

**The Role of Berthing Habitability and Job Demand on Factors Critical to Personnel
Retention**

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Abstract

Objectives. Studies have found that job demands and berthing habitability play an important role on sleep and health outcomes. However, less is known about how job demands and habitability impact factors critical for personnel retention, such as job satisfaction and affective commitment. This study examines how sailors' berthing habitability and job demands influence factors related to personnel retention.

Methods. Structural equation models examined the relative contribution of job demands and berthing habitability on key occupational factors related to health and well-being outcomes among a large sample of naval personnel (N>11,000).

Results. Results show that high job demands and poor berthing habitability are negatively associated with health outcomes, satisfaction, and affective commitment to the organization. Findings also showed statistical differences in the various pathways between the subgroups in age, gender, race, and paygrade. In particular, there was a stronger relationship between berthing habitability and affective commitment for younger respondents. For junior officers, job demands also played a greater role to their physical health and mental health. These findings indicate that job demands and berthing habitability more substantially influence junior personnel than more senior personnel.

Conclusions. Job demands and berthing habitability have differential effects on naval subpopulations with important implications for personnel retention. Specifically, these factors can impair the development of affective commitment and job satisfaction among junior personnel, which are both critical factors to their long-term retention. Focusing on improving berthing habitability and lowering job demands would help junior personnel develop their commitment to the organization and potentially reduce personnel losses.

Key Messages

1. What is already known on this topic – summarise the state of scientific knowledge on this subject before you did your study and why this study needed to be done

Studies have shown that berthing habitability and job demands have a significant impact on numerous occupational factors, but the relative contribution of each upon different populations remains unknown. For example, junior personnel are still developing an affective commitment to the organization relative to more experienced personnel, which could impact how these occupational factors impact their attitude and well-being in the development of that commitment.

2. What this study adds – summarise what we now know as a result of this study that we did not know before

This study uses structural equation modeling while incorporating subgroup analyses to show how the predictors differentially affect various subgroups as divided by age, gender, race, paygrade. The more complex analytical method and large population are necessary to explore these questions across various subgroups.

3. How this study might affect research, practice or policy – summarise the implications of this study

Junior personnel are still developing their affective commitment to the organization. If they are particularly susceptible to berthing habitability issues and the stress of job demands, it could impair the development of their organizational commitment and reduce personnel retention rates.

The Role of Berthing Habitability and Job Demand on Factors Critical to Personnel Retention

Introduction

Naval operations impose considerable mental and physical demands on crew members due to environmental stressors. For example, the occupational environment creates continual exposure to noise hazards (1–3), temperature-induced physiological stress (4), and sailors regularly sustain physical injuries (5,6). Moreover, there are additional challenges to overcoming any of these hazards compared to land-based occupations. Naval operations require crews to live and work in the same eco-system, which results in their being exposed to environmental hazards throughout an entire day rather than just during working hours.

Repeated exposure is not only a question of volume, but also one of recovery. Multiple efforts have documented the wide variety of factors that can lead to sleep deprivations among naval personnel (7–9). Because personnel regularly have disturbed sleep, this limitation further prevents optimal worker health as these greater exposures are combined with suboptimal opportunity to recover. One particularly important challenge to effective sleep and recovery involves berthing habitability (i.e., the crew's sleeping area) (10–12). Crews are often faced with uncomfortable mattresses, ambient noise, invasive lighting, and other disruptive factors that prevent good sleep quality in their berthing compartments. Thus, the berthing compartments themselves represent an important obstacle to occupational health and well-being; that is, unless these spaces can be optimized to support better sleeping conditions.

Although berthing habitability is a critical issue affecting sleep quality, its impact must be explored through the myriad of other factors that affect sailor mental and physical health

outcomes to fully understand the combined influence. Job stress in particular has been shown to interact with sleep quality in multiple occupations with constrained sleeping conditions, including naval operations (10,13), long-haul truck drivers (14,15), and offshore oil personnel (16,17). In such occupations, workers sleep and work in the same setting, which potentially exacerbates job-related stressors and further impairs sleep quality. Specifically, workers have difficulty isolating pervasive thoughts related to job stress that might prevent them from falling asleep when the workspace and sleeping space are co-located.

Still, while job stressors and berthing habitability are known to impact sleep quality, there remains a need to explore how these factors promulgate problems to other elements of individual well-being. As personnel working in shared living-working spaces spend significant time with their colleagues, these shared problems also have implications for cohesion, commitment, and satisfaction within the team and across the ranks (18). Additionally, job satisfaction can be directly related to perception of the social atmosphere and working conditions (19). Each aspect has important implications for developing an attachment to the organization that supports long-term personnel retention. If job stress and environmental habitability interfere with the development of affective commitment and job satisfaction, then personnel will become more inclined to find another occupation. Organizational commitment itself is a complex subject with a rich history outlining the many ways individual connection to an organization can be manipulated by specific circumstances (20–22).

