RESEARCH ARTICLE

BORNEO SCIENCE
THE JOURNAL OF SCIENCE & TECHNOLOGY

Journal homepage: https://jurcon.ums.edu.my/ojums/index.php/borneo-science

SUSTAINABLE THE IMPACT OF INDOOR AIR QUALITY ON OCCUPANCY STRESS LEVEL IN WARSHIP: SYSTEMATIC LITERATURE REVIEW

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Received: 2 September 2025
Revised: 24 December 2025
Accepted: 24 December 2025
Published online:
31 December 2025

Doi:
10.51200/bsj.v46i2.6775

Keywords:
Indoor Air Quality; Systematic Literature Review; Occupancy Stress Level; Self-Efficacy
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ABSTRACT. *Indoor air quality (IAQ) plays a critical role in influencing the health, comfort, and psychological performance of individuals operating in enclosed and confine space such as warships. However, research regarding the impact of IAQ on occupancy stress levels in warships remains challenging due to the limited number of studies. Therefore, this study aims to conduct a systematic literature review on the impact of IAQ on stress levels among warship crews. The methodology is based on a systematic literature review that employs the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). A comprehensive search was conducted across Scopus, Google Scholar, Web of Science, ProQuest, and ScienceDirect databases, covering literature published between 2019 and 2025. The review process includes three main methodological steps: identification, screening, and eligibility, followed by the PRISMA checklist. Three key themes were found: (a) IAQ– physical parameter and indoor air contaminant, (b) Self-efficacy– vicarious experience and performance outcomes, and (c) Stress – response and trigger. A factor analysis confirmed the validity of the thematic structure and reinforced the interconnection between environmental conditions and psychological outcomes. The findings provide valuable knowledge gaps for future studies. This review supports Environmental, Social, and Governance (ESG) principles by advocating for sustainable and health-centric practices in the maritime environment.*

INTRODUCTION

Indoor air quality (IAQ) has increasingly been recognized as a critical component of human health, cognitive function, and psychological well-being, especially in enclosed environments such as warships. Naval vessels, by design, operate in confined and isolated conditions with limited ventilation, recycled air systems, and shared living quarters, factors that amplify the potential exposure to airborne pollutants (Al-Mamun *et al.,* 2022).

In such settings, IAQ not only affects physical health but may also act as an environmental stressor that contributes to elevated psychological stress levels among naval personnel (Chen, 2023). Military operations often subject crew members to long-term confinement, strict routines, and high-stakes missions. These operational demands, when combined with poor IAQ, may heighten stress responses, impair decision-making, and reduce occupational performance (Yusof, 2021). While existing literature has addressed the influence of IAQ in residential, educational, and healthcare settings (Khan, 2022; Zhang, 2020), studies specific to warship environments remain limited. This gap is concerning, as warships present unique environmental stressors that are not directly comparable to land-based facilities. which is known as re-suspension. When this happens, the compound or pollutant that is trapped in the sediment will be remobilized (Lick, 2009).

Furthermore, the psychological resilience and well-being of naval personnel have strategic implications, affecting both individual mental health and overall operational readiness. Proactively managing environmental stressors, including air quality, is essential in supporting mission effectiveness and reducing long-term occupational health risks (Lim, 2021). To address these concerns, this study presents a systematic literature review (SLR) aimed at evaluating the relationship between IAQ and stress levels in warship settings. This review follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 framework (Page, 2021) to ensure a transparent and replicable methodology. The search strategy focused on peer-reviewed literature published between 2019 and 2025 across multiple databases, including Scopus, Web of Science, Google Scholar, ScienceDirect, and ProQuest. The findings of this review not only highlight key IAQ indicators and psychological outcomes but also contribute to the development of a conceptual framework grounded in Social Cognitive Theory to explore mediating factors such as self-efficacy. Ultimately, this study supports sustainable naval operations and aligns with Environmental, Social, and Governance (ESG) goals by advocating for improved air quality monitoring and stress mitigation strategies in maritime defense environments.

