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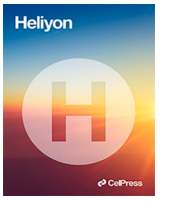

The association between workplace physical environment and nurses' safety compliance: A serial mediation of psychological and behavioral factors

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ABSTRACT

Aim: This study describes Jordanian intensive care unit nurses' satisfaction with their physical environment and investigates the association between workplace physical environment and nurses' safety compliance. Additionally, the study offers serial mediation analyses of psychological and behavioral factors between satisfaction with the workplace physical environment and nurses' safety compliance.

Introduction: Compliance with safety measures is a vital indicator of safety performance, as less compliance directly reflects undesirable safety outcomes among nurses, like occupational accidents, injuries, and fatalities. Social cognitive theory and the safety triad model contribute to understanding safety compliance behaviors to safety procedures. Thus, enhancing safety compliance in healthcare organizations remains a challenge and concern.

Methods: A quantitative research method was used based on cross-sectional and descriptive data from eight governmental hospitals in Jordan. The population included all intensive care unit nurses in the Ministry of Health's hospitals (n = 1104). A cluster sampling technique selected 285 nurses to participate. Empirical results were obtained through structural equation modeling (i.e., Smart PLS-SEM), which has become popular in this kind of research.

Results: The mean of Jordanian ICU nurses' satisfaction with the workplace physical environment was 3.36, which is moderate. Although the Smart PLS findings did not support the direct association between the workplace physical environment and nurses' safety compliance, serial mediation of safety participation in the workplace physical environment and nurses' safety

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compliance and perceived safety management commitment confirm the indirect association in the study model.

Conclusion: This study fills a gap in available safety and nursing literature, especially when considering the scarce studies that investigated the physical elements in the workplace and both safety compliance and safety participation. The findings are valuable for academicians, health providers, and policymakers and may trigger creative ideas and interventional solutions to improve nurses' safety compliance in healthcare organizations.

1. Introduction

Compliance with safety measures is one element of safety behaviors and a vital indicator of individual safety performance in healthcare organizations. It directly reflects healthcare workers' safety outcomes (i.e., occupational accidents, injuries, and fatalities) in their working duties, such as [1–3]. Safety compliance recognizes the mandatory behaviors that employees must adhere to in core safety tasks [4]. These activities are needed to guarantee workplace safety [4,5]. Safety compliance is one subset of job performance sourced from the job performance theory [6]; more precisely, safety compliance signifies task performance in a safety context. Hence, it is not debatable among healthcare professions (i.e., nursing) [3].

In healthcare organizations, continuing compliance with daily work, including safety activities that nurses perform in intensive care unit (ICU) environments, is mentally, physically, and psychologically intense [7,8]. A recent systematic review revealed that compliance with safety procedures such as hand hygiene among ICU nurses is only 9.1% in low-income countries such as Jordan [9]. Accordingly, exploring safety compliance among ICU nurses is demanded because the risk is exacerbated, and belief in safety compliance in these units is vital to keep nurses safe [10]. Several constructs like safety climate, safety knowledge, and motivation [11–15], leadership, supervisory, and managerial practices [16,17], psychological and social factors like psychological empowerment [10,18,19], professional work environments such as organizational justice, job demand, control, and support [20,21] have been investigated with safety compliance as an outcome. Given the importance of safety compliance, advancing research to explore nurses' safety compliance predictors is required [9]. In this study, nurses' safety compliance is defined as mandatory safety behaviors that nurses must undertake and adhere to in their daily duties.

The literature has identified the role of physical hazards in ICUs [22,23], and engineering approaches and strategies to control ICU hazardous environments have been developed [24,25]. However, physical hazards like occupational noise, inadequate lighting, unit design, and inadequate ventilation remain common concerns in ICUs [26]. The workplace physical environment plays a significant role in daily work, considering the long duration of work hours, which extend to 12 h or more in some circumstances. Moreover, the complexity of the physical work environment in ICUs, such as occupational noise and lighting, creates issues. Hence, this study recognizes this kind of environment regarding nurses' safety. However, the available literature results testing the direct link between the physical environment and safety outcomes are blurry. For instance, some have found no significant association between workplace physical environment and safety behaviors [27,28]; others confirmed that physical environment is indirectly related to safety behaviors. Hence, additional empirical studies concerning the workplace physical environment and safety compliance behaviors are required [29].

Managing workplace safety requires understanding the psychological perspective and cognitive process between the physical environment and safety compliance [29,30]. Thus, the study model used the Social Cognitive Theory (SCT) to support the study model. Previous studies in the safety context, such as Cui et al. in the Chinese mining industry, used SCT in a causation model regarding the organizational safety integrative model. They recommended further retesting their integrative approach in other countries' safety contexts to understand better the linkages among the physical environment, psychological issues, and, eventually, safety behaviors [29].

SCT presents a triadic, reciprocal association among persons, environment, and behaviors [31]. Studies suggest that the environment influences the psychological aspects and the formation of cognitive processes and social behaviors [32]. SCT posits that the environment influences the development of psychological aspects of individuals and helps form cognitive processes and social behaviors [33]. Thus, our model proposes that the physical environment in ICUs will influence the development of cognitive aspects among nurses (i.e., perceived safety management commitment and help form safety compliance and participation behavior [33].

This study investigates the nurses' safety compliance model by testing six direct and four mediation hypotheses in the Jordanian context. Additionally, the current study describes the level of nurses' satisfaction with their physical environment in the ICU. The following part presents the theoretical background and hypothesis building.

2. Theoretical background and hypotheses building

2.1. Workplace physical environment

The concept of the work environment in the ICU includes physical, professional, and emotional environments [34]. The workplace physical environment in healthcare settings, particularly in ICUs, is unique as it is one of a hospital's most important units [35]. The ICU physical environment is a source of potential hazards, harm, or adverse events among workers; it is no wonder that previous research has called it a source of workplace stressors [34] or a hazardous environment [29].

