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IMPACT OF SOUNDDSCAPE ON HEALTHCARE WORKERS' WELLBEING

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ABSTRACT

This study conducted questionnaire surveys in four Chinese hospitals, involving 103 healthcare workers from intensive care units (ICUs) and 122 from non-ICU departments. The online questionnaire comprised four major sections. The first section included questions on disturbance, noise annoyance, and noise sensitivity, while the second section focused on job satisfaction, physical health symptoms, and anxiety. The third section covered coping strategies, childcare responsibilities, and attitudes toward colleagues and patients. Lastly, personal information about the participants was collected. The collected data were analysed using structural equation modeling. The results indicated that noise disturbance and annoyance affected healthcare workers' well-being, including burnout and anxiety. Additionally, noise sensitivity showed significant effects on noise disturbance and annoyance. Furthermore, noise annoyance showed a significant relationship with coping strategies.

Keywords: *Healthcare workers, wellbeing, soundscape, noise annoyance, disturbance, ICU, non-ICU, burnout, anxiety*

1. INTRODUCTION

It is well established that noise levels in hospital departments, particularly intensive care units (ICUs), often exceed recommended thresholds for both patients and healthcare workers [1, 2]. Numerous studies have documented the adverse effects of excessive noise, including sleeping disturbance [3], voice disorders [4], and hearing impairment [5]. Beyond physical health risks, prolonged exposure to high noise levels in ICUs may also compromise healthcare workers' mental well-being. For instance, research has linked excessive noise to increased stress, anxiety, and reduced job satisfaction among ICU staff [6-8]. Terzi *et al.* [7] found that elevated noise levels negatively impacted nurses' extrinsic job satisfaction and trait anxiety, based on noise measurements and questionnaire surveys. Similarly, Ziwei *et al.* [5] proposed a conceptual model (derived from interviews) outlining the potential effects of ICU noise on nurses' mental well-being, though this model remains unvalidated.

Despite these findings, few studies have holistically examined the ICU's acoustic environment or compared its impact on healthcare workers to those in non-ICU departments. To address this gap, this study investigated how ICU staff perceive and react to noise, as well as how noise exposure affects their well-being relative to non-ICU workers. Field surveys were conducted across four hospitals in Chongqing, China with approximately 220 participants. Using structural equation modeling (SEM), the multiple relationships between noise perception, psychological responses, and well-being outcomes (i.e. health symptoms and anxiety) were analysed.

2. METHOD

2.1 Sites and participants

Questionnaire surveys were conducted in four hospitals in China. Participants were recruited from both ICU and non-ICU departments in each hospital. Over 100 participants were enrolled from each group, resulting in a total of 225 respondents. As shown in Table 1, 214 out of 225

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participants were female, and more than half were over 30 years old.

Table 1. Survey respondents' personal characteristics

Personal Characteristics	ICU (*N*=103)	Non-ICU (*N*=122)	Total (*N*=225)
Gender			
Female	97	117	214
Male	6	5	11
Age (yr)			
20-25	6	23	29
25-30	21	27	48
30-35	44	38	82
>35	32	34	66
Role			
Nurse manager	4	9	13
Clinical nurse	20	31	51
Charge nurse	10	12	22
Registered nurse	69	70	139
Years of working			
<1 yr	0	5	5
1-2 yr	7	14	21
2-5 yr	21	31	52
5-10 yr	46	37	83
>10 yr	28	35	63
Hours of working per week			
<40 hours	0	7	7
40-50 hours	62	93	155
51-60 hours	29	17	46
>60 hours	12	5	17
Have you worked in other departments before?			
Yes	13	22	35
No	90	100	190

2.2 Measures

The questionnaire assessed six key domains: noise disturbance, noise annoyance, burn out, health-related symptoms, anxiety, and noise sensitivity.

2.2.1 Noise disturbance

Respondents rated the extent to which noise disturbed three specific activities: conversation with patients, conversation with colleagues, and patient sleep. Responses were recorded on a 5-point scale ranging from 1 (*not at all*) to 5 (*extremely*).

2.2.2 Noise annoyance

Annoyance was measured for four noise sources: conversations between staff, conversations between staff and patients, noise from medical activities, and equipment alarms. Participants rated their annoyance on a 5-point scale (1: *not at all*; 5: *extremely*).

2.2.3 Burnout inventory

Burnout inventory was evaluated using two statements: "I feel exhausted when I get off work every day", and "This job has made me indifferent". Responses were collected using a 5-point scale ranging from 1 (strongly disagree) to 5 (strongly agree).

2.2.4 Health-related symptoms

Participants reported the frequency of five physical symptoms: headache, difficulty concentrating, easily getting tired, voice tiredness, and voicelessness. These were assessed on a 7-point scale (1: never; 7: frequently).

2.2.5 Anxiety

Anxiety was assessed using three times (anxious, worried, and, pleasant) adapted from Bosson *et al.* [9]. Responses were given on a 5-point scale (1: not at all; 5: extremely), with pleasant reversed coded.

2.2.6 Coping strategy

Coping strategy was assessed using a 5-point scale (1: never; 5: always) for nine strategies such as "I accept that I cannot do anything to stop the noise".

2.2.7 Noise sensitivity

Noise sensitivity was assessed using the 13-item NoiSeQ-R, with responses recorded on a 4-point scale (0: strongly disagree; 3: strongly agree). The sum of the 13 items was used in the analysis.

