Trends in Avoidable Death over 20 Years in Korea

To evaluate the achievement of health care services in Korea independent of other socioeconomic factors, we observed the time trend of avoidable death between 1983 and 2004. A list of avoidable causes of death was constructed based on the European Community Atlas of "Avoidable Death". We calculated sex- and age-standardized mortality rates of Korean aged 1-64 yr using data of the Korea National Statistical Office. The avoidable mortality rate (per 100,000 persons) decreased from 225 to 84 in men and from 122 to 41 in women. Accordingly, the proportion of avoidable deaths among all classifiable deaths was reduced by 8.1% in men and 6.4% in women. However, mortality rates from some preventable causes such as ischemic heart disease and malignant neoplasms of lung, breast, cervix, and colorectum have been on the rise. Mortality preventable by appropriate medical care showed the greatest reduction (by 77.8%), while the mortality preventable by primary prevention showed the least reduction (by 50.0%). These findings suggest that health care service has significantly contributed to the improvement of health in Korea. However, more effective intervention programs would be needed given the less reduction in mortality avoidable by primary or secondary prevention than expected and unexpectedly increasing mortality from several preventable causes.

Key Words : *Avoidable Death; Amenable Death; Cause of Death; South Korea; Mortality; Quality of Health Care*

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INTRODUCTION

Mortality rates have been remarkably decreasing while the mean life expectancy has been increasing worldwide over the past several decades (1). Korea has recently seen great improvements in the population health level, and the life expectancy of Koreans has increased from 61.9 yr in 1970 to 78.6 yr in 2005 (2). Although this improvement in population health status is, at least in part, attributable to the recent changes in the national health care systems and advancements in medical technology, the marked socio-economic development that has been taking place in Korea in recent years is also thought to have contributed considerably to these improvements (3). A series of economic developments following the World War 2 and the Korean War have shifted the economic status of Korea from an underdeveloped country toward a developed country, placing Korea 24th in the Organization for Economic Co-operation and Development (OECD) member countries (4). The gross national income per capita of Korea reached about 10,000 US dollars in the year 2000 with an annual growth rate approaching 10%, which represents a 100-fold increase in the gross domestic product (GDP) per capita in less than 40 yr (5). In this regard, a study evaluating the quality of medical health care service itself seems necessary for health service planning. Studies on this issue have been conducted in well-developed Western countries using the concept of avoidable mortality as an indicator of the quality of medical care. However, these types of studies have rarely been conducted in developing countries.

Since Korea is the country currently experiencing the most economic growth among the previously less developed countries, an evaluation of the achievement of medical health care services in Korea would help facilitate further improvements in the population health levels of other developing countries through a more effective utilization of health care resources. Avoidable mortality is defined as unnecessary and untimely death that may have been prevented by the timely provision of appropriate medical intervention (6), and it is frequently used as a statistical indicator of the achievement of medical health care services in order to assess the improvement of health level independent of other socioeconomic factors (7). Avoidable mortality was first suggested by Rutstein in the 1970s and was later modified by Mackenbach (8). Although

some problems such as the ambiguity of the definition and
some arbitrariness in disease selection remain (9, 10), avoid-
able mortality proved to be useful in evaluating the quality
of medical services provided at different times and in differ-
ent places (7, 8, 11-14), and it has been adopted by the World
Health Organization (WHO) as a tool for comparing data
from different countries (15).

This study aimed to evaluate the achievement of medical
health care services available in Korea by analyzing the time
trends in avoidable mortality of whole Koreans from 1983
to 2004 based on national death report data provided by the
Korea National Statistical Office.

MATERIALS AND METHODS

Selection of the list of avoidable causes of death

A list of avoidable causes of death was constructed mainly
based on the European Community Atlas of "Avoidable
Death", which was published by Holland and collaborators
in 1993 with financial support from the commission of the
European community (Table 1) (16). There are two different
points between the lists in this study and in the European
Community Atlas. Firstly, perinatal death was not included
in this study in order to reduce the probable bias that would
arise from the substantial under-reporting of perinatal deaths

Table 1. Selected causes of avoidable death[†]

