Cardiovascular mortality in Korea: a country experiencing epidemiologic transition

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Background — The pattern of morbidity and mortality of cardiovascular disease (CVD) changes with epidemiologic transition. An understanding of this pattern in rapidly developing countries might provide important clues for the understanding of the epidemiological trends in CVD mortality. The objective of this paper was to address the changing pattern of CVD mortality in Korea during the period 1984-1999, and to examine the significant changes in associated major risk factors for CVD over a similar period.

Methods — For the purpose of this study, three main categories in CVD were reviewed: hypertensive heart disease, ischaemic heart disease, and cerebrovascular disease (stroke). The analyses of mortality were based on nationwide mortality data published by the National Statistical Office from 1984 to 1999. All the mortality rates were adjusted for age using the direct method. Changes in major CVD risk factors (blood pressure, cigarette smoking, serum total cholesterol and diet) were also reviewed during similar periods.

Findings — During the 15-year period investigated, the age-adjusted mortality from CVD decreased markedly. It decreased by 57% in males (from 172.2 to 73.0/100,000) and 48% in females (from 135.5 to 70.2/100,000). The age-adjusted mortality from stroke decreased while the proportion of ischaemic strokes among total stroke deaths increased. The proportion increased about 5.2 times in men and 4.9 times in women. The age-adjusted mortality from hypertensive heart disease decreased markedly. It decreased by 92% in men (from 51.6 to 4.1/100,000) and 84% in women (from 34.1 to 5.3/100,000). Also the age-adjusted mortality from ischaemic heart disease increased significantly. In 1999, the rates for men and women were 11.9 and 7.5/100,000, respectively. These rates were 3.8 and 3.6 times higher than the rates in 1984 for men and women, respectively.

The changes of CVD risk factors in Korea observed during a similar period were a decrease in hypertension prevalence, although still present at a high level, an increase in serum total cholesterol level and intake of total fat along with a high, although decreasing, prevalence of cigarette smoking.

Interpretation — The mortality changes in Korea are consistent with the change that occurs during the transition from the age of receding pandemics to the age of degenerative and man-made diseases. This study has indicated that the change of CVD mortality was closely associated with the change in CVD risk factors. In order to avert the ongoing epidemic of CVD in developing countries, prevention and treatment of modifiable risk factors must become a high health priority. *(Acta Cardiol 2001; 56(2): 75-81)*

Keywords: *cardiovascular disease – cardiovascular disease mortality – epidemiologic transition – Korea.*

Introduction

Cardiovascular disease (CVD) was the leading cause of death in the world in 1990. In developed countries, it has been the leading cause of death for many decades[1]. Furthermore, also in developing countries, it is estimated that CVD became the leading cause of death in the mid-1990s. The emerging epidemic of CVD in developing countries was predicted in a US Institute of Medicine report[2]. The approaching epidemic of CVD in developing countries is anticipated to have a serious impact on the health of people living in these countries. Therefore, measures to prevent and control the global epidemic of CVD are urgently needed.

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The pattern of morbidity and mortality of CVD changes with epidemiologic transition. An understanding of this pattern in the rapidly developing countries of Eastern Europe and Asia might provide important clues for the understanding of the epidemiological trends in CVD mortality. Eastern Europe has already experienced a rapid rise in CVD[3], and there are strong indications that Asia will also experience a similar pattern[4].

The Republic of Korea (South Korea) is one of the Asian countries experiencing rapid economic growth and social changes recently. In Korea, CVD has emerged as the leading cause of death since the major cause of death changed from infectious disease to non-infectious disease in the 1970s[5]. The pattern of CVD mortality in Korea has changed remarkably during the last two decades. In 1999, the crude death rate of Koreans was 522.7 per 100,000. CVD-related deaths accounted for 23.3% of the total deaths[6] and the annual medical cost for CVD accounted for more than 10% of Korea's total medical expenditure[7].

The objective of this paper was to address the changing pattern of CVD mortality in Korea during the period 1984-1999, and to examine changes in major risk factors for CVD during a similar period.

