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Design for end-user acceptance: requirements for work clothing for fishermen in mediterranean and northern fishing grounds

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ABSTRACT

Fishing is one of the most dangerous occupations, and as many as 24,000 fishermen around the world suffer fatal injuries or drowning at sea every year. Although fishermen in the European fishing fleet work in harsh and dangerous environments, many fishermen do not use personal protective clothing and buoyancy aids due to reduced work comfort and poor functionality. This emphasizes the importance of designing work clothing and personal protective equipment (PPE) with functionality that matches the fishermen's needs.

The aim of this study was to identify the requirements for work clothing in terms of comfort, protection, and safety for fishermen operating in northern fishing grounds and in the Mediterranean. Furthermore, we investigated whether fishermen in the Mediterranean prioritize work-clothing requirements differently from fishermen in northern fishing grounds. Interviews and observations of fishermen provided us with the requirements for work clothing for fishermen. A questionnaire was then distributed to a selection of European fishermen.

The study showed that fishermen operating in the Mediterranean prioritized their requirements differently from fishermen in northern fishing grounds. There was good agreement on requirements regarding work comfort. Safety requirements, such as integrated buoyancy, were ranked as less important by the Mediterranean fishermen compared to fishermen in northern fishing grounds. The results of this study provide a basis for the development of work clothing and PPE for fishermen. Work clothing and PPE that fulfil the requirements are likely to obtain end-user acceptance and thus improve safety for fishermen at sea.

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Key words: fishing, safety, work clothing, user requirements, product design, Mediterranean, northern fishing grounds, user-centred design

INTRODUCTION

A report released by the International Labour Office (ILO) states that fishing is among the most dangerous of all occupations, with as many as 24,000 fishermen around the world killed every year [1]. Reports from Iceland indicate that every year, 10% of all Icelandic fishermen are subject to injuries [2]. In the UK, 256 fishermen died due to accidents on fishing vessels between 1992 and 2006. Almost one third (83) of these were the result of falling overboard [3]. In the Norwegian fishing fleet, 31% of fatal accidents were related to capsizing and grounding, while 28% drowned as a result of falling or being pulled overboard [4].

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The European fishing fleet ranges from large seagoing trawlers to smaller vessels that operate in coastal waters, in climatic conditions from the cold and harsh waters of the Barents Sea to the warmer waters of the Mediterranean [5, 6]. In the Arctic Ocean (bounded by the Barents Sea, the Norwegian Sea, and the Northeast Atlantic), fishermen are subjected to an extreme polar climate with mean water temperatures between 0–10°C, while temperatures in the North Sea usually range between 3 and 18°C [6]. The climate in the almost enclosed Mediterranean is warm and dry, and the water temperatures are generally higher (14–29°C) than most other European seas [7].

However, accidents at sea do not only occur in the cold and harsh northern fishing grounds (in this study defined as the Barents Sea, Spitsbergen, Bear Island, North Sea, Norwegian Sea, Iceland, South/ /East Greenland, Skagerrak, Kattegat, and the Baltic Sea). Zytoon (2011) showed that the Mediterranean fishing industry involves many hazardous work conditions and practices, resulting in high rates of injury, morbidity, and mortality [8]. A total of 26 fatal accidents during a six-year period were documented in this study. Of these deaths, 13 drowning cases occurred during work periods and nine were due to vessels sinking.

Improved PPE and work clothing are thus essential to reducing the severity of accidents at sea. Several studies have mapped the working conditions and user requirements of fishermen in the Norwegian fishing fleet, and these have resulted in improved personal protective clothing for this group. One study showed that requirements regarding comfort, protection, and safety differ with vessel type, workload, and whether the vessel operates far out to sea or in coastal waters [9]. Functional requirements and the need for comfort during work determine what kind of work clothing and PPE fishermen decide to wear. Interviews conducted in this study showed that most fishermen, operating in both the Mediterranean and in the northern fishing grounds, use everyday clothing under their oilskins during work. The jeans and cotton trousers and sweaters used today provide poor thermal comfort during work because of inadequate thermal protection and moisture transport capabilities.

In spite of the significant risk of falling overboard, fishermen in northern areas report that they rarely wear buoyancy aids while working on deck. A study by the RNLI and Seafish also showed that standard inflatable lifejackets are criticized by the fishermen for having dangerous snag points and for hindering freedom of movement [10].

