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The correlation between mindfulness traits and fatigue among Chinese civil aviation pilots

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Abstract: The problem of flight crew fatigue has always been a hot topic in aviation safety management. Few studies have investigated the actual fatigue of civil aviation pilots. More importantly, the rate at which pilot fatigue accumulates over time at work and alleviates over time at rest may be influenced by individual differences, particularly by individual psychological traits. The characteristics of mindfulness may be one of the internal factors of individual differences in fatigue. To explore the relationship between mindful traits and fatigue in civil aviation pilots, 393 pilots were recruited and completed an online questionnaire. The results showed that no significant differences in mindfulness and fatigue was found among pilots in different positions. There was a significant negative correlation between mindfulness trait and all dimensions of fatigue. Specifically, the stronger the mindfulness trait, the weaker the impact of circadian rhythm, sleep and workload on fatigue. Pilots with high mindfulness also reported lower levels of subjective fatigue. This suggests that the enhancement of mindful traits may help reduce the pilots' perception of fatigue. Mindfulness intervention may be a psychological measure to relieve flight fatigue.

1. Introduction

The problem of flight crew fatigue has always been a hot topic in aviation safety management. The Fatigue management Requirements issued by The Civil Aviation Administration of China in May 2021 clearly stipulate that the certificate holder shall establish a fatigue risk management system (FRMS) or "normative practices". This shows the importance of flight personnel fatigue in aviation safety.

In the investigation of flight personnel fatigue, existing researches mainly focus on military pilot fatigue, and it is found that military pilot fatigue is relatively common. A survey of 924 military pilots found that 37.1% of them were positive for fatigue symptoms [1]. There are relatively few studies on fatigue among civil aviation pilots in China. In view of the fact that the fatigue of civil

aviation flight personnel is an important factor of human error, it is of great significance to conduct in-depth research on the fatigue of civil aviation flight personnel.

The fatigue of flight personnel is gradually accumulated with the working time and relieved with the rest time. It is based on such universal common sense that the fatigue management scheme adopted by the current civil aviation system calculates the fatigue degree based on the rest period, duty period, flight time and other information, so as to achieve the goal of flight personnel fatigue management. In fact, the rate at which fatigue accumulates with working hours and relieves with rest time may be influenced by individual differences, or even by individual psychological states at different times. For example, a study on driver fatigue found significant individual differences in the variation trend and amplitude from wakefulness to fatigue[2]. Individual differences in fatigue have been paid more attention in highway traffic drivers. However, there is little attention on individual differences in fatigue of flight personnel in aviation. Exploring individual differences and influencing factors of flight crew fatigue is helpful to improve the accurate identification of flight crew fatigue.

Mindfulness, derived from Eastern Buddhist meditation, refers to consciousness that emerges through conscious, present-moment, non-judgmental attention to moment-to-moment experiences [3]. It emphasizes attention to the present and the here and now, including external stimuli, bodily sensations and inner emotions and thoughts, and also emphasizes acceptance of the stimuli and inner experiences perceived in the present without trying to change or eliminate them. As An individual's positive psychological trait, mindfulness is significantly associated with stress, fatigue, sleep quality [4-6].

In summary, existing studies have found that individual mindful traits may be related to individual differences in fatigue. In view of the occupational characteristics of civil aviation pilots, fatigue is relatively common. Therefore, exploring the correlation between mindful traits and fatigue state of civil aviation pilots is helpful to provide new ideas for fatigue mitigation strategies.

2. Method

2.1 Participants and procedure

The survey included 393 airline pilots, all male, including 199 vice-captain, 100 captains, and 94 flight instructors. The ages ranged from 25 to 59 years, with a mean age of 34.75 years and a standard deviation of 7.23 years.

Ethics approval was granted by an ethics committee. Pilot participants voluntarily participate in the research. The questionnaire was distributed online, and the invited pilots completed the questionnaire after reading the informed consent. The test time was approximately 10 minutes.

2.2 Measures

2.2.1 Mindfulness

The Mindful Attention Awareness Scale (MAAS) developed by Brown and Ryan (2003) [7] and revised by Deng et al. (2011) [8] was used for measurement of mindfulness. The scale consists of 15 items on a 6-point scale (1-6 points from "always" to "almost none"). Scores range from 15 to 90, with higher scores indicating higher levels of mindfulness.

