Perceived hazardous physical work environments and job-related affective well-being of navy officers aboard the Republic of Korea Navy ships and submarines in South Korea

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ABSTRACT

Introduction Navy ships and submarines are important military measures that protect the Republic of Korea. They also comprise naval officers’ workplace. However, few studies have examined naval officers’ working environment and their job-related well-being. This study aimed to explore exposure to hazardous work environments among navy officers aboard ships and submarines and their association with job-related affective well-being.

Methods This was a cross-sectional descriptive study. The sample comprised 146 officers from 4 navy ships and 98 officers from 5 submarines. Items of exposure to the eight types of hazardous work environments and the Job-related Affective Well-being Scale (JAWS) were included in the self-report survey questionnaires.

Results The most common hazards reported by officers aboard navy ships were vibration (63.7%) and air pollution (56.2%). For submarine officers, these hazards were lack of personal space (72.4%) and air pollution (67.3%). The average JAWS score for ship officers and submarine officers was 69.81 (SD=10.89) and 70.50 (SD=10.83), respectively. For ship officers, exposure to air pollution, noise, vibration, thermal discomfort during summer or winter and lack of personal space were significantly correlated with lower JAWS scores. For submarine officers, exposure to fire, burning or electrical shock, air pollution, noise, thermal discomfort during summer or winter and lack of personal space were significantly correlated with lower JAWS scores.

Conclusions This study revealed that some naval officers aboard ships or submarines are exposed to hazardous work environments. Moreover, certain types of hazardous work environments were associated with naval officers’ job-related affective well-being.

INTRODUCTION

The Republic of Korea Navy (ROK Navy) has about 70,000 personnel and possesses high-tech ships and submarines. It has a relatively high proportion of officers compared with other divisions because ships and submarines with advanced technology require special operation capabilities. For example, all submarine crews are commissioned or non-commissioned officers, and there is no seaman or civilian employee. Moreover, the officers comprise 60% of ship personnel. Seamen are all conscript civilian employee. Moreover, the officers comprise all submarine crews are commissioned or non-commissioned officers. Seamen are all conscript personnel may be exposed to physical work hazards, such as noise, whole-body vibration and toxic chemicals, specific to working aboard ships and the exposure rate to some physical hazards is high. For example, a study found that 74.3% of Royal Norwegian Navy personnel reported exposure to noise and 49.9% to vibration. Studies have found that the work environment aboard ships and submarines of the ROK Navy may have various hazards such as noise, vibration and limited personal space. No study has investigated the prevalence of hazards perceived by the people on board.

Affective well-being refers to ‘the frequency and intensity of positive and negative emotions and mood’. (p. 431) Having high affective well-being indicates presence of positive affect, such as happiness, contentment and excitement, and absence of negative affect, such as sadness, anxiety and anger, and has been studied in military personnel. Clark et al examined affective well-being in military personnel and their family concerning the effect of deployment. Job-related affective well-being refers to emotional states or feelings associated with the work environment. It indicates the affective...
responses to job stressors and, thus, is an important facet for employees’ occupational health. Therefore, job-related affective well-being and its associated work environments have been studied in people employed in various types of jobs. Nevertheless, there is a dearth of information regarding job-related affective well-being in navy personnel.

The work environment of ROK navy officers and their workplace well-being have rarely been studied. Moreover, no research has examined the work conditions and the job-related emotional health of navy officers. While some studies have revealed the significant associations between exposure to work hazards and job-related affect, no study has examined this relationship in military personnel. Therefore, this study aimed to explore the exposure to physical work hazards in navy personnel and the correlation with job-related affective well-being.

