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Increasing dietary fish intake has contributed to decreasing mortality from CHD among the older population in Hong Kong

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Abstract

Objective: To test whether change in the frequency of fish intake at population level would affect the trends of death from CHD and how many CHD events could be prevented in Hong Kong, a population among those with the highest fish consumption and the lowest CHD mortality in the world.

Design: Time trends analysis with data from repeated dietary surveys and death registration.

Setting: Hong Kong SAR, People's Republic of China.

Subjects: A total of 3096 men and women aged 40–69 years who participated in territory-wide surveys in 1995 or 2003 were included in the analysis of changes in dietary fish intake; all adults aged 40–69 years in Hong Kong were included in the analysis of time trends of CHD mortality.

Results: Over the period, the frequency of fish intake increased and CHD mortality decreased significantly in the population age group of 50–69 years, while in the age group of 40–49 years little change in both fish intake and CHD mortality was observed. It was estimated that 240 CHD deaths (or 29% of the total) were avoided among the population aged 40–69 years in 2003, as more than half of the population consumed fish every day in Hong Kong.

Conclusions: The time trend of CHD mortality was inversely related to the trend of fish intake. The frequency of fish intake may have a substantial impact on the population for the prevention of CHD deaths in Hong Kong.

Keywords
Dietary fish intake
Coronary heart disease
Population impact

The protective effect of dietary fish intake on CHD, partly through the pathway of *n*-3 PUFA and especially EPA and DHA, has been explored in general populations as well as among CHD patients for almost half a century. The inverse association between fish consumption and CHD has been observed in both Eastern and Western populations[1–6]. A dose–response relationship between the size of the effect on CHD and the amount of fish consumed or the frequency of dietary fish intake was demonstrated in a meta-analysis of thirteen cohort studies[7]. Dietary fish intake has been recommended in guidelines on CVD prevention by many medical societies around the world[8–11]. However, whether changes in the frequency of fish intake at population level would affect the trends of CHD, and what proportion or number of CHD deaths could be averted due to the frequency of fish intake in a given population, has not been assessed.

The population of Hong Kong is among those with the highest fish consumption and the lowest CHD mortality in the world. The percentage of dietary energy from fish intake in Hong Kong was the third highest and the age-adjusted CHD mortality was the second lowest among those populations with data available in the UN[12]. The population impact of fish intake on CHD mortality in Hong Kong, however, has not been quantitatively estimated. The present report aims to fill this gap by comparing the frequency of daily fish intake and CHD mortality in age- and sex-specific populations between two time points (1995 *v.* 2003), and estimating the potential population impact of fish intake on CHD deaths in Hong Kong, using recently described measures[13].

Methods

Data sources

The frequency of daily fish intake in the Hong Kong population was obtained from two independent surveys

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conducted in Hong Kong in 1995 and 2003. Detailed methods have been described previously[14,15]. The first was the Adult Dietary Survey, which was conducted with a sub-sample of the territory-wide cardiovascular risk factor study in Hong Kong from 1995 to 1996[14]. In brief, 1010 subjects aged 25–74 years were recruited for the dietary survey using an interviewer-administered questionnaire. The frequency and number of standard portions of food taken during the previous week were recalled. There were thirty-one different fish or shellfish and fish products included in the questionnaire. The second survey was conducted in 2003 as part of a study on positive ageing, and comprised a group of 2970 subjects aged 40–74 years living in various regions of Hong Kong[15]. In this latter survey, only the frequency of fish intake during the previous week was inquired with the same kind of fish and fish products included in the questionnaire, but no detailed information on the amounts of fish consumed was collected. Therefore, the present analysis compared only the prevalence of daily fish intake (fish consumed for at least one meal per day during the previous week) in the population. The subjects younger than 40 years or older than 69 years were excluded, as the survey in 1995 included only six subjects aged 70 years and over, and the survey in 2003 did not include subjects younger than 40 years. In total, 641 subjects in 1995 and 2455 in 2003 were included in the analysis to compare the prevalence of daily fish intake by the population aged 40–69 years at the two time points.

