

How do well-being and cognitive factors influence healthcare workers' adherence to internet-based stress management: A mixed methods study

Miqi Li, Quan WANG, Danli ZHENG, Danni FENG, Xiaorong LANG

Submitted to: Journal of Medical Internet Research
on: March 01, 2025

Disclaimer: © The authors. All rights reserved. This is a privileged document currently under peer-review/community review. Authors have provided JMIR Publications with an exclusive license to publish this preprint on its website for review purposes only. While the final peer-reviewed paper may be licensed under a CC BY license on publication, at this stage authors and publisher expressly prohibit redistribution of this draft paper other than for review purposes.

Table of Contents

Original Manuscript..... 5

Supplementary Files..... 29

 Figures 30

 Figure 1..... 31

Preprint
JMIR Publications

How do well-being and cognitive factors influence healthcare workers' adherence to internet-based stress management: A mixed methods study

Miqi Li¹; Quan WANG²; Danli ZHENG³; Danni FENG³; Xiaorong LANG³

¹ Tongji hospital, Tongji medical college, Huazhong university of science and technology wuhan CN

² Nursing school, Tong medical college, Huazhong university of science and technology wuhan CN

³ Tongji hospital, Tongji medical college, Huazhong university of science and technology wuhan CN

Corresponding Author:

Danli ZHENG

Tongji hospital, Tongji medical college, Huazhong university of science and technology
No.1965 Jiefang Road
wuhan
CN

Abstract

Background: High levels of stress are common among healthcare employees (HCWs), which are harmful to their health and the stability of healthcare human resources. Mobile stress management has been identified as a promising intervention for reducing work-related stress; however, poor adherence may limit its maximum effectiveness. Exploring factors influencing HCW adherence to mobile stress management may thus aid in the development of optimal interventions to help reduce work-related stress in the healthcare setting.

Objective: The current research sought to investigate: (1) how HCWs' well-being and cognitive factors influenced their treatment adherence in MSM; and (2) what HCWs' specific needs for MSM were.

Methods: The research employs a convergent mixed-methods design. HCWs are recruited through a mobile stress management project in a large Chinese general hospital. Quantitative data included sociodemographic characteristics, fatigue symptom assessment, perceived stress, user experience, attitudes towards mobile stress management, and practicing frequency, all of which were analyzed using hierarchical regression analyses and a structural equation model. Qualitative data are collected online using an open-ended question, and they are analyzed using a pragmatic method to reflexive-thematic analysis.

Results: A total of 157 participants were included in the present study. Results from the hierarchical regression analyses showed that fatigue, user experience, and perceived usefulness were independent predictors of treatment adherence. Results from the structural equation model demonstrated that user experience indirectly influenced treatment adherence via perceived usefulness (indirect effect = 0.045, $P = 0.001$). The qualitative data identified four themes about the experience of individualized intervention, effective feedback, reward and constraint mechanisms, and duration of intervention.

Conclusions: This study indicates that alleviating fatigue symptoms and improving attitudes towards mobile stress management by promoting a user experience is vital to ensuring treatment adherence. To improve the user experience, future studies may need to consider focusing on individualized needs, providing effective feedback, developing reward and constraint mechanisms, and developing flexible intervention duration.

(JMIR Preprints 01/03/2025:73306)

DOI: <https://doi.org/10.2196/preprints.73306>

Preprint Settings

1) Would you like to publish your submitted manuscript as preprint?

✓ **Please make my preprint PDF available to anyone at any time (recommended).**

Please make my preprint PDF available only to logged-in users; I understand that my title and abstract will remain visible to all users.
Only make the preprint title and abstract visible.

No, I do not wish to publish my submitted manuscript as a preprint.

2) If accepted for publication in a JMIR journal, would you like the PDF to be visible to the public?

✓ **Yes, please make my accepted manuscript PDF available to anyone at any time (Recommended).**

Yes, but please make my accepted manuscript PDF available only to logged-in users; I understand that the title and abstract will remain visible to the public.

Yes, but only make the title and abstract visible (see Important note, above). I understand that if I later pay to participate in <http://www.jmir.org/>, I will be able to make my accepted manuscript PDF available to anyone.

No. Please do not make my accepted manuscript PDF available to anyone.



Original Manuscript

How do well-being and cognitive factors influence healthcare workers' adherence to internet-based stress management: A mixed methods study

Abstract

Background: High levels of stress are common among healthcare employees (HCWs), which are harmful to their health and the stability of healthcare human resources. Mobile stress management has been identified as a promising intervention for reducing work-related stress; however, poor adherence may limit its maximum effectiveness. Exploring factors influencing HCW adherence to mobile stress management may thus aid in the development of optimal interventions to help reduce work-related stress in the healthcare setting.

Objective: The current research sought to investigate: (1) how HCWs' well-being and cognitive factors influenced their treatment adherence in MSM; and (2) what HCWs' specific needs for MSM were.

Method: The research employs a convergent mixed-methods design. HCWs are recruited through a mobile stress management project in a large Chinese general hospital. Quantitative data included sociodemographic characteristics, fatigue symptom assessment, perceived stress, user experience, attitudes towards mobile stress management, and practicing frequency, all of which were analyzed using hierarchical regression analyses and a structural equation model. Qualitative data are collected online using an open-ended question, and they are analyzed using a pragmatic method to reflexive-thematic analysis.

Results: A total of 157 participants were included in the present study. Results from the hierarchical regression analyses showed that fatigue, user experience, and perceived usefulness were independent predictors of treatment adherence. Results from the structural equation model demonstrated that user experience indirectly influenced treatment adherence via perceived usefulness (indirect effect = 0.045, $P = 0.001$). The qualitative data identified four themes about the experience of individualized intervention, effective feedback, reward and constraint mechanisms, and duration of intervention.

