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Relationship between workers' return to work, job retention and income in industrial accidents in Korea: a longitudinal study

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ABSTRACT

Objective This study aims to compare workers' income before and after an occupational injury, with regard to return to work and job retention, over a period of 5 years.

Design This study was designed as a longitudinal study.

Setting The Panel Study of Workers' Compensation Insurance (PSWCI) survey targeted workers involved in industrial accidents for which medical care was terminated in the year 2012.

Participants The panel study was conducted on a final sample of 2000 workers who were selected proportionally by region (nine regions) after priority assignment by disability rating (six levels). A total of 1458 workers were finally included in this study.

Methods This study used data from the first to fifth PSWCI. To identify the effect on income after occupational injury considering return to work and job retention, we used the generalised estimating equation.

Results In regard to workers' return to work, the OR that income after an occupational injury would be higher than that before an occupational injury was 3.17 (2.41–4.17) for those who returned to original work and 2.32 (1.81–2.97) for those re-employed as compared with who did not return to work and 1.27 (1.07–1.15) for those who retained their job as compared with those who did not. The ORs were 2.91 (2.26–3.75) for those who were re-employed and retained jobs and 2.96 (2.15–4.08) for those who returned to original work and did not retain jobs as compared with those who did not return to work and did not retain jobs.

Conclusions It is important for accident victims to retain their jobs to maintain their economic status.

INTRODUCTION

According to the Korean Ministry of Employment and Labor, 102 305 workers were involved in industrial accidents in 2018, which translates to an accident rate of 0.54%.[1–3] Compared with the previous year, this number has increased by 13.9%, while the accident rate has increased by 0.06%.[3] The trend of workers involved in industrial accidents over the past 10 years shows that the number of workers involved in industrial

Strengths and limitations of this study

► This study is the first to examine the changes in income based on return-to-work status and job retention for Korean workers involved in industrial accidents.

► The data used in the study are from the only panel study in Korea conducted by the Korea Workers' Compensation and Welfare Service with a 5-year follow-up on the quality of life of workers who had been involved in industrial accidents.

► One limitation to this study is that we did not consider the effect that a disability compensation lump sum would have on income after occupational injury.

► Because the year of the accident was not recorded, income before occupational injury was calculated using the duration of medical care.

accidents has steadily declined since 2009, but increased sharply in 2018 and still exceeds by about 90 000.[1–5]

Industrial accidents have significant negative impacts from multiple perspectives.[2 4 6] Specifically, workers involved in industrial accidents are burdened by worries of recovery and anxiety about the future.[7 8] Loss in labour force due to industrial accidents can cause economic problems due to the loss in human resources in charge of household income or the loss of social labour force beyond an individual-level problem.[9 10]

The amount paid out for workers' compensation for industrial accidents in Korea was approximately KRW 4 trillion (US$ 3.3 billion) in 2017, which was a 3.64% increase from the previous year. The estimated economic loss (direct and indirect loss) in the same year was approximately KRW 22 trillion (US$ 18.0 billion), indicating an increase of 3.64% compared with the previous year.[1 2 4] Industrial accidents cause significant loss, both

directly and indirectly, to the country, business owners and workers alike.[2]

Workers' compensation insurance was adopted in many countries to protect workers who experienced an occupational injury.[11 12] One of the main goals of workers' compensation insurance was to ensure that workers who have been involved in industrial accidents return to work.[12] In Korea, the concepts of social return and return to work were promoted by the Korea Workers' Compensation and Welfare Service (KCOMWEL) by establishing a customised rehabilitation support service via medical care. This led to the return-to-work rate increasing from 50.1% in 2011 to 65.3% in 2018 for workers involved in industrial accidents.[13]

For workers involved in industrial accidents, return to work can induce social balance after occupational injury by reducing the negative impacts and reducing the economic burdens of both workers and the government.[4 5 14–17] Previous studies have been conducted to examine the return-to-work rate of workers involved in industrial accidents. Factors that affect the return-to-work rate were personal factors (eg, gender, age, marital status, education level, household income and subjective health status), occupational factors (eg, industry employed in before the industrial accident, occupation, number of employees, duration of employment and status of worker), degree of disability after the accident, length of hospitalisation, length of medical care, hospital quality and primary physicians' and employers' interest in return to work.[5 9 18–30]

Although it is essential to identify workers' return-to-work rate and job retention status to ensure successful return to work, research on workers' status after their return to work is insufficient.[5] While a few studies have examined workers' compensation for industrial accidents or changes in their income according to their disability rating, industries before the industrial accident and economic activity after the occupational injury,[2 4 12 31–33] studies that directly examine changes in income following return to work and job retention after occupational injury are severely lacking. Furthermore, few studies have directly calculated the amount of income that is lost when workers with injuries are unable to return to work or return to a workplace that is different from their original one, in the long term. We hypothesised that while there may be an initial increase in income from various compensation measures that are awarded by insurance companies and the government to individuals who have had an occupational injury, after a certain period (maximum of 5 years), all injured individuals suffer from a decrease in income.

Thus, the objectives of the study were to examine workers' income before and after an occupational injury according to return to work and job retention and to investigate exact yearly changes in income.

