Archives of Occupational Health | Volume 3 | Issue 4 | October 2019 | 443-51.

Original

The Effect of Behavior–based Safety Interventions on the Reduction of Unsafe Behavior

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Abstract

Background: Behavioral-based safety interventions such as the safety training system and reward and punishment procedures were used in most industries in order to reduce unsafe behaviors. **Methods:** In this applied study, unsafe behavior was evaluated by collecting data through observation, interviews, checklists and the Safety Behavior Sampling technique. After conducting safety training, as well as reward and punishment procedures for two consecutive months, unsafe behaviors were evaluated again. To determine the rate and diversity of the behaviors through a pilot study, a sample size of 1162 was determined to be observed. Moreover, to analyze the data and to specify the relationship between the variables, the ratio test, contingency tables, chi-square test and SPSS 22 statistical software package were used. **Results:** The results of the study showed that 22.8% of employees' behaviors were unsafe before applying interventions, which got decreased to 17% after the intervention. There was also a significant relationship between the unsafe behaviors of the employees and their work experience (*P*-value was 0. 004), age (*P*-value was 0.023), work shift (*P*-value was 0.027), day of the week (*P*-value was 0. 007) and month of year (*P*-value was 0. 043). **Conclusions:** The paper indicated that continuous implementation of safety training courses and continuous implementation of the reward and punishment system are necessary in order to reduce unsafe behaviors.

Keywords: Safety; Unsafe behavior; Food industry

Introduction

The evolution of the global market has led to economic growth via industrialization which not only impacts the profitability of companies and workers' quality of life significantly, but also results in an increasing number of accidents at the workplace.[1] By definition, Economic Growth is "the increase in the inflation-adjusted market value of the goods and services produced by an economy over time", "The percent rate of increase in real gross domestic product" has been used to measure Economic Growth.[2]An occupational accident will temporarily or permanently disrupts the predetermined safety programs in the working environment in which it occurs.[3] As statistics of

Citation: Jadidi E, Borgheipour H, Mohammadfam I. **The Effect of Behavior–based Safety Interventions on the Reduction of Unsafe Behavior.** Archives of Occupational Health. 2019; 3(4): 443-51.
Article History: Received: 14 December 2019; Rivised: 18 January 2019; Accepted: 23 February 2019
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[DOI: 10.18502/aoh.v3i4.1555]

International Labor Organization indicates, millions of people die because of work-related accidents and diseases every day. That means more than 2.78 million people die each year. Moreover, there are about 374 million non-fatal work-related injuries and illnesses each year, most of them are resulting in extended absences from work. Poor occupational safety and health practices impose 3.94 percent of global Gross Domestic Product burden on the economic annually.[4]

Moreover, according to the latest statistics released by the European Statistics Institute in 2014, nearly 3.2 million non-fatal occupational accidents occur resulting in at least four days of absenteeism.[5] Considering the consequences of these kinds of events, humans have always sought solutions to control and reduce them, so safety in work has been the subject of many researches, studies and daily discussions.[6] Then, most of the industries try to increase the safety at workplaces by identifying, evaluating, and managing different risks and reducing accidents.[7] all accidents can be avoided by knowing the root of them on which the researchers are working.[8] It was claimed that unsafe behaviors have caused over 88% of preventable accidents.[9] Several harsh accidents have been happened with great loss of lives of workers and workplaces during the industrial history.[7] Toppazzini and Wiener were among those who believe that the majority of safety incidents are behavioral.[10] Human factors are very important in safety management and recently industry has reached to this point and is aware of it. By investigating accidents, many of the systemic causal factors are human by root, including inadequate training, bad designing or poor safety culture.[11] Nevertheless, these are workers who are finally blamed for what has happened because of forgetfulness, inattention, incompetence and lazy attitude. Accident prevention strategies that follow this opinion believe that unsafe behaviors should be removed.[12] However, this viewpoint has been criticized for over-simplifying accident connection processes and for leading to blame the culture.[13] To improve their safety management systems, organizations consider many variables that contribute to the safety behavior of the individuals within the group.[10]

