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SERVICE-RELATED HEALTH RISKS AMONG MARITIME SEARCH AND RESCUE (SAR) PERSONNEL: A QUESTIONNAIRE SURVEY

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Summary

Background. Maritime Search and Rescue (SAR) personnel are exposed to combined physical, environmental, and psychosocial burdens, yet data on their health risks and lifestyle patterns in the Baltic Sea region remain limited.

Material and methods. A cross-sectional diagnostic survey was conducted among 126 male SAR crew members from central SAR units (n=47) and coastal rescue stations (n=79). An author-designed 35 item online questionnaire assessed sociodemographic profile, intervention characteristics, physical and environmental load, psychosocial support, and health related behaviors. Qualitative variables were analyzed using descriptive statistics and Chi squared tests (p<0.05).

Results. Two distinct risk profiles were identified. Coastal rescue station personnel reported high regular exposure to environmental hazards: the moderate but systematic category was indicated by 70.9% for noise without hearing protection, 73.4% for fuels and chemicals, 74.7% (biological material), 69.6% for intense sunlight/UV. In central units, 36.2% declared no contact with fuels/chemicals and 31.9% no contact with biological material. Health and lifestyle indicators were less favorable in central units. Normal body mass index (18.5-24.9) was observed in 53.2% vs 86.1% in coastal stations (p<0.001).

Conclusions. SAR personnel require differentiated, unit specific and service-length sensitive prevention, including structured debriefing and targeted health promotion.

Keywords: water rescue, VWRS, occupational health hazards, health threats, SAR

Introduction

Search and Rescue (SAR) is defined as search operations that use available personnel and resources to locate persons in distress. Rescue operations include the evacuation of persons in danger, the provision of immediate medical or other assistance and their transport to a place of safety. These activities take place on land (including mountain and urban settings), in the air and at sea [1]. In Poland, SAR is a state budgetary unit subordinated to the minister responsible for maritime affairs. It was established on January 1, 2002, under the Act of November 9, 2000, on maritime safety. SAR fulfills obligations set out in international agreements and conventions, mainly the search for and rescue of human life at sea, and the mitigation of threats to and pollution of the marine environment. It also carries out other tasks related to maritime safety: maintaining constant readiness to receive and analyze distress reports at sea, planning, conducting and coordinating search and rescue operations, maintaining maritime rescue forces

and assets in readiness, cooperating with other rescue systems operating in the country and cooperating with the relevant services of other states, in particular during search and rescue actions [2-4]. Within maritime rescue operations, Polish rescuers cooperate with other entities, including the State Fire Service, Border Guard, Police, Navy, and other services useful during operations. According to Article 15 of the Polish Act on State Emergency Medical Services, SAR units cooperate with medical entities in the field of Emergency Medical Services (EMS) and advanced first aid [5,6]. SAR conducts rescue operations in the waters of the Baltic Sea basin. In recent years, the number of operations has exceeded 200 per year. These have mainly involved saving human life at sea, medical evacuations, emergency medical care, containment and neutralization of spills and beach operations [7,8].

Interventions in water rescue, particularly at sea, generate many adverse factors and environmental and human conditions relevant to health. These include weather conditions, water movements (currents and waves), hazardous objects, water pollution, and atypical behavior of rescued persons [9,10]. In practice, numerous risk factors are assigned to SAR crew members, understood as the probability of occurrence of adverse work-related events. SAR personnel are also frequently exposed to people in life threatening conditions, to traumatic scenes and to actions carried out under time pressure, all of which impose a substantial psychological burden [11]. Given these numerous occupational burdens, mobile SAR personnel should take care of their own health. This is also of interest to researchers who examine the extent of self-care and everyday health practices in the context of a physically and psychologically demanding profession. System level measures for health surveillance and safety of water rescue personnel include several areas: ergonomic work design, quality of rescue equipment, personal protective equipment, occupational health and safety regulations, stationing sites, and the relevant legal and institutional framework [12,13].

In addition to system level solutions, an individual approach to physical condition and mental health among SAR members is essential. This concerns diet, physical activity, health checks outside mandatory occupational examinations, use of psychoactive substances and sleep hygiene. These aspects are highlighted by authors of national and international studies on emergency service personnel working in shift systems [14-17].

Aim of the work

The aim of this study was to assess health risks and the level of burden related to selected psychophysical factors among crew members of maritime search and rescue units. A secondary objective was to evaluate respondents' individual approach to determinants of a healthy lifestyle.

Material and methods

Research design

A diagnostic survey study was conducted using an online questionnaire. The study included 126 SAR crew members serving in SAR organizational units. The research tool was an author-designed questionnaire consisting of 35 items. The survey was made available online using a Google Forms questionnaire. The electronic format was chosen because SAR units are widely dispersed along the entire national coastline of the Baltic Sea. The SAR directorate supported distribution of the questionnaire through internal official email and communication platforms used by the personnel. The form was available between October 13, 2025, and November 10, 2025.

Pilot testing and content evaluation

The questionnaire was pilot tested with 24 participants from two coastal rescue stations between October 1 and 7, 2025. Pilot participants were not included in the main study sample, despite no concerns being reported regarding question content or response options. The pilot assessed clarity of questions, adequacy of operational wording and completion time. No systematic ambiguities or problems with mapping responses were identified. The mean completion time fell within the planned range of 7 to 10 minutes. No modifications were introduced between the pilot and the final version of the questionnaire.

