



Challenges and Considerations in Seafarer Feeding in the Merchant Navy: A Literature Review

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ARTICLE INFO

Article history:

Received 21 Feb 2024;
in revised form 01 Mar 2024;
accepted 15 May 2024.

Keywords:

Seafarers' nutrition; maritime health;
operational safety; cultural diversity;
dietary challenges.

ABSTRACT

Objective: To identify, verify and analyse the scientific literature specific to seafarer feeding in the merchant navy and to synthesise its findings on the challenges and considerations of the problem.

Methods: Bibliographic review with descriptive bibliometric analysis. Targeted searching by thematic blocks with a publication cut-off date of March 2024, backward searching from key reviews and verification of each record against the publisher's source. The corpus (47 articles plus the MLC 2006) was classified by year, journal, study type, population and theme, and an evidence map was built.

Results: The corpus is concentrated in International Maritime Health (40.4%) and in observational studies (34.0%); only 9 of the 36 seafarer-focused works specifically address food (6 since 2018), and no controlled trials in seafarers were identified. Studies describe diets with high access to meat, processed foods, sugary drinks and alcohol and low fruit and vegetable intake, with pooled prevalences of 41.7% for overweight and 18.6% for obesity. Challenges are logistical, educational, organisational, cultural and regulatory. Links between diet, mental health, fatigue and operational safety rest mostly on indirect evidence.

Conclusion: The specific literature is scarce, concentrated in few journals and groups, and rarely interventional. On-board studies with objective indicators and intervention designs, and a replicable multi-database search, are needed.

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1. Introduction.

Maritime transport underpins global trade and relies on a workforce that lives and works in the same confined environment for prolonged periods (Hystad and Eid, 2016). Working conditions on board combine high physical and mental demands, long working hours, time pressure and separation from family – factors which seafarers themselves identify as the main stressors in their work (Oldenburg et al., 2009, 2010). Added to this are social isolation (Sampson and Thomas, 2003), accumulated fatigue (Allen et al., 2008; Jepsen et al., 2015) and

a significant burden of psychological distress (Carotenuto et al., 2012; Iversen, 2012).

In this context, food plays a role that goes far beyond providing energy and nutrients. Whilst on board, seafarers have limited control over the quality and quantity of the food they consume over a period of several months (Oldenburg et al., 2013). In one of the surveys cited by these authors, 95 per cent of seafarers considered food on board to be 'very important' or 'important' for their job satisfaction and day-to-day wellbeing, and around 80 per cent stated that they would prefer to eat more healthily (Oldenburg et al., 2013). Food is therefore a factor in health and, at the same time, a factor in quality of life and staff retention.

Concerns about nutrition at sea are long-standing. Scurvy, a deficiency disease caused by a lack of vitamin C, was for centuries one of the leading causes of illness and death amongst seafarers, and its history illustrates that available knowledge does not always translate into effective provisioning practices (Baron, 2009; Sutton, 2003). Today, the predominant nutritional problem is no longer specific defi-

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ciency, but rather imbalance and excess: recent reviews document a high prevalence of overweight, obesity, hypertension and other cardiovascular risk factors amongst seafarers (Sagaro et al., 2023; Szafran-Dobrowolska et al., 2019), accompanied by diets high in meat and fat and deficient in fruit, vegetables, dairy products and cereals (Baygi et al., 2021; Zyriax et al., 2018).

The organisation of food on board also faces structural constraints: limited storage capacity, infrequent supplies, high prices for fresh fruit and vegetables, and cooks with little or no prior training (Hjarnoe and Leppin, 2014b), compounded by cost-minimisation decisions (Baum-Talmor and Şahin, 2024) and the difficulty of catering for multi-ethnic crews (Oldenburg et al., 2013). The international legal framework, led by the Maritime Labour Convention, 2006 (MLC 2006), sets out requirements regarding the quality, nutritional value and quantity of food, but its practical implementation varies by flag State and is not standardised (International Labour Organisation [ILO], 2006; Oldenburg et al., 2013).

Specific research into the diets of seafarers remains limited: comprehensive studies on dietary patterns are scarce, and most rely on interviews to record eating habits, without objective methods to estimate actual intake or the energy expenditure associated with work tasks (Oldenburg et al., 2013). Furthermore, much of the evidence comes from homogeneous European crews and does not fully reflect the current composition of fleets, which comprise seafarers from a wide variety of cultural, religious and linguistic backgrounds.

The aim of this study is to identify, verify and analyse the specific scientific literature on the diet of seafarers in the merchant navy and to synthesise its findings regarding the challenges and considerations surrounding this issue. Specifically, the study aims to: (1) define and document a replicable search strategy; (2) to characterise the retrieved corpus bibliometrically (year, journal, type of study, population and topic) and to draw up a map of the evidence; (3) to summarise the literature's contributions regarding dietary patterns, physical and mental health, operational safety, and logistical, cultural and regulatory challenges; and (4) to identify gaps that will guide future research.

2. Methodology.

2.1. Design and review question.

A narrative literature review was conducted, accompanied by a descriptive bibliometric analysis of the retrieved corpus. The research question was formulated using the PICO framework (Population, Phenomenon of Interest, Context): What published scientific evidence exists regarding the diet of merchant navy seafarers (P), their logistical, cultural, organisational and regulatory challenges, and the implications for health, wellbeing and operational safety (I), on merchant vessels and in maritime environments (Co), and how is this evidence distributed across study designs, populations and themes? Supporting evidence from other populations was also included where it provided relevant mechanisms. To ensure the transparency of the report, the PRISMA-ScR recommendations were followed where applicable; no prior protocol was registered, and the search was not intended to be exhaustive.

2.2. Sources and search strategy.

The identification process combined two complementary approaches. (a) Searches by thematic blocks (Table 1), in English and Spanish, using academic search engines and the websites of publishers

and open-access repositories of specialist journals (including International Maritime Health, BMC Public Health, Journal of Occupational Medicine and Toxicology and Marine Policy) and PubMed Central, with no restriction on the start date. (b) A retrospective ('snowball') search based on the reference lists of key reviews (Baygi et al., 2021; Sagaro et al., 2023; Szafran-Dobrowolska et al., 2019; Oldenburg et al., 2013). A publication cut-off date of 31 March 2024 was applied: records published after this date were excluded from the corpus. The search strings in Table 1 are provided in Boolean syntax for replication in PubMed, Scopus and Web of Science; in this study, they guided the targeted search and records were not counted separately by database.

2.3. Eligibility criteria.

The eligibility criteria are summarised in Table 2. Articles from scientific journals on the diet, health or working conditions of merchant seafarers were included, as were studies of the general population or shift workers where these provided evidence on mechanisms (diet and mental health, diet and sleep, shift work and metabolism). The text of the MLC 2006 was also taken into account as a reference regulatory instrument.

2.4. Selection and verification process.

Records were screened by title and abstract against the criteria set out in Table 2. Each selected record was then cross-checked against the publisher's or repository's website to verify the authors, year, journal, volume, page numbers and DOI, and its abstract was read. This step enabled us to correct bibliographic data (DOI, volume, article number) that differed between secondary sources. The workflow is summarised in Figure 1. The final corpus comprised 47 articles and one regulatory instrument.

2.5. Extraction, classification and analysis.

For each document, the following details were recorded: the year, the journal, the type of study (systematic review or meta-analysis, narrative review or synthesis, quantitative observational, qualitative or mixed-methods study, controlled trial and others), the population (seafarers, the general population or shift workers, historical sources) and a main theme (A–H, as defined in the note in Table 3). Classification was based on the title and abstract, and a single thematic label was assigned per article. A descriptive analysis of frequencies and percentages was carried out, and an evidence map (theme × study type) was constructed. No formal assessment of risk of bias was performed; in the synthesis, priority was given to systematic reviews, large sample sizes and the most recent studies. Figures 5, 6 and 7 were produced using data published in the original studies; Figures 1 to 3 are derived from the corpus analysis; and Figure 4 is a conceptual synthesis.