Conclusions: This study indicates that alleviating fatigue symptoms and improving attitudes towards mobile stress management by promoting a user experience is vital to ensuring treatment adherence. To improve the user experience, future studies may need to consider focusing on individualized

needs, providing effective feedback, developing reward and constraint mechanisms, and developing flexible intervention duration.

KEYWORDS

Adherence; stress management; internet-based intervention; work-related stress; healthcare



Introduction

Healthcare workers (HCWs) are often more vulnerable to work-related stress due to multiple stressors that exist in the healthcare contexts, including long working hours, excessive workload, shift work, and inadequate staffing^[1-3]. Moreover, the post-pandemic era may require HCWs to spend more energy and time on extra work, which puts them in a more strained and stressful situation^[4, 5]. It is estimated that the prevalence of stress among HCWs is about 29.8% to 63.0%^[6, 7]. The detrimental effects of overwhelming work-related stress on HCWs have been well established, such as mental disorders, sleep disturbance, and physical symptoms^[8-10]. Long-term work-related stress may also reduce patient satisfaction and jeopardize patient safety^[11, 12]. Hence, implementation of stress management interventions is essential to improving the personal health of HCWs and further ensuring the stability of healthcare human resources.

In the current industrial society, practicing stress management techniques has been considered one of the essential components of healthy behaviors for individuals. For now, several stress management techniques, including mindfulness, deep breathing, and regular exercise, have been identified as simple to apply and effective in alleviating both the physical and psychological indices of stress^[13-15]. Despite the availability and effectiveness of stress management techniques, however, adherence to stress management behaviors may not be that easy for HCWs with shift work and irregular working schedules. A recent mixed-methods study concluded that cumulative stressors would hinder the application of recommended stress management techniques, resulting in half of them failing to adhere to stress management behaviors^[16]. All these findings suggest that it is critical to develop an adaptable and accessible stress management intervention so that HCWs can better employ stress management strategies to cope with daily stress.

The widespread use of digital devices suggests that internet-based intervention may be more flexible than traditional face-to-face intervention, as the former can break the time and space limit and make the intervention available 24/7. That means internet-based intervention can provide more flexibility and convenience for participants to review educational materials, communicate with professionals, and acquire regular feedback. During the past decade, accumulative research evidence has suggested that mobile stress management (MSM) intervention may produce promising effects on improving stress symptoms and well-being in the workplace^[17-19]. However, unlike traditional interventions in which the psychotherapist may supervise the adherence to treatment through face-to-face communications, the adherence of online participants has always been a bottleneck issue in such

intervention^[20, 21]. Recent studies suggested that personal support might enhance the adherence to internet-based interventions rather than a "pure" self-guided intervention, and the effects varied with the intensity of the intervention^[22]. For example, a randomized study found that the adherence rate for stress management in the content-focused guidance sample was 70.5%, higher than both the adherence-focused guidance sample (68.8%) and the administrative guidance sample (42.0%)^[23]. On the one hand, personal guidance may be regarded as an effective approach to improving adherence to internet-based stress management; on the other hand, it would be meaningful to find out factors that influence interindividual differences in nonadherence to such interventions.

Previous research identified that well-being might be a critical individual factor that might influence treatment adherence. For example, a qualitative study conducted among general populations identified that high stress levels and fatigue symptoms would hinder individuals from prioritizing and engaging in internet-based interventions^[24]. However, another study conducted among HCWs suggested that high workload rather than stress levels may exist as a barrier to web-based intervention for modifying their lifestyle, including physical activity^[25]. This might be explained by the fact the appraisal of stress can be varied among various people, while some individuals presume stress as a "hindrance" others would identify it as a "challenge" instead^[26]. As a result, high-stress levels may not be a barrier for HCWs because they are used to working under stressful circumstances; however, an excessive task may be a hindrance because it leaves little energy for them to create new habits. Given the previous findings, it would be fascinating to investigate how individual well-being, as expressed by stress and fatigue complaints, impacts HCWs' adherence to MSM.

Meanwhile, cognitive elements of therapy adherence should be considered. Although earlier study has examined adherence to different treatments such as video material, performance feedback, and human support^[24, 27], users' perspective on with these intervention components or user experience cannot be overlooked. Because work-related stress can cause a wide range of symptoms, including psychological, physical, and behavioral problems^[28-30], those who suffer from different stress symptoms will require different interventions^[31]. According to the Technology Acceptance Model (TAM) and User Experience (UX) models, individuals will only implement and use an intervention if they believe it is valuable and feasible^[32]. To put it another way, if consumers perceive the intervention to be more focused on broad rather than particular requests, they may have a terrible user experience and a negative attitude toward it. To build an effective tailored stress management

intervention, it would be required to focus on the user experience and investigate its effects on attitudes and adherence to SMS.

To summarize, the current research sought to investigate: (a) how HCWs' well-being and cognitive factors influenced their treatment adherence to MSM, and (b) what HCWs' requests for MSM were. In particular, we suggested the following research hypothesis.

H1: Individual well-being has a significant influence on HCWs' treatment adherence, and fatigue has a negative effect although stress levels do not.

H2: The user experience of HCWs would have significant effects on their perceived feasibility and utility.

H3: The attitudes would have significant effects on HCWs' treatment adherence.

H4: The attitudes of HCWs would significantly mediate the impact of their user experience on treatment adherence.

Methods

Study Design, Participants, and Data Collection

We investigated the influence of HCWs' well-being and cognitive variables on their adherence to MSM using a convergent mixed-method approach. This study was reported in compliance with the Good Mixed Methods Research Reporting Guidelines^[33]. We acquired secondary data from HCWs who participated in the MSM program at a large general hospital in China. The MSM was a human-assisted intervention that provided weekly feedback and online stress management education. Stress management training were provided by a neuropsychologist in the form of video clips, posters, and messaging. Participants were encouraged to use at least one of the three recommended stress management approaches on a weekly basis (physical activity, deep breathing, and mindfulness). Participants were asked to keep a weekly journal that documented their practice frequency and mood state, and they were subsequently given feedback based on their replies. ClinicalTrials.gov provided information on the research intervention (NCT05239065).