The physical environment in the ICU consists of stimuli such as ambient properties (i.e., noise, air quality, and hygiene), Interior design (i.e., unit design, equipment, and furnishing), and architectural design (i.e., lighting, surfaces, and ventilation) [36,37]. A model of organizational behavior management and occupational safety establishes the importance of environmental conditions in workplaces [38]. However, a need exists for better theoretical frameworks to understand the impacts of the workplace physical environment on employee behaviors [39], as hazardous physical factors in workplaces negatively affect the health and well-being of human beings [35].

Nurses' dissatisfaction with these physical environments is massive, adversely influencing their desire and ability to perform and reducing ratings of patient care quality, increasing psychological strain, stress, and burnout, increasing medication errors, and negatively contributing to occupational health and safety [40–44]. Looking at the issue from a different perspective, this study supposes that satisfaction with the workplace physical environment will be positively associated with nurses' compliance and participation behaviors and, accordingly, improve their safety. The current study also supposes that satisfaction with the workplace physical environment is defined as a nurse's subjective evaluation of all physical work elements, material objects, and stimuli in ICU work settings. Thus, this satisfaction influences the nurses' perception of safety management commitment, compliance, and participation in safety activities in ICU settings.

This proposition is based on Pickens's Perception Processing System, which argues that human senses detect external stimuli like workplace physical environments senses, are transferred by neurological transmitters to the brain, and converted to logical meanings [45]. Scant previous literature has adopted the Perception Processing System in a safety context, but a few studies support this link. For example, Cui et al. reported that workers' perceptions of their hazardous environment reflect their perceptions of management's commitment to safety ($R^2 = 33\%$) [28]. Thus, the first three hypotheses in this study are:

H1. Nurses' satisfaction with the ICU physical environment will significantly and positively affect their perception of safety management commitment.

H2. Nurses' satisfaction with the ICU physical environment will significantly and positively affect their participation in safety activities.

H3. Nurses' satisfaction with the ICU physical environment will significantly and positively affect their compliance with safety activities.

2.2. Perceived safety management commitment

Recognition of safety management commitment has been debated using different concepts. For example, Brown and Holmes employed management concern for employee well-being [46]. Gershon et al. used nurses' perceptions that safety is important to management [12]. Other studies used management attitudes toward safety [47,48]. Safety management commitment remains essential in successful safety programs [49,50]. Additionally, it is a core meaning of the safety climate construct [51,52] and one key variable to measure safety climate [53,54].

The achievement of other safety climate dimensions somewhat depends on this construct and is assumed to be a secondary contributor [55]. However, "few studies [have] focused on studying management commitment independently to assure workplace safety." Safety management commitment is often done through managers' commitment and practices that support safety [15]. Robust safety management commitment is essential because it affects employees' experiences regarding balancing safety focus concerns and production pressure-focused concerns [56]. Thus, improvements in safety outcomes depend on employees' perceptions of management's sincere commitment to safety [57]. This assertion aligns with Hofmann et al., who said that personnel must receive these safety concerns in both deeds and words of management [58].

Recent decades have witnessed an increased number of studies that recognized the benefits of deed management commitment in a safety context, such as minimizing risk-taking behaviors [59–61], decreasing injury rates [62], successful safety programs [49,50], satisfaction with safety activities [63], wearing personal protective equipment and safety initiatives [64], intention to stay [65] and improving safety compliance and participation [66,67]. This study argues that perceived safety management commitment, which refers to nurse's perceptions of upper management's value and support for workplace safety, will influence safety behaviors among Jordanian ICU nurses. Thus, the following hypotheses are posited:

H4. Perceived safety management commitment will significantly and positively affect nurses' participation in safety activities.

H5. Perceived safety management commitment will significantly and positively affect nurses' compliance with safety activities.

A typical organizational characteristic controlling the safety climate is management commitment regarding safety [67], and the direct influence of perceived safety management commitment as a part of the organization's safety climate and employees' safety behaviors has been established [66]. However, studies investigating the role of perceived safety management commitment as a meditator are unique [9]. Previous safety studies focused on the mediating effect of safety climate dimensions as a construct [65,68,69]. Unfortunately, "no consistent measure of safety climate has emerged" [70]. Responding to the call of previous studies to investigate this mediation in the healthcare industry [9], the current research seeks to fill the gap. Thus, the following hypotheses are posited.

H6. Perceived safety management commitment will mediate the relationship between nurses' satisfaction with the ICU physical environment and their safety participation.

H7. Perceived safety management commitment will mediate the relationship between nurses' safety participation and safety compliance.

2.3. Safety participation

Past literature has agreed that safety participation as volunteering behaviors in safety activities contributes to workplace safety indirectly [4,71]. Participation develops an environment that promotes safety and indicates safety performance in the workplace. These behaviors include civic virtue, helping, stewardship, voice, whistleblowing, and initiating safety-related changes [71]. Participation in voluntary safety activities indicates how important safety is to nurses; thus, compliance with core safety activities is also expected. Prior studies from other industries confirm the association between safety participation and compliance with safety activities [72]. Accordingly, safety participation is indicated via a nurse's voluntary activities promoting safety, such as serving co-nurses, safety initiatives, and trying to advance workplace safety. Following this stream of research, the following hypothesis is posited.

H8. Nurses' safety participation will significantly and positively affect their compliance with safety activities.

Although safety participation was previously mainly used as an outcome and dependent variable [15,73,74], occasional studies proposed engagement in voluntary behaviors as an explanatory variable in the safety context [72]. Accordingly, this study aims to establish the mediation effect of safety participation between the perceived safety management commitment, ICU physical environment, and safety compliance. Thus, the following hypotheses are posited:

H9. Nurses' safety participation will mediate the relationship between perceived safety management commitment and safety compliance.

H10. Nurses' safety participation will mediate the relationship between satisfaction with the ICU physical environment and safety compliance.