Table 1: Search blocks and chains proposed for replication (PubMed, Scopus, Web of Science).

Block	String (Boolean syntax)	Usage
B1. Population	seafarer OR seaman OR seamen OR mariner OR “merchant navy” OR “merchant marine” OR “merchant ship” OR “ship crew” OR marinos OR “Seafarers” OR “marina mercante”	Must appear in all combinations
B2. Food	nutrition OR diet OR food OR catering OR meal OR “ship’s cook” OR galley OR provisions OR food OR diet OR nutrition	Must appear in all combinations
B3. Results	obesity OR overweight OR “cardiovascular risk” OR “metabolic syndrome” OR “mental health” OR fatigue OR stress OR safety OR “job satisfaction”	Health and safety implications
B4. Context and management	multicultural OR “multi-ethnic” OR “cultural diversity” OR “Maritime Labour Convention” OR MLC OR COVID-19 OR intervention OR training	Organisational, cultural and regulatory challenges
B5. Evidence of support	(“shift work” OR sleep OR “Mediterranean diet” OR depression OR “ultra-processed”) AND diet	Mechanisms (general population)
Combination	B1 AND B2 AND (B3 OR B4); B5 independently	Main strategy

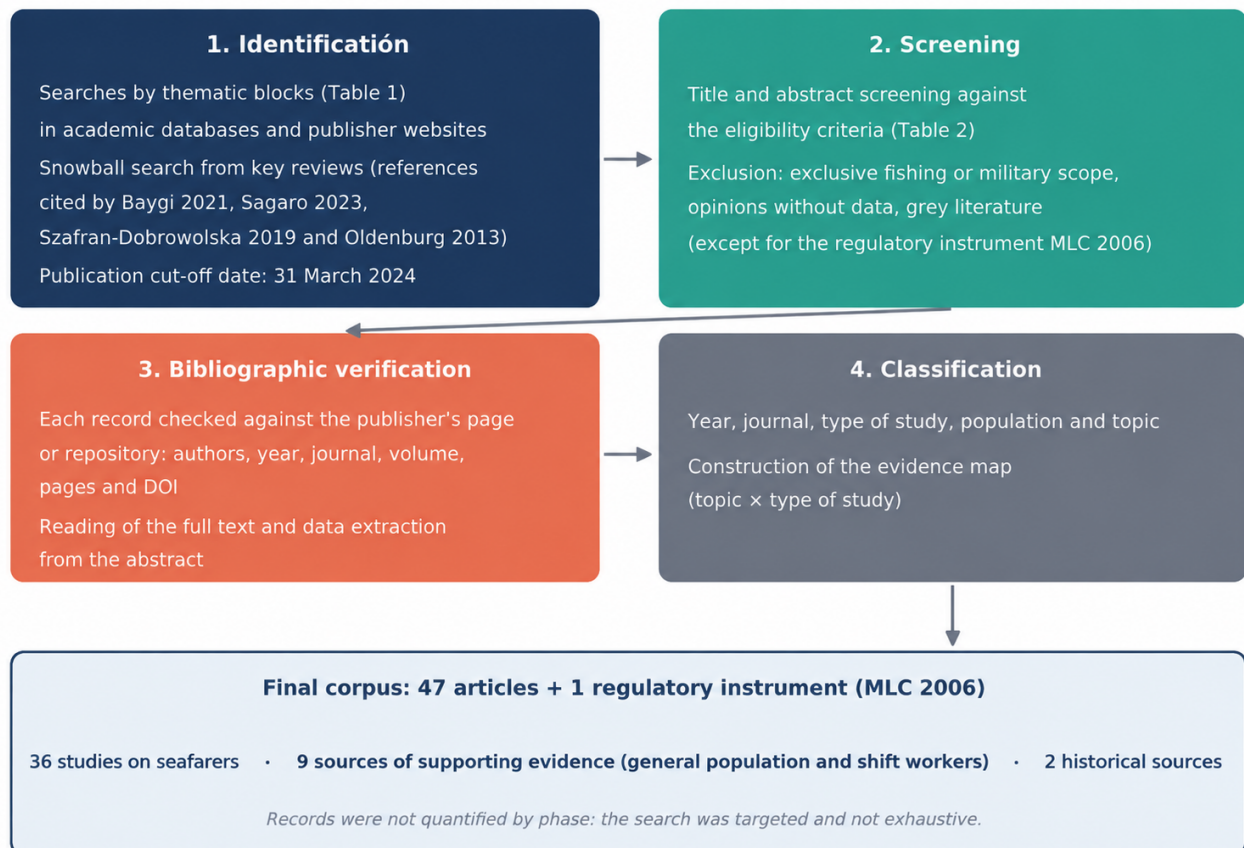
Note: The asterisk (*) indicates that the figure has been truncated. Source: compiled by the author.

Table 2: Eligibility criteria (PICO framework).

Criterion	Inclusion	Exclusion
Population	Seafarers in the merchant navy (deck, engine, galley). Supporting evidence: the general population and shift workers.	Studies focusing exclusively on fishing or the military sector.
Phenomenon of interest	Nutrition, diet, food provision and preparation, and their implications for health, wellbeing and safety; organisational, cultural and regulatory factors.	Studies unrelated to nutrition or its determinants or consequences.
Context	Merchant ships and maritime environments; MLC 2006.	—
Document type	Scientific journal articles (original articles, reviews, short communications) and the MLC 2006 regulatory instrument.	Opinions without data; grey literature (except for the MLC 2006).
Language and date	English or Spanish; no minimum date; published up to 31 March 2024.	Other languages; published after 31 March 2024.
Verifiability	Verifiable record on the publisher’s or repository’s website (authors, year, journal, DOI or identifier).	Non-verifiable records.

Source: Own compilation.

Figure 1: Process for identifying, verifying and classifying the bibliography.



Source: Own compilation.

Table 3: Characterisation of the bibliographic corpus (n = 49).