MATERIALS AND METHODS
Study design and participants
This study used data from the first to fifth Panel Study of Workers' Compensation Insurance (PSWCI), which was conducted to establish, manage and advance workers' compensation insurance policies. The PSWCI collected dynamic time-series data by surveying workers involved in industrial accidents. The PSWCI survey targeted 82 493 workers involved in occupational injuries for which medical care was terminated in the year 2012; the panel study was conducted on a final sample of 2000 workers who were selected proportionally by region (nine regions) after priority assignment by disability rating (six levels). Panel surveys have been conducted annually, the first in 2013 and the fifth in 2017. Interviewers conducted face-to-face interviews and employed a computer-assisted personal interviewing method to obtain responses from participants.[2 4 5 26 34–36]

By the fifth panel study, 1616 of the original 2000 respondents completed the survey showing a retention rate of 80.8%. Longitudinal non-response bias emerging from survey drop-outs was controlled for by using sample weights to adjust for each wave. These sample weights were provided by the PSWCI to be used by researchers incorporating longitudinal data analysis. The ratio of unequal selection probabilities due to missing observations was calculated and further adjusted for poststratification, trimming and raking ratios, to compensate for changes over time among certain classes and characteristics (ie, income data which increase naturally over time). The PSWCI also incorporated Kalton and Kasprzyk's regression imputation method, to predict the values of missing responses for crucial variables.

Owing to the difficulty of estimating the explanatory variable if the duration of medical care after occupational injury exceeded 2 years, such respondents were excluded from our model. Moreover, we excluded workers who were either self-employed or employers at the occupational site at the time of injury. Lastly, we excluded 13 respondents who did not have a response for the explanatory variable.

Patient and public involvement
Patients and public were not involved in the research process.

Sociodemographic characteristics
Age in years was categorised into five groups: <30, 30–39, 40–49, 50–59 and ≥60. Marital status was categorised into three groups: not married, married and others (separated, divorced or widowed). Education was categorised into three groups: less than high school, high school and college or above.

Occupational-related characteristics
Industry was classified according to the Korean Standard Industrial Classification which is based on the International Standard Industrial Classification. The

manufacturing and construction industries accounted for more than half of occupational injuries and illnesses (manufacturing accounted for 26.8% and construction accounted for 27.1% in 2018).[3] Therefore, the occupational industry was categorised as either manufacturing, construction, service or others.

The following occupational characteristics were based on the job the worker had at the time of occupational injury. The worker's employment status was categorised as either a regular worker (permanent job) or a daily worker (temporary job and daily job). Self-employed individuals and employers were excluded. The number of employees was classified into four groups: <5, 5–9, 10–29 and ≥30. The duration of employment was classified into three groups: <1 year, 1–3 years and ≥3 years.

Injury-related characteristics

The type of occupational injury was divided into two categories: injury or disease. If workers endured an occupational injury or illness and met the requirements for industrial accident compensation, then they received a disability rating.[37] In accordance with the Korean Industrial Accident Compensation Insurance Act, the disability rating ranged from 1 to 14 with a lower rating indicating a more traumatic injury.[2 4] This study categorised disability ratings into five groups: 1–3 (critical), 4–7 (severe), 8–10 (moderate), 11–14 (mild) and none.

Return-to-work-related characteristics

PSWCI included six types of economic activities. These included return to original work, re-employment, self-employment, unpaid family work, unemployment and economic inactivity. Returned to original work refers to workers involved in occupational injuries who return to the occupational site of the industrial accident after completing medical care. Re-employed workers are workers who were re-employed (paid work) at a site other than that of the industrial accident at the time of the survey. Self-employed means those individuals who own business or freelancing. Unpaid family work refers to assisting a family or relative for more than 18 hours per week (3–4 hours per day or more). Those who looked for a job more than once in the past 4 weeks for income and responded that they would work if they found a suitable job within the past week were categorised as unemployed. Economic inactivity means that the individuals have not looked for a job more than once in the past 4 weeks for income or responded that they could not work even if there was a suitable job within the past week.[26] In this study, participants who returned to original work or were self-employed were categorised as return to original work, participants who were re-employed were categorised as re-employed and participants who were unpaid family workers, unemployed or economically inactive were categorised as non-return-to-work. Work retention was defined as maintaining employment for 24 months or longer at the same workplace.[5]

Main outcome variables

The main outcome variables of this study were income before and income after a worker's occupational injury. Income before occupational injury was determined by the following question: 'What is the average monthly wage at the workplace (ie, job) where the industrial accident occurred?'[2 4] Income after occupational injury was estimated as the sum of the individual's earned income and non-work income. Earned income includes wages and business income, and non-work income includes disability lump sum income and disability pensions related to industrial accidents. We excluded property income and private transfer income, which were not related to industrial accidents.[2 4]

Statistical analyses

The general characteristics and incomes of the subjects before an occupational injury considering return to work and job retention were analysed using a t-test and an analysis of variance (ANOVA). We used a repeated measures ANOVA, linear mixed-effects model and generalised estimating equation (GEE) to analyse longitudinal and repeated measures data. A 'lag' effect was given as a test of robustness, for panel data analysis.

The respondents' annual income before and after occupational injury considering return to work and job retention—their income before occupational in jury and their 5-year average income after occupational injury—were compared using a repeated measures ANOVA. To identify changes in income after occupational injury considering general characteristics, we used a linear mixed-effects model for analysis by setting the value of the income after occupational injury minus the income before occupational injury as the dependent variable. To identify the association between post occupational injury income and return-to-work status and job retention status, we used a GEE to calculate ORs with 95% CIs. All analyses were performed using SAS statistical package V.9.4 (SAS Institute).

