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Original Article

A Policy Intervention Study to Identify High-Risk Groups to Prevent Industrial Accidents in Republic of Korea

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ABSTRACT

Background: The objective of this study is to identify high-risk groups for industrial accidents by setting up 2003 as the base year and conducting an in-depth analysis of the trends of major industrial accident indexes the index of industrial accident rate, the index of occupational injury rate, the index of occupational illness and disease rate per 10,000 people, and the index of occupational injury fatality rate per 10,000 people for the past 10 years.
Methods: This study selected industrial accident victims, who died or received more than 4 days of medical care benefits, due to occupational accidents and diseases occurring at workplaces, subject to the Industrial Accident Compensation Insurance Act, as the study population.
Results: According to the trends of four major indexes by workplace characteristics, the whole industry has shown a decreasing tendency in all four major indexes since the base year (2003); as of 2012, the index of industrial accident rate was 67, while the index of occupational injury fatality rate per 10,000 people was 59.
Conclusion: The manufacturing industry, age over 50 years and workplaces with more than 50 employees showed a high severity level of occupational accidents. Male workers showed a higher severity level of occupational accidents than female workers. The employment period of < 3 years and newly hired workers with a relatively shorter working period are likely to have more occupational accidents than others. Overall, an industrial accident prevention policy must be established by concentrating all available resources and capacities of these high-risk groups.

1. Introduction

According to the report on the status of industrial accidents in Korea, the industrial accident rate has shown a steady decrease since 2004. It had stayed at 0.7% for 12 years since the International Monetary Fund crisis, but it fell to 0.69% in 2010 [1] and then to 0.59 in 2012. To be more specific, the number of industrial accident victims who required more than 4 days of medical care benefits was estimated at 92,256 (deaths, 1,864; injuries, 83,349; occupational illness patients, 6,742), among 15,548,423 persons who worked at 1,825,296 workplaces, subject to the Industrial Accident Compensation Insurance Act. The previous year, the number of workplaces and workers increased by 5.01% and 8.26%, respectively, from the previous year. Despite that, the number of industrial accident victims declined by 1.11%, while the industrial accident rate fell by 0.06% compared with those in the previous year [2].

According to the report on industry accident fatality, 1,864 persons died of industrial accidents in 2012: occupational injury fatality accounting for 1,134 deaths and occupational illness and disease fatality for 730 deaths. With regard to occupational accidents, 373 people lost their lives due to fall (fall of persons from height) and another 136 persons died of compression (compressed by equipment or object). In regard to occupational illness and disease fatality, 333 workers died of pneumoconiosis and another 301

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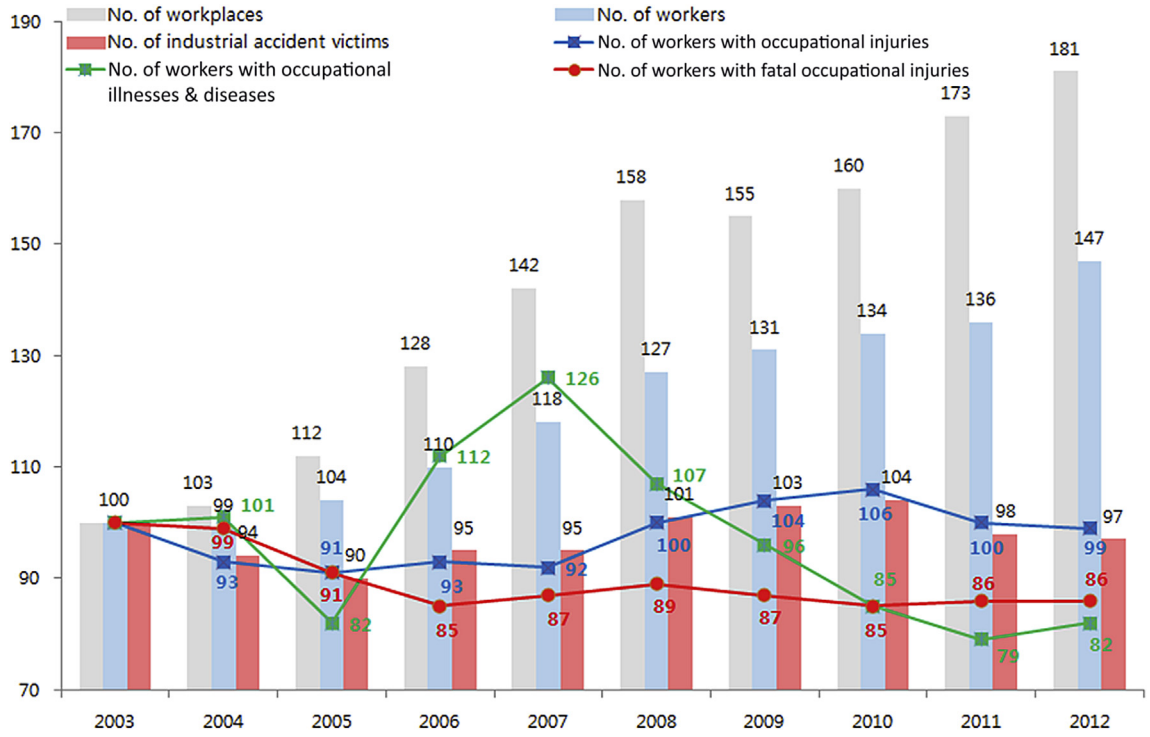