The time trends of CHD mortality for the Hong Kong population in the same age classes in 1995 and 2003 were analysed using data from vital statistics provided by the Department of Health, Hong Kong Special Administrative Region[16]. The *International Classification of Diseases* (ICD) version 9 was used before 2001 and ICD version 10 was used from 2001 onwards to code the underlying causes of deaths. Mortality from CHD (ICD9 codes 410–414, ICD10 codes I20–I25) in 5-year age groups by gender was included in the analysis.

Statistical analysis

The frequency (%) of daily fish intake was compared between 1995 and 2003 among age (40–49 years, 50–59 years, 60–69 years) and sex subgroups. The χ^2 test was applied to examine the statistical significance of differences in frequency and the trends of changes.

The CHD mortality (per 100 000 per year) was adjusted according to the age structure in 2003 and averaged over three years (the year before and after, and the point year) to reduce the natural fluctuation. The annual percentage change in mortalities was estimated with Poisson's regression analysis.

The population impact of daily fish intake on CHD mortality for one year among the Hong Kong population was estimated using the formula of PIN-ER-*t* (population impact number, over time *t*, of eliminating risk) suggested by Heller *et al.*[13]:

$$\text{PIN-ER-1} = n \times \text{Ip} \times \text{PAR},$$

with

$$\text{PAR} = \frac{\text{Pe}(\text{RR} - 1)}{1 + \text{Pe}(\text{RR} - 1)},$$

where n is the population size, Ip is the incidence of CHD deaths in the Hong Kong population, PAR is the population-attributable risk, Pe is the prevalence of daily fish intake estimated from the dietary survey in 2003 and RR is the relative risk of CHD for people who ate daily compared with those who consumed fish less than once monthly. RR of 0·62 (95 % CI 0·46, 0·82), with adjustment for major risk factors of CHD, was adopted from the meta-analyses of thirteen large cohort studies[7]. The same RR was applied to the estimation of the population impact number in one year (PIN-ER-1) for men and women and for the three age groups, as the meta-analysis showed that the RR was not statistically significantly different between gender or age groups[7].

Results

Trends in dietary fish intake

In the two surveys, more than 50 % of participants ate fish in at least one daily meal during the previous 7 d (Table 1). The prevalence was not statistically different between men and women or between the two time points (1995 *v.* 2003). However, the frequency of daily fish intake tended to decrease in the younger age group (−1·5 % for men and −5·9 % for women) but to increase among the older age groups (9·1 % for men and 12·7 % for women); the trends of fish intake by age group were statistically significant ($P < 0{\cdot}05$).

Trends of CHD mortality

Table 2 presents the time trends of CHD mortality, compared between 1995 and 2003. In the age group of 40–49 years, CHD mortality levelled off for men and women during the 8-year period; however, it decreased by 29–38 % (5 % annually) in women and by 27–28 % (4 % annually) in men in the age groups of 50–59 years and 60–69 years.

The time trends of frequency of daily fish intake were contrary to the trends of CHD mortality among the subgroups of population in Hong Kong.

Population impact of daily fish intake on CHD mortality

The number of CHD deaths that might have been prevented due to daily fish intake in the subgroups of population in Hong Kong in 2003 was estimated with PIN-ER-1 (Table 3). Among 2·6 million adults aged 40–69 years, with more than 51 % of the population consuming

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Table 1 Frequency of daily fish intake in the adult population, Hong Kong, 1995 and 2003

	1995			2003			
Sex/age group	*n*	Frequency (%)	95% CI	*n*	Frequency (%)	95% CI	Difference (2003–1995)
Men							
40–49 years	152	52·6	44·7, 60·5	280	51·1	45·2, 57·0	−1·5
50–59 years	93	58·1	48·1, 68·1	355	57·5	52·4, 62·6	−0·6
60–69 years	75	56·4	45·2, 67·6	308	65·5	60·2, 70·8	9·1
P for trend							<0·05
Women							
40–49 years	149	64·4	56·7, 72·1	593	58·5	54·5, 62·5	−5·9
50–59 years	102	59·8	50·3, 69·3	456	62·5	58·1, 66·9	2·7
60–69 years	70	57·5	45·9, 69·1	463	70·2	66·0, 74·4	12·7
P for trend							<0·001

Table 2 Time trends of CHD mortality rate (per 100 000 per year) by age and sex in Hong Kong, 1995–2003