Research setting

The study was based on the author-designed questionnaire. The data covered three domains:

I. sociodemographic profile, with 5 variables categorizing respondents: age, gender, service position, length of service and workplace;
II. questions on the frequency and type of interventions and the resulting psychophysical burden and health risks;
III. questions on lifestyle, including eating habits, type of diet, physical activity, use of psychoactive substances, hydration, and sleep.

The third part was developed to assess relationships between the characteristics of the study group recorded in the sociodemographic section and respondents' attitudes towards maintaining a healthy lifestyle. The questionnaire consisted of closed-ended questions with a single response option, questions assessing the intensity of events and opinion questions using a 5-point Likert scale.

Characteristics of the research area

The observations focused on personnel from all units included in the national SAR service, i.e., the central maritime search and rescue units and coastal rescue stations functioning as local field branches. The minimum sample size was calculated for a population of n=350 (maximum personnel performing duties in SAR units as employees or volunteers during the study period), with a confidence level of 95% (Z=1.96) and p=0.5. A total of 126 fully completed questionnaires were collected, which corresponds to an estimated maximum error of 7%. The national SAR structure comprises 14 coastal units, including two coordinating centers located in the ports of Gdynia and Świnoujście [8].

Statistical analysis

Qualitative variables were presented as quantity (n) and percentage values of the whole group (%), while proportions between groups were assessed with a Chi squared test. Statistica 13 software (StatSoft Inc., Tulsa, OK) was used in the statistical analysis. A significance level of p<0.05 was adopted.

Results

Sociodemographic characteristics

The study group consisted exclusively of males (100%). Questionnaires that were incomplete were excluded at the stage of preparing the database for statistical analysis (n=11). Statistically significant differences were observed in age distribution (p<0.001). In coastal rescue stations, rescuers aged 35-45 years predominated (70.9%), whereas in central SAR units, this proportion was only 23.4%. An analogous pattern concerned length of service (p<0.001). In coastal rescue stations, more than two thirds of respondents (68.4%) had 11-15 years of service, with a relatively small share of personnel with more than 15 years of experience (7.6%). In central SAR units, the distribution of service length was more dispersed: 27.7% had 11-15 years of service, 27.7% more than 15 years, and 21.3% less than 5 years. Clear differences also emerged in the nature of duties (p<0.001). In coastal rescue stations, crew members predominated (69.6% vs. 27.7% in central SAR units), whereas in central SAR units, commanders formed a substantial subgroup (29.8% vs. 1.3%), with a comparable proportion of professional and volunteer maritime rescuers in both types of units.

Type of rescue operations

Statistically significant differences were found in the type of operations most frequently performed during SAR duty (p<0.001). In central SAR units, operations related to searching for missing persons predominated (57.4% vs 25.3% in coastal rescue stations). In contrast, in coastal rescue stations, water contamination was significantly more often indicated as the typical operation (49.4% vs. 8.5% in central SAR units). The proportion of incidents related to water transport accidents was similar (23.4% vs 19.0%).

Physical workload

In all analyzed aspects of physical workload, significant differences were observed between central SAR units and coastal rescue stations. For lifting loads exceeding 25 kg (stretchers, equipment) (p=0.006), a “moderate” level of burden predominated in coastal rescue stations: 53.2% of respondents indicated category “2” and 30.4% category “3”. A similar pattern was seen for work in constrained body positions (p<0.001). In coastal rescue stations, 64.6% of respondents selected category “2”, whereas in central SAR units, the distribution of answers was more even, with a greater share of categories “0”, “1”, “3” and “more than 5”. For vibration or impact (wave/boat) (p<0.001), coastal rescue stations were again dominated by response “2” (69.6%), while in central SAR units, answers “1”, “3” and “more than 5” appeared

more often. This suggests that personnel in coastal rescue stations more frequently experience moderate but systematic mechanical loads, whereas in central SAR units, the frequency of exposure is more variable, ranging from sporadic to very frequent.

Environmental hazards

For noise exposure without hearing protection, pronounced differences were noted (p<0.001). In coastal rescue stations, almost three quarters of rescuers (70.9%) indicated category "2", whereas in central SAR units, this value was only 12.8%. In central SAR units, responses "0" and "1" were much more frequent (25.5% and 31.9% vs. 2.5% and 8.9% in coastal rescue stations). This can be interpreted as more continuous, everyday noise exposure in coastal rescue stations and a more heterogeneous situation in central SAR units. Even greater differences were observed for exposure to fuels, oils, solvents, and other chemicals (p<0.001). In coastal rescue stations, response "2" predominated (73.4%), and the proportion of "more than 5" was relatively high (12.7%). In central SAR units, 36.2% of respondents reported no exposure ("0"), 29.8% indicated category "1", and only 17.0% category "2". Contact with biological material (blood/body fluids) was also more often regular in coastal rescue stations (74.7% response "2"), whereas in central SAR units, 31.9% of rescuers reported no such contact ("0"), and the remaining answers were distributed more evenly across categories "1-3" (p<0.001). For intensive exposure to sunlight/ultraviolet radiation without protection (p<0.001), coastal rescue stations were again dominated by category "2" (69.6%). In central SAR units, a considerable share of respondents reported no exposure ("0" – 29.8%) or low frequency ("1" – 27.7%). These findings indicate that rescuers in coastal rescue stations are markedly more often exposed to constant environmental hazards (noise, chemicals, ultraviolet radiation, biological material), while in central SAR units, a more bimodal distribution is visible – individuals with minimal and moderate exposure coexist with a smaller group with high exposure.