Nº	Referencia	Revista	Tipo	Población	Tema
1	Abila y Acejo (2021)	Int Marit Health	RN	Seafarers	C
2	Allen et al. (2008)	Int Marit Health	RN	Seafarers	C
3	Baron (2009)	Nutr Rev	RN	Historical	G
4	Baum-Talmor y Şahin (2024)	Inquiry	CUAL	Seafarers	D
5	Baygi et al. (2022)	Int Marit Health	Another	Seafarers	A
6	Baygi et al. (2021)	BMC Public Health	RS/MA	Seafarers	A
7	Carotenuto et al. (2012)	Int Marit Health	RN	Seafarers	C
8	Doumbia-Henry (2020)	WMU J Marit Aff	Another	Seafarers	F
9	Estruch et al. (2018)	N Engl J Med	ECA	General population	H
10	Gómez-Pinilla (2008)	Nat Rev Neurosci	RN	General population	H
11	Gregorio et al. (2016)	Int Marit Health	OBS	Seafarers	B
12	Hall et al. (2019)	Cell Metab	ECA	General population	H
13	Hansen et al. (2011)	Int Marit Health	OBS	Seafarers	B
14	Hjarnoe y Leppin (2014a)	Health Promot Int	OBS	Seafarers	A
15	Hjarnoe y Leppin (2014b)	Int Marit Health	CUAL	Seafarers	D
16	Hystad y Eid (2016)	Saf Health Work	OBS	Seafarers	C
17	Iversen (2012)	Int Marit Health	RN	Seafarers	C
18	Jacka et al. (2017)	BMC Med	ECA	General population	H
19	Jensen y Oldenburg (2020)	Int Marit Health	Another	Seafarers	E
20	Jepsen et al. (2015)	Int Marit Health	RN	Seafarers	C
21	Lassale et al. (2019)	Mol Psychiatry	RS/MA	General population	H
22	Liu et al. (2018)	Int J Epidemiol	RS/MA	General population	H
23	Lowden et al. (2010)	Scand J Work Environ Health	RN	General population	H
24	Lucas et al. (2021)	Int Marit Health	Another	Seafarers	F
25	Møller Pedersen y Riis Jepsen (2013)	Int Marit Health	OBS	Seafarers	B
26	Neumann et al. (2021)	J Occup Med Toxicol	OBS	Seafarers	A
27	Nittari et al. (2019)	BMC Public Health	OBS	Seafarers	B
28	Oldenburg et al. (2010)	J Occup Health	RN	Seafarers	C
29	Oldenburg et al. (2013)	Int Marit Health	RN	Seafarers	A
30	Oldenburg y Jensen (2019)	Int Marit Health	Another	Seafarers	D
31	Oldenburg et al. (2009)	Int J Public Health	OBS	Seafarers	C
32	Papadakis et al. (2020)	Int Marit Health	OBS	Seafarers	B
33	Pauksztat et al. (2022a)	Saf Sci	OBS	Seafarers	F
34	Pauksztat et al. (2022b)	Mar Policy	OBS	Seafarers	F
35	Roberts y Jaremin (2010)	Int Marit Health	OBS	Seafarers	B
36	Sagaro et al. (2023)	J Pers Med	RS/MA	Seafarers	B
37	Sampson y Thomas (2003)	Int Marit Health	Another	Seafarers	C
38	Sampson y Zhao (2003)	World Engl	CUAL	Seafarers	E
39	Srouf et al. (2019)	BMJ	OBS	General population	H
40	St-Onge et al. (2016)	Circulation	RN	General population	H
41	Stoll et al. (2020)	Int Marit Health	RS/MA	Seafarers	B
42	Sutton (2003)	J R Soc Med	Another	Historical	G
43	Szafran-Dobrowolska et al. (2019)	Int Marit Health	RN	Seafarers	B
44	Tang et al. (2022)	Mar Policy	CUAL	Seafarers	F
45	von Katzler et al. (2019)	BMC Public Health	OBS	Seafarers	B
46	Westenhoefer et al. (2018)	BMC Obes	OBS	Seafarers	E
47	Zyriax et al. (2018)	J Occup Med Toxicol	OBS	Seafarers	A

Note. Type: RS/MA = systematic review or meta-analysis; RN = narrative review or synthesis; OBS = quantitative observational; CUAL = qualitative or mixed methods; RCT = randomised controlled trial; Other = editorial, short communication, policy analysis, historical or unclassified. Topic: A = dietary patterns and perception; B = obesity, cardiometabolic risk and lifestyle; C = mental health, stress, fatigue and isolation; D = cooks, organisation and interventions; E = cultural diversity and communication; F = COVID-19; G = history and regulatory framework; H = evidence from the general population. Source: own compilation.

3. Results.

3.1. Bibliographic analysis of the corpus.

3.1.1. Composition and changes over time.

The corpus consists of 47 articles and one piece of legislation. Of these articles, 36 (76.6 per cent) focus on seafarers, 9 (19.1 per cent) provide supporting evidence drawn from the general population or shift workers, and 2 (4.3 per cent) are historical sources on scurvy (Figure 2a). By period, there are 7 articles from 2003–2009, 10 from 2010–2014, 16 from 2015–2019 and 14 from 2020 to March 2024. This distribution should be interpreted with caution as it reflects a targeted search rather than a comprehensive survey of the literature.

Only 9 of the 36 studies on seafarers (25.0 per cent) specifically address diet: Oldenburg et al. (2013), Hjarnoe and Leppin (2014a, 2014b), Zyriax et al. (2018), Westenhoefer et al. (2018), Baygi et al. (2021), Neumann et al. (2021), Baygi et al. (2022) and Baum-Talmor and Şahin (2024). Six of these were published since 2018, indicating a recent and growing interest; the other 27 mainly address the consequences (cardiometabolic risk, mental health, fatigue) or the context (COVID-19, communication) without focusing on food.

3.1.2. Journals.

The 47 articles are drawn from 25 journals. *International Maritime Health* accounts for 19 (40.4 per cent), followed by *BMC Public Health* (3), the *Journal of Occupational Medicine and Toxicology* (2) and *Marine Policy* (2); the remaining 21 journals each contribute one article (Figure 2b). An asymmetry is observed: evidence specific to seafarers is concentrated in a specialist journal, whilst supporting evidence is scattered across high-impact general journals (N Engl J Med, BMJ, Circulation, Cell Metabolism, Molecular Psychiatry, amongst others). For anyone seeking literature on this topic, the specialist journal and key reviews are therefore the most productive starting points.

3.1.3. Types of study and populations.

Quantitative observational studies predominate (16; 34.0 per cent), followed by narrative or synthesis reviews (12; 25.5 per cent), other documents (7; 14.9 per cent), systematic reviews or meta-analyses (5; 10.6 per cent), qualitative or mixed-methods studies (4; 8.5 per cent) and controlled trials (3; 6.4 per cent) (Figure 2c). Among the 36 articles on seafarers, there are 15 observational studies, 8 narrative reviews, 6 of other types, 4 qualitative or mixed-methods studies and 3 systematic reviews (Baygi et al., 2021; Sagaro et al., 2023; Stoll et al., 2020), but no controlled trials: the three trials in the corpus were drawn from the general population (Estruch et al., 2018; Hall et al., 2019; Jacka et al., 2017). Table 3 summarises the classification of the 47 articles.

With regard to the populations, the primary studies mainly describe fleets or groups from Denmark, Germany, Italy, Greece and the United Kingdom, with a smaller representation of Filipino and Kiribati seafarers (Gregorio et al., 2016; Neumann et al., 2021; Zyriax et al., 2018). No primary studies on on-board catering in Spanish-flagged fleets were identified in the corpus, which constitutes a geographical gap.

3.1.4. Concentration of authorship.

Ten of the 36 articles on seafarers (27.8 per cent) list M. Oldenburg as a co-author, and six of the 47 list B.-C. Zyriax. Of the nine studies focusing on diet, six (66.7 per cent) include one or the other

amongst their authors. The specific output therefore depends to a large extent on a single research group, which provides methodological consistency but also carries the risk of homogeneity in the populations studied (crews of European shipping companies) and in the methods used (self-reported questionnaires). This tally is based on the lists of authors in the verified references; in some references with abbreviated author lists, it was not possible to verify the full authorship..

3.1.5. Evidence map.

The evidence map (Figure 3) cross-references the eight themes with the six study types. Themes B (obesity and cardiometabolic risk; 10 articles) and C (mental health, stress, fatigue and isolation; 9) are the most widely represented. Theme C, however, relies primarily on narrative reviews (6 out of 9), indicating a lack of primary evidence of its own. Theme A (dietary patterns and perceptions of food; 6) is covered by 3 observational studies, one systematic review, one narrative review and one editorial, and none of the themes specific to seafarers are supported by controlled trials. The only studies on organisation and intervention (theme D) are two qualitative or mixed-methods studies: the course for cooks by Hjarnoe and Leppin (2014b), evaluated using a before-and-after design based on interviews and questionnaires, and the analysis by Baum-Talmor and Şahin (2024). Furthermore, no study in the corpus links measurements of the on-board diet to objective outcomes relating to fatigue, mental health or safety. These omissions highlight the main gaps in knowledge.

