

ROLE OF WARNING SIGNS IN ACCIDENTS SEVERITY AND ACCIDENTS FREQUENCY AND THE RATE OF USING PERSONAL PROTECTIVE EQUIPMENT IN AN AUTO-PART MANUFACTURING COMPANY

Reza Khoshkdaman¹, Gholamhosein Halvati², Yaser Torabi³

- 1. MSc in Professional Health Engineering, Sabzewar University of Medical Sciences**
- 2. Assistant Professor of Professional Health Engineering, Shahid Saduqi University of Medical Sciences, Yazd**
- 3. Lecturer, Statistics, Sabzewar University of Medical Sciences**

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ABSTRACT

Accidents and damages have always been an important challenge of factories and work places. The aim of this study is to evaluate the role of warning signs on accidents severity and accident frequency as well as the rate of using personal protective equipment (PPE) in an auto-part manufacturing company.

Method

This is a cross sectional-intervention study evaluating occupational accidents from one year before interventions to one year after interventions in an auto-part manufacturing company with 296 labors located in Sabzvar. This study uses Pearson correlation test, linear regression and square t-test.

Results

Accident frequency and accident severity rates were 50.34 and 143.05, respectively prior to interventions. They reduced to 19.4 and 79.59 within 6 months after interventions. In addition, frequency-severity indicator showed a significant decrease from 2.68 to 1.23 while the rate of educated workers' use of PEEs showed a significant increase (p-value=0.0000).

Conclusion

Warning signs can reduce accidents in terms of frequency and severity. It should be noted that this effectiveness may change over time and decrease.

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Introduction

According to available statistics, occupational accidents are currently the third cause of fatality in Iran proceeded by car accidents [1]. Occupational accidents and damages have always been an important challenge of factories and work places. Working condition is an important debate of the safety literature. Different researches and evidences suggest the relationship of working conditions and transparency shortage with unsafe behaviors and occupational accidents. Therefore, the quality of working relationships and conditions affect the incidence of unsafe behaviors [2]. Today, auto-making industry is the focus of area in Iran from occupational accidents point of view. Considering the principle of productivity, the promotion workers' physical and mental health in work places and the direct effect of stress on workers' efficiency, the identification of risky areas on the one hand and the individuals' awareness of current conditions on the other hand can serve as an important and essential intervention. This results in workers' promotion, productivity enhancement, and more importantly, the reduction of unsafe activities, and finally, the prevention of accidents in Iranian industries, especially the studied industry [3].

The surprising result of studies is that there is an inverse relationship between the rate of unsafe activities, the incidence of accidents and workers' education level in the meaning that the higher the education is the lower is unsafe activities. The

reason may be traced in the effect of education on individuals' attitude towards safety so that high educated people are more aware of safety issues, capture safety-oriented educations more effectively and perceive and execute safety instructions in their positions more desirably [4]. The use of warning signs is actually notifying workers' of dangers with the expectation that they will avoid the commitment of unsafe behaviors. The results of different studies emphasize the importance and role of warning signs in the promotion of safety. Some researchers believe that this can be an effective approach to controlling occupational accidents [5]. The latest approach, i.e. the use of PPEs is a way for achieving the above target. It should be noted, however, that although the equipment are not necessarily in accordance with relevant standards, they are being generally used by workers in work places. The use of such equipment in work places has reduced the commitment of workers to the use of such equipment. The low-quality of some PPEs which are provided by employers to workers, getting annoyed with PPEs, the lack of accurate and suitable training, or stereotypic trainings, about the use of the equipment and paying no attention to effective incentives regarding the use of the equipment have caused workers not to welcome the equipment [6].