Fig. 1 presents the multi-mediator model of this study.

3. Methods

3.1. Ethical considerations

Institutional approval was received from the *Research and Ethics Committee* (MOH REC 170172) of the JMoH. The current study targeted Jordanian ICU nurses. Their involvement was voluntary and confidential, and the collected data were only used for academic purposes.

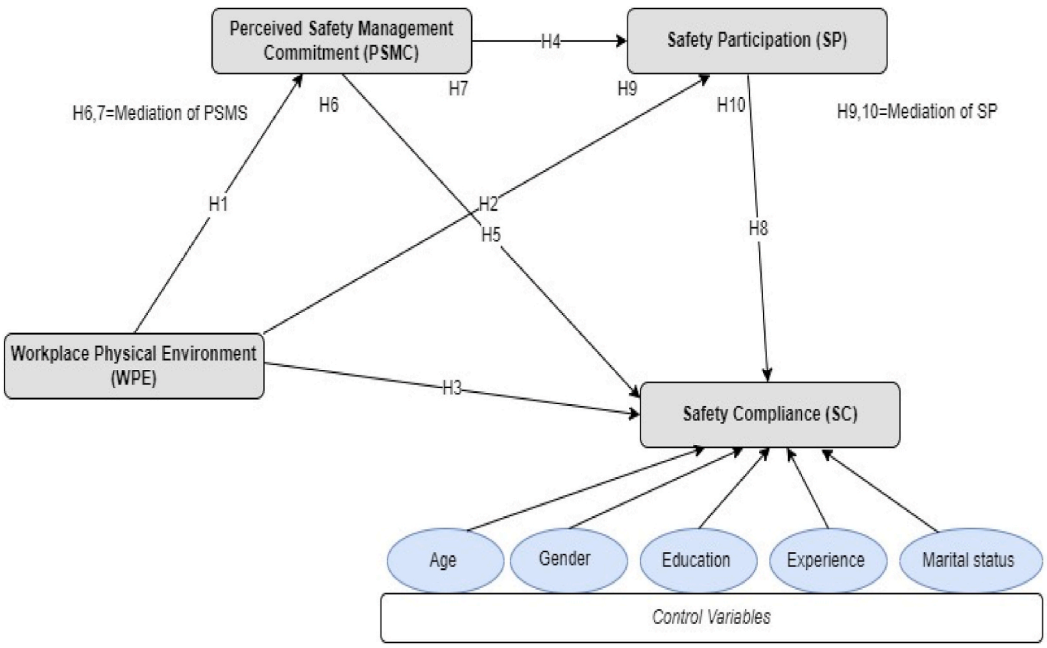

Fig. 1. A Serial mediation model.

3.2. Design and sampling

This descriptive, cross-sectional, hypotheses-testing study utilized a quantitative research method by applying structured self-reported questionnaires to examine the hypothesized model. The total population was all ICU nurses in the Jordanian Ministry of Health ($n = 1104$). Following Gay and Diehl's procedure, a cluster sampling technique was utilized [75]. Each province in Jordan was considered one cluster; three clusters were selected randomly, and the surveys were disseminated to all nurses working in these clusters, which included eight hospitals. Of the 551 distributed, 311 surveys were collected. Two hundred eighty-five were valid, which is considered adequate based on a common sample size formula (i.e., Krejcie and Morgan) [76].

3.3. Data collection procedure

After obtaining the approval letter from JMoH, the researchers targeted all nurses in three clusters. The data collection team met with the nursing directors for 10–15 min to explain the study procedure. Then, a letter of consent was sent to ICU head nurses. Meetings were held with all selected head nurses and in-charge nurses responsible for the evening and night shifts to explain study survey concerns further. Several visits were made to nurses in all shifts to encourage them to complete the surveys to obtain a high response rate. Nurses were asked to submit their answers to the senior nurses, who coordinated with them to establish the appropriate schedule to gather the completed surveys. The data collection process was planned to be finished in three months. However, due to these units' high workload, some senior nurses requested an extension of the data collection interval from two to five weeks due to their work hours. Thus, the data were collected between January 1 and April 15, 2018.

3.4. Measures and operational definition

The study model comprised four constructs. The first measured the nurses' satisfaction with the ICU physical environment, which referred to nurses' subjective evaluation of all physical work elements, material objects, and stimuli in ICU work settings. Satisfaction was measured on a twelve-item scale, adapted from Fleury-Bahi and Marcouyeux's study [77], and one item associated with the type of working surface was adapted from Carlopio's study; the Cronbach alpha was .93 [78]. A 5-option Likert-type scale ranging from one (strongly unsatisfied) to five (strongly satisfied) was used.

The second construct was perceived safety management commitment, which referred to nurse's perception of upper managements' value and support for workplace safety. A nine-item scale was adapted from Vinodkumar and Bhasi's study. Cronbach's alpha was .91 [66].

The third construct was safety participation, which refers to the nurses' voluntary activities promoting safety, such as serving co-nurses, safety initiatives, and trying to advance workplace safety. Five items were adapted from Vinodkumar and Bhasi's work to measure safety participation. The Cronbach alpha was .83 [66].

The last construct was safety compliance, which refers to mandatory safety behaviors that must be undertaken and adhered to by nurses in their daily duties. An eleven-item scale was adapted from Hayes et al. to measure safety compliance [79]. The Cronbach alpha for the current sample was .94.

A 5-option Likert-type scale was used to measure perceived safety management commitment, participation, and compliance to safety, with one representing strongly disagree and five representing strongly agree (See Appendix 1).

3.5. Data analysis technique

Smart PLS 3.3.3 analyzed the study data. Smart PLS 3.3.3 is Variance-Based Structural Equation Modeling (VB-SEM) software considered a substitute for Covariance-Based Structural Equation Modeling (CB-SEM) [80]. Bootstrapping is the core of Smart PLS,

Table 1
Nurses' satisfaction with the WPE (n = 285).