METHODS

This study employed an SLR methodology to identify and synthesize existing research on the relationship between IAQ and occupancy stress levels in warship environments. The review process adhered to the PRISMA 2020 guidelines (Page, 2021), ensuring transparency, replicability, and methodological rigor.

Systematic Search Strategy

A comprehensive search was conducted across multiple databases, including Scopus, ScienceDirect, ProQuest, Web of Science (WoS), and Google Scholar, to retrieve relevant peer-reviewed and grey literature published between 2019 and 2025. The selection of these databases was based on their multidisciplinary coverage and credibility, in line with best practices for systematic reviews (Haddaway, 2015; Kounadi, 2020).

The literature search combined elements of both traditional and systematic review approaches to identify knowledge gaps in the current body of research. Boolean operators (e.g., AND, OR), truncation, and phrase searching were used to formulate the search strings. The primary keywords included “indoor air quality,” “warship,” “crew stress,” and “self-efficacy,” along with their related synonyms (e.g., "indoor air contaminant," "vicarious experience," "performance outcome"). Table 1 details the complete keyword mapping and Boolean combinations used.

This hybrid search method was critical for capturing a broad yet focused pool of literature while minimizing bias. There is no specific tool to reduce the risk of bias in this study. Following the identification stage, studies were screened and assessed for eligibility based on predefined inclusion and exclusion criteria. These criteria included language (English only), publication date (2019–2025), peer-reviewed status, and relevance to the themes of IAQ, stress, and naval or maritime environments.

Table 1. Selected Database Used for the Search String

Database	String
Scopus	TITLE-ABS-KEY ((“warship” OR “indoor air quality” OR “maritime” OR “indoor air contaminant” OR “physical parameter”) AND (“crew stress” OR “stress triggered” OR “stress response” OR “stress confined space”) AND (“self-efficacy naval” OR “vicarious experience” OR “performance outcome”))
Science Direct	((“warship” OR “indoor air quality” OR “maritime” OR “indoor air contaminant” OR “physical parameter”) AND (“crew stress” OR “stress triggered” OR “stress response” OR “stress confined space”) AND (“self-efficacy naval” OR “vicarious experience” OR “performance outcome”))
Google Scholar	allintitle: ((“warship” OR “indoor air quality” OR “maritime” OR “indoor air contaminant” OR “physical parameter”) AND (“crew stress” OR “stress triggered” OR “stress response” OR “stress confine space”) AND (“self-efficacy naval” OR “vicarious experience” OR “performance outcome”))
ProQuest	((“warship” OR “indoor air quality” OR “maritime” OR “indoor air contaminant” OR “physical parameter”) AND (“crew stress” OR “stress triggered” OR “stress response” OR “stress confined space”) AND (“self-efficacy naval” OR “vicarious experience” OR “performance outcome”))
WoS	TS= ((“warship” OR “indoor air quality” OR “maritime” OR “indoor air contaminant” OR “physical parameter”) AND (“crew stress” OR “stress triggered” OR “stress response” OR “stress confined space”) AND (“self-efficacy naval” OR “vicarious experience” OR “performance outcome”))

PRISMA Flow Diagram

The PRISMA flow diagram was employed to visually present the literature selection process (Page, 2021). The diagram illustrates the systematic flow of articles through four distinct phases: identification, screening, eligibility, and inclusion. This visual tool enhances methodological transparency and provides readers with a clear overview of how studies were selected and filtered for inclusion in the review.

1) Identification Phase: This phase involved searching databases and repositories using tailored search strings. A total of 3,774 records were retrieved during this initial search stage. Synonym expansion and keyword refinement were conducted to increase search accuracy (Mohamed, 2020).

2) Screening Phase: Duplicate records were removed, and titles and abstracts were reviewed to exclude irrelevant studies. Articles published before 2019 were also excluded at this stage to maintain relevance.

