JESK J Ergon Soc Korea 2017; 36(3): 231-244
http://dx.doi.org/10.5143/JESK.2017.36.3.231
http://jesk.or.kr eISSN:2093-8462

Characteristics of Occupational Injuries in the Automobile Parts Manufacturing Industry

Seung Tae Yang[1], Byung Yong Jeong[2], Myoung Hwan Park[2]

[1]Korean Industrial Health Association, Health Management, Seoul, 06667
[2]Department of Industrial and Management Engineering, Hansung University, Seoul, 02876

Corresponding Author
Myoung Hwan Park
Department of Industrial and Management Engineering, Hansung University, Seoul, 02876
Mobile : +82-10-9027-1576
Email : mhpark@hansung.ac.kr

Received : April 24, 2017
Revised : April 27, 2017
Accepted : May 12, 2017

Objective: This study aims to understand the occupational injury characteristics of the workers in the motor vehicle parts (automobile parts) manufacturing industry and to present basic guidelines on accident prevention through accident analysis.

Background: There occur many occupational injuries in the motor vehicle parts manufacturing industry. But there were few researches for the occupational injuries of the workers in the motor vehicle parts manufacturing industry.

Method: This study analyzed the data of occupational injuries of 1,609 workers in the motor vehicle parts manufacturing industry in 2015. The accident characteristics were analyzed by dividing them into worker related factors and accident related factors.

Results: Among the occupational injuries of the workers in the motor vehicle parts manufacturing industry, 80.6% of the victims were males, 64.0% were older than 40. 57.8% of the victims were employed by the companies with less than 50 workers. In addition, there was a difference in accident characteristics according to age, work experience, employment type, events or exposures, accident time of the day, agents, natures of injuries and illnesses, injured organs and injured body part.

Conclusion: It is important to prevent equipment/machinery accidents. For this purpose, more efforts should be made to establish safety measures faithful to the basics of safety devices and safety work procedures. It is also suggested that prevention of disasters should be intensively carried out for workplaces with less than 50 employees and middle-aged and elderly people.

Application: The result can be used to present guidelines for preventative measures for the workers in the motor vehicle parts manufacturing industry including safety education/training.

Keywords: Automobile parts, Manufacturing industry, Occupational injury, Worker related factors, Accident related factors

1. Introduction

Unexpected occupational injuries frequently occur in the industrial sites, as industrial structure becomes complex and diversified along with industrialization. Recent occupational injuries in the industrial sites take on diverse types due to facility diversification, complexity of human resource, and change in working environment (Hong et al., 2011). The motor vehicle parts (automobile parts) manufacturing industry

is no exception. According to the data of the Statistics Korea (KOSIS, 2015), the number of establishments of the transportation equipment manufacturing industry including the motor vehicle parts manufacturing industry was 13,322, and the number of the injured was 2,692. Among them, the employees in the motor vehicle parts manufacturing industry were 1,609, taking up 59.7% of the injured in the transportation equipment manufacturing industry (KOSIS, 2015). In the U.S., a total of 17,150 cases of nonfatal injuries and illnesses occurred in the transportation equipment manufacturing industry, and 5,510 (32.1%) cases of nonfatal injuries and illnesses took place in the motor vehicle parts manufacturing industry (BLS, 2015). This means that the injury rate in the transportation equipment manufacturing industry cannot be reduced without decreasing the injury rate in the motor vehicle parts manufacturing industry. However, researches on the accident characteristics targeting employees in the motor vehicle parts manufacturing industry are currently insufficient.

As a result of making efforts to establish injury prevention measures through occupational injury analysis, there have been great achievements. Recently, there are several researches to analyze occupational injuries characteristics by occupation targeting the workers in the same occupation in order to establish suitable systematic injury prevention measures in consideration of the characteristics of workers' occupation. Studies on the parking lot managing work, household moving work, cabling work, and delivery work have been conducted (Byun et al., 2017; Jeong and Park, 2017; Kim et al., 2016; Kim et al., 2016; Lee, 2012; Park et al., 2015; Park and Jeong, 2016).