Occupational accidents are considered a national loss and safety specialists believe that more than 80% of occupational accidents and diseases can be protected by simple ways and low costs. The study of Mohammadi et al emphasized that the use of PPEs, training and safety interventions along with the accurate supervision of work place and observing safety rules are effective in avoiding occupational accidents [7]. The aim of this study is to evaluate the effect of warning signs on the reduction of the frequency and severity of occupational accidents as well as on workers' use of PPEs. It should be mentioned, however, that the signs are based on items that are produced in Iran. Therefore, they sometimes may not be in accordance with national and international standards. On the other hand, low financial facilities can be considered as a limitation of this study.

Method

This is a quasi-experimental, cross-sectional-intervention study evaluating occupational accidents and the rate of workers' use of PPEs. It was conducted in an auto-part manufacturing company located in Sabzvar. Necessary data was collected from HSE log in book as well as pre-intervention field observation. The interventions, i.e. the use of safety warning equipment, which were trained to workers as individually and group trainings, were conducted throughout the company. Following a one-year period, the frequency and severity of accidents as well as the rate of PPE use were calculated using the following relations. Data was analyzed in Excel.

$$AFR = \frac{\text{number of booked accidents} \times 200000}{\text{number of workers} \times 40 \times 50}$$

$$1- ASR = \frac{\text{number of lost working days within one year} \times 200000}{\text{number of workers} \times 40 \times 50}$$

Frequency severity indicator (FSI) provides a more valid criterion for evaluation purposes. Therefore, the values obtained before and after interventions were assessed using this indicator as follows:

$$2- FSI = \sqrt{\frac{AFR \times ASR}{1000}}$$

This study uses Pearson correlation factor, linear regression and square t-test.

Results

This study was conducted on occupational accidents from one year before interventions to one year after interventions. The mean age of studied cases is 27.3±4.4 and 57.3% of cases aged 25 to 30. The mean job background of cases was 5.1±3.3 and 27.2% of cases had a job background of <5 years. This means that the majority of cases were skilled, not armature, workers. Considering safety indices, the following results were obtained:

- 1- Accident frequency rate one year before intervention (time scope=12 months)

$$AFR = \frac{74 \times 200000}{147 \times 40 \times 50} = \frac{14800000}{294000} = 50/34$$

- 2- Accident frequency rate after interventions (installing warning signs and face-to-face training of workers):

$$AFR = \frac{28 \times 200000}{147 \times 40 \times 50} = 19/04$$

- 3- Accident severity rate one year before intervention:

$$ASR = \frac{211 \times 200000}{\text{number of employees} \times 40 \times 50} = 143/05$$

- 4- Accident severity rate in follow-up assessments (after training interventions and installing warning signs):

$$ASR = \frac{117 \times 200000}{\text{number of employees} \times 40 \times 50} = 79/59$$

Frequency-Severity Indicator (FSI):