3) Eligibility Phase: Full-text articles were assessed against the inclusion criteria. Studies unrelated to warship environments or those lacking empirical IAQ or stress measurements were excluded. Specific reasons for exclusion were documented to ensure transparency.

4) Included Phase: A total of 37 studies met the eligibility criteria and were included in the final synthesis. These studies were reviewed in detail and incorporated into the conceptual framework. To ensure the validity and reliability of the review process, a quality appraisal of all included studies was conducted. Studies were assessed based on clarity of research design, relevance to the review objectives, and methodological soundness. The use of multiple databases, keyword expansion, and systematic filtering helped minimize selection bias (Kounadi, 2020).

PRISMA Checklist

The PRISMA 2020 Checklist was used as a reporting framework to guide the development of the review (Page, 2021). The checklist comprises 27 items covering key sections of the review, including the title, abstract, introduction, methods, results, discussion, and funding. Each item ensures comprehensive reporting to facilitate transparency, reproducibility, and evidence-based synthesis.

1) Title and Abstract: Clearly identify the study as a systematic review and summarize the review scope, methods, and key findings.

2) Introduction: Clearly state the review's rationale, objectives, and research questions.

3) Methods: Report the eligibility criteria, data sources, selection process, and search strategy.

4) Results: Provide detailed outcomes of the selection process, study characteristics, and synthesized findings using narrative and tabular formats.

5) Discussion: Address major findings, limitations, and implications for future research and practice.

6) Funding: Disclose any funding sources and potential conflicts of interest.

By adhering to the PRISMA framework, this study enhances the transparency and rigor of the systematic review process, ensuring that the findings contribute meaningfully to the literature on IAQ and psychological well-being in warship environments.

RESULTS AND DISCUSSIONS

This systematic review analyzed 37 selected studies to explore the relationship between IAQ, self-efficacy, and crew stress aboard warships. Using the PRISMA method, studies were screened, evaluated, and categorized into key themes and sub-themes. A validated factor analysis confirmed three core components: IAQ, self-efficacy, and stress. The findings guided the development of a conceptual framework grounded in Social Cognitive Theory, emphasizing the mediating role of self-efficacy in linking environmental conditions to psychological outcomes among naval personnel.

PRISMA Flow Diagram Result

The PRISMA flow diagram, summarized in Figure 1, outlines the four key phases: identification, screening, eligibility, and inclusion. During the Identification Phase, a total of 3,774 records were retrieved from major academic databases: Scopus (n = 161), ScienceDirect (n = 629), Google Scholar (n = 429), ProQuest (n = 1,843), and Web of Science (n = 712). After removing 924 duplicate records, 2,850 records remained for screening.

In the Screening Phase, all 2,850 records were assessed based on titles and abstracts. A total of 2,710 records were excluded for irrelevance, and 140 full-text articles were selected for detailed evaluation. However, seven articles could not be retrieved, leaving 133 full-text articles for eligibility assessment, including population involving seafarers, IAQ element, persistent stress scales, and any related to self-efficacy.

During the Eligibility Phase, these 133 articles were reviewed in detail. The following were excluded: (a) Studies not conducted in ship or maritime settings (n = 60), (b) Articles targeting non-naval populations (n = 24), (c) Studies employing non-quantitative methodologies (n = 12).

This process resulted in 37 studies that met the full inclusion criteria and were included in the final review. This rigorous multi-step approach enhances the validity and reproducibility of the review, consistent with PRISMA's objectives of improving reporting transparency in systematic reviews (Liberati, 2020; Page, 2021).