Psychosocial support and training

Marked differences were found in debriefing practices after difficult events (p<0.001). In coastal rescue stations, debriefing was mainly irregular (82.3%), and regular, structured forms were rare (3.8%). In central SAR units, regular debriefing was reported by 27.7%, irregular debriefing by 40.4%, while 29.8% of rescuers declared a complete absence of this

form of support. This indicates that formal support procedures after demanding missions are more often in place in central SAR units, although a part of the crews remain entirely without such support.

Body mass index, sleep, physical activity, and health habits

Significant differences were observed for body mass index (BMI) (p<0.001). In coastal rescue stations, the proportion of individuals with normal BMI (18.5-24.9) was 86.1%, whereas in central SAR units, it was only 53.2%. Average sleep duration also differed significantly (p<0.001). In coastal rescue stations, 8 hours of sleep predominated (59.5%). In central SAR units, more personnel slept 6 hours (12.8% vs. 5.1%) or more than 8 hours (25.5% vs 5.1%), and fewer reported exactly 8 hours (25.5%). This may reflect a more irregular shift-related workload in central SAR units and compensatory strategies for fatigue. Physical activity significantly differentiated the groups as well (p<0.001). In coastal rescue stations, more than half of rescuers (68.4%) exercised 2-3 times per week, whereas in central SAR units, this proportion was only 23.4%. Tobacco use, including electronic cigarettes, also differed between the groups (p=0.008). In coastal rescue stations, 87.3% were non-smokers, compared with 59.6% in central SAR units (Table 1).

Table 1. Characteristics of the Search and Rescue rescuer population by unit type

Question	Response	All (n=126)	Central SAR units (n=47)	Coastal rescue stations (n=79)	*p*
2. Age	**<25 years**	3 (2.4%)	2 (4.3%)	1 (1.3%)	<0.001
	25-34 years	22 (17.3%)	13 (27.7%)	9 (11.4%)	
	35-45 years	67 (52.8%)	11 (23.4%)	56 (70.9%)	
	>45 years	34 (26.8%)	21 (44.7%)	13 (16.5%)	
3. Length of service	**<5 years**	16 (12.6%)	10 (21.3%)	6 (7.6%)	<0.001
	5-10 years	24 (18.9%)	11 (23.4%)	13 (16.5%)	
	11-15 years	67 (52.8%)	13 (27.7%)	54 (68.4%)	
	>15 years	19 (15%)	13 (27.7%)	6 (7.6%)	
4. Type of unit Coastal rescue stations	**Coastal rescue stations**	79 (62.2%)	0 (0.0%)	79 (100%)	<0.001
	Central SAR units	47 (37.0%)	47 (100%)	0 (0.0%)	
5. Nature of duty (most frequently)	**Crew member**	68 (53.5%)	13 (27.7%)	55 (69.6%)	<0.001
	Commander	15 (12.6%)	14 (29.8%)	1 (1.3%)	
	Operator	10 (7.9%)	5 (10.6%)	5 (6.3%)	
	Volunteer maritime rescuer	17 (13.4%)	8 (17.0%)	9 (11.4%)	

	Professional maritime rescuer	16 (12.6%)	7 (14.9%)	9 (11.4%)	
7. Which type of operations is most frequently performed during SAR duty	**Other**	9 (7.1%)	4 (8.5%)	5 (6.3%)	<0.001
	Search for persons	47 (37.0%)	27 (57.4%)	20 (25.3%)	
	Water contamination	43 (33.9%)	4 (8.5%)	39 (49.4%)	
	Water transport accidents	26 (20.5%)	11 (23.4%)	15 (19.0%)	
8. Physical workload: how often lifting loads >25 kg (stretchers/equipment)	**0**	14 (11%)	9 (19.1%)	5 (6.3%)	0.006
	2	61 (48.0%)	19 (40.4%)	42 (53.2%)	
	3	31 (24.4%)	7 (14.9%)	24 (30.4%)	
	>5	20 (15.7%)	12 (25.5%)	8 (10.1%)	
9. Physical workload: how often work in constrained body position	**0**	6 (4.7%)	4 (8.5%)	2 (2.5%)	<0.001
	1	24 (18.9%)	15 (31.9%)	9 (11.4%)	
	2	59 (46.5%)	8 (17.0%)	51 (64.6%)	
	3	14 (11.0%)	9 (19.1%)	5 (6.3%)	
	>5	23 (18.1%)	11 (23.4%)	12 (15.2%)	
10. Physical workload: how often vibration/impact (wave/boat)	**0**	6 (4.7%)	5 (10.6%)	1 (1.3%)	<0.001
	1	25 (19.7%)	19 (40.4%)	6 (7.6%)	
	2	60 (47.2%)	5 (10.6%)	55 (69.6%)	
	3	7 (5.5%)	6 (12.8%)	1 (1.3%)	
	>5	28 (22.0%)	12 (25.5%)	16 (20.3%)	
11. Harmful factors - how often noise exposure (without hearing protection)	**0**	14 (11.0%)	12 (25.5%)	2 (2.5%)	<0.001
	1	22 (17.3%)	15 (31.9%)	7 (8.9%)	
	2	62 (48.8%)	6 (12.8%)	56 (70.9%)	
	3	12 (9.4%)	6 (12.8%)	6 (7.6%)	
	>5	15 (11.8%)	8 (17.0%)	7 (8.9%)	
12. Harmful factors: how often fuels/oils/solvents, chemical substances (contact)	**0**	19 (15.0%)	17 (36.2%)	2 (2.5%)	<0.001
	1	21 (16.5%)	14 (29.8%)	7 (8.9%)	
	2	66 (52.0%)	8 (17.0%)	58 (73.4%)	
	3	9 (7.1%)	7 (14.9%)	2 (2.5%)	
	>5	11 (8.7%)	1 (2.1%)	10 (12.7%)	
13. Harmful factors: how often contact with biological material (blood/body fluids)	**0**	17 (13.4%)	15 (31.9%)	2 (2.5%)	<0.001
	1	21 (16.5%)	9 (19.1%)	12 (15.2%)	
	2	74 (58.3%)	15 (31.9%)	59 (74.7%)	
	3	13 (10.2%)	8 (17.0%)	5 (6.3%)	
	6	1 (0.8%)	0 (0.0%)	1 (1.3%)	
14. Harmful factors: how often intense sunlight/UV (without protection)	**0**	14 (11.0%)	14 (29.8%)	0 (0.0%)	<0.001
	1	21 (16.5%)	13 (27.7%)	8 (10.1%)	
	2	60 (47.2%)	5 (10.6%)	55 (69.6%)	
	3	11 (8.7%)	5 (10.6%)	6 (7.6%)	
	>5	19 (15.0%)	10 (21.3%)	9 (11.4%)	
15. Debriefing after difficult events	**None**	24 (18.9%)	14 (29.8%)	10 (12.7%)	<0.001
	Irregular	84 (66.1%)	19 (40.4%)	65 (82.3%)	
	Regular/structured	16 (12.6%)	13 (27.7%)	3 (3.8%)	