Fig. 1. Trends of indexes of workplaces, workers, and industrial accident victims in the whole industry for the past 10 years. No., number.

people lost their lives because of cerebrovascular or cardiovascular diseases. The index of occupational injury fatality rate per 10,000 people (IOIFR) fell by 0.10‰p compared with that in the previous year and has showed a declining tendency since 2003. The direct and indirect losses caused by industrial accidents were estimated at 19,256,435 million Won, an increase of 6.23% from the previous year. An increase in economic losses despite a decline in the number of industrial accident victims can be ascribed to a higher severity level of industrial accidents [2]. The industrial accident rate fell to the 0.5% range in 2010 from the 0.6% range in 2010. This improvement was possible thanks to a remarkable achievement in industrial accident prevention activities [3].

According to the distribution of industrial accidents by industry, the "other industries" accounted for 34.7% (32,033 people), which was the highest percentage, followed by the manufacturing industry (34.3%; 31,666 people) and the construction industry (25.3%; 23,349 people). These industries combined accounted for almost all industrial accidents throughout the whole spectrum of industries [2]. In terms of industrial accidents according to the scale of workforce or projects, the manufacturing industry showed a relatively higher occurrence rate in a workplace with less than 50 full-time employees, while the construction industry had a higher industrial accident occurrence rate in a project worth < 2 billion Won [4–7]. If we look at the distribution of industrial accident fatality tolls, the manufacturing industry accounted for 29.1% among a total of 1,864 people, followed by the construction industry (26.6%), the other industries (19.5%), the mining industry (17.2%), and the transportation, warehousing, and telecommunication industry (7.5%). In terms of IOIFR, the mining industry showed the highest occurrence rate of 243.87‰, followed by the construction industry (1.78‰); the transportation, warehousing, and telecommunication industry (1.73‰); the manufacturing industry (1.44‰); and the other industries (0.45‰) [2].

After a review of the previous studies, it can be expected that the service industry with a relatively high level of occupational diversification had a higher industrial accident occurrence rate than the manufacturing and construction industries because of the occupational diversification due to changes in industry and employment structures [8–11]. To reduce industrial accidents, this study aimed to identify the high-risk groups, which are the target points of prevention efforts. To that end, we collected and analyzed data of the past 10 years (2003–2012) in relation to the number of workplaces subject to the Industrial Accident Compensation Insurance, workforce, and industrial accident victims. The objective of this study is to find out high-risk groups by industry type, workplace scale, gender, and working period, where industrial accident prevention efforts must be concentrated, by setting up 2003 as the base year (index 100) by analyzing major industrial accident indexes such as the index of industrial accident rate (IIAR), index of occupational injury rate (IOIR), index of occupational illness and disease rate per 10,000 people (IOIDR), and IOIFR. We conducted a comparative analysis of the trends by workplace characteristics (the type of industry and the scale of workforce) and by individual characteristics (gender, age, and employment period). This study is expected to contribute to reducing industrial accidents by identifying high-risk groups, which requires concentration of resources to reduce industrial accidents.