Causes of death	ICD*-9	ICD-10	Age (yr)	Sex
Causes of death avoidable by primary prevention[‡]				
Malignant neoplasm of the lip, oral cavity, pharynx, esophagus, or larynx	140-150, 161	C00-C115, C32	1-64	M.F
Malignant neoplasm of the liver	155	C22	1-64	M.F
Malignant neoplasm of the lung or bronchus	162	C33-C34	1-64	M.F
Malignant neoplasm of the bladder	188	C67	1-64	M.F
Cerebrovascular diseases	430-438	I60-I69	1-64	M.F
Cirrhosis of the liver	571	K74	1-64	M.F
Causes of death avoidable by secondary prevention[§]				
Malignant neoplasm of the skin	I73	C44	1-64	M.F
Malignant neoplasm of the breast	174	C50	1-64	M.F
Malignant neoplasm of the cervix uteri	180	C53	1-64	F
Malignant neoplasm of the placenta, uterus, other and unspecified	179, 181, 182	C54-C55	1-64	F
Malignant neoplasm of the testicle	186	C62	1-64	M
Hodgkin's disease	201	C81	1-64	M.F
Malignant neoplasm of the stomach	151	C16	1-64	M.F
Malignant neoplasm of the colon and rectum	153-154	C18-C21	1-64	M.F
Causes of death avoidable by hygiene condition and medical care[‖]				
Infectious intestinal diseases	001-009	A00-A09	1-64	M.F
Tuberculosis	010-018	A15-A19	1-64	M.F
Viral hepatitis	070	B15-B19	1-64	M.F
Infectious diseases	001-139	A00-B99	1-64	M.F
Leukemia	204-208	C91-C95	1-64	M.F
Chronic rheumatic heart disease	393-398	I00-I09	1-64	M.F
Hypertensive disease	401-405	I10-I13	1-64	M.F
Ischemic heart disease	410-414	I20-I25	1-64	M.F
Pneumonia	481-486	J12-J18	1-64	M.F
Bronchitis, chronic and unspecified	490-494	J40-J46	1-64	M.F
Emphysema, asthma				
Respiratory disease	460-519	J00-J99	1-64	M.F
Ulcer of the stomach and duodenum	531-533	K25-K27	1-64	M.F
Appendicitis	540-543	K35-K38		
Hernia of abdominal cavity	550-553	K45-K46	1-64	M.F
Cholelithiasis and cholecystitis	574-575.1	K80-K81	1-64	M.F
Maternal deaths	630-676	O00-O99	15-64	F
Congenital anomalies of heart and circulatory system	745-747	Q25-Q28	1-64	M.F

*, International classification of diseases; [†], determined based on the European Community Atlas of "Avoidable Death". Perinatal death was excluded.
Deaths from malignant neoplasms of the stomach and colorectum were added; [‡], diseases for which major etiological factors such as smoking, occupa-
tional and environmental exposure have been identified and whose impact should be reduced through adequate primary prevention; [§], neoplastic
diseases for which early diagnosis, followed by appropriate therapy, has been shown to largely increase patient survival rates; [‖], diseases associat-
ed with poor hygienic conditions and other diseases which are strongly influenced by the efficiency of the public health system in providing correct
diagnosis and an appropriate treatment in due time.

in Korea (17). Secondly, deaths due to stomach or colorectal cancers were added to the list in this study because the mortality rates from those causes are high among Koreans and because early detection and treatment have proven to be effective in preventing these cancers (18).

We followed the categorization of the avoidable causes of death proposed by the European Community Atlas, where the avoidable causes of death in the list were categorized into three groups according to the mode of medical health services used for prevention (16): group 1, diseases for which major etiological factors such as smoking, occupational and environmental exposure have been identified and whose impact should be reduced through adequate primary prevention; group 2, neoplastic diseases for which early diagnosis, followed by appropriate therapy, has been shown to largely increase patient survival rates; and group 3, the diseases associated with poor hygienic conditions and other diseases which are strongly influenced by the efficiency of the public health system in providing correct diagnosis and an appropriate treatment in due time.

Study subjects and statistical methods

Data on age, gender, and specific cause of death in persons who died between 1983 and 2004 was obtained from the annual death report (between 1983 and 1990) and death dataset (between 1991 and 2004), provided by the Korea National Statistical Office. We referred to the annual death reports for the years between 1983 and 1990 because raw data was not available (19). Although the national death report has been published annually since 1980, we used the data from 1983 and thereafter for this study because the specific causes of death were missing or unknown for more than 10% of the deceased in earlier death report data (20). The age range of the study subjects was limited to between 1 and 65 yr, which would allow the results of our study to be compared with those of other previous studies. After classifying the death data according to sex, age group (5-yr interval), and specific cause of death, the directly standardized death rate of each year was calculated using the entire Korean population in 1990 as a reference group. We then calculated the relative percentage (%) of each year's standardized mortality rate using the age- and sex-standardized mortality rate in 1983 as a reference (100%). The Institutional Review Board of Samsung Medical Center (Seoul, Korea) approved this study.