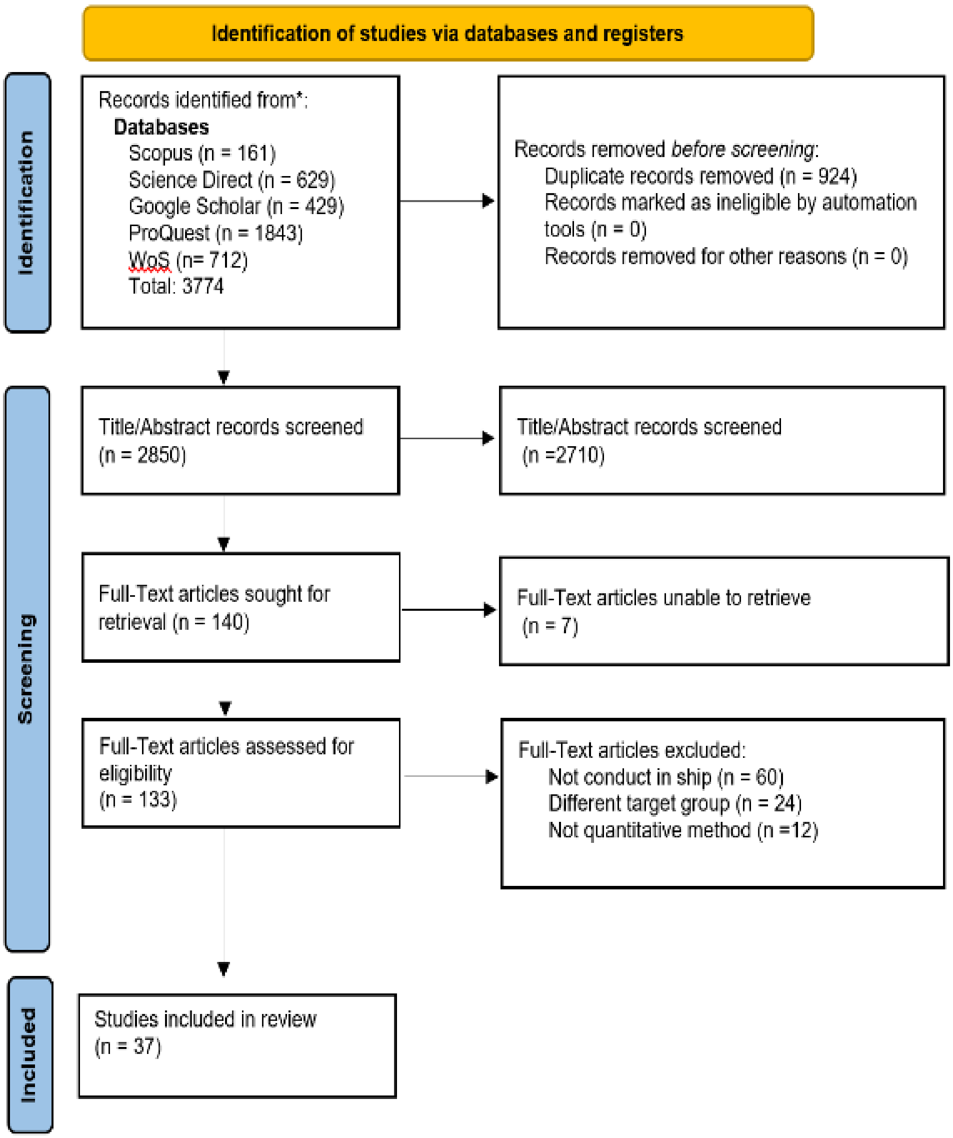

Figure 1. PRISMA flow diagram.

PRISMA Check List Result

The 37 studies paper included in this systematic review were assessed using the PRISMA 2020 Checklist, which is listed in Table 1 encompasses five major domains: title, abstract and introduction; methods; results; discussion; and other relevant information. This evaluation aimed to determine the extent to which each study adhered to the recommended standards for transparent and rigorous reporting in systematic reviews.

Table 1. Table for the summary of the 27 PRISMA checklist.