	Strongly unsatisfied		Unsatisfied		Neither dissatisfied nor satisfied		Satisfied		Strongly satisfied		Mean	SD
	N	%	N	%	N	%	N	%	N	%		
Noise environment	51	17.8	78	27.4	46	16.1	84	29.5	26	9.1	2.84	1.28
Possibility of concentrating in my unit	15	5.3	56	19.6	61	21.4	129	45.3	24	8.4	3.32	1.05
The quality of the lighting	18	6.3	55	19.2	56	19.6	124	43.5	32	11.2	3.35	1.11
The physical position of my workstation	22	7.7	53	18.6	61	21.4	105	35.7	44	15.4	3.33	1.17
Possibility of having private conversations	22	7.7	49	17.1	58	20.3	105	35.7	51	17.8	3.48	1.17
Possibility of managing noise	20	7.0	74	25.9	59	20.7	90	31.5	42	14.7	3.21	1.19
The furniture in my unit	29	10.1	62	21.7	46	16.1	105	36.8	43	15	3.27	1.23
Possibility of seeing outside	18	6.3	55	19.2	63	22.1	115	40.3	34	11.9	3.34	1.11
The cleanliness of my work area	14	4.9	38	13.3	48	16.8	122	42.8	63	22.1	3.64	1.11
The equipment available in my unit	16	5.6	43	15.1	52	18.2	122	42.8	52	18.2	3.55	1.10
The air circulation in my unit	36	12.6	46	16.1	33	11.5	113	39.6	47	16.5	3.31	1.28
The surfaces I usually walk on in my unit	20	7.0	54	19,0	47	16.5	115	40.3	49	17.2	3.49	1.18

which is "resampling with replacement in obtaining the estimates for path coefficients and their respective standard errors" [81]. This technique has become common in the social sciences. Before Smart PLS3 was run, a preliminary analysis, dealing with missing data and generating descriptive results, was conducted using SPSS Version 24.0.

4. Results

4.1. Descriptive statistics

The data cleaning and screening phases were conducted before analyzing the data. Out of the 11,978 data points, only 36 points were missed (0.003). Accordingly, the mean substitution technique was used to replace these missed values. Skewness and kurtosis values assessed normality. Skewness values ranged (from −1.231 to 1.186), while kurtosis values ranged (from −1.833 to 2.132). These results indicated that data were normally distributed. The Variance Inflation Factor test examined collinearity. The results ranged from 1.813 to 4.308, demonstrating no critical issue with multicollinearity in this study. Regarding the mean and standard deviation, Table 1 shows that the highest mean was for safety participation, while the workplace physical environment had the highest standard deviation. Last, the study model's goodness of fit indices were CFI = 0.96, RMSEA = 0.048, and CMIN/df = 1.49.

The study described nurses' satisfaction level with their physical environment, including ambient properties, interior design, and architectural design. The standard deviation ranged from 1.05 for the possibility of concentrating in my unit to 1.28 for the noise environment, and the mean of nurses' satisfaction for these items ranged from 2.84 to 3.64 for the noise environment and the cleanliness of my work area, respectively. Last, the average mean of nurses' satisfaction with the workplace physical environment of Jordanian ICU nurses was 3.36, which is moderate. Table 1 shows the rating of twelve items of nurses' satisfaction with their physical environment.

4.2. Measurement model

A PLS measurement model mainly aims to test a study model's validity and reliability. In this study, Discriminant validity (Fornell-Larcker Criterion and Heterotrait-Monotrait Ratio (HTMT)) and reliability tests, including item factor loading (FL), Composite Reliability (CR), Average Variance Extracted (AVE), and Cronbach's alpha for each construct) were investigate [82]. Only one item, "I do not follow safety rules that I think are unnecessary," had an unacceptable factor loading (<0.50) and was removed from the analysis; the remaining items had acceptable values. Otherwise, all tests achieved an acceptable score. See Tables 2 and 3, and Fig. 2.

4.3. Demographic characteristic

Of the 285 participant nurses in the study, more than 50% of the respondents were between 25 and 45 years old and were married, and around 60% were females. Regarding education, 78% of the participant ICU nurses held Bachelor's degrees. Last, about half of the nurses had work experience between 3 and 8 years in ICUs (See Table 4.).

4.4. Structural model

4.4.1. Direct path

The primary purpose of a PLS structural model is to investigate the direct hypotheses and mediation analyses. This study includes six direct hypotheses. As Table 5 and Fig. 3 display, the findings support all direct hypotheses except H_3, so the direct association between satisfaction with the workplace physical environment and nurse safety compliance was unsupported ($\beta = 0.09$, t = 1.41, P = .16). The workplace physical environment was the most significant factor in predicting a safety management system ($\beta = 0.77$, t = 31.90, P = .00). The R^2 value of SC =(0.58), means that all WPE, PSMC, and SP explained 58% of the variations in SC among ICU nurses, which is considered a moderate R^2 value [84]. Moreover, the control variables of age, gender, marital status, education, and experience were insignificantly affected by the dependent variable (i.e., safety compliance). See Fig. 4 and Table 5.

4.4.2. Mediation analysis

The study proposed four possible mediation effects to understand our integrative model. Smart PLS as an SEM technique has been

Table 2
Mean, standard deviation, and reliability of study constructs.

Construct	Mean ± Standard Deviation	AVE ≥.50	CR ≥.70	Cronbach's Alpha ≥.70
WPE	3.33 ± .88	.56	.94	.93
PSMC	3.44 ± .82	.59	.93	.91
SP	3.84 ± .63	.65	.88	.83
SC	3.82 ± .65	.65	.95	.94

Note. WPE is Workplace Physical Environment, PSMC is Perceived Safety Management Commitment, SP is Safety Participation, and SC is Safety Compliance.

Table 3
Discriminant validity.