RESULTS

Table 1 displays the income before occupational injury for each participant characteristic, stratified by return-to-work status. The participants mean annual income before occupational injury was KRW 29.26 million (US$ 24 000) for the return to original work group, KRW 25.98 million (US$ 20 000) for the re-employed group and KRW 22.26 million (US$ 18 000) for the non-return-to-work group. The proportion of men was relatively high in all three return-to-work groups. The income before occupational injury was higher in men compared with women in all three return-to-work groups (p<0.0001 for all three groups).

The general characteristics of the 'non-RTW (Retuen-to-work) group', 'returned to original work' group and 're-employed' group were different, according to age, sex, industry, severity of injury and other variables. As

Table 1 General characteristics and income before occupational injury by return-to-work status (unit: million KRW)

Variables	Non-RTW (Return-to-work)					Returned to original work					Re-employed				
	N	%	Mean	SD	P value*	N	%	Mean	SD	P value*	N	%	Mean	SD	P value*
Total	155	100	22.26	11.35		556	100	29.26	13.87		747	100	25.98	11.58	
Age (years)					0.0132					<0.0001					<0.0001
<30	9	5.8	18.69	6.73		29	5.2	27.01	9.66		44	5.9	19.60	5.52	
30–39	10	6.5	25.13	13.37		103	18.5	31.10	11.94		95	12.7	26.16	11.20	
40–49	16	10.3	25.90	10.57		170	30.6	33.31	14.26		177	23.7	27.23	12.06	
50–59	54	34.8	24.44	12.93		191	34.4	28.15	14.59		279	37.4	27.68	11.70	
≥60	66	42.6	19.64	9.78		63	11.3	19.75	9.50		152	20.4	23.15	11.30	
Sex					<0.0001					<0.0001					<0.0001
Male	110	71.0	26.11	10.97		472	84.9	31.43	13.62		621	83.1	28.24	11.30	
Female	45	29.0	12.85	5.02		84	15.1	17.11	7.61		126	16.9	14.86	4.20	
Marital status					0.5636					<0.0001					<0.0001
Not married	19	12.3	21.27	7.31		73	13.1	25.65	7.73		112	15.0	23.60	9.62	
Married	110	71.0	22.03	11.77		436	78.4	30.67	14.70		510	68.3	27.24	11.96	
Others	26	16.8	23.94	12.15		47	8.5	21.82	9.42		125	16.7	22.99	10.81	
Education level					0.0702					<0.0001					0.0017
Less than high school	94	60.7	21.98	12.00		161	29.0	23.22	10.87		340	45.5	24.78	11.15	
High school	47	30.3	21.22	9.74		284	51.1	30.71	13.41		306	41.0	27.52	12.15	
College or above	14	9.0	27.62	11.21		111	20.0	34.32	15.86		101	13.5	25.35	10.78	
Industry					<0.0001					<0.0001					<0.0001
Manufacturing	45	29.0	22.67	10.47		267	48.0	30.45	13.61		243	32.5	24.81	10.96	
Construction	53	34.2	28.08	12.73		59	10.6	34.52	13.49		274	36.7	32.06	11.43	
Service	17	11.0	13.47	4.67		88	15.8	27.93	15.68		80	10.7	18.40	8.61	
Others	40	25.8	17.82	7.75		142	25.5	25.68	12.37		150	20.1	20.82	8.39	
Status of workers					0.7023					0.0244					<0.0001
Regular worker	52	33.6	21.82	8.87		449	80.8	29.91	13.59		311	41.6	23.65	9.95	
Daily worker	103	66.5	22.48	12.45		107	19.2	26.55	14.76		436	58.4	27.65	12.37	
Occupational injury type					0.9594					0.0002					0.3589
Injury	143	92.3	22.27	11.56		493	88.7	28.48	13.57		698	93.4	26.08	11.61	
Disease	12	7.7	22.10	8.80		63	11.3	35.37	14.75		49	6.6	24.51	11.18	
Number of employees					0.1067					<0.0001					0.3561
<5	45	29.0	19.89	11.40		106	19.1	25.28	10.08		184	24.6	25.00	11.49	

Continued

Table 1 Continued

Variables	Non-RTW (Return-to-work)					Returned to original work					Re-employed				
	N	%	Mean	SD	P value*	N	%	Mean	SD	P value*	N	%	Mean	SD	P value*
5–9	33	21.3	21.35	12.47		100	18.0	26.93	12.44		211	28.3	26.32	11.44	
10–29	40	25.8	24.31	10.47		136	24.5	26.83	11.82		218	29.2	25.92	11.52	
≥30	37	23.9	23.74	10.98		214	38.5	33.87	15.98		134	17.9	26.90	12.06	
Duration of employment (years)					0.2793					<0.0001					0.0002
<1	118	76.1	22.61	11.75		217	39.0	25.63	11.07		595	79.7	26.59	11.96	
1 to less than 3	17	11.0	18.90	10.29		88	15.8	25.03	11.55		85	11.4	21.79	8.07	
≥3	20	12.9	23.07	9.64		251	45.1	33.89	15.35		67	9.0	25.85	11.00	
Disability rating					0.0001					0.0058					0.2676
1–3	5	3.2	27.64	7.28		1	0.2	21.60	–		0	0.0	–	–	
4–7	16	10.3	30.67	12.67		17	3.1	32.04	17.29		22	3.0	24.88	9.99	
8–10	39	25.2	23.93	13.70		92	16.6	28.84	11.99		132	17.7	26.67	11.24	
11–14	75	48.4	20.61	9.95		338	60.8	30.28	14.01		462	61.9	26.24	11.77	
None	20	12.9	17.10	5.84		108	19.4	26.06	14.04		131	17.5	24.56	11.51	
Job retention										<0.0001					0.2653
Non-retention	155	100.0	22.26	11.35		90	16.2	24.97	9.92		290	38.8	25.39	11.89	
Job retention	0	0.0	–	–		466	83.8	30.09	14.37		457	61.2	26.36	11.38	

