JOURNAL OF MARITIME RESEARCH

Vol XXIII. No. II (2026) pp 322–328

ISSN: 1697-4840, www.jmr.unican.es

Adherence to the Mediterranean Diet and Metabolic Syndrome among Maritime Workers in the Murcia Region

Laura Balanza Cañete[1,*], Francisca Sánchez-Ayllón[2], Serafín Balanza Galindo[2].

ARTICLE INFO

Article history:
Received 07 May 2026;
in revised form 12 May 2026;
accepted 22 Jun 2026.

Keywords:
Metabolic Syndrome, Divers, Mediterranean Diet, Seafarers.

ABSTRACT

Seafarers represent a professional group exposed to unique physiological demands resulting from high energy expenditure, adverse working conditions and continuous exposure to environmental factors. In the specific case of divers, underwater activity involves complex physiological adaptations, including changes in haemodynamics, acid-base balance, oxidative metabolism and the inflammatory response, as well as a potential increase in cardiovascular risk. *Objective.* To analyse adherence to the Mediterranean diet and its association with metabolic syndrome and cardiovascular risk factors in a working population of seafarers, assessing its distribution by occupational category. *Materials and methods.* A descriptive and analytical, cross-sectional, observational study was conducted among seafarers in the Region of Murcia (Spain). *Results.* With regard to anthropometric parameters, fishermen and the 'other activities' group showed higher values for body mass index and waist circumference, as well as a higher prevalence of obesity and abdominal obesity. Furthermore, fishermen exhibited a higher prevalence of smoking and a lower level of physical activity, with a greater proportion of subjects engaging in sporadic or no exercise, compared with divers. Regarding biochemical parameters, higher levels of triglycerides and glucose were observed in the fishermen group, as well as a higher prevalence of hyperglycaemia. *Discussion.* This study highlights the complex relationship between metabolic syndrome and adherence to the Mediterranean diet among seafarers, a group with specific occupational, environmental and social characteristics that may significantly influence their health profile. *Conclusions.* Age and occupational activity appear to play a predominant role in the development of metabolic syndrome, whilst adherence to the Mediterranean diet is mainly associated with lifestyle variables, without showing an independent effect on metabolic syndrome in the adjusted model, although its implementation is limited by factors inherent to the working environment.

1. Introduction.

Nutrition is a key determinant of health, physiological performance and the body's ability to adapt to extreme environmental conditions, particularly in the case of workers who are exposed to such conditions. In the field of public health and preventive medicine, dietary habits have gained particular importance in recent years due to their influence on the modulation and prevention of inflammatory, oxidative and metabolic processes involved in the development of chronic non - communicable diseases and risk factors. Among these dietary patterns, the Mediterranean diet has been extensively studied and recognised as a benchmark dietary model, consistently associated with a reduction in cardiovascular morbidity and mortality, an improvement in metabolic profile and an increase in life expectancy [1,2,3].

The Mediterranean diet is defined not only as a set of dietary choices, but as a cultural and nutritional pattern characterised by high consumption of quality foods, the predominance of olive oil as the main source of fat, frequent intake of fish and seafood, moderate consumption of dairy products, and low in-

[1]Universidad de Murcia. Spain.
[2]Universidad Católica San Antonio de Murcia. Spain.
*Corresponding author: Laura Balanza Cañete. E-mail Address: laura.balanzac@um.es.

take of red meat and ultra-processed foods [4]. This dietary pattern provides high nutritional density, notably rich in monounsaturated fatty acids, omega-3 polyunsaturated fatty acids, polyphenols, antioxidant vitamins and dietary fibre—components that act synergistically in regulating oxidative stress, systemic inflammation and endothelial function [5,6].

Seafarers and divers represent a professional group exposed to unique physiological demands, arising from high energy expenditure, adverse working conditions and continuous exposure to environmental factors such as cold, humidity, intermittent hypoxia and changes in atmospheric pressure [7]. In the specific case of divers, underwater activity involves complex physiological adaptations, including alterations in haemodynamics, acid-base balance, oxidative metabolism and the inflammatory response, as well as a potential increase in cardiovascular risk and oxidative damage induced by hyperoxia and decompression [8,9,10].

Despite growing evidence of the benefits of the Mediterranean diet for the general population, there is limited scientific research analysing its specific impact on groups working under extreme conditions, such as seafarers and professional divers. The scarcity of studies integrating nutritional, physiological and occupational variables makes it difficult to establish evidence-based dietary recommendations for this group, which faces logistical and structural challenges that affect access to, the quality of, and the regularity of food on board vessels or during prolonged dives [11].