Methods

For the purpose of this study, three main categories in CVD were reviewed: hypertensive heart disease (ICD-9: 401-405), ischaemic heart disease (ICD-9: 410-414), and cerebrovascular disease (ICD-9: 430-438). Because less than half of deaths from cerebrovascular disease have been reported by subtype, the proportion of the cerebrovascular disease subtypes [haemorrhagic stroke (ICD-9 430-432) and thrombotic stroke (433-434)] among all reported strokes was also analyzed. The analyses of mortality were based on nationwide mortality data published by the National Statistical Office from 1984 to 1999[6]. They have published yearly a book of death statistics since 1981. Because the registration of deaths only started in 1981 in Korea and the statistics in the first few years may not be valid, death rates since 1984 were analyzed in this paper. All the mortality rates were adjusted for age using the direct method. The age distribution of the Korean population in 1981 was used to represent the standard population.

Changes in major CVD risk factors during a similar period were also reviewed. For changes in blood pressure (BP), data from three nationwide BP surveys performed in 1980, 1990 and 1998, were used[8-10]. The prevalence of hypertension (systolic BP ≥ 140 mm Hg and/or diastolic BP ≥ 90 mm Hg, or being on antihypertensive treatment) was compared by age group 30 years and over. The prevalence of cigarette smoking was drawn from two sources. Data for 1980 and 1990 was obtained from the nationwide interview surveys conducted by the Korean Institute of Tuberculosis[11], and data for 1999 from the nationwide telephone surveys conducted by Korea Gallup[12].

Since national data to examine the change of serum total cholesterol is not available, data from medical insurance reports was used. Medical insurance for civil servants and private school workers is offered by one of the major health insurance companies in Korea (the Korea Medical Insurance Corporation: KMIC) and it covered 1.4 million workers and their dependents in 1996[7]. All insured workers are required to have medical examinations, performed biennially by KMIC. This medical examination data from KMIC was reanalyzed for serum total cholesterol from 1984 to 1998. Data on dietary patterns was drawn from the annual National Nutrition Survey conducted by the Ministry of Health and Welfare over the period 1980 to 1995.

Results

1. Mortality

Figure 1 shows age-adjusted, total CVD mortality, by year and sex during 1984-1999. The age-adjusted rate in 1984 was 172.2 and 135.5 per 100,000 in men and women, respectively. During the 15 year period there was a marked decline in total CVD mortality and the rate of decrease was quite consistent during the period. The decline was more prominent in men than in women. It decreased by 57% in men and 48% in women. In 1999, the age-adjusted rate was 73.0 and 70.2 per 100,000 in men and women, respectively.

Figure 2 shows the pattern of mortality from cerebrovascular diseases. The age-adjusted death rate for cerebrovascular disease in men showed a decreasing trend. However, the rate for women fluctuated, but recently it has shown a decreasing trend since 1994. While the death rate for men was higher than for women, the difference has gradually been reducing during the period. The rate for women has been higher than that for men since 1992. In 1999, the age-adjusted death rate per 100,000 population was 41.6 for men and 42.8 for women.

Table 1 shows the proportion of haemorrhagic and ischaemic strokes among all reported stroke deaths. There was an increase in the proportion in both types of stroke during the period. But, the increase in ischaemic stroke was more prominent. While the proportion of ischaemic stroke increased about 5 times in both sexes, the increase in haemorrhagic stroke was about 1.5 times in both sexes (Table 1).

Figure 3 shows age-adjusted death rates for hypertensive heart diseases. It shows declining trends for

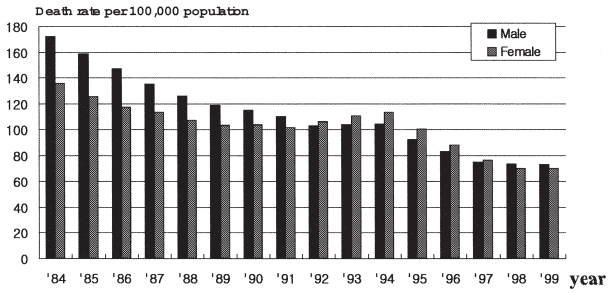

Fig. 1. – Age-adjusted death rates for total cardiovascular disease: Korea, 1984-1999.