*Analyses were done by using t-test and analysis of variance.

expected, the mean income of those who returned to their original workplace was highest, followed by those re-employed. The greatest proportion of individuals in the 'non-RTW' group belonged to those aged 60 years or older, whereas the greatest proportion of individuals in the 'returned to original work' group were aged between 40 and 49 years and the re-employed group were aged between 50 and 59 years. While 29% of the individuals in the 'non-RTW' group were females, only 15.1% of the individuals in the 'returned to original work' group and 16.9% of the individuals in the 're-employed' group were females. Regarding industry, the greatest proportion of individuals in the 'non-RTW' group and 're-employed' group belonged to the construction industry, whereas the greatest proportion of those in the 'returned to original work' group belonged to the manufacturing industry.

There were differences in annual incomes before and after occupational injury and the 5-year average income after the occupational injury by work status (p<0.0001, p<0.0001, respectively) (table 2). Income in the first year after injury was higher than income before the accident, regardless of work status. Although income rapidly lowers in the second year after injury, it gradually increases thereafter. Furthermore, only workers who were in the returned to original work group and the job retention group showed an increase in income after occupational injury as compared with before occupational injury. Workers who were in the non-return-to-work group and not in the job retention group experienced a sharp reduction in income after experiencing occupational injury.

There were no differences in annual incomes before and after occupational injury and the 5-year average income after occupational injury between the return to original work plus non-retention group and the re-employed plus job retention groups (p=0.5219, p=0.3662, respectively) (figure 1).

To compare workers' incomes before and after occupational injury in the injured workers, the value obtained by subtracting the before occupational injury income from the after occupational injury income was used as a dependent variable. Table 3 shows the change in income after occupational injury. After adjusting for all covariates, analyses revealed that the reduction in income was greater for men compared with women (p=0.0088). In terms of industry, the reduction in income was significantly greater in construction workers compared with service workers (p<0.0001). The reduction in income for workers who were either re-employed or who did not return to work was significantly greater than for those who returned to original work (p<0.0001, p<0.0001, respectively). The reduction in income for workers in the non-retention group was significantly greater than the reduction in income for workers in the job retention group (p<0.0001).

This study used a GEE to investigate the effects of return to work and job retention status on income after an occupational injury. figure 2 provides the OR that income after an occupational injury would be higher than before,

depending on workers' return to work and job retention status. In regard to workers' return to work, the OR that income after an occupational injury would be higher than that before an occupational injury was 3.17 (2.41–4.17) for those who returned to original work and 2.32 (1.81–2.97) for those re-employed compared with those who did not return to work. In terms of job retention, the OR that income after an occupational injury would be higher than that before an occupational injury was 1.27 (1.07–1.15) for those who retained their job as compared with those who did not. Such association did not differ by income distribution quartile (online supplemental table 1) and/or region (online supplemental table 2).

Figure 3 provides the OR that income after an occupational injury would be higher than that before an occupational injury depending on workers' work status. The OR for income being higher after occupational injury than before was 4.10 (3.16–5.32) for those who returned to original work and retained jobs compared with those who did not return to work and did not retain jobs. The ORs were 2.91 (2.26–3.75) for those who were re-employed and retained jobs and 2.96 (2.15–4.08) for those who returned to original work and did not retain jobs.

DISCUSSION

This study examined changes in income after an occupational injury according to return to work and job retention status in injured workers who completed medical care as well as to compare income before and after their occupational injury. These results are similar to previous findings.[2 4]

The income before occupational injury is more related to general income characteristics of workers than it is to injury-related characteristics.[2] Income before occupational injury is higher for men, workers aged 40–49 years, workers with a higher education and workers employed by a company with a higher number of employees in the workplace (table 1). This is in line with the 2018 wage status report of the Ministry of Employment and Labor.[13] The higher income for construction workers compared with those in the manufacturing or service sectors also align with previous results.[4] As the methods of PSWCI rely on self-reported responses, results may not be accurate due to recall bias.[36] Moreover, the proportion of daily workers is high in construction.[38 39] If workers who are paid daily responded by stating their wages including weekends, income may have been measured to be higher than the actual income.[4]

Regarding the differences in baseline characteristics that were apparent in table 1, results were in alignment with some previous studies, but in conflict with others. In our study, we found that the greatest proportion of individuals in the 'non-RTW' group belonged to those aged 60 years or older, whereas the greatest proportion of individuals in the 'returned to original work' group were between 40 and 49 years and in the re-employed group were between 50 and 59 years. The implication that it is

Table 2 Relationship between work status and annual income changes before and after occupational injury (unit: million KRW)

