig 1). Because of the known identifiability problem of APC models, where there was inherent linear independence between the three component effects (ie, birth cohort = period of deaths – age at death), only second-order changes (ie inflection points or changes in slopes) were interpretable. Among men and women, the mortality increased with age in the two income groups. There was also an acceleration at the age approximately after 50 years. There was a higher risk of mortality for the low-income group than the high-income group, particularly among older age-groups.

Relative risks were estimated for the fifteen 10-year birth cohorts beginning in the calendar year 1899 and the six 5-year time periods from 1976 to 2005 (Fig 2). Cohort effects dominated, and inflection points could be identified, while there were less apparent second-order changes in period effects. Regarding the cohort effects, there was a downturn in the 1920s for women in both income groups. In contrast for men, there was an earlier downturn followed by an upturn in the cohort effect around 1945 (ie for the first generation largely born in Hong Kong). The downward effect by cohort appeared to either start in an earlier generation for the high-income group than for the low-income group, or the downturn was more marked for the high-income group than the low-income group. In the join point analyses, the join points identified were consistent with the inflection points described above. With regard to the period effects, downward period effects in the early 1990s and upward period effects in the late 1990s were more evident for the low-income than the high-income group. Similar results were found in join point analyses for high-income men and women.

TABLE. Projected age-standardised ischaemic heart disease (IHD) mortality by income group from 2006 to 2020

Period for projection	Projected IHD mortality per 100 000 (95% CI)	
	Low-income group	High-income group
Female		
2006-10	24.9 (19.2-31.6)	16.0 (14.9-17.2)
2011-15	19.7 (10.8-31.6)	10.9 (9.6-12.3)
2016-20	19.7 (5.9-33.5)	7.9 (6.8-9.0)
Male		
2006-10	45.5 (36.6-55.3)	34.2 (32.7-35.8)
2011-15	41.0 (25.3-61.5)	29.5 (27.5-31.6)
2016-20	41.2 (17.1-74.1)	26.5 (24.2-29.4)