	Men				Women			
	Mortality rate		Change (%)		Mortality rate		Change (%)	
Age group	1995	2003	Over 8 years	Annual†	1995	2003	Over 8 years	Annual†
40–49 years	12·4	14·3	15·3	0·4	2·5	2·1	−16·0	−1·3
50–59 years	59·1	43·3*	−26·7	−3·8	12·6	9·0*	−28·6	−4·5
60–69 years	184·9	132·2***	−28·5	−4·0	84·7	52·2***	−38·4	−5·4
P for trend			<0·05				<0·05	

Significantly different compared with 1995: *$P<0·05$, ***$P<0·001$.
†Annual percentage change in CHD mortality was estimated with a Poisson regression model.

Table 3 Impact of daily fish intake on CHD deaths in the Hong Kong population, 2003

Sex/age group	Population ($\times 10^3$)	No. of CHD deaths	Frequency of daily fish intake (%)	PAR† (%)	PIN-ER-1‡
Men					
40–49 years	634	90	51	24	22
50–59 years	405	175	58	28	49
60–69 years	252	333	66	33	110
Women					
40–49 years	675	14	59	29	4
50–59 years	389	35	63	31	11
60–69 years	230	120	70	36	44
Total	2585	767	59	29	240

†PAR (population-attributable risk) = [Pe(RR−1)]/[1+Pe(RR−1)], where Pe is the prevalence of daily fish intake and RR is relative risk (=0·62).
‡PIN-ER-1 (population impact number, over 1 year, of eliminating risk) = number of deaths avoided due to daily fish intake in the population for 1 year.

fish every day and 767 CHD deaths recorded in the Hong Kong population in 2003, we estimated that about 240 CHD deaths (or 29% of the total) were avoided in the population aged 40–69 years in 2003 in Hong Kong. In other words, 240 more CHD deaths would have occurred if those who consumed fish every day did not do so in 2003. The benefit increased with age and was more prominent in men. This reflects higher CHD death rates among men and in older age groups.

Discussion

Compared with the same age groups in 1995, the frequency of daily fish intake decreased slightly in the population aged 40–49 years but increased in the population aged 50–69 years in 2003; in contrast, CHD mortality changed insignificantly in the younger age group but decreased remarkably in the older age group in Hong Kong. More than half of the middle-aged population in Hong Kong ate fish every day, and this contributed to 240 less CHD deaths (29% of the total) in 2003.

Strength and weaknesses

The territory-wide dietary surveys in 1995 and 2003 provided the opportunity to track the trend in frequency of dietary fish intake for the same age groups over the time and to estimate its impact on CHD mortality. Free access to public health services for the whole population and the standard death registration and classification system in Hong Kong ensured the reliability of the data on CHD mortality. In the estimation of population impact of

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dietary fish intake on CHD deaths, we used the RR from the pooled estimate from thirteen large cohort studies, including a Chinese cohort[7], with adjustment for other common risk factors of CHD. This should be more reliable than the estimate from an individual cohort study alone.

One of the weaknesses is that the difference in prevalence of fish intake at the two time points may be not really representative of the general population in Hong Kong as the sampling methods differed in the two surveys: the subjects from the first survey in 1995 were randomly drawn from a multistage sampling frame, while in 2003 the subjects were invited from communities in each area without random selection. However, the difference, if any, should not be substantial since the age- and sex-specific prevalence of smoking obtained from the surveys were similar to those from large-scale surveys conducted by government agencies during the same time period.

Time lag was not taken into account in the analysis as dietary fish intake obtained from the food frequency survey during the last 7 d was assumed to be representative of long-term dietary habits, rather than a one-off or a short-period exposure.

The types of fish (e.g. fatty fish, which contain more *n*-3 fatty acids than lean fish, or salted fish, which may cause more harm than good) and the amount of fish intake were not collected in the 2003 survey; thus the effect of changing fish type or intake amount could not be addressed in the analysis.

There might be other confounding factors influencing the relationship between time trends of fish intake and that of CHD mortality as demonstrated. If the change in fish intake had been associated with changes in other aetiological or preventive exposures, these might at least partly account for the associations with CHD trends.