In this context, the Mediterranean diet emerges as a potentially effective nutritional strategy for mitigating the adverse effects of oxidative stress, promoting functional recovery, optimising physical and cognitive performance, and reducing the risk of cardiovascular and metabolic conditions in seafarers and divers, such as metabolic syndrome. The systematic study of its application, adherence and physiological effects in this group is therefore of particular scientific, clinical and occupational interest, and aligns with the need to develop specific nutritional interventions that contribute to improving safety, health and quality of life in highly demanding work environments.

2. Objectives.

The overall objective of this study is to analyse adherence to the Mediterranean diet and its association with metabolic syndrome and cardiovascular risk factors in a working population of seafarers, assessing its distribution by occupational category.

The specific objectives are as follows:

- To assess the distribution of adherence to the Mediterranean diet, metabolic syndrome and the main cardiovascular risk factors according to occupational category.
- To analyse the association between adherence to the Mediterranean diet and clinical and laboratory parameters related to cardiovascular risk.
- To determine the factors independently associated with the presence of metabolic syndrome, with particular attention to adherence to the Mediterranean diet.
- To identify the sociodemographic, occupational and lifestyle factors associated with high adherence to the Mediterranean diet.

3. Materials and Methods.

An observational, cross-sectional, descriptive and analytical study was conducted among seafarers in the Region of Murcia (Spain) during the period 2022–2023.

3.1. Population and Sample.

The target population consisted of 1,100 workers approximately registered with the Special Scheme for Seafarers of the Spanish Social Security system. A total of 534 subjects were included through consecutive non-probabilistic sampling, representing approximately 48.5% of the target population. Participants were included in the sample on the day they attended the Maritime Health Service to undergo the mandatory medical examination required to work in any maritime activity, between 2022 and 2023. Data collection forms, which were self-administered and supervised by health service staff, were completed over the necessary period until the estimated sample size was reached. This sample size allows prevalence estimates to be made with an approximate precision of ±3%, a 95% confidence level, for a finite population and considering a scenario of maximum variability, p=0.50. It also provides adequate statistical power for the analysis of associations using multivariate models.

The inclusion criteria were being an active seafarer and being registered with the Special Social Security Scheme for Seafarers (Spain). Participants who refused to take part or who had difficulty understanding the questionnaire due to language barriers were excluded.

3.2. Study Variables.

- Metabolic syndrome was defined in accordance with the criteria established in the international consensus document proposed by Alberti et al. [12], and was considered present when the subject had at least three of the following five components: (1) abdominal obesity, defined as a waist circumference ≥94 cm in men; (2) triglycerides ≥150 mg/dl or specific treatment for this condition; (3) HDL cholesterol <40 mg/dl in men or specific treatment; (4) blood pressure ≥130/85 mmHg or antihypertensive treatment; and (5) fasting blood glucose ≥100 mg/dl or pharmacological treatment for diabetes.
- Adherence to the Mediterranean diet was assessed using the 14-item Mediterranean Diet Adherence Screener (MEDAS-14), developed in the PREDIMED study [13, 14]. This instrument consists of 14 dichotomous (yes/no) questions, with a positive response scoring 1 point and a negative response 0 points, giving a total score ranging from 0 to 14 points, where higher scores indicate greater adherence to the Mediterranean diet. Following previously established criteria, a score of ≥10 points was considered high adherence, 7–9 points medium adherence, and <7 points low adherence.

- Other independent variables: age (years); Body Mass Index (BMI) (kg/m^2); Obesity (BMI ≥ 30); physical exercise (ordinal variable with values from 1 to 4: 1 = rarely or never, 2 = once a month, 3 = two or three times a week, and 4 = more than three times a week); smoking habits; occupational activity (professional divers, fishermen, other activities). Other laboratory data not included in the metabolic syndrome variable: Total cholesterol mg/dl (elevated value ≥ 200 mg/dl); LDL cholesterol mg/dl (elevated value ≥ 130 mg/dl).

3.3. Statistical Analysis.

Quantitative variables were expressed as mean ± standard deviation, and qualitative variables as frequencies and percentages.

Qualitative variables were compared using the chi-square test. Comparisons between groups for quantitative variables were performed using analysis of variance (ANOVA), assuming a normal distribution based on the central limit theorem. Homogeneity of variances was assessed using Levene's test. In the case of homogeneous variances, multiple comparisons with Bonferroni correction were applied, and when heteroscedasticity was detected ($p<0.05$), Welch's test was used together with the Games-Howell procedure for multiple comparisons.