16. Medical/occupational health and safety training in the last 12 months	**1-2 sessions**	92 (72.4%)	27 (57.4%)	65 (82.3%)	<0.001
	>2 sessions	27 (21.3%)	19 (40.4%)	8 (10.1%)	
	None	5 (3.9%)	1 (2.1%)	4 (5.1%)	
17. Outside SAR, do you also serve in other rescue organizations	**Mountain rescue service**	20 (15.7%)	1 (2.1%)	19 (24.1%)	<0.001
	National firefighting and rescue system	13 (10.2%)	6 (12.8%)	7 (8.9%)	
	EMS	36 (28.3%)	3 (6.4%)	33 (41.8%)	
	Volunteer water rescue service	11 (8.7%)	4 (8.5%)	7 (8.9%)	
	Other	3 (2.4%)	2 (4.3%)	1 (1.3%)	
	No	43 (33.9%)	31 (66.0%)	12 (15.2%)	
18. BMI	**<18.5**	6 (4.7%)	4 (8.5%)	2 (2.5%)	<0.001
	>18.5-24.9	93 (73.2%)	25 (53.2%)	68 (86.1%)	
	>24.9	27 (21.3%)	18 (38.3%)	9 (11.4%)	
19. Average sleep duration	**6 hours**	10 (7.9%)	6 (12.8%)	4 (5.1%)	<0.001
	7 hours	41 (32.3%)	17 (36.2%)	24 (30.4%)	
	8 hours	59 (46.5%)	12 (25.5%)	47 (59.5%)	
	>8 hours	16 (13.4%)	12 (25.5%)	4 (5.1%)	
20. Physical activity (any form)	**Once per week**	30 (23.6%)	15 (31.9%)	15 (19.0%)	<0.001
	2-3 times per week	65 (51.2%)	11 (23.4%)	54 (68.4%)	
	<once per week	14 (11.0%)	9 (19.1%)	5 (6.3%)	
	>3 times per week	17 (13.4%)	12 (25.5%)	4 (5.1%)	
21. Average daily fluid intake	**<1 L**	7 (5.5%)	6 (12.8%)	1 (1.3%)	<0.001
	1-1.5 L	79 (62.2%)	19 (40.4%)	60 (75.9%)	
	>1.5 L	39 (30.7%)	22 (46.8%)	16 (20.3%)	
22. Diet: do you pay attention to the quality of meals	**No**	14 (11.0%)	10 (21.3%)	4 (5.1%)	<0.001
	No opinion	71 (55.9%)	11 (23.4%)	60 (75.9%)	
	Yes	23 (18.1%)	14 (29.8%)	9 (11.4%)	
	Definitely no	7 (5.5%)	4 (8.5%)	3 (3.8%)	
	Definitely yes	12 (9.4%)	8 (17.0%)	3 (3.8%)	
23. Diet: I pay attention to the number and timing of meals	**No**	32 (25.2%)	15 (31.9%)	17 (21.5%)	<0.001
	No opinion	62 (48.8%)	11 (23.4%)	51 (64.6%)	
	Definitely no	11 (8.7%)	6 (12.8%)	5 (6.3%)	
	Definitely yes	22 (17.3%)	15 (31.9%)	6 (7.6%)	
24. Regular health checks	**No**	14 (11.0%)	10 (21.3%)	4 (5.1%)	<0.001
	Yes, through primary care physician and preventive programs	68 (53.5%)	7 (14.9%)	61 (77.2%)	
	Only mandatory occupational health	45 (35.4%)	30 (63.8%)	14 (17.7%)	

	examinations at work				
25. Tobacco use, including e-cigarettes	**No**	98 (77.2%)	28 (59.6%)	69 (87.3%)	0.008
	Occasionally	18 (14.2%)	12 (25.5%)	6 (7.6%)	
	Yes	5 (3.9%)	3 (6.4%)	2 (2.5%)	
	Yes, regularly	5 (3.9%)	3 (6.4%)	2 (2.5%)	

Notes: EMS – Emergency Medical Services, SAR – Search and Rescue.