2. Materials and methods

As the source of data used for analyzing the trends of major industrial accident indexes, those industrial accident victims who were diagnosed to die of occupational incidents or occupational diseases among industrial accidents and those who received more than 4 days of medical care benefits were counted. Those workplaces that did not subscribe to the Industrial Accident Compensation Insurance were excluded from the study. In this study, the major industrial accident indexes were compiled by collecting data from medical care benefit applications submitted to Korea Workers' Compensation and Welfare Service and from industrial accident

questionnaires used in surveys conducted by local labor authorities, to analyze the trends of major industrial accident indexes.

3. Results

Since the base year (2003), the workplace and worker indexes have shown a steadily increasing trend. As of 2012, the workplace index was recorded at 181, the worker index was 147, and the industrial accident victim was 97. The occupational accident victim index had increased until 2010 and then indicated a decreasing tendency since 2011. The occupational illness and disease victim index had peaked at 128 in 2007 and declined sharply after that. The occupational injury fatality toll index was recorded to be 86 in 2012 (Fig. 1).

According to the analysis results of major industrial accident indexes, the IOIR and IOIFR in the whole industry had shown a steady decline for 10 years since the base year (2003). As of 2013, the IIAR was recorded at 66, the IOIR was measured at 67, and the IOIFR fell by 40% to 59 from the previous year (Fig. 2).

By industry type, the manufacturing industry's four major indexes, such as the IIAR, IOIR, IOIDR, and IOIFR, have shown a steady decline. What is noteworthy is that the IOIFR is located higher than the IOIR, which indicates a high severity level of industrial accidents. However, the construction industry had shown an opposing trend. All the four major indexes of the construction industry increased in 2004, but declined thereafter. In 2008, the IIAR and IOIR indicated an increasing trend again. Although the IOIFR had continuously declined since 2004, the index was located above the IOIR both in 2003 and in 2008. Since 2009, this index has been located below the IOIR, which means that the construction industry's severity of industrial accidents was insignificantly low.

In terms of the service industry, the IIAR and IOIR remained at a standstill until 2009. Since 2009, these indexes showed a remarkably decreasing trend. The IOIFR declined below 70 in 2006, and since then, it indicated a modestly declining trend. In 2012, it further plummeted to 54, a 50% decrease from that in the base year.

Table 1
Trends of four major indexes of industrial accidents in the industries for the past 10 years*

Year	Manufacturing				Construction			
	IIAR	IOIR	IOIDR	IOIFR	IIAR	IOIR	IOIDR	IOIFR
2003	100	100	100	100	100	100	100	100
2004	90	91	88	89	109	108	119	131
2005	83	86	64	94	87	87	88	101
2006	84	84	82	91	83	80	181	89
2007	77	77	86	89	77	74	213	76
2008	81	82	75	91	74	72	147	73
2009	73	76	58	84	75	73	146	67
2010	75	78	56	89	80	79	124	67
2011	68	71	50	79	85	84	124	72
2012	59	60	49	72	97	94	154	73
Year	Service				Forestry			
	IIAR	IOIR	IOIDR	IOIFR	IIAR	IOIR	IOIDR	IOIFR
2003	100	100	100	100	100	100	100	100
2004	93	94	88	102	129	127	266	106
2005	93	96	68	98	133	134	133	95
2006	96	96	125	67	164	162	319	71
2007	95	90	152	70	193	185	639	107
2008	95	92	124	59	263	260	474	156
2009	100	100	117	65	434	419	1,311	174
2010	95	94	92	52	292	287	540	246
2011	84	84	81	59	220	219	305	138
2012	71	73	71	54	256	256	287	222

* Base year, 2003 (index, 100).
IIAR, index of industrial accident rate; IOIDR, index of occupational illness and disease rate per 10,000 people; IOIFR, index of occupational injury fatality per 10,000 people; IOIR, index of occupational injury rate.

