Influence Analysis of Field Evacuation in Reducing Psychological Anxiety of Subway Fire

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Abstract. In order to effectively reduce the psychological anxiety of subway passengers in the fire state and improve the effect of fire emergency management, the fire anxiety status of passengers of different genders was counted, based on the fire state-trait anxiety questionnaire. The questionnaire and mathematical statistics were used to discuss the influence of different time periods after the intervention of on-site drills on the psychological anxiety level of passengers. Results: Before the field exercise, the overall fire anxiety level of the sample was in the normal range ; After on-site exercise, female fire anxiety level decreased, but still did not eliminate anxiety, and the effect of male education is not obvious ; After one hour of on-site training, the overall scores of fire anxiety of the samples were reduced; One day after the on-site exercise, women's psychological anxiety scores began to improve, and men's psychological anxiety continued to improve. Conclusion: On the whole, on-site drills are effective. After one day of on-site drills, the intervention effect basically disappears. However, on-site drills have a significant effect on eliminating the tension in the face of subway fires, and there are significant differences in these aspects of characteristics between people of different genders in the face of subway fires.

1 Introduction

The subway has the characteristics of semi-closed, with a large number of people and poor ventilation effect. Fire accident is one of the most prone accidents in the subway. Once a fire occurs in the station, it will be filled with smoke, causing serious disaster and difficult to carry out fire work [1]. In the event of a fire, it is one aspect for the escape person to master certain escape skills, but whether its psychological quality can support its successful escape success is also an important aspect. The emotional behaviour of passengers under fires often makes it more difficult for escape and rescue to succeed [2], even because of excessive panic, give up escape and negative response, caused more casualties [3]. Investigate the psychology and behaviour related to panic evacuation in subway emergency [4]. Using the potential failure model of reason and taking the description and predictability of cusp model as the mapping, the essence of the accident is explained from the human instability caused by the alignment of potential conditions and the influence of activity errors [5].

In the early 20th century, the evacuation began to attract the attention from many scholars at home and abroad [6], and the scholars have had some research on the different stress response of passengers under the fire. The psychology and behaviour of evacuation under fire were studied by questionnaire [7]. The subway fire was analysed from the perspective of stress response [8]. Analysis on characteristics of stress physiological reaction in subway passenger fire by experiment and catastrophe theory [9]. A survey of the 2007 Greek fire found that some people developed anxiety characteristics four months after the fire, especially those with injured loved ones in the fire, with higher levels of depression and anxiety characteristics [10]. A preliminary framework of subway fire cause analysis model based on system dynamics is proposed [11]. Psychological-environment correction of different people by fuzzy logic and formula [12], proves that it can have a positive impact on fire evacuation. By building an indoor population evacuation model [13], it is found that selfish behaviour has a negative impact on evacuation efficiency.

An investigation of survivors of the London bombings revealed obvious mutual assistance between groups, and the evacuation and stampede was not obvious [14]. A questionnaire of different passengers showed differences in their cognition and understanding of emergency evacuation information, tools and procedures [15]. Through the mobile virtual environment, this paper studies the influence of exit familiarity and other pedestrians' exit behaviour on people's exit choice in the emergency evacuation scene [16]. Studies prompted users to show social effects of herd behaviour during evacuation and show that decision makers are affected by people closer to export and their

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socioeconomic characteristics [17]. Some found that psychological stress responses caused by fire had a significant adverse effect on road-finding behaviour [18]. The psychological stress caused by the fire was analysed, and a revised fire evacuation model was proposed as more reliable than the social force model [19]. A comprehensive Hybrid Clustered Shuffled Frog-Leaping Algorithm-Particle Swarm Optimization algorithm was proposed to deal with social problems [20]. The influence of the concept of performance specification on human behaviour in fire research is investigated by using evacuation model [21]. The reliability of the Chinese version of the Status-Trait Anxiety Questionnaire (STAI) was demonstrated by data analysis from a large number of samples [22].

The on-site evacuation is an important technical means to improve the ability to respond to emergencies [23]. This paper intends to intervene in subway passengers' fire anxiety by means of on-site exercise.

2 Method

2.1 Research and design

This study used a cross-sectional study to analyse the intervention effects of the subjects before the intervention, just after the intervention, 1 hour after the intervention and 1 day after the intervention. The intervention method is on-site evacuation, which is implemented once for about 10 minutes. According to the characteristics and laws of H. Ebbinghaus forgetting curve, representative time nodes within 20 minutes (just after the intervention), 1 hour and 1 day were selected. The psychological anxiety was measured by using the Fire State Trait Anxiety Questionnaire (STAI).