A motor vehicle is a product assembled with more than 20,000 parts, and the amount that motor vehicle manufacturing companies purchase from the first vendors account for more than 50% of the sales amount of the motor vehicle manufacturing companies (Kim, 2005). Motor vehicle parts consist of various types of parts, such as power train, braking system, steering mechanism, shock absorbers, bumpers, seats, and mirrors. They are made of materials including steel, nonferrous metals, plastics, rubbers, and glasses. The manufacturing processes in the motor vehicle parts manufacturing industry include most processes like casting, forging, cutting, injection molding, and assembling.

The previous studies on occupational injuries related with motor vehicle parts manufacturers were mainly on musculoskeletal disorders (Jang et al., 2008; Yang and Cho, 2007; Mok et al., 2013) and job stress (Kim and Kim, 2014). Kim et al. (2009) reported that workers complain pains most in the shoulders, waist, and neck in the order, and found that the major harmful factors of processes are uncomfortable postures, handling heavy weight, and repetitive work in the descending order through workers' characteristics analysis including age, gender, and work experience.

This study aims to understand the injury characteristics and to offer basic guidelines for injury prevention by analyzing injury characteristics of the workers in the motor vehicle parts manufacturing industry.

2. Methods

2.1 Definition

This study classified work-related occupational injury victims as the dead, the disabled, and the injured, and targeted only those who gained the approval of 4 days or more of sick leave days (days away from work) in the motor vehcile parts manufacturing work.

2.2 Data collection

This study targeted 1,609 workers who were approved as occupational injury victims due to accidents occurring in the motor vehicle parts manufacturing industry in 2015. Their mean age was 44.127 (standard deviation: 11.271), and males were 80.6%, and

females were 19.4%. The 1,609 victims consisted of 17 dead people (1%), 458 disabled people (28.5%), and 1,134 injured people (70.5%).

2.3 Data analysis

The accident characteristics in the motor vehicle parts manufacturing industry were analyzed in view of the worker related factors and accident related factors. The worker related factors included age, gender, work experience, the size of employment, and employment type. The accident related factors included injury level (fatality, disability and nonfatal injury), day of the week, time of the day, events or exposures, agents, injured body part, and nature of injury. The differences in the distribution of the injured according to accident characteristics and injury level were analyzed using a chi-square (χ^2) test. To verify whether there was a difference between the mean sick leave days of the injured and the disabled, one way ANOVA was carried out. For statistical test, a statistical package, SPSS 18.0, was used, and significance level of 0.05 was applied.

3. Results

3.1 Analysis of the accidents in view of worker related factors

3.1.1 Analysis of the injured by age

Table 1 shows the distribution of the injured by age. Upon looking at the distribution of the injured by age, those who were in their 50s or older (36.9%), 40s (27.1%), 30s (23.4%), and younger than 30s (12.6%) occurred most in order, and thus those who were in their 40s or older took up 64.0% of the total injured.

There were statistically significant differences in the distribution of the dead, the nonfatal injured, and the disabled by age ($\chi^2=20.448$, $p=0.002$). Upon looking at injury level by age, the dead showed high ratio at younger than 30 (1.5%), but the disabled

Table 1. Distribution of injured persons by age

Age	Frequency	Nonfatal	Fatal	
	Total	Injury	Death	Disability
Under 30	203	146	3	54
	(12.6%)	(71.9%)	(1.5%)	(26.6%)
30~39	376	286	3	87
	(23.4%)	(76.1%)	(0.8%)	(23.1%)
40~49	436	321	5	110
	(27.1%)	(73.6%)	(1.1%)	(25.2%)
50 or more	594	381	6	207
	(36.9%)	(64.1%)	(1.0%)	(34.8%)
Total	1,609	1,134	17	458
	(100.0%)	(70.5%)	(1.1%)	(28.5%)
Statistical test	$\chi^2=20.448$, $p=0.002$			

showed higher ratio at 50s or older (34.8%), compared to the other age groups. The proportion of the nonfatal injured showed 64.1% at 50s or older, lower than the other age groups. Therefore, the ratio of the dead or the disabled was higher in the age group of 50s or older.