Hence, unsafe behaviors should be mainly effective in reducing accidents and improving safety performance.[14, 15]Behavior is simply defined as anything that someone does or says, but psychology defines it as an action or reaction of a person or thing in response to an external or internal inducements.[16] Behavioral approach focuses on how people behave on the job.[16] McSween believes that if we change safety habits of people, their attitudes about safety will change, too, especially as their colleagues adopt better safety habits.[17] Organizations and companies aim to reduce injuries due to the costs related to workplace injuries and the time required for accident investigation.[18, 6] Although the effect of behavioral safety interventions has been addressed in most studies, the impact of safety interventions with the emphasis on reward and punishment and training together has not been studied in any of those studies. Safety training has been one of the vital methods for improving safety.[19] Those who know what to do will guide themselves toward a safe manner.[16] Training helps workers to understand how they can be safe and well. One of the means that can encourage good health and safety of employees and workers at workplaces can be providing incentives and rewards for them. In the food industry, the incidence of work-related accidents can be a threat to workers' health in addition to affecting the quality of products depending on the nature of work, the type of equipment used and the high sensitivity of raw materials.

Some unsafe behaviors in this industry include: sleeping while being on duty that leads to failing to perform properly or neglecting the duty, improper layout and storage arrangements resulting in falls and damages, smoking in non-smoking areas, not turning power OFF and disconnecting the power cord before

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cleaning and maintenance of the instruments, removing or crushing machine guards, riding on the forklift forks and disabling micro switch hence endangering the individuals' health. That is why; it is a necessity to improve workplace safety in this type of industry. The company assessed in this study, as one of the food processing poles, is no exception, and preventing accidents has always been a concern for its employees and employers.[20] Therefore, according to the studies and analyses carried out to determine the causes of accidents, it is quite clear that the most important cause of incidents in the food industry is unsafe behaviors due to various factors such as lack of belief in profitability of observing and applying the principles of safety in the work environment, lack of knowledge about the methods of controlling the risks, the existence of wrong habits in working, severe shortage in monitoring systems. All of these factors made the work environment unsafe in this organization. Thus, the safety of the work environment and the reduction of unsafe behaviors seem necessary, especially in the intended organization.

To achieve this goal, through examining the most important safety interventions simultaneously, this research seeks to raise the level of safety behavior of the staff and reduce the unsafe behaviors and the continuous improvement in safety performance, as well as investigating the relationship between the mentioned interventions with decreasing unsafe behaviors, assessing the rate of unsafe behaviors before and after applying these interventions, and examining the relationship between demographic characteristics of employees and reducing unsafe behaviors in this organization. It is worth noting that in this study, the emphasis was on the effect of demographic factors on the behavior and it was evaluated before and after conducting the interventions. The most popular way of managing safety for people is known as the behavior-based safety approach. Originally, the named approach is developed in the US, and it looks for what motivates and reinforces people's behavior.[6] Briefly speaking, BBS effects are visible by measuring safety climate or awareness before and after its implementation for understanding change in safety performance.[21]

Therefore, the present study aims at applying behavior–based safety interventions to reduction of unsafe behaviors, which is predicted to result in a decreased rate of work-related accidents and an increased level of safety among industry employees. Regarding the importance of reducing work-related accidents and their relevant consequences, studies have been conducted to increase the level of safety through safety interventions and the promotion of safety behaviors. Li et al. evaluated safety interventions to make the safety climate better with training and the frequent monitoring of the use of personal protective equipment and safety plans. It is concluded that there is a significant relationship between the safety climate, safety behavior and involuntary accidents. It also strengthens the relationship between the occupational safety climate and safety behavior with occupational injuries, which resulted in identifying some effective measurements to prevent and control injuries at workplaces in China.[22] Kiani et al. started training intervention at workplace and reviewed the effectiveness of safety training on enhancing safety awareness considering the role of the staff control center as a moderator variable. He concluded that, safety training increased the consciousness of the staff compared to the control group, and when the control center, as a moderator variable, entered into this relationship, safety training was only effective on people with an internal control center.[23] Guo et al. examined a model to construct workers' safety behavior. The results of such examination showed that management safety commitment was significantly related to social support and production pressure, and both had the same effect on safety behavior. The mentioned model suggests a combination of "a safe organization", "safe groups" and "safe workers"