- 1- FSI in the pre-intervention year

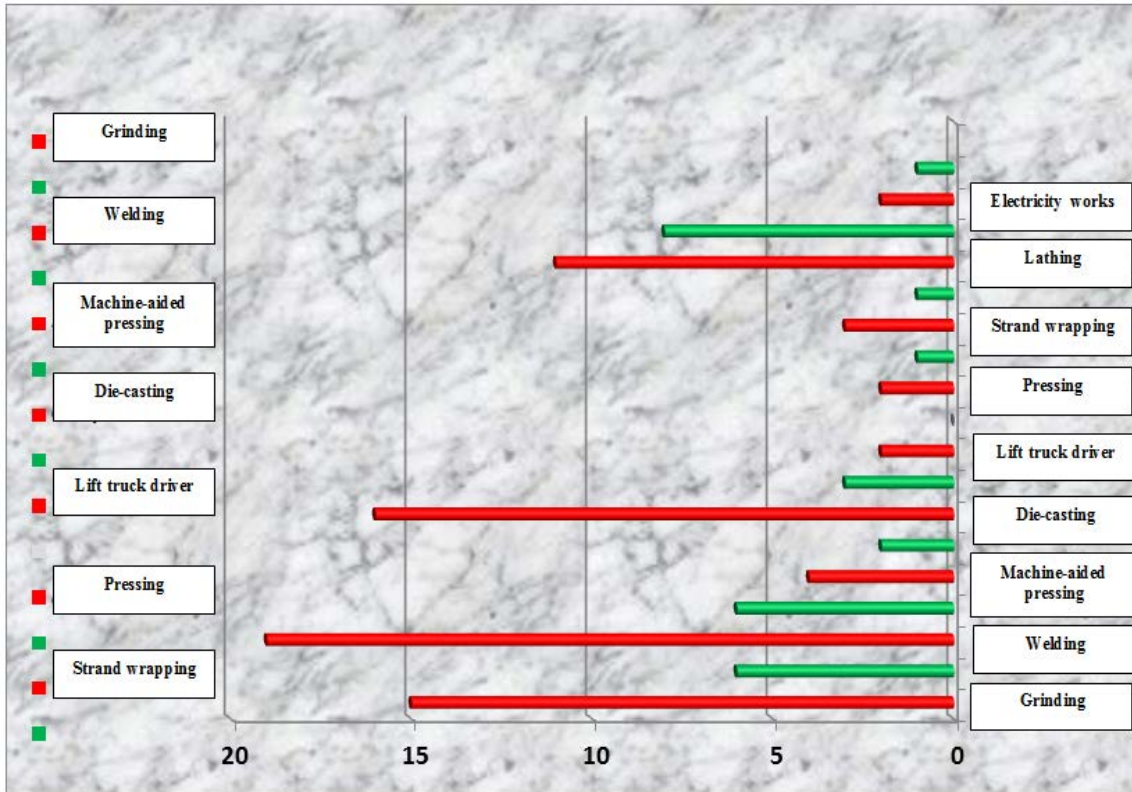
$$FSI = \sqrt{\frac{50/34 \times 143/05}{1000}} = 2/68$$

- 2- FSI after training interventions and installing warning signs in work place:

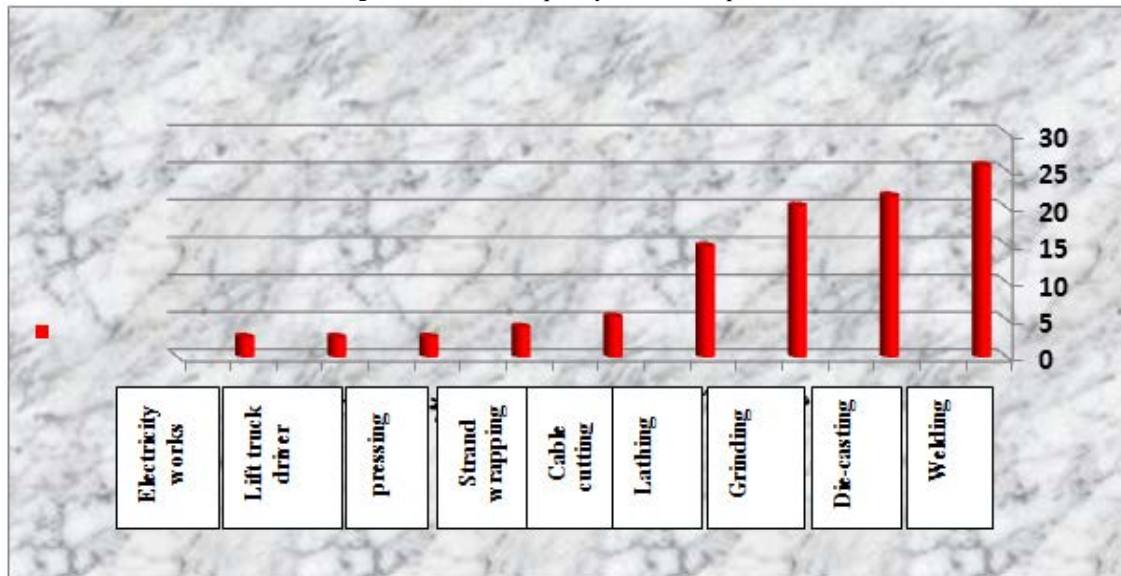
$$FSI = \sqrt{\frac{1904 \times 79/59}{1000}} = 1/23$$

From above figures, it can be concluded that the interventions and corrective actions have a significant effect on reducing risk level in the studied company.

