The effect of intervention based on Health Action Model to promote workers’ safe behavior in Isfahan Steel Company

Maryam Amidi Mazaheri, Alireza Heidarnia

Department of Health Services, School of Health, Isfahan University of Medical Sciences, Isfahan, 1Department of Health Education, School of Medicine, Tarbiat Modares University, Tehran, Iran

ABSTRACT

Background: The worldwide concern for safety has created the need for new and effective methods to improve safety in the workplace. This study was designed to determine the effect of educational intervention based on Health Action Model on the safe behavior among workers in Isfahan Steel Company. Materials and Methods: This study was designed as a quasi-experimental research with experimental and control groups with pre- and post-intervention measurements. The experimental group received intervention based on the Health Action Model. The control group did not receive any intervention except that they participated in the current safety courses of the company. The sample size was 270 workers who were randomly selected and divided into two groups: Experimental (n = 135) and control (n = 135). Data were collected using a questionnaire and a checklist after and before the intervention and were analyzed. Based on the distribution of variables, parametric (t-test, paired t-test) or nonparametric (Chi-square, Wilcoxon) tests were utilized to analyze data. P value less than 0.05 was considered significant. Results: The results indicated that before intervention, the experimental and control groups were similar in model structures. After intervention, the mean scores of knowledge, attitude, and behaviors in relation to safety in the experimental group increased statistically significantly and the observed difference in the control group was not significant. The results also indicated that unsafe behaviors in the experimental group decreased following the educational intervention. This difference also was not statistically significant in the control group. Conclusion: The results showed that application of Health Action Model has an acceptable and positive influence on promoting safe behaviors, knowledge, normative system, and facilitating factors among workers in Isfahan Steel Company. It is, therefore, recommended that Health Action Model based intervention be used for other and similar industries.

Key words: Health Action Model, intervention study, roll mill, safe behavior, steel making

INTRODUCTION

Most of the individuals spend more than one-third of their adulthood life in the workplace and encounter various occupational hazards. Among the work-related hazards (occupational disease, fatigue, accidents), work injury, compared to others, is the most important. Occupational injuries are measured as a public health difficulty, which are estimated to kill more than 300,000 workers worldwide every year and cause many more cases of disability. In Iran, due to lack of accurate recording of events, the exact statistics of incidents and events is not available. However,
studies on work-related accidents in Iran indicate that there are enormous human and financial loss.[1]

Also, studies have shown that metal industry is a group of businesses that account for the highest cost compensation due to occupational injuries.[3]

The steel industry has historically been and continues to be a dangerous industry. Workers employed in basic steel facilities are at greater risk for non-fatal injuries and illnesses than the workers in other industries.[4]

Operations in the iron and steel industry may expose workers to a wide range of hazards or workplace activities or conditions that could cause incidents such as injury, death, ill health, or diseases.[5]

Since workers’ behavior and work activities are related to accidents in a number of cases, providing educational intervention about workplace hazards and how to control them is essential to promote safe behaviors among workers.[6]

In recent years, efforts have been made to create awareness among workers about occupational hazards and to encourage them to adopt safer and healthier behavior. Nevertheless, only a limited number of these interventions have proven to be successful. A probable reason for this relative lack of success is that interventions, in general, focus on risk analysis and increasing the awareness, whereas the literature on preventive health behavior change indicates that knowledge and awareness with regard to health risks are neither necessary nor sufficient to change behavior. To increase the efficiency of prevention programs and safety interventions, other related determinants of behavior need to be addressed.[7] These determinants play a key role in the psychological theories and models of health-related behavior.[8] These theories and models are useful in various phases of planning, implementation, and evaluation of an intervention.[9]

The Health Action Model (HAM), developed by Tones (1990), is one of the health education and promotion models that provides a comprehensive framework of the key variables influencing the selection of healthy and safe behaviors and probably gives the most thorough description of factors that may influence behavior change following training. HAM has two main parts: The first section deals with behavioral intention which is composed of three dimensions (belief, motivation, and normative) and the second section deals with the factors that determine whether an individual’s intention leads to action. This model could explicate the relationship between influencing factors related to the process of decision making about safe or unsafe behavior.[10]