Work status	Before (2012)*		First (2012)*		Second (2013)*		Third (2014)*		Fourth (2015)*		Fifth (2016)		P value†	First to fifth (2012–2016)‡		P value§
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD		Mean	SD	
Work status													<0.0001			<0.0001
Non-return-to-work +job retention (N=0)	–	–	–	–	–	–	–	–	–	–	–	–		–	–	
Non-return-to-work +non-retention (N=155)	25.64	13.10	32.78	25.61	5.65	10.94	3.75	6.01	6.42	8.76	6.54	9.51		11.03	8.05	
Re-employed +non-retention (N=290)	29.23	13.69	30.55	19.04	17.81	15.24	17.40	13.98	20.56	15.14	20.24	14.56		21.31	11.51	
Returned to original work +non-retention (N=90)	28.89	11.48	36.22	18.05	28.25	16.96	17.89	13.49	21.94	17.26	21.71	14.01		25.20	11.36	
Re-employed +job retention (N=457)	30.49	13.17	33.16	20.94	22.93	16.62	24.00	13.76	24.85	12.24	24.40	13.79		25.87	11.73	
Returned to original work +job retention (N=466)	34.48	16.09	44.86	25.11	35.99	18.84	34.11	16.28	33.43	15.89	33.48	19.86		36.37	16.76	

*All adjusted to fit the wages of 2016, according to changes in South Korea's inflation rate.
†Analyses were done by using a repeated measures ANOVA and linear mixed-effects model.
‡Average of the first-year to fifth-year income.
§Analyses were done on annual income before occupational injury and the average of the first-year to fifth-year annual income by using a repeated measures ANOVA and linear mixed-effects model.
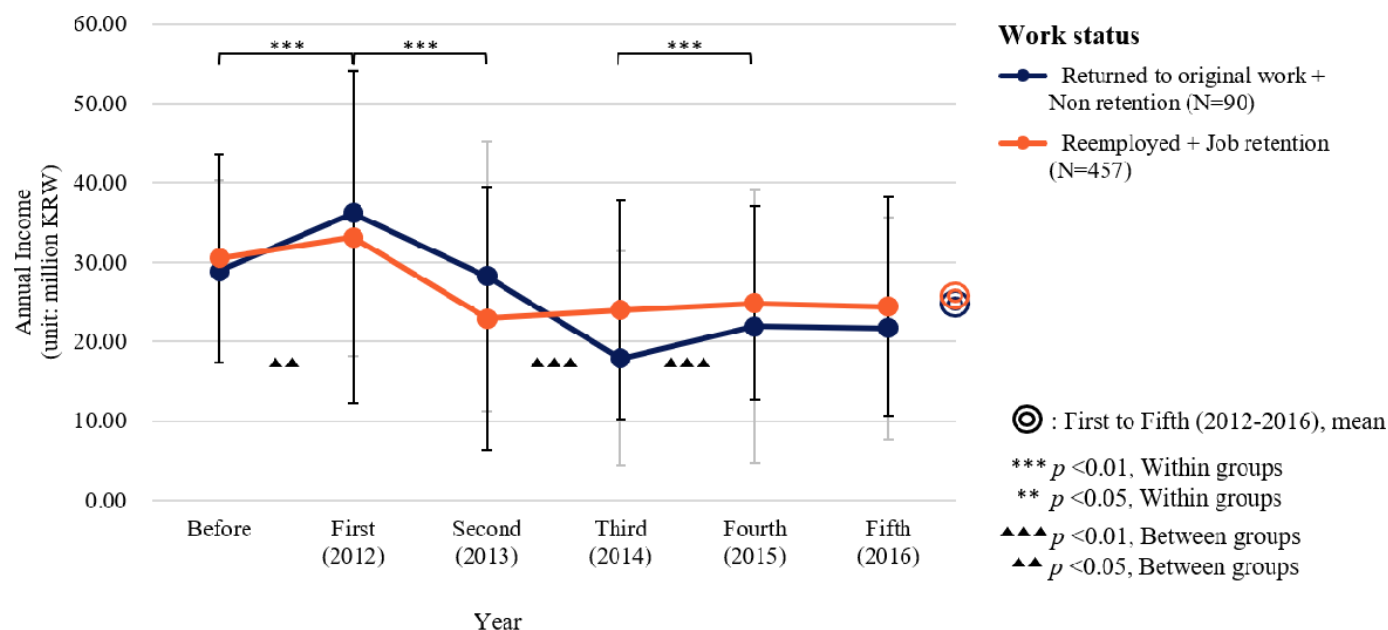ANOVA, analysis of variance.

Figure 1 Relationship between work status (returned to original work+non-retention, re-employed+job retention) and annual income before and after occupational injury (unit: million KRW).

more difficult for older adults to return to work is apparent in multiple studies; in a study of workers' compensation claims in Australia, older age was associated with greater days of wage replacement, even after adjusting for injury type and severity,[40] while another study of 50–64 years olds with permanent impairment from an occupational injury or illness found that older age (60–64 years of age compared with 55–59 or 50–54 years) was associated with early retirement, especially for manual jobs (compared with mixed or non-manual jobs).[41] However, in one longitudinal study tracking 56 cases of work injury claims, there was no significant correlation between age and work status at 1, 2 or 5 years post injury.[42]

In our study, gender also seemed to affect returning to work, with 29% of the individuals in 'non-RTW' group being females but only 15.1% of the individuals in the 'returned to original work' group and 16.9% of the individuals in the 're-employed' group being females. The association between gender and return to work following an injury are mixed; a previous study of individuals with a work-related mild traumatic brain injury found that women were more proactive than men in seeking and requesting medical and rehabilitation services,[43] while another study found no significant association between gender and RTW in a sample of 872 individuals with work-related upper extremity injuries.[44] Further studies of gender-related influences and RTW are recommended for an accurate understanding of this association.