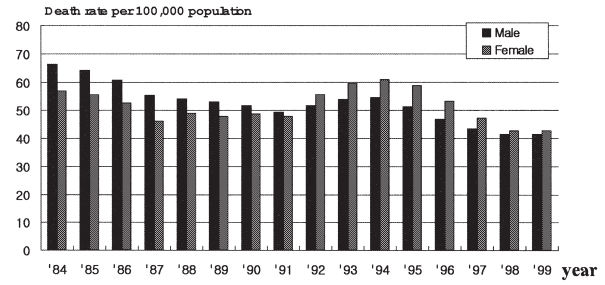

Fig. 2. – Age-adjusted death rates for cerebrovascular disease: Korea, 1984-1999.

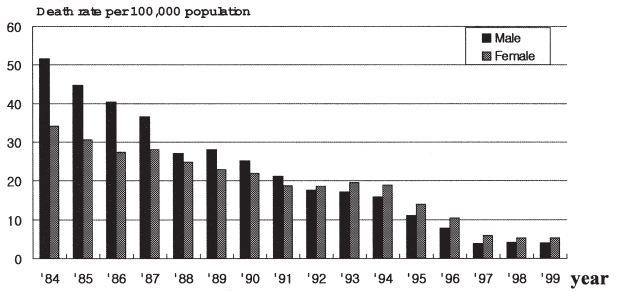

Fig. 3. – Age-adjusted death rates for hypertensive heart disease: Korea, 1984-1999.

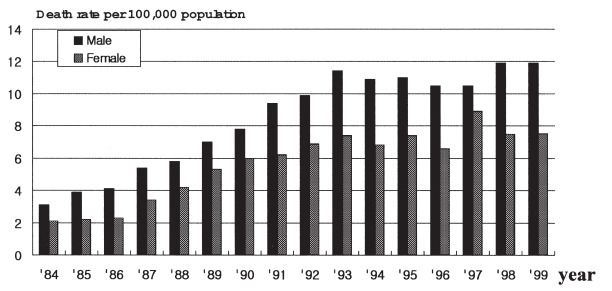

Fig. 4. – Age-adjusted death rates for ischaemic heart disease: Korea, 1984-1999.

both sexes during the period with the rate for men declining much faster and more consistently than that for women. The mortality decreased by 92% in men (from 51.6 to 4.1/100,000) and 84% in women (from 34.1 to 5.3/100,000). As in the death rates for cerebrovascular disease, the gender difference has changed since 1992, with the rates for women climbing above those of men from 1992 to 1999. The age-adjusted death rate (per 100,000) in 1999 was 4.1 in men and 5.3 in women.

Figure 4 shows the mortality for ischaemic heart disease. Contrary to the changes in mortality for cerebrovascular disease and hypertensive heart disease, the mortality for ischaemic heart disease increased between 1984 and 1999. Even though the rate was relatively low compared with the rate of cerebrovascular disease, the rate rapidly increased between 1984 and 1993 and has stabilized thereafter in both sexes. In 1999, the age-adjusted death rates for men and women were 11.9 and 7.5 per 100,000, respectively. These rates were 3.8 and 3.6 times higher than the rates in 1984 for men and women, respectively.

2. Major CVD risk factors

a. Hypertension

The prevalence rates of hypertension in adult Koreans aged 30 years and older are shown in Table 2. The age-adjusted rates for hypertension in 1980, 1990 and 1998 were 35.5, 28.9, and 30.0% for men and 25.8, 26.6

Table 1. – *Proportion of haemorrhagic and ischaemic strokes among all stroke deaths in Korea*

Unit: %

Sex	Type of stroke	1984	1987	1990	1993	1996	1999
Men	Haemorrhagic stroke	21.6	24.6	25.9	28.5	29.7	31.8
	Ischaemic stroke	2.9	4.5	6.5	8.5	12.7	15.2
	Unclassified stroke	75.5	70.9	67.6	63.0	57.6	53.0
Women	Haemorrhagic stroke	19.9	23.2	25.3	27.3	28.4	30.4
	Ischaemic stroke	2.8	4.6	6.0	7.5	11.2	13.6
	Unclassified stroke	77.3	72.2	68.7	65.2	60.4	56.0

Table 2. – *Prevalence rates of hypertension in Koreans*

Unit: %

	Total			Men			Women		
Age	1980	1990	1998	1980	1990	1998	1980	1990	1998
30-39 yrs	16.4	13.8	12.4	23.5	17.7	18.4	8.8	9.7	6.1
40-49 yrs	26.4	24.8	23.9	33.0	27.3	29.6	19.7	22.1	18.1
50-59 yrs	37.3	35.8	37.3	43.3	35.5	40.2	32.1	36.0	34.5
60-69 yrs	47.6	44.3	44.7	52.5	44.6	42.4	43.7	44.1	46.5
70 yrs and over	62.6	53.2	55.7	64.1	53.9	46.9	61.9	52.8	60.4
Total *	29.3	26.8	27.2	35.5	28.9	30.0	25.8	26.6	25.2