2.2 Intervention protocol

The intervention group is composed of two members, master and doctor of safety technology and engineering. They have been teachers of safety engineering for about 10 years. They have a good reputation among previous students and have good affinity and communication skills between teachers and students. The field drill was conducted outside the gymnasium of Anhui University of technology. The intervention method is practical training for smoke escape and the use of fire extinguishers. The intervention experimental materials were fire state trait anxiety questionnaire, mobile simulated smoke escape tent and fire extinguisher.

A total of 10 free volunteers were recruited for evacuations. The experimental procedure was to issue the questionnaire to 10 volunteers, then analyse the results, measure the stress level after completion, 1 h and 1 day after completion of the intervention strategy; finally, the measurements of the four time nodes were analysed, and the intervention results and pre-intervention measurements were analysed. The specific procedures are shown in Figure 1.

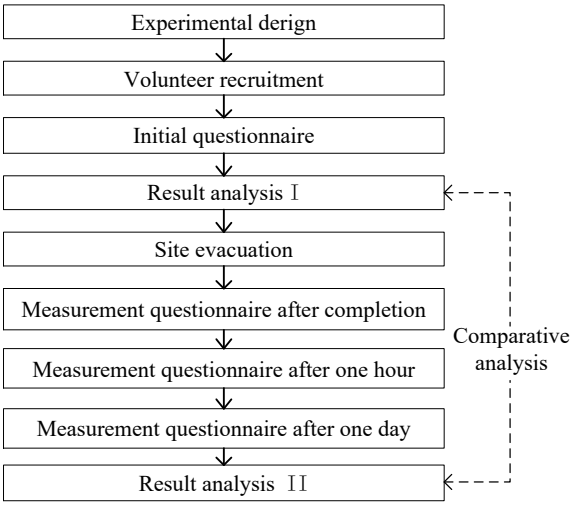

Fig. 1. Intervention Implementation Procedure Map

The volunteers participated in simulated smoke escape and evacuation outside the gymnasium of Anhui University of technology. Two people participated in the training of fire extinguisher use as a group. Part of the intervention process are shown in Figure 2.

Fig.2. Part of intervention process

3 Results

3.1 Descriptive statistical analysis

Since volunteer No.5 did not fill in the questionnaire after one hour and one day of the evacuation, and volunteer No. 6 did not fill in the questionnaire after one day of the evacuation, 10 volunteers in the evacuation group finally collected the valid data as the measurement questionnaire of 8 volunteers. SPSS was used to analyze the reliability of the fire state trait anxiety questionnaire of volunteers before, after, 1 hour after and 1 day after the on-site exercise intervention. It was calculated that the Cronbach's Aalpha was 0.932. The standard for reliable data is that the Cronbach's Aalpha coefficient is greater than 0.8. So it is considered that the measurement results are reliable and can be used, as shown in table 1.

Table 1. Reliability statistics.

Cronbach's Alpha	Items
0.932	20

The scores and comparison of the STAI before, after, 1 hour after and 1 day after the overall evacuation of men, women and volunteers are counted, calculated and summarized, as shown in Table 2.

Table 2. Average score of the STAI under evacuation intervention.

		Total average	Men	Women
Before evacuation	score	50.38	43.20	62.33
After evacuation	score	47.13	41.60	56.33
	compare with before evacuation	-3.25	-1.60	-6.00
One hour after evacuation	score	40.25	36.00	47.33
	compare with before evacuation	-10.13	-7.20	-15.00
	compare with after evacuation	-6.88	-5.60	-9.00
One day after evacuation	score	40.63	33.60	52.33
	compare with before evacuation	-9.75	-9.60	-10.00
	compare with after evacuation	-6.50	-8.00	-4.00
	compare with one hour after evacuation	0.38	-2.40	5.00

According to Table 2, the total average score of anxiety scores of volunteers before the evacuation is 50.38, including 43.2 for men and 62.33 for women. According to the norm of anxiety level of normal men and women and patients with depression in China.

3.1.1 Before the evacuation

Women had fire anxiety status in anxiety levels, men in the normal range, and the overall fire anxiety level in the sample in the normal range.

