

Impact of the Marine Environment on the Health and Efficiency of Seafarers

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Abstract: Maritime transport has been the oldest and cheapest way of carriage of people and goods. Its modern development has led to an increase in productivity and energy efficiency as well as further automation of processes and reduction of crew composition. Seafarers find themselves in the midst of these processes. During voyages they have to subsist in a restricted space and limited social context along with being exposed to the marine environment. The operation of the peculiar on-board equipment, the risk of falling overboard, vibrations, tight compartments, the inherent microclimate, etc. have been recognized as potential triggers that cause various traumatic and psycho-emotional conditions in seafarers. Over time they could become chronic. Seafarers' long duration of contracts often results in their inability to adapt to life on shore within the normal and expected time once they disembark from the vessel. This, in turn, may give rise to health and mental impairment and disorders. The present paper explores the impact of the marine environment on the health and employability of seafarers as well as any new technologies for the control of the effect of risk factors. The primary efforts are directed at raising seafarers' awareness and training in their safety and health in the marine environment.

Key Words: health, marine environment, risk factors, safety, seafarers.

1 Specifics of the seafarers' job

Seafarers perform in conditions that are fundamentally different from normal labour conditions. The sailor's body interacts with the on-board specific environment, which is composed of various factors continually exerting effect on the person involved.

With the commencement of voyage, seafarers' work and daily routine alters while their physical and psycho-emotional stress grows significantly. These could trigger fatigue and exhaustion as early as the time prior to departure on a long contract.

Over the course of the voyage, seafarers' performance is burdened with the change in the overall work dynamics even on board stationary vessels. The work process turns into a complex adaptive response to the new conditions of life and work afloat. Due to the significant load and stress on the body, time is to be allowed for adaptation and adjustment to the sailing environment.

Following the end of the contract, seafarers' daily routine once again undergoes modifications with the return to activities ashore. The internal biological rhythm is impaired, the body load is increased and a person's motivation shifts given the fatigue and exhaustion of the regulatory mechanisms that occurred over the course of sailing. While shore

adaptation lasts, seafarers may experience depression or functional changes.

On a physiological level the change in seafarers' bodily functions in the period before, during and after sailing can be described as functional accommodation of organs and systems to the specific conditions.

Under certain circumstances, unfavorable development of some physical changes may give rise to pre-clinical and pathological conditions causing the onset of various diseases.

Three major factors determine the particulars of the seafarers' job: [1, 2, 5, 6]

- **Factors associated with any operation with equipment:**

- work with specific technological equipment;
- work with pressure and tension equipment;
- electric shocks from an uninsulated unit or machine;
- impact from vibrations;
- temperature effects;
- production noise;
- risk of falling overboard;
- danger of compression from cargo poorly secured or broken loose in the event of overloading;
- effects of dust, chemicals, oils, fumes, etc.

- **Factors associated with the working compartments and equipment:**
 - disposition of technical facilities;
 - compartments' size;
 - ventilation;
 - illumination.
- **Factors associated with the work organization:**
 - working in shifts;
 - unregulated working hours;
 - working at night time;
 - manual work;
 - acquiring a particular working posture;
 - heavy physical load;
 - specific work skills;
 - various weather conditions. [4, 7, 8]

The main health risks for seafarers operating in the marine environment arise from the combined influence of the three groups of factors as well as the severity and duration of their action.

2 Specifics of the impact of the marine environment on seafarers

The technological progress over the past few years and the advanced design achieved by modern marine engineering have led to a reduction in the composition of ship's crews and improved rates of loading/unloading. The current trend towards automation of most on-board process has significantly cut down the physical work of seafarers, but at the same time the changes in conventional seafaring have increased the mental tension and social exclusion associated with this job.

The first group of natural conditions refers to the hydro-meteorological conditions for sailing: air and water temperature, humidity, direction and force of air and water currents, wave height, etc. These parameters' values determine the ship's passage across different latitudes and require certain adaptation.

Navigation at latitudes over 65°-70°N/S depends on factors, such as the ocean ice cover, the low temperatures of air and water, the insufficient natural light at polar nights and excess light at polar days (midnight sun), ultraviolet radiation deficiency, the increased cosmic radiation, etc. Conversely, navigation at 0°-25°N/S is marked by nearly constant trade winds, tropical hurricanes as well as high air and water temperatures.