Group	Item No.	Keyword Checklist Item	Reported (n)	Percentage (%)
Title, Abstract & Introduction	1	Title as literature review	20	54.05%
	2	Structured abstract	22	59.46%
	3	Rationale for review	34	91.89%
	4	Stated objectives (PICOS)	30	81.08%
Methods	5	Eligibility criteria	24	64.86%
	6	Info sources used	18	48.64%
	7	Search strategy	27	72.97%
	8	Selection process	21	56.76%
	11	Risk of bias assessment	20	54.05%
Results	16a	Study selection (e.g., PRISMA flow)	15	40.54%
	16b	Excluded studies with reason	20	54.05%
	17	Study characteristics	18	48.64%
	18	Bias results per study	6	16.21%
	19	Individual study results	29	78.38%
Discussion	23a	Interpretation of findings	14	37.84%
	23b	Evidence limitations	8	21.62%
	23c	Review process limitations	29	78.38%
	23d	Practice/research implications	28	75.68%
Other Information	24a	Review registration info	9	24.32%
	24b	Protocol access	8	21.62%
	24c	Amendments to protocol	21	56.76%
	25	Support/funding info	11	29.73%
	26	Competing interests	8	21.62%
	27	Data/material availability	4	10.81%

Title, Abstract, and Introduction

The analysis revealed that 54.05% (n = 20) of the studies explicitly included both the terms "indoor air quality" and "stress" in their titles, while the remainder omitted one or both keywords. A total of 59.45% (n = 22) of the abstracts were found to be well-structured and clearly outlined the research methodologies, reflecting good adherence to reporting guidelines. Moreover, 81.08% (n = 30) of the studies articulated their research questions using the PICOS framework, an essential component in systematic review design that covers population, intervention, comparison, outcomes, and study design. Importantly, 91.89% (n = 34) of the studies provided a strong rationale and justification for conducting the review, demonstrating an understanding of the research problem's relevance and significance.

Methods

In the methods section, 56.75% (n = 21) of the studies presented clear inclusion and exclusion criteria for study selection, while 48.64% (n = 18) identified the specific databases, registers, and sources used to collect information. A total of 72.97% (n = 27) of the papers provided a detailed description of the search strategy used for each database, including keywords and Boolean logic, enhancing the transparency and reproducibility of the literature search process. However, only 56.75% (n = 21) reported a controlled selection process that included detailed eligibility screening. Consideration of study bias was identified in 54.05% (n = 20) of the papers, indicating room for improvement in the methodological quality appraisal across the reviewed literature.

Results

Regarding the results domain, only 40.54% (n = 15) of the studies included a clearly presented flow diagram to visually depict the literature screening and selection process, despite its importance in communicating systematic review procedures. Surprisingly, just 50.05% (n = 2) of the studies provided a complete justification for study inclusion or exclusion decisions, with appropriate citations and reasoning. Approximately 48.64% (n = 18) of the studies reported detailed characteristics of the included studies, such as sample sizes, study designs, or follow-up periods. Alarmingly, risk of bias assessments were conducted in only 16.21% (n = 6) of the studies, reflecting a significant methodological limitation. Nevertheless, a high proportion of the studies, 78.47% (n = 29), presented summary statistics and effect estimates for each outcome, thereby enhancing the interpretability and comparability of results across studies.

Discussion

Within the discussion section, 37.84% (n = 14) of the studies provided a comprehensive interpretation of their findings in the context of existing literature. Only 21.62% (n = 8) acknowledged limitations in the body of evidence included in their reviews. Despite this, 78.37% (n = 29) of the studies discussed the limitations of the review process itself, such as potential search bias, inclusion bias, or methodological weaknesses. Furthermore, 75.67% (n = 28) of the papers thoughtfully considered the implications of their findings for practice, policy, or future research, indicating an effort to link research evidence with practical application and decision-making contexts.