Characteristics by length of service

Length of service was significantly associated with function within the SAR system (p<0.001). In groups with shorter service (<5 and 5-10 years), crew members predominated (38% and 58%, respectively). Among rescuers with more than 15 years of service, command positions were much more frequent (47%). With increasing length of service, the proportion of professional maritime rescuers and volunteers also rose, which reflects a transition from mainly operational roles to positions with greater responsibility.

Physical workload and harmful factors

For physical workload and exposure to harmful factors (lifting loads >25 kg, work in constrained body positions, vibration/impact, noise, contact with fuels/chemicals, biological material and intensive ultraviolet radiation), a systematic increase in exposure frequency with length of service was observed (p<0.001 for most analyzed variables). Rescuers with the shortest service more often reported no exposure or only a sporadic occurrence of a given factor. In the group with more than 15 years of service, responses indicating frequent or very frequent exposure (categories “3” and “more than 5”) were relatively more common.

BMI, sleep, physical activity, and health behaviors

Significant differences in BMI were found between service length groups (p<0.001). The highest proportion of individuals with normal body weight (18.5-24.9) was observed in the 11-15-year group, whereas in the group with more than 15 years of service, values above the normal BMI range appeared clearly more often. Average sleep duration also differed by length of service (p=0.002). In the 11-15-year group, 8-hour sleep predominated. Among rescuers with the longest service, shorter sleep (6 hours) or more irregular sleep patterns were more frequent.

Physical activity significantly differentiated the groups as well (p<0.001). Rescuers with 11-15 years of service most often exercised 2-3 times per week, whereas in the group with more than 15 years of service, "once a week" or "less than once a week" answers appeared more frequently. For daily fluid intake (p<0.001), consumption of 1-1.5 liters per day predominated in the 11-15 year group. In the group with more than 15 years of service, both intake below 1 liter and above 1.5 liters were more often reported. Regarding meal quality (p=0.001), individuals with longer service more often declared consciously paying attention to diet quality ("yes" or "definitely yes"), while a high proportion of "no opinion" responses persisted in the medium service groups. For the number and timing of meals, the relationship with length of service did not reach statistical significance (p=0.066) (Table 2).

Table 2. Characteristics of the SAR rescuer population by length of service

Question	Response	<5 years (n=16)	5-10 years (n=24)	11-15 years (n=67)	>15 years (n=19)	*p*
2. Age	**<25 years**	3 (19%)	0 (0%)	0 (0%)	0 (0%)	<0.001
	25-34 years	7 (44%)	9 (38%)	6 (9%)	0 (0%)	
	35-45 years	2 (12%)	10 (42%)	54 (81%)	1 (5%)	
	>45 years	4 (25%)	5 (21%)	7 (10%)	18 (95%)	
3. Length of service	**<5 years**	16 (100%)	0 (0%)	0 (0%)	0 (0%)	<0.001
	5-10 years	0 (0%)	24 (100%)	0 (0%)	0 (0%)	
	11-15 years	0 (0%)	0 (0%)	67 (100%)	0 (0%)	
	>15 years	0 (0%)	0 (0%)	0 (0%)	19 (100%)	
4. Type of unit	**Coastal rescue stations**	6 (38%)	13 (54%)	54 (81%)	6 (32%)	<0.001
	Central SAR units	10 (62%)	11 (46%)	13 (19%)	13 (68%)	
5. Nature of duty (most frequently)	**Crew member**	6 (38%)	14 (58%)	47 (70%)	1 (5%)	<0.001
	Commander	1 (6%)	1 (4%)	4 (6%)	9 (47%)	
	Operator	2 (12%)	3 (12%)	3 (4%)	2 (11%)	
	Volunteer maritime rescuer	5 (31%)	4 (17%)	5 (7%)	3 (16%)	
	Professional maritime rescuer	2 (12%)	2 (8%)	8 (12%)	4 (21%)	
7. Which type of operations is most frequently performed during SAR duty	**Other**	4 (25%)	1 (4%)	2 (3%)	2 (11%)	<0.001
	Search for persons	9 (56%)	11 (46%)	15 (22%)	12 (63%)	
	Water contamination	0 (0%)	3 (12%)	38 (57%)	2 (11%)	