Most approaches to product innovation focus on user involvement only after a clear idea has been established for a product, with the result that important decisions are made without fully knowing the context and user needs. Lack of adequate market research has been shown to be a key factor in the failure of innovations. Involving users in the decision about what to design makes their acceptance for the final product more likely [11, 12].

This emphasizes the fact that knowledge of user requirements and needs is a critical factor and a prerequisite for end-user acceptance. Such knowledge exists for fishermen operating in the northern fishing grounds, but to our knowledge no study has yet identified equivalent requirements for Mediterranean areas. There is a need for such knowledge, if we are to provide this group with satisfactory work clothing.

The aim of this study was thus to identify the requirements for work clothing in terms of comfort, protection, and safety for fishermen operating in northern fishing grounds and in the Mediterranean. We also wanted to investigate whether fishermen in the Mediterranean prioritized work-clothing requirements differently from fishermen in northern fishing grounds.

We hypothesized that it should be possible to identify fishermen's requirements to work clothing by interviewing and observing key informants from several European countries, and that a survey sent out to a selection of European fishermen would show that fishermen operating in the Mediterranean prioritize their requirements differently from fishermen in northern fishing grounds.

MATERIAL AND METHODS

To map the fishermen's requirements to work clothing regarding comfort, protection, and safety, we adopted a user-centred design approach [13]. Key informants from several European fishing countries contributed their expertise regarding personal protective clothing for fishermen. Thirty-one semi-structured interviews with fishermen, fishermen's organizations, and national search and rescue associations were held. The interviews were with fishermen working on vessels of different types, lengths, and nationalities, utilizing different types of fishing gear and operating on different fishing grounds under a wide range of climatic conditions. The interviews were conducted in five European countries: France, Finland, Italy, Norway, and Sweden. Some of

the interviews were combined with direct observations on board the fishing vessels. The work of the fishermen and use of the work clothing was documented by using photo and video. The observations were analysed in light of the aim of the study, e.g. use, areas of wear and tear, exposure, and need for protection were examined to identify requirements for the work clothing and to gain insight on how the work clothing of the fishermen can be improved. Statements from the interviews and knowledge gained through observations were transformed into requirements for personal protective clothing [14].

The requirements formed the basis of an Internet-based questionnaire [15] that was distributed to a selection of European fishermen in terms of fleet size, catches, vessel types, and geographical location of fishing grounds. The questionnaire was presented in seven languages (Danish, Finnish, French, Italian, Norwegian, Spanish and Swedish) in addition to an English version. The link to the Internet questionnaire was distributed by project partners to fishermen's organizations and fishermen in Italy, France, Spain, the United Kingdom, Iceland, Denmark, Norway, and Sweden either by e-mail or personal contact. The fishermen's organizations presented the link to their members and encouraged them to take part in the survey. In Finland and Spain the questionnaire was distributed and collected on paper and then registered into the Internet survey by the partners.

The available resources for survey distribution were limited, and the goal was to get participants from different European countries through existing networks within the fishing industry in the selected countries. In most countries it is still rare that fishermen have their own e-mail account or easy access to the Internet. Therefore, it was not possible to send personal Internet links to each fisherman in order to log respondents. The total number of recipients is not available due to this approach; hence, the actual response rate is unknown.

The respondents were asked to tick, according to their own preferences and needs related to work clothing, the 15 most important requirements. Their prioritizations are presented in Table 1. This study presents the results of the fishermen who operates either in northern fishing grounds or in the Mediterranean. Background information such as age of the fishermen, type of work done on board, registered nationality of vessel, vessel type, and vessel length were also collected and are presented in Figures 1–5.

RESULTS

A total of 125 fishermen completed the Internet-based questionnaire. Sixty-one of these respondents operate in northern fishing grounds while 64 operate in the Mediterranean.

Figure 1 shows the age distribution of the responding fishermen operating in northern fishing grounds and in the Mediterranean. Most responding fishermen in the Mediterranean are between 30 and 39 years (37.5 %), while most responding fishermen in northern fishing grounds are between 40 and 49 years (27.9 %).

Figure 2 shows the current employment on board for the responding fishermen. In both groups most respondents work as fishermen.