3.1.2 Analysis of the injured by gender/employment type

Table 2 shows the distribution of the injured by classifying the workers in the motor vehicle parts manufacturing industry according to age and employment type. Among all the injured, males were 1,297 (80.6%) and females were 312 (19.4%). Upon looking at the distribution of the injured according to employment type, full-time workers were 88.3%, and the temporary workers were 11.7%.

The distribution of the dead, the nonfatal injured, and the disabled according to age and employment type showed no statistically significant difference ($\chi^2=9.851$, $p=0.131$).

Table 2. Distribution of injured persons by gender/employment type

Working condition		Frequency	Nonfatal	Fatal	
		Total	Injury	Death	Disability
Male	Full-time	1,155	828	16	311
		(71.8%)	(71.7%)	(1.4%)	(26.9%)
	Temporary	142	91	0	51
		(8.8%)	(64.1%)	(0.0%)	(35.9%)
Female	Full-time	265	182	1	82
		(16.5%)	(68.7%)	(0.4%)	(30.9%)
	Temporary	47	33	0	14
		(2.9%)	(70.2%)	(0.0%)	(29.8%)
Total		1,609	1,134	17	458
Statistical test		$\chi^2=9.851$, $p=0.131$			

3.1.3 Analysis of the injured by work experience

Table 3 shows the distribution of the injured by work experience. Overall, the injured having less than one year of work experience were 40.4% of the total victims.

The distribution of the dead, the nonfatal injured, and the disabled by work experience showed statistically significant differences ($\chi^2=14.945$, $p=0.021$). The ratio of the dead was high from the workers with 3 years and more of work experience, but the ratio of the disabled was high from the workers with less than 10 years of work experience. The nonfatal injured showed highest ratio from the workers with 10 years and more of work experience (75.7%), and the ratios of the dead and the disabled were relatively lower. The ratio of the nonfatal injured was lower from the workers with 3~10 years and less than one year of work experience, and the ratios of the dead and the disabled were relatively higher.

Table 3. Distribution of injured persons by work experience

Work experience	Frequency	Nonfatal	Fatal	
	Total	Injury	Death	Disability
Under 1 year	644	447	6	191
	(40.0%)	(69.4%)	(0.9%)	(29.7%)
1~3 years	321	233	0	88
	(20.0%)	(72.6%)	(0.0%)	(27.4%)
3~10 years	331	217	6	108
	(20.6%)	(65.6%)	(1.8%)	(32.6%)
Over 10 years	313	237	5	71
	(19.5%)	(75.7%)	(1.6%)	(22.7%)
Total	1,609	1,134	17	458
Statistical test	$\chi^2=26.280$, $p=0.021$			

3.1.4 Analysis of the injured by size of employment

Table 4 shows the distribution of the injured by the size of employment. The injured were distributed in the following order: 33.3% in the companies with 5~29 employees, 22.9% with 100~499 employees, 12.6% with less than 5 employees, 12.2% with 30~49 employees, 11.9% with 50-less than 100 employees, and 7.5% with 500 and more of employees. Overall, 57.8% of the injury occurred in the workplaces with less than 50 employees.

The distribution of the dead, the nonfatal injured, and the disabled by the size of employment showed no statistically significant difference ($\chi^2=10.091$, $p=0.443$).

