Archives of Occupational Health | Volume 3 | Issue 2 | April 2019 | 314-7.

Original

The Effects of Alarm on the Situation Awareness in Firefighter

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Abstract

Background: One of the effective factors on controlling fire stations' system is situational awareness potentially varying in different scenarios. This study will investigate the relationship between situational awareness, as a set of the cognitive attributes, and ergonomics. It has been proved that situational awareness improves the performance of an organization's staff. **Methods:** This is semi-experimental research in which 30 firefighters from Isfahan urban fire stations participated. Materials used in this research are brachial pressure, a pulse oximeter (fingertip), and Situation Awareness Assessment Approaches. In each step, five firefighters from one fire station were tested twice. **Results:** Average score of situational awareness did not change significantly after the fire station alarm compared to before it. After the alarm, physiological variables such as blood pressure and heart rate decreased and increased, respectively. The results showed work experience played a significant role in the score of situational awareness and increase in heartbeat. **Conclusion:** Given the lack of effect of alarm but the effect of work experience on situational awareness, experienced firefighters' experiences and training can be used for improving situational awareness in young and inexperienced firefighters.

Keywords: Situation awareness; Fire station alarm; Firefighters

Introduction

Each year, fires destroy much of the residential area or the nature across the world. In addition to casualties, fires bring about loss of billions of dollars for governments, insurers, and private companies.[1] According to the International Fire and Rescue Association (2017), in 2015, 3.5 million fires took place in 14 of the world's largest cities, killing 184,000 people. Overall, from 1993 to 2015, 86.4 million fires occurred, with 1018,000 deaths.[2] In Iran in 2014, there were 53,608 incidents and fires in the capital. One of the most important incidents of fires in Iran in the past years was the Plasko building fire, leading to the death of 16 firefighters and 50 civilians.[1] The control of these statistics depends on a number of factors, such as weather conditions, the location of the incident, and the area and extent of flammable materials, etc.

One of the factors influencing the performance of the fire control system and firefighters, and ultimately the success of the operation, is the level of situational awareness of firefighters. Situational awareness can vary in different situations. Situational awareness is one of

Citation: Ghodsiniya MH, Habibi E. **The Effects of Alarm on the Situation Awareness in Firefighter.** Archives of Occupational Health. 2019; 3(2): 307-13.
Article History: Received:4 October 2018, Revised:16 November 2018, Accepted: 9 December 2018

[DOI: 10.18502/aoh.v3i2.668]

the subdivisions of cognitive ergonomics. In recent years, this concept has been raised as a causative factor in events and incidents in the field of occupational safety.[3] Endsley[4] defines situational awareness as "understanding the elements of the environment at a definite point in time and place, understanding their meaning, and predicting their state in the near future." According to Endsley[5], the first level of situational awareness is based on the understanding of environmental elements such as color, size, position, speed, and so on.

The second level of situational awareness is based on its first level and the ability to understand the situation, especially objects and important events. The third level of situational awareness is to predict the future state of the environment[6] based on its first and second levels, which provides knowledge and understanding of the current environment.[7] According to this theory, situational awareness accelerates designing decisions and actions to achieve occupational goals and objectives based on the awareness of the situation of the environment. In other words, understanding what information is received in the workplace and anticipating future events.[3] Many studies have shown that a lack of necessary situational awareness leads to poor human performance.[4]

One of these variables that appears to affect situational awareness is alarms. The alarm a sounding a bell which is installed in the fire stations and is activated to inform firefighting personnel in the event of an accident. The understanding of the working environment and the prediction of situations based on the information received will influence the performance of the workers in the future. Therefore, the present study was conducted to investigate the factors affecting situational awareness in firefighters.

Methods

After obtaining the necessary permissions from the Firefighting Organization of Isfahan to start the field survey, sampling and data collection were started. First, the potential research units of the study were identified and the informed consent form for participation in the study was completed by them if they volunteered to participate in the study. In this study, 30 firefighters in Isfahan city were investigated using a simulated environment of a fire station. In each stage, firefighters were tested two times. The research tools included Situation Awareness Assessment Approaches (NASA), which is a self-report instrument and was downloaded from the NASA website, along with a checklist of vital signs that were completed after the first and second drills. First, a demographic questionnaire (name, surname, age, and work experience) and a checklist of physiological factors (blood pressure, blood oxygen level, and heart rate) were completed with the help of one person using a brachial barometer (Microlife) and pulse oximeter (Fingertip).

Then, the firefighters were subjected to alarms two times. In the first drill, the layout of the simulated laboratory was normal and the firefighters performed the drill according to the regular protocol. In the second drill, the laboratory layout was performed based on ergonomics, and then the alarm was activated and the firefighters performed fire extinguishing according to the regular protocol. In the first stage, the video of various firefighters was broadcast was played for 3 minutes, and after completion of the video, the firefighters completed a translated version of the self-report NASA according to their observations in the video.