The analysis in this study solely comprised the intervention group since participants in the controls group had not been examined to MSM. Participants qualified if they were (1) currently employed, (2) self-reported having Internet access, (3) did not have any serious medical problems (e.g., cancer or stroke), and (4) were willing to participate in this study and sign the consent form. Participants

were excluded if they (1) intended to leave the hospital or units for any reason, or (2) were in insufficient medical condition to be followed up on. Research Electronic Data Capture (REDCap), a web-based online survey tool, was used to capture both quantitative and qualitative data. The quantitative data included sociodemographic characteristics (gender [male/female], age [years], marriage status [married/unmarried], educational background [undergraduate/postgraduate], position [physician/nurse/other], working hours [hours], income [Chinese Yuan]), well-being factors (fatigue symptoms, perceived stress) cognitive factors (user experience, attitudes [perceived usefulness, perceived feasibility, perceived enjoyment], as well as treatment adherence (practice frequency weekly).

At baseline, the Fatigue Assessment Scale (FAS), a regularly used tiredness measure consisting of ten questions, was employed to assess fatigue symptoms^[34]. Each item was graded using a 5-point Likert scale ranging from 0 (never) to 4 (always). Those with a higher FAS total score had more severe tiredness symptoms. FAS has a Cronbach alpha of 0.883, suggesting that the internal reliability of this scale was satisfied in this study.

The 14-item Perceived Stress Scale (PSS-14) was used to gauge stress levels at the baseline. PSS-14 is an internationally used self-reported 5-point Likert scale, with a greater total score indicating a higher degree of stress^[35]. The Cronbach alpha was 0.835, indicating that the PSS-14 was a credible instrument in this study for measuring felt stress.

We evaluated the user experience at the conclusion of the intervention using eight items: "Can you tell us about your experience with this research? (in terms of studying organization, quality of staff for communication/explanation, quality of videos, quality of instructional brochure, quality of education regarding the effects of stress on health, quality of education regarding stress management strategies, quality of weekly feedback reports, portable device and app applications)". These elements were evaluated on a 5-point Likert scale (1-extremely terrible to 5-extremely excellent), and the overall user experience score varied from 8 to 40, with a higher score indicating a better user experience. The Cronbach's alpha coefficient for these eight items was 0.933, indicating that the eight-item questionnaire was trustworthy for assessing HCW user experience.

SMS attitudes were assessed on three dimensions: perceived utility, perceived ease-of-use, and perceived enjoyment. Perceived usefulness was defined as "the level of one's belief in using technology," perceived ease-of-use was defined as "a person's belief in the use of a technology that can be easily used," and perceived enjoyment was defined as "the degree of enjoyment of using a

technology," as suggested by the previous study. We specifically investigated HCW sentiments using three items: (1) "Did you find the Stress Management Intervention Study beneficial in general?" (perceived utility), (2) "Did you find the Stress Management Intervention Study to be straightforward to complete?" (feasibility), and (3) "Did you find the Stress Management Intervention Study interesting overall?" (perceived enjoyment). The three items were graded on a 5-point Likert scale, with higher scores suggesting a more favourable attitude about MSM. The Cronbach's alpha coefficient for these three items was 0.713, showing that the three-item questionnaire was consistent enough to assess attitudes against MSM among HCWs.

A closed-ended question, "Did you practice the stress management interventions?" was used to assess adherence to MSM. Participants were asked to use a 7-point Likert scale to rate their practice frequency of physical activity, deep breathing exercise, and mindfulness (0-never to 6-everyday). A higher overall score suggested more MSM adherence. The Cronbach's alpha coefficient for these three items was 0.793, indicating that the three-item questionnaire was trustworthy in assessing HCWs' adherence to MSM.

Furthermore, in order to learn about the unique needs of HCWs when using MSM, we requested HCWs to answer an open-ended question (online interview), "Do you have any suggestions for improving the mobile stress management program?"

Analysis

Quantitative Data Analysis

SPSS 26.0 and AMOS 28.0 were used to analyze quantitative data. For each categorical item, a descriptive analysis of the response frequencies was performed, and the mean and standard deviations ($M \pm SD$) for the continuous variables were calculated. Then, hierarchical regression analyses were run to examine the relative contributions of demographic variables, well-being factors, and cognitive factors in treatment adherence variances. The dependent variable was set to treatment adherence, and all predictors were included in the regression step by step. Finally, path analysis was used to investigate the mediation of attitude between experience and MSM adherence. The model fit was evaluated using several goodness-of-fit indices, including the root mean square of approximation (RMSEA), the comparative fit index (CFI), and the Tucker-Lewis index (TLI), with an RMSEA less than 0.08 and a CFI and TLI greater than 0.90 indicating an acceptable fit^[18]. With

5,000 bootstrap samples, the indirect effects were examined, and a significant effect was determined if the 95% confidence interval (CI) did not include zero.

Qualitative Data Analysis

Nvivo 14.0 was used to analyze qualitative data. The open-ended survey responses were analyzed using a pragmatic approach to reflexive-thematic analysis^[36]. The analysis was carried out in six steps: (1) familiarization with the data, (2) code generation, (3) theme construction, (4) review of potential themes, (5) theme definition and naming, and (6) report production. In this study stage, two experienced researchers (MQL and QW) independently read the transcript and coded the findings.

Ethical Approval

This study was approved by the ethnic committee of the Medical Ethics Committee of Tongji Medical College, Huazhong University of Science and Technology, China (approval number: IRB # 2021S141). All participants provided informed consent for each sample component, and the principles of voluntarism and security were emphasized during the recruitment process.