2.2.2 Fatigue

Dai et al. (2018) developed a fatigue questionnaire for Chinese pilots [9], which contains four dimensions, namely, circadian rhythm, sleep, workload, and subjective fatigue. The scale has been

tested for reliability and validity and can be used for pilot fatigue investigation and evaluation. The lowest score of each dimension is 0, and the lower the score is, the lower the corresponding fatigue degree is. The highest possible score is 23 for circadian rhythm, 46 for sleep, and 39 for workload. The higher the score is, the more the fatigue of pilots is affected by circadian rhythm, sleep, and workload. The highest possible score for subjective fatigue was 48, with higher scores indicating stronger subjective fatigue. The highest fatigue score is 156, and the higher the score, the more fatigued the pilot.

2.3 Data analysis

Descriptive statistics, independent sample T test and correlation analysis were conducted with SPSS 20.0. Firstly, descriptive statistics and correlations were analyzed on the pilots' mindful traits and fatigue degree. Secondly, independent sample T-test was conducted on the pilots' mindful traits and fatigue degree of different positions.

3. Result

3.1 Descriptive statistics and correlations

Through descriptive statistics and correlation analysis, the results are shown in Table 1. There was a significant negative correlation between pilots' mindfulness traits and fatigue (rs = -0.14 ~ -0.49, ps < 0.01). The higher the mindfulness traits were, the lower the effects of sleep, circadian rhythm and workload on fatigue. Meanwhile, pilots with higher mindfulness traits reported lower subjective fatigue. This suggests that mindful traits may serve as effective intra - individual moderator of pilot fatigue.

Table 1 Descriptive statistics and correlations of Mindfulness and fatigue of Chinese aviation pilots

	1	2	3	4	5	6
1.Mindfulness						
2.Circadian rhythms	-0.14**					
3.Sleep	-0.33**	0.34**				
4.Work load	-0.21**	0.48**	0.34**			
5.Subjective fatigue	-0.49**	0.30**	0.65**	0.35**		
6.Fatigue scores	-0.43**	0.57**	0.84**	0.66**	0.85**`	
M	74.16	18.13	27.82	26.93	24.29	97.17
SD	14.84	2.38	6.01	4.44	6.77	15.13

Note: ** p < 0.01.

3.2 Analysis of pilot mindfulness and fatigue differences in different positions

Pilot positions (vice-captain, captain and flight instructor) were taken as independent variables, while mindfulness, circadian rhythm, sleep, workload, subjective fatigue and fatigue scores were taken as dependent variables, and one-way ANOVAs were conducted. The results showed (Table 2) that there were no significant differences in mindfulness, circadian rhythm, sleep, workload, subjective fatigue and fatigue scores among pilots in different position (ps > 0.05).

Table 2 One-way ANOVAs of mindfulness and fatigue levels in vice-captain, captains, and flight instructors

		SS	*df*	*MS*	*F*	*p*
1.Mindfulness	Between group	224.61	2	112.31	0.509	0.602
	Within group	86108.92	390	220.79		
	Total	86333.53	392			
2.Circadian rhythms	Between group	0.56	2	0.28	0.05	0.952
	Within group	2216.56	390	5.68		
	Total	2217.12	392			
3.Sleep	Between group	20.15	2	10.07	0.28	0.757
	Within group	14126.03	390	36.22		
	Total	14146.17	392			
4.Work load	Between group	64.56	2	32.28	1.64	0.195
	Within group	7662.30	390	19.65		
	Total	7726.86	392			
5.Subjective fatigue	Between group	9.44	2	4.72	0.10	0.903
	Within group	17955.07	390	46.04		
	Total	17964.51	392			
6.Fatigue scores	Between group	2.20	2	1.10	0.01	0.995
	Within group	89714.05	390	230.04		
	Total	89716.25	392			

4. Discussion

This study found that mindfulness traits were negatively correlated with civil aviation pilot fatigue. That is, pilots with higher mindfulness traits had lower levels of fatigue. This finding is consistent with previous research, which found that pilots with higher mindfulness traits had lower levels of mental fatigue [10]. Previous studies have focused on the fatigue monitoring of flight personnel, and few studies have explored psychological measures for fatigue relief. This study focused on examining the possible role of psychological traits (i.e., mindfulness traits) in fatigue relief.

Why mindfulness interventions work for fatigue relief? First of all, from the perspective of cognition and emotion, the mindfulness reperceiving model holds that by maintaining awareness and acceptance of ones' own experience, self-regulation can be improved, and cognitive, emotional and behavioral flexibility can be enhanced, which makes mindfulness practice have a positive effect [11]. Related research results also support this hypothesis, such as a 9-week mindfulness intervention, the individual's ability to regulate emotions was significantly enhanced, and both impulsivity and depression were significantly reduced [12]. That is, from a cognitive and emotional perspective, mindfulness may reduce cognitive and emotionally induced mental fatigue.