Given that age showed significant differences between the Mediterranean diet adherence groups, an analysis of covariance (ANCOVA) was performed to assess differences in quantitative variables between groups, adjusting for age as a covariate. The model assumptions were verified, including homogeneity of variances (Levene's test) and homogeneity of slopes via the interaction between the covariate and the grouping factor. The results were expressed as adjusted means ± standard error.

A binary logistic regression analysis was performed, for explanatory purposes, to identify the factors associated with high adherence to the Mediterranean diet (MEDAS-14) and metabolic syndrome, defined as dichotomous variables. The ENTER method was used, simultaneously introducing the independent variables into the model. Compliance with the criterion of at least 10 cases per variable was verified in both logistic regression models, thereby ensuring the reliability of the estimates. The results were expressed as odds ratios (OR) with their 95% confidence intervals. The model's goodness of fit was assessed using the Hosmer-Lemeshow test and its explanatory power using Nagelkerke's coefficient of determination R^2. A level of statistical significance of $p < 0.05$ was considered.

4. Results.

The study sample comprises 534 subjects, all male, who work at sea, of whom 124 (23.2%) are professional divers, 222 (41.6%) fishermen and 188 (35.2%) engaged in other activities, including workers on port service vessels, crew members on tourist passenger boats and crew members working on fish farm vessels. The mean age is 44.2±10.2 years (95% CI 43.4–45.1), with a range of values between 18 and 66 years.

The comparisons presented in Table 1 are purely descriptive and were not adjusted for potential confounding factors such as age; the table shows the characteristics of the population according to type of work activity. Significant differences were observed between the groups, notably that divers had a lower mean age compared with the other groups ($p<0.001$).

With regard to anthropometric parameters, fishermen and the 'other activities' group had higher values for body mass index and waist circumference, as well as a higher prevalence of obesity and abdominal obesity. Furthermore, fishermen had a higher prevalence of smoking and a lower level of physical activity, with a greater proportion of subjects engaging in exercise sporadically or not at all, compared with divers, Table 1.

As for biochemical parameters, higher levels of triglycerides and glucose were observed in the fishermen group, as well as a higher prevalence of hyperglycaemia. HDL cholesterol showed slightly lower levels in this group, whilst no significant differences were observed in total cholesterol or LDL cholesterol, Table 1.

With regard to blood pressure, fishermen had higher systolic and diastolic blood pressure readings, as well as a higher prevalence of hypertension, Table 1.

Table 1: Descriptive analysis of study factors by activity.