	Water transport accidents	3 (19%)	8 (33%)	12 (18%)	3 (16%)	
8. Physical workload: how often lifting loads >25 kg (stretchers/equipment)	**0**	2 (12%)	6 (25%)	2 (3%)	4 (21%)	<0.001
	2	7 (44%)	9 (38%)	41 (61%)	4 (21%)	
	3	2 (12%)	4 (17%)	21 (31%)	4 (21%)	
	>5	5 (31%)	5 (21%)	3 (4%)	7 (37%)	
9. Physical workload: how often work in constrained body position	**0**	1 (6%)	4 (17%)	0 (0%)	1 (5%)	<0.001
	1	4 (25%)	6 (25%)	11 (16%)	3 (16%)	
	2	3 (19%)	7 (29%)	48 (72%)	1 (5%)	
	3	1 (6%)	4 (17%)	4 (6%)	5 (26%)	
	>5	7 (44%)	3 (12%)	4 (6%)	9 (47%)	
10. Physical workload: how often vibration/impact (wave/boat)	**0**	1 (6%)	3 (12%)	2 (3%)	0 (0%)	<0.001
	1	5 (31%)	6 (25%)	10 (15%)	4 (21%)	
	2	2 (12%)	7 (29%)	49 (73%)	2 (11%)	
	3	1 (6%)	2 (8%)	2 (3%)	2 (11%)	
	>5	7 (44%)	6 (25%)	4 (6%)	11 (58%)	
11. Harmful factors: how often noise exposure (without hearing protection)	**0**	1 (6%)	6 (25%)	4 (6%)	3 (16%)	<0.001
	1	3 (19%)	5 (21%)	10 (15%)	4 (21%)	
	2	6 (38%)	7 (29%)	48 (72%)	1 (5%)	
	3	3 (19%)	1 (4%)	3 (4%)	5 (26%)	
	>5	3 (19%)	4 (17%)	2 (3%)	6 (32%)	
12. Harmful factors: how often fuels/oils/solvents, chemical substances (contact)	**0**	7 (44%)	4 (17%)	6 (9%)	2 (11%)	<0.001
	1	1 (6%)	7 (29%)	7 (10%)	6 (32%)	
	2	3 (19%)	10 (42%)	49 (73%)	4 (21%)	
	3	1 (6%)	0 (0%)	3 (4%)	5 (26%)	
	>5	4 (25%)	3 (12%)	2 (3%)	2 (11%)	
13. Harmful factors: how often contact with biological material (blood/body fluids)	**0**	5 (31%)	6 (25%)	2 (3%)	4 (21%)	<0.001
	1	4 (25%)	6 (25%)	9 (13%)	2 (11%)	
	2	5 (31%)	10 (42%)	52 (78%)	7 (37%)	
	3	2 (12%)	2 (8%)	4 (6%)	5 (26%)	
	6	0 (0%)	0 (0%)	0 (0%)	1 (5%)	
14. Harmful factors: how often intense sunlight/UV (without protection)	**0**	3 (19%)	5 (21%)	4 (6%)	2 (11%)	<0.001
	1	4 (25%)	5 (21%)	9 (13%)	3 (16%)	
	2	0 (0%)	8 (33%)	49 (73%)	3 (16%)	
	3	2 (12%)	3 (12%)	3 (4%)	3 (16%)	

	>5	7 (44%)	3 (12%)	2 (3%)	7 (37%)	
15. Debriefing after difficult events	**None**	5 (31%)	5 (21%)	9 (13%)	5 (26%)	0.182
	Irregular	8 (50%)	13 (54%)	52 (78%)	11 (58%)	
	Regular/structured	3 (19%)	5 (21%)	5 (7%)	3 (16%)	
16. Medical/occupational health and safety training in the last 12 months	**1-2 sessions**	11 (69%)	16 (67%)	56 (84%)	9 (47%)	0.001
	>2	4 (25%)	8 (33%)	5 (7%)	10 (53%)	
	None	1 (6%)	0 (0%)	4 (6%)	0 (0%)	
17. Outside SAR, do you also serve in other rescue organizations	**Mountain rescue service**	0 (0%)	2 (8%)	17 (25%)	1 (5%)	<0.001
	National firefighting and rescue system	2 (12%)	1 (4%)	5 (7%)	5 (26%)	
	EMS	1 (6%)	5 (21%)	29 (43%)	1 (5%)	
	Volunteer water rescue service	3 (19%)	2 (8%)	4 (6%)	2 (11%)	
	Other	0 (0%)	1 (4%)	2 (3%)	0 (0%)	
	No	10 (62%)	13 (54%)	10 (15%)	10 (53%)	
18. BMI	**<18.5**	3 (19%)	1 (4%)	2 (3%)	0 (0%)	<0.001
	>18.5-24.9	9 (56%)	17 (71%)	60 (90%)	7 (37%)	
	>24.9	4 (25%)	6 (25%)	5 (7%)	12 (63%)	
19. Average sleep duration	**6 hours**	2 (12%)	1 (4%)	1 (1%)	6 (32%)	0.002
	7 hours	6 (38%)	10 (42%)	20 (30%)	5 (26%)	
	8 hours	5 (31%)	9 (38%)	40 (60%)	5 (26%)	
	>8 hours	3 (19%)	4 (17%)	6 (9%)	3 (16%)	
20. Physical activity (any form)	**Once per week**	3 (19%)	8 (33%)	8 (12%)	11 (58%)	<0.001
	2-3 times per week	5 (31%)	7 (29%)	50 (75%)	3 (16%)	
	<1 per week	5 (31%)	2 (8%)	3 (4%)	4 (21%)	
	>3 times per week	3 (19%)	7 (29%)	5 (7%)	1 (5%)	
21. Average daily fluid intake	**1-1.5 L**	6 (38%)	14 (58%)	53 (79%)	6 (32%)	<0.001
	<1 L	3 (19%)	0 (0%)	1 (1%)	3 (16%)	
	>1.5 L	6 (38%)	10 (42%)	13 (19%)	9 (47%)	
22. Diet: do you pay attention to the quality of meals	**No**	4 (25%)	4 (17%)	4 (6%)	2 (11%)	0.001
	No opinion	4 (25%)	10 (42%)	51 (76%)	6 (32%)	
	Yes	3 (19%)	5 (21%)	8 (12%)	7 (37%)	
	Definitely no	2 (12%)	1 (4%)	1 (1%)	3 (16%)	
	Definitely yes	3 (19%)	4 (17%)	3 (4%)	1 (5%)	