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strategies to reduce unsafe behavior in workplaces.[8] Toppazzini and Wiener express two leading approaches which are the person approach and the system approach that can deal with human errors. The person approach concentrates on the unsafe acts, errors and violations that are attributed to individual characteristics such as distraction, poor motivation, and carelessness. The system approach directs on individual workplace conditions, and on implementing defenses based on the understanding that error will always exist.[10]

Clancy has introduced a behavior-based safety approach used in the manufacturing industry. The results indicated that the behavior-based safety approach commenced in many Australian manufacturing organizations and had significant improvements in safety performance in the first 6 months of implementation.[11] Toppazzini and Wiener studied the importance of both organizational climate and individual characteristics on safety behavior in the work environment, and realized that safety behavior was in direct connection with safety climate, and conscientiousness. In contrast, neuroticism, and impulsiveness had no relation to safety behavior.[10] Choudhry initiated an approach based on goal setting, feedback, and an effective measure of safety behavior, which could promote safety performance suggestively in construction site environments, if properly applied by the relevant management. They also discovered that the BBS management technique is applicable in any culture as a capable approach to promote the safety of front-line workers and that it is useful for ongoing construction projects.[16]

Methods

The main method used in this study is the safety behavior sampling technique. Therefore, at the beginning and through interviewing the staff and examining the documents, the demographic characteristics of all employees of the company, including marital status, age, work experience and level of education were recorded in special forms. Some places were then assigned to conduct behavioral sampling, which included all the production halls. A list of unsafe acts, previously occurred and resulted in the incidents, were also provided through interviews and studying the rules. In the pilot study, according to the determined ratio of unsafe actions in the whole study, which was 37%, the volume of required observations with an accuracy of 0.05 and a 95% confidence level was estimated using the following formula (Equation 1) (the comparison formula based on the pilot sample) was 1162.

Eq1: $1\text{-}\ N = \frac{K^2\,(1-P)}{S^2 P}$ [24]

N: Total number of the required observations

K: The value of the confidence level obtained from the normal standardized table

S: Required accuracy

P: Percent of unsafe behaviors for performing statistical tests

After the pilot study was done, sampling of employees' behavior was randomly performed during two consecutive months and 1000 observations were recorded. Then, statistical analysis was performed using SPSS 22 software package; it was found that in most cases, the causes of incidents were the precautionary nature of the workers who did not follow the instructions from their superiors seriously and did not comply with safety regulations. Therefore, necessary safety interventions were codified and implemented in order to improve the safety behavior of the employees. After evaluating the training needs, some deficiencies in the knowledge and attitude of people toward safety could be seen. Hence, using a set of requirements, a comprehensive training program was developed and trained to all target personnel by qualified experts who are confirmed by the Ministry of Cooperatives Labor and Social Welfare. Moreover, in order to be better engaged in activities and closely monitor the implementation of the rules, the reward and punishment system was executed following the regulation. Execution of interventions lasted for two months.

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After implementation of the defined interventions, unsafe behavior sampling was repeated and the relevant data were analyzed for 2 consecutive months in order to compare the unsafe behavior rate before and after interventions to ensure the effectiveness of the interventions. It should be noted that the descriptive statistics such as frequency distribution tables were used to study and describe the general characteristics of employees in this study. Ratio tests, contingency tables, chi-square tests were used to determine the effect of safe behavior training and the system of reward and punishment. The sample size was estimated to be 291(Cochran formula) with 95% confidence and an error of 0.05. In order to increase the accuracy of the survey, 631 people were taken into consideration.