The effect of weather conditions may be partially or fully mitigated by regular preventive measures taken onboard. Alternatively, the hydro-meteorological conditions during the voyage could cause adverse effects on seafarers' health, inflicting

overcooling or overheating of the body, sea sickness, ultraviolet deficiency, hypovitaminosis.

The human body is very sensitive to fluctuations in body temperature and can only function normally at 37°C. When body temperature falls below this margin, it goes into cooling and overcooling. High humidity, high winds, wet clothes and wet shoes exacerbate the cooling process. Preventive measures against overcooling involve body tempering, time reduction of work outdoors, proper clothing and footwear for working in low temperatures, increase in the energy value of food portions, etc.

Among illnesses related to elevated core body temperature, the International Classification of Diseases (ICD) identifies burns, heat strokes, heat seizures and convulsions as well as fatigue due to prolonged exposure to high temperatures. Thermal trauma in seafarers may occur when sailing in tropical and subtropical climates or when operating in overheated space.

With the increase in outside temperature, skin temperature also rises. This disrupts the regulation of the water-salt exchange in the body and the acid-alkaline balance, which in turn suppresses sweating, resulting in deficiency of trace elements and vitamins. When body temperature reaches 39° C, sweat gland functioning exhibits a reduction in output. Following a heat stroke, sweating is blocked and the temperature quickly rises to the deadly 41-43°C. Heat strokes frequently occur after heavy physical work in high temperature conditions. Stress factors can also lead to such an increase in metabolism as a result of impaired heat exchange, and are likely to cause a heat stroke without prior heat exhaustion.

The second group factors regarding the technical conditions onboard include illumination, size of work and accommodation spaces, noise, vibrations, dust, which also require certain adaptation. The impact of these factors on the human body depends on both these parameters' values and the duration of their action. The unfavourable accommodation environment leads to a decrease in the seafarers' working capacity.

The third group factors concerning social conditions refer to the seafarers' labour, such as work and rest hours, limited motor activity, monotonous life, high psycho-emotional tension, etc. The emotional-psychological climate on board greatly determines the efficiency of the performance of the entire crew whose member operate as one system of continuously interacting elements.

The adjustment of the biological rhythm to the new conditions on the vessel is perceived by seafarers as fatigue, weakness, loss of energy,

insomnia, low efficiency. This phenomenon is often referred to as desynchronization.

One of the main reasons for seafarers' fatigue and low efficiency is the continuous alternation of the two modes of operation during voyage:

- daily work mode;
- standby mode.

In the event of any kind of average onboard, work and rest hours change and sometimes seafarers' chance to rest becomes virtually non-existent. On a physiological level, seafarers' performance in such conditions is characterized by great stress due to the pressure for time on the emergency. Such circumstances lead to an increase in psycho-emotional tension and rapid fatigue.

Consideration ought to be given to seafarers' limited mobility and their particular diet during voyage. The social exclusion onboard gives rise to unhealthy eating habits. Overeating is quite common among maritime crews. Meal onboard must be provided free of charge in keeping with the religious and cultural demands of seafarers. Hygiene standards for food preparation must be met.

Unfavourable work conditions combined with stress and limited physical activity increase the risk of many diseases. Studies in some maritime countries show an alarming trend: overweight, obesity and smoking in sailors appear to be almost twice as high as in other jobs.

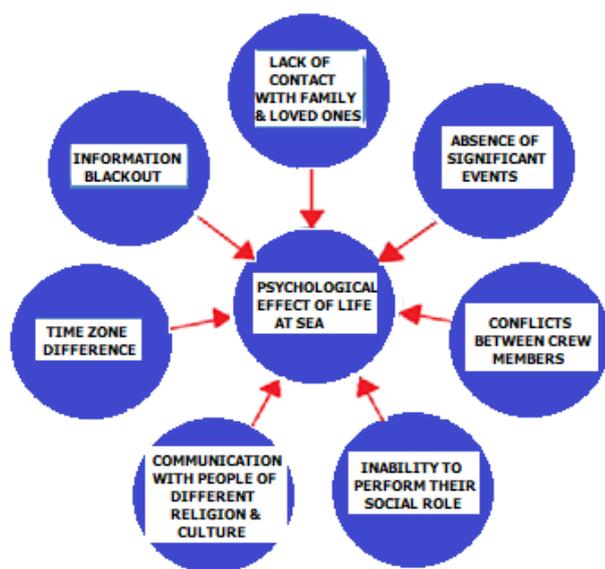


Fig. 1 Psychological effect of life at sea

The psychological effect of life at sea can be summarized as follows: [1, 9], (Figure 1)