2.3 Data analysis

The data were analysed using AMOS version 29.0 to examine the multivariate relationships. Confirmatory factor analysis (CFA) with maximum likelihood estimation was conducted to validate the constructs. Model fit was evaluated using the goodness-of-fit index (GFI), the adjusted root mean square error approximation (RMSEA), and the relative Chi-square (χ^2/df).

3. RESULTS

3.1 Confirmatory factor analysis

Factor constructs were developed through exploratory factor analyses (EFA), and a confirmatory factor analysis (CFA) was then performed to examine the construct validity and reliability. The results of the confirmatory factor analysis are summarized in Table 2. The reliability coefficients (Cronbach's alphas) were calculated in order to assess the internal consistency of the subscale. Convergent validity was assessed using factor loading and average variance extracted (AVE). The factor loading of each individual indicator with its respective construct were statistically significant ($p<0.01$). Factor loadings were all greater than 0.3, which is a recommended value [10], and they were considered 'practically significant' because most of them were greater than 0.5 [11], except for ND5 and A4. The AVE indicates the overall amount of variance in the indicators accounted for by the latent construct. The AVE should exceed 0.5 for adequate convergence [12]. In this study, the AVE ranged from 0.514 to 0.733. Therefore, it was confirmed that the CFA model has good construct reliability and adequate convergent validity.

Table 2. Results of confirmatory factor analysis

Latent variable	Observed variable	Factor loading	Average variance extracted	Cronbach's alpha
Noise disturbance	ND5	0.396	0.548	0.767
	ND6	0.942		
	ND7	0.775		
Noise annoyance	NA1	0.730	0.514	0.808
	NA2	0.794		
	NA4	0.664		
	NA7	0.671		
Burnout inventory	BI1	0.940	0.733	0.844
	BI4	0.763		
Health symptoms	H1	0.860	0.612	0.887
	H2	0.678		
	H3	0.706		
	H4	0.866		
	H5	0.784		
Anxiety	A1	0.806	0.518	0.777
	A2	0.621		
	A4	0.394		
Coping	C1	0.802	0.524	0.897
	C2	0.740		
	C3	0.710		
	C4	0.814		
	C8	0.667		
	C9	0.744		
	C10	0.562		
	C11	0.724		

3.2 Path analysis

According to the literature review, a conceptual model was developed, and it is presented in Figure 1. This model was tested using path analysis.

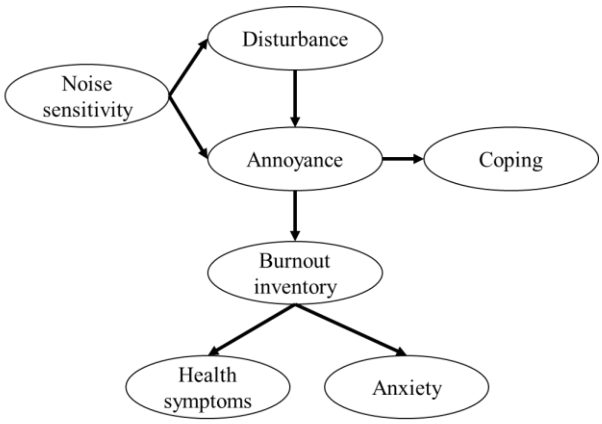

Figure 1. Conceptual model

The results of the path model are listed in Table 3. All the paths were statistically significant, except for the path from burnout inventory to health symptoms. The RMSEA was 0.043, lower than the normal cut-off limits of 0.06 [13]. The comparative fit index (CFI) was 0.953, indicating a good fit [13].

The model supported a relationship between noise disturbance and annoyance. Similar to a previous study [14], disturbance had a positive relationship with noise annoyance, suggesting that increased disturbance led to greater noise annoyance. Noise annoyance had a positive influence on burnout inventory, implying that greater noise annoyance was associated with greater burnout inventory. The relationship between noise annoyance and coping strategies was positive, indicating that higher noise annoyance resulted in more frequent use of coping strategies. Burnout inventory showed positive relationships with both health symptoms and anxiety, meaning that greater burnout inventory was associated with more frequent health-related symptoms and anxiety. However, the relationship between burnout inventory and health symptoms was not statistically significant ($p=0.115$) Finally, noise sensitivity had significant impacts on noise disturbance and annoyance, implying that higher noise sensitivity resulted in greater noise disturbance and annoyance.

Table 3. Results of path analysis (*$p<0.01$ and **$p<0.05$)

Path	Standardised estimate
Disturbance → Annoyance	0.19**
Annoyance → Burnout inventory	0.331*
Annoyance → Coping	0.510*
Burnout inventory→ Health symptoms	0.117
Burnout inventory→ Anxiety	0.417*
Noise sensitivity → Annoyance	0.296*
Noise sensitivity → Disturbance	0.181**

4. CONCLUSIONS

This study investigated the impact of noise on healthcare workers' well-being using structural equation modeling (SEM) to analyse survey responses from 225 participants. The results confirmed that noise disturbance significantly contributes to noise annoyance, which in turn increases burnout and anxiety among healthcare workers. Noise sensitivity was found to increase both disturbance and annoyance, suggesting individual differences in noise tolerance. While burnout was strongly linked to anxiety, its association with health symptoms was not statistically significant. These findings highlight the need for targeted noise reduction strategies in hospital settings, particularly in ICUs, to mitigate adverse psychological effects on staff. In the future, the comparisons between ICU and non-ICU staff will be examined.

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