

Work-related Cerebro-Cardiovascular Diseases in Korea

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Cerebro-cardiovascular disease (CVD) is one of compensable occupational diseases in Korea as in Japan or Taiwan. However, most countries accept only cardiovascular diseases (ischemic heart diseases) as compensable occupational diseases if any, but not cerebrovascular diseases. Korea has a prescribed list of compensable occupational diseases. CVD was not included in the list until 1993. In the early 1990s, a case of cerebral infarction was accepted as occupational disease by the Supreme Court. The decision was based on the concept that workers' compensation system is one of the social security systems. In 1994, the government has established a diagnostic criterion of CVD. The crude rate of compensated cerebrovascular disease decreased by 60.0% from 18.5 in 2003 to 7.4 in 2008 per 100,000 workers, and that of compensated coronary heart disease decreased by 60.5% from 3.8 in 2003 to 1.5 in 2008 per 100,000 workers. The compensated cases of CVD dramatically increased and reached its peak in 2003. Since many preventive activities were performed by the government and employers, the compensated cases have slowly decreased since 2003 and sharply decreased after 2008 when the diagnostic criterion was amended. The strategic approach is needed essentially because CVDs are common, serious and preventable diseases which lead to economic burden.

Key Words: Work-related; Cerebrovascular Diseases; Cardiovascular Diseases; Psychosocial Factors; Compensation; Korea

INTRODUCTION

Diseases of the circulatory system are the major cause of morbidity and mortality in Korea. According to 2009 statistics in Korea, they were the second cause of death (22.0% of all) to cancer (1). Cerebrovascular diseases (CBVD) were the most common cause of death at 47.6% among diseases of the circulatory system in Korea, followed by coronary heart diseases (CHD) at 23.8%, while the western countries showed the reverse pattern. In CBVD, hemorrhage has been dominant to infarction until 2003 when infarction became the most frequent condition among CBVD in Korea while the western people have showed much higher occurrences of infarction than hemorrhage.

The correlation between CHD and work is relatively well-known. Coronary atherosclerosis has been designated as the "prime mover" of CHD, and other risk factors were identified (e.g., hyperlipidemia, hypertension, diabetes, obesity). CHD has individual characteristics, genetic susceptibility, anomaly of brain system and risky behaviors (e.g., smoking, over-eating, sedentary lifestyle, stress) as playing a primary role in its etiology (2). At work, chemicals and physical agents can develop or trigger CHD. Psychosocial factors such as psychosocial demand, shift work and long working hours can affect developing CHD.

However, the relationship between CBVD and work is not well-known. The major causes of CBVD are hypertension and

atherosclerosis. Same etiologic factors that cause or exacerbate CHD may affect the development of CBVD, especially infarction, because both are basically diseases due to degenerative atherosclerosis. Cerebral hemorrhage can also be induced by acute stress such as tension, fear, or fright. Poor occupational health management also triggers the development of CBVD in workers who have pre-existing underlying factors.

Even if the relationship between work and CHD is clear, it is very difficult to evaluate the causal relationship between them for an individual worker. Furthermore, it is more difficult to evaluate the relationship between work and CBVD. However, a worker who developed CHD or CBVD, hereafter, cerebro-cardiovascular diseases (CVD) during work may make a successful claim for compensation, even though the disease occurred while working was coincidental. Thus, a practical guideline is necessary to compensate work-related CVD.

The Korea Workers' Compensation and Welfare Service (COMWEL) is a semi-government organization which covers all work-related compensation in Korea by the Industrial Accident Compensation Insurance (IACI) Act. In 2009, COMWEL compensated 8,721 occupational illness claims, where the claims were divided into 1,746 cases of occupational diseases and 6,975 cases of work-related diseases (3). Work-related diseases consisted of 639 cases of CVD and 6,234 cases of musculoskeletal diseases. Of 639 CVD cases, 490 were CBVDs with 197 fatalities, and

149 were CHDs with 123 fatalities. The cost for CVD in 2008 was approximately 288 million USD, which occupied 9.5% of the total expenses for compensation (3). The number of compensated CVD was relatively high compared to Japan and Taiwan. This phenomenon was caused by the diagnostic criteria of work-related CVD, which was established by social consensus.

This paper describes the history of compensation for CVD in Korea, the statistics of CVD and the government action for prevention.