- Important psychological ties are severed, i.e. with the family, relatives, hobbies, entertainment, as opposed to relationships on shore;

- The absence of different stimuli and significant events makes life boring and monotonous. This leads to the desire for new sensations and makes a person susceptible to errors at work;

- The lack of information (information blackout) and limited contacts due to shortage of time, time zone difference, lack of Internet and telephone connection exacerbate sailors' sensitivity;

- Conflicts are inevitable onboard due to the limited space, the lack of privacy, and mixture of different cultural and ethnic stereotypes of communication and behavior;

- Each person has different social roles in their life on shore (father, spouse, etc.), which imply certain social responsibilities and decision-making. In the work environment onboard seafarers act only as maritime specialists according to their position.

3 Dynamics of seafarers' efficiency

People's best abilities to complete a certain task are contingent on the functional state of the body, their professional experience and emotional state.

The changes in the functional state of the body when performing work duties in maritime environment determine the dynamics of seafarers' efficiency.

The dynamics of seafarers' level of performance onboard can be divided into six stages: (Figure 2)

- warming-up;
- high efficiency;
- keeping-up;
- inability to keep up;
- reduced efficiency;
- last efforts.

The warming-up stage is normally observed in the first days of the sailing contract. It is marked by a gradual increase in work capacity, quality and speed of work.

The high efficiency stage is central to people's labour. During this stage a person's abilities, work efficiency and wilful efforts are at their best, and body's systems go into an optimal level of functioning. This stage is regarded as a period of sustainable adjustment to the conditions of a particular task. For seafarers, its duration depends on work pressure and on the severity of the action of external factors. The more unfavorable working conditions are, the less this stage lasts.

The keeping-up stage is characterized by certain subjective and objective changes. Top performance abilities start to diminish due to growing fatigue. Work efficiency is still maintained at the expense of increased emotional tension and the use of strength reserves.

In the next stage when the body is showing signs of inability to keep up at the same level of performance due to increasing fatigue, human abilities continue to decline. Complaints of low self-esteem become more common. Taking initiative is seriously lacking while the amount of errors increases, work speed is slowed and there are more unfulfilled aspects of the tasks assigned.

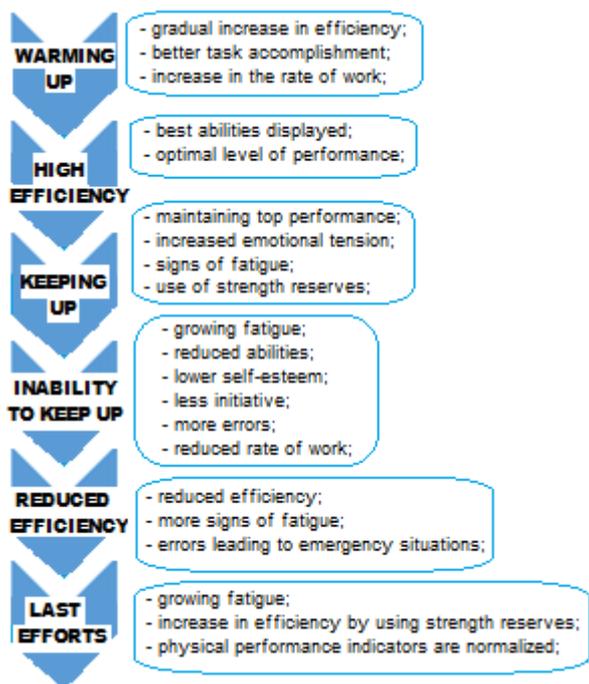


Fig. 2 Dynamics of seafarers' efficiency on board

The stage of decline in seafarers' performance is manifested in reduction of power and labour efficiency, leading to growing fatigue. Seafarers experience deterioration in body functions. The time required for the completion of a task and amount of errors in sensorimotor reactions may abound. Efficiency continues to deteriorate. Errors occur in the operation with equipment which may lead to emergency situations.

The exertion of all efforts is the final stage of task completion. Despite the growing fatigue and lessening abilities, human performance is marked by a sudden surge in at the expense of emotional tension and the use of strength reserves. This final uplift in sailors' work is usually observed at the end of each watch and in the last days before signing off. In this stage the emotional tone is higher, complaints are less common and the performance measurement indicators improve. At the same time, the sailor's accuracy at the task does not match the beginning stage level, but physical indicators are normalized.