Results

Sample Characteristics

There were 157 participants in total, with 135 (86.0%) females and 22 (14.0%) males. In terms of age, 35 (22.3%) participants were under the age of 30, 97 (61.8%) were between the ages of 30 and 40, and 25 (15.9%) were over the age of 40. In terms of marital status, 115 (73.2%) participants were married, while 42 (26.8%) were single. In terms of position, 30 participants (19.1%) were physicians, 104 (66.2%) were nurses, and 23 (14.7%) were other HCWs. When it came to family income, 18 (11.5%) of the participants had less than 10,000 RMB. 81 (51.6%) participants had a family income of 10,000 to 15,000 Chinese Yuan, 35 (22.3%) had a family income of 15,000 to 20,000 Chinese Yuan, and 23 (14.6%) had a family income of more than 5000 Chinese Yuan. When it came to working hours, 22 (14.0%) participants worked less than 35 hours per week, 74 (47.1%) worked 35 to 44 hours per week, and 61 (38.9%) worked more than 44 hours per week (see Table 1).

Table 1. Respondent characteristics (n=157)

Characteristics		Participants [n, (%)]
Gender	Female	135 (86.0)
	Male	22 (14.0)
Age group (years)	< 30	35 (22.3)

	30 to 40	97 (61.8)
	> 40	25 (15.9)
Marital status	Married	115 (73.2)
	Unmarried	42 (26.8)
Educational level,	Associate or bachelor's degree	120 (76.4)
	Postgraduate degree	37 (23.6)
Occupation	Physician	30 (19.1)
	Nurse	104 (66.2)
	Other healthcare workers	23 (14.7)
Income (Chinese Yuan)	< 10,000	18 (11.5)
	10,000 to 15,000	81 (51.6)
	15,001 to 20,000	35 (22.3)
	> 20,000	23 (14.6)
Working (hours)	< 35	22 (14.0)
	35 to 44	74 (47.1)
	> 44	61 (38.9)
Body mass index	≤ 23.9	120 (76.4)
	> 23.9	37 (23.6)

Descriptive Statistics

Table 2 displays descriptive results for the main study variables. Participants rated perceived usefulness as 2.96 out of 5.0 (SD 0.85), perceived feasibility as 3.71 out of 5.0 (SD 0.72), and perceived enjoyment as 3.59 out of 5.0 (SD 0.69), in that order. The HCWs rated their experience with MSM as 32.03 out of 40.0 (SD 5.01), and the "quality of weekly feedback reports" received the highest mean score of 4.17. (SD 0.73). Participants rated their adherence to MSM to physical activity as 2.91 out of 5.0 (SD 1.15), deep breathing as 3.25 out of 5.0 (SD 1.34), and mindfulness as 2.92 out of 5.0 (SD 1.33), on average.

Table 2. Descriptive Statistics of Attitude, Experience, and Adherence to MSM.

Variables	Range	Mean	SD	Min	Max
Experience ^a	8-40	32.03	5.01	8.00	40.00
Experience regards to study organization	1-5	3.74	0.71	1.00	5.00
Quality of staff for communication/ explanation	1-5	4.08	0.77	1.00	5.00
Quality of the videos	1-5	4.03	0.80	1.00	5.00
Quality of education regarding the effects of stress on health	1-5	4.09	0.77	1.00	5.00
Quality of education regarding stress management strategies	1-5	4.06	0.77	1.00	5.00
Quality of weekly feedback reports	1-5	4.17	0.73	1.00	5.00
Applications of portable device and app	1-5	4.01	0.75	1.00	5.00
Attitude ^a	3-15	10.26	1.82	5.00	15.00
Perceived usefulness	1-5	2.96	0.85	1.00	5.00
Perceived feasibility	1-5	3.71	0.72	2.00	5.00
Perceived interest	1-5	3.59	0.69	1.00	5.00
Adherence to mobile stress management ^a	3-21	9.15	3.22	3.00	18.00
Physical activity	1-7	2.97	1.15	1.00	6.00
Deep breathing	1-7	3.25	1.34	1.00	7.00
Mindfulness	1-7	2.92	1.33	1.00	7.00

Note: ^a Composite score of questionnaire.

Hierarchical regression analyses

For the hierarchical regression analysis, four models were obtained. As shown in Table 3, the demographic variables (gender, age, marriage status, position, income, and working hours) were entered into the model in the first step, and no variable was found to be significant in explaining the variance of treatment adherence. When perceived stress and fatigue symptoms were included in Step 2, the percentage of treatment adherence explained by the predictors significantly increased from $R^2 = 0.043$ in Model 1 to $R^2 = 0.093$ in Model 2, and fatigue symptom was demonstrated to be a significant predictor ($b = -0.050$, $t = -2.859$, and $P = 0.005$). Then, after user experience was included as the predictor in Step 3, the percentage of treatment adherence explained by the predictors significantly increased from $R^2 = 0.093$ in Model 2 to $R^2 = 0.205$ in Model 3. And user experience was demonstrated to be a significant predictor ($b = 0.074$, $t = 4.569$, and $P < 0.001$). In the last step, when attitude was included as the predictor, the percentage of treatment adherence explained by the predictors significantly increased from $R^2 = 0.205$ in Model 3 to $R^2 = 0.315$ in Model 4, while attitude was shown to be a significant predictor ($b = 0.238$, $t = 4.863$, and $P < 0.001$), the significance of attitude was shown to be disappear in Model 4 ($b = 0.031$, $t = 1.770$, and $P = 0.079$). All the predictors of Model 4 together explained 31.5% of the variance of treatment adherence ($R^2 = 0.315$, $P < 0.001$).

Table 3. Hierarchical regression analysis of burnout symptoms.