Fornell- Larcker Criterion				
	SP	**WPE**	**SC**	**PSMC**
SP	**0.77**			
WPE	0.42	**0.75**		
SC	0.73	0.47	**0.81**	
PSMC	0.42	0.77	0.49	**0.77**
Heterotrait-Monotrait Ratio (HTMT)				
	SP	WPE	SC	PSMC
SP				
WPE	0.48			
SC	0.80	0.5		
PSMC	0.47	0.82	0.51	

Note. The acceptable ratio of HTMT should not exceed the threshold of 0.85 [83].

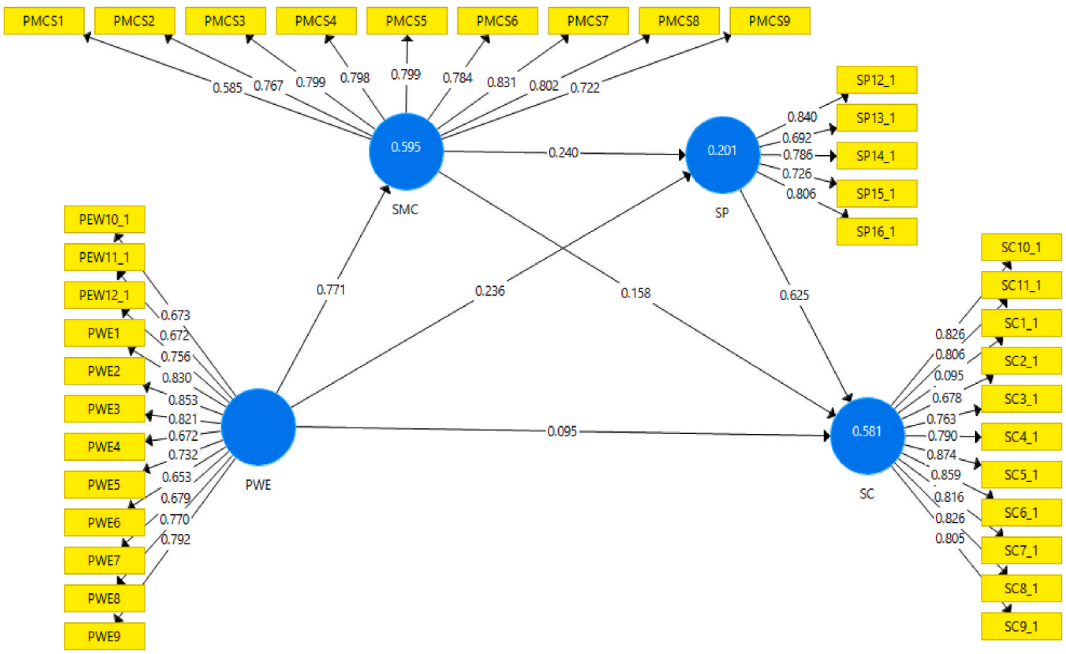

Fig. 2. PLS-SEM output (Measurement Model).

Table 4
Demographic characteristics of 285 participant nurses.

Characteristic	Profile	Number	Percentage %
Age	<24 years	24	8.30%
	Between 25 and 34 years	171	59.9%
	Between 35 and 44 years	73	26.0%
	>45 years	17	5.90%
Gender	Male	113	39.6%
	Female	172	60.4%
Marital status	Married	195	68.5%
	Single	83	29.1%
	Divorced/widowed	7	2.40%
Education	2-years Diploma	36	12.5%
	Degree in nursing	223	78.2%
	Master's degree	26	9.30%
	Doctor of Philosophy (PhD)	0	0.00%
Experience	Less than 2 years	72	25.3%
	3–8 years	133	46.7%
	9–14 years	54	19.0%
	Above 15 years	26	9.00%

Table 5
Findings of direct relationships (structural model).

#	Hypothesis	β	Effect size (f^2)	STDEV	T statistics	p-value	Status
H_1	WPE - > PSMC	.77	1.47	.02	31.90	.00***	Supported
H_2	WPE - > SP	.24	0.03	.09	2.50	.01**	Supported
H_3	WPE - > SC	.09	0.01	.07	1.41	$.16^{ns}$	Not supported
H_4	PSMC - > SC	.15	0.02	.06	2.70	.01**	Supported
H_5	PSMC - > SP	.24	0.03	.09	2.70	.01**	Supported
H_8	SP —— > SC	.63	0.75	.05	12.95	.00***	Supported
Control variables	Age - > SC	.065	0.007	.05	1.23	0.218^{ns}	Not supported
	Education - > SC	.038	0.002	.04	0.95	0.340^{ns}	Not supported
	Experience - > SC	−.053	0.004	.04	1.08	0.282^{ns}	Not supported
	Gender - > SC	.07	0.008	.04	1.51	0.131^{ns}	Not supported
	Marital status - > SC	.029	0.003	.04	0.636	0.525^{ns}	Not supported

P**value > 0.01 (2.58) & P* value > 0.05 (1.96).

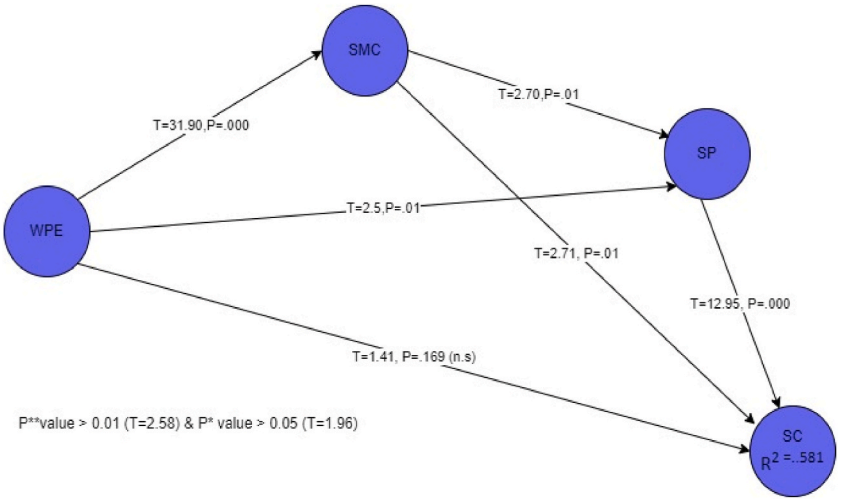

Fig. 3. Findings of Structural Model Output - Direct hypothesis.