In other words, the HAM identifies key psychological, social, and environmental factors which influence an individual adopting and sustaining safe or unsafe related behavior. Rennie (1995) adjusted the definitions of its five constructs or systems, all of which influence behavior, as follows:

- **Knowledge system**: Baseline safety knowledge;
- **Normative system**: Worksite norms and rules;
- **Motivational system**: Motivational elements in the workplace;
- **Belief system**: Values and beliefs of the target audience; and
- **Worksite environmental system**: Worksite physical conditions.[11]

Isfahan Steel Company, the oldest iron and steel maker of Iran, was commissioned in the year 1967. It is located at 45 km in the southwest of Isfahan city and is one of the three main sources of iron and steel in Iran. Due to the nature of work, the main complexities of this company are work-related accidents.

This study was designed to determine the effect of educational intervention based on HAM on the safe behavior among workers in Isfahan Steel Company.

**MATERIALS AND METHODS**

This study was designed as a quasi-experimental research with experimental and control groups with pre- and post-intervention measurements. Previous studies have shown that steel making and roll mill are the most eventful parts of the company. Events such as fractures, bruising, and amputated limbs occur in these two sectors frequently.[11] Consequently, the study involved these workshops from the company. The selected workshops (steel making and roll mill) were the same in size and working conditions. From each workshop, 135 individuals were randomly selected as samples using random number table. The steel making workshop was randomly assigned as the experimental group and the roll mill workshop as the control group.

Data were collected by a self-reported questionnaire and direct observation of behavior before and 3 months after intervention.

Survey questionnaire was designed based on the HAM and included questions about demographic variables and structures of the model. In order to check the validity of the questionnaire, face validity and content validity were used and comments of a panel of experts (10 health education and health and safety occupation experts) were used to modify the questionnaire. The reliability of questionnaire was examined using Cronbach’s alpha, with a value of 0.6 or higher considered acceptable.

Cronbach’s alpha of 0.63 was obtained for belief system, 0.74 for motivational system, 0.72 for normative system, 0.63 for facilitating factors to convert behavioral intention into behavior, and 0.83 for behavioral intention.

Checklist of behavior observation consisted of two parts, the use of personal protective equipment and safe behaviors.
To observe behavior, in each workshop, two safety authorities who were willing to cooperate were selected. These individuals were informed about the research objectives. They were taught behavior observation techniques and were asked to observe selected workers for 10–15 min and record the use of personal protective equipment and safe behaviors in the checklist.

Considering the results of pre-test, the intervention was designed and implemented on the experimental group. Control groups only received usual education of company. Three months after intervention, data were collected and analyzed by parametric (t-test, paired t-test) or nonparametric (Chi-square, Wilcoxon) tests. P value of 0.05 or higher was considered acceptable.

**Educational intervention**

Based on HAM, the educational intervention consisted of two main parts: The first section was related to workers’ educational sessions and the second section was concerned with the strategies to change normative systems and the facilitating factors for conversion of behavioral intention into behaviors.

**Educational sessions**

To educate workers, focus group discussion and adult education principles were used. Adult education is the process in which adults engage in organized and continued learning activities in order to gain new forms of knowledge, skills, attitudes, or values. In this process, learning should be directed to group situation instead of individual case, and active participation is important, especially to adult learners.

Experimental group was divided into 9 subgroups. Each subgroup had 13 participants. Each subgroup participated in three focused group discussion sessions (90 min). In the first session, based on adult education theory, they were asked to discuss about the accidents caused and the human errors involved in safety incidents, problems and hazards, and personal protective equipment needed for their jobs. In the second session, they were asked to discuss about safe and unsafe behaviors. In addition, each worker was given a copy of the results of the last risk assessment in their workshop and was requested to think about appropriate control measures to address the hazards until the next meeting. In the third session, the solutions discussed in the previous session were reviewed. The workers were asked to discuss about barriers to safe behaviors and facilitating factors, and finally workers pledged to follow the safety regulations.