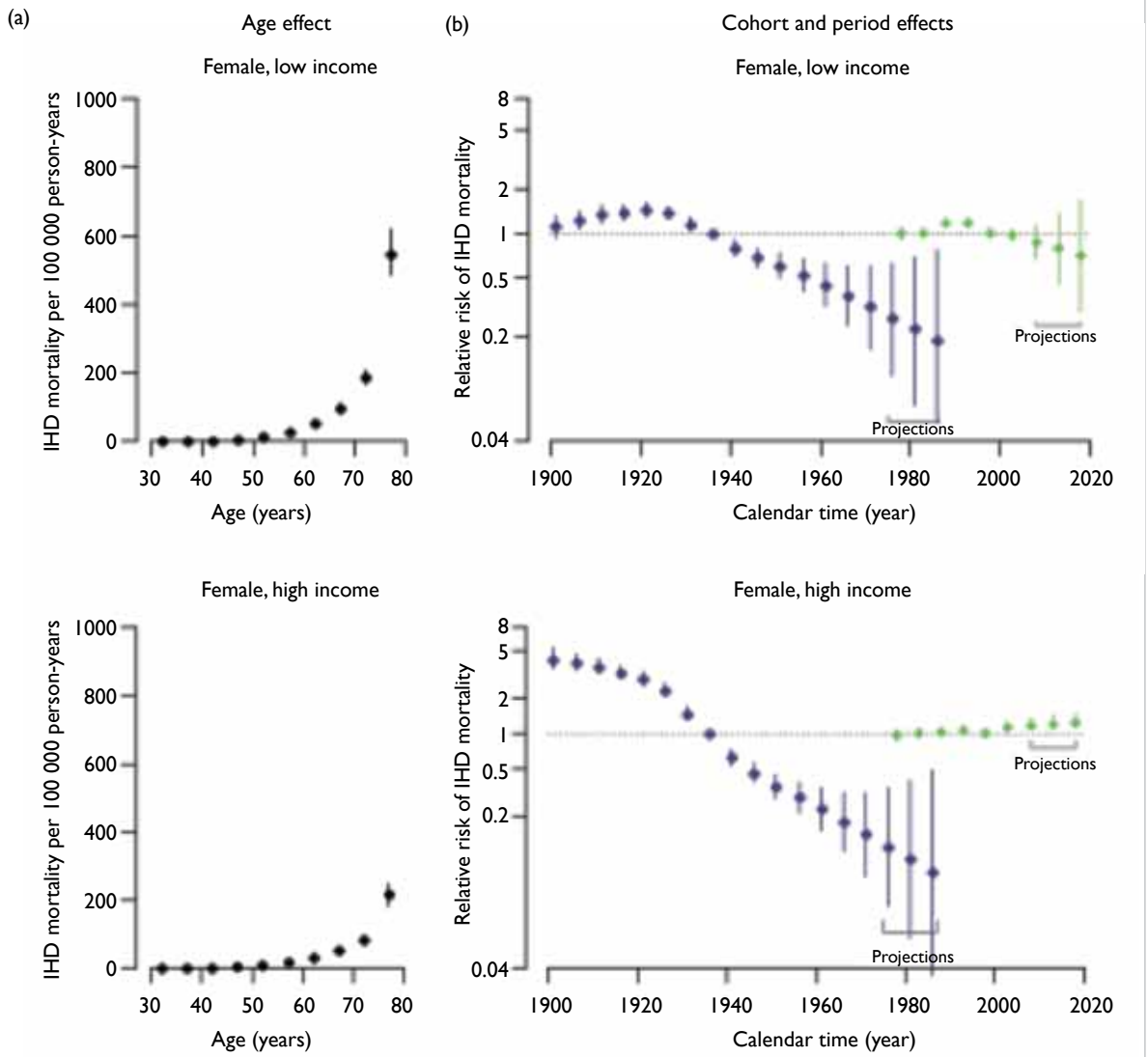

FIG 1. For women (DIC=453.604 for low-income group, DIC=443.02 for high-income group), (a) estimated age-specific annual ischaemic heart disease (IHD) mortality, and (b) estimated relative risks for 10-year birth cohorts and 5-year calendar periods, including projected cohort effects for birth cohorts centred on the years 1978, 1983 and 1988 and projected period effects for periods centred on the years 2008, 2013, and 2018

Discussion

In Hong Kong, there was no evidence of an emerging epidemic of IHD among men. The IHD mortality for both sexes was declining over the period. There was an upturn in the cohort effect for men for the first generation born in Hong Kong, but this was offset by other changes, so that the net change was still a decline, albeit a smaller decline than for women. It may seem counter-intuitive that IHD mortality is projected to decrease when many IHD risk factors (such as diabetes) are likely to increase as the lifestyle becomes more sedentary and westernised. The Framingham score substantially over-predicts the absolute risk of IHD in China.[4] The Framingham score is based on risk factors, not causal factors. The items in the Framingham score may correlate better with the underlying causal factors in some populations than others.

In contrast, with the somewhat unexpected findings of a lack of an epidemic of IHD among men, social inequality in IHD is widening. This reversal may be connected with a cohort effect, with corresponding implications for reversibility in a short-time frame.

The period effects were more marked for the low-income group, which is more sensitive to population-wide changes, such as the establishment of the Hospital Authority that coincided with a more marked downturn for the low-income group, and the Asian financial crisis in 1997 that coincided with a more marked upturn for the low-income group.