Results

In the above-mentioned factory, 40 unsafe behaviors were identified, some of which are as follows: Failure to use or improper use of personal protective equipment, telephone conversations, use of compressed air tubes, poor postures, standing under suspended loads, unauthorized speed, removal of machine shields, lifting and carrying heavy loads by hand and servicing or cleaning devices when they are on.

Sampling checklist was used to evaluate the responses. In the first phase, 22.8 % of the total behaviors recorded in the sampling checklist were unsafe while in the second phase, it decreased to 17.1 % after 2 months of implementing safety interventions. In the first step, in terms of frequency distribution, certain unsafe behaviors had the highest frequency percentage due to not using or inappropriate use of personal protective equipment (30.7% of all unsafe behaviors and 7% of all observed behaviors), carrying overloaded goods (15.35% of all unsafe behaviors and 3.5 % of the total observed behaviors) and inappropriate postures (12.72% of the total unsafe behaviors and 2.9% of the total observed behaviors), respectively. The results are shown in Table 1.

In the second step, the above-mentioned behaviors were the most frequent percentages with different percentages from the first step, respectively. The results are shown in Table 2. Moreover, in the first stage of the unsafe behavior and due to the frequency distribution, the use of inappropriate equipment (0.44% of all unsafe behaviors and 0.1% of the total observed behaviors) had the lowest frequency. In the second step, unsafe behaviors of carrying / pulling and removing unsafe loads, disabling the micro-switch, improper load layout, and running inside the hall (0.58% of the total unsafe behaviors and 0.1% of the total observed behaviors) had the lowest frequency.

General characteristics of the Staff

In terms of age distribution, approximately 44% of the employees were between 30 and 40 years old, with the highest frequency percentage, and 0.6% of employees were less than 20 years of age, with the lowest percentage of frequency. More than 45% of the staffs were single and 54.8% were married. 58% of employees had a working experience of 1 to 5 years that had the highest frequency and 0.6% had the work experience of more than 20 years which had the lowest percentage of frequency. Regarding the level of education, 51.2% of the staff did not have a high school diploma which had the highest frequency in the sampling volume, and 3.9% had a bachelor's degree or higher having the lowest frequency.63.9 % of employees were in the morning shift and 36.1 % were in the night shift. The results are shown in Table 3.

Table 1. Highest frequency percentage of unsafe behaviors in the first step

Unsafe Behavior	Percentage	
	All unsafe behaviors	Total observed behaviors
non-use or inappropriate use of personal protective equipment	30.70%	7.00%
carrying overloaded goods	15.35%	3.50%
inappropriate postures	12.72%	2.90%

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Table 2. Highest frequency percentage of unsafe behaviors in the second step

Unsafe Behavior	percentage	
	All unsafe behaviors	Total observed behaviors
non-use or inappropriate use of personal protective equipment	32.75%	5.60%
carrying overloaded goods	23.39%	4.00%
inappropriate postures	9.36%	1.60%

Table 3. Highest and lowest frequency percentage of general characteristics of the staff

general characteristics		Frequency	Percentage
Age	30-40 years	438	43.8
	Less than 20 years	6	0.6
Marital status	Single	452	45.2
	Married	548	54.8
Education	Under diploma	512	51.2
	Bachelor and higher	39	3.9
Working experience	1-5 years	580	58
	More than 20 years	6	0.6
Working shift	Morning	639	63.9
	Night	361	36.1

Table 4. Relationship between unsafe behaviors and demographic characteristics

	P-value	
	Before Intervention	After Intervention
marital status	0.829	0.507
Age	0.023	0.838
work experience	0.004	0.999
educational level	0.368	0.186
days of the week	0.007	0.498
months of the year	0.043	0.561
Shift	0.027	0.079

P-value < 0.05

Data analysis

To investigate the relationship between the distributions of qualitative variables, two-variable Chi-square test was used. According to the results, there was a significant relationship between the reduction of unsafe behaviors and applying safety interventions through the reward and punishment system and the staff training system). Since the amount of test statistic was 3,195,333 and *P*-value was 0.0007 (*P*-value< 0.001), at a significance level of 0.05, it was observed that the proportion of unsafe behaviors was reduced after applying the intervention.