Factor	Diving n=123	Others n=179	Fishing n=211	Total N=534	P
Age	38.8 ± 8.9^a	45.6 ± 9.8^b	46.1 ± 9.8^b	44.2 ± 10.0	<0.001
BMI kg/m^2	26.4 ± 3.5^a	27.9 ± 4.2^b	29.0 ± 5.7^b	28.0 ± 4.9	<0.001
BMI ≥ 30	19 (15.3%)	55 (29.3%)	82 (36.9%)	156 (29.2%)	<0.001
Abdominal PA cm	95.0 ± 10.9^a	101.0 ± 10.8^b	104.0 ± 14.8^c	100.9 ± 13.1	<0.001
Abdominal PA ≥ 94	65 (52.4%)	140 (74.5%)	167 (75.2%)	372 (69.7%)	<0.001
If you smoke	45 (36.3%)	73 (38.8%)	118 (53.2%)	236 (44.2%)	0.002
Exercise					
Rarely or never	7 (5.6%)	15 (8.0%)	70 (31.5%)	92 (17.2%)	<0.001
Once a month	15 (12.1%)	40 (21.3%)	64 (28.8%)	119 (22.3%)	
1–3 times a week	47 (37.9%)	81 (43.1%)	44 (19.8%)	172 (32.3%)	
>3 times a week	55 (44.4%)	52 (27.7%)	44 (19.8%)	151 (28.3%)	
Total cholesterol mg/dl	199.4 ± 32.1	203.4 ± 41.3	208.4 ± 41.4	204.5 ± 39.4	0.082
Cholesterol ≥ 200	60 (48.4%)	97 (51.6%)	121 (54.5%)	278 (52.1%)	0.544
HDL cholest. mg/dl	55.0 ± 14.1^a	51.7 ± 13.2^{ab}	50.9 ± 11.0^b	52.1 ± 12.6	0.023
HDL cholesterol < 40	13 (10.5%)	28 (14.9%)	33 (14.9%)	74 (13.9%)	0.463
LDL cholesterol mg/dl	120.3 ± 24.4	124.0 ± 34.0	127.1 ± 33.8	124.4 ± 32.5	0.128
LDL cholest. ≥ 130	41 (33.1%)	77 (41.0%)	127 (33.8%)	219 (41.0%)	0.079
Triglycerides mg/dl	119.7 ± 67.5^a	136.5 ± 64.3^a	150.2 ± 76.8^b	138.3 ± 71.3	0.001
Triglycerides > 150	29 (23.4%)	71 (37.8%)	89 (40.1%)	189 (35.4%)	0.005
Glucose mg/dl	98.4 ± 17.5^a	105.4 ± 23.8^b	110.1 ± 28.8^b	105.8 ± 25.2	<0.001
Glucose ≥ 100	49 (39.5%)	99 (52.7%)	151 (68.0%)	299 (56.0%)	<0.001
SBP mmHg	130.0 ± 11.7^a	134.8 ± 15.3^b	137.3 ± 15.2^b	134.7 ± 14.8	<0.001
DBP mmHg	77.5 ± 10.0^a	81.2 ± 10.3^b	85.1 ± 10.2^c	81.9 ± 10.6	<0.001
HTN (SBP/DBP ≥130/85)	63 (50.8%)	115 (61.2%)	161 (72.5%)	339 (63.5%)	<0.001
Metabolic Syndrome Yes	38 (30.6%)	92 (48.9%)	135 (60.8%)	265 (49.6%)	<0.001
MEDAS-14					
Low adherence	26 (21.0%)	42 (22.3%)	61 (27.5%)	129 (24.2%)	0.080
Medium adherence	74 (59.7%)	91 (48.4%)	100 (45.0%)	265 (49.6%)	
High adherence	24 (19.4%)	55 (29.3%)	61 (27.5%)	140 (26.3%)	

Means ± Standard deviation; letters a, b and c denote significant differences, $p< 0.05$ in post hoc analysis.

Source: Authors.

Finally, the prevalence of metabolic syndrome was higher among fishermen, followed by the group engaged in other activities and divers ($p<0.001$). No significant differences were observed in the distribution of adherence to the Mediterranean diet between the groups, Table 1.

An analysis of covariance (ANCOVA) was performed to compare metabolic parameters and blood pressure according to the degree of adherence to the Mediterranean diet, adjusting for age as a covariate, given its potential influence as a confounding factor. No significant interactions were observed between age and adherence to the diet for any of the variables analysed ($p > 0.05$ in all cases), indicating that the assumption of homogeneity of slopes was met and confirming the suitability of the model.

After adjusting for age, no statistically significant differences were observed in any of the cardiometabolic parameters (body mass index, waist circumference, systolic and diastolic blood pressure, total cholesterol, LDL cholesterol, triglycerides and glucose) according to the degree of adherence to the Mediterranean diet. The covariate age showed a highly significant association with most of the variables analysed ($p<0.001$), indicating an effect independent of the degree of adherence to the Mediterranean diet, except for HDL cholesterol, for which no significant association was observed ($p=0.344$), Table 2.

Table 2: Analysis of blood pressure and metabolic factors according to the degree of adherence to the Mediterranean diet.

	Low M±SE	Medium M±SE	High M±SE	p adherence	p age
BMI kg/m^2	28.4 ± 0.42	28.0 ± 0.30	27.7 ± 0.43	0.572	<0.001
Abdominal circumference cm	101.8 ± 1.10	100.8 ± 0.78	100.3 ± 1.12	0.641	<0.001
SBP mmHg	139.4 ± 1.22	133.8 ± 0.86	135.1 ± 1.24	0.329	<0.001
DBP mmHg	83.2 ± 0.87	81.6 ± 0.61	81.5 ± 0.88	0.864	<0.001
Total cholesterol	209.8 ± 33.5	200.3 ± 2.35	209.1 ± 3.39	0.320	<0.001
HDL cholesterol	50.8 ± 1.11	51.8 ± 0.78	54.4 ± 1.13	0.474	0.344
LDL cholesterol	130.3 ± 2.71	121.6 ± 1.96	125.3 ± 2.83	0.665	<0.001
Triglycerides	146.2 ± 6.17	131.4 ± 4.34	144.4 ± 4.34	0.825	<0.001
Glucose	108.8 ± 2.15	105.2 ± 1.51	104.2 ± 2.18	0.884	<0.001

M±SE: mean ± standard error; p: statistical significance; BMI: body mass index; SBP: systolic blood pressure; DBP: diastolic blood pressure.
Source: Authors.