Table 4. Distribution of injured persons by size of employment

Company size	Frequency	Nonfatal	Fatal	
	Total	Injury	Death	Disability
Under 5 persons	202	146	0	56
	(12.6%)	(12.9%)	(0.0%)	(12.2%)
5~29 persons	531	370	4	157
	(33.0%)	(32.6%)	(23.5%)	(34.3%)
30~49 persons	196	133	1	62
	(12.2%)	(11.7%)	(5.9%)	(13.5%)
50~99 persons	192	130	4	58
	(11.9%)	(11.5%)	(23.5%)	(12.7%)
100~499 persons	368	268	6	94
	(22.9%)	(23.6%)	(35.3%)	(20.5%)

Table 4. Distribution of injured persons by size of employment (Continued)

Company size	Frequency	Nonfatal	Fatal	
	Total	Injury	Death	Disability
Over 500 persons	120	87	2	31
	(7.5%)	(7.7%)	(11.8%)	(6.8%)
Total	1,609	1,134	17	458
	(100.0%)	(100.0%)	(100.0%)	(100.0%)
Statistical test	χ^2=10.091, p=0.433			

3.1.5 Analysis of the injured by detailed employment type

Table 5 reveals the distribution of the injured by detailed employment type. Upon looking at the injured by employment type, the full-time workers were 1,420 (88.3%), and the temporary workers were 189 (11.7%).

The distribution of the dead, the nonfatal injured, and the disabled by employment size showed no statistically significant difference (χ^2=10.367, p=0.110).

Table 5. Distribution of injured persons by employment type

		Frequency	Nonfatal	Fatal	
		Total	Injury	Death	Disability
Full-timer workers	Regular	1,420	1,010	17	393
		(88.3%)	(71.1%)	(1.2%)	(27.7%)
Temporary workers	Regular	64	41	0	23
		(4.0%)	(64.1%)	(0.0%)	(35.9%)
	Daily workers	89	64	0	25
		(5.5%)	(71.9%)	(0.0%)	(28.1%)
	Part timer	36	19	0	17
		(2.2%)	(52.8%)	(0.0%)	(47.2%)
Total		1,609	1,134	17	458
Statistical test		χ^2=10.367, p=0.110			

3.2 Analysis of the injured in view of accident related factors

3.2.1 Analysis of the injured by day of the week

Table 6 reveals the distribution of the injured by day of the week. The injured by day of the week occurred in the following order: 299 workers (18.6%) on Wednesday, 285 workers (17.7%) on Thursday, 282 workers (17.5%) on Monday, 262 workers (16.3%) on

Friday, and 251 workers (15.6%) on Tuesday.

The distribution of the injured by day of the week did not show statistically significant difference ($\chi^2=7.708$, $p=0.808$).

Table 6. Distribution of the injured by day of the week

	Frequency	Nonfatal	Fatal	
	Total	Injury	Death	Disability
Mon	282	192	4	86
	(17.5%)	(68.1%)	(1.4%)	(30.5%)
Tue	251	171	3	77
	(15.6%)	(68.1%)	(1.2%)	(30.7%)
Wed	299	223	2	74
	(18.6%)	(74.6%)	(0.7%)	(24.7%)
Thu	285	195	4	86
	(17.7%)	(68.4%)	(1.4%)	(30.2%)
Fri	262	187	1	74
	(16.3%)	(71.4%)	(0.4%)	(28.2%)
Sat	166	117	2	47
	(10.3%)	(70.5%)	(1.2%)	(28.3%)
Sun	64	49	1	14
	(4.0%)	(76.6%)	(1.6%)	(21.9%)
Total	1,609	1,134	17	458
	(100.0%)	(100.0%)	(100.0%)	(100.0%)
Statistical test	$\chi^2=7.708$, $p=0.808$			

3.2.2 Analysis of the injured by time of day

Table 7 shows the distribution of the injured by daytime and nighttime. The daytime is defined as 06:00 to 18:00, and the nighttime is defined as 18:00 to 06:00. 1,240 victims (77.1%) occurred during the daytime, and 369 victims (22.9%) occurred during the nighttime.