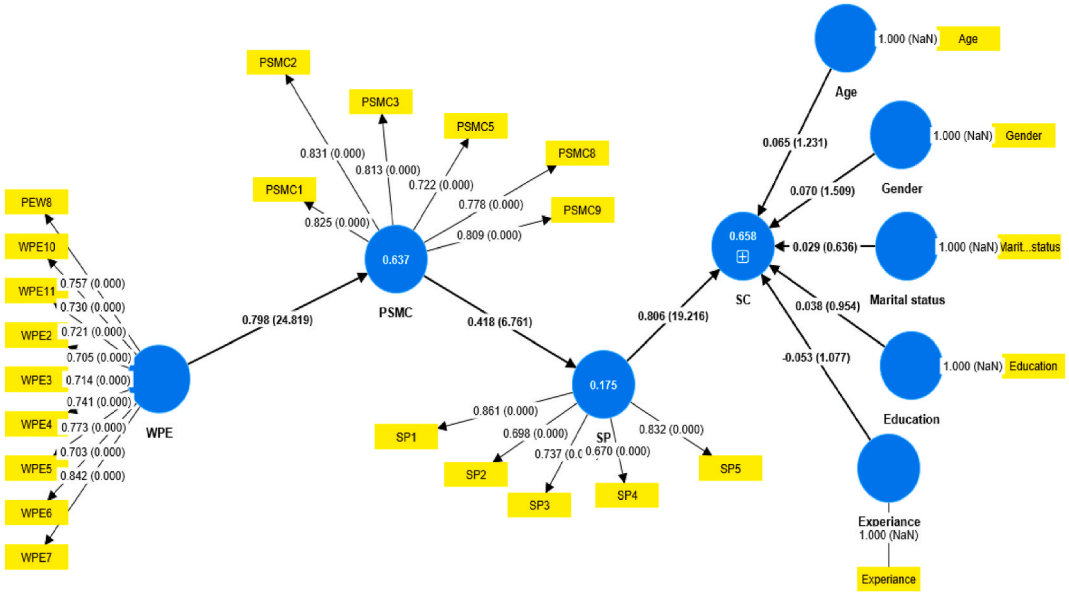

Fig. 4. Final PLS-SEM output.

considered suitable for studies looking for mediation effects because bootstrapping offers accurate calculations and measures [83,85]. Following Hayes' approach, the mediation was tested first by calculating the direct effect (Path a & Path b); these paths were significant [86]. Then, calculating the indirect effect, the results show that all indirect effects of relations were significant. Last, the percentile bootstrap Confidence Interval (CI) [87] was calculated to confirm meditation analysis; the indirect effects of 95% Boot CI should not straddle the value Zero in between.

The first mediator in this study was PSMC. The H_7 and H_6 were about the meditation effect of PSMC between WPE and SC and SP among ICUs nurses in Jordan. The indirect effect (WPE - > PSMC - > SC) was $\beta = .12$, t = 2.63, $p < .01$, and (WPE - > PSMC - > SP) was $\beta = 0.18$, t = 2.62, $p < .01$ consecutively, the percentile bootstrap Confidence Interval (CI): [LL = 0.025, UL = 0.221] and [LL = 0.027, UL = 0.236] consecutively; thus, H_7 and H_6 were supported.

The second mediator in this study was SP. H_9 was concerned with the meditation effect of SP between PSMC and SC among ICU nurses in Jordan. The indirect effect (WPE - > PSMC - > SP) was $\beta = .15$, t = 2.57, $p < .01$, and the percentile bootstrap Confidence Interval (CI): [LL = 0.014, UL = 0.288]. Hence, The H_9 was supported.

The last mediation of SP was between WPE and SC. The indirect effect (WPE - > SP - > SC) is $\beta = .15$, t = 2.48, $p < .01$, and the percentile bootstrap Confidence Interval (CI): [LL = 0.034, UL = 0.269]. Therefore, H_{10} was supported. See Table 6.

5. Discussion

The present study extends Cui et al.'s integrative model of safety behaviors [29]. While Cui's model investigated the outdoor physical environment in the Chinese coalmine industry, this study highlights the indoor physical environment in a different industry (i.e., healthcare). Remarkably, most past research concentrated on a single element of the workplace physical environment in the healthcare industry, like noise [88–90], the nursing unit and patient room design [91], lighting [92,93], and the physical design of ICUs [94,95]. This study describes nurses' satisfaction with these elements (See Table 1). Most study respondents expressed moderate to high scores on the workplace physical environment scale. However, the mean value of noise environment had the lowest mean of physical work satisfaction. These could be due to factors like monitoring alarms and equipment, family visits to ICU patients, and daily rounds of multidisciplinary teams participating in patients' care, specifically in the daytime, contributing to the noise environment. Other elements received better satisfaction scores, indicating that Jordanian ICU nurses are satisfied with these elements of their workplace physical environment.

5.1. Discussion of direct findings

The second goal of this study was to scrutinize the direct association between the model variables. Among the six hypotheses posited, only the third hypothesis had a surprising result, as it was insignificant. Despite the scant literature investigating the direct association between physical environment and safety compliance, the available evidence supports this path indirectly through explanatory factors [29]. Our justification of insignificant association due to nurses' compliance with safety practices is vital to assure nurses' safety and well-being regardless of their satisfaction with the physical environment; this is rooted in survival instinct.