MATERIALS AND METHODS

The present authors reviewed the history of compensation, the statistics of compensated cases and the government action for prevention of CVD. To identify the effectiveness of prevention activities, we calculated the number of deaths of CVD in general and working population and compared it with the compensated work-related CVD. The data of compensated cases and all insured workers from 1996 to 2009 were obtained from Occupational Safety and Health Research Institute (OSHRI). Mortality data from 1983 to 2009 were obtained from Korea Nation Statistics Office (KNSO) (1). The cause of death was coded and classified according to the ICD-10. The population data were also obtained from KNSO using the resident registration population on July 1st of each year.

RESULTS AND DISCUSSION

History of compensation for CVD

CVD was not accepted as a work-related disease when the IACI Act was enacted in 1963. IACI accepted a few cases of cerebral hemorrhage which were developed in night shift workers with hypertension. In 1982, acceptance criteria for intracranial hemorrhage as compensated work-related diseases were established in Korea. Cerebral hemorrhage could be compensated if the existing hypertension was aggravated by long working hours or much work stress. However, most cases of claimed CVD were not accepted as work-related.

In the early 1990s, a taxi driver claimed a compensation for cerebral infarction against the government at the Supreme Court. The Court accepted the case under the reason that workers' compensation system is a part of social security systems and there is no need to prove the clear relationship between disease and work. Many workers and relatives whose CVD claims were not accepted by COMWEL as a work-related disease had struggled to bring up their cases to the court. At that time, the acceptance criteria for occupational diseases was changed from definite causal relationship to reasonable relationship and the burden of proof was practically to be placed on the insurer (COMWEL) (4). The court accepted many CVD cases including cerebral infarction as work-related if the workers proved that they suffered

from long working hours or job stress.

There was fair evidence that CHD can be caused by psychosocial factors (5), but there was none in CBVD. At that time, Japan also experienced the same problem known as Karoshi (death due to overwork) and compensated it as work-related (6). The Ministry of Employment and Labor (MOEL) had long been making efforts to achieve the balance between workers' compensation and the social security. Eventually, the regulation of the criteria of work-related diseases was established in 1994. Compensable work-related CVD included cerebral infarction, hypertensive encephalopathy and CHD, as well as hemorrhage. Since then, work-related CVD had rapidly increased and reached its peak in 2003 (Fig. 1).

The diagnostic criterion for work-related CVD was established in 1994 as a notice of MOEL. CBVD was the main problem of the litigation, because it was the most common diseases at the time. It could be developed at workplace if there was no proper occupational health management for hypertension. Cerebral infarction was added to the list. Myocardial infarction, which was relatively small and was not a problem at that time, was also included. The conditions surrounding diseases were also required. They include abrupt changes in the working environment, physical overburden and mental stress caused by the increase in workload by 30% within a week before the occurrence of the disease, or cerebral hemorrhage which occurred during work.

The mean working hour in 1994 in Korea was 2,453 hr, which could be 50 hr a week. Excessive work was decided as a 30% increase from usual working hours, which could be 65 hr work a week, and exceeding approximately 20 hr above from the legal working hours of 44 hr a week in 1994. Cerebral hemorrhage was accepted if it occurred during the work because it could be easily exacerbated by acute, sudden events at workplaces in workers with hypertension. However, the diagnostic criteria did not include stress caused by chronic workload which was difficult to evaluate.

The criteria was partially amended and established as a regu-

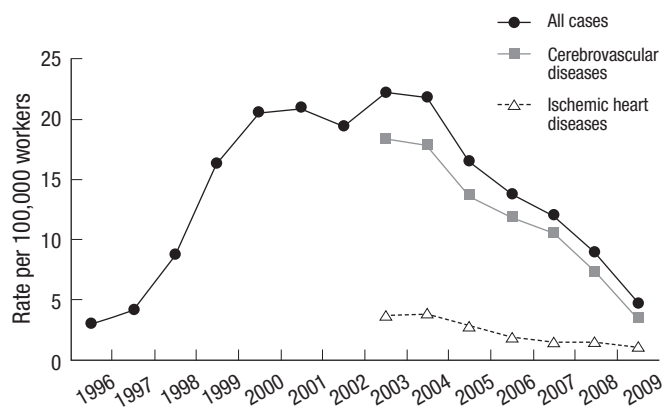


Fig. 1. Rate of compensated cerebro-cardiovascular diseases in Korea (1996-2009).

lation of the IACI Act in 1995. At that time, CBVD (intracranial hemorrhage, subarachnoid hemorrhage, cerebral infarction, hypertensive encephalopathy) and CHD (myocardial infarction, angina pectoris), and dissecting aneurysm (added in 1999) were included in the prescription list of work-related CVDs.