Other Information

In terms of other information, 56.75% (n = 21) of the studies documented amendments made to their protocol or research registration records, if applicable. Only 24.32% (n = 9) referenced any form of review registration, including details such as registration platform or number, while the rest either omitted or did not register their systematic review. In relation to transparency, 29.73% (n = 11) of the papers acknowledged financial or non-financial support received, and 21.62% (n = 8) disclosed any potential conflicts of interest among the authors. Finally, only 10.81% (n = 4) of the studies reported the availability of supplementary materials such as data extraction forms, datasets, or analysis codes, thereby limiting reproducibility and transparency.

Included Paper for Theme Selection

A total of 37 papers were selected for theme extraction, as outlined in Table 2. These papers were identified through the PRISMA systematic review process and represent the final pool of eligible studies. Each paper was systematically analyzed and categorized according to its focus on the three central themes of this review: IAQ, Self-Efficacy, and Crew Stress. Within these main themes, a series of sub-themes were also identified to provide more nuanced insights.

For IAQ, the sub-themes include IAQ Contaminants (such as VOCs, CO_2, and $PM_{2.5}$) and Physical Parameters (temperature, humidity, and ventilation). For Self-Efficacy, the sub-themes encompass Vicarious Experience (VE) and Performance Outcomes (PO), while Crew Stress is further examined through Stress Triggers (ST) and Stress Responses (SR). This thematic classification not only facilitates an organized synthesis of the literature but also contributes to the development of a conceptual framework linking IAQ, self-efficacy, and stress among naval personnel.

Table 2. Summary of included paper for theme selection.

No	Author	Factors Contributing to IAQ					Mediating Factor		Factor in Stress	
		IAQ Contaminant			Physical Parameter		VE	PO	ST	SR
		CO_2	CO	Temp	RH	WS				
1.	Boxer, P. (1990)	*	*	*	*	*		*		
2.	Abdul-Wahab, S.A., En, S., Elkamel, A., Ahmadi, & Yetilmezsoy, K. (2015).	*	*	*	*	*		*		
3.	Org, S. (2015)	*						*		
4.	Śmiełowska, M. & Zabiegała, B. (2017).	*	*	*	*	*		*		
5.	Wame (2019)	*	*	*	*	*		*		
6.	Xu, X. & Ou, S. (2019)		*	*	*	*		*		
7.	Kelly, F.J. & Fussell, J.C. (2019)						*	*		
8.	Mujan, Anđelk, Munćan, Kljajić, & Ružić (2019)	*	*	*	*	*		*		
9.	Khanna, Chatterjee, Goyal, Pisharody, Patra. & Sharma (2019)						*	*	*	*
10.	D., G.L. (2019)						*	*	*	*
11.	Bluyssen, P.M. (2019)	*	*	*	*	*		*		
12.	Petrowski, Bastianon, Bührer, & Brähler, (2019)	*	*	*	*	*		*	*	*
13.	David P.W. & Pawel W. (2019)						*	*	*	*
14.	Langer, Österman, Strandberg, Moldanová. & Fridén, H. (2020)	*	*	*	*	*		*		
15.	Roskams, M. & Haynes, B.P. (2020)	*	*	*	*	*		*		
16.	Saini, J., Dutta, M. & Marques, G. (2020)	*	*	*	*	*		*		
17.	Tham, Thompson, Landeg, Murray, K.A. & Waite, T. (2020).	*	*	*	*	*		*		
18.	Gawade, A., Sanap, A., Baviskar, V.S., Jahnige, R., Zhang, Q. & Zhu, T. (2020).	*	*	*	*	*		*		
19.	Kim S, & Lee. (2020)	*	*	*	*	*		*		
20.	Pinault, Thomson, Christidis. & Colman, I. (2020).	*	*	*	*	*		*	*	*
21.	Sutherland & Cooper (2020)							*	*	*
22.	Lazarus, R.S. & Folkman, S. (2020)						*	*	*	*
23.	Bellizzi, Panu Napodano, Pichierri. & Muthu, (2021)	*	*	*	*	*		*		
24.	Glaser *et al.* (2021)							*		
25.	Jo, D. & Koh, C. (2021).	*	*	*	*	*		*		
26.	Jensen, H. & Oldenburg, M. (2021)						*	*	*	*
27.	Paleologos, Selim. & Mohamed, A.O. (2021)	*	*	*	*	*		*		
28.	Metreveli, Y. (2021)	*	*	*		*				
29.	Thach, T.Q., Mahirah, D. & Sauter, C. (2022)	*	*	*		*		*	*	*
30.	Maryam Zahaba *et al.* (2022)	*	*	*		*		*		
31.	Dąbrowiecki, Z. (2022)	*	*	*		*		*		
32.	Du, B. (2022)			*				*		
33.	Qiu, X. & Danesh-Yazdi, M. (2022).			*						
34.	Weisskopf, M. (2022)			*				*		
35.	Kumar, Rana, Sharma. & Kumar (2022)	*	*	*						
36.	Schalm, Carro, Jacobs, Lazarov. & Stranger (2023)			*	*	*				
37.	Gilardi, L., Marconcini, M., Metz-Marconcini, A., Esch, T. & Erbertseder, T. (2023)	*	*	*				*	*	*