Regarding industry, the greatest proportion of individuals in the 'non-RTW' group and 're-employed' group belonged to the construction industry, whereas the greatest proportion of those in the 'returned to original work' group belonged to the manufacturing industry.

Whether certain jobs result in greater proportions of RTW is a frequently researched topic; in a recent study of 8343 males and 5131 females with claims for occupational injuries, tradespersons and service workers had greater odds of returning to work following an injury than labourers or intermediate production/transport workers.[45] In another study of 251 sick-listed employees from 40 different treatment and facilities in Norway, being in a low-strain job resulted in increased RTW,[46] while in a study of 1341 patients with a traumatic brain injury, professionals and skilled workers were up to three times more likely than manual labourers to return to the workplace.[47]

Regarding the changes in income before and after occupational injury, the income in the first year after completion of medical care was higher than the income prior to occupational injury, regardless of return to work or job retention status. Income decreased markedly the following year and subsequently increased with each year (table 2). These results are similar to previous findings. The fact that income increases in the first year after the accident and decreases in the second year after the accident may be due to the disability compensation lump sum payment. Moreover, the reason income increases over time after the second year may be due to the return-to-work status.[2 4] In Korea, if an industrial accident is closed in accordance with the Industrial Accident Compensation Insurance Act, the workers' compensation insurance compensates the worker according to disability grades if the worker is deemed to have a disability at the time of such closure. Workers with disability ratings of 1–3 are provided with a pension payment. They can be paid half of the sum of the first to fourth year of payments in one lump sum if they wish. Workers with disability ratings of

Table 3 Relationship between the general characteristics and post accident income minus the income before the occupational injury (unit: million KRW)

Variables	ß*	SE	P value
Age (years)			
<30	−0.60	1.23	0.6228
30–39	ref		
40–49	−3.05	0.75	<0.0001
50–59	−4.85	0.83	<0.0001
≥60	−5.47	0.93	<0.0001
Sex			
Male	−2.01	0.77	0.0088
Female	ref		
Marital status			
Not married	−1.42	0.84	0.0907
Married	ref		
Others	−0.47	0.71	0.5141
Education level			
Less than high school	−0.05	0.63	0.9413
High school	ref		
College or above	−0.12	0.79	0.8777
Industry			
Manufacturing	−0.61	0.90	0.4944
Construction	−4.06	1.04	<0.0001
Service	ref		
Others	−0.10	0.93	0.9119
Status of workers			
Regular worker	ref		
Daily worker	−0.65	0.70	0.3497
Occupational injury type			
Injury	−1.38	0.97	0.1538
Disease	ref		
Number of employees			
<5	ref		
5–9	−2.48	0.76	0.0011
10–29	−2.74	0.74	0.0002
≥30	−1.48	0.77	0.0550
Duration of employment (years)			
<1	−0.96	0.85	0.2541
1 to less than 3	ref		
≥3	−0.13	0.94	0.8883
Disability rating			
1–3	ref		
4–7	−2.66	4.26	0.5314
8–10	−4.52	4.11	0.2720
11–14	−9.95	4.08	0.0149
None	−11.57	4.12	0.0051

Continued

Table 3 Continued

Variables	ß*	SE	P value
Return to work			
Non-RTW	−10.24	1.09	<0.0001
Returned to original work	ref		
Re-employed	−4.16	0.64	<0.0001
Job retention			
Non-retention	−3.45	0.62	<0.0001
Job retention	ref		

*Statistical estimated from a linear mixed-effects model that adjusted for all other covariates excluding an interesting variant.

4–7 can select payment in pension or lump sum and can opt to receive half of the total sum for 2 years in one lump sum, should they choose to take the pension. Workers with disability ratings of 8–14 are paid in lump sums only.[37]

In figure 2, we compared the income levels of individuals who did not return to work post injury with those who did. Compared with workers who did not return to work, those who returned to their original workplace (3.17, 2.41–4.17) and those who were re-employed (2.32, 1.81–2.97) had higher incomes after occupational injury than before occupational injury. Workers who retained jobs for 24 months (1.27, 1.07–1.51) also had a higher income than those who did not (figure 2). It can therefore be said that returning to their original workplace and job retention are important factors for maintaining the income levels of workers involved in industrial accidents.[4] However, it must be noted that overall, while there may be an initial increase in income from various compensation measures that are awarded by insurance companies and the government to individuals who have had an occupational injury, after a certain period (maximum of 5 years), all injured individuals in our investigation suffered from a decrease in income.

Returning to the original workplace is prioritised over re-employment for successful return to work[48]; besides, there are no policies that protect re-employed workers involved in industrial accidents and that encourage employers to hire—and maintain employment for—those workers.[5] The post injury income of the workers who were re-employed and who retained their jobs was at a level similar to that of the workers who returned to their original workplace but did not retain their jobs (figures 1 and 3). Rather than failing to retain jobs after returning to their original workplace, it may be more economically beneficial to be re-employed and to retain jobs. In addition, protection policies for re-employed workers or benefits for employers hiring re-employed workers should be considered.[5]