Secondly, from a physiological perspective, various researchers have found the correlation between mindfulness traits/mindfulness interventions and physiological functions from the perspectives of heart rate variability, hormone secretion, and brain neural activity. For example, mindfulness intervention can enhance the regulatory function of the prefrontal cortex and reduce the secretion of cortisol, epinephrine and norepinephrine, thereby attenuating stress responses and reducing the risk of stress-related diseases [13]. This suggests that, from a physiological perspective, mindfulness may reduce physical fatigue.

In fact, mindfulness interventions have been widely used by researchers for fatigue relief,

including clinical patients, such as chronic fatigue patients, cancer convalescent patients, or non-clinical individuals, such as college students, athletes etc. Mindfulness interventions have been shown to have favorable effects on the relief of fatigue symptoms. Meta-analyses of mindfulness for fatigue symptom relief in patients with brain injury or neurological symptoms such as stroke, traumatic brain injury, and multiple sclerosis show moderate effect [14], and mindfulness interventions had moderate to large effects in chronic fatigue patients [15]. In summary, mindfulness interventions may have enormous potential value in alleviating pilot fatigue, and future research could focus on adaptive pilot mindfulness interventions.

References

[1] Guo, J., Chen, S., Bai, J., Li, N., Ma, Z., Shen, J., et al. (2012). Investigation and analysis on fatigue status of military pilots. Med J Chin PLA, 37(3), 249–252.

[2] Wu, C., Sun, Y., Zhang, H., Xiao, Y., & Li, X. (2019). Sensitivities of fatigue driving steering features to individual difference. Journal of Transportation Systems Engineering and Information Technology, 19(5), 120–127.

[3] Kabat-Zinn, J. (2010). Mindfulness-based interventions in context: past, present, and future. Clinical Psychology Science & Practice, 10(2), 144–156.

[4] Du, J., An, Y., Ding, X., Zhang, Q., & Xu, W. (2019). State mindfulness and positive emotions in daily life: an upward spiral process. Personality and Individual Differences, 141, 57–61.

[5] Xu, W., Wang, Z., & Fu, Z. (2018). The moderating role of dispositional mindfulness and locus of control in the impact of perceived stress on negative emotions in daily life. Journal of Psychological Science, 41(3), 239–244.

[6] Zhang, Y., Li, B., Wang, J., Yang, J., & Zhang, L. (2019). Effect of mindfulness trait factors on sleep quality of college students: the mediating role of cognitive emotion regulation strategies and anxiety. Chinese Journal of Behavioral Medicine and Brain Science, 28(9), 788–792.

[7] Brown, K. W., & Ryan, R. M. (2003). The benefits of being present: Mindfulness and its role in psychological well-being. Journal of Personality and Social Psychology, 84(4), 822–848.

[8] Deng, Y. Q., Li, S., Tang, Y. Y., Zhu, L. H., Ryan, R., & Brown, K. (2011). Psychometric properties of the Chinese translation of the Mindful Attention Awareness Scale (MAAS). Mindfulness, 3(1), 10–14.

[9] Dai, J. , Luo, M. , Hu, W. , Ma, J. , & Wen, Z. (2018). Developing a fatigue questionnaire for Chinese civil aviation pilots. International Journal of Occupational Safety & Ergonomics, 1–13.

[10] Li, Y., Chen, H., Xin, X., Ji, M., & Graham, A. (2020). The influence of mindfulness on mental state with regard to safety among civil pilots. Journal of Air Transport Management, 84, 101768.

[11] Shapiro, S. L., Carlson, L. E., Astin, J. A., & Freedman, B. (2010). Mechanisms of mindfulness. Journal of Clinical Psychology, 62(3), 373–386.

[12] Deplus, S., Billieux, J., Scharff, C., & Philippot, P. (2016). A mindfulness-based group intervention for enhancing self-regulation of emotion in late childhood and adolescence: a pilot study. International Journal of Mental Health & Addiction, 14, 775–790.

[13] Creswell, J. D., & Lindsay, E. K. (2014). How does mindfulness training affect health? a mindfulness stress buffering account. Current Directions in Psychological Science, 23(6), 401–407.

[14] Ulrichsen, K. M., Tobias, K., Dorum, E. S., Kolskar, K. K., Richard G., Dag, A., et al. (2016). Clinical utility of mindfulness training in the treatment of fatigue after stroke, traumatic brain injury and multiple sclerosis: A systematic literature review and meta-analysis. Frontiers in Psychology, 7, U2780.

[15] Sollie, K., Nss, E. T., Solhaug, I., & Thimm, J. C. (2017). Mindfulness training for chronic fatigue syndrome: a pilot study. Health Psychology Report, 5(3), 240–250.