Table 2. Time trend of age- and sex-adjusted all-cause and avoidable mortality rates* (relative percent[†]) among Korean persons aged between 1 and 64 yr, from 1983 to 2004

Year	Classifiable cause of death/all cause death %	Mortality from classifiable causes (relative %[†])	Avoidable mortality					
			All	Men		Women		
			Mortality rate (relative%)	Avoidable/ classifiable mortality[‡]	Mortality rate (relative%)	Avoidable/ classifiable mortality[‡]	Mortality rate (relative%)	Avoidable/ classifiable mortality[‡]
1983	92.7	333 (100.0)	174 (100.0)	52.0%	225 (100.0)	52.5%	122 (100.0)	52.9%
1984	95.8	331 (99.4)	175 (101.7)	53.2%	229 (101.8)	52.9%	119 (97.5)	53.6%
1985	86.3	309 (92.8)	170 (99.4)	55.7%	227 (100.9)	55.1%	112 (91.8)	56.3%
1986	82.7	290 (87.1)	158 (93.6)	55.9%	213 (94.7)	54.7%	107 (87.7)	57.3%
1987	82.3	279 (83.8)	149 (87.3)	54.1%	202 (89.8)	53.9%	100 (82.0)	56.4%
1988	82.9	261 (78.4)	142 (82.1)	54.4%	191 (84.9)	54.1%	92 (75.4)	56.4%
1989	82.1	257 (77.2)	141 (80.9)	54.5%	186 (82.7)	52.8%	88 (72.1)	54.7%
1990	81.2	250 (75.1)	131 (75.7)	52.4%	176 (78.2)	52.2%	83 (68.0)	53.9%
1991	84.2	260 (78.1)	125 (72.8)	48.5%	168 (74.7)	47.8%	78 (63.9)	49.4%
1992	89.9	247 (74.2)	120 (71.1)	49.8%	164 (72.9)	49.4%	76 (62.3)	51.0%
1993	94.1	238 (71.5)	119 (69.4)	50.4%	160 (71.1)	48.9%	76 (62.3)	51.7%
1994	96.3	233 (70.0)	115 (67.1)	49.8%	158 (70.2)	48.9%	73 (59.8)	52.1%
1995	99.1	229 (68.8)	107 (61.8)	46.7%	147 (65.3)	46.8%	65 (53.3)	47.8%
1996	99.2	219 (65.8)	98 (58.4)	46.1%	136 (60.4)	44.6%	62 (50.8)	48.8%
1997	99.1	203 (61.0)	91 (54.3)	46.3%	125 (55.6)	44.7%	59 (48.4)	49.2%
1998	99.1	193 (58.0)	87 (50.9)	45.6%	118 (52.4)	44.8%	52 (42.6)	45.6%
1999	98.7	188 (56.5)	86 (49.7)	45.7%	118 (52.4)	45.8%	53 (43.4)	46.5%
2000	99.0	178 (53.5)	83 (49.7)	48.3%	117 (52.0)	47.8%	51 (41.8)	50.0%
2001	99.2	165 (49.5)	79 (45.7)	47.9%	109 (48.4)	48.5%	48 (39.3)	50.0%
2002	99.5	158 (47.4)	74 (43.9)	48.1%	103 (45.8)	48.2%	49 (40.2)	50.0%
2003	99.5	153 (45.9)	68 (40.5)	45.8%	94 (41.8)	44.5%	43 (35.2)	46.7%
2004	99.6	143 (42.9)	64 (37.6)	45.5%	84 (37.3)	44.4%	41 (33.6)	46.5%

*, Age- and sex-standardized rates per 100,000 persons, calculated using the entire Korean population in 1990 as a reference group; [†], percentage of age- and sex-adjusted mortality rate in each year compared to that in 1983; [‡], proportion of avoidable mortality of all classifiable mortality.