Figure 3 shows the registered nationality of the vessel where the responding fishermen work. Most of the responding fishermen operating in the Mediterranean are working on vessels registered in Spain. In northern fishing grounds most vessels are registered in Finland.

Figure 4 shows the length of the vessels where the responding fishermen work. In both groups most vessels are longer than 24 metres.

Figure 5 shows the type of vessel where the responding fishermen work. In the Mediterranean most of the responding fishermen work on longliner vessels (37.5%) or „other" vessels (37.5%), while in northern fishing grounds most of the responding fishermen work on freezer trawlers (26.2%).

Figure 6 shows that fishermen operating in northern fishing grounds rated freedom of movement, integrated buoyancy, and durability as the top three requirements. Functional properties like wind- and waterproof clothing and good thermal protection were also given high priority. Easy to put on and take off, lightweight, and good fit were highlighted as important comfort requirements for the work clothing.

Figure 7 shows that fishermen operating in the Mediterranean rated waterproof clothing, freedom of movement, and durability as their three most important requirements. Other important functional and safety requirements included windproof clothing, good thermal protection, high visibility of the work clothing, and an integrated man overboard alarm. Easy to put on and take off, lightweight, and loose fit were regarded as important for work comfort.

Table 1 shows the prioritization of the requirements for all respondents sorted by different geographical location of fishing grounds. The cell containing the most highly prioritized requirement is highlited in bold.

Table 1. Prioritization of requirements for work clothing for all respondents (n = 125), sorted by different geographical location of fishing grounds (figures represent percentages)

Geographical location of fishing grounds → ↓ User requirements to outerwear (OW) regarding comfort, protection, and safety	Northern fishing grounds n = 61 (%)	Mediterranean n = 64 (%)
Provides good freedom of movement	86.9	87.5
Keeps you afloat in water	82.0	40.6
Is durable	80.3	78.1
Is waterproof	77.0	95.3
Is windproof	70.5	73.4
Can be put on and taken off quickly	68.9	59.4
Keeps you warm	63.9	71.9
Remains waterproof, even after several washings	60.7	42.2
Is light weight	60.7	54.7
Comes in different sizes to fit all users	59.0	57.8
Is highly visible	55.7	68.8
Withstands tears and cuts	41.0	37.5
Is machine-wash friendly	41.0	7.8
Is reinforced on parts especially exposed to wear and tear (knees, underarms, and front)	39.3	45.3
Has a hood	39.3	48.4
Ventilates sweat and heat	39.3	12.5
Is suitable for both summer and winter use	37.7	28.1
The price of the OW is less important if the functionality and durability is good	36.1	15.6
Reduces the risk of entanglement	36.1	34.4
Has an affordable price	34.4	18.8
Dries quickly	34.4	54.7
Is oil, dirt, and blood repellent	32.8	42.2
Has an integrated man-overboard alarm	31.1	65.6
Hood is spacious enough to wear head protection underneath	29.5	25.0
Has closing solutions to stop water from entering at wrists and ankles	29.5	37.5
Is easy to clean with a hose	27.9	53.1
Tears and cuts in the OW can be easily repaired	21.3	7.8
Has a loose fit	19.7	54.7
Has a knife storage solution	14.8	20.3
Size can be adjusted in width and length	11.5	18.8
Has watertight pockets	11.5	53.1
Has a padding solution for the knees	8.2	17.2
Can easily be adjusted to quick changes in activity level	6.6	10.9
Has practical openings for ventilation	6.6	7.8
Other (specify):	0.0	0.0

Both groups gave high priority to comfort requirements such as freedom of movement, good fit, easy to put on and take off, and light weight. However, fishermen in the Mediterranean preferred looser fitting clothing than those operating in northern areas.

They also agreed that clothing should be durable, windproof and waterproof, and keep the wearer warm. "Withstands tears and cuts" and "Remains waterproof after several washings" were only given high priority by fishermen in northern fishing grounds while for fishermen operating in the Mediterranean the clothing should be easy to clean with a hose and be quick-drying.