In 1996, 252 cases of CVD were accepted as work-related disease. In 1998, many workers were laid off, and the workload and work stress of the remaining workers abruptly increased when Korea faced economic crisis. Compensated CVD cases have rapidly increased. The compensated CVD has reached up to 2,358 in 2003 by the generous examination procedure in conjunction with increased workload after the economic crisis.

Since 2000, the economical burden of CVD in IACI fund has increased. The proportion of expense for CVD was 6.5% while the number of compensated cases was 2.5%. Thus, MOEL needed to make an action for prevention of CVD of workers.

Diagnostic criteria of work-related CVD at present

The diagnostic criterion was amended and the Enforcement Presidential Decrees of the IACI Act was enforced, effective from July 2008, toward the direction of including chronic job stress, removing acceptance of cerebral hemorrhage occurred during work and removing non-serious disease.

The criterion states that:

A. Cerebrovascular diseases, namely intracranial hemorrhage, subarachnoid hemorrhage and cerebral infarction are regarded as work-related; a cardiovascular disease, on the other hand, includes myocardial infarction and dissecting aneurysm developed with any of the following conditions. However, they are not considered work-related if they developed as a natural course of aggravation.

- 1) In the cases where a significant physiologic change occurs due to sudden work environment change including abrupt and unexpected tension, excitement, fear, and fright during the past 24 hr before occurrence.
- 2) In the cases of physical and mental overload, where the level of disturbance negatively affects the normal function of cerebral and cardiac vessels due to rapid increase in workload, i.e. change in the amount, duration, inten-

sity, and responsibility of work, and work environment during the past 7 days before occurrence.

- 3) In the cases where physical and mental burden significantly impacts on normal function of cerebral and cardiac vessels due to chronic overloads from changing amount, duration, intensity and responsibility of work and work environment during past 3 months before occurrence.

B. If any of the cerebrovascular diseases or cardiovascular diseases not listed in section A shows considerably strong relationship between its arousal or development and work, based on medical and sequential aspect, it is considered work-related.

CVD caused by chemicals or physical agents

There were many cases of CVD caused by chemicals and physical agents. Causes of cardiac ischemia may be either acute, which transiently result in increased demands for oxygen (such as during heavy work in a hot humid climate), or chronic, which contribute directly or indirectly to the development of coronary artery disease (5). Carbon disulfide (CS₂), carbon monoxide (CO), nitrates esters, and physical inactivity at work have been definitely linked to acute cardiac ischemia (5). The association between episodes of angina pain, myocardial infarction, and cardiovascular death and acute occupational exposures to nitrate esters in the manufacture of explosives was clear (7, 8). Excessive exposures to CO have resulted in myocardial infarction, arrhythmia, and sudden death (9, 10). Many arrhythmia cases have been of intentional overexposures, such as blue sniffing (toluene) (11, 12) and acute exposure to high levels of halogenated solvents (5).

Since 1992, the OSHRI of Korean Occupational Safety and Health Agency (KOSHA) has been conducting the epidemiological investigation for occupational diseases including work-related diseases. OSHRI investigated few cases of CVD, but 7 of 15 cases were CHD and related to psychosocial factors. Eight cases of CHD were caused by chemicals and physical agents from 1992 to 2009 (13-15). They were 2 cases of ischemic heart disease, atrioventricular block, dilated cardiomyopathy, congestive heart failure, atrial fibrillation, and 2 cases of myocardial infarction (Table 1).

Table 1. Cases of occupational heart diseases confirmed by Occupational Safety and Health Research Institute (OSHRI)

Year*	Disease [†]	Cause	Industry	Job process
1995	Ischemic heart disease	Heat	Glass manufacturing	Melting
2001	Atrioventricular block	Toluene	Printing	Coating
2001	Ischemic heart disease	Carbon monoxide	Boiler operation	Boiler maintenance
2001	Dilated cardiomyopathy	Carbon monoxide	Iron canning	Smelting furnace
2002	Congestive heart failure	Carbon monoxide	Waste disposal	Incinerating
2002	Myocardial infarction	Nitroglycerine	Explosives storing	Experimenter
2003	Atrial fibrillation	Halogenated hydrocarbons (1,1,1-trichloroethane)	Mechanics manufacturing	Heat treatment
2008	Myocardial infarction	Heat	Rubber tire manufacturing	Forming operation

*Year at investigation; [†]Psychosocial factor (including long working hours, shift work, work stress) suspected 7 cases are not included in this table.