**Strategies to change normative systems and facilitating factors**

In the intervention group only, the workers’ supervisor received special training on proper communication and interaction with the workers and their role in promoting workplace safety indicators and indexes was emphasized. Also, in order to improve interaction between worker and safety inspector, safety inspectors were requested to be present at group discussion sessions. High-quality personal protective equipment was provided. No specified local time inspections were performed beforehand. Workers in intervention group were encouraged to report incidents and near miss and were provided suggestions to improve safety. In order to obey ethical considerations, after the final stage of data collection, the intervention was implemented for the control group.

**RESULTS**

The average age of workers in the intervention and control groups was 33.32 and 34.85 years, respectively. The average work experience in the intervention and control groups was 7.85 and 8.95 years, respectively. Most people in both groups were married.

On comparing the two groups with Chi-square test, it was found that demographic variables such as employment and marital status, the level of education, and work accident history were not significantly different between the two groups ($P \geq 0.05$).

On comparing the two groups with independent t-test, it was observed that the average values of age and work experience were not significantly different between the two groups ($P \geq 0.05$).

Also, on comparing the two groups, independent t-test showed that knowledge score, normative system score, motivational system score, belief system score, and facilitating factors for conversion of the behavioral intention into behaviors were not significantly different between the two groups ($P \geq 0.05$). Therefore, the two groups matched pre-test.

Comparing the mean scores before and after intervention revealed that in the intervention group, all scores, but beliefs and attitudes system scores, were significantly increased, whereas changes in the control group were not significant ($P \geq 0.05$) [Table 1].

Comparing the mean scores before and 3 months after intervention revealed that all structures of HAM, but the belief and motivational system, were significantly different in experimental and control groups. Comparison of the observed behavior of workers in experimental and control groups is presented in Table 2.

**DISCUSSION**

The present study was based on HAM in which knowledge, beliefs, motivational and the normative systems, and safety behavior intention were examined before the intervention, and it became clear that workers had a desirable condition of safety behavior intention, but the scores of knowledge and their observed behavior were not desirable as expected. Therefore, the intervention focused on promoting awareness of occupational hazards and other facilitator factors to convert intention into behavior.
After the intervention, knowledge and behavioral intention scores of the experimental group workers, compared to pre-intervention and control group, were increased significantly. The positive impact of the intervention on knowledge was consistent with the finding of Sanaei Nasab et al.\[12\]. The findings in the field of facilitating factors revealed that the mean scores of the experimental group were significantly increased, and the scores were significantly different from the control group as well.

Supervisor support is considered as one of the important facilitators of safe behavior. Previous studies have demonstrated that supervisor safety support plays a critical role in predicting injury incidence.\[13\]

Madadzadeh’s study in Esfahan Steel Company revealed that supervisors and safety experts were the influencing factors on safe behaviors of workers.\[14\]

In this study, in order to change the normative systems in the experimental group, attempt was made to attract support from supervisors and shift managers. Also, the supervisor received special training on proper communication and interaction with the workers and their role in promoting workplace safety indicators and indexes was emphasized. Results showed that workers in the experimental group after intervention had significantly earned higher scores in the normative system.

Table 1: The mean scores of structures of Health Action Model in the experimental and control groups before and 3 months after intervention