* Age-adjusted rate

Table 3. – *Prevalence rates of cigarette smoking in Koreans*

Unit: %

	Men			Women		
Age	1980	1990	1999	1980	1990	1999
20-29 yrs	76.5	77.7	70.4	1.3	1.5	4.8
30-39 yrs	78.4	79.1	71.3	2.7	1.4	3.2
40-49 yrs	81.6	72.9	65.2	9.2	3.3	2.8
50-59 yrs	83.3	73.2	51.9	28.4	11.3	4.8
60 yrs and over	79.5	68.9	44.4	47.2	29.5	10.4
Total *	69.5	68.2	64.9	11.0	6.8	4.4

* Age-adjusted rate

Table 4. – *Proportion of KMIC beneficiaries whose serum total cholesterol was 240 mg/dl and over (%)*

Sex	1984	1994	1998
Men	4.6	9.1	10.1
Women	2.8	6.1	14.3
Total	4.2	8.3	12.8

and 25.2% for women, indicating that the incidence of hypertension for men has shown a decreasing trend, but not for women. In men, the decrease in the prevalence of hypertension was more marked in the 30-39 years group and the 60 years and over groups (60-69 and 70 yrs and over).

b. Cigarette smoking

Table 3 shows smoking prevalence rates for Koreans aged 20 years and over in 1980, 1990 and 1999. The prevalence rates decreased significantly during the period for both men and women. In 1999, the prevalence rate was 64.9% and 4.4% in men and women, respectively.

In men, the change in the prevalence rate was more marked in the older age groups. In the age group 50-59 and 60 and older, the prevalence decreased 37.7% and 44.2%, respectively. The change in the prevalence of smoking in women also varied by age group. As with men, the prevalence in the middle-aged and old age female groups (aged 40 and over) decreased, but the prevalence increased in the younger age groups (less than 40 years) even though the rate was still relatively low. The increase in prevalence was remarkable especially in the age group 20-29, where it increased 3.7 times.

c. Serum total cholesterol

Table 4 shows the proportions of KMIC beneficiaries whose serum cholesterol was over 240 mg/dl between 1984 and 1998. The proportion increased rapidly during the period and the change was more remarkable in women than in men. It increased 2.2 times in men and 3.0 times in women. In 1998, the proportion was 10.1% in men and 14.3% in women. There was also a significant increase in mean serum

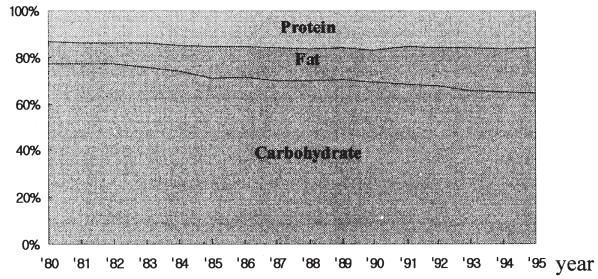

Fig. 5. – Composition of total energy intake: Korea, 1980-1995.

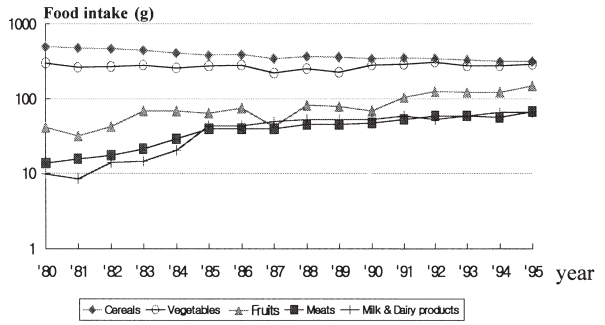

Fig. 6. – Yearly change in the average food intake for each food group: Korea, 1980-1995.

total cholesterol. In men, the mean was 175.0 mg/dl in 1984 increasing to 188.5 mg/dl in 1998. In women the mean levels were 167.4 mg/dl and 178.7 mg/dl in 1984 and 1998, respectively.