Most cases of occupational CVD by chemicals in Korea were caused by carbon disulfide. An outbreak of carbon disulfide intoxication was reported in 1987 (16), which resulted in 950 compensated occupational disorders until 2008. The approved diagnostic criteria of CS₂ poisoning in 1993 included retinal microaneurysm, multiple cerebral infarction (17-19), coronary heart disease, and hypertension (20) as a progressive coronary disease (21, 22). One study that evaluated the retired workers of a rayon manufacturer reported that 61.5% and 15.4% of workers among the 117 chronic carbon disulfide poisoning patients had CBVD and psychiatric disorders, respectively (23). In Korean cases of carbon disulfide poisoning, CBVD including multiple cerebral infarction has predominantly increased in exposed workers than CHD, the result of which was different among European countries. It could be caused because CBVD was more common diseases than CHD in Korea.

Mortality by CVD in general population and working population

The CVD cases have decreased from 2,358 in 2003 to 1,207 in 2008. Compensated CBVD were 1,956 and 998 cases in 2003 and 2008, respectively. Compensated CHD were 402 and 209 cases in 2003 and 2008, respectively. The crude rate of compensated CVD was 22.2 per 100,000 workers in 2003, and decreased by 59.9% to 8.9 in 2008. The crude rate of compensated CBVD was further decreased by 60.0% from 18.5 to 7.4 per 100,000 workers,

and that of compensated CHD was decreased by 60.5% from 3.8 to 1.5 per 100,000 workers (Fig. 1). Fatal cases have decreased from 820 in 2003 to 482 in 2008. The fatality rate decreased by 8-9% annually from 2005 to 2008, but decreased dramatically in 2009 by 34%. The decrease of CVD since 2003 could be caused by the strict application of diagnostic criteria because the acceptance rate has also decreased. The rapid decrease of CVD after 2008 was clearly related to the change of diagnostic criterion of CVD. However, it can not explain the decrease since 2003 because the CVD in working population has also decreased differently from the general population.

The number of deaths due to CHD in working population aged from 21 to 60 has not increased since 2003, while that of in general population excluding the working population has continuously increased (Fig. 2). The deaths due to CHD in working population were decreased by 9.3% from 2,433 cases in 2003 to 2,208 cases in 2008, but those of in general population excluding the working population were increased by 11.7% from 9,390 cases in 2003 to 10,492 in 2008. The number of deaths due to CBVD in working population aged from 21 to 60 showed about 50% decrease and consistently showed a decreasing pattern since 1995 when MOEL has started programs of management for basic life style diseases such as hypertension and of health promotion, while that of the general population excluding the working population showed stable or slight decrease. The deaths due to CBVD in working population were decreased by 48.4% from 6,849

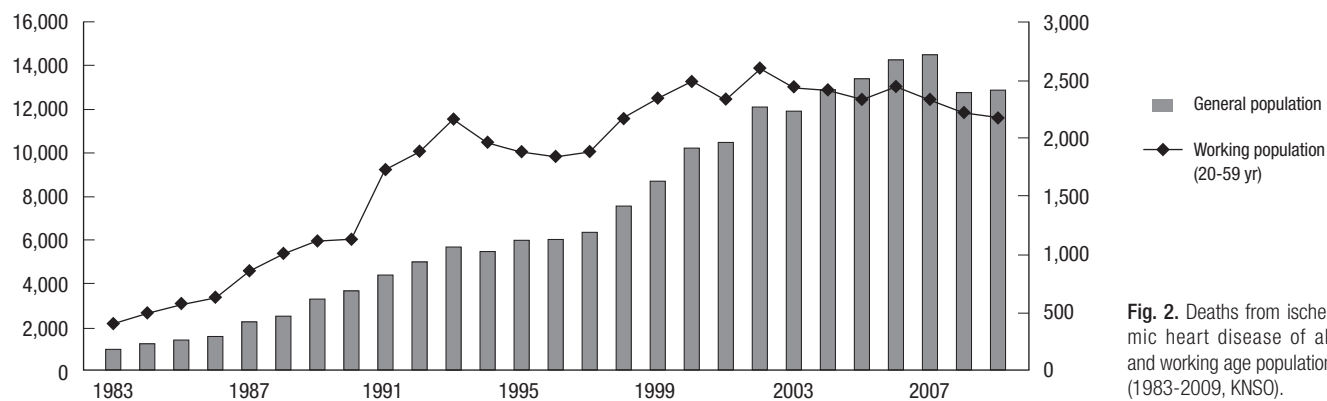


Fig. 2. Deaths from ischemic heart disease of all and working age population (1983-2009, KNSO).