| Variable          | Group            | Pre-intervention | Post-intervention | P       |
|-------------------|------------------|------------------|-------------------|---------|
|                   |                  | Mean  | Standard deviation | Mean   | Standard deviation |     |
| Knowledge         | Experimental     | 8.86  | 3.5               | 11     | 3.5               | ≤0.001 |
|                   | Control          | 8.13  | 2.6               | 8.37   | 2.61              | ≥0.05  |
| Belief system     | Experimental     | 30.4  | 2.9               | 30.5   | 2.61              | ≥0.05  |
|                   | Control          | 30.03 | 2.6               | 30.13  | 2.64              | ≥0.05  |
| Motivation system | Experimental     | 31.02 | 3.5               | 31.9   | 3.3               | ≥0.05  |
|                   | Control          | 31.77 | 3.52              | 31.49  | 4.1               | ≥0.05  |
| Normative system  | Experimental     | 31.76 | 5.4               | 33.01  | 4.7               | ≤0.001 |
|                   | Control          | 30.56 | 6.1               | 30.62  | 6.1               | ≥0.05  |
| Facilitators      | Experimental     | 28.2  | 4.8               | 31.46  | 4.6               | ≤0.001 |
|                   | Control          | 27.84 | 4.7               | 27.79  | 4.7               | ≥0.05  |
| Behavioral intention | Experimental | 31.2  | 3.1               | 33.08  | 3.04              | ≤0.001 |
|                   | Control          | 31.01 | 3.2               | 31.09  | 3.1               | ≥0.05  |

Table 2: Comparison of the observed behavior of workers in experimental and control groups before and 3 months after intervention

| Stage              | Group          | Experimental | Control | Chi-square test |
|--------------------|----------------|--------------|---------|-----------------|
|                    | n   | %   | n   | %   |                  |
| Pre-intervention   |     |     |     |     |                  |
| Unsafe             | 79  | 59.5| 87  | 64.4| P≥0.05         |
| Safe               | 56  | 41.5| 48  | 35.6|              |
| Post-intervention  |     |     |     |     |                  |
| Unsafe             | 39  | 30  | 89  | 75.4| P<0.001        |
| Safe               | 91  | 70  | 29  | 24.6|              |

Wilcoxon test results

\[ Z = -1.94, P = 0.05 \]
\[ Z = -6.164, P ≤ 0.001 \]

Studies in the field of safety culture emphasize that perceptions, attitudes, and behaviors of managers and supervisors in relation to safety and health are considered as a foundation of safety in the workplace.\[15\]

For effective safety behavior programs, evaluation must be based on concrete planning. Numerous studies have concluded that observing workers during workplace operations is essential for planning and evaluating education programs.\[16\]

In this study, the status of worker safety behaviors in the two groups before the intervention showed that 59.5% of the workers in the experimental group and 64.5% of the workers in the control group had adverse behavioral conditions, which was consistent with previous studies.\[17\]

After intervention, significant difference was observed between the two groups. These findings were similar to those of other studies.\[12,14,18,19\]

In this study, no significant differences were found in the post-test scores of belief and motivational systems in the two groups. It can be said that belief and motivational system simply does not change, and to change these systems, more time and broader interventions (change in safety culture) are essential.

Despite the absence of significant changes in the belief and motivational systems, significant increase was observed in the normative system and facilitating factors, knowledge of workers, and finally, safe behavior in the experimental group.

One reason for this behavior change could be the type of intervention used in this study (group discussion and application of the principles of adult learning). The study of Cheraghi in Isfahan mining industry indicated that group discussion method, compared to other training techniques, led to behavior change.\[20\] Also, in Salminen’s study in Finland group discussion lead to significant behavior change.\[18\] Also,
in the study of Stave et al. in Sweden, group discussion and social support had led to a significant increase in the safety activities of workers.\[19\]

One of the other reasons for efficacy of this intervention was the use of HAM. Also, in Nieto-Montenegro et al.’s study, the HAM was useful to identify the different factors affecting safety behaviors.\[21\]

Considering that increasing the safety behaviors in workplace leads to decrease of work-related accidents and injuries and the efficacy of HAM to promote safe behavior among industrial workers, this model can be used in different industrial scenarios to develop educational safety interventions.

This study had several limitations. First, it is possible that workers, especially the temporary workers, responded to the questionnaires conservatively and unrealistically. In some cases, the participation in educational sessions was interfering with work pressure; however, steps were taken to minimize this. Secondly, the 3 months follow-up period was relatively short and the long-term effect of intervention should be evaluated.