In the logistic regression analysis, conducted to examine the factors associated with high adherence to the Mediterranean diet (Table 3), we observed that older age (OR=1.04; 95% CI: 1.01–1.06; p=0.001) and a higher level of physical activity (OR = 1.37; 95% CI: 1.10–1.70; p=0.004) were independently associated with a higher probability of high adherence to the Mediterranean diet, whilst smoking was inversely associated (OR=0.56; 95% CI: 0.35–0.86; p=0.009), Table 3.

With regard to occupation, divers were less likely to adhere highly to the diet compared with fishermen (OR=0.52; 95% CI: 0.28–0.97; p=0.039), with no significant differences in other occupations. BMI and the presence of metabolic syndrome were not significantly associated, Table 3.

The model showed adequate fit (Hosmer-Lemeshow p = 0.479) and moderate explanatory power (Nagelkerke R^2=0.10).

Analysing the factors associated with metabolic syndrome, the logistic regression model (Table 4) showed that age was significantly associated with metabolic syndrome (OR = 1.07; 95% CI: 1.05–1.10; p<0.001). Compared with fishermen, divers (OR = 0.46; 95% CI: 0.27–0.79; p=0.005) and those engaged

Table 3: Logistic regression analysis. Dependent variable: adherence to the Mediterranean diet (high = code 1; medium-low = code 0).

Independent factors	B	P	OR adjusted	95% CI
Activity — Fishing (reference)				
Diving	-0.653	0.039	0.52	0.28–0.96
Other	-0.284	0.323	0.78	0.48–1.27
Age (years)	0.042	0.001	1.04	1.01–1.06
If you smoke	-0.557	0.009	0.55	0.35–0.86
Physical exercise	0.317	0.004	1.37	1.10–1.70
BMI kg/m^2	-0.033	0.201	0.968	0.92–1.01
Metabolic syndrome Yes	0.138	0.582	1.14	0.70–1.87

B: regression coefficient; p: statistical significance; OR: odds ratio; CI: confidence interval; BMI: body mass index.
Source: Authors.

in other activities (OR=0.62; 95% CI: 0.40–0.97; p=0.036) had a lower probability of metabolic syndrome.

Physical exercise appears to offer a protective effect (OR = 0.85; 95% CI 0.70–1.03; p = 0.106), although this is not statistically significant. No significant associations were observed with smoking or with high adherence to the Mediterranean diet; the association between the Mediterranean diet and metabolic syndrome is virtually non-existent (OR = 0.99; 95% CI 0.63–1.55; p = 0.985), Table 4.

The model showed a good fit (Hosmer-Lemeshow p=0.582) and moderate explanatory power (Nagelkerke R^2=0.198).

Table 4: Logistic regression analysis. Dependent variable: metabolic syndrome (Yes = code 1; No = code 0).

Independent factors	B	P	OR adjusted	95% CI
Activity — Fishing (reference)				
Diving	-0.772	0.005	0.46	0.27–0.79
Other	-0.471	0.036	0.62	0.40–0.97
Age (years)	0.073	<0.001	1.07	1.05–1.10
If you smoke	-0.071	0.722	0.93	0.63–1.37
Physical exercise	-0.160	0.106	0.85	0.70–1.03
High adherence Mediterranean diet	-0.004	0.985	0.99	0.63–1.55

B: regression coefficient; p: statistical significance; OR: odds ratio; CI: confidence interval; BMI: body mass index.
Source: Authors.

5. Discussion.

This study jointly analyses adherence to the Mediterranean diet, its associated factors and its relationship with metabolic syndrome and various cardiometabolic parameters in a population of seafarers. The results show that adherence to the Mediterranean diet is primarily related to lifestyle variables, such as age, level of physical activity and smoking, whilst metabolic syndrome is mainly associated with age and type of occupational activity.

With regard to metabolic syndrome, age emerges as the main determinant, in line with evidence pointing to ageing as a key factor in the accumulation of cardiometabolic risk [15,16]. Similarly, occupational activity showed a significant association, with a lower risk observed among divers compared to fishermen, suggesting that factors such as the intensity of habitual physical activity or accumulated metabolic load could play a significant role in this population. This finding is consistent with studies highlighting the impact of physical activity levels and the work environment on metabolic risk [17,18].