Watertight pockets were given a high ranking by fishermen in the Mediterranean (53.1%) while

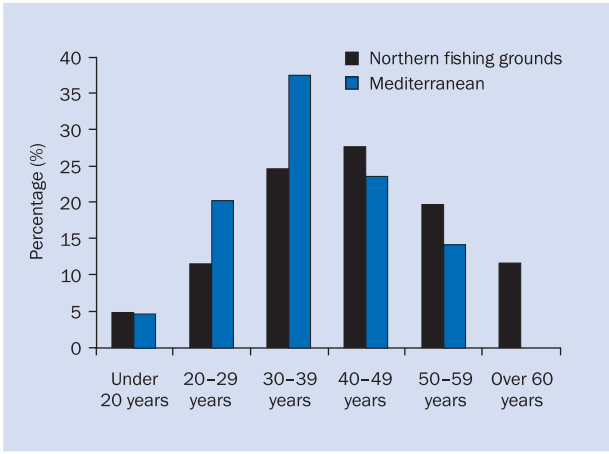

Figure 1. The age distribution of responding fishermen in northern and Mediterranean fishing grounds

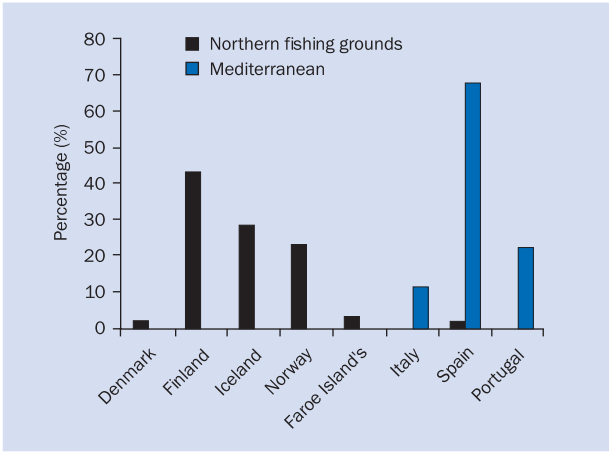

Figure 3. Registered nationality of the vessels where the responding fishermen work

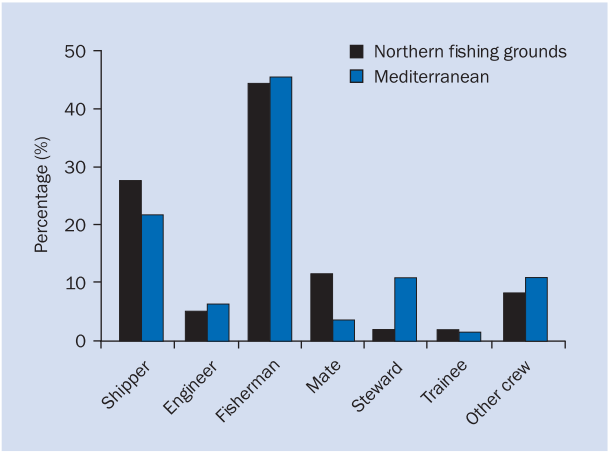

Figure 2. Current employment onboard for the responding fishermen

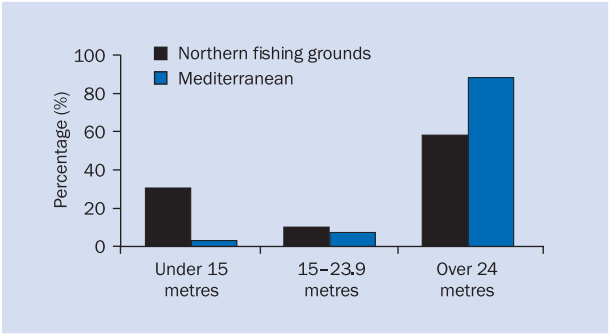

Figure 4. Length of the vessels where the responding fishermen work

these were given very low priority by fishermen in the north.

Requirements regarding safety were prioritized quite differently by the two groups of fishermen. “Keeps you afloat in water” is the second most important requirement for fishermen in the north (82.0%), while Mediterranean fishermen did not rank it within the top 15 requirements (40.6%). The requirement for an integrated man overboard alarm was prioritized more highly by Mediterranean fishermen (65.6%) than fishermen in the north (31.1%). Both groups prioritized high visibility of the work clothing.

The importance of price was also prioritized differently among the groups. Fishermen operating in northern grounds regarded price as being less important if the functionality and durability of the work clothing is good, unlike fishermen in Mediterranean areas.