The dynamics of seafarers' efficiency as set out in the present paper is for guidance purposes only. Sailors' performance onboard during a particular voyage does not necessarily include all six stages. Three of the stages are central to any work onboard: warming-up, lasting efficiency and gradually reduced efficiency.

4 A program designed to limit seafarers' risks for health and employability purposes

There is a wide spectrum of ailments on board vessels. Apart from seasickness, other health issues are not uncommon. The most frequent causes for medical intervention are respiratory, skin diseases and injuries. Along with the above diseases there are always risks associated with sailing in different climatic zones and in ports where new types of diseases, especially infections, can be encountered. The most common health disorder is related to mental health issues.

The statistical distribution of medical conditions among crew members of the merchant fleet indicates that 1/3 of them have suffered from some injury and one in eight sailors has experienced dental problems. [3] (Figure 3)

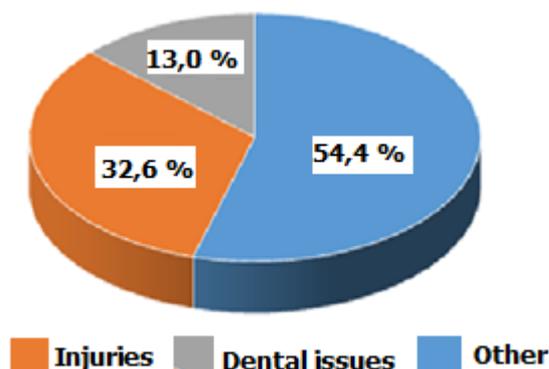


Fig. 3 Statistical distribution of medical conditions among crew members of the merchant fleet

Respiratory diseases rank among the third most common illnesses along with injuries and gastrointestinal diseases. Inflammations in the area of the nose, throat and bronchi (common cold, pharyngitis, bronchitis, influenza) constitute the predominant part of the total number of respiratory diseases.

In recent decades, infectious and parasitic diseases have been observed only incidentally among maritime crews. However, such diseases still occur on board older vessels with low hygiene standards. Incidences of salmonellosis, shigellosis

and parasitic intestinal conditions show a declining trend.

Sexually transmitted diseases prove to be a persisting problem with seafarers. Statistics indicate that 20% of sailors contract a venereal infection at least once in their naval career. Gonorrhea is the most common venereal disorder tested positive in 90% of the diagnoses of patients infected with a sexually transmitted disease.

Many seafarers complain of hearing disorders due to the high noise levels on board vessels. Diseases of the genitourinary system show an increasing tendency. They are more likely to appear while the crews are sailing in tropical areas and have insufficient fluid intake. Diseases of the skin and subcutaneous tissue show a decreasing trend, possibly due to improved personal hygiene and better hygiene practices on board.

One of the adverse changes in seafarers' bodily functions is the vitamin deficiency arising from increased vitamin expenditure in the specific working conditions onboard. During long passages in high latitude climates ultraviolet radiation is reduced, causing ultraviolet deficiency.

The program designed for limiting seafarers' risks for health and employability purposes includes:

- **Communication and training:** Raising awareness of the duties and responsibility for all positions; improving the quality of the training process; targeting efforts to prioritize potential risks and averages, identified as a result of analysis and observations by crew members.

- **Control of compliance with safety procedures:** A crucial part in the prevention of averages and incidents onboard; performing analysis and comparison of current procedures and the results of their application.

- **Crew involvement in risk prevention:** Analysis of all situations that could lead to a risk or an accident. Increasing personal responsibility regarding own health, which is of primary importance to enable life in the extreme working and living conditions at sea. Most fatalities on board are due to this reason.

- **Good practices:** Good practices ought to be encouraged by all means, with moral and material incentives, but most of all to be applied in all possible ways among crew members and to implement them into shipping companies' policy.

The objective of this program is to provide due training and drills for seafarers in accordance with conventions' requirements, maritime laws, IMO regulations, national maritime administrations, shipping companies and shipowners.

The results of the implementation of the program must be documented and an entry in the ship's logbook must be recorded. The data must be analyzed and stored so that the physical and mental health of crew members can be effectively controlled and corrective measures taken, if applicable. [10, 11, 12]

5 Conclusion

Hazards and risks to the health and employability of seafarers are directly linked to the work organization in marine environment. Therefore, it is necessary to continuously improve the control and the program for limiting risks. New measures should be developed and implemented through maritime practices for the purpose of seafarers' health safety and protection.

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