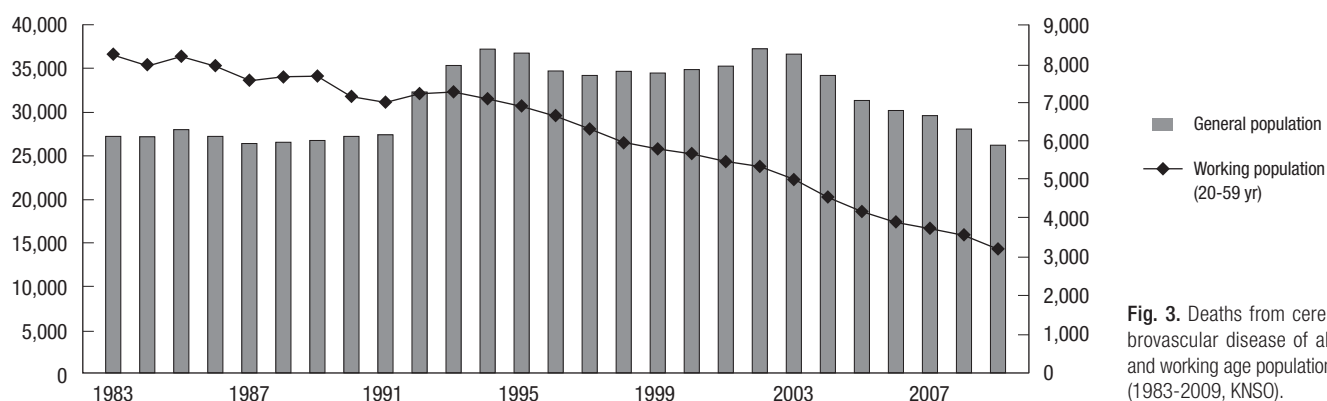


Fig. 3. Deaths from cerebrovascular disease of all and working age population (1983-2009, KNSO).

cases in 1995 to 3,533 cases in 2008, but those of in general population excluding the working population were decreased by 17.8% from 29,567 cases in 1995 to 24,399 cases in 2008 (Fig. 3).

The decrease in the number of deaths due to CVD in working population was partially due to active prevention activities for workers as well as general improvement in emergency care. However, we assumed that it could be due to active prevention activities because it would be same to general population if it was caused by the improvement in emergency care. It is more reasonable that the more prominent decrease in working population could be closely related to prevention activities. However, it is necessary to perform a detailed study for revealing the reason of decreasing CVD among the working population since 2003.

Findings on causal factors of compensated CVD by survey

OSHRI has investigated the compensated cases the previous year to find the causes of work-related CVD since 2000. In 2009, OSHRI analyzed 211 cases of CBVD (30% of total cases) and all 117 cases of CHD compensated from 2008 to March 2009 (24). CBVD cases consisted of cerebral hemorrhage and intracranial hemorrhage (49.3%), subarachnoid hemorrhage (34.6%), cerebral infarction (13.3%), and others (2.8%). CHD cases were mostly ischemic heart disease (83.8%) according to the survey (24).

The health status before the occurrence of CBVD was healthy condition (60.2%), hypertension (20.4%), diabetes, arrhythmia, hyperlipidemia, previous cerebral disease (5.2%), others (0.9%), and unknown (13.3%). Otherwise, in CHD, the underlining health status was healthy condition (43.6%), hypertension (17.9%), diabetes, arrhythmia, ischemic heart disease, hyperlipidemia, previous cerebral disease (7.7%), others (6.0%), and unknown (23.9%). The triggering factors in CBVD were job stress (20.9%), overload (32.7%), shift and night work (3.3%), professional driving (2.4%), environmental change (1.4%), others (7.1%), and unknown (32.2%). On the other hand, the factors contributing to the occurrence of CHD were job stress (22.2%), overload (44.4%), shift and night work (3.5%), professional driving (0.9%), environmental change (0.9%), others (8.5%), and unknown (19.7%) (24).