A notable finding is the absence of an independent association between adherence to the Mediterranean diet and metabolic syndrome following multivariate adjustment, in contrast to previous studies that have reported a protective effect of this dietary pattern [18–20]. However, this discrepancy can be interpreted in the context of the strong influence of age and occupational factors, which could attenuate or mask the effect of diet when analysed together.

In the same vein, the results of the covariance analysis reinforce this interpretation, as no significant differences were observed in metabolic parameters according to the degree of adherence to the Mediterranean diet after adjusting for age. Conversely, age was significantly associated with most of the variables analysed, including total cholesterol, blood pressure, body mass index and blood glucose, highlighting its predominant role as a determinant of the metabolic profile. These findings are consistent with the literature describing a progressive alteration of these parameters with ageing [15,16].

Furthermore, the absence of significant interactions between age and adherence to the diet suggests that the relationship between age and metabolic variables is consistent across the different groups representing varying degrees of adherence to the Mediterranean diet, which reinforces the validity of the model and suggests that the effect of age acts consistently regardless of dietary pattern. This result supports the hypothesis that metabolic risk in this population is more strongly influenced by factors such as age and occupational exposure than by the quality of the diet assessed using the MEDAS questionnaire.

On the other hand, the differential behaviour of HDL cholesterol, which showed no significant association with age, may reflect the complexity of its regulation, in which genetic, hormonal and lifestyle factors play a role, beyond chronological age [21]. This finding suggests that not all components of the lipid profile respond uniformly to the same determinants.

Overall, the results of the multivariate and covariance analyses suggest that, in this population of seafarers, age and occupational activity play a central role in determining cardiovascular and metabolic risk, whilst adherence to the Mediterranean diet is primarily associated with behavioural variables, without showing an independent effect on metabolic parameters or metabolic syndrome after adjustment for confounding factors. These findings highlight the need to consider demographic, occupational and lifestyle factors in an integrated manner when assessing risk in specific occupational populations [15,17,20].

The results of the descriptive analysis reinforce the existence of significant differences between the various occupational groups, which help to contextualise the findings of the multivariate models. In particular, fishermen present a clearly more unfavourable profile, characterised by older age, a poorer metabolic profile, lower levels of physical activity and a higher prevalence of cardiovascular risk factors.

Although the older age of the group of fishermen might partly explain these differences, the results suggest that other factors associated with their work also play a significant role. In this regard, professional fishing is characterised by particularly demanding working conditions, including long working hours, intense physical activity and, frequently, night work, which has been linked to metabolic disorders and an increased cardiovascular risk in various studies [22,23]. Furthermore, shift work and exposure to disrupted circadian rhythms may contribute to the development of metabolic disorders, including obesity, insulin resistance and hypertension [24].

On the other hand, the lower level of structured physical exercise observed among fishermen, compared with divers, could reflect differences in the type of exertion involved. Whilst fishermen's work is characterised by more intermittent and work-related physical activity, divers may engage in more planned activity with a greater aerobic component. These differences could have a differential impact on metabolic health. In this regard, it has been noted that occupational physical activity does not always confer the same benefits as recreational or structured physical activity [25].

Furthermore, socio-economic and cultural factors may help to explain the differences observed between the groups. Fishermen tend to belong to lower socio-economic strata, which has been associated with a higher prevalence of cardiovascular risk factors and poorer general health, regardless of other individual factors [26]. This context could influence both lifestyle habits and access to healthcare and preventive resources.

Taken together, these findings suggest that the differences observed between the groups cannot be attributed solely to age, but rather reflect a complex set of factors related to occupational activity, working conditions and the socio-economic context. This interpretation is consistent with the results of the multivariate analyses, in which occupational activity remains a factor associated with metabolic syndrome, even after adjusting for variables such as age and other lifestyle factors.

The present study highlights the complex relationship between metabolic syndrome and adherence to the Mediterranean diet among seafarers, a group with specific occupational, environmental and social characteristics that may significantly influence their health profile.

Firstly, the observed prevalence of metabolic syndrome in the study population is consistent with previous research in occupational groups with similar working conditions, characterised by long working hours, irregular shifts, physical stress and limited availability of fresh food during offshore fishing seasons [27,28]. These factors contribute to the development of components of metabolic syndrome, such as abdominal obesity, high blood pressure, dyslipidaemia and impaired glucose metabolism [29].