When considering how organizational commitment might develop, a related issue involves whether the attachment remains comparable across demographic factors such as age, ethnicity, gender, or rank. For example, younger personnel may be more susceptible to a variety of stressors and mental health issues (23), although ethnicity may not be associated with

subjective stress level (24). Few naval studies have considered gender as a predictor of well-being because the populations of most of the studies were predominantly male. Studies that did parse out gender found that it was not related to sleepiness or well-being (25), although one study of naval personnel found females at greater risk of depression (26). Subgroup analyses thus represent an important component in exploring how the demographics of a naval crew may exacerbate or mitigate any relationships between berthing habitability, job stressors, and organizational commitment.

The current study explored how occupational health factors related to job demands and berthing habitability affected several components important to personnel retention, including health, satisfaction, and affective commitment. Structural equation modeling analyses utilized a large dataset ($N > 11,000$) of naval personnel, which is essential to allow for multiple influences of both manifest and latent variables across a variety of population demographics. A key hypothesis involves affective commitment among younger personnel. If these individuals are still developing an attachment to the organization and making long-term career choices, then impairing their commitment and job satisfaction will ultimately lead to reduced employee retention rates.

Research Questions:

- 1) What is the relative contributions of job demands and berthing habitability on sailors' health, job satisfaction, and affective commitment?
- 2) Are there any significant subgroup differences (i.e., gender, race, rank, age) in the various relationships?

Methodology

Sample and Data collection

Data was collected from the Afloat Safety Climate Assessment Survey (ASCAS) (27), which was completed by 112 ships between November 2021 and September 2022 (see Figure 1).

Participation in the survey was voluntary and responses were anonymous.

[Insert Figure 1 here]

Table 1 summarizes the study's overall sample of 11,295 participants.

Table 1: Demographics for ASCAS survey participants

Demographic	Total
Gender	
-Female	2,296 (20%)
-Male	8,924 (80%)
Race	
-Non-white	5,081 (46%)
-White	5,990 (54%)
Age	
-17-21	1,664 (14.8%)
-22-25	3,049 (27.2%)
-26-30	2,329 (20.8%)
-31-35	2,007 (17.9%)
-36-40	1,338 (11.9%)
-41-45	624 (5.6%)
-46-50	160 (1.4%)
-51-55	41 (0.4%)
-56-60>	6 (0.1%)
Rank	
-E1-E3	1,677 (14.9%)
-E4-E6	6,430 (57.1%)
-E7-E9	1,350 (12%)
-Officer / CWO	1,797 (16%)

Measures

The ASCAS captures factors that can help identify priority targets affecting operational safety outcomes for intervention and mitigation. ASCAS consists of a number of safety and human performance measures. The following constructs were included in this study:

1. The Job Demands measure assesses the demands the respondents might encounter at work, regarding lack of time, equipment, and manning, working overtime, and lead pressure, using a 5-item Likert-like scale ranging from 1 (never) to 5 (very often). The latent variable Job Demands consists of the following components: the respondents (1) do not have enough time to carry out their tasks properly, (2) do not have the equipment needed to do their job properly, (3) do not have sufficient manning to achieve allocated tasks on time, (4) have to work beyond regular duty hours to get work done, and (5) are pressured by leadership to maintain performance standards at the cost of safety (28).
2. Berthing habitability factor assesses how ambient noise (e.g., air system, miscellaneous equipment), IMC announcements, crew mate noise (e.g., open/closing rack, chatting, etc.), uncomfortable rack and mattress, invasive lighting, and temperature (cold and hot) affects respondent ability to sleep while onboard the current ship. Each item is rated on a five-point Likert scale ranging from 1 (not at all) to 5 (extremely).
3. Health outcomes: (a) physical health is determined by how many days during the past 30 days the respondent physical health, including physical illness and injury, was good (the original question was phrased as “bad,” so recoding was implemented) ; (b) mental health is assessed by the number of days during the past 30 days in which respondents mental

health, including stress, depression, and problems with emotions, was good (the original question was phrased as “bad,” so recoding was implemented) (29).

4. Satisfaction with the Command measure uses a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree) to assess respondents (a) motivation to perform their best for the command, (b) satisfaction with being assigned to that command, and (c) satisfaction with the safety practices of the command.
5. Affective commitment towards the command measures emotions regarding the command (i.e., feeling like “part of the family”, “emotionally attached”, and a strong sense of belonging) using a five-point Likert scale from 1 (strongly disagree) to 5 (strongly agree) (30).