**METHODS**

**Study design and procedure**

A cross-sectional study was conducted using a self-report survey. The sample was selected based on a stratified two-stage cluster sampling approach where the strata was ship or submarine and where the first stage unit was squadron and the second stage unit battalion. A total of 330 officers in four ships and 122 officers in five submarines were considered for the selected battalions. Among these officers, 152 (46%) ship officers and 99 (81%) submarine officers responded to the survey questionnaires. After excluding the incomplete responses, 146 ship officers and 98 submarine officers were included in the study sample. To decrease under-reporting and over-reporting in the self-report survey, subjects were informed of how privacy was protected and confidentiality maintained during the informed consent procedure. A researcher of this study visited the battalions and distributed the questionnaires to the officers with an explanation about the survey; however, in ships and submarines, where visiting was not allowed at the time of the survey, a person in uniform was present to ensure the participants’ mood regarding their jobs. Ten items pertained to positive affect and 10 to negative affect. An example item for positive affect was “*My job made me feel at ease*” and an example for negative affect was “*My job made me feel angry*”. The question was “*Please check one response for each item that best indicates how often you’ve experienced each emotion at work over the past 30 days*”. The answers ranged from 1 (never) to 5 (extremely often). Possible total scores ranged from 20 to 100. Higher scores indicated better emotional health. Cronbach’s alpha in the current study for positive affect and negative affect were 0.89 and 0.92. Face validity was assessed prior to the study.

**Data analysis**

SPSS/WIN V23.0 program was used. A point-biserial correlation analysis was used to evaluate the relationship between each hazardous work environment and JAWS score. This analysis was selected because there was no clear evidence to support a dependency or causal relation between these two variables. Exposure to each hazardous environment was coded as 1 while not-exposure was coded as 0. In terms of missing values, there were no missing values for the work hazard items and the missing values of JAWS were replaced by the mean score of JAWS of the subject.

**RESULTS**

**Participant characteristics**

The mean age for ship officers was 30.70, with a median of 29 years, and that for submarine officers was 29.61, with a median of 27 years (Table 1). There were six (2.5%) female ship officers, while there were no female submarine officers. The average service duration was 12.96 and 17.66 months for ship officers and submarine officers, respectively.

**Hazardous work environment**

The most common hazardous work environments reported by ship officers were vibration (63.7%), air pollution (56.2%), lack of personal space (54.8%) and noise (54.8%) (Table 2). The most common hazards reported by submarine officers were lack of personal space (72.4%), air pollution (67.3%) and dangerous tools, equipment or machinery (45.9%). The rates of exposure to three types of hazards—vibration, thermal discomfort during
summer or winter and lack of personal space—differed significantly between the two groups.

**Job-related affective well-being**

The average JAWS score for ship officers was 69.81 (SD = 10.89), while that for submarine officers was 70.50 (SD = 10.83). There was no significant difference in JAWS score between submarine and ship officers. Moreover, the correlation analysis between each sociodemographic (age, sex, marital status and religion) and work-related characteristics (duration of service and overtime work) of the officers and JAWS scores revealed no significant association for ship officers or submarine officers.

**DISCUSSON**

This study explored hazardous work environments perceived by naval officers working aboard ships and submarines in South Korea and examined their association with job-related affective well-being. The results showed that certain percentages of South Korean naval personnel experienced various work hazards, some of which were associated with their job-related affective well-being.

Vibration was one of the most frequently reported work hazards by crews working on ships. In this study, 63.7% of ship personnel reported exposure to vibration, while this figure stood at 44.9% among submarine personnel. These results reflect a study on the Royal Norwegian Navy, which revealed that 49.9% of the navy personnel reported exposure to vibration, while they are higher than the national data of South Korean naval personnel.18-20 A study revealed that the overall noise level in the residency areas of the crew of a 665-ton naval supply ship was 78 dB, exceeding the 60 dB limit.21

**Correlation between hazardous work environments and job-related affective well-being**

For ship officers, exposure to air pollution, noise, vibration, thermal discomfort during summer or winter and lack of personal space were significantly correlated with lower JAWS scores (Table 3). For submarine officers, exposure to fire, burning or electrical shock, air pollution, noise, thermal discomfort during summer or winter and lack of personal space were significantly correlated with lower JAWS scores.