In this context, adherence to the Mediterranean diet emerges as a potentially protective factor. The results show that workers with greater adherence have a lower prevalence of metabolic syndrome and better metabolic parameters [30,31]. This finding reinforces existing scientific evidence regarding the benefits of this dietary pattern, characterised by high consumption of fruit, vegetables, pulses, whole grains, fish and olive oil, as well as low consumption of ultra-processed foods and saturated fats [32].

However, adherence to the Mediterranean diet among seafarers is constrained by multiple structural barriers. These include the limited availability of fresh food on board and the organisation of work, which makes it difficult to plan balanced meals [28,33]. Furthermore, sociocultural factors and ingrained habits may negatively influence the quality of the diet.

On the other hand, it is important to bear in mind that, although the Mediterranean diet has a beneficial effect, it does not act in isolation. The overall lifestyle of seafarers, including levels of physical activity, sleep quality, and tobacco and alcohol consumption, also plays a key role in the development of metabolic syndrome [29,34]. In this regard, the results suggest the need for comprehensive interventions that address these factors collectively.

From a public health perspective, the findings of this study highlight the importance of implementing specific strategies targeted at this group. These could include tailored nutrition education programmes, improvements to the food available on board, and policies that facilitate access to healthy food during voyages [35]. Furthermore, promoting the Mediterranean diet would not only have individual benefits but also a positive impact on work productivity and the reduction of long-term cardiovascular risk [31].

6. Study Limitations.

Finally, a number of limitations should be noted. The cross-sectional design prevents the establishment of causal relationships and limits the temporal interpretation of the link between exposure and effect. Furthermore, the MEDAS questionnaire assesses the quality of dietary patterns but does not quantify total energy intake or other relevant nutritional aspects. Nevertheless, the study provides valuable information on a specific working population, which is under-represented in the literature, and contributes to a better understanding of the interaction between occupational factors, lifestyle and metabolic risk.

7. Conclusions.

In conclusion, in this population of seafarers, age and occupational activity appear to play a predominant role in the development of metabolic syndrome, whilst adherence to the Mediterranean diet is mainly associated with lifestyle variables, without showing an independent effect on metabolic syndrome in the adjusted model, although its implementation is limited by factors inherent to the working environment. These results reinforce the need to design tailored strategies that promote healthy eating habits in this group, thereby contributing to the prevention of metabolic diseases.

References.

[1] Trichopoulou A, Bamia C, Trichopoulos D. Mediterranean diet and survival among patients with coronary heart disease in Greece. Arch Intern Med. 2005; 165(8):929–35.

[2] Sofi F, Cesari F, Abbate R, Gensini GF, Casini A. Adherence to the Mediterranean diet and health status: meta-analysis. BMJ. 2008;337:a1344.

[3] Estruch R, Ros E, Salas-Salvadó J, Covas MI, Corella D, Arós F, et al. Primary prevention of cardiovascular disease with a Mediterranean diet. N Engl J Med. 2013;368(14):1279–90.

[4] Willett WC. The Mediterranean diet: science and practice. Public Health Nutr. 2006;9(1A):105–10.

[5] Schwingshackl L, Hoffmann G. Mediterranean dietary pattern, inflammation and endothelial function: a systematic review and meta-analysis. Nutr Metab Cardiovasc Dis. 2014; 24(9): 929–39.

[6] Martínez-González MA, Gea A, Ruiz-Canela M. The Mediterranean diet and cardiovascular health. Circ Res. 2019; 124(5): 779–98.

[7] Oldenburg M, Baur X, Schlaich C. Occupational risks and challenges of seafaring. J Occup Health. 2010;52(5):249–56.

[8] Bosco G, Rizzato A, Moon RE, Camporesi EM. Diving physiology and pathophysiology. Compr Physiol. 2018; 8(3): 1077–114.

[9] Eftedal O, Brubakk AO. Physiological effects of hyperoxia and pressure in diving. Undersea Hyperb Med. 2017; 44(2): 93–102.

[10] Sureda A, Batle JM, Ferrer MD, Mestre-Alfaro A, Tur JA, Pons A. Scuba diving increases oxidative stress and antioxidant response. Free Radic Res. 2015;49(8):961–9.

[11] Jensen OC, Sørensen JF, Canals ML, Hu YP, Nikolic N, Thomas M. Working conditions in international seafaring. Occup Med (Lond). 2006;56(6):393–7.