Table 1. The mean systolic blood pressure, diastolic blood pressure, blood oxygen levels and heart rate of the firefighters before and after the alarms.

Variable	Before alarm	After alarm	
	Mean	Mean	*P*
Systolic blood pressure (SD)mmHg	118.60 (8.90)	113.20 (13.90)	0.02
Diastolic blood pressure mmHg	72.00 (10.30)	67.50 (9.80)	0.03
Blood oxygen level (%)	96.50 (1.80)	95.80 (2.60)	0.20
Heart rate (BPM)	71.70 (10.70)	75.40 (11.20)	0.02

*P= 0.05

[DOI: 10.18502/aoh.v3i2.668]

Table 2. Pearson correlation coefficients between the work experience of firefighters and situational awareness score, reduction in systolic blood pressure, diastolic blood pressure and blood oxygen levels, and increase in heart rate

Variable	Work experience	
	r	*P*
Situational awareness score	0.39	0.04*
Reduction in systolic blood pressure	0.16	0.40
Reduction in diastolic blood pressure	-0.21	0.27
Reduction in blood oxygen level	-0.30	0.11
Increase in heart rate	-0.38	0.04

*P=0.05

The Persian duplicate of NASA, along with a checklist of vital signs, was completed after the first drill. In the second phase, after 10 minutes, the same video was played again to the firefighters, and at the end of the playing, the fire alarms was activated for them. After the video was completed, physiological factors were again recorded in the checklist, and again the firefighters filled out NASA within 5 minutes. Data were analyzed using the SPSS. Descriptive statistics were calculated for the variables and reported as frequency distribution tables with mean and standard deviation. Then, paired t-test and Pearson's correlation coefficient were used to test the hypotheses.

Results

Data analysis was done at two descriptive levels. The results of descriptive statistics including age and work experience of firefighters showed that the age range of firefighters was 24-54 years old with a mean of 7.33 (8.8) Meanwhile, their average work experience was 12.5 years with a standard deviation of 8.7. The mean scores of the situational awareness of the firefighters before and after the alarms were, respectively, 2.63 (SD= 96) and 7.64 (SD= 10.5), without any statistically significant difference.

The mean systolic pressure and diastolic blood pressure of the firefighters decreased significantly after the alarms compared to before the alarms (*P*=0.03) Table 1. However, there was no significant difference between the mean oxygen levels of the firefighters between the two times. The average heart rate of the firefighters increased significantly after the alarms compared to before the alarms (*P*=0.02).

The results showed that there was a direct and significant correlation between the work experience of firefighters and their situational awareness score. In other words, firefighters with more work experience had higher situational awareness.

Discussion

The results of this study indicate that there was no significant difference between the mean score of position awareness before and after firefighting alarms. Contrary to our study, Hao et al., after examining the effect of different traffic congestions on the driver's mental and occupational awareness, concluded that with increasing traffic, drivers' performance does not decrease, and drivers' workload and situational awareness increase and decrease, respectively. The results of this study indicate that situational awareness based on reminding and cognitive-based tests are not homogeneous and do not show consistent results[8], and Abbaszadeh et al. in a study on driving performance in the driving simulator, concluded that comparison of situational awareness before and after hazardous situations, showed situational awareness increased after dangerous situations.

It is likely that drivers have been seeking to maintain their driving balance by assigning more cognitive resources to their driving task after observing hazardous situations. It seems that hazardous conditions force drivers to concentrate on the road environment in order to increase their awareness of road information, and also avoid potential hazardous conditions.[9] The limitations of this study can be related to the occupation of firefighters that is a special occupation as they are likely to be studied for several times so that they may be frequently asked to fill out several questionnaires by researchers within one month; therefore, some

[DOI: 10.18502/aoh.v3i2.668]

firefighters might not have completed the questionnaire carefully.

Conclusion

Fitting the man to the job is based on the idea of improving productivity or efficiency by selecting individuals that have special talents for a specific occupation. This hypothesis, which forms one of the foundations of modern industrial psychology, is based on the assumption that for any work to be done, special talents that can be identified and objectively measured are required. This hypothesis is applicable to the selection of individuals with qualifications or specialized skills for specific occupations.

The hypothesis also is applicable to a number of other occupations; even today, physically hard occupations such as firefighting or lifesaver or other occupations, such as a military aircraft pilot, are restricted to people with special talents and physical characteristics. Given that firefighters are currently exposed to high levels of stress and excessive workload, and therefore, due to loss of situational awareness in the operational area, cause serious damage to themselves or those whom they are saving, then, irrespective of specialty and special skills, people who successfully complete a situational awareness test prior to enrollment into an occupation are needed.

Acknowledgments

I thank all those who helped me collect information for this research, including my great professor, Dr. Ehsanaollah Habibi, and Mrs. A'zam Salehi Velahashani.

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[DOI: 10.18502/aoh.v3i2.668]