Strengths and limitations

This study has several strengths. First, the data used in the study are from the only panel study in Korea conducted by the KCOMWEL with a 5-year follow-up on the quality
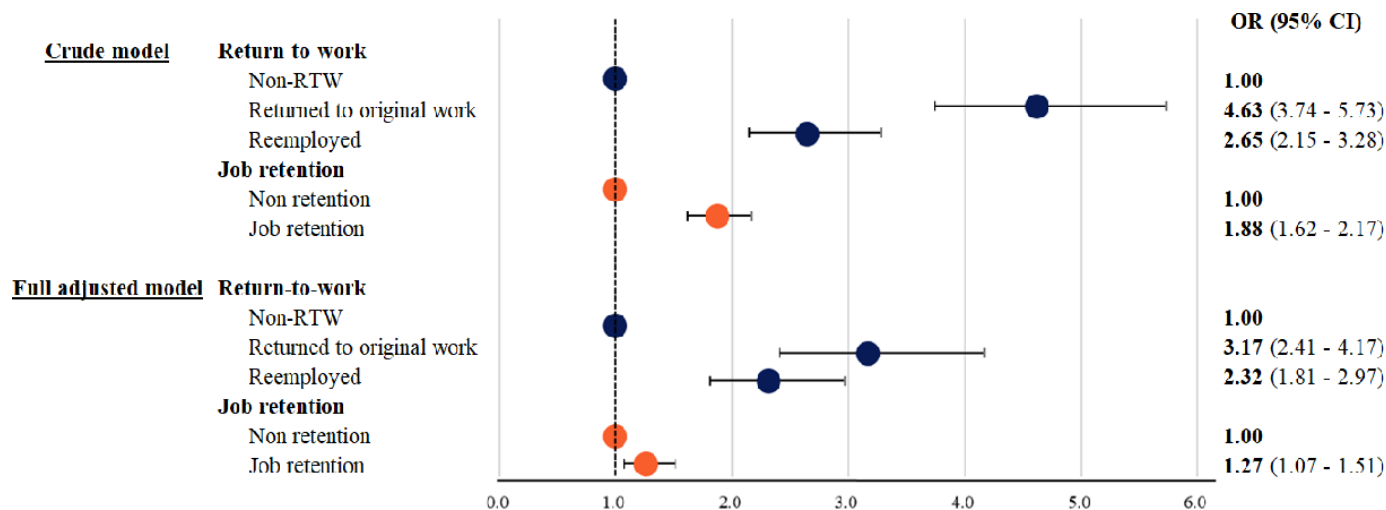
	OR (95% CI)
Crude model **Return to work**	
Non-RTW	**1.00**
Returned to original work	**4.63** (3.74 - 5.73)
Reemployed	**2.65** (2.15 - 3.28)
Job retention	
Non retention	**1.00**
Job retention	**1.88** (1.62 - 2.17)
Full adjusted model **Return-to-work**	
Non-RTW	**1.00**
Returned to original work	**3.17** (2.41 - 4.17)
Reemployed	**2.32** (1.81 - 2.97)
Job retention	
Non retention	**1.00**
Job retention	**1.27** (1.07 - 1.51)

Figure 2 Generalised estimating equation with annual income after occupational injury by return to work and job retention.

of life of workers who had been involved in industrial accidents and who completed medical care in 2012.[2 4 34–36] The PSWCI is considered to be a nationally representative survey of workers in South Korea as they employ stratified systematic sampling methods according to sex, age, residential region, disability grade and the utilisation of a rehabilitation service that reflect the proportions of national statistics.[4 5] Second, this study is the first to examine the changes in income based on return-to-work status and job retention for Korean workers involved in industrial accidents. Lastly, by using a longitudinal analysis strategy to analyse income value changes year by year, we were able to track the same workers from before and after their injury for a period of 5 years. By adjusting all values to fit the wages of 2016 according to changes in South Korea's inflation rate, we were able to provide income change values for our study population that reflected the general development in wages over the years. This resulted in a novel finding that income following an injury may increase slightly after an injury due to various compensation measures, but will eventually decrease to a level below the 'before injury' within 5 years' time, even with job retention.

One limitation to this study is that we did not consider the effect that a disability lump sum compensation would have on income after occupational injury. We