Researches on the risk factors of CVD

Shift and night work was a prominent occupational risk factor (25). A significant association between rotating-shift work and ischemic heart disease was found in Japanese male workers (26). Rotating night shift work has been identified as a risk factor for CHD (26, 27) and a variety of findings regarding cardiovascular mortality (28). The psychosocial mechanisms between shift work and CHD were related to difficulties in controlling working hours, decreased work-life balance, and poor recovery following work (29). It is caused by the inflammation of arteries and the activation of autonomic nerve system. There was also an opposite opinion showing that there was limited epidemiologic evidence for

a causal relation between shift work and ischemic heart disease by reviewing the relevant papers (30).

Long working hours (overtime work) were associated with increased risk of CHD independently of conventional risk factors (31). Working 11 or longer hours a day was associated with a 1.56 fold risk of CHD, after accounting for the sociodemographic factors such as age, sex, marital status and occupational grade (31). Overtime work and insufficient sleep may be related to the increased risk of acute myocardial infarction (32). In a Japanese case-control study, there was a U shaped relation between the mean working hours (either >11 on the average, or <7) and the risk of acute myocardial infarction (33). But working hours may not be an independent predictor of health effect (25). Difficulties in controlling working hours, decreased work-life balance, and poor recovery following work would be the mechanism to develop CVD in long working hours.

The evidence of the relationship between CBVD and psychosocial factors is limited. The relationship between ischemic stroke and night shift workers with a history of 15 more years was slightly positive in a cohort study among nurses (34). However, the association between ischemic stroke and shift work was not evident in a Swedish case-control study (35).

Claims from CVD who had a short tenure within 6 months and under the age of 50 were significantly associated with work overload (long working hours, shift work) (36). However, the influencing factors to the approval rates of CVD should be investigated because they were highly different by the type of industry and occupation. (37). There was also no consistent pattern on work-relatedness such as shift work, night shift, and long working hours between approval and non-approval cases in the litigation for CVD against COMWEL (38). However, in order to prevent CVD the most important aspect was to control hypertension which was the most common one among risk factors in compensated CVD (39).

Prevention activities for CVD at workplace

Many preventive activities were performed to manage CVD. The preventive action lies in the direction of controlling life style disease like hypertension, improving workers' health and changing the work culture toward reducing job stress. Health promotion was included in the responsibility of the government in Occupational Safety and Health (OSH) Act since 1996. Detailed items were established in the Enforcement Presidential Decree of the Act. Voluntary workplace health promotion was encouraged by the guideline for health promotion at workplace since 1999. Employers' responsibility for prevention of physical fatigue and mental stress was established by the OSH Act since 2002. Detailed guideline was described in the regulation for occupational health standard (protection of health effects by job stress) in 2003. The KOSHA code was established for prevention of CVD in 2004, which required risk assessment of CVD. The KOSHA

code entitled "The guideline for measurement of job stress by Korean" was established in 2006 and "The guideline for health management of shift work" in 2008.

According to the regulation, many actions were taken in workplaces with high risk CVD workers. Education and information were provided to workplaces where many cases of CVD have occurred. KOSHA developed an evaluation program for assessing the risk of CVD, which were composed of lifestyle, work and personal factors. From 1993, KOSHA funded occupational health service agencies to provide occupational health services to small-scaled industries. KOSHA has provided occupational nurses to conduct special consultations to medium-scaled workplaces where many cases of lifestyle diseases including hypertension, diabetes, and hyperlipidemia were detected by the health examination. In addition, KOSHA has also supported workplaces to develop voluntary health promotion activities.

CONCLUSION

CVD can be developed by chemicals and physical agents as well as psychosocial factors. Although CVDs, especially cardiovascular diseases, are related to psychosocial factors, it is very difficult to evaluate the relationship between a disease and psychosocial factors for compensation. Korea has accepted CVD as an occupational disease, which is believed to be caused by long working hours, job stress or shift work. Increasing compensation of CVD has brought the economic burden and social concern that lead proactive prevention activities for lifestyle diseases of workers. They include controlling risk factors for the high risk group such as hypertension and health promotion for workers. Relevant legislation and guidelines for employers and employees have established.

CVD compensation has originated from the decision by social science rather than that by medical science, and as a consequence, compensation has brought better working environment at workplaces. Compensated CVDs have decreased since 2003, which may be caused by active prevention activities. Therefore, it will be strategically useful to compensate CVD as a work-related disease to reduce its occurrence and to improve workers' health. In addition, the strategic approach is needed essentially because CVDs are common, serious and preventable diseases which lead to economic burden.

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