Predictors	Model1			Model2			Model3			Model4	
	b	Beta	T	b	Beta	T	b	Beta	T	b	Beta
Constant	1.750	3.773***		2.505	3.789***		0.076		0.093	-0.814	
Gender	0.095	0.031	0.359	0.100	0.032	0.383	0.174	0.056	0.708	0.082	0.027
Age	0.185	0.084	0.997	0.170	0.078	0.934	0.078	0.036	0.452	-0.068	-0.03
Education	0.113	0.131	0.865	0.051	0.035	0.389	0.002	0.001	0.014	0.033	0.023
Time	-0.185	-0.151	-1.785	-0.173	-0.141	-1.701	-0.119	-0.097	-1.241	-0.052	-0.04
Working hours	0.151	0.069	0.794	0.167	0.076	0.883	0.192	0.088	1.084	0.174	0.079
Perceived stress				0.026	0.152	1.634	0.017	0.100	1.140	0.013	0.076
Job fatigue				-0.050	-0.264	-2.859**	-0.041	-0.214	-2.452**	-0.038	-0.20
Burnout symptoms											
Work experience							0.074	0.345	4.569***	0.031	0.144
Job demands										0.238	0.402
	0.043			0.093			0.205			0.315	
	1.385			2.182*			4.774***			7.520***	

Δ: * $p < 0.05$, ** $p < 0.01$ Δ*** $p < 0.001$; *b*, unstandardized coefficient; *Beta*, standardized coefficient.

Mediation analysis

According to Hu and Bentler's ^[37] suggested model fit indicators, the model in this paper had a good fitting degree. Table 4 shows that the χ^2/df values were less than 3, the SRMR and RMSEA values were less than 0.80, and the CFI, NFI, IFI, and TLI values were all greater than 0.90, all of which were within the range of acceptable fit indexes. To summarize, the results of confirmatory factor analysis confirm that the empirical model comprised of attitude, experience, and adherence has good validity; the collected data are highly reliable; and the research findings are robust.

Table 4. Goodness of fit indexes for serial mediation models.

Index	Goodness-of-fit measure		Model fit
	Good fit	Accept fit	
Chi-square/df	$0 \leq \chi^2/df \leq 2$	$2 < \chi^2/df \leq 3$	1.640
p-value	$0.05 < p \leq 1.00$	$0.01 < p \leq 0.05$	0.073
RMSEA	$0 \leq RMSEA \leq 0.05$	$0.05 < RMSEA \leq 0.08$	0.064
SRMR	$0 \leq SRMR \leq 0.05$	$0.05 < SRMR \leq 0.08$	0.061
NNFI	$0.97 < NNFI \leq 1.00$	$0.95 \leq NNFI \leq 0.97$	0.951
CFI	$0.97 < CFI \leq 1.00$	$0.95 \leq CFI \leq 0.97$	0.980
AGFI	$0.90 < AGFI \leq 1.00$	$0.95 \leq AGFI \leq 0.97$	0.928

Figure 1 depicts the results of attitude mediation between experience and adherence to MSM. The path coefficient from experience to adherence was 0.079 ($P = 0.001$), and the path coefficient from attitude to adherence was 0.568 ($P = 0.001$). Meanwhile, the Bootstrapping estimates revealed that the direct influence of experience on adherence was not significant (direct effect=0.002, $P = 0.862$), implying that experience had a full indirect effect on adherence via the attitude toward MSM (indirect effect = 0.047, $P = 0.001$).

Results of open-ended survey response

The open-ended survey received 96 responses from 157 participants, which were identified and categorized into four themes: (a) individualized intervention, (b) effective feedback, (c) reward and constraint mechanisms, and (d) duration of

intervention. Each theme could have three subthemes. Table 5 summarizes the themes, subthemes, and sample quotes.



Table 5. List of themes, subthemes, and sample quotes from the open-ended survey responses.

Themes	Sub-themes	Sample quotes
	Diversified modules	"Everyone's stress sources are different and require one-on-one counseling from professionals." (Participant 79)
		"I want to learn more about how to alleviate my anxiety." (Participant 118)
		"I find it hard to change my sleep quality." (Participants 83 and 107)
		"I want to know how to reduce negative emotions and deal with doctor-patient conflicts." (Participant 100)
Individualized intervention	Adapt to work schedules	"I often work too long hours, and I find it difficult to guarantee enough time to practice those techniques." (Participant 9)
		"I didn't have time to exercise". (Participant 26)
	Staging the intervention	"It's hard to get started." (Participant 137)
		"It's hard to insist on." (Participant 14, 32, 50, 128)
Effective feedback	Feedback content	"Professionals are required to follow up and guide the practice process." (Participant 79)
		"The content of the feedback should be more specific to the weekly plan and monthly schedule, which would be more intuitive". (Participant 68)
	Feedback frequency	"The weekly questionnaire should be adapted to each individual's situation." (Participant 41)
		"It would be better if we could get summarized and analyzed feedback data on a weekly or biweekly basis." (Participant 147)
Reward/constraint mechanisms	Motivations for practice	"We need more supervision and feedback." (Participant 117)
		"More frequent reminders are needed." (Participant 143)
		"Giving rewards to stimulate movement would be useful". (Participant 108)
		"It would work by motivating everyone to exercise through group check-ins." (Participant 50)
		"It's important to mobilize the wisdom of everyone in the group and share more methods, skills, and experiences together". (Participant 156)

Duration of intervention	More restraints	"It is completely dependent on self-consciousness and self-restraint." (Participant 158)
		"It would be best if participants could be supervised and demanded a little more". (Participant 79)
		"A little more restraint is needed to help us form habits." (Participant 96)
	Short-term intervention	"Reduce the experimental cycle." (Participant 18)
	Long-term intervention	"I hope the project will continue for a longer time." (Participant 54, 90)

Discussion

This research focused on how individual treatment adherence differed depending on their well-being and cognitive factors. By using a convergent mixed-methods research, we specifically examined the direct effects of well-being factors on treatment adherence and the indirect effects of cognitive factors on treatment adherence, as well as learning about the specific requirements of HCWs for mobile stress management interventions.