3.2. Thematic summary of the relevant literature.

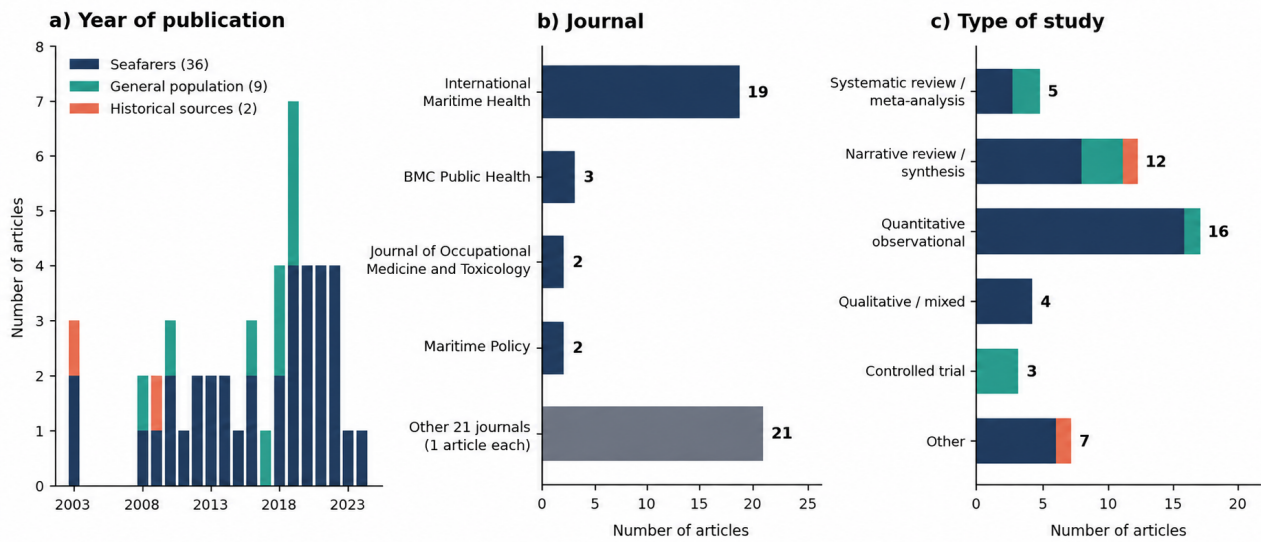
The content of the studies, grouped by theme (A–H), is summarised below. Figure 4 summarises the conceptual framework underpinning the synthesis, and Table 4 sets out the characteristics and main findings of the key studies.

3.2.1. From deficiency diseases to non-communicable diseases (topic G).

Scurvy illustrates the historical link between diet and health at sea. It is an ancient disease characterised by apathy, weakness, skin haemorrhages, bleeding gums and oedema, and can be fatal if left untreated; sailors and some ship's doctors used oranges and lemons to cure and prevent it long before its cause was identified (Baron, 2009). The comparative trial attributed to James Lind in 1747 preceded the systematic use of citrus fruits for prevention in the British Navy by almost half a century, and the disease reappeared around 1860, when lime juice inadvertently replaced lemon juice (Baron, 2009). The Royal Navy did not adopt citrus rations until 1795, and an analysis of the original documents from Lind's ship suggests an official culture reluctant to record the disease, which may have contributed to his work being overlooked (Sutton, 2003). The historiography of this episode remains a subject of debate (Baron, 2009), but its main lesson is clear: nutritional problems on board are not resolved by scientific knowledge alone, but through decisions regarding provisioning and organisation.

With the availability of preserved foods, refrigeration and improved provisioning, the predominant nutritional problem shifted towards excess and imbalance. Early studies estimated the energy expenditure of merchant navy seafarers at around 3,000–3,500 kcal per day, with variations depending on the stage of the voyage and the weather, whilst subsequent studies reported that 64 per cent of seafarers were overweight and 23 per cent were obese (Oldenburg et al., 2013). In other

Figure 2: Bibliometric characterisation of the corpus: year of publication, journal and type of study.



Source: Own compilation (n = 47 articles).

Figure 3: Evidence map: topics by study type.

	Systematic review / meta-analysis	Narrative review / synthesis	Quantitative observational	Qualitative / mixed	Controlled trial	Other	Total
A. Food supply and perceptions of food on board	1	1	3	-	-	1	6
B. Obesity, cardiovascular risk and lifestyle	2	1	7	-	-	-	10
C. Mental health, stress, fatigue and well-being	-	6	2	-	-	1	9
D. Cooks, organisation and interventions	-	-	-	2	-	1	3
E. Cultural diversity and communication	-	-	1	1	-	1	3
F. COVID-19	-	-	2	1	-	2	5
G. Costs and economic aspects	-	1	-	-	-	1	2
H. General evidence and prevalence	2	3	1	-	3	-	9

Source: Own compilation (n = 47 articles; one topic per article).

words, diet on board has shifted from being a problem of specific nutrient deficiencies to becoming a risk factor for non-communicable diseases.

3.2.2. Meal plan on board (topic A).

The systematic review by Baygi et al. (2021), which included 26 articles selected from 4,449 records, provides the most comprehensive overview of dietary patterns in maritime environments. Quantitative studies, based on menu analyses, 24-hour recall surveys, dietary records, dietary habit questionnaires and analyses of food stocks and waste on board the vessel, agree that access to meat, processed meat,

eggs, frozen and tinned foods, sugary drinks, alcohol, and fatty and salty foods is high, whilst the consumption of fruit, vegetables, dairy products and cereals falls short of recommended levels (Figure 5). The authors conclude that dietary habits and intakes in maritime environments are unhealthy.

These findings are consistent with the SeaNut study, which involved 48 seafarers from Kiribati and 33 Europeans from four merchant ships operated by a German shipping company, and which found that the intake of meat, fat and eggs was more than double the recommended levels, whilst the intake of fruit, vegetables, dairy products and cereals was well below the recommended levels; both groups, par-

Table 4: Characteristics and main findings of the key studies included in the review.

Study	Design and sample	Key findings
Oldenburg et al. (2013)	Narrative review	Non-standardised meals, multi-ethnic crews, irregular mealtimes due to shift patterns; a lack of studies using objective methods.
Baygi et al. (2021)	Systematic review; 26 studies (4,449 records)	High availability of meat, processed, frozen and tinned foods, sugary drinks, alcohol, fat and salt; low consumption of fruit, vegetables, dairy products and cereals.
Zyriax et al. (2018)	Cross-sectional (SeaNut); 48 Kiribati seafarers and 33 Europeans, 4 vessels	Intake of meat, fat and eggs more than double the recommended amount; fruit, vegetables, dairy products and cereals well below recommended levels; insufficient intake of fibre and micronutrients.
Neumann et al. (2021)	Cross-sectional; 64 seafarers observed on board and 820 via questionnaire (277 Europeans, 543 Filipinos)	More fruit and vegetables and less cola at home than on board; 45.8 per cent were overweight (Europeans 55.4 per cent; Filipinos 40.8 per cent).
Hjarne and Leppin (2014b)	Mixed-method intervention; chefs from two Danish shipping companies	Two-day cookery course; significant change in self-reported dietary behaviour after one year; barriers relating to storage, supply and price.
Baum-Talmer and Şahin (2024)	Qualitative; on-board observation and interviews with seafarers	Poor conditions on some vessels, cost-driven decisions and a lack of standardisation in food preparation.
Sagaro et al. (2023)	Meta-analysis; 21 studies, 145,913 participants	Pooled prevalence: hypertension 45.3 per cent, overweight 41.7 per cent, smoking 40.1 per cent, alcohol consumption 38.6 per cent, obesity 18.6 per cent, diabetes 12.7 per cent.
Nittari et al. (2019)	Cross-sectional study; 1,155 seafarers on Italian-flagged vessels	≈ 40 % were overweight and > 10 % were obese; higher than in the general population of the same ethnic group.
Szafran-Dobrowolska et al. (2019)	Literature review; > 31 studies	Overweight and obesity > 64 per cent; more common than in the general population; also hypertension, smoking, diabetes and dyslipidaemia.
Hystad and Eid (2016)	Survey; 402 (platform supply) and 340 (passenger and cargo)	Psychological capital predicts fatigue and sleep quality; greater fatigue on mixed-use vessels.
Pauksztat et al. (2022a)	Comparative cross-sectional study; 793 before and 504 during the pandemic	Higher levels of depression and anxiety during the pandemic, particularly with longer stays.