RESULTS

Table 2 shows the annual age- and sex-adjusted mortality rates between 1983 and 2004. The mortality rate has been decreasing continuously with time, and by 2004 it was reduced to less than a half of that in 1983. Avoidable mortality has declined even faster, and the 2004 rate was 37.6% of that in 1983. The degree of reduction in avoidable mortality was slightly higher in men than in women.

Table 3 shows the time trend of avoidable mortality rates according to each category of medical intervention effective for preventing death. Mortality avoidable by medical intervention has been continuously decreasing since 1983, while mortality avoidable by primary or secondary prevention increased initially but then began to decrease in the mid-1980s. Although avoidable mortality has decreased in all three categories of medical intervention over the last 20 yr, the degree of reduction was most remarkable in mortality avoidable by medical care. The degree of reduction in mortality avoidable by secondary prevention was greater in men, while mortality avoidable by primary prevention and medical care were lower in men than in women.

Fig. 1 shows the time trend in highly prevalent causes of avoidable death among Koreans according to the category of medical intervention. Mortality from a malignant neoplasm of the liver or liver cirrhosis increased until the late 1980s and then began to decrease in the 1990s. Mortality rate associated with malignant neoplasm of the lung began to decline in the late 1990s after increasing in the early 1990s, but the rate of lung cancer mortality in 2004 still remained higher than that in 1983. The mortality rate from stomach neoplasm has been decreasing continuously, but it is still the leading cause of cancer mortality. Mortality from breast, cervix, and colorectal cancers have been increasing over the last 20 yr. Mortality from cerebrovascular disease, which is avoidable by primary and secondary prevention, has been decreasing consistently while mortality from ischemic heart diseases has been on the rise. Among the deaths avoidable by intervention with appropriate medical care, mortality from infectious diseases, respiratory diseases, and hypertensive diseases has decreased enormously.

Table 3. Time trend of avoidable mortality rates* (relative percent[†]) among Koreans aged 1-64 yr by each category of medical intervention effective for preventing death, from 1983 to 2004

Year	Category of medical interventions effective for prevention of death								
	Primary prevention[‡]			Secondary prevention[§]			Medical care[∥]		
	All	Men	Women	All	Men	Women	All	Men	Women
1983	74 (100.0)	108 (100.0)	42 (100.0)	28 (100.0)	30 (100.0)	27 (100.0)	72 (100.0)	91 (100.0)	51 (100.0)
1984	78 (105.4)	112 (103.7)	42 (100.0)	28 (100.0)	31 (103.3)	27 (100.0)	69 (95.8)	88 (96.7)	49 (96.1)
1985	79 (106.8)	115 (106.5)	43 (102.3)	28 (100.0)	31 (103.3)	27 (100.0)	63 (87.5)	82 (90.1)	42 (82.4)
1986	77 (104.0)	114 (105.6)	43 (102.3)	26 (92.9)	29 (96.7)	24 (88.9)	55 (76.4)	71 (78.0)	39 (76.5)
1987	74 (100.0)	109 (100.9)	41 (97.6)	25 (89.3)	27 (90.0)	24 (88.9)	50 (69.4)	66 (72.5)	36 (70.6)
1988	73 (98.6)	108 (100.0)	40 (95.2)	24 (85.7)	26 (86.7)	22 (81.5)	45 (62.5)	58 (63.7)	30 (58.8)
1989	75 (101.4)	109 (100.9)	39 (92.9)	23 (82.1)	24 (80.0)	21 (77.8)	43 (59.7)	53 (58.2)	27 (52.9)
1990	71 (95.9)	106 (98.1)	36 (85.7)	22 (78.6)	24 (80.0)	22 (81.5)	38 (52.8)	49 (53.8)	25 (49.0)
1991	68 (91.9)	103 (95.4)	35 (83.3)	21 (75.0)	22 (73.3)	20 (74.1)	36 (50.0)	46 (50.5)	23 (45.1)
1992	68 (91.9)	103 (95.4)	36 (85.7)	20 (71.4)	23 (76.7)	21 (77.8)	32 (44.4)	42 (46.2)	20 (39.2)
1993	68 (91.9)	99 (91.7)	37 (88.1)	21 (75.0)	21 (70.0)	19 (70.4)	30 (41.7)	40 (44.0)	19 (37.3)
1994	66 (89.2)	99 (91.7)	35 (83.3)	20 (71.4)	21 (70.0)	21 (77.8)	29 (40.3)	38 (41.8)	17 (33.3)
1995	64 (86.5)	95 (88.0)	33 (78.6)	19 (67.9)	19 (63.3)	18 (66.7)	24 (33.3)	34 (37.4)	15 (29.4)
1996	59 (79.7)	88 (81.5)	32 (76.2)	18 (64.3)	18 (60.0)	17 (63.0)	21 (29.2)	30 (33.0)	14 (27.5)
1997	54 (73.0)	81 (75.0)	30 (71.4)	18 (64.3)	17 (56.7)	18 (66.7)	19 (26.4)	28 (30.8)	12 (23.5)
1998	49 (66.2)	75 (69.4)	25 (59.5)	16 (57.1)	15 (50.0)	15 (55.6)	22 (30.6)	31 (34.1)	12 (23.5)
1999	50 (67.6)	74 (68.5)	24 (57.1)	16 (57.1)	15 (50.0)	17 (63.0)	20 (27.8)	30 (33.0)	12 (23.5)
2000	47 (63.5)	73 (67.6)	25 (59.5)	16 (57.1)	16 (53.3)	16 (59.3)	20 (27.8)	29 (31.9)	12 (23.5)
2001	45 (60.8)	68 (63.0)	22 (52.4)	15 (53.6)	16 (53.3)	16 (59.3)	19 (26.4)	27 (29.7)	11 (21.6)
2002	43 (58.1)	65 (60.2)	22 (52.4)	14 (50.0)	15 (50.0)	16 (59.3)	17 (23.6)	25 (27.5)	10 (19.6)
2003	38 (51.3)	57 (52.8)	19 (45.2)	14 (50.0)	14 (46.7)	14 (51.9)	16 (22.2)	23 (25.3)	10 (19.6)
2004	34 (45.9)	52 (48.1)	17 (40.5)	14 (50.0)	13 (43.3)	14 (51.9)	16 (22.2)	23 (25.3)	9 (17.6)