Since 2005, the disparity between the IOIR and the IOIFR, especially in the service industry, had grown wider until 2010, but started to become narrower again afterward. This was due to a sudden drop in the IOIR since 2009 and a slow decline in the IOIFR. The service

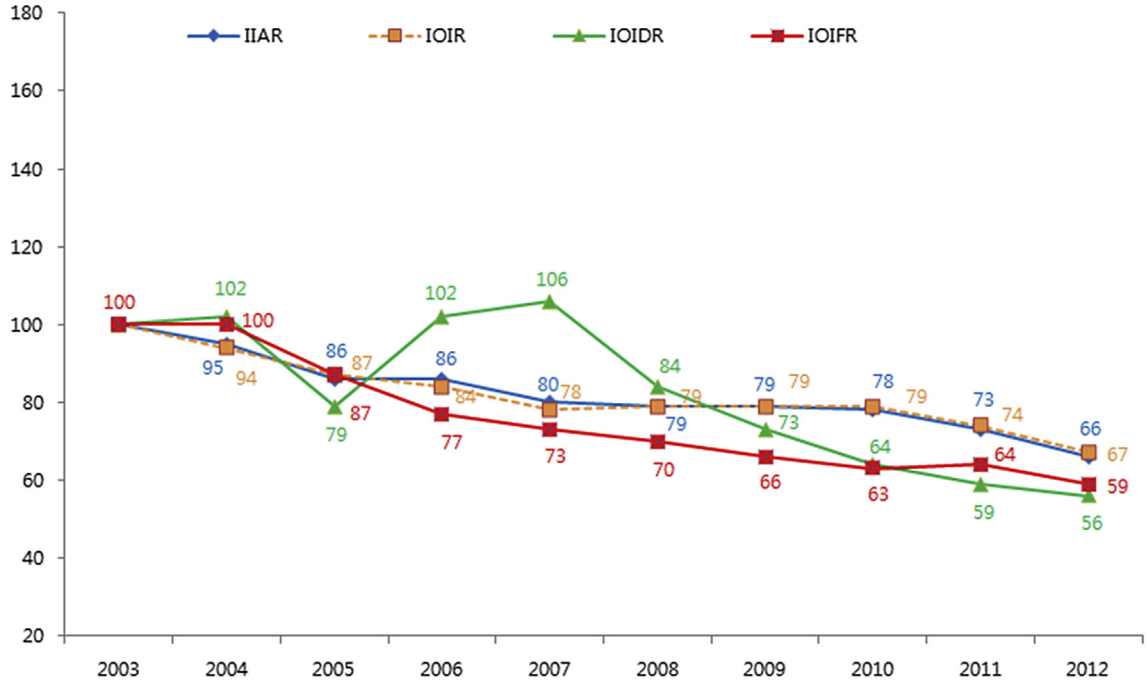

Fig. 2. Trends of four major indexes of industrial accidents in the whole industry for the past 10 years. IIAR, index of industrial accident rate; IOIDR, index of occupational illness and disease rate per 10,000 people; IOIFR, index of occupational injury fatality per 10,000 people; IOIR, index of occupational injury rate.

Table 2
Trends of four major indexes of industrial accidents according to the number of workers for the past 10 years*

Year	< 50 workers				> 50 workers			
	IIAR	IOIR	IOIDR	IOIFR	IIAR	IOIR	IOIDR	IOIFR
2003	100	100	100	100	100	100	100	100
2004	96	96	98	99	95	93	103	106
2005	95	95	85	91	78	79	73	86
2006	92	89	143	78	74	72	79	75
2007	87	82	169	72	63	61	71	73
2008	86	83	136	67	59	60	54	74
2009	86	84	125	64	55	58	43	66
2010	84	83	103	60	52	55	41	67
2011	79	78	95	64	46	48	37	56
2012	72	71	90	60	43	45	36	51

* Base year, 2003 (index, 100).
IIAR, index of industrial accident rate; IOIDR, index of occupational illness and disease rate per 10,000 people; IOIFR, index of occupational injury fatality per 10,000 people; IOIR, index of occupational injury rate.