Graph 1. comparison of accident frequency before and after intervention



Graph 2. accidents frequency in different positions



Total number of workers and education level (percent)

Total number of workers (%)	Below diploma (%)	Diploma-associate degree (%)	B.S. (%)	Over B.S. (%)
253	12	74	11	3

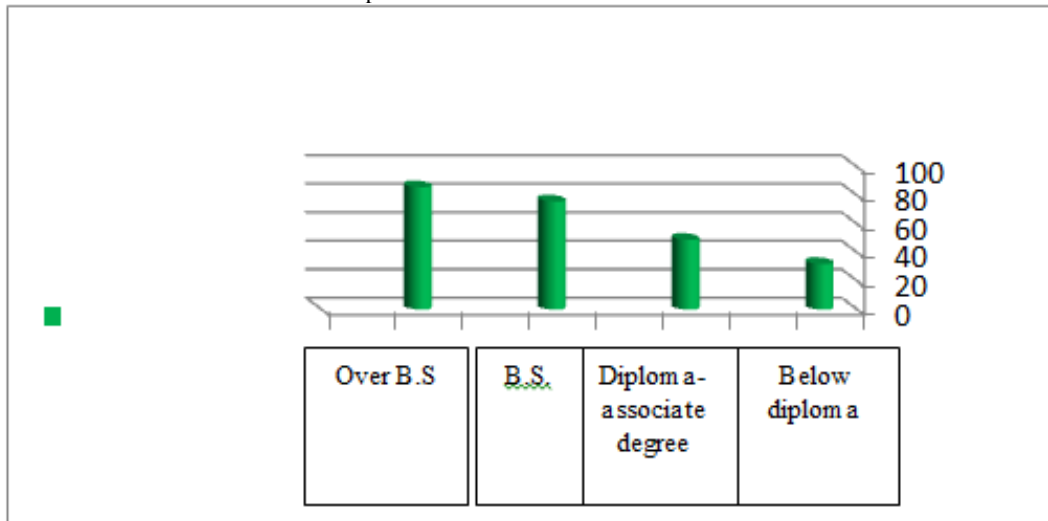
Workers who used to use PPE before intervention

Below diploma (%)	Diploma-associate degree (%)	B.S. (%)	Over B.S. (%)
15	23	18	28