d. Diet

Diet has changed dramatically in the last 20 years in Korea. The mean daily per capita intake of total food energy of Koreans has decreased from 2,052 kcal in 1980 to 1,839 kcal in 1995. Figure 5 shows the trends in carbohydrate, protein, and total fat intake in Korea from 1980 to 1995. The consumption of fat has increased and the consumption of carbohydrates has decreased. In 1980, fat accounted for only 9.6% of energy intake, but that proportion had increased to 19% in 1995. Between 1980 and 1995, carbohydrate intake in percent calories had decreased, whereas protein intake showed no significant change overtime.

Figure 6 depicts the yearly change in the average food intake for each food group. Between 1980 and 1995, there was a substantial increase in intakes of meat, poultry and their products, milk and dairy products, and fruits, whereas the intake of cereals and grain products has decreased. No distinct change was observed in vegetable intake.

The increased fat consumption noted apparently comes from the increased quantity of meat, poultry and their products, milk and milk products consumed.

Discussion

The form of CVD and the burden that it causes evolves as a country undergoes economic development. This evolution usually follows the three stages for epidemiologic transition[13]. For countries in the earliest stage of development (age of pestilence and famine), the predominant circulatory diseases are rheumatic heart disease, infections, and nutritional deficiency-related disorders of the heart muscle. In the second stage (age of receding pandemics), as infectious disease burdens are reduced and nutrition improves, diseases related to hypertension, such as haemorrhagic stroke and hypertensive heart disease become more common. In the third stage (age of degenerative and man-made diseases), as life expectancy continues to improve, high-fat diets, cigarette smoking, and sedentary lifestyles become more common, the main stroke mortality changes from the haemorrhagic type to the thrombotic type, and there is an increase in ischaemic heart disease[2].

This paper showed a changing pattern of CVD in Korea during the last fifteen years. In the 1980s, haemorrhagic stroke and hypertensive heart disease were the more common forms of CVD, but, during the 15 year period, the mortality of hypertensive heart disease decreased markedly while the proportion of ischaemic stroke among total stroke deaths increased. Also the mortality from ischaemic heart disease increased significantly. This mortality change is consistent with the changes that occur in the transition from the second stage (age of receding pandemics) to the third stage (age of degenerative and man-made diseases).

Until recently, similar to many East Asian countries, Korea was known as a country in which haemorrhagic stroke was the common form of stroke. But the incidence has been changing during the last two decades. Now, the incidence of ischaemic stroke is higher than that of haemorrhagic stroke. In a prospective cohort study which followed 114,793 Korean men, aged 35-59, for 6 years (1993-1998) 1,398 men were either hospitalized because of or died from stroke. Among all cases, the incidences of ischaemic, haemorrhagic, and other strokes were 682 (48.8%), 528 (37.8%) and 188 (13.4%), respectively. The number of fatal cases was 39 (ischaemic stroke), 106 (haemorrhagic stroke) and 5 (other stroke). This study showed that the incidence of ischaemic stroke was higher than that of haemorrhagic stroke, but the mortality from ischaemic stroke was lower than that from haemorrhagic stroke[14]. This discrepancy between incidence and mortality seems to be due to a difference in the case fatality rate. The case fatality rate of haemorrhagic

stroke has been reported to be much higher than that of ischaemic stroke[15].

The most remarkable changes in mortality were a decrease in hypertensive heart disease mortality and an increase in ischaemic heart disease mortality during the period of the study. The decrease in hypertensive heart disease mortality seems to be related to the decrease in the prevalence of hypertension. Korea is known as the country with the lowest ischaemic heart disease mortality in the world[16]. Among 55 countries, Korea showed the lowest ischaemic heart disease mortality in the age range of 55-74 years. Even though the mortality rate was relatively low, the change during the period was unexpected. In order to prevent an epidemic of ischaemic heart disease, a prevention and control program of known risk factors should be started at the national level.