23. Diet: I pay attention to the number and timing of meals	**No**	5 (31%)	7 (29%)	14 (21%)	6 (32%)	0.066
	No opinion	4 (25%)	10 (42%)	42 (63%)	6 (32%)	
	Definitely no	3 (19%)	2 (8%)	2 (3%)	4 (21%)	
	Definitely yes	4 (25%)	5 (21%)	9 (13%)	3 (16%)	
24. Regular health checks	**No**	6 (38%)	2 (8%)	3 (4%)	3 (16%)	<0.001
	Yes, through primary care physician and preventive programs	2 (12%)	13 (54%)	49 (73%)	4 (21%)	
	Only mandatory occupational health examinations at work	8 (50%)	9 (38%)	15 (22%)	12 (63%)	
25. Tobacco use, including e-cigarettes	**No**	9 (56%)	18 (75%)	60 (90%)	10 (53%)	0.014
	Occasionally	4 (25%)	3 (12%)	5 (7%)	6 (32%)	
	Yes	2 (12%)	2 (8%)	1 (1%)	0 (0%)	
	Yes, regularly	1 (6%)	1 (4%)	1 (1%)	2 (11%)	

Notes: EMS – Emergency Medical Services, SAR – Search and Rescue.

Discussion

Tasks related to maritime safety and the control of threats and pollution at sea are demanding activities that also generate health risks for rescue personnel. A 2021 analysis highlights the phenomenon of the accidental rescuer. Drowning is a public health threat and a leading cause of injury-related death. In Türkiye, drowning causes about 900 deaths per year, and this rate is increasing. The authors analyzed drownings among water rescuers. In total, 237 accidental rescuers drowned (90% males; 35% aged 15-24 years) [18]. Our analysis concerned only professional affiliated rescuers, yet statistics on accidental rescuers are important for the practice of professional services.

Drownings among rescuers were also analyzed by Zhu et al. [19]. Drownings during rescue attempts are common worldwide, and interventions undertaken by untrained bystanders often lead to the death of the primary drowning victim, the rescuer or both. A total of 225 rescue incidents were identified in China, of which 14 were victim-rescuer drownings. Rescuer mortality (13.3%) was similar to mortality in the primary drowning victim group (11.5%) ($\chi(2)=0.5$, $p=0.49$). The authors promote the principle "rescuer safety first" and emphasize that people should be encouraged to attempt rescue only with priority given to their own safety [19].

Similar observations were made by Dunne et al. [20] in an analysis of lay rescuer interventions in fatal drownings in Canada. They described the characteristics of lay rescuers who died while trying to save another person. The events included cases in which a lay rescuer drowned while attempting a rescue. Lay rescuers frequently used high-risk contact rescue techniques [20].

Koon et al. [21] draw attention to water sports participants and the phenomenon of accidental rescuers. Surfers play a key role in preventing drownings along the coast and, according to conservative estimates, perform a number of rescues comparable to that of beach lifeguards. Surfers are more observant and more aware of water safety hazards. They better understand ocean conditions and risks, acquire new rescue skills and techniques, gain insight into their own safety, and increase their confidence in responding to emergencies. The role of surfers in ensuring coastal safety is crucial before professional rescue services arrive [21].

Another analysis confirms the trend of water rescue among surfers. An online survey of 2,048 surfers from Portugal and Spain assessed their role in cardiopulmonary resuscitation (CPR). This study provides evidence for the important contribution of surfers to saving lives on beaches in Portugal and Spain. The results indicate that the number of rescues performed annually by surfers in these countries is significant in reducing fatal incidents along the coast [22]. This analysis does not directly relate to the assumptions of our own study, but it may serve as a warning for professional rescuers that in difficult conditions, they may face both primary victims and secondary accidental rescuers needing assistance.

Barton et al. [23] draw attention to mass casualty incidents in aquatic environments which pose serious challenges for rescuers. The authors describe mass casualty triage tools for water incidents, which may be important as procedures for water rescue personnel. The proposed rescue sequence aims to improve identification and prioritization of submerged persons and takes into account factors such as hazards, limited visibility, purposeful swimming, movement or floating, airway position, availability of rescue support and effectiveness of rescue devices [23].

Stickley et al. [24] emphasize the impact of severe weather conditions in marine waters. Wind increases wave height and current speed, which raises the risk of drowning or near drowning. Serious incidents can lead to death, so marine recreation in poor weather conditions should be avoided. In addition, people engaging in coastal recreational activities need improved safety awareness and self-rescue skills [24].

Another analysis relates directly to the Baltic Sea and prevailing conditions. Coastal upwelling along the southeastern Baltic coast is common, especially in the warm season. It

significantly lowers sea surface temperature in coastal areas and is responsible for reducing mean summer sea surface temperature. The Baltic basin is therefore cooler on average than tourist seas in subtropical zones. Hypothermia is more likely in accident scenarios. This has implications for various areas of socio-economic activity [25]. In other regions of the world, different determinants of severe incidents have been highlighted. Rip currents, i.e., fast seaward directed currents, are a major cause of deaths and rescues on surf beaches worldwide. Observations in this study concern rip currents along the Californian coast [26].