Unlike safety compliance, nurses linked their safety participation to a proper workplace physical environment, as hypothesis H_2 posited. While compliance is a compulsory task, safety participation is voluntary [4], the permanency of engagement in voluntary safety behaviors needs stimulus and motivation [4], and the workplace physical environment is one of these stimuli.

The association between nurses' satisfaction with the ICU physical environment and the level of perceived safety management commitment was positive and significant, supporting the research model's first hypothesis. This finding aligns with the argument that an organization's management has power and resources and is mainly responsible for controlling the hazardous physical environment in their hospitals and units. Their commitment to safety will likely affect nurses' perceptions of safety concerns [61]. From the nurses' perspective, satisfaction is reflected in the appropriate physical environment, which indicates the hospital management's commitment to managing tasks concerning safety issues. This conclusion is consistent with Pickens's theory and extended Cui et al.'s integrative model [29,45].

As expected, a relationship was found between safety commitment by management as one dimension of safety climate and safety behaviors (i.e., participation and compliance). This finding aligns with previous safety studies among nurses [12,16,61] and with organization support theory (OST). This finding means nurses and upper managers have a mutual association through the social exchange perspective [96]. This finding adds contemporary connotation to social exchange theory, which means that nurses will exhibit a positive outcome corresponding to job resources received from their organizations' management [97].

The last finding regarding the direct hypotheses shows a significant association between the two safety behaviors (i.e., participation and compliance). Most past studies emphasized predictors of safety behavior components [16,66,98]; however, few studies were consistent with our findings that SP is closely related to SC behaviors [72,99]. In this instance, involvement in voluntary safety behaviors is recommended to advance workplace safety and assure SC among ICU nurses to conduct safety tasks perfectly. Unfortunately, achieving this objective is not easy due to the lack of safety resources and the tasks nurses perform, and it needs strong safety management systems.

5.2. Discussion of multiple mediator findings

The third goal was to explore the indirect effect between workplace physical environments and safety compliance through multiple mediator models of perceived safety management commitment and safety participation. These hypotheses were supported.

Table 6
Indirect effect and bootstrapping confidence interval calculation.

	Mediation approach	*β*	STDEV	T -value	P value	95% LL	95% UL	Status
H6	Path a = (WPE - > PSMC)	.77	.02	31.90	.00**			supported
	Path b = (PSMC - > SC)	.16	.06	2.66	.01**			
	Indirect Effect =(WPE - > PSMC - > SC)	.12	.05	2.63	.01**	**0.025**	**0.221**	
H7	Mediation approach	***β***	**STDEV**	**T -value**	**P value**	**95% LL**	**95% UL**	**Status**
	Path a = (WPE - > PSMC)	.77	.02	31.90	.00**			supported
	Path b = (PSMC - > SP)	.24	.09	2.70	.01**			
	Indirect Effect = (WPE - > PSMC - > SP)	.18	.05	2.62	.01**	**0.027**	**0.236**	
H9	Mediation approach	***β***	**STDEV**	**T -value**	**P value**	**95% LL**	**95% UL**	**Status**
	Path a = (PSMC - > SP)	.24	.09	2.70	.00**			supported
	Path b = (SP - > SC)	.63	.05	12.99	.00**			
	Indirect Effect = (PSMC - > SP - > SC)	.15	.07	2.57	.01**	**0.014**	**0.288**	
H10	Mediation approach	***β***	**STDEV**	**T -value**	**P value**	**95% LL**	**95% UL**	**Status**
	Path a = (WPE - > SP)	.24	.09	2.50	.01**			supported
	Path b = (SP - > SC)	.63	.05	12.99	.00**			
	Indirect Effect = (WPE - > SP - > SC)	.15	.06	2.48	.01**	**0.034**	**0.269**	

P**value > 0.01 (2.58) & P* value > 0.05 (1.96).

Establishing mediating effects is a major contribution of this work because the safety management literature does not contain abundant casual evidence to corroborate a claim of mediation of perceived safety management commitment and safety participation [10,72]. An interesting result is that perceived safety management commitment and workplace physical environment indirectly affected safety compliance through safety participation; this result indicates the significance of the voluntary behaviors of nurses toward better safety activities. As ICU staff are precious resources to implement a safety protocol that contributes to safety for both patients and staff [26], maximizing nurses' safety participation is challenging due to the high workload among ICU staff and the need for a proper and active safety management system. However, a safety participation culture benefits nurses' safety compliance.

The nurses' perception of safety commitment is important to be considered as it can configure their safety climate [12,100]. Perceived safety commitment is represented by nurses' shared perceptions about the alignment between management's words and deeds [101]. PSMC, as part of the psychological safety climate, has been found to be a mediator in the safety literature [64,102,103]. In our study, PSMC has an explanatory role in strengthening the link between nurses' satisfaction with the workplace physical environment and safety compliance [88]. PSMC also was established as a partial mediator between the WPE and SP. Hence, PSMC can explain the link between the WPE and SP. This line of reasoning means that commitment to safety management and a feeling of a healthy environment contribute to nurses' engagement in safety participation.

5.3. Theoretical contribution of the study

Previous studies reported the importance of the physical elements to organizational outcomes [102]. However, models explaining how these elements influence safety outcomes among ICU staff are still unique. This study fills the gap in available safety and nursing literature, especially when considering the scarce studies that investigated the physical elements in the workplace and both safety compliance and safety participation. Moreover, the current study contributes to understanding this relation through serial mediation analysis by utilizing the structure equation modeling approach.