The main CVD risk factors for Koreans, blood pressure, cigarette smoking and serum total cholesterol, were also similar with those found in Western countries[17]. The most significant changes of CVD risk factors in Korea during the last two decades might be the increase in serum total cholesterol level and intake of total fat, along with the decreasing prevalence of cigarette smoking and, for men, hypertension. Even though the average serum cholesterol level and total fat intake are still relatively low compared with those of people in Western countries, the levels have increased significantly for Koreans. The impact of such a rapid increase of these risk factors in a lean population, like the Korean one, which had maintained low levels of these risk factors for a long time may be more profound than in a population which had been permanently exposed to a higher level of these risk factors. There is evidence to support this hypothesis. A recent study showed that moderate total fat intake, which could be regarded as safe for Western people, is a risk factor for ischaemic heart disease for Koreans[18]. This implies that the level of fat intake which increases the risk of ischaemic heart disease could vary with different populations. The increase in total fat intake and subsequent increase in serum total cholesterol level seem to contribute to the increase in ischaemic stroke and ischaemic heart disease rates.

Cigarette smoking is an important risk factor for CVD, also for Koreans. Korean men have shown the highest prevalence of smoking in the world[19], and even though the prevalence of smoking has started to decline, it is still very high. A recent study showed that cigarette smoking was the most important risk factor for ischaemic heart disease, and ischaemic stroke for Korean men[20]. Recent increases in the incidence of ischaemic stroke and ischaemic heart disease might be associated with the smoking epidemic in Korea.

Hypertension is a well known risk factor for CVD. The prevalence of hypertension is very high in all countries in Northeast Asia, including Korea, Japan and Taiwan[21]. In the People's Republic of China, hypertension is the major cause of mortality from stroke, which is mostly haemorrhagic (25% of total deaths), and there is a positive and highly significant association with systolic and diastolic blood pressure[3]. Hypertension is also the major risk factor for CVD for Koreans. The population attributable risk of hypertension among total CVD (34%) was the highest among the major CVD risk factors (serum total cholesterol, cigarette smoking and diabetes mellitus). Since hypertension is a strong risk factor for haemorrhagic stroke, the decrease in the incidence of haemorrhagic stroke might be associated with the decrease of blood pressure levels for Koreans, especially in men.

One of the characteristics of the Korean diet is its high salt content. The salt content of some traditional Korean foods e.g. kimchi, is very high. The Korean population has one of the highest 24-h urinary sodium excretions in the world[22,23]. Korea has also among the highest mortality rates for stroke and stomach cancer, diseases which have been linked to the level of salt intake. More attention should be paid to the level and changes in salt intake in Korea on which few recent data are available.

For the analyses of mortality, vital statistics based on registered deaths were used. Because a death certificate can be issued by either a physician or a leader in the local community in Korea, there could be a problem in the accuracy of diagnosis. The proportion of deaths certified by a physician was only 33.0% in 1984 and it increased to 69.2% in 1999. The remaining deaths were certified by local community leaders. However, since most patients were treated by physicians before death, these leaders might have heard about the causes of death from either relatives of the patients or the physicians themselves. Therefore, the diagnoses may not be entirely unfounded. While the specific death rates may not be exactly accurate due to these reporting procedures, the overall trend of mortality can be observed from this data.

Health screening of KMIC beneficiaries has been conducted in many hospitals contracted by KMIC. Therefore, the accuracy of screening data may suffer due to a lack of standardization in testing methods for cholesterol and fasting blood sugar. However, this data can be used for the analysis of overall trends since testing was conducted in a similar manner throughout the period. Regarding the quality of laboratory examination, inter-laboratory quality assessments in clinical chemistry have been performed by the Korean Society of Quality Control in Clinical Pathology every year and hence the quality control of cholesterol measurements is regarded as reliable in Korea.

This study addressed the change in cardiovascular mortality and CVD risk factors in Korea over a 15 year period. In this period the mortality rate from total

cerebrovascular disease decreased significantly. Among cerebrovascular diseases, the mortality from haemorrhagic stroke remained high. However, the mortality from thrombotic stroke showed a pattern of rapid increase during the period. The patterns of prevalence of the major CVD risk factors, i.e., high rates of cigarette smoking and hypertension, and increases in serum cholesterol level and total fat intake, seem to be associated with changes in mortality from CVD in Korea.

In conclusion, Korea is a country which has shown an epidemiologic transition in CVD. This study showed that the change in CVD mortality was closely associated with the CVD risk factors. In order to avert the ongoing epidemic of CVD in developing countries, the prevention and treatment of modifiable risk factors must become a high priority health issue.

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