Theme Selection

The theme selection process identified three main variables, which are IAQ as the Independent Variable (IV), Self-Efficacy as the Mediating Variable (MV), and Crew Stress as the Dependent Variable (DV). Each theme is supported by relevant sub-themes: IAQ Contaminant and Physical Parameter under IAQ; Vicarious Experience and Performance Outcome under Self-Efficacy; and Stress Triggers and Stress Responses under Crew Stress.

These themes and sub-themes, derived from the SLR, are summarized in Table 3. To ensure the validity of these constructs, a factor analysis was conducted, confirming the grouping of items and reinforcing the study's variables.

Table 3. Theme considered a variable.

Theme	Sub Theme	Type of Variable
Indoor Air Quality (IAQ)	IAQ Contaminant	Independent Variable (IV)
	Physical Parameter	
Self-Efficacy	Vicarious Experience	Mediating Variable (MV)
	Performance Outcome	
Crew Stress	Stress Triggers	Dependent Variable (DV)
	Stress Responses	

Factor Analysis

To validate the selection of themes derived from the SLR, a factor analysis was conducted to identify the underlying structure among the observed variables. This statistical method is particularly useful when dealing with a large set of interrelated variables, as it reduces dimensionality by grouping variables that exhibit similar patterns of responses. In this study, factor analysis was used to confirm whether the survey items could be meaningfully categorized into the three proposed components: IAQ, Self-Efficacy, and Crew Stress Levels.

The analysis was performed using Principal Component Analysis (PCA) with Varimax rotation, a technique that facilitates clearer interpretation by maximizing the variance of loadings across factors. As suggested by Hair *et al.* (2010), the threshold for acceptable factor loading depends on the sample size. Given that the sample size for this study was fewer than 200 respondents, a minimum factor loading of 0.50 was applied to ensure that only variables with moderate to strong contributions to each component were retained for interpretation (Hair *et al.,* 2010). The results of the factor analysis, summarized in Table 4, identified three principal components, aligning with the thematic constructs identified in the literature.

Component 1: Indoor Air Quality (IAQ)

This component includes items related to indoor air contaminants and physical parameters. Factor loadings ranged from 0.510 to 0.743, with Item A4 (0.743) and Item A7 (0.643) demonstrating the highest loadings. These items are strong indicators of air quality conditions aboard warships and reinforce the validity of IAQ as a distinct construct.

Component 2: Self-Efficacy

This factor captures items associated with vicarious experience and performance outcomes, with loadings between 0.543 and 0.767. Item C5 (0.767) exhibited the strongest contribution to this factor, indicating its central role in measuring perceived self-efficacy among crew members in operational settings.

Component 3: Crew Stress Levels

The third component represents stress-related dimensions, including both stress triggers and stress responses. Loadings for this component ranged from 0.527 to 0.698, with Item F2 (0.698) having the highest factor loading, highlighting its importance in capturing the psychological stress experienced by naval personnel.