The advance in clinical management (earlier and more precise diagnoses and improvement of treatment) is an important contributor to the general decrease of CHD deaths in Hong Kong, but it could not explain the discrepancy of the trends of CHD mortality between the younger and the older age groups: the improvement has no reason to benefit only the older age group.

The uncertainty of the diagnoses of death from CHD should also be taken into account. However, the more notable decrease in all-cause mortality and total cardiovascular mortality observed in the Hong Kong population indicated that the changing trends in CHD mortality could not be due to the switching of diagnosis from other causes.

Other lifestyle-related risk factors could also have played important roles in the discrepancies of the CHD trends. For example, smoking and physical inactivity changed during the period. Data from the same surveys conducted in 1995 and 2003 indicated that the prevalence of smoking decreased and that of physical exercise (≥30 min/d) increased more in the older age group for both men and women but less in the younger age group in men, while the favourable change did not occur in younger aged women; thus the prevalence of smoking increased and that of leisure-time physical exercise decreased (data not shown here). These trends in prevalence of smoking and physical exercise could explain the discrepancy in CHD trends between age groups, but could not explain the gender differences.

Possible mechanisms and implications for policy makers

Previous ecological studies have indicated that fish consumption is related inversely to CHD mortality in different countries[12,17] and prospective cohort studies have shown that individuals with high fish intake experience lower incidence of CHD, in both Eastern and Western populations[1,2,4,5,18–21]. The current study revealed that increased frequency of fish intake at population level was related to a decrease in CHD mortality. It added more evidence to the protective effect of dietary fish intake on CHD death.

Although some cohort studies did not find a significant effect of fish intake on CHD[3,22,23], the meta-analysis performed in 2004 revealed no evidence of significant heterogeneity between the cohorts which found protective effects and those which did not, and the pooled results showed a dose–response relationship between fish consumption and CHD deaths[7].

The possible mechanism of the protective effect of fish intake on CHD is partly through *n*-3 PUFA, especially EPA and DHA; both are abundant in fish oil, which has anti-arrhythmic, anti-atherogenic and anti-thrombotic effects as tested in laboratories with animals, in clinical trials and in prospective cohort studies[5,24–33]. Fish fatty acids as a percentage of total energy intake in the Hong Kong population (0·66 %) was relatively constant during the last half century and higher than that in the USA (0·22 %) and Mediterranean countries like Spain (0·44 %), supporting the theory at population level[34].

However, the effect of *n*-3 fatty acids on total cardiovascular events was inconclusive in a recent published meta-analysis[35]. This could be partly due to the analysis combining studies using different *n*-3 fatty acid supplements and different endpoints, since DHA and EPA (not all *n*-3 PUFA supplements contain both) have different protective effects on patients with different profiles of cardiovascular risk factors and on fatal and non-fatal CHD events[29,33].

The estimates of the population effect of dietary fish intake on CHD deaths in the Hong Kong population in the age group 40–69 years revealed that some 240 (or 29 % of the total) CHD deaths were avoided in 2003 as more than half of the population consumed fish every day. If the population had maintained the same frequency of daily fish intake as it had in 1995, there would have been only 213 CHD deaths averted in 2003. Thus the increasing frequency of dietary fish intake in the older population saved more lives from CHD.

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The current estimation was rather conservative as the RR (0·62) we used in the calculation is for those ate fish more than five times weekly compared with those ate fish less than once monthly. In the real scenario, those who did not take fish every day still took it more than once per month in the Hong Kong population.

Dietary fish intake has been recommended by many guidelines to control or prevent CVD[8–11]. However, the population impact of dietary fish intake on CHD has not been assessed in local populations as it depends largely on the population size, incidence of CHD deaths and the frequency of dietary fish intake locally. The PIN-ER-*t*, which derives absolute numbers of the population impact, is more meaningful than proportions or probabilities to measure the magnitude of the effect, especially in the evaluation of the effect of health promotion and prevention in a given population.

In conclusion, the more favourable trends of CHD mortality in the Hong Kong population aged 50–69 years and less favourable trends in the younger age group may be partly due to the different trends of dietary fish intake. The habit of eating fish every day in the Hong Kong population has contributed substantially to the prevention of CHD mortality. Encouraging fresh fish intake among the younger population, but avoiding contaminated or salty fish, could help reduce the burden of CHD.

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