Table 7. Distribution of the injured by time of day

	Frequency	Nonfatal	Fatal	
	Total	Injury	Death	Disability
Day	1,240	868	9	363
	(77.1%)	(70.0%)	(0.7%)	(29.3%)

Table 7. Distribution of the injured by time of day (Continued)

	Frequency	Nonfatal	Fatal	
	Total	Injury	Death	Disability
Night	369	266	8	95
	(22.9%)	(72.1%)	(2.2%)	(25.7%)
Total	1,609	1,134	17	458
	(100.0%)	(100.0%)	(100.0%)	(100.0%)
Statistical test	$\chi^2=7.018$, $p=0.030$			

The distribution of the dead, the nonfatal injured, and the disabled by daytime and nighttime showed statistically significant difference ($\chi^2=7.018$, $p=0.030$). Although the ratios of the nonfatal injured and the disabled were higher during the daytime, the ratio of the dead was relatively higher at nighttime.

3.2.3 Analysis of the injured by events or exposures

Table 8 shows the distribution of the injured by events or exposures. The injured occurred in the following order: caught in (48.9%), work-related disorders (13.5%), struck against object (7.7%), slips or trips (6.1%), and struck by object (6.1%).

The distribution of the dead, the nonfatal injured, and the disabled by events or exposures showed statistically significant differences ($\chi^2=91.920$, $p<0.001$). The ratio of the dead was high by work-related disorders including brain and cardiovascular disease and struck by or against objects. The disabled were relatively higher by caught in at 38.1%. The nonfatal injured showed lower ratio in the accident of caught in something, and thus the ratio of the dead or the disabled was higher by the accident of caught in. In this regard, the occurrence rate of the accident of caught in was high, and fatal rate was high as well. Therefore, caught in is the event or exposure that needs management most.

Table 8. Distribution of the injured by events or exposures

	Frequency	Nonfatal	Fatal	
	Total	Injury	Death	Disability
Caught in	787	481	6	300
	(48.9%)	(61.1%)	(0.8%)	(38.1%)
Work-related disorders	217	161	7	49
	(13.5%)	(74.2%)	(3.2%)	(22.6%)
Struck against object	124	94	2	28
	(7.7%)	(75.8%)	(1.6%)	(22.6%)
Slips or trips	98	85	0	13
	(6.1%)	(86.7%)	(0.0%)	(13.3%)
Struck by object	98	84	1	13
	(6.1%)	(85.7%)	(1.0%)	(13.3%)

Table 8. Distribution of the injured by events or exposures (Continued)

	Frequency	Nonfatal	Fatal	
	Total	Injury	Death	Disability
Cuts, lacerations, punctures	65	49	0	16
	(4.0%)	(75.4%)	(0.0%)	(24.6%)
Fall to lower level	52	39	0	13
	(3.2%)	(75.0%)	(0.0%)	(25.0%)
Others	168	141	1	26
	(10.4%)	(83.9%)	(0.6%)	(15.5%)
Total	1,609	1,134	17	458
	(100.0%)	(70.5%)	(1.1%)	(28.5%)
Statistical test	$\chi^2=91.920$, $p<0.001$			

3.2.4 Analysis of the injured by agent

Table 9 shows the distribution of the injured by agent. The agents causing the injured were the highest in the following order: 818 workers (50.8%) by the machine/equipment, 256 workers (15.95) by others including work-related disorders such as brain cardiovascular disease, and 250 workers (15.5%) by parts (adjuncts) and materials.

The distribution of the dead, the nonfatal injured, and the disabled by agent showed statistically significant differences ($\chi^2=54.754$, $p<0.001$). The dead showed high ratio in others including work-related disorders, such as brain cardiovascular disease, and the disabled showed relatively higher ratio in the machine/equipment (35.2%). Upon looking at the nonfatal injured alone, the ratio of machine/equipment was relatively lower (63.9%), and thus the ratios of the dead and the disabled were relatively higher. Therefore, the accidents caused by facility/machinery took up the highest ratio, and the fatal rate was high as well. Consequently, the machine/equipment is the agent requiring management most.