Overall, the adherence score of internet-based mobile-supported stress management on the lower level compare to the attitude and experience, especially the adherence of mindfulness and physical activities are lower than deep breathing. The results are consistent with previous studies^[19, 21], despite the dropouts are reduced in internet-based contrast to face to face, the participants often fail to entire adherence. For the specific adherence of management, the effectiveness of physical activities and mindfulness are proved, while the explanation of bad adherence to physical and mindfulness probable related to the long work hours^[7, 15, 18, 38]. A previous study showed that breathing exercises can reducing stress levels even in the short term (mean time of 1.9 minutes)^[39], which mean that breathing exercises may be more available for healthcare workers who spend most of their time providing healthcare. Healthcare workers are a special group of people who with heavy workloads and limited job autonomy. The time spending, setting requirements and accessibility of management programs were priorities in stress management for this group of people. Therefore, in the future, stress management of specific interventions needs to be based on the working conditions such as working hours or environment of different healthcare workers, taking into account the feasibility of developing a personalized management plan to improve adherence.

On the issue of burnout symptoms, this study revealed that fatigue symptoms exhibited statistical significance rather than perceived stress. An explanation for this

finding is that Bond discovered that perceived stress did not reach a statistically significant level in relation to burnout. One possible reason for this could be attributed to insufficient training hours, while another factor may be the nurses' anticipation of encountering stressful work in their future shifts. Additionally, according to Maslow's hierarchy of needs theory, fatigue symptoms represent fundamental and immediate needs, whereas perceived stress can potentially be managed through various methods by healthcare workers. As professional practitioners, healthcare workers consciously adapt themselves to reduce stress levels; however, it is important to consider potential biases resulting from psychological effects during the design phase of this study. Furthermore, fatigue and burnout may have intertwined effects as evidenced by a prospective cohort study which reported that individuals in the "burnout & fatigue" group had a higher proportion of chronic course type compared to those experiencing "pure burnout" or "pure fatigue". Severe burnout and fatigue symptoms become interconnected with each other as well as with other psychological and/or somatic complaints^[40]. However, the specific association between fatigue and specific factors remains unclear^[41].

The most interesting finding is that the attitude mediates to experience and adherence. The result of the total effect between the experience and adherence significantly increase ($r=0.047$, $P=0.001$), while there are have no significant direct effect of the experience and adherence. Most existing studies have emphasized the importance of user experience on treatment adherence^[19, 38]. However, the direct relationship between the experience and adherence is limited in a definite explanation. On the contrary, the discussion of attitude and adherence is a classic issue, and the amount of evidence report the relationship between attitude and adherence in stress management interventions^[38, 42, 43]. Our research indicated that the direct impact of user experience on treatment adherence disappeared after inputting the variable of attitudes. An implication of the further relationship is the possibility that the improvement of experience with the object of adherence increasing is to make the attitude of the

internet-based mobile-supported program or management positive, despite the weak significant association between the experience and attitude. It may provide another perspective on retention in stress management, and a similar relationship in other psychological health of HCWs should be developed in the future.

We also identify the four aspects of individualized intervention, effective feedback, reward/constraint mechanisms, and duration of intervention as certain factors to adherence to internet-based mobile-supported stress management. Generally, all the factors are highlight the personalized service throughout the whole intervention. The high quality and individual needs of intervention contents are more vital; inadequate-supported contents are the hindering. Furthermore, HCWs as the special population with healthcare education background, faced the problem of personal situation, have no time to integrate exercises into their daily lives, and needs more personal conversation with eCoach in the stage of staging and feedback. It's in line with previous observations^[44-46]. In the reward/constraint mechanisms, HCWs required the increasing demands outwards, which addressed the role of the organization in the interventions. Proving reminders, encouraging each other, and using rewards as the external triggers were taken for effective measures to increase adherence in other evidence^[47, 48]. To the duration of intervention, extensive studies have pointed out that stress was reduced with the increasing duration of intervention^[8, 49, 50]. Considering that healthcare often required demanding physical and psychological efforts, HCWs often left little energy to complete stress management strategies on a daily basis. Therefore, future studies may need to be more focused on less exhausting intervention for those working in healthcare contexts.

Strength and Limitations

Its novel perspective of this study uses mixed methods, which is a combination of qualitative and quantitative, to explore the relationship among experience, attitude, and adherence. This paper further complements the mediation effect of attitude in user

experience and adherence in stress management of HCWs; it's contribute to similar psychological health management or intervention program. Some limitations in the paper also need to be taken into consideration. First, the exploratory study investigated a small sample size with a short-term intervention. Second, the data collection of qualitative research online could result in lacking information. Furthermore, the implication of this paper is that participants in qualitative research may have been positively biased in their support of the intervention because all the interviewees finished the intervention. It would be valuable in future work to extend the sample, focus on those who chose to drop out of the intervention, and explore the reasons for dropping out.

Conclusion

Our study attested to the value of experience in stress management adherence by a mediator of attitude in the internet-based mobile-supported intervention. HCWs, as the special participants in stress management, have required more individualized measures, effective feedback, rewards/ constraint mechanisms, and duration of intervention are contributors to adherence. Future research should enter more path variables based on this paper to explore the potential relationship for the completed mechanisms of adherence to internet-based mobile-supported interventions.

Reference

- [1] JOSEPH B, JOSEPH M. The health of the healthcare workers [J]. Indian Journal of Occupational and Environmental Medicine, 2016, 20(2): 71-2.
- [2] MEDISAUSKAITE A, KAMAU C. Prevalence of oncologists in distress: Systematic review and meta-analysis [J]. Psycho-oncology, 2017, 26(11): 1732-40.
- [3] REITH T P. Burnout in United States Healthcare Professionals: A Narrative Review [J]. Cureus, 2018, 10(12): e3681.
- [4] CARUSO C C. Negative impacts of shiftwork and long work hours [J]. Rehabilitation Nursing : the Official Journal of the Association of Rehabilitation Nurses, 2014, 39(1): 16-25.
- [5] ROSA D, TERZONI S, DELLAFIORE F, et al. Systematic review of shift work and nurses' health [J]. Occupational Medicine (Oxford, England), 2019, 69(4): 237-43.