Source: Own compilation based on the studies cited.

Figure 4: A conceptual framework for the challenges of in-flight catering and its relationship to health and safety.

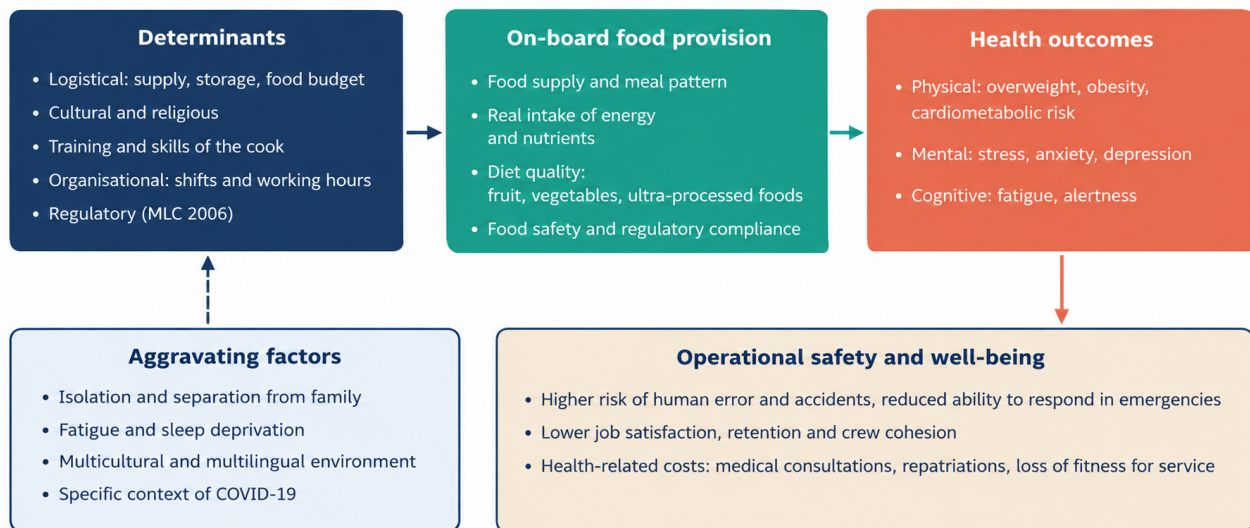


Figure. Conceptual framework: aggravating factors that influence the determinants and the response to the diet.

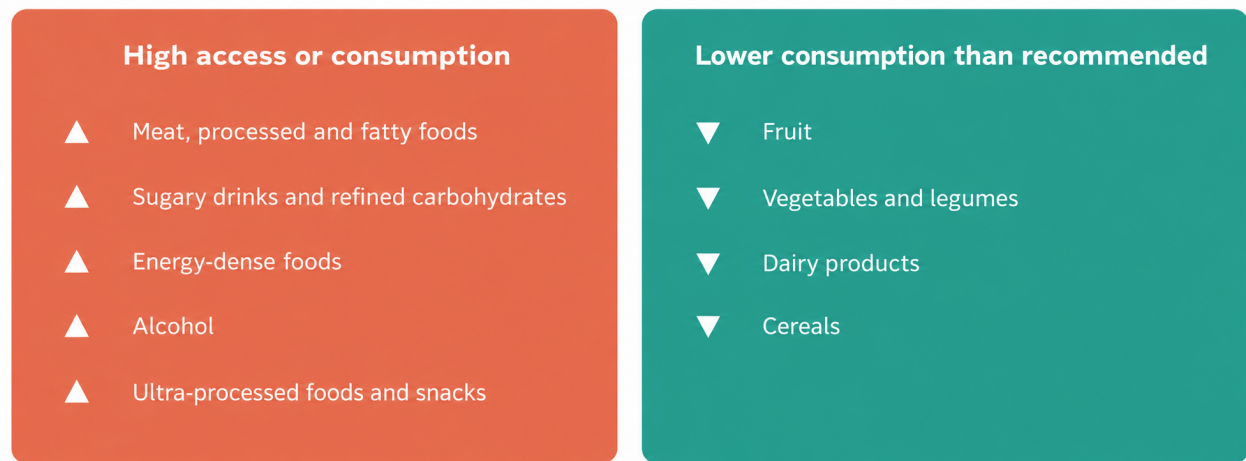
Source: Own compilation based on the literature reviewed.

ticularly the Kiribati seafarers, failed to meet the reference values for macronutrients, micronutrients and fibre (Zyriax et al., 2018). A subsequent study by the same group, involving observations on board of 64 Burmese, Filipino and European seafarers on three vessels, showed that they consumed more fruit and vegetables and less cola whilst at home than whilst on board (Neumann et al., 2021). The surveys sum-

marised by Oldenburg et al. (2013) point in the same direction: the items most missed on board were fresh produce, local cuisine, variety and quality; around 19 per cent of respondents stocked up on food in their cabins and 20 per cent took dietary supplements, two-thirds of whom were Filipino.

It is worth highlighting a methodological limitation common to

Figure 5: Dietary patterns on board, according to the systematic review by Baygi et al. (2021).



Source: own compilation with data from Baygi et al. (2021).

these studies: most are based on self-reported data and cross-sectional designs, with little objective measurement of energy intake and expenditure (Baygi et al., 2021; Oldenburg et al., 2013). Baygi et al. (2021) propose combining menu analysis with mobile self-reporting tools as a viable method in a hard-to-reach setting such as a ship.

3.2.3. Consequences for physical health (topic B).

The meta-analysis by Sagaro et al. (2023), comprising 21 studies and 145,913 participants published between 1994 and 2021, estimated the following pooled prevalences of cardiovascular risk factors amongst seafarers: hypertension, 45.3 per cent; overweight, 41.7 per cent; smoking, 40.1 per cent; alcohol consumption, 38.6 per cent; obesity, 18.6 per cent; and diabetes mellitus, 12.7 per cent (Figure 6). The authors note a high degree of heterogeneity between studies ($I^2 = 98$ per cent for smoking) and that sensitivity analyses modify some estimates; therefore, the figures should be interpreted as orders of magnitude rather than exact values.

Other reviews and national studies confirm this pattern. Szafran - Dobrowolska et al. (2019), after analysing more than 31 studies, concluded that being overweight and obesity are the most common risk factors amongst seafarers (more than 64 per cent), more so than in the general population, alongside high blood pressure, smoking, type 2 diabetes and an unfavourable lipid profile. In a sample of 1,155 seafarers on Italian-flagged vessels, approximately 40 per cent were overweight and over 10 per cent were obese, with a greater tendency towards excess weight than the general population of the same ethnicity, regardless of nationality and rank (Nittari et al., 2019). Similar findings have been reported among Danish seafarers, with obesity persisting as a major health risk (Hansen et al., 2011) and the presence of metabolic syndrome (Møller Pedersen and Riis Jepsen, 2013), in a study of 3,712 Greek seafarers focusing on hyperlipidaemia, smoking and obesity (Papadakis et al., 2020), and in a comparison between Kiribati and European seafarers (von Katzler et al., 2019). Mortality from cardiovascular disease has also been studied in the British merchant navy compared with that of seafarers working ashore (Roberts and Jaremin, 2010). Among Filipino seafarers, who constitute one of

the largest groups in the fleet, knowledge, attitudes and practices regarding cardiovascular diseases have been assessed (Gregorio et al., 2016).