Table 9. Distribution of the injured by the agent

	Frequency	Nonfatal	Fatal	
	Total	Injury	Death	Disability
Machine/Equipment	818	523	7	288
	(50.8%)	(63.9%)	(0.9%)	(35.2%)
Parts and materials	250	186	2	62
	(15.5%)	(74.4%)	(0.8%)	(24.8%)
Buildings/Structure and surfaces	133	112	1	20
	(8.3%)	(84.2%)	(0.8%)	(15.0%)
Handtools	83	71	0	12
	(5.2%)	(85.5%)	(0.0%)	(14.5%)

Table 9. Distribution of the injured by the agent (Continued)

	Frequency	Nonfatal	Fatal	
	Total	Injury	Death	Disability
Containers, furniture and fixtures	69	57	0	12
	(4.3%)	(82.6%)	(0.0%)	(17.4%)
Others	256	185	7	64
	(15.9%)	(72.3%)	(2.7%)	(25.0%)
Total	1,609	1,134	17	458
	(100.0%)	(100.0%)	(100.0%)	(100.0%)
Statistical test	$\chi^2 = 54.754$, $p < 0.001$			

3.2.5 Analysis of the injured by injured body part

Table 10 shows the distribution of the injured by injured body part. Upon looking at the injured body part, the injured body parts taking up the highest ratio were revealed in the following order: 1,004 workers (62.4%) on the arm/hand, 242 workers (15.0%) on the leg/foot, 141 workers (8.8%) on the trunk, 98 workers (6.1%) on the face/head, and 98 workers (4.4%) on the shoulder.

Table 10. Distribution of the injured by the injured body part

	Frequency	Nonfatal	Fatal	
	Total	Injury	Death	Disability
Face/Head	98	76	6	16
	(6.1%)	(77.6%)	(6.1%)	(16.3%)
Neck	24	18	0	6
	(1.5%)	(75.0%)	(0.0%)	(25.0%)
Shoulder	70	54	0	16
	(4.4%)	(77.1%)	(0.0%)	(22.9%)
Trunk	141	107	3	31
	(8.8%)	(75.9%)	(2.1%)	(22.0%)
Arm/Hand	1,004	651	0	353
	(62.4%)	(64.8%)	(0.0%)	(35.2%)
Leg/Foot	242	206	0	36
	(15.0%)	(85.1%)	(0.0%)	(14.9%)
Others	30	22	8	0
	(1.9%)	(73.3%)	(26.7%)	(0.0%)
Total	1,609	1,134	17	458
Statistical test	$\chi^2 = 287.515$, $p = 0.000$			

The distribution of the injured by injured body part showed statistically significant differences ($\chi^2 = 287.515$, $p < 0.001$). Concerning the injured on the other body parts (heart) and face/head, the ratio of the dead was high, and the disabled showed the highest ratio on the arm/hand. The ratio of the nonfatal injured was lowest on the arm/hand, and thus the fatal injury ratios of the dead and the disabled were relatively higher.

3.2.6 Analysis of the injured by natures of injury and illness

Table 11 shows the distribution of the injured by natures of injuries and illnesses. Upon looking at the natures of injuries or illnesses, most occurred in the following order: 557 workers with crush/amputation (34.6%), 461 workers with fractures (28.7%), and 384 workers with sprain/musculoskeletal disorders (23.9%).

The distribution of the injured by natures of injuries and illnesses showed statistically significant differences ($\chi^2 = 329.721$, $p < 0.001$). The high ratio of the dead occurred in the cerebral cardiovascular disease, and the high ratio of the disabled occurred in the crush/amputation. The ratio of the nonfatal injured was low in the crush/amputation (56.6%) and cerebral cardiovascular disease (66.7%), and thus the ratios of the dead and the disabled were relatively higher.