- [6] TEO I, CHAY J, CHEUNG Y B, et al. Healthcare worker stress, anxiety and burnout during the COVID-19 pandemic in Singapore: A 6-month multi-centre prospective study [J]. *PloS One*, 2021, 16(10): e0258866.
- [7] ZHANG M, MURPHY B, CABANILLA A, et al. Physical relaxation for occupational stress in healthcare workers: A systematic review and network meta-analysis of randomized controlled trials [J]. *Journal of Occupational Health*, 2021, 63(1): e12243.
- [8] BISCHOFF L L, OTTO A-K, HOLD C, et al. The effect of physical activity interventions on occupational stress for health personnel: A systematic review [J]. *International Journal of Nursing Studies*, 2019, 97.
- [9] GEORGE L S, LAIS H, CHACKO M, et al. Motivators and Barriers for Physical Activity among Health-Care Professionals: A Qualitative Study [J]. *Indian Journal of Community Medicine : Official Publication of Indian Association of Preventive & Social Medicine*, 2021, 46(1): 66-9.
- [10] PHILBRICK G, SHERIDAN N F, MCCAULEY K. An exploration of New Zealand mental health nurses' personal physical activities [J]. *International Journal of Mental Health Nursing*, 2022, 31(3): 625-38.
- [11] CONVERSANO C, CIACCHINI R, ORRù G, et al. Mindfulness, Compassion, and Self-Compassion Among Health Care Professionals: What's New? A Systematic Review [J]. *Frontiers In Psychology*, 2020, 11: 1683.
- [12] GOYAL M, SINGH S, SIBINGA E M S, et al. Meditation programs for psychological stress and well-being: a systematic review and meta-analysis [J]. *JAMA Internal Medicine*, 2014, 174(3): 357-68.
- [13] HEBER E, EBERT D D, LEHR D, et al. The Benefit of Web- and Computer-Based Interventions for Stress: A Systematic Review and Meta-Analysis [J]. *Journal of Medical Internet Research*, 2017, 19(2): e32.
- [14] STANIĆ J, BARTH J, DANON N, et al. Adherence to standardized 8-week mindfulness-based interventions among women with breast or gynecological cancer: a scoping review [J]. *Journal of Psychosocial Oncology Research & Practice*, 2021.
- [15] TAYLOR H, CAVANAGH K, FIELD A P, et al. Health Care Workers' Need for Headspace: Findings From a Multisite Definitive Randomized Controlled Trial of an Unguided Digital Mindfulness-Based Self-help App to Reduce Healthcare Worker Stress [J]. *JMIR MHealth and UHealth*, 2022, 10(8): e31744.
- [16] EBERT D D, KÄHLKE F, BUNTROCK C, et al. A health economic outcome evaluation of an internet-based mobile-supported stress management intervention for employees [J]. *Scandinavian Journal of Work, Environment & Health*, 2018, 44(2): 171-82.
- [17] EBERT D D, FRANKE M, ZARSKI A-C, et al. Effectiveness and Moderators of an Internet-Based Mobile-Supported Stress Management Intervention as a Universal Prevention Approach: Randomized Controlled Trial [J]. *Journal of Medical Internet Research*, 2021, 23(12): e22107.
- [18] XIA Y, YANG Y. RMSEA, CFI, and TLI in structural equation modeling with ordered categorical data: The story they tell depends on the estimation methods [J]. *Behavior Research Methods*, 2019, 51(1): 409-28.
- [19] ZARSKI A-C, LEHR D, BERKING M, et al. Adherence to Internet-Based Mobile-Supported

- Stress Management: A Pooled Analysis of Individual Participant Data From Three Randomized Controlled Trials [J]. *Journal of Medical Internet Research*, 2016, 18(6): e146.
- [20] BIJELIC T, EKBERG E, WILLMAN A, et al. Expectations and Experiences of Internet-Based Therapy for Adolescents with TMD Pain [J]. *Journal of Oral & Facial Pain and Headache*, 2022, 36(3-4): 237–52.
- [21] JOHANSSON M, MARCUSSON-CLAVERTZ D, GUNNARSSON C, et al. Feasibility and preliminary evaluation of internet-based compassion and cognitive-behavioral stress-management courses for health care professionals: A randomized controlled pilot trial [J]. *Internet Interventions*, 2022, 30: 100574.
- [22] TODKILL D, POWELL J. Participant experiences of an internet-based intervention and randomised control trial: interview study [J]. *BMC Public Health*, 2013, 13: 1017.
- [23] FUHR K, SCHRÖDER J, BERGER T, et al. The association between adherence and outcome in an Internet intervention for depression [J]. *Journal of Affective Disorders*, 2018, 229: 443-9.
- [24] ZAVOROTNY M, EHRLICH F, NENADIC I. Health-related Internet use and treatment adherence: A transdiagnostic comparison of outpatients with major depressive disorder and schizophrenia [J]. *PsyCh Journal*, 2020, 9(2): 174-84.
- [25] WU D, LOWRY P B, ZHANG D, et al. Patient Trust in Physicians Matters-Understanding the Role of a Mobile Patient Education System and Patient-Physician Communication in Improving Patient Adherence Behavior: Field Study [J]. *Journal of Medical Internet Research*, 2022, 24(12): e42941.
- [26] WEISEL K K, ZARSKI A-C, BERGER T, et al. User Experience and Effects of an Individually Tailored Transdiagnostic Internet-Based and Mobile-Supported Intervention for Anxiety Disorders: Mixed-Methods Study [J]. *Journal of Medical Internet Research*, 2020, 22(9): e16450.
- [27] WALLIN E, NORLUND F, OLSSON E M G, et al. Treatment Activity, User Satisfaction, and Experienced Usability of Internet-Based Cognitive Behavioral Therapy for Adults With Depression and Anxiety After a Myocardial Infarction: Mixed-Methods Study [J]. *Journal of Medical Internet Research*, 2018, 20(3): e87.
- [28] CAVANAGH K. Turn on, tune in and (don't) drop out: Engagement, adherence, attrition, and alliance with internet-based interventions [M]. *Oxford guide to low intensity CBT interventions*. New York, NY, US; Oxford University Press. 2010: 227-33.
- [29] COELHO S C, TOBO P R, LACERDA S S, et al. A New Mental Health Mobile App for Well-Being and Stress Reduction in Working Women: Randomized Controlled Trial [J]. *Journal of Medical Internet Research*, 2019, 21(11): e14269.
- [30] LI J, RIEDEL N, BARRECH A, et al. Long-Term Effectiveness of a Stress Management Intervention at Work: A 9-Year Follow-Up Study Based on a Randomized Wait-List Controlled Trial in Male Managers [J]. *BioMed Research International*, 2017, 2017: 2853813.
- [31] KNEKT P, VIRTALA E, HÄRKÄNEN T, et al. The outcome of short- and long-term psychotherapy 10 years after start of treatment [J]. *Psychological Medicine*, 2016, 46(6): 1175-88.
- [32] HERR R M, BARRECH A, RIEDEL N, et al. Long-Term Effectiveness of Stress Management at Work: Effects of the Changes in Perceived Stress Reactivity on Mental Health and Sleep Problems Seven Years Later [J]. *International Journal of Environmental Research and Public*