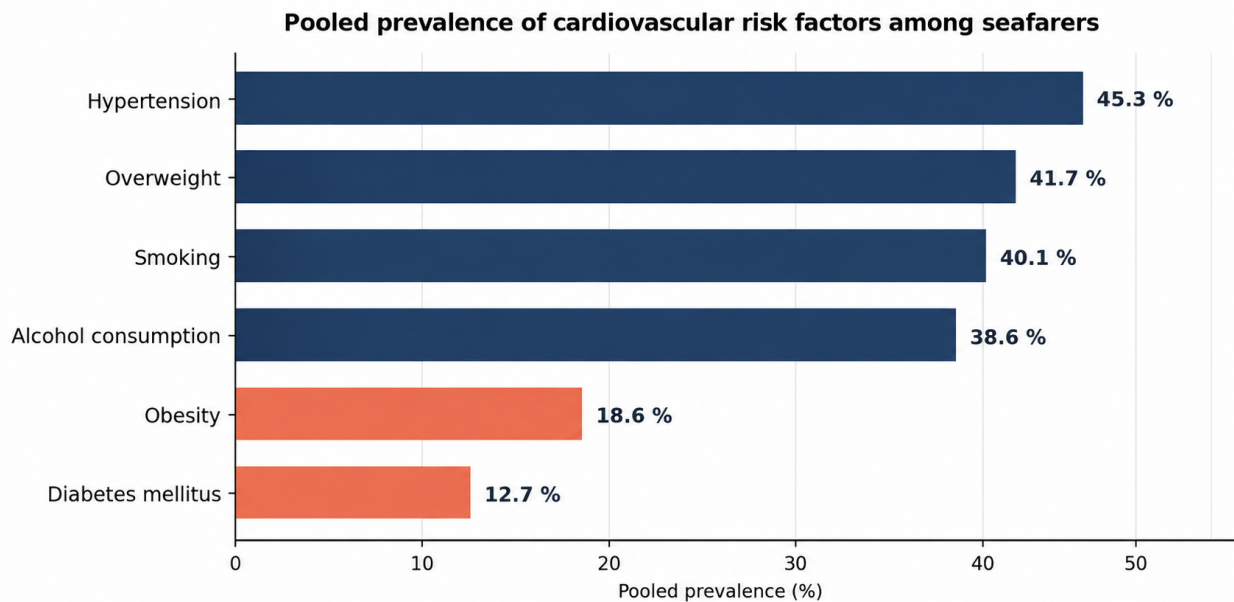
It is important to qualify the interpretation of these data. Overweight and obesity have multifactorial causes, and among seafarers these are compounded by a sedentary lifestyle (the measurement of which in the maritime environment requires specific methods; Oldenburg and Jensen, 2019), smoking, alcohol consumption (a systematic review of PubMed comprising 13 studies on seafarers and fishermen found prevalence rates ranging from 11.5 per cent to 89.5 per cent, with a median of 53.0 per cent; Stoll et al., 2020), fatigue and shift work, as well as diet. The designs of most studies prevent a causal link from being established between excess weight and on-board diet. Nevertheless, excess weight is not merely an individual health issue: Nittari et al. (2019) emphasise that it can constitute a safety issue, as it hinders manoeuvres such as using emergency exits or boarding a lifeboat.

3.2.4. Diet, mental health and cognitive performance (topics C and H).

Reviews on the mental health of seafarers highlight the significance of stress, loneliness and depression (Carotenuto et al., 2012; Iversen, 2012). A narrative review of 28 studies on Filipino seafarers concluded that published research on the mental health of seafarers is scarce and that primary evidence is limited (Abila and Acejo, 2021). The stressors most frequently cited by seafarers themselves (separation from family, time pressure and long working hours; Oldenburg et al., 2009) could also influence dietary choices, meaning that the relationship between diet and mental health would be bidirectional, although this aspect has not been specifically studied in seafarers.

There are no trials directly assessing the effect of diet on seafarers' mental health; therefore, the evidence must be extrapolated from other populations. A systematic review with a meta-analysis of observational studies found that greater adherence to the Mediterranean diet was associated with a lower risk of incident depression (combined relative risk of 0.67; 95% CI: 0.55–0.82), with more limited evidence for other dietary quality indices (Lassale et al., 2019). In

Figure 6: Pooled prevalence of cardiovascular risk factors among seafarers.



Source: Own compilation with data from Sagaro et al. (2023).

the SMILES trial, a dietary intervention programme added to standard care for adults with major depression resulted in a significantly greater improvement in symptoms than the social support control group, with remission rates of 32.3 per cent versus 8.0 per cent (Jacka et al., 2017), albeit with a small sample size. At a mechanistic level, various nutrients influence brain function, synaptic plasticity, mood and cognition (Gómez-Pinilla, 2008). Taken together, this evidence makes it plausible that a diet deficient in fruit, vegetables and fresh foods contributes to psychological distress and fatigue in the maritime environment, but does not allow this to be stated with the certainty required for policy decisions.

3.2.5. Fatigue, shift work and operational safety (topics C and H)

Fatigue is one of the main concerns in maritime safety. Jepsen et al. (2015) point out that working at sea involves multiple risk factors for fatigue, which, in addition to acute effects (cognitive impairment, accidents), contribute – via autonomic, immunological and metabolic pathways – to the development of chronic illnesses that are particularly common amongst seafarers. In a study involving 402 seafarers from the offshore supply sector and 340 seafarers on mixed passenger and cargo vessels, psychological capital predicted fatigue and sleep quality, and seafarers on mixed vessels reported higher levels of fatigue (Hystad and Eid, 2016).

Diet and shift work interact. Lowden et al. (2010) reviewed the evidence on shift workers and concluded that their increased risk of metabolic disorders may be linked to diet quality and irregular meal-times, alongside psychosocial stress, circadian disruption, sleep debt and physical inactivity. A meta-analysis of observational studies also found a positive association between shift work and being overweight or obese (Liu et al., 2018). In turn, sleep deprivation is associated with unfavourable lifestyle behaviours, including dietary habits, and with poorer cardiometabolic health (St-Onge et al., 2016). On board, shift work leads to irregular mealtimes, as well as unequal provision

between the crew mess and the officers' mess (Oldenburg et al., 2013).

With regard to operational safety, the link to diet is based on chains of inference (diet, fatigue, sleep, cognitive performance, human error), for each of which there is partial evidence; however, no studies have been identified that directly measure the association between the quality of the diet on board and accidents or navigational errors. This gap should be interpreted as a research priority, not as an absence of risk.

3.2.6. Logistical, organisational and training challenges (topic D).

Catering on board depends on a chain of decisions that begins on shore. In the intervention study carried out at two Danish shipping companies, the following barriers were identified: limited storage capacity, a lack of suitable equipment, infrequent deliveries and high prices for fresh fruit and vegetables, as well as the fact that many cooks had received little or no prior training; the authors conclude that these challenges must be addressed at management level (Hjarnoe and Leppin, 2014b). A qualitative analysis based on on-board observation and interviews with seafarers links precarious employment practices and cost-cutting to poor conditions on some vessels, cost-centred decisions and a lack of standardisation in food preparation (Baum-Talmor and Şahin, 2024).

The cook is the individual with the greatest direct influence on what is eaten. In the Danish study, a two-day cookery course was associated with positive feedback from participants and a significant change in the crew's self-reported eating behaviour one year later, although structural barriers persisted (Hjarnoe and Leppin, 2014b). The qualitative analysis by Baum-Talmor and Şahin (2024) also addresses the quality, availability and cultural appropriateness of food on board, as well as the level of training of the cooks. These studies highlight cook training and support, and supply management, as levers for improvement, but empirical evaluation of these remains limited.