3.1.2 After the evacuation

The psychological anxiety state of women's fire is 6 points lower than that before the evacuation, which is still at the anxiety level, indicating that the evacuation has an effect on women, but the anxiety has not been eliminated. The psychological anxiety state of men was 1.6 points lower than that before the evacuation, which was in the normal range, indicating that the evacuation had no obvious effect on men's education. The overall grouping is 3.25 points lower than that before the evacuation, which is in the normal range, indicating that the evacuation is effective as a whole.

3.1.3 One hour after the evacuation

The psychological anxiety state of female fire is 15 points lower than that before the evacuation and 9 points lower than that after the evacuation, which is at the boundary of normal value and anxiety value, indicating that the effect of the evacuation is still having an impact one hour after the evacuation. The psychological anxiety of men was 7.2 points lower than that before the evacuation and 5.6 points lower than that before the evacuation, which was in the normal range, indicating that the evacuation still had an effect on men's education. The overall average fire psychological anxiety state is 10.13 points lower than that before the evacuation and 6.88 points lower than that after the evacuation, which is in the normal range, indicating that the impact of the evacuation continues one hour after the evacuation.

3.1.4 One day after the evacuation

Women's psychological anxiety is still at the anxiety level, which is 5 points higher than that after one hour of on-site exercise, indicating that the educational effect of on-site exercise on women began to disappear. The psychological anxiety of men continued to improve, 9.6 points lower than that before the evacuation, 8 points lower than that after the evacuation, and 2.4 points lower than that after one hour of the evacuation, indicating that the impact of the evacuation on men continued. In general, after one day of the evacuation, the fire anxiety level score of the volunteers was 40.63, which was lower than the normal range, 9.75 points lower than before the evacuation, 6.5 points lower than after the evacuation, and 0.38 points higher than after one hour of the evacuation, indicating that the intervention effect basically disappeared after one day of the evacuation, and its change trend is shown in Figure 3.

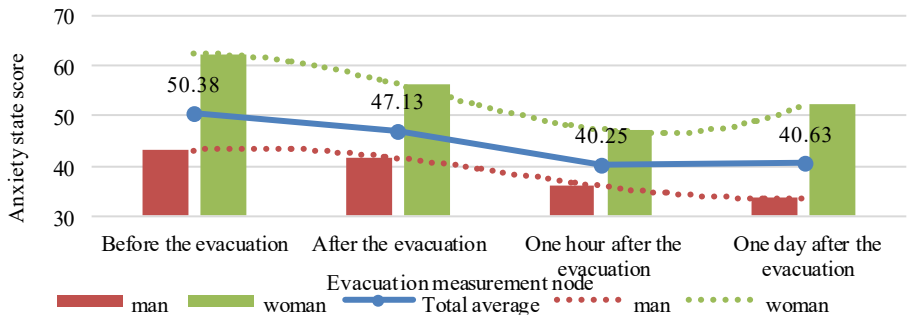

Fig.3. Trend of fire anxiety level under evacuation

3.2 Variance analysis

Previously, the change trend of volunteers' subway fire anxiety level under the on-site exercise intervention mode was analysed. The significance of the change difference will be further verified below. After the one-way ANOVA (significance level = 0.05) of the test results by SPSS, it is found that only the significance level of Topic 3 (I am nervous in the face of subway fire) is less than 0.05, indicating that the on-site drill plays an obvious role in eliminating the tension in the face of subway fire.

Sex as the level of subway fire anxiety in field intervention, one-way analysis of variance (significance level of 0.05), found that the influence of gender on field intervention effect is wide, including 13 topics (topic 1, 2, 3, 4, 5, 7, 9, 11, 12, 13, 15, 18, 19), shows that the characteristics of subway fire in different gender.

4 Conclusions

Overall, the on-site evacuation has a certain effect on reducing the psychological anxiety of subway fire. Through the intervention, the scores of passengers' fire anxiety state decreased, but after one day of the on-site exercise, the intervention effect of women obviously diminished, while the impact of the on-site evacuation on men continued. The effect of the intervention was consistent with the Ebbinghaus forgetting curve, and the forgetting speed of boys for such events was slower than that of girls. SPSS was used for one-way ANOVA of the test results. It was found that the on-site evacuation had a significant effect on eliminating the tension in the face of subway fire, and there were significant differences in these characteristics of people of different genders in the face of subway fire. The anxiety level of women was generally higher than that of men.

This paper is supported by Anhui Province Housing and Urban Rural Construction Science and Technology Plan, Grant No.2022-YF005; Start-up Funds for Post-doctoral Researches of Ma'anshan University, Grant No. PRC2021001; Beijing Social Science Foundation, Grant No. 19GLB035.

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