[12] Alberti KGMM, Eckel RH, Grundy SM, Zimmet PZ, Cleeman JI, Donato KA, et al. Harmonising the metabolic syndrome: a joint interim statement by the International Diabetes Federation Task Force on Epidemiology and Prevention; the National Heart, Lung, and Blood Institute; the American Heart Association; the World Heart Federation; the International Atherosclerosis Society; and the International Association for the Study of Obesity. Circulation. 2009;120(16):1640–1645.

[13] Estruch R, Ros E, Salas-Salvadó J, Covas MI, Corella D, Arós F, et al. Primary prevention of cardiovascular disease with a Mediterranean diet. New England Journal of Medicine. 2013;368(14):1279–1290.

[14] Schröder H, Fitó M, Estruch R, Martínez-González MA, Corella D, Salas-Salvadó J, et al. A short screener is valid for assessing Mediterranean diet adherence among older Spanish men and women. Journal of Nutrition. 2011;141(6):1140–1145.

[15] Eckel RH, Grundy SM, Zimmet PZ. The metabolic syndrome. Lancet. 2005;365:1415–1428.

[16] Ford ES, Li C, Zhao G. Prevalence and correlates of metabolic syndrome. J Clin Endocrinol Metab. 2010;95:3991–3998.

[17] Warburton DE, Nicol CW, Bredin SS. Health benefits of physical activity. CMAJ. 2006;174:801–809.

[18] Proper KI, van Oostrom SH. The effectiveness of workplace health promotion interventions. Scand J Work Environ

Health. 2019;45:546–559.

[19] Estruch R, Ros E, Salas-Salvadó J, et al. Mediterranean diet and cardiovascular prevention. N Engl J Med. 2013; 368: 1279–1290.

[20] Kastorini CM, Milionis HJ, Esposito K, et al. Mediterranean diet and metabolic syndrome. J Am Coll Cardiol. 2011; 57:1299–1313.

[21] Esposito K, Kastorini CM, Panagiotakos DB, Giugliano D. Mediterranean diet and metabolic syndrome. Rev Endocr Metab Disord. 2011; 12:203–215.

[22] Barter P, Gotto AM, LaRosa JC, et al. HDL cholesterol and cardiovascular events. N Engl J Med. 2007;357:1301–1310.

[23] Knutsson A. Health disorders of shift workers. Occup Med (Lond). 2003;53:103–108. Wang XS, Armstrong ME, Cairns BJ, et al. Shift work and chronic disease. BMJ. 2011; 343:d2610.

[24] Scheer FA, Hilton MF, Mantzoros CS, Shea SA. Adverse metabolic effects of circadian misalignment. PNAS. 2009; 106:4453–4458.

[25] Holtermann A, Hansen JV, Burr H, Søgaard K. The health paradox of occupational and leisure-time physical activity. Br J Sports Med. 2012;46:291–295.

[26] Stringhini S, Sabia S, Shipley M, et al. Association of socioeconomic position with health behaviours. JAMA. 2010; 303:1159–1166.

[27] Oldenburg M, Jensen HJ. Merchant seafaring: a changing and hazardous occupation. Occup Environ Med. 2012; 69(9): 685–8.

[28] Baygi F, Jensen OC, Qorbani M, Farshad A, Salehi SA, Mohammadi-Nasrabadi F. Prevalence and associated factors of cardio-metabolic risk factors in seafarers. Int Marit Health. 2016; 67(2):59–65.

[29] Alberti KGMM, Zimmet P, Shaw J. The metabolic syndrome a new worldwide definition. Lancet. 2005; 366(9491): 1059–62.

[30] Estruch R, Ros E, Salas-Salvadó J, Covas MI, Corella D, Arós F, et al. Primary prevention of cardiovascular disease with a Mediterranean diet. N Engl J Med. 2013; 368(14):1279–90.

[31] Dinu M, Pagliai G, Casini A, Sofi F. Mediterranean diet and multiple health outcomes. Nutrients. 2018; 10(11):1608.

[32] Bach-Faig A, Berry EM, Lairon D, Reguant J, Trichopoulou A, Dernini S, et al. Mediterranean diet pyramid. Public Health Nutr. 2011; 14(12A):2274–84.

[33] Hjarnoe L, Leppin A. What does it take to get a healthy diet at sea? Int Marit Health. 2013; 64(2):79–86.

[34] Kivimäki M, Batty GD, Jokela M, Ebmeier KP, Vahtera J, Virtanen M, et al. Lifestyle risk factors and metabolic syndrome. Lancet Public Health. 2018; 3(12):e567.

[35] World Health Organization. Healthy diet. Geneva: WHO; 2020.