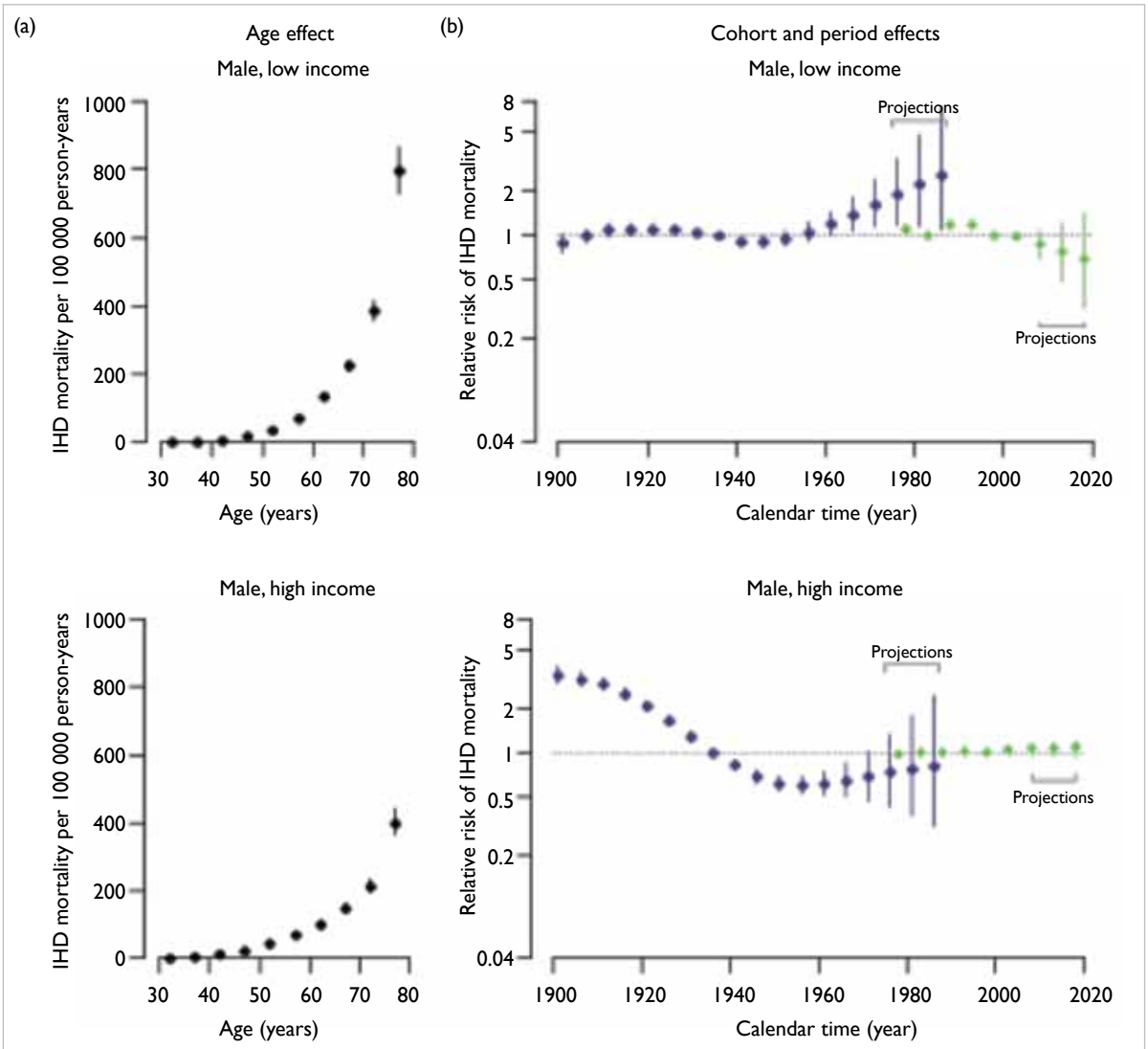

FIG 2. For men (DIC=526.797 for low-income group, DIC=569.726 for high-income group), (a) estimated age-specific annual ischaemic heart disease (IHD) mortality, and (b) estimated relative risks for 10-year birth cohorts and 5-year calendar periods, including projected cohort effects for birth cohorts centred on the years 1978, 1983 and 1988 and projected period effects for periods centred on the years 2008, 2013, and 2018

Acknowledgements

This study was supported by the Health and Health Services Research Fund, Food and Health Bureau, Hong Kong SAR Government (#08090861). We thank the Census and Statistics Department, Hong Kong SAR Government, for their facilitating data access. We also thank Dr Elaine Lau and Dr Roger Chung for their assistance in data retrieval and management.

Results of this study have been published in: Wong IO, Cowling BJ, Leung GM, Schooling CM. Age-period-cohort projections of ischaemic heart disease mortality by socio-economic position in a rapidly transitioning Chinese population. PLoS One 2013;8:e61495.

References

1. Janus ED. The Hong Kong cardiovascular risk factor prevalence study 1995-1996. Hong Kong: Department of Clinical Biochemistry, Queen Mary Hospital; 1997.
2. Holford TR. Understanding the effects of age, period, and cohort on incidence and mortality rates. Annu Rev Public Health 1991;12:425-57.
3. Tiwari RC, Cronin KA, Davis W, Feuer EJ, Yu B, Chib S. Bayesian model selection for join point regression with application to age-adjusted cancer rates. J R Stat Soc Ser C Appl Stat 2005;54:919-39.
4. Liu J, Hong Y, D'Agostino RB Sr, et al. Predictive value for the Chinese population of the Framingham CHD risk assessment tool compared with the Chinese Multi-Provincial Cohort Study. JAMA 2004;291:2591-9.