**Table 1** General participant characteristics

<table>
<thead>
<tr>
<th></th>
<th>Ships (n=146)</th>
<th>Submarines (n=98)</th>
<th>Total (n=244)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>30.70 (19–48)</td>
<td>31.52 (21–46)</td>
<td>31.16 (19–49)</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>140 (95.9%)</td>
<td>134 (97.5%)</td>
<td>274 (95.8%)</td>
</tr>
<tr>
<td>Women</td>
<td>6 (4.1%)</td>
<td>4 (2.5%)</td>
<td>10 (4.2%)</td>
</tr>
<tr>
<td>Marital status</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single</td>
<td>79 (54.1%)</td>
<td>134 (94.9%)</td>
<td>213 (87.5%)</td>
</tr>
<tr>
<td>Married</td>
<td>67 (45.9%)</td>
<td>10 (5.1%)</td>
<td>77 (32.5%)</td>
</tr>
<tr>
<td>Religion</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No religion</td>
<td>79 (54.1%)</td>
<td>46 (46.9%)</td>
<td>125 (51.2%)</td>
</tr>
<tr>
<td>Having religion</td>
<td>67 (45.9%)</td>
<td>52 (53.1%)</td>
<td>119 (48.8%)</td>
</tr>
<tr>
<td>Duration of service (months)</td>
<td>12.96 (7.77)</td>
<td>17.66 (15.45)</td>
<td>20.39 (15.76)</td>
</tr>
<tr>
<td>Over work hours (&gt;40 hours/week)</td>
<td>No</td>
<td>No 104 (71.2%)</td>
<td>155 (63.5%)</td>
</tr>
<tr>
<td></td>
<td>No 42 (28.8%)</td>
<td>No 47 (48.8%)</td>
<td>89 (36.5%)</td>
</tr>
</tbody>
</table>

**Table 2** Perceived hazardous work environment

<table>
<thead>
<tr>
<th>Hazardous environments</th>
<th>Ship officers (n=146)</th>
<th>Submarine officers (n=98)</th>
<th>r pb</th>
<th>P value</th>
<th>r pb</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toxic chemicals</td>
<td>40 (27.4%)</td>
<td>20 (20.4%)</td>
<td>1.545</td>
<td>0.214</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dangerous tools, equipment or machinery</td>
<td>106 (72.6%)</td>
<td>78 (79.6%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fire, burning or electrical shock</td>
<td>77 (52.7%)</td>
<td>45 (45.9%)</td>
<td>1.091</td>
<td>0.296</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air pollution</td>
<td>69 (47.3%)</td>
<td>53 (54.1%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Noise</td>
<td>62 (42.5%)</td>
<td>34 (34.7%)</td>
<td>1.484</td>
<td>0.223</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vibration</td>
<td>84 (57.5%)</td>
<td>64 (65.3%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thermal discomfort during summer or winter</td>
<td>82 (56.2%)</td>
<td>66 (67.3%)</td>
<td>3.073</td>
<td>0.080</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lack of personal space for privacy</td>
<td>64 (43.8%)</td>
<td>32 (32.7%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Noise</td>
<td>80 (54.8%)</td>
<td>42 (42.9%)</td>
<td>3.342</td>
<td>0.068</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vibration</td>
<td>66 (45.2%)</td>
<td>56 (57.1%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thermal discomfort during summer or winter</td>
<td>93 (63.7%)</td>
<td>44 (44.9%)</td>
<td>8.418</td>
<td>0.004</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lack of personal space for privacy</td>
<td>53 (36.3%)</td>
<td>54 (55.1%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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Original research
drivers in South Korea. In this study, for ship officers, expo-
workers in the USA and higher than the score of 54.5 for taxi
rine officers, which are lower than the score of 99.8 for office
(\text{SD}=10.89) for ship officers and 70.50 (\text{SD}=10.83) for subma-
burning or electrical shock.

Compared with this national data, ship and submarine naval
ation, thermal discomfort during summer or winter and lack of
well-
that exposure to work hazards such as noise and toxic chemicals
et al revealed

exposed to toxic chemicals and fire,
officers seem to be more exposed to toxic chemicals and fire,

Inadequate space for work and break could be one of the
stress factors affecting occupational health. Lack of personal
space was the most frequently reported hazard by submarine
personnel and the fourth-most frequently reported hazard by
ship personnel. The limited space aboard submarines does not
afford privacy in their bunks. Moreover, submariners work and
live in a confined and isolated space while on duty, which creates
an extreme work environment. According to a report in South
Korea, residential space per person in Navy submarines is just
3.9 m\textsuperscript{2}. Regarding navy ships, crew members experience difficulty in finding sufficient personal and private space.

Thermal discomfort is another of the hazardous work envi-
ronments. In this study, thermal discomfort during summer or winter occurred in 18.5\% of ship officers and just 2.0\% of
submarine officers. Ship crews are often exposed to hot and cold
temperature during door watch duty or work on deck.