Table 11. Distribution of the injured by natures of injury or illness

	Frequency	Nonfatal	Fatal	
	Total	Injury	Death	Disability
Crush/Amputations	557	315	3	239
	(34.6%)	(56.6%)	(0.5%)	(42.9%)
Fracture	461	340	4	117
	(28.7%)	(73.8%)	(0.9%)	(25.4%)
Sprain/Musculoskeletal	384	308	0	76
	(23.9%)	(80.2%)	(0.0%)	(19.8%)
Burns	108	99	0	9
	(6.7%)	(91.7%)	(0.0%)	(8.3%)
Cerebral cardiovascular	21	14	7	0
	(1.3%)	(66.7%)	(33.3%)	(0.0%)
Contusion/bruise	18	17	0	1
	(1.1%)	(94.4%)	(0.0%)	(5.6%)
Others	60	41	3	16
	(3.7%)	(68.3%)	(5.0%)	(26.7%)
Total	1,609	1,134	17	458
	(100.0%)	(100.0%)	(100.0%)	(100.0%)
Statistical test	$\chi^2 = 329.721$, $p = 0.000$			

4. Conclusion and Discussion

This study analyzed injury characteristics using the injury data of the workers in the motor vehicle parts manufacturing industry in 2015. The results revealed that differences in injury level existed by age, work experience, employment type, events or exposures, accident time of the day, agents, natures of injuries and illnesses and injured body part.

Among the injured, 80.6% were males, and the age group with the highest accidents was the workers in their 40s or older (64.0%). 88.3% were full-time workers, and 57.7% of the injured occurred in workplaces with less than 50 employees. 40.4% of the injured occurred from the workers with less than one year of work experience. In the U.S., 65.2% of nonfatal occupational injuries were males, and 66.6% occurred from the workers aged 35 or older. 31.9% occurred from the workers with less than one year of work experience (BLS, 2015). Therefore, there is differences compared to those of Korea.

Concerning accident related characteristics, the accidents of caught in (48.9%) and work related disorders (13.5%) comprised most of accidents, and high ratio of accidents occurred in the machine/equipment (50.8%) in terms of agent. As for injured body part, the injured occurred with the highest ratio in the following order: arm/hand (62.4%), leg/foot (15.0%), and trunk (8.8%). As for the events or exposures, crush/amputation (34.6%), fractures (28.7%), and sprain/musculoskeletal disease (23.9%) occurred in the order. Concerning the U.S. nonfatal occupational injuries, overexertion and bodily reaction (41.7%), struck by or against object (20.3%), slips or trips (16.7%) occurred in the order. As for sources, the nonfatal occupational injuries occurred in worker motion or position (20.9%), and parts and materials (19.6%). Regarding the parts of body affected, the ratios were in the following order: arm/hand/wrist (33.4%), trunk (22.0%), and knee/ankle/foot (17.8%). As for the natures of injuries and illnesses, sprains, strains, tears (35.7%), cuts, lacerations, punctures (18.5%), and fractures (9.4%) showed the highest ratio in the order. Amputations were quite rare at 1.4%, and thus reveals differences from Korea (BLS, 2015).

The results imply that prevention of accidents due to caught in by machine/equipment, which is conventional accident, is important in the motor vehicle parts manufacturing industry. Besides, fatal rate including death or disability is relatively high. The accident of caught in is linked with an accident causing disability to the hand due to amputation, which suggests more efforts need to be made so that safety measures faithful to basics in working methods exploiting safety devices and safety work regulations can be established.

As for the workplaces, the workplaces with less than 50 employees took up 57.8% of the injured, and many injuries occurred to middle aged and elderly workers aged 40 or older (64.0%). Therefore, injury prevention measures should be intensively provided for the workplaces with less than 50 employees and for the workers the middle aged and elderly workers. Sprain/musculoskeletal disorders caused by relatively frequent handling of heavy weights and brain cardiovascular disease mainly occurred from the middle aged and elderly people can be part of the characteristics of the injured. Therefore, systematic management of accident prevention for the middle aged and elderly workers will be an important issue.

The study can be used to present basic guidelines to establish systematic prevention measures on the occupational injuries of the workers in the motor vehicle parts manufacturing industry.

Acknowledgements

This research was financially supported by Hansung University.