Exploratory Analysis

Exploratory analysis began with a visual evaluation of all variables to determine their frequency, percentage, and near-zero variance for categorical variables (i.e., rank, gender, race, age, affective commitment, job demands, satisfaction with the command, factors impacting sleep), as well as distribution for numeric variables (i.e., age), and their corresponding missing value patterns (31). Near-zero variance happens whenever a categorical variable has a low frequency of distinct values over the sample size (i.e., the variable is almost constant). Near-zero variance was addressed by merging several variable categorizations. When numeric variables do not present a normal distribution, variable transformations such as logarithmic and Box-Cox were explored. Imputation algorithms were implemented to address missing variables, followed by sensitivity analyses to certify if the results were stable with and without imputation (32). For the exploratory analysis, a standardized mean difference (SMD) was used, which is the

proportions or mean difference divided by the pooled standard deviation. When interpreting SMD magnitude, the following guidelines were used: SMD = 0.2 equaled a small effect, SMD = 0.5 equaled a medium effect, and SMD = 0.8 equaled a large effect (33). P values for t-tests (for numeric variables) and Chi-square tests (for categorical variables) are presented. P values below 0.05 were considered statistically significant.

Structural equation modeling

The structural equation model involved five variables in its measurement model: Berthing habitability, Job Demands, Mental Health, Physical Health, Satisfaction, and Affective Commitment. The Berthing habitability factor included the following manifest variables: ambient noise, 1mc announcements, crewmate noise, uncomfortable rack/mattress, invasive lighting, cold temperature, hot temperature, and sleep availability. The latent variable Job Demands comprised of the following items: they do not have enough time to complete their tasks properly, do not have the equipment that they need to do their job properly, do not have sufficient manning to achieve allocated tasks on time, have to work beyond regular duty hours to get work done, and there is leadership pressure to maintain performance standards at the cost of safety. The third latent variable, Health, is composed of a) Mental Health, which refers to sailors' report of how many days in the past 30 days did they experience good mental health, and b) Physical Health, which refers to sailors' report of how many days in the past 30 days did they experience good physical health. The fourth variable, Satisfaction, included the following items: they are motivated to perform their best for their command, happy to be assigned to their command, and satisfied with the safety practices of their command. The last latent variable, Affective Commitment, comprehended items related to their emotions towards their command: if

they are feeling like “part of the family,” “emotionally attached,” and a strong sense of belonging under their command.

Then, structural models were established by examining relationships between the latent and manifest variables. Health, Satisfaction, and Affective Commitment were all linked to variables representing Job Demands and Berthing habitability. In order to compare the paths, the Wald test on linear restrictions between regressions paths was used to test the equality of the standardized regression coefficients.

The following goodness-of-fit measures were used to evaluate all models: Chi-squared statistics along with degrees of freedom and p-value, Comparative Fit Index (CFI), Incremental Fit Index (IFI), Relative Noncentrality Index (RNI), Goodness-of-Fit Index (GFI), Root Mean Square Error of Approximation (RMSEA), and Standardized Root Mean Square Residual (SRMR).

To determine how the participants’ characteristics and operational settings influenced operational performance, the model was created to evaluate multigroup differences for Health, Satisfaction, and Affective Commitment paths. The participant’s gender, race, age, and rank measurements were among the characteristics we evaluated. To determine whether job-related issues were affected by operational and environmental stressors, the same model was tested using a difference in terms of regression coefficients of the Health, Satisfaction, and Affective Commitment paths between the following groups (level 1 vs. level 2): gender (male vs. female), race (white vs. non-white), age (17-30 vs. 31-60>), paygrade [junior/petty (E1-E6) vs. chiefs (E7-E9, Officer/CWO)].

Results

The model yielded a satisfactory fit, χ^2 statistic of 3709.628 (df=159, $p < 0.001$), as well as multiple indicators of overall adequate model fit, including the Goodness of Fit Index (GFI = 0.967) and Comparative Fit Index (CFI = 0.964) with values greater than .90; and the Root Mean Square Error of Approximation (RMSEA = 0.044) and Standardized Root Mean Residuals (SRMR = 0.046) with values lower than .08. See Figure 2.

[Insert Figure 2 here]

The model showed that poor berthing habitability and high job demands were both negatively associated with sailors' health, job satisfaction, and affective commitment. Furthermore, Wald test showed that job demands had a higher association to sailors' health than berthing habitability ($p < 0.001$), and berthing habitability to affective commitment than job demands ($p < 0.001$).