Another threat relevant to SAR practice arises from the negative consequences of criminal activities at sea that require lifesaving operations. The authors underline the ethical dimensions of maritime rescue and reveal a complex network of interactions. Intervening in criminal systems of migrant exploitation is dangerous. Smugglers and human traffickers use migrants for profit. This type of risk was not included in our questionnaire because the Baltic Sea is relatively calm, with lower migration pressure. However, we recognize this as a limitation of our study [27].

The migration crisis in the Mediterranean Sea is also discussed by Kosmas et al. [28] and Wetterich [29]. These authors argue that migration has increased the number of search and rescue operations along the Central Mediterranean Route and that SAR vessels mainly perform rescue and humanitarian tasks to prevent loss of life at sea.

Doremidov [30] suggests that rescue operations involving professional crews are easier due to training, appropriate communication and signaling, which are unknown to untrained passengers. The study assessed seafarers' knowledge of emergency situations, rescue equipment and procedures for abandoning ship in a crisis. When rescue services are approaching, preparation for their arrival is essential. Communication between seafarers and rescuers relies on agreed signals. Masts or antennas should be lowered, especially when the operation involves a helicopter [30].

Beardslee et al. [31] address rescue aspects related to seafarers on submarines. The analysis focuses on submarine crews operating far from rescue units who must remain vigilant to potential threats: enemy forces, onboard fires, anomalies in breathing atmosphere, radiation risk, fatigue, and mental load. Challenges associated with submarine service have led to the development of a distinct field of undersea medicine [31]. This source also points to gaps in our own analysis. In our questionnaire, we did not ask personnel about experience with submarines or radiation risk.

Given that the national coastline exceeds 750 km, with high tourist pressure and intensive shipping routes, this water rescue area is very demanding for SAR. Frequent search

operations and ongoing control of threats and environmental pollution are part of the daily responsibilities of SAR personnel [32,33].

According to Castelle et al. [34] understanding and predicting hazards in the surf zone is crucial for preventing drownings and severe spinal injuries on beaches worldwide. It is assumed that evolving strategies of lifeguards (for example preferred locations of supervised bathing zones, preventive measures) reflect a gradual accumulation of knowledge about the spatial and temporal variability of surf zone hazards at their beach, depending on tidal state and wave conditions [34].

Rasmussen et al. [35] address simulation-based training in the Danish water rescue service across the country and identifies related factors. The most common scenario was an unconscious adult drowning victim. Discovery time was significantly longer in the group with unsatisfactory performance (median 26 s, interquartile range 3-99) compared with the satisfactory group (median 1 s, interquartile range 0-11; $p<0.01$). Distraction was associated with unsatisfactory performance [35].

Other authors draw attention to the difficulty of medical evacuation on the open sea, as discussed by Dillard et al. [36], and in various water areas including Arctic regions, as described by Kruke et al. [37]. The objectives of our study focused on experiences of crew members operating in the Baltic Sea basin, yet weather constraints, technical limitations and time pressure show certain similarities regardless of the region.

Limitations

The questionnaire did not include all possible occupational hazards discussed by other researchers. The aim was to determine the intensity of the most frequent risks and burdens in relation to local conditions, i.e., the national coastline and territorial waters. However, crews of maritime units may also have experience gained in other regions of the world. First, the cross-sectional design does not allow for causal inference, so the observed associations should be interpreted as hypothesis generating. Second, all variables were self-reported, which may have introduced recall bias and social desirability bias, especially for lifestyle and health-related behaviors.

Conclusions

The analysis showed that SAR rescuers form two clearly distinct risk populations: coastal rescue stations, with a high burden of chronic environmental exposures (noise, vibration, chemicals, ultraviolet radiation, contact with biological material), and central SAR units, with a less favorable health and lifestyle profile (BMI, sleep, physical activity, smoking). This implies that preventive strategies cannot be uniform. In coastal rescue stations, they should focus on protection of the musculoskeletal system, hearing, and skin, as well as task rotation. In central SAR units, the priority should be intensive health promotion interventions, including weight reduction, sleep hygiene, physical activity, and limitation of psychoactive substances. Length of service clearly behaves as a risk factor for cumulative load, particularly in the group with more than 15 years of service, where the proportion of command roles also increases. This supports the introduction of planned transition of some rescuers to less demanding positions. The uneven and often irregular character of debriefing and psychosocial support indicates a need for standardized mandatory structured debriefing after severe incidents, with clear responsibility assigned to commanders and guaranteed access to professional support. Finally, the data suggest that the SAR system can serve as a model platform for developing common standards of occupational health and safety, prevention and psychological support across the wider emergency services system, provided that conclusions from this study are translated into concrete organizational decisions and do not remain at the level of diagnosis alone.

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The questionnaire was fully anonymous and participation was voluntary, as stated in the information provided to all the respondents. The analysis complied with the principles of the Declaration of Helsinki and with the European General Data Protection Regulation (GDPR). In June 2024, written permission for the study was obtained from the SAR Director. In addition, approval was granted by the Bioethics Committee of the Medical University of Warsaw (AKBE/298/2025, October 13, 2025).

Artificial intelligence (AI) was not used in the creation of the manuscript.

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