5.4. Practice implications of the study

This study found that satisfaction with the WPE and the roles of these elements reflect safety outcomes among Jordanian ICU nurses. Detecting nurses' satisfaction with the WPE is a critical indicator because it can help health leaders make better decisions about the role of the WPE and the success of their safety performance. Multiple hospital managerial units, such as quality assurance, quality control, and infection control, should continuously assess the workplace physical environment. However, improving the workplace physical environment is not limited to local units inside hospitals; it is a central function of JMoH. The JMoH has an essential role in bettering the workplace physical environment by updating ICU regulations and policies and providing adequate funds. Many investigators found that ICUs have unique design criteria and recommended a new approach in this regard [34,103]. Nurses' compliance requires a reliable safety climate, and managers have a responsibility to improve safety outcomes by considering the WPE as a contributory factor among nurses in Jordan. As a practical thought and consideration, professionals with high perceptions of management commitment to safety will engage in activities with safety concerns in mind. Healthcare organizations can boost these perceptions by controlling factors like satisfaction with the WPE and perceived management concern with safety.

5.5. Study limitations

Despite utilizing a structural equation modeling to develop a multiple mediator model of workplace safety, possible limitations in this kind of study must be considered. For instance, selecting respondents from only JMOH may weaken the ability to generalize the

findings in different kinds of hospitals (i.e., private or military). Given that the gathered data from nurses self-reporting at one point in time could raise the concern of common method bias and disable the causality principle. Accordingly, principal component analysis was conducted to ensure no common method bias in this study, and the result of Harman's one-factor analysis minimized this concern. Further studies and investigation into other factors that influence the nurses' safety compliance either qualitatively or by observation techniques are recommended. Investigating a comprehensive model of safety behaviors in healthcare organizations is also recommended, as it is significant in the occupational safety field.

6. Conclusion

The psychological and behavioral factors that achieve disciplined safety compliance that ultimately help workplace safety must be understood. The current study empirically supports the indirect effects of psychological and behavioral factors on the work environment and safety compliance in its multiple mediator model. This model provides insights into the importance of the physical workplace environment and promotes perceived safety management commitment to preserve and improve participation in safety and subsequent safety compliance. Understanding how nurses' satisfaction with the workplace physical environment may be associated with messages sent about safety compliance at both individual and organizational levels to enrich workplace safety. Accordingly, perceived safety management commitment and nurses' safety participation may play a part in this process.

Data availability statement

The datasets used and/or analyzed during the current study are available from the corresponding author (Al-Bsheish) upon reasonable request.

CRediT authorship contribution statement

Mohammad Al-Bsheish: Writing – review & editing, Writing – original draft, Methodology, Data curation, Conceptualization, Visualization, Software, Resources, Project administration, Investigation. **Mu'taman Jarrar:** Visualization, Validation, Supervision, Software, Project administration, Formal analysis. **Khalid Al-Mugheed:** Software, Supervision, Visualization. **Lujain Samarkandi:** Project administration, Methodology, Investigation, Funding acquisition, Investigation. **Faraj Zubaidi:** Resources, Investigation, Funding acquisition, Formal analysis. **Hanin Almahmoud:** Validation, Funding acquisition. **Abdallah Ashour:** Formal Analysis, Data Curation.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix 1. study scale items

Scale	Code	Statement	Source(s)
Workplace physical Environment [*Nurses' subjective evaluation of all physical work elements, material objects, and stimuli in ICU work settings]*.	WPE1	Noise environment	Fleury-Bahi and Marcouyeux [77] Carlopio [78]
	WPE2	Possibility of concentrating in my unit	
	WPE3	The quality of the lighting	
	WPE4	The physical position of my workstation	
	WPE5	Possibility of having private conversations	
	WPE6	Possibility of managing noise	
	WPE7	The furniture in my unit	
	WPE8	Possibility of seeing outside	
	WPE9	The cleanliness of my work area	
	WPE10	The equipment available in my unit	
	WPE11	The air circulation in my unit	
Perceived Safety Management Commitment [*Nurse's perception of upper managements' value and support for workplace safety*].	PSMC1	Safety is given high priority by my hospital management.	Vinodkumar and Bhasi [66]
	PSMC2	Safety rules and procedures are strictly followed by my hospital management.	
	PSMC3	Corrective action is always taken when my hospital management is told about unsafe practices.	

(*continued on next page*)

(*continued*)

Scale	Code	Statement	Source(s)
	PSMC4	In my workplace, managers do not show interest in the safety of nurses.	
	PSMC5	My hospital management considers safety to be equally important as patients' care.	
	PSMC6	Members of my hospital management do not attend safety meetings.	
	PSMC7	I feel that my hospital management is willing to compromise on safety for increasing patients' care.	
	PSMC8	When near-miss accidents are reported, my hospital management acts quickly to solve the problems.	
	PSMC9	My hospital provides sufficient personal protective equipment for the nurses.	
Safety Participation *[Nurses' voluntary activities promoting safety, such as serving co-nurses, safety initiatives, and trying to advance workplace safety]*.	SP1	I voluntarily carry out tasks or activities that help to improve my unit safety.	Vinodkumar and Bhasi [66]
	SP2	I always point out to the management if any safety-related matters are noticed in my unit.	
	SP3	I help my co-workers when they are working under risky or hazardous conditions.	
	SP4	I put extra effort to improve the safety of my unit.	
	SP5	I encourage my co-workers to work safely.	
Safety Compliance *[Mandatory safety behaviors must be undertaken and adhered to by nurses in their daily duties]*	SC1	I do not follow safety rules that I think are unnecessary. (Removed)	Hayes et al. [79]
	SC2	I handle all situations as if there is a possibility of having an accident.	
	SC3	I wear the safety equipment required by practice.	
	SC4	I encourage co-workers to be safe.	
	SC5	I keep my work area clean.	
	SC6	I encourage co-workers to be safe. I keep my work equipment in safe working condition.	
	SC7	I overlook safety procedures in order to get my tasks done more quickly.	
	SC8	I report safety problems to my supervisor when I see safety problems.	
	SC9	I correct safety problems to ensure accidents will not occur.	
	SC10	I take shortcuts to safe working behaviors to get the job done faster.	
	SC11	I follow all safety procedures regardless of the situation I am in.	

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