Table 3
Trends of four major indexes of industrial accidents according to gender for the past 10 years*

Year	Male workers				Female workers			
	IIAR	IOIR	IOIDR	IOIFR	IIAR	IOIR	IOIDR	IOIFR
2003	100	100	100	100	100	100	100	100
2004	95	94	102	100	97	96	105	113
2005	85	86	79	86	98	99	78	129
2006	85	83	99	78	99	97	124	74
2007	79	76	102	74	94	90	142	85
2008	77	77	80	71	96	94	113	70
2009	75	75	67	67	107	106	117	64
2010	74	76	61	65	104	105	91	54
2011	70	71	56	65	94	95	80	52
2012	64	65	54	61	85	86	73	49

* Base year, 2003 (index: 100).
IIAR, index of industrial accident rate; IOIDR, index of occupational illness and disease rate per 10,000 people; IOIFR, index of occupational injury fatality per 10,000 people; IOIR, index of occupational injury rate.

industry's IOIR was lower by 10 points and 20 points, respectively, than that of the manufacturing and construction industries. The transportation, warehousing, and telecommunication industry's IIAR and IOIR showed a steady decline, while the IOIFR showed a W-shaped pattern, with peaks in 2006, 2008, and 2010. The IOIR was recorded at 60 in 2012, and the IOIFR was measured at 83.

Unlike other industries, the forestry industry's IIAR and IOIR increased dramatically until 2009 (by 4.2 times compared with the base year) and then dropped sharply. In 2011, it once again showed an increasing tendency. The IOIFR had declined until 2006 and then rebounded sharply until 2010 (by 2.5 times compared with the base year). We believe that as the forestry industry's IOIR and IOIFR were exceptionally high compared with those of the other industries, a strong policy intervention by the government is necessary (Table 1).

In terms of workplaces with less than 50 employees, the IIAR (72 in 2013) and IOIR (71 in 2013) had shown a slow declining trend, while the IOIFR (60 in 2012) indicated a considerable decline compared with these two indexes. However, the four major indexes of the workplaces with more than 50 employees showed a more drastic decline than those of the workplaces with less than 50 employees (IIAR 43, IOIR 45, IOIDR 36, and IOIFR 51 in 2012). However, workplaces with more than 50 employees indicated a higher severity level of industrial accidents than those with less than 50 employees (Table 2).

According to the analysis results of sex specific index trends, the IIAR, IOIR, and IOIFR of male workers all showed a steady declining tendency since the base year (IIAR 65 in 2012, IOIR 61). However, the IOIDR rebounded to 103 in 2007, and it continued to decline since then and eventually fell to 54 in 2012. However, the IOIR of female workers stayed at a standstill at 97 until 2008, and increased to 107 in 2009 and fell again to 86 in 2013. The IOIFR soared to 129 in 2005, which was 1.3 times that of the base year, and dropped sharply to 74 in 2006. The index declined gradually every year and fell to 49 in 2013. According to the disparity between the IOIR and IOIFR by sex, the IOIFR of female workers was located below the IOIR by far lower than that of male workers was, which means that the industrial accident severity of male workers was more intense than that of their female counterparts (Table 3).

After analyzing the index trends by dividing the study population into groups of workers aged < 50 years and those aged > 50 years, it was found that the IIAR, IOIR, and IOIFR of those aged < 50 years showed a steadily declining trend, and all the indexes fell to half the levels of the base year in 2013. Especially, the IOIFR was located far below the IOIR, and plummeted dramatically to 42 in 2013 compared with the base year. In addition, unlike workers aged < 50 years, the distribution of the IIAR and IOIR indexes of those aged > 50 years showed a declining trend until 2007 and remained at a standstill after rebounding by a modest degree. As of 2013, the IIAR was measured at 67, while the IOIR was recorded at 70, both of which showed a higher level than those of workers aged < 50 years. The IOIFR had also declined steadily since the base year and fell to 50 in 2008, which was half the level of the base year. Thereafter, the index remained at a standstill (Table 4). According to the four major index trends of those workers with an employment period of < 1 year, their IIAR and IOIR increased to 92 from 92 to 97 in the base year. Thereafter, it remained at a standstill. By contrast, their IOIFR indicated a gradual decreasing tendency and was recorded at 63 in 2013. According to the major index trends of those workers with an employment period of > 1 year but < 3 years, their IIAR and IOIR showed an overall declining tendency each year. They showed a temporary modest increase in 2008, but a decreasing trend afterward. Their IOIFR had declined until 2009 (index 72) and rebounded afterward (index 77 in 2013). According to the four major index trends of those workers with an employment period of > 3 years, their IIAR and IOIR had shown a