Exposure to toxic chemicals, including organic solvents and heavy metals, was reported by 27.4\% of ship officers and 20.4\%
of submarine officers. Moreover, exposure to fire, burning or
electrical shock was reported by 42.5\% of ship officers and 34.7\%
of submarine officers. According to the KNHANES, just
16.4\% of the Korean population were exposed to toxic chem-
icals at work and 15.5\% to fire, burning or electrical shock.

Compared with this national data, ship and submarine naval
officers seem to be more exposed to toxic chemicals and fire,
burning or electrical shock.

With regard to the JAW, the average JAWS scores were 69.81
(\text{SD}=10.89) for ship officers and 70.50 (\text{SD}=10.83) for subma-
rine officers, which are lower than the score of 99.8 for office
workers in the USA and higher than the score of 54.5 for taxi
drivers in South Korea. In this study, for ship officers, expo-
sure to air pollution, vibration, noise, thermal discomfort during
summer or winter and lack of personal space were associated
with lower affective well-being. For submarine officers, expo-
sure to toxic chemicals, fire, burn or electric shock, air pollu-
tion, thermal discomfort during summer or winter and lack of
personal space were associated with lower affective well-being.

Furthermore, the association between physical or ergonomic
hazards and mental health has been reported. Zeng et al revealed
that exposure to work hazards such as noise and toxic chemicals
was significantly associated with lower levels of psychological
well-being among workers. This study is the first to support
the relationship between physical work hazards and affective
health among navy personnel.

This study has the following limitations. First, this study used
the self-report survey method. There might be self-reporting
bias, such as social desirability bias and recall bias. Second, this
study examined the correlations between different types of
hazardous environments and affective well-being without consid-
ering which one is independent and dependent. Moreover, the
contounding variables of this relationship were not evaluated;
therefore, the mechanisms underlying this association remain
unclear. Further research is also required to consider multiple
factors, including organisational work environments, to under-
stand navy personnel’s job-related affective well-being. Third,
in the current study, chemicals were not examined separately.
Studies need to be performed to explore the individual exposure
rates of the various types of toxic chemicals, such as asbestos,
organic solvents, petrol and lead, aboard ships and submarines
because each chemical has very different levels of dangers and
harms. Forth, this study assessed individual perceptions through
self-reported measures. Further research must include data
obtained using objective exposure measurement techniques and
develop methods to reduce the exposures on navy ships and
submarines. Fifth, although the sample was selected with a
stratified two-stage cluster random sampling procedure, the
small sample size might affect the generalisability of the study.
Studies with larger samples need to be performed. Furthermore,
this study only included a small number of female officers. There
were no female submarine officer because ROK naval subma-
rines do not allow women on board. In this study, only 2.5\% of
ship officers were women. The exact number of female officers
on board ships in the ROK Navy has not been reported. Further
study is needed to focus on female naval officers on board naval
ships. Women in the military may have different psychological
well-being experiences. Finally, this study only included offi-
cers and did not include lower-ranking seamen. There are no
seamen in the ROK submarines, but further study is needed to
focus on lower-ranking seamen on board navy ships. They may
have different work-related health issues than officers.

CONCLUSIONS

Ships and submarines are central to the work and lives of naval
officers. This study revealed that some naval officers aboard
ships or submarines are exposed to hazardous work environ-
ments. Moreover, certain types of hazardous work environ-
ments were associated with naval officers’ job-related affective
well-being. The ROK naval ships and submarines are important
military means to protect national security but, at the same
time, they are the workplaces of South Korean naval officers who are
employees of the ROK Armed Forces. Efforts should be devoted
to reduce hazardous work environments and improve their
occupational health.

Contributors DJ and CKK made substantial contributions to conception and design of the study. DJ conducted a survey and analysis of data. DJ and CKK wrote a draft of the article and have read and approved the manuscript. This work is derived from a master’s thesis of Lieutenant Commander DJ (first author).

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Competing interests None declared.

Patient consent for publication Not required.

Ethics approval The study was approved by the Institutional Review Board of the Armed Forces Medical Command. Participants who volunteered to participate completed the survey. Written informed consent was obtained from all participants. A security review process was conducted by the ROK Navy prior to the survey.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available on reasonable request.

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REFERENCES