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## Short Communication

# Crew awareness as key to optimizing habitability standards onboard naval platforms: A 'back-to-basics' approach

Surg Cdr Anand Neelakantan<sup>a,\*</sup>, Surg Capt Mookkiah Ilankumaran<sup>b</sup>,  
Surg Capt Sougat Ray<sup>c</sup>

<sup>a</sup>JDMS (CSL), O/o DGMS (N), Integrated Headquarters of Ministry of Defence (Navy), New Delhi 110011, India

<sup>b</sup>Director Medical Services (Health), Integrated Headquarters of Ministry of Defence (Navy), New Delhi 110011, India

<sup>c</sup>Senior Staff Officer (Health), Headquarters Western Naval Command, Mumbai 400001, India

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## ABSTRACT

**Background:** A healthy habitable environment onboard warships is vital to operational fleet efficiency and fit sea-warrior force. Unique man-machine-armament interface issues and consequent constraints on habitability necessitate a multi-disciplinary approach toward optimizing habitability standards. Study of the basic 'human factor', including crew awareness on what determines shipboard habitability, and its association with habitation specifications is an essential step in such an approach. The aim of this study was to assess crew awareness on shipboard habitability and the association between awareness and maintenance of optimal habitability as per specifications.

**Methods:** A cross-sectional descriptive study was carried out among 552 naval personnel onboard warships in Mumbai. Data on crew awareness on habitability was collected using a standardized questionnaire, and correlated with basic habitability requirement specifications. Data was analyzed using Microsoft Excel, Epi-info, and SPSS version 17.

**Results:** Awareness level on basic habitability aspects was very good in 65.3% of crew. Area-specific awareness was maximum with respect to living area (95.3%). Knowledge levels on waste management were among the lowest (65.2%) in the category of aspect-wise awareness. Statistically significant association was found between awareness levels and habitability standards (OR = 7.27).

**Conclusion:** The new benchmarks set in the form of high crew awareness levels on basic shipboard habitability specifications and its significant association with standards needs to be sustained. It entails re-iteration of healthy habitation essentials into training; and holds the key to a fit fighting force.

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\* Corresponding author.

E-mail address: [vivekk75a@yahoo.com](mailto:vivekk75a@yahoo.com) (A. Neelakantan).

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## Introduction

'Habitability' is one of the most vital aspects of new age shipbuilding practice and a soft, yet key determinant of fighting power of a nation's navy. It can be determined by its physical arrangements, spatial characteristics, and ambient environmental qualities of vibration, noise, indoor climate, and lighting'.<sup>1</sup> Co-existence of men, equipment, and arsenal in high density and in close proximity, coupled with rapid fleet modernization and expansion add to the challenges toward ensuring healthy habitability. The five critical habitability aspects amenable to assessment, measurement, and control as per laid down guidelines are: accommodation, whole-body vibration, noise, indoor climate, and lighting. Quality of life studies onboard naval platforms have revealed that shipboard life is one among several work and non-work factors that help explain retention plans, behavior, and efficiency.<sup>2,3</sup>

Human-centered and habitability-centered ship designing, incorporating human factors, and ergonomics right from the start of the ship-building process is highly desirable. Provision of modular accommodation and separate sleeping billet for each sailor along with state-of-the-art galley equipment installation to ensure hygienic food preparation is required. Provision of isolated spaces with dedicated ventilation systems is incorporated to prevent spread of air-borne infections. The Heating, Ventilation and Air Conditioning (HVAC) systems on vessels are designed to effectively control indoor thermal environmental parameters to within acceptable limits.

The severity of discomfort due to mechanical vibration varies as per acceleration experienced, from no discomfort at an acceleration of <0.3 meter per second to being extremely uncomfortable at acceleration of >2.5 meter per second. Conditions that promote seasickness include atmosphere, visual clues, smells, heat, confined spaces, position, contagion, and apprehension.<sup>4</sup>

Ship-borne noise menace is more severe than land based ones. The maximum acceptable noise levels in various compartments/spaces of ship vary from 60 dBA in radio rooms, sleeping cabins, and sickbays, to 110 dBA in machinery spaces, bridge wings, and forecabin.<sup>5</sup> Lighting of crew spaces should facilitate visual task performance, facilitate movement of crew members in the space, and aid in creation of an appropriate visual environment. LED and CFL are encouraged to reduce lighting load. Waste disposal facilities include arrangements for automated waste disposal and installation of compact waste treatment units.

One study found that sea state was inversely related to fighting effectiveness, with sea state levels of 5 causing inconvenience and longer work duration. Sleep becomes difficult and weapon systems degradation sets in at sea state 6, where nearly half of the crew becomes sick. The crew's efficiency as a fighting unit was found to be seriously compromised at sea states 7 and above.<sup>6</sup>

With this background, this study was carried out with the twin objectives of evaluating the knowledge among ship's crew members on habitability components and to analyze the association of the awareness levels with the habitability guidelines.

## Material and methods

This was a descriptive study, carried out among personnel onboard Indian naval warships in Mumbai. The study included serving officers and sailors of warships that were in the harbor during the period. Taking the prevalence of knowledge of habitability standards among crew members to be 60% and 5% error of margin, with 95% confidence interval and 80% power, the sample size was worked out to be 369 (Epi Info 7). The prevalence of (crew) knowledge ( $p$ ) as 60% was found by undertaking a pilot study among 30 participants, and the subsequent calculation of sample size was based on the findings obtained from the pilot testing. However, a total of 552 personnel participated for sake of convenience. Stratified random sampling technique was used to select the sample, proportionate to the number of Officers, Senior sailors and Junior sailors in each class of ship, which consisted of two prototype ships from Frigate class (Brahmaputra class-2005 vintage and Talwar class-2004) and one ship each from a Destroyer class (Mysore class-1993), Corvette class (K22-2002 vintage), Oil tanker (2011), and a Minesweeper (1998 vintage).

Data was collected by the validated questionnaire, which was structured into personal particulars, service details, and assessment of awareness on habitability standards. The scoring system for assessment was worked out thus. The habitability items formed 12 major and one minor composites or scales, created on an a priori basis and verified by a principal component factor analysis. The composites of habitability items were grouped according to crew members' awareness on habitability, in five main areas of the ship, that is, berthing areas, working areas, messing areas, head or sanitary facilities, and the ship in general. A composite, point-wise weighted scoring, wherein a total of 25 points was provided for the composite score. Each of the 12 major determinants of habitability (guidelines thereof) were allocated two points each, making a total of 24 points; pest control was allotted one point, adding up to 25 points.

The awareness levels were rated as follows: any score of <6 (out of 25) was rated as inadequate, 7–12 as fair, 13–18 as good, and >19 as very good. Subsequently, the relationship between the awareness levels was correlated with habitability guidelines as existent on ground, in each of the five areas of the ship as per the guidelines mentioned above. The survey responses were analyzed using Epi-info and SPSS version 17. For purpose of stratified data analysis and display of certain variables, the responses were grouped into two: 'inadequate' and 'fair' were clubbed as 'just average'; and 'Good' and 'very good' were clubbed as 'above average'. The cut-off level for designating awareness level as 'average' has been placed/defined as 12 out of a total of 25 points.

## Results

Distribution of the study population as per age and rank revealed the mean age of the study participants to be 29.4 + 4.2 years. More than half of the study subjects were junior sailors (Table 1). Analysis of awareness levels (Fig. 1) revealed that 91.7% of crew members onboard ships had above average

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