3.2.7. Cultural diversity and multilingualism (theme E).

The multi-ethnic composition of crews is one of the defining features of today's merchant navy and has a significant impact on catering: in addition to differing eating habits, the food on offer may vary between the crew mess and the officers' mess (Oldenburg et al., 2013). Eating habits and attitudes towards food and body shape vary across cultures; in the SeaNut study, satisfaction with the meals served, food preferences and knowledge of healthy eating differed markedly between Kiribati and European seafarers (Zyriax et al., 2018). A study from the SeaNut project showed that cultural differences in attitudes towards food and body shape were associated with differences in body mass index within the same dietary environment, in the case of Kiribati and European seafarers (Westenhoefer et al., 2018).

Data from Neumann et al. (2021), obtained through on-board observations and an online questionnaire completed by 277 Europeans and 543 Filipinos from 68 vessels operated by German shipping companies, enable these differences to be quantified (Figure 7). 45.8 per cent of seafarers were overweight and 9.8 per cent were obese, but overweight was more common amongst Europeans (55.4 per cent) than amongst Filipinos (40.8 per cent). A higher proportion of Europeans reported weight gain over the course of their careers (50.2 per cent compared with 40.7 per cent) and, amongst those who gained weight, the weight gain occurred whilst at home more frequently amongst Europeans (43.9 per cent) than amongst Filipinos (23.1 per cent). The authors interpret this to mean that the weight and habits of Asian seafarers are particularly affected by working and living conditions on board, although they note that prospective studies are required to confirm this.

Multilingualism creates a barrier to communication. English serves as the lingua franca on ships with multilingual crews, and communication on board encompasses both work-related aspects and social interaction, which cannot be considered in isolation (Sampson and Zhao, 2003). It is reasonable to assume that this makes it difficult to express preferences, dietary requirements or complaints to the cook, although this specific aspect has not been studied. Training programmes have been proposed to address multicultural coexistence and stress on board (Jensen and Oldenburg, 2020).

3.2.8. Regulatory framework: the MLC 2006 (Section G).

The MLC 2006, which came into force in 2013, stipulates in Rule 3.2 and Standard A3. 2 that ships must provide seafarers with food and drinking water of appropriate quality, nutritional value and quantity, taking into account different cultural and religious backgrounds; that catering staff must be trained and qualified; and that documented inspections of supplies, storage and galleys must be carried out (ILO, 2006). The requirements of the mandatory part, however, are formulated as general objectives and do not set quantifiable nutritional indicators. A critical analysis by Oldenburg et al. (2013) concludes that the nutritional situation on board is neither standardised nor subject to mandatory compliance in precise terms, but rather adapts to the standards of each Member State and reflects those of the flag State. This flexibility partly explains the heterogeneity observed between vessels and shipping companies, and suggests that there is scope for improvement both in the operational implementation of the regulation and in its enforcement.

3.2.9. The COVID-19 pandemic as an aggravating factor (topic F).

The COVID-19 pandemic highlighted the vulnerability of seafarers as essential workers (Doumbia-Henry, 2020). At its peak, the crew change crisis left some 400,000 seafarers stranded on their ships, beyond the terms of their contracts (Tang et al., 2022). Comparing matched samples from before and during the pandemic (793 and 504 seafarers), the pandemic was associated with significantly higher levels of depression and anxiety, particularly among those with longer working periods, who remained on board for longer than planned, or who were sailing on ships flying flags of convenience (Pauksztat et al., 2022a). In another study involving 622 seafarers, peer support and external support reduced mental health problems and fatigue, whilst access to the internet did so indirectly (Pauksztat et al., 2022b). A mixed-methods study identified 22 measures of mental health support, all of which were perceived as beneficial but were not always available to seafarers (Tang et al., 2022). A brief French report documented 142 calls from 32 seafarers to a telephone psychological counselling service over ten months, the majority of which were linked to the pandemic (Lucas et al., 2021).

Studies on the pandemic have focused on mental health, and empirical evidence on its effect on diet is scarce. It may be assumed that prolonged stays on board exacerbate supply constraints and reinforce compensatory eating behaviours, but this hypothesis requires specific studies. Baygi et al. (2022) call for new evidence-based dietary guidelines for seafarers, particularly regarding micronutrient supplementation, and urge shipping companies and the authorities to support research in this field.

3.2.10. Proposed improvement strategies.

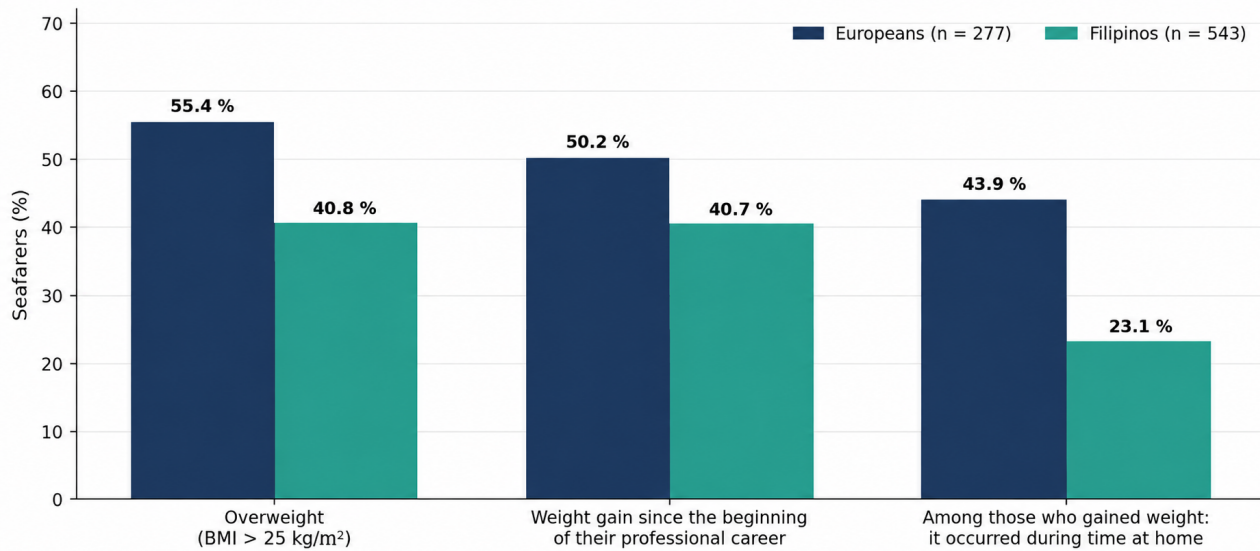
Table 5 summarises the challenges identified and the strategies proposed in the studies reviewed. The best-documented intervention focuses on the cook (training and support; Hjarnoe and Leppin, 2014b), whilst those targeting food ordering, budgets and individual behaviour have been proposed with less empirical evaluation. Baum-Talmor and Şahin (2024) emphasise the need to improve regulation, training opportunities and consideration for the welfare of seafarers.

4. Discussion.

The literature review shows that the specific scientific literature on the diet of seafarers is limited, concentrated in a specialist journal and a research group, and is predominantly observational and self-reported. Only 9 of the 36 studies on seafarers focus on food, and most of the evidence on health outcomes (cardiometabolic risk, mental health, fatigue) is indirect in relation to the diet on board. The absence of trials involving seafarers, of studies with objective measures of intake, and of studies linking diet to safety outcomes does not imply that the effect does not exist, but rather that it has not been measured. The consistency across studies of different fleets reinforces, however, the robustness of the descriptive findings.

This review converges on a single finding: diet in the merchant navy is characterised by an unbalanced dietary pattern that correlates with an unfavourable cardiometabolic profile, within a context of low individual autonomy, irregular shifts and cultural diversity. The convergence between studies from different countries is notable, but any causal interpretation must be cautious: cross-sectional designs, self-reported data and the coexistence of other factors (tobacco, alcohol, physical inactivity, fatigue) make it impossible to isolate the effect of

Figure 7: Overweight and weight gain according to the sailors' country of origin.