- Health, 2018, 15(2).
- [33] O'CATHAIN A, MURPHY E, NICHOLL J. The quality of mixed methods studies in health services research [J]. *Journal of Health Services Research & Policy*, 2008, 13(2): 92-8.
 - [34] MIHALITS D S, SCHILLER B, BARRECH A, et al. The Flipside of Work Engagement: A Qualitative Evaluation of a Stress Management Intervention in the Workplace [J]. *Human Arenas*, 2019, 6: 358-72.
 - [35] COHEN S, KAMARCK T, MERMELSTEIN R. A global measure of perceived stress [J]. *Journal of Health and Social Behavior*, 1983, 24(4): 385-96.
 - [36] CAMPBELL K A, ORR E, DUREPOS P, et al. Reflexive Thematic Analysis for Applied Qualitative Health Research [J]. *The Qualitative Report*, 2021.
 - [37] HU L T, BENTLER P M. Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives [J]. *Structural Equation Modeling: A Multidisciplinary Journal*, 1999, 6(1): 1-55.
 - [38] VIZHEH M, QORBANI M, ARZAGHI S M, et al. The mental health of healthcare workers in the COVID-19 pandemic: A systematic review [J]. *Journal of Diabetes and Metabolic Disorders*, 2020, 19: 1967 - 78.
 - [39] ADEYEMO O O, TU S, FALAKO S, et al. Stressors on frontline healthcare workers during the COVID-19 pandemic: a focus on moral injury and implications for the future [J]. *International Archives of Occupational and Environmental Health*, 2022, 95(8): 1755-62.
 - [40] LEONE S S, HUIBERS M J, KNOTTNERUS J A, et al. A comparison of the course of burnout and prolonged fatigue: a 4-year prospective cohort study [J]. *J Psychosom Res*, 2008, 65(1): 31-8.
 - [41] VAN DAM A, KEIJERS G, VERBRAAK M, et al. Level and appraisal of fatigue are not specific in burnout [J]. *Clin Psychol Psychother*, 2015, 22(2): 133-41.
 - [42] DE KOCK J H, LATHAM H A, COWDEN R G. The mental health of healthcare workers during the COVID-19 pandemic: a narrative review [J]. *Current Opinion In Psychiatry*, 2022, 35(5): 311-6.
 - [43] DONG F, LIU H-L, YANG M, et al. Immediate Psychosocial Impact on Healthcare Workers During COVID-19 Pandemic in China: A Systematic Review and Meta-Analysis [J]. *Frontiers In Psychology*, 2021, 12: 645460.
 - [44] DE SIO S, LETIZIA C, PETRAMALA L, et al. Work-related stress and cortisol levels: is there an association? Results of an observational study [J]. *European Review For Medical and Pharmacological Sciences*, 2018, 22(24): 9012-7.
 - [45] FRANCK E, HAEGDORENS F, GOOSSENS E, et al. The Role of Coping Behavior in Healthcare Workers' Distress and Somatization During the COVID-19 Pandemic [J]. *Frontiers In Psychology*, 2021, 12: 684618.
 - [46] PAPPAS S, SAKKAS N, SAKKA E. A year in review: sleep dysfunction and psychological distress in healthcare workers during the COVID-19 pandemic [J]. *Sleep Medicine*, 2022, 91: 237-45.
 - [47] PANAGIOTI M, GERAGHTY K, JOHNSON J, et al. Association Between Physician Burnout and Patient Safety, Professionalism, and Patient Satisfaction: A Systematic Review and Meta-analysis [J]. *JAMA Internal Medicine*, 2018, 178(10): 1317-31.
 - [48] MONTGOMERY A, DOEF M, PANAGOPOULOU E, et al. Connecting Healthcare Worker

- Well-Being, Patient Safety and Organisational Change The Triple Challenge: The Triple Challenge [M]. 2020.
- [49] BARTLETT L, MARTIN A, NEIL A L, et al. A systematic review and meta-analysis of workplace mindfulness training randomized controlled trials [J]. *Journal of Occupational Health Psychology*, 2019, 24(1): 108-26.
- [50] ZACCARO A, PIARULLI A, LAURINO M, et al. How Breath-Control Can Change Your Life: A Systematic Review on Psycho-Physiological Correlates of Slow Breathing [J]. *Frontiers In Human Neuroscience*, 2018, 12: 353.

Supplementary Files

Figures

Fig. 1 Perceived usefulness as a mediator for experience-adherence relationship.