*, Age- and sex-standardized rates per 100,000 persons, calculated using the entire Korean population in 1990 as a reference group; [†], percentage of age- and sex-adjusted mortality rate in each year compared to that in 1983; [‡], diseases for which major etiological factors such as smoking, occupational and environmental exposure have been identified and whose impact should be reduced through adequate primary prevention; [§], neoplastic diseases for which early diagnosis, followed by appropriate therapy, has been shown to largely increase patient survival rates; [∥], diseases associated with poor hygienic conditions and other diseases which are strongly influenced by the efficiency of the public health system in providing correct diagnosis and an appropriate treatment in due time.
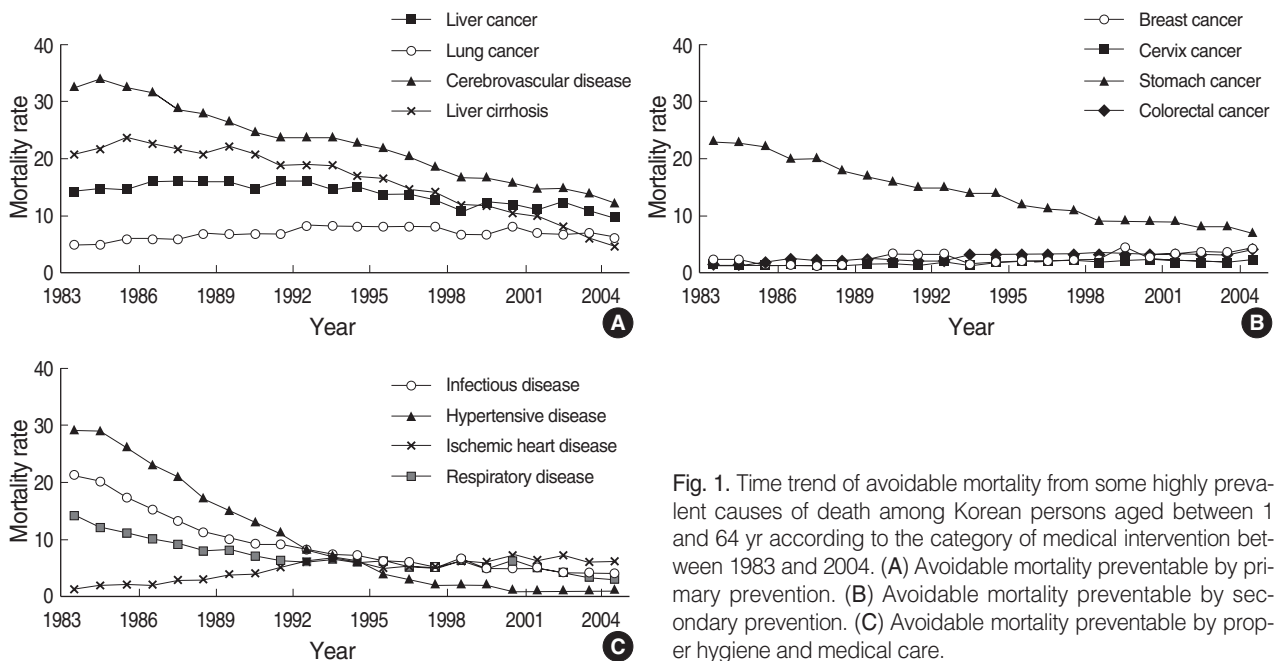
Fig. 1. Time trend of avoidable mortality from some highly prevalent causes of death among Korean persons aged between 1 and 64 yr according to the category of medical intervention between 1983 and 2004. (**A**) Avoidable mortality preventable by primary prevention. (**B**) Avoidable mortality preventable by secondary prevention. (**C**) Avoidable mortality preventable by proper hygiene and medical care.