References

BLS, Case and Demographic Characteristics for Work-related Injuries and Illnesses Involving Days Away From Work, (2015 yearly base), https://www.bls.gov/iif/ (retrieved April 20, 2017)

Byun, J.H., Jeong, B.Y. and Park, M.H., Characteristics of motorcycle crashes of food delivery workers, *Journal of the Ergonomics Society of Korea*, 36(2), 2017.

Hong, S.J., Jeon, M.J. and Kim, C.Y., The Actual State of Industrial Accidents in Small-medium Manufacturing Industries. *Korean Journal of Occupational Health Nursing*, 20(1), 93-103, 2011.

Jang, Y.S., Lee, T.Y. and Park, S.Y., Analysis of the Risk Level of Musculoskeletal Disorders for Workers at Automative Component Factory Using Work Sampling, *The Journal of Korean Society of Occupational Therapy*, 16(4), 77-88, 2008.

Jeong, B.Y. and Park, M.H., Risk assessment of parking lot management based on occupational injuries data. *Human Factors and Ergonomics in Manufacturing & Service Industries*, 2017. DOI: 10.1002/hfm.20698

Kim, C.H., Lee, M.H. and Moon, M.K., Analysis of Musculoskeletal Disorders for Various occupations and industries, *Proceedings of the Ergonomics Society of Korea*, Fall, 20-27, 2009.

Kim, D. and Kim, Y., A study of the job stress in auto part manufacturing company, *Journal of the Korean Society of Safety*, 29(1), 168-171, 2014.

Kim, J.N., Jeong, B.Y. and Park, M.H., Characteristics of motorcycle collisions by work experience of delivery postmen. *Journal of the Ergonomics Society of Korea*, 35(5), 465-472, 2016.

Kim, J.Y., A Study on the International Competitiveness of Korean Auto Parts Industry-Focus on the Exporting Concentration and Competitiveness in US Market. *International Commerce and Information Review*, 7(4), 351-365, 2005.

Kim, Y.R., Park, M.H. and Jeong, B.Y., Hazardous factors and accident severity of cabling work in telecommunications industry. *Journal of the Ergonomics Society of Korea*, 35(3), 155-163, 2016.

KOSIS, Summary of Occupational Accidents by Industry (Divisions), (2015 yearly base), http://kosis.kr/eng (retrieved April 20, 2017)

Lee, K.T., The characteristics of industrial accidents in shipbuilding industry. *Journal of the Ergonomics Society of Korea*, 31(1), 137-142, 2012.

Mok, Y.S., Lee, D.W. and Chang, S.R., A Study on the Work Ability and the Job Stress of the Workers in Manufacturing Industry of Automobile Parts. *Journal of the Korean Society of Safety*, 28(3), 100-106, 2013.

Park, M.H., Jeong, B.Y. and Kim, S.H., Occupational accidents and injuries for moving helpers. *Journal of the Ergonomics Society of Korea*, 34(4), 353-362, 2015.

Park, M.H. and Jeong, B.Y., Occupational injuries and sick leaves in household moving works. *International Journal of Occupational*

Safety and Ergonomics, 1-7, 2016. http://dx.doi.org/10.1080/10803548.2016.1198081

Yang, S.H. and Cho, M.S., Case study of diagnosis on musculoskeletal disorders risk factors at an autopart company. *Journal of the Korea Safety Management and Science*, 9(2), 33-48, 2007.

Author listings

Seung Tae Yang: youngsw94@kiha21.or.kr
Highest degree: PhD Candidate, Hansung University
Position title: Korean Industrial Health Association
Areas of interest: Ergonomics, Safety and Health Management

Byung Yong Jeong: byjeong@hansung.ac.kr
Highest degree: PhD, Department of Industrial Engineering, KAIST
Position title: Professor, Department of Industrial and Management Engineering, Hansung University
Areas of interest: Ergonomics, Safety and Health Management

Myoung Hwan Park: mhpark@hansung.ac.kr
Highest degree: PhD, Department of Industrial Engineering, KAIST
Position title: Professor, Department of Industrial and Management Engineering, Hansung University
Areas of interest: Management Science, Innovation Engineering