Subgroup Analysis

To further determine whether the outcome variables were affected by operational and environmental stressors, the same initial model was tested using a difference in terms of regression coefficients of the Health, Satisfaction, and Affective Commitment paths between the following groups (level 1 vs. level 2): gender (male vs. female), race (white vs. non-white), age (17-30 vs. 31-60>), rank [junior enlisted or petty officer (E1-E6) vs. chiefs (E7-E9, Officer/CWO)]. Table 3 displays the sample size distribution between levels for groups.

Table 2: Sample size distribution between levels for groups

	Level 1	Level 2
Gender	8924	2296
Race	5990	5081
Age	7042	4176
Rank	8107	3147

Table 3 summarizes the significant differences in the regression coefficients between the subgroups.

Table 3. Regression coefficients of the Model Paths that show significant differences between subgroups

Path	Estimate Difference
Gender (male v. female)	
Satisfaction ~ JobDemands	b = 0.053 (b1 = -0.201; b2 = -0.148), 95% CI [0.019, 0.087], $\beta = 0.063$, z = 3.032, p = 0.002
Race (white v. non-white)	
Satisfaction ~ BerthHabitability	b = 0.081 (b1 = -0.242; b2 = -0.16), 95% CI [0.046, 0.116], $\beta = 0.046$, z = 4.559, p < 0.001
AffectComm ~ BerthHabitability	b = 0.159 (b1 = -0.455; b2 = -0.295), 95% CI [0.097, 0.222], $\beta = 0.047$, z = 5.013, p < 0.001
Health ~ BerthHabitability	b = 0.483 (b1 = -1.725; b2 = -1.242), 95% CI [0.172, 0.794], $\beta = 0.054$, z = 3.04, p = 0.002
Age (17-30 v. 31-60>)	
AffectComm ~ BerthHabitability	b = 0.076 (b1 = -0.391; b2 = -0.314), 95% CI [0.015, 0.138], $\beta = 0.032$, z = 2.426, p = 0.015
Rank (jr. v. chief officers)	
Health ~ JobDemands	b = 0.399 (b1 = -1.738; b2 = -1.339), 95% CI [0.108, 0.69], $\beta = 0.053$, z = 2.687, p = 0.007

Gender (male v. female): There was gender difference in the direct effect of Job Demands on Satisfaction with Command ($\beta = 0.063$, p=0.002), indicating that for males, there was a stronger relationship between Job demands to Satisfaction with Command.

Race (white v. non-white): There was greater association for white respondents from habitability to sailors' health ($\beta = 0.054$, $p = 0.002$), satisfaction ($\beta = 0.046$, $p < 0.001$), and affective commitment ($\beta = 0.047$, $p < 0.001$).

Age (17-30 v. 31-60>): Statistically significant path differences were observed for the age subgroups ($\beta = 0.032$, $p = 0.015$), indicating a stronger association between berthing habitability and affective commitment for those who were 17-30 compared with those 31-60>.

Rank (jr. v. chief officers):

Statistically significant differences held between junior enlisted versus chief/officer groups for the direct effect of Job Demands on Health ($\beta = 0.053$, $p = 0.007$), indicating a stronger association between job demands and health for junior officers compared with chief officers.

Discussion

Previous studies have shown that sailors' berthing habitability and job demands negatively impact their sleep (10–12). This study expands upon the negative association and demonstrates how these factors similarly influence sailors' health, satisfaction, and affective commitment. Poor living conditions lead to worse health (mental and physical), low satisfaction with the command, and decreased affective commitment to the team. High job demands also worsens sailors' health and decreases their sense of satisfaction and affective commitment—all critical factors to personnel retention. Policy recommendations should consider ways to improve sailors' poor berthing habitability and lower job demands in order to increase sailors' health and psychological well-being.

Furthermore, there is a differential impact from berthing habitability and job demands on the outcome variables. Job demands had a greater negative association to sailors' health than berthing habitability, but berthing habitability had a greater negative association to affective commitment than job demands. These results show that it is not straightforward whether to focus more on improving berthing habitability or lowering job demands, as they have different relative contributions on the outcome variables.

Subgroup analyses also show differential relationships between job demand and berthing habitability to sailors' health, job satisfaction, and affective commitment. For males, there was a stronger relationship between Job demands to Satisfaction with Command. There was also greater association for white sailors from habitability to sailors' health, satisfaction, and affective commitment. A particularly important outcome concerned the role of age in the subgroup analyses. Specifically, junior sailors were more impacted by the negative influences of job demands and berthing habitability than more senior personnel. Because junior personnel are still developing their affective commitment to the organization, this influence becomes more important as it could negatively impact long-term personnel retention rates (34). Therefore, future work should focus on improving berthing habitability and lowering job demands, especially for younger personnel as they make decisions about whether to remain with the organization.

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