DISCUSSION

In this study of mortality among Koreans, we observed that mortality has been markedly reduced over the last 20 yr. This reduction in mortality was greatly attributable to the reduction of avoidable mortality, an indicator reflecting the quality of medical health care service.

The findings of this study are consistent with the findings from other previous studies conducted at different times and in different populations. In Sweden, avoidable mortality declined by 19.0% in men and by 20.5% in women over the 12 yr between 1974 and 1985 (13). A study in Belgium also showed a decrease in avoidable mortality between 1974 and 1994 (12). All European countries, except for Hungary, showed a 2.4% annual reduction in avoidable mortality between 1980 and 1997 (14). Avoidable mortality decreased faster than non-avoidable mortality in all of the countries mentioned above, which was consistent with the finding of our study.

There were noticeable differences between men and women in the patterns and trends in mortality according to the category of medical intervention proven effective for prevention of disease. Although the mortality rates were higher in men than in women in all three categories of avoidable mortality, the proportion of mortality preventable by secondary prevention among all causes of avoidable mortality was relatively higher in women than that in men. Furthermore, the degree of reduction in mortality avoidable by secondary prevention over the last 20 yr was smaller in women than in men. This finding suggests that there might be an inequality between the sexes in terms of the usage of preventive medical services in Korea. A study in a representative Korean

population reported that men were more likely than women to use medical services for health screening (21).

Surprisingly, we observed that mortality rates associated with some causes thought to be preventable by improved medical care have actually increased in recent years. Lung cancer mortality was on the rise until the end of the 1990s. This unexpected finding was also observed in previous European reports (13, 14) and could have been the result of insufficient strategies for smoking prevention given that lung cancer was strongly associated with smoking and can be prevented by the active management of smoking behavior. The smoking population in Korea has increased from 12.3 billion in 1945 to 106.5 billion in 1999 and has only recently began to decrease (22). The age at which people began to smoke started becoming younger in the 1970s, meanwhile the amount of cigarettes consumed per person has increased, and more young women have started smoking (22). This pattern of smoking behavior among Koreans raises a concern about further increases in lung cancer in the future, especially at young ages and in women. Therefore, more aggressive efforts should be made to prevent the Korean population from smoking.

Mortality rates associated with breast and colorectal cancers, which were known to be preventable by secondary prevention, have been increasing in Korea over the last 20 yr. Delayed introduction of secondary prevention is less likely to be a main reason of the increase. Rather, several other reasons, such as an increased rate of diagnosis of these cancers or increased incidence probably due to increased exposure to risk factors secondary to changes in dietary habits or life style, should be considered.