Table 4. Factor analysis table.

Construct	Dimension	Items	Component 1	2	3
IAQ	Indoor Air Contaminant	A1	.619	.176	-.214
		A2	.528	.031	-.435
		A3	.575	.107	-.167
		A4	.743	-.027	-.005
		A5	.607	-.078	.098
		A6	.571	-.143	.006
		A7	.643	-.031	.082
	Physical Parameter	B1	.603	-.117	-.247
		B2	.510	-.060	-.140
		B3	.506	-.184	-.109
		B4	.617	-.079	-.313
		B5	.547	-.076	-.106
		B6	.509	-.188	-.042
Self Efficacy	Vicarious Experience	C1	-.165	.544	.036
		C2	-.197	.694	-.316
		C3	-.207	.656	.338
		C4	-.440	.590	.302
		C5	-.214	.767	.071
	Performance Outcome	D1	-.449	.543	.339
		D2	-.161	.619	.195
		D3	-.177	.544	.098
		D4	-.036	.606	.103
		D5	-.052	.573	.225
Stress Level	Stress Response	E1	-.043	.546	.514
		E2	.130	.177	.658
		E3	-.120	.190	.593
		E4	-.473	.074	.594
		E5	-.325	.267	.684
		E6	.238	-.411	.650
	Stress Triggered	F1	.326	-.437	.551
		F2	.488	-.405	.698
		F3	-.340	-.410	.527
		F4	-.267	-.325	.618
		F5	-.447	-.415	.654

Extraction Method: Principal Component Analysis
a. 3 components extracted.

Collectively, these three components accounted for a substantial proportion of the total variance, confirming that the identified variables effectively represent distinct but interrelated constructs within the study. Notably, Component 1 (IAQ) explained the largest share of the variance, followed by Self-Efficacy and Crew Stress Levels. The outcome of the factor analysis supports the theoretical framework of the study and validates the categorization of the items into the three core themes. This empirical confirmation provides a solid foundation for further statistical analysis and reinforces the relevance of IAQ, self-efficacy, and stress as critical dimensions in understanding the well-being and performance of crew members aboard warships.

CONCLUSION

This SLR has provided a comprehensive and structured examination of the relationship between IAQ and occupancy stress levels within the confined environment, which is warships. This systematic literature review has explored the relationship between IAQ and occupancy stress levels in warship environments, revealing three core themes: IAQ, self-efficacy, and crew stress. Using the PRISMA approach and supported by factor analysis, the study confirmed that IAQ significantly impacts crew well-being. The significance of this study lies in its contribution to bridging a critical gap in maritime and military research. By focusing specifically on naval environments, this review sheds light on the effects of poor air quality in confined space ventilation systems, prolonged occupancy, and operational stressors typical of naval life at sea. Furthermore, the study contributes to a novel interdisciplinary connection that integrates environmental science, occupational psychology, and naval operations, offering valuable insights for researchers, naval architects, and defense health policymakers. In doing so, it aligns with broader ESG objectives by advocating for health-centric, sustainable practices within the defense sector.

Based on the findings, several key recommendations are proposed. From an operational standpoint, it is imperative that naval organizations invest in routine monitoring and assessment of IAQ aboard ships, employing advanced filtration systems and real-time sensors to detect contaminants. Additionally, ship design and retrofitting initiatives should incorporate IAQ-enhancing engineering solutions, including improved ventilation systems and environmental feedback systems. From a research perspective, there is a need for more empirical, field-based studies that directly measure IAQ and psychological outcomes aboard warships. Moreover, future research should integrate ESG metrics, emphasizing not only environmental compliance but also crew welfare and health centric of defense resources. In conclusion, this study contributes to a deeper understanding of the environmental determinants of stress in naval settings and provides a foundation for evidence-based interventions. Enhancing IAQ is a strategic move that affects mission readiness, mental health, and the sustainability of naval operations.

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