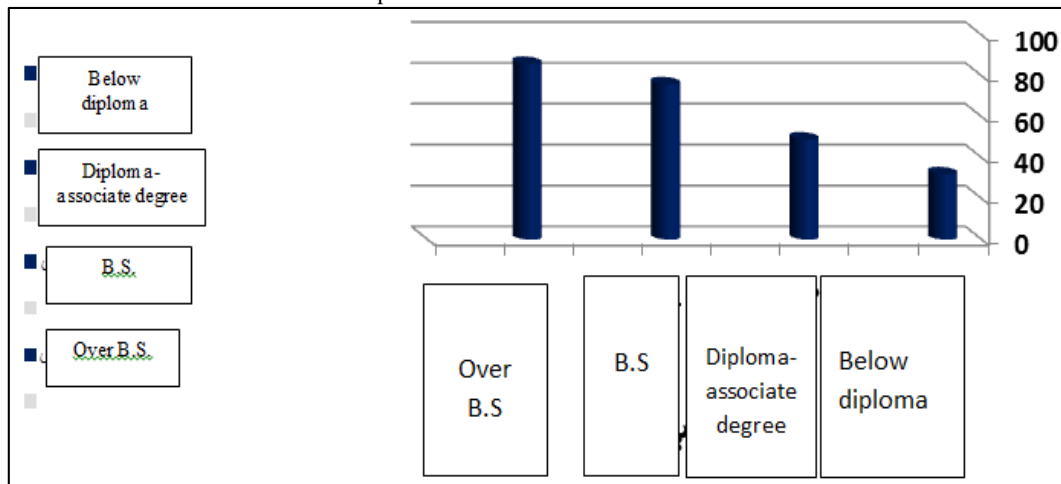
Workers who use PPE after intervention

Below diploma (%)	Diploma-associate degree (%)	B.S. (%)	Over B.S. (%)
32	49	76	82

Graph for PPE use rate before intervention



Graph for PPE use rate after intervention



Discussion

The aim of this study was to evaluate the role of warning signs in ASR and AFR as well as in PPE use rate in an auto-part manufacturing company. According to Heinrichs' theory, unsafe behaviors, unsafe conditions and unpredicted factors account for 88%, 10% and 2% of accidents, respectively. Naturally, unsafe activities can be reduced and accidents can be minimized by adopting suitable interventions. Unsafe activities were introduced as the main cause of accidents in the second half of 20th century. Therefore, developed countries focused on controlling unsafe behaviors in order to control accidents so that such change to attitude resulted in the emergence of behavior-based safety science. The results of this study agrees with this idea because interventions could affect unsafe activities and significantly reduced accidents severity and frequency (p-value=0.0000). During the process of finding the cause of accidents, it was revealed that no use, or inappropriate use, of PPE

is the most important cause of accidents so that it account for 43.7% of accidents. This finding agrees with the results of a study conducted on the workers of a casting company in Hamedan. Another study on an auto-making company revealed that unsafe behaviors and accidents are associated with PPE use [8]. Considering the data of this study, it was revealed that there is a significant relationship between PPE use percent and workers' education (p-value=0.0000). This agrees with the results of a study in Sabzvar conducted on carpenters where it was revealed that education is an important factor in workers' acceptance of orders and PPE use [9]. Workers' unawareness, or insufficient awareness, of accidents is the predominant cause of accidents because in the majority of cases, the workers are not aware of unsafe conditions in their work place. On the other hand, the lack of supervisory activities or the lack of necessary warnings can affect the incidence of accidents. Therefore, the existence of warning signs can serve as a strong and effective factor in reducing accidents. This was clearly confirmed by the results of this study. This agrees with the results of Nasiri and Khoshakhlagh who introduced education and providing safe working instructions as an important approach to controlling and reducing threats and increasing safety knowledge [10]. The results of square t-test showed that awareness and notices could have a positive influence so that differences were significant before and after interventions. Relying on these results it can be concluded that adopting safe interventions and education can be a beneficial approach to controlling accidents and it changes individuals' attitude over time. On the other hand, if high-educated workers are selected for performing dedicated tasks and they are provided with necessary at-start trainings, a safe and accident-free work place will be created. Another surprising point is that the perception of workers' of the existence of unsafe condition and activities differs in different working positions. This causes workers to use PPEs heartily and to avoid risky activities. Some researchers believe that incentive-punishment system can affect the effectiveness or continuity of warning signs and enhance their efficiency. It can be expressed that the main aim of warning signs is to notify workers of work place risks and to provide them with safe approaches. Such conditions and risks can be identified and avoided by installing boards and stickers and similar ways. This finding agrees with the studies of Salvandi and Letoniner who believe that warning signs are effective in controlling and avoiding accidents [11]. Finally, such interventions cause managers and supervisors to take necessary actions on the one hand and to consider the elimination of unsafe conditions and providing necessary educations as an integrated part of their management system on the other hand, in order to promote workers' awareness and to reduce accidents and, in turn, consequent costs.

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