therefore made an additional comparison using 5-year average incomes after occupational injury.[2] Moreover, some answers—especially regarding income before occupational injury—can be affected by respondents' recall bias, as we analysed data obtained through interviews in a certain time frame. Furthermore, we were only able to adjust for the inflation rate in our analysis, but many longitudinal factors, including productivity growth, seasonal changes and economic events, that could not be controlled were likely to have affected the results of our analysis. Likewise, while various statistical techniques were employed to control for both item and unit non-responses, it was impossible to fully eliminate related biases. Although we employed a poststratification and non-response weight adjustment calculation to inflate base weights and minimise longitudinal bias, the multiple imputation of drop-outs may have been more appropriate in compensating for the loss of data. We also failed to impute the data for 13 individuals with missing information regarding income before and after an occupational accident, which may have skewed our results. Finally, because the year of the accident was not recorded, income before occupational injury was calculated using the duration of medical care.[2 4]
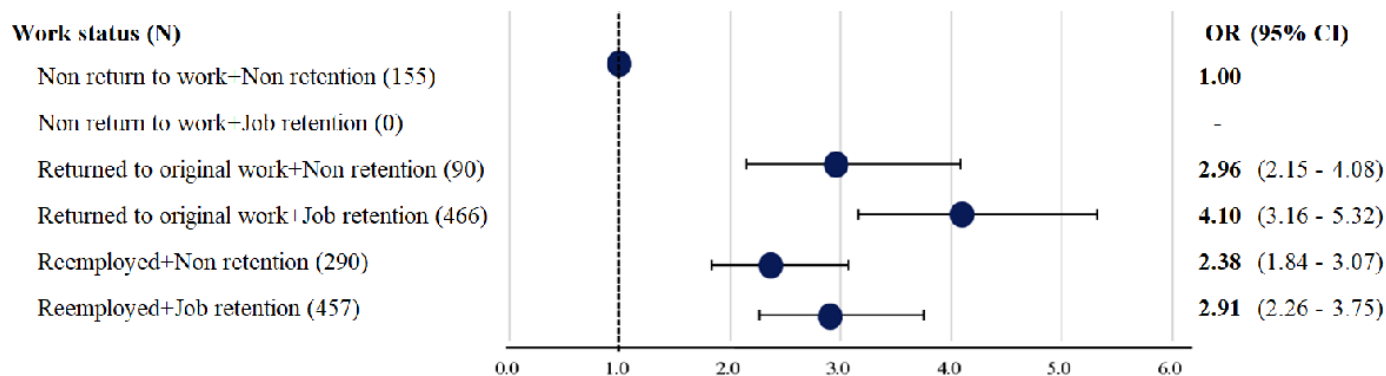
Work status (N)	OR (95% CI)
Non return to work−Non retention (155)	**1.00**
Non return to work−Job retention (0)	–
Returned to original work+Non retention (90)	**2.96** (2.15 - 4.08)
Returned to original work+Job retention (466)	**4.10** (3.16 - 5.32)
Reemployed+Non retention (290)	**2.38** (1.84 - 3.07)
Reemployed+Job retention (457)	**2.91** (2.26 - 3.75)

Figure 3 Generalised estimating equation with annual income after occupational injury by return to work and job retention.

CONCLUSIONS

In conclusion, the income of workers involved in occupational injuries generally decreased, compared with their income before the occupational injury. Although workers who returned to their original workplace and retained their jobs had increased incomes after occupational injury, other workers had decreased incomes. However, workers who returned to their original workplace but did not retain jobs had similar incomes to workers who were re-employed and retained their jobs. This signifies that although returning to the original workplace is very important to maintain the economic level of workers involved in occupational injuries, it is also important to retain jobs, even if the individual cannot return to their original workplace. Based on these findings, there is an urgent need for policies that can help workers involved in occupational injuries to maintain their jobs.

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Supplemental material

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Supplementary Table 1. Subgroup Analysis of Income Distribution (by quartile) among Individuals with Increased Income (n=461)

Post-Accident	Non return to work + Job retention (N=0)	Non return to work + Non retention (N=8)		Reemployed + Non retention (N=86)		Returned to original work + Non retention (N=26)		Reemployed + Job retention (N=139)		Returned to original work + Job retention (N=202)	
		n	%	n	%	n	%	n	%	n	%
Income Quartiles											
0-25% (low)	-	7	87.50	30	34.88	5	19.23	43	30.94	51	25.25
25-50%	-	0	0.00	26	30.23	10	38.46	41	29.50	57	28.22
50-75%	-	0	0.00	22	25.58	7	26.92	40	28.78	54	26.73
75-100% (high)	-	1	12.50	8	9.30	4	15.38	15	10.79	40	19.80

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Supplementary Table 2. Subgroup Analysis of Income Distribution According to Region (unit: million KRW)

	Before (2012)*		First (2012)*		Second (2013)*		Third (2014)*		Fourth (2015)*		Fifth (2016)		p-value‡	First to Fifth (2012-2016)†		p-value§
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD		Mean	SD	
Area													<0.0001			<0.0001
Seoul (N=164)	30.23	14.16	32.87	19.27	22.37	15.49	22.78	14.12	23.99	14.93	23.60	13.54		25.12	12.27	
Busan (N=141)	30.69	13.88	35.53	20.18	24.09	17.45	22.55	15.11	24.19	16.14	23.11	15.84		25.90	14.28	
Daegu/Gyeongbuk (N=167)	29.33	13.27	33.83	24.30	24.03	18.21	22.04	14.77	22.21	14.06	22.69	15.07		24.96	14.18	
Gangwon (N=57)	28.58	11.32	32.38	18.41	15.82	11.91	15.57	12.68	17.94	13.49	20.48	19.71		20.44	11.99	
Ulsan/Gyeongnam (N=172)	36.58	16.52	43.71	27.22	33.17	24.01	30.33	19.54	30.62	18.77	29.45	18.93		33.46	18.64	
Gyeonggi (N=331)	30.16	14.04	35.79	24.14	22.82	18.38	21.78	16.10	23.15	14.84	23.25	15.67		25.36	14.13	
Incheon (N=128)	33.13	15.62	37.53	20.34	25.98	20.05	26.36	19.13	27.65	17.39	29.12	27.90		29.33	17.65	
Jeolla (N=147)	27.77	13.62	36.14	20.69	23.41	19.73	21.77	18.28	24.28	16.85	21.99	15.91		25.52	14.94	
Chungcheong (N=151)	30.76	13.85	38.95	25.12	25.35	18.62	23.92	17.14	24.81	16.93	25.06	17.02		27.62	16.12	

* All adjusted to fit the wages of 2016, according to changes in South Korea's inflation rate

† Average of the first to fifth-year income

‡ Analyses were done by using a repeated measures ANOVA, linear mixed-effects model

§ Analyses were done annual income before occupational injury and the average of the first to fifth-year annual income by using a repeated measures ANOVA, linear mixed-effects model