The analysis of statistical tests also shows the following results:

There was no significant relationship between marital status and unsafe behaviors before applying interventions. There was a significant relationship between age and unsafe behaviors before applying interventions (*P*-value was 0.023). The most unsafe actions were observed in people aged 30 to 40 years old (43.8%). The *P*-value of all of the data is depicted in Table 4.

There was a significant relationship between work experience and unsafe behaviors before applying the interventions (*P*-value was 0.004) and the highest percentage of unsafe actions were observed in people who had a work experience of less than 5 years (58%). There was no significant relationship between education and unsafe behaviors before applying interventions. There was a significant relationship between the day of week and unsafe behaviors before applying interventions (*P*-value was 0.007), so that the most unsafe actions occurred on Sunday (16.9%). There was also a significant relationship between the months of the year and unsafe behaviors before applying interventions (*P*-value was 0. 043). In case of job shifts, the number of unsafe behaviors occurred in day shifts were less than that of night shifts (36.1%), and it was found that there is a significant relationship between shifts and unsafe behaviors before applying interventions (*P*-value was 0.027) .

It is worth mentioning that in the second phase and after applying safety interventions, there was no significant relationship between the frequency of unsafe behaviors and marital status, age, education, work experience, working day and the shift because of the fact that employees' knowledge and attitudes towards safety issue were improved, and they were more involved in safety. The managers created the necessary incentives to carry out serious and constructive activities, reporting the hazardous situations and encourage their colleagues to observe safety principles

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[DOI: 10.18502/aoh.v3i4.1555]

among the staff. In addition, the required training has been provided for the supervisors about how to deal with someone who has done unsafe actions correctly. Increasing the precise and continuous monitoring of employee's behavior, the implementation of workplace rules, and the periodic rewarding the workers have complied with safety regulations applied.

Discussion

According to the results, unsafe behaviors are the main cause of the accidents in the organization. Therefore, in order to reduce unsafe behaviors and control the rate of accidents and damages, corrective measures should be taken to reduce such behaviors among the staff. Based on the results of statistical tests, over 90% of the subjects did not have university education. Low level of knowledge about safety principles and lack of belief in the profitability of observance of safety principles have caused some unsafe behaviors that can be reduced by carrying out need assessment, planning and continuous training courses based on behavioral safety principles. Since the percentage of unsafe behaviors among single and married people was the same, reasons such as mental distractions due to marital status have no effect on working and the observance of the principles and rules of safety.

There are different unsafe behaviors among people of different ages that can be due to their energy and patience in doing their jobs safely or having wrong habits. Also, the number of unsafe behaviors in day shifts is lower, which can be attributed to more fatigue due to reasons such as sleepiness in night shifts. Rotational shifts that change working hours from day to evening or from night to day can reduce unsafe behaviors. Since the first phase of this study has been carried out in the early months of the year, factors such as the holiday season and the spring climate can have an impact on unsafe behaviors. The highest percentage of unsafe actions was observed in people with a work experience below 5 years, which could be due to their low experience in doing the right thing. The mangers should reduce the percentage of unsafe behaviors by providing them with initial in-service training, as well as proper monitoring of their performance. In addition, most unsafe actions occurred on Sundays, which could be due to increased work pressures and extra work hours in the early days of the week. Authorities should reduce the level of unsafe behaviors by providing solutions, such as creating rest programs and interruptions during work to increase the efficiency of individuals, as well as monitoring the employee.