Unlike the decreasing tendency of morbidity observed in

cancer registry data (23), mortality from uterine cervical cancer (International Classification of Disease [ICD-10]: C53) was found to be increasing in this study. A possible explanation for this unexpected finding could be that more of cervical cancer were misclassified to a "malignant neoplasm of uterus, unspecified site" (ICD-10: C55) in the past. In a study by Shin et al. (24), where they found that mortality from cervical cancer decreased between 1993 and 2002 when they took malignant neoplasm of unspecified site of uterus into consideration and calculated corrected mortality from cervical cancer based on the data of the Korea Central Cancer Registry. However, the study did not evaluate the whole period we concerned. Another possible explanations for the increase in cervix cancer mortality with time are younger age at onset of cervical cancer (25), earlier onset of sexual activity, increase in number of sexual partners, increased exposure to high-risk partners, and increased smoking rates in young women. However, little is known about the extent to which those factors contributed to the increase in cervical cancer mortality in Korean women. When we take the discrepancies between the trends in cervical cancer incidence and mortality into consideration, it could be possible that the proportion of cervical cancer cases being diagnosed at more advanced stages has increased. Very low participation rates in cervical cancer screening programs among Korean women (19.6% in 1995) compared to those in developed countries (74-89%) (26) could be another important reason for the maintenance of a higher rate of cervical cancer mortality in Korea, and stronger policy encouraging more women to participate in regular screening tests is necessary.

Contrary to the findings in Western developed countries, where the mortality from ischemic heart disease is very high but gradually beginning to decrease, mortality from ischemic heart disease in Korea has rapidly increased over the last 20 yr. Similarly, studies from other Asian countries, where ischemic heart disease was much less prevalent in the past, have recently reported increasing incidences of ischemic heart disease (27). The increase in mortality from ischemic heart disease in Asian populations, including the Korean population, might be related to increasing exposure to risk factors such as hypercholesterolemia (28), sedentary life style, and diabetes mellitus accompanied by socioeconomic changes and related life style transitions. The continued lack of proper medical care for severe ischemic heart disease might also have contributed to the maintenance of a high mortality rate. Thus, more efforts are required to provide effective medical care to patients with ischemic heart diseases and, more importantly, to prevent further occurrences of ischemic heart diseases by actively managing the risk factors associated with ischemic heart diseases.

Mortality rates from liver cancer and chronic liver diseases, which were strongly associated with chronic hepatitis B virus infection, have been decreasing in Korea. Korea is one of the areas with endemic hepatitis B virus infection. However, after the introduction of a nationwide hepatitis B vaccination program, the chronic hepatitis B carrier rate has been declining (29). Therefore, the mortality rate from liver diseases associated with hepatitis B viral infection is expected to decrease further in the coming years.

Mortality from cerebrovascular diseases has been decreasing in Korea, and this finding is in agreement with the findings from European studies conducted between 1980 and 1997 (14). However, we should pay attention to the finding that cerebrovascular disease mortality is still much higher in Korea than in other OECD countries, and greater efforts need to be focused on the prevention of cerebrovascular disease through the active control of risk factors, such as hypertension and smoking (30).

This study has some limitations to be considered. Because we restricted the age of the study subjects to between 1 and 65 yr of age in order to compare the results of our study with those of previous studies, our results cannot reveal anything about the mortality trend in populations older than 65 yr. Due to its nature of transformation, the term 'avoidable death' needs constant correction to accommodate the ever-changing list of possible causes. It may be inappropriate to adopt the list of causes of avoidable mortality suggested by the European community when evaluating the effectiveness of health care service in Korea because of time and geography (9, 10). It is also important to note that there might be considerable misclassification of the causes of deaths (17). However, significant bias seems unlikely because our analysis was based on classifiable mortality only, and the trend was consistent over time without fluctuation by disease category.

To our knowledge, our study is the first study to examine the contribution of medical health care services to the improvement of the population health level using avoidable mortality as an indicator of the quality of medical services in recently developed or developing countries. Therefore, despite its limitations, the finding from our study is valuable because it proved that quality medical health care service significantly contributes to the prevention of untimely and unnecessary death, even in a country that was considered underdeveloped until the mid-20th century. Furthermore, the finding that health care-related problems can hinder the effective reduction of avoidable mortality observed in our study can be used to facilitate further improvements in the population health levels of other developing countries in similar situations.

In conclusion, we proved the effect of quality medical health care services in Korea by showing the remarkable reduction in avoidable mortality over the past 20 yr. However, the rate of reduction was slower for mortality avoidable by primary or secondary prevention methods than for that preventable by direct medical care, and mortality from some diseases in those categories even increased, indicating that there is a need to put more effort toward primary and secondary prevention.

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