Source: Own compilation with data from Neumann et al. (2021).

Table 5: Challenges identified and strategies proposed in the literature.

Challenge	Evidence	Proposed strategies
Logistics and budget	Limited storage capacity, infrequent deliveries and high prices for fruit and vegetables (Hjarnoe and Leppin, 2014b); cost-driven decisions (Baum-Talmor and Şahin, 2024).	Managing orders at management level; budgets that do not penalise fresh produce; improvements to equipment and storage facilities.
Chef training	Many chefs with little or no prior training (Hjarnoe and Leppin, 2014b); training identified as an area for improvement (Baum-Talmor and Şahin, 2024).	Regular healthy cooking courses and ongoing support for chefs.
Cultural and religious diversity	Differences in satisfaction, weight and weight trends depending on origin (Zyriax et al., 2018; Westenhoefer et al., 2018; Neumann et al., 2021).	Rotating menus tailored to the composition of the crew; consideration of religious restrictions (ILO, 2006); training in managing multicultural coexistence (Jensen and Oldenburg, 2020).
Shift work and irregular meal patterns	Metabolic and performance disturbances in shift workers (Lowden et al., 2010; Liu et al., 2018).	Availability of healthy meals across all shifts; specific dietary guidelines for shift work.
Assessment and monitoring	Predominance of self-reported and cross-sectional data (Baygi et al., 2021).	Combining menu analyses with mobile tools; intervention studies using objective measures.
Regulatory implementation	General requirements, without quantifiable indicators (ILO, 2006; Oldenburg et al., 2013).	Translate the regulation into operational indicators and strengthen inspections of supplies, storage and kitchens.

Source: Own compilation based on the studies cited.

the on-board diet. Pooled estimates show high heterogeneity (Sagaro et al., 2023), suggesting real differences between fleets, shipping companies, nationalities and vessel types.

A key cross-sectional finding is that many of the determinants of the on-board diet are structural rather than individual. Seafarers consider food to be important for their well-being and job satisfaction (Oldenburg et al., 2013), but what ends up on the table depends on supply logistics, the budget and the cook's training (Baum-Talmor and Şahin, 2024; Hjarnoe and Leppin, 2014b). This shifts the focus away from individual education – which remains useful – towards the responsibility of shipping companies, catering suppliers and flag States. The historical experience of scurvy points in the same direction: the solution was not so much a discovery as its institutional implementation (Baron, 2009; Sutton, 2003).

A second aspect is cultural diversity, which presents both a challenge and an opportunity. Data from Zyriax et al. (2018), Westenhoefer et al. (2018) and Neumann et al. (2021) show that satisfaction with

food, weight and weight trends differ amongst European, Filipino and Kiribati seafarers even within the same dietary environment, and that in all three groups observed, less fruit and vegetables are consumed on board than at home. This suggests that interventions must be adapted to the crew's cultural profile and that improving the provision of fruit and vegetables is a shared objective. Rotating menus, training chefs in the cuisines of other nationalities, and taking cultural and religious needs into account—as required by the MLC 2006 itself (ILO, 2006)—are measures consistent with these findings; Baum-Talmor and Şahin (2024) also highlight the cultural appropriateness of food as an area for improvement.

With regard to strategies for menu composition, evidence from the general population supports dietary patterns such as the Mediterranean diet, which has been associated with a lower risk of cardiovascular events in a primary prevention trial (Estruch et al., 2018) and of depression (Lassale et al., 2019). As a working hypothesis, it is worth noting that several of its components (olive oil, nuts, pulses, tinned

fish) are suitable for long-term storage and could help improve food supply when fresh fruit and vegetables are in short supply; this idea should be evaluated in on-board intervention studies. Furthermore, a distinction must be made between preservation and ultra-processing: ultra-processed foods increased energy intake by approximately 500 kcal per day in a controlled trial involving 20 adults (Hall et al., 2019) and were associated with an increased cardiovascular risk in a large cohort (Srour et al., 2019), whereas frozen or tinned foods are not necessarily ultra-processed. Maritime studies, which group together ‘processed, frozen and tinned’ foods, do not currently allow for a distinction between these two concepts, which constitutes a limitation for the formulation of recommendations.

With regard to operational safety, this review has not identified any studies directly linking the quality of the on-board diet to accidents or errors. The causal chain is plausible (diet influences sleep, mood and cognition; fatigue and stress impair performance), but is based on indirect evidence. Applying the label ‘safety risk’ to poor diet therefore requires studies that integrate objective measures of intake, fatigue and performance, and incident records.

From a regulatory perspective, the MLC 2006 sets out objectives rather than indicators. Whilst not a definitive recommendation, the reviewed literature suggests some avenues: regular and verifiable training for cooks and management of food orders at management level (Hjarnoe and Leppin, 2014b), budgets that do not penalise the purchase of fresh food (Baum-Talmor and Şahin, 2024) and regular dietary assessment using methods that combine menu analysis and mobile technologies (Baygi et al., 2021).

Conclusions.

The specific literature on seafarers’ diets is limited: of 36 studies on seafarers, only 9 focus on food; the evidence is concentrated in one specialist journal (40.4 per cent of the corpus) and one research group, and no controlled trials involving seafarers were identified.

The evidence map highlights as key gaps the lack of studies with objective measures of intake, of intervention studies with a control group, and of studies linking the diet on board to fatigue, mental health and operational safety.

Diet on board merchant ships is characterised by an unbalanced dietary pattern, with high availability of meat, processed foods, sugary drinks and alcohol, and insufficient consumption of fruit, vegetables, dairy products and cereals, alongside a high prevalence of overweight, obesity and hypertension.

The main challenges are structural in nature: provisioning and storage, budgets, training and support for cooks, irregular shifts and working hours, multi-ethnic and multilingual crews, and the inconsistent implementation of the MLC 2006, whose requirements are general in nature and lack quantifiable nutritional indicators.

There is strong plausibility, based on indirect evidence, that diet influences mental health, fatigue and cognitive performance, and therefore operational safety; however, there is a lack of on-board studies directly demonstrating these relationships.

Seafarers, from diverse backgrounds, overwhelmingly wish to eat more fruit and vegetables, which offers a shared starting point for culturally adapted interventions combining ongoing training for cooks, the management of provisions orders, a healthy range of products in the ship’s store, and leadership by example.

There is a need for up-to-date, on-board research using objective indicators, which reflects the actual composition of crews and current operational demands, and which can inform nutritional policies and standards for the merchant navy.

Limitations of the study.

This study has limitations. The corpus is restricted to publications up to March 2024 and does not include subsequent evidence. The search was targeted, neither exhaustive nor documented, and records were not quantified by database; consequently, selection bias cannot be ruled out, and the temporal and journal distribution should be interpreted as descriptive of the corpus; classification by type, population and topic was carried out by the same team, with a single topic label per article and without independent double-blinding; the risk of bias was not formally assessed; a significant proportion of the evidence comes from a small number of research groups and crews of specific origins; and the prevalence figures are derived from heterogeneous studies.

Future lines of research.

Notable future lines of research include replicating the search using the search strings in Table 1 in Scopus, Web of Science and PubMed, with a PRISMA flowchart and a breakdown by database; analysing keyword co-occurrence and co-citation using bibliometric tools; and periodically updating the corpus; also of note are studies conducted on board using objective methods to measure energy intake and expenditure (Oldenburg et al., 2013); intervention trials focusing on food ordering, chef training and digital platforms; the inclusion of less-studied crews and fleets, including women; and the analysis of the relationship between diet, fatigue and safety.

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