The most frequent unsafe actions occur during the late hours of each shift and during the hours close to lunch time, which can be attributed to hunger, fatigue, and loss of willingness to continue working at these hours. Managers can reduce unsafe behaviors by providing snacks during work or interruption and relaxation. In addition, the continuous implementation of the system of reward and punishment and the use of various incentive schemes, such as financial incentives, incentive leave, granting appreciation letters, the introduction of the best workers at specific periods and job promotion for employees can motivate them to observe safety principles, meet the needs of the industry and enhance safety. Considering various penalties, such as oral and written notices, financial penalties, and even firing the offenders, as a deterrent to unsafe behaviors, are important in advancing safety objectives. The continuous monitoring of workers and careful monitoring of application of laws and regulations, implementation of suitable safety culture and the use of scientific evidence from academic research are also suggested. Li et al. along with this research concluded that monetary rewards and punishments had the same impact on employee behavior.[22] Wang et al.

concluded that the implementation of the HSE management system and its teachings have reduced the incidents and unsafe behaviors.[25] Stride et al. believes that there is a positive relationship between work experience and unsafe behavior.[26] In line with the results of the present study, Clancy concluded that the

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application of behavioral based safety interventions significantly improve safety performance of employees.[11] According to Choudhry, the BBS management technique is suitable and applicable in every country's culture, and indicated that BBS would be a good approach for improving the safety of front-line workers6. Khaleghinejad and Ziaaldini concluded that safety knowledge and motivation are influential on safety behavior[27] which is in accordance with the present study. Based on the results of research, in most studies on unsafe behavior, similar results were obtained, which emphasize the accuracy of the findings of this research. The findings also show that unsafe behavior can be affected by various aspects such as level of education, marital status, work experience, age, work shift and the task assigned to them, due to the complexity and unpredictability of human beings, it is difficult to control their behavior, however, unsafe behavior can be reduced by coding and planning carefully.

Research Limitations

The authors acknowledge certain limitations of the study. The lack of cooperation of the company's administrators in the full implementation of the system of reward and punishment was one of the limitations of this research. Also, the lack of cooperation between the administrators and staff for the proper implementation of training was considered as another limitation of this research. Implementation of safety interventions with the approach of the training system and the establishment of the system of reward and punishment is time-consuming and reaching its results requires sufficient time, control, periodic monitoring and continuity in the implementation of all defined interventions. Therefore, one of the main constraints of this research was time limitation.

Conclusion

The purpose of this study was to investigate the effect of behavioral –based safety interventions using the safety training and reward and punishment systems in reducing unsafe behaviors in the food industry. In this study, specifically, the behaviors of the employee of a food production company were investigated before and after training and reward and punishment system. Based on the results, the ratio of unsafe behaviors has decreased after the safety interventions. Therefore, considering the fact that the significance value (*p*-value) is smaller than the error level (0.05), with 95% confidence, it is concluded that there is a significant relationship between applying the system of reward and punishment and employee training system and reduction of unsafe behaviors.

In the first step and before applying the safety interventions, 0.228% of the behaviors were unsafe and after 2 months of applying the interventions, this rate was decreased to 0.171%. Thus, it can be concluded that the use of two interventions simultaneously, affected a significant number of individuals with different demographic characteristics, such as age, work experience and different levels of education, and it could make a significant difference in their behavior in a short period of time. Ultimately it can reduce the percentage of unsafe behaviors. The results also indicated that using these interventions would adequately affect the needs of the organization and enhance the safety, as well as the views of the employees, their participation, and encourage their colleagues to safety, which is very important in the industry. Therefore, it is the administrators' part in the industry to reduce unsafe behaviors through applying behavior–based safety training and appropriate reward and punishment system.

Conflict of interest

None declared

Acknowledgment

The authors would like to thank all of the personnel who participated in this study.

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[DOI: 10.18502/aoh.v3i4.1555]

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