Table 4
Trends of four major indexes of industrial accidents according to the age for the past 10 years*

Year	< 50 y				> 50 y			
	IIAR	IOIR	IOIDR	IOIFR	IIAR	IOIR	IOIDR	IOIFR
2003	100	100	100	100	100	100	100	100
2004	94	94	92	104	94	92	114	96
2005	86	88	67	89	83	82	90	81
2006	85	83	107	80	81	81	85	71
2007	78	75	115	60	75	75	81	57
2008	76	74	93	61	76	78	60	50
2009	72	71	78	51	77	81	54	51
2010	69	70	68	48	76	81	46	48
2011	62	62	59	43	73	77	44	52
2012	55	55	54	42	67	70	43	45

* Base year, 2003 (index: 100).
IIAR, index of industrial accident rate; IOIDR, index of occupational illness and disease rate per 10,000 people; IOIFR, index of occupational injury fatality per 10,000 people; IOIR, index of occupational injury rate.

Table 5
Trends of four major indexes of industrial accidents according to working duration for the past 10 years*

Year	Employment period of < 1 y				Employment period of > 1 y but < 3 y				Employment period of > 3 y			
	IIAR	IOIR	IOIDR	IOIFR	IIAR	IOIR	IOIDR	IOIFR	IIAR	IOIR	IOIDR	IOIFR
2004	100	100	100	100	100	100	100	100	100	100	100	100
2005	91	91	78	81	99	100	84	96	87	91	75	103
2006	94	92	171	75	94	90	143	86	80	82	74	76
2007	93	89	216	71	84	87	153	88	70	71	68	76
2008	90	88	160	70	96	91	146	85	63	68	52	60
2009	97	95	165	67	88	86	118	72	56	62	40	66
2010	98	97	126	63	81	79	99	75	56	62	39	66
2011	97	97	123	69	71	70	86	76	49	55	35	53
2012	92	92	120	63	65	64	79	77	43	46	33	56

* Base year, 2003 (index, 100).
IIAR, index of industrial accident rate; IOIDR, index of occupational illness and diseases rate per 10,000 people; IOIFR, index of occupational injury fatality per 10,000 people; IOIR, index of occupational injury rate.

steady decrease each year. Their IOIFR has repeated ups and downs since the base year. Overall, those workers with shorter employment periods tended to show higher levels of IOIR and IOIFR, which confirms that newcomers are more likely to fall victim to occupational accidents (Table 5).

4. Discussion

An analysis of the major industrial accident indexes in Korea can help identify high-risk groups that require a concentration of resources to prevent industrial accidents. First, a preventive measure must focus on the high-risk groups for occupational injuries, including workers of the construction industry, those in workplaces with less than 50 employees, workers aged > 50 years, female workers, and workers with an employment period of < 1 year. Second, the primary objective of an industrial accident prevention measure is to reduce the occupational injury fatality tolls. Among the high-risk groups for occupational injury fatality, the manufacturing industry showed the highest risk, followed by the construction industry and the transportation, warehousing, and telecommunication industry. In regard to occupational injury fatality tolls, workers in workplaces with less than 50 employees, those aged > 50 years, male workers, and workers with an employment period of < 3 years are classified as high-risk groups, into which it must be concentrated all available resources and capacities.

Finally, the high-risk groups for occupational illness and disease fatality include workers of the construction industry, those in workplaces with more than 50 employees, workers aged < 50 years, female workers, and workers with an employment period of < 1 year. In the future, an industrial accident prevention measure must be established by concentrating all available resources on those high-risk groups that were classified based on the results of this study.

Conflicts of interest

The authors declare that there are no conflicts of interests regarding the publication of this article.

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