Acknowledgments
This article is an extract from a health education Ph.D. dissertation in Tarbiat Modarres University. We would like to thank the employees and management at the participating workshops for their cooperation.

Financial support and sponsorship
Tarbiat Modares University.

Conflicts of interest
There are no conflict of interest.

REFERENCES

1. Mazaheri MA, Hidarnia A, Ghofranipour F. The effect of intervention on the implementation of an incident reporting system in Isfahan Steel Company. Iran Red Crescent Med J 2010;12:529.
2. Akbari M, Naghavi M, Soori H. Epidemiology of deaths from injuries in the Islamic Republic of Iran. East Mediterr Health J 2006;12:382-90.
3. Bull N, Riise T, Moen BE. Compensation for Occupational Injury and Disease in Norway: Ranking of Job Groups. J Occup Environ Med 2000:42:621-8.
4. Mazaheri MA, Darani FM, Esami AA. Effect of a brief stress management intervention on work-related stress in employees of Isfahan Steel Company, Iran. J Res Med Sci 2012;17:S87-92.
5. Bakhtiyari M, Delpishah A, Riahi SM, Latifi A, Zayeri F, Salehi M, et al. Epidemiology of occupational accidents among Iranian insured workers. Safety Sci 2012;50:1480-4.
6. Zalewski E. Reduce injuries with proper technique. Occup Health Saf 2005;74:42.
7. Coléomont A, Van den Broucke S. Measuring determinants of occupational health related behavior in flemish farmers: An application of the Theory of Planned Behavior. J Safety Res 2008;39:55-64.
8. Glanz K, Rimer BK, Viswanath K. Health behavior and health education: Theory, research, and practice. USA: John Wiley and Sons; 2008.
9. Noar SM, Zimmerman RS. Health Behavior Theory and cumulative knowledge regarding health behaviors: Are we moving in the right direction? Health Educ Res 2005;20:275-90.
10. Tones K, Tilford S. Health promotion: Effectiveness, efficiency, and equity. Cheltenham: Nelson Thornes; 2001.
11. Rennie DM. Health education models and food hygiene education. J R Soc Health 1995;115:75-9.
12. Sanaei Nasab H, Ghofranipour KA, Khavanin A, Tavakoli R. The effect of safety education on promote in petrochemical workers’ safe behavior. Eur J Sci Res 2008;23:167-76.
13. Huang YH, Chen PY, Krauss AD, Rogers DA. Quality of the execution of corporate safety policies and employee safety outcomes: Assessing the moderating role of supervisor safety support and the mediating role of employee safety control. J Bus Psychol 2004;18:483-506.
14. MadadZade N. The effect of educational intervention based on BAZNEF model on safety of Isfahan Steel coking workers. Isfahan: Isfahan University of Medical Sciences; 2006.
15. Clarke S. Perceptions of organizational safety: Implications for the development of safety culture. J Organ Behav 1999;20:185-98.
16. Clayton DA, Griffith CJ, Price P, Peters AC. Food handlers’ beliefs and self-reported practices. Int J Environ Health Res 2002;12:25-39.
17. Mohammad-Fam A, Zamanparva A. Evaluation unsafe practices among investment casting plant workers in Hamadan in 1379. Journal of Health Services, Hamadan Univ Med Sci 2003;23:51-6.
18. Salminen S. Two interventions for the prevention of work-related road accidents. Safety Sci 2008;46:545-50.
19. Stave C, Törner M, Eklöf M. An intervention method for occupational safety in farming-evaluation of the effect and process. Appl Ergon 2007;38:357-68.
20. Cheraghi J, Rezaaali M, Amirkhini R. Effects of two methods for health and safety training on the promotion of knowledge and attitude of workers. J Yazd Univ Med Sci 2003;2:44-5.
21. Nieto-Montenegro S, Brown JL, LaBorde LF. Using the health action model to plan food safety educational materials for Hispanic workers in the mushroom industry. Food Control 2006;17:757-67.