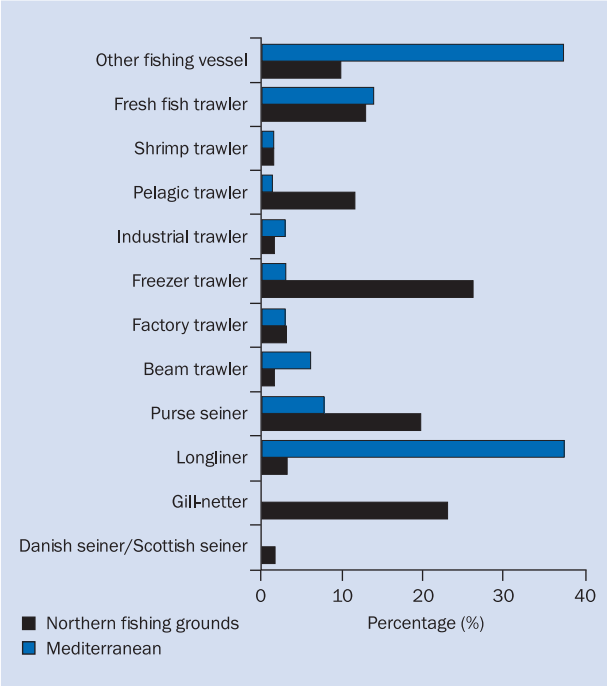

Figure 5. Type of vessel where the responding fishermen work

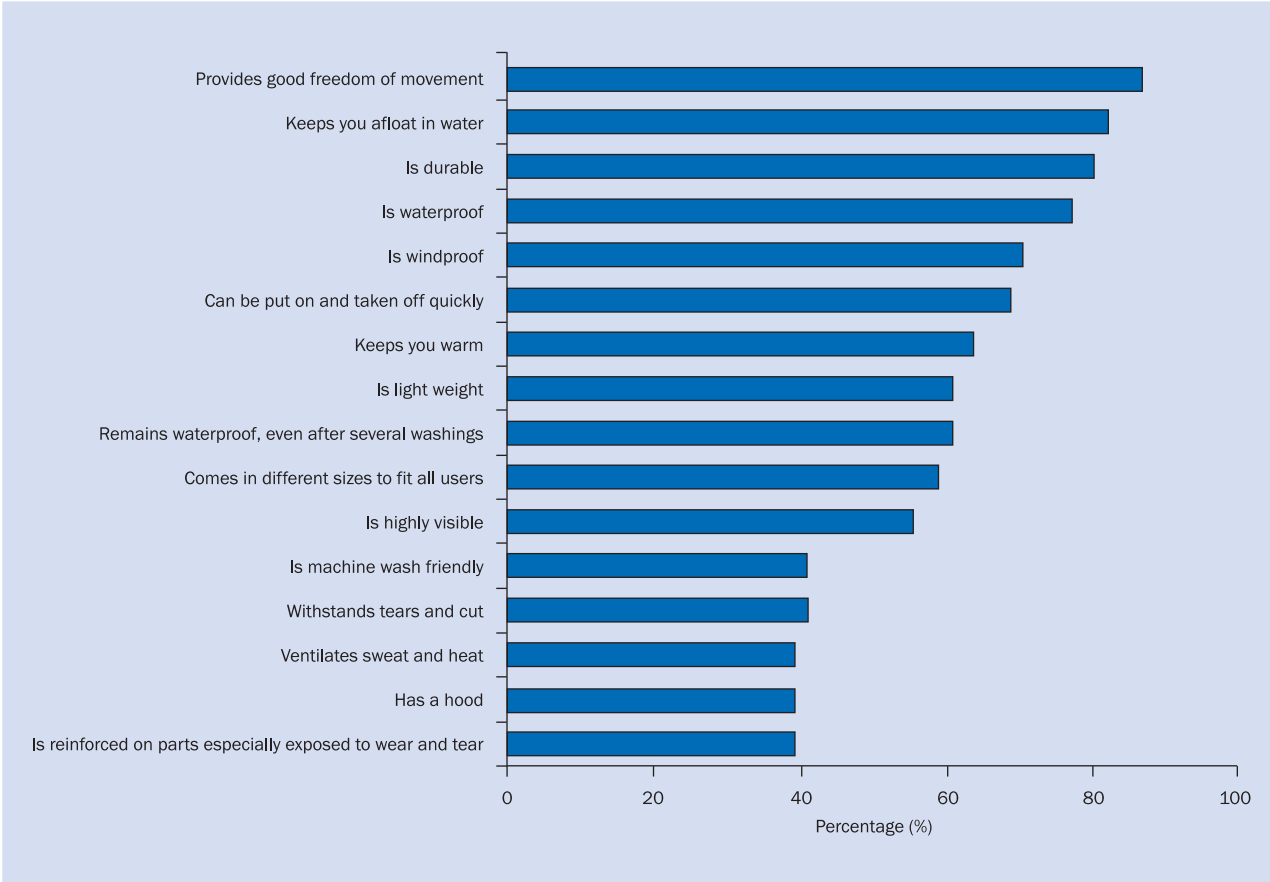

Figure 6. Prioritization of the 16 most important requirements for work clothing (in questionnaire referred to as outerwear) for fishermen operating in northern fishing grounds (n = 61)

DISCUSSION

There was good agreement between fishermen operating in northern fishing grounds and those operating in the Mediterranean on requirements regarding work comfort. However, there was a difference regarding the fit of the work clothing. Several of the fishermen working on large trawlers in northern fishing grounds mentioned that loose fitting clothing would increase the risk of entanglement in heavy machinery. Fishermen in the Mediterranean utilize other types of fishing gear which might not involve the same risk of entanglement. Increased ventilation might also explain why a loose fit is preferred by fishermen operating in the warm climate of the Mediterranean.

Several requirements regarding functionality and protection were prioritized differently by the two groups. The difference regarding the ability to withstand tears and cuts might be explained by the fact that many of the responding fishermen in northern fishing grounds work on large freezer trawlers (26.2%) and purse seiners (19.7%), utilizing heavy fishing gear, wires, and winches, resulting in an increased risk of tears and cuts in the work clothing. Most of the responding fishermen in the Mediterranean work on longliner vessels, which do not involve the same risk of tears and cuts.

There was also a difference in priorities regarding cleaning and washability. This might be explained by the washing facilities available on board the vessels. From the interviews and observations we know that many vessels operating in northern fishing grounds have a laundry room onboard, making easy cleaning and quick air drying less important, while most of the Mediterranean vessels did not have the same washing and drying facilities onboard, leading to different prioritization of these requirements.

Functional solutions like watertight pockets were only prioritized highly among fishermen in the Mediterranean. Such pockets are typically used for storing mobile phones, which might explain the different needs. In remote waters in northern fishing grounds cell phones cannot be used, due to lack of coverage, while vessels operating in coastal Mediterranean waters may be able to use mobile phones at sea.

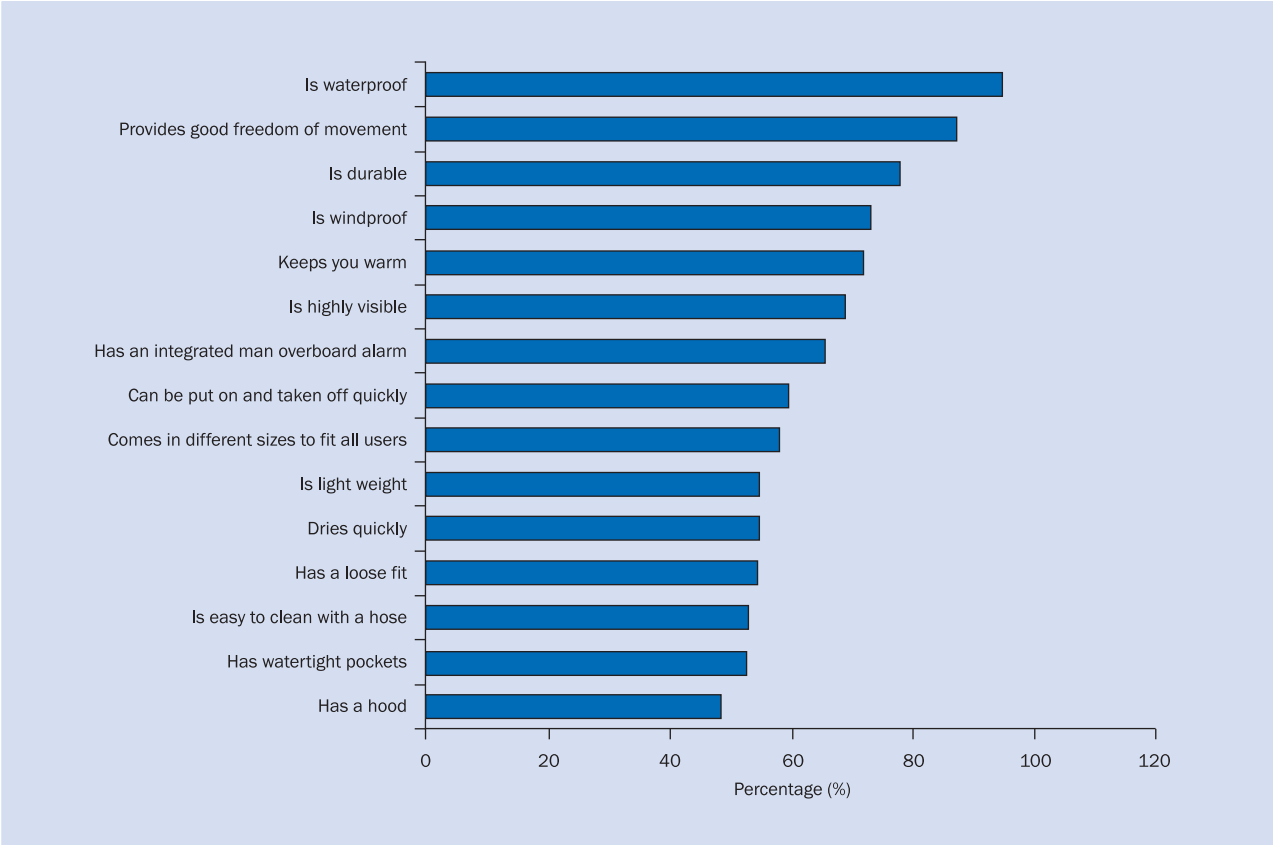

Figure 7. Prioritization of the top 15 requirements for work clothing for fishermen operating in the Mediterranean (n = 64)

The most obvious differences in the priorities of the two groups of fishermen were requirements regarding safety. The evident desire for integrated buoyancy by northern fishermen can probably be explained by the greater risk of drowning in man overboard (MOB) situations in northern waters. Vessels in the Mediterranean operate in coastal waters, while the vessels in the north operate further from the shore in more remote waters. The time needed for search and rescue in case of a MOB situation will usually be longer in northern fishing grounds. The cold northern waters, especially the North Atlantic, also involve a much greater risk of drowning as a result of cold shock response or hypothermia than in the warmer waters of the Mediterranean.

In case of an MOB event, the potential success of a quick search and rescue operation is higher in the Mediterranean if an alarm signal can be transmitted when fishing vessels operate closer to shore and closer to each other. This might explain why the fishermen of the Mediterranean regard an integrated MOB alarm as being more important for survival in a MOB situation than clothing with integrated buoyancy. They are less worried about staying afloat and more about giving notice of the situation, while fishermen in the north prioritize the other way around.

The high priority given to high visibility of the work clothing shows that this is an important requirement in all regions.

The requirement regarding the price of the work clothing indicates that fishermen in the north are willing to pay more for improved quality and functionality than fishermen in the Mediterranean. This might be due to a greater spending power, but it also indicates that high-quality work clothing is a prerequisite for fishing in cold and harsh northern waters. From the interviews we learned that most fishermen buy their own work clothing, while the ship-owners provide required PPE such as helmets and lifejackets. On some large vessels in Norway the ship-owners subsidize the purchase of the fishermen's work clothing, and this might contribute to greater spending power among the fishermen in the north.

CONCLUSIONS

Interviews and observations with key informants in a selection of EU fishing nations provided us with the requirements for work clothing for fishermen

operating in Mediterranean and northern fishing grounds. A web-based questionnaire distributed to a selection of European fishermen showed that fishermen operating in the Mediterranean prioritized their requirements differently from fishermen in northern fishing grounds.

There was good agreement between the two groups on requirements regarding work comfort. Several functionality and safety requirements for the work clothing were prioritized differently. The results of this study provide a good basis for the development of work clothing and PPE for fishermen in northern and Mediterranean fishing grounds. Work clothing and PPE that fulfil the requirements are likely to obtain user acceptance and thus improve safety for fishermen at sea.

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