Bone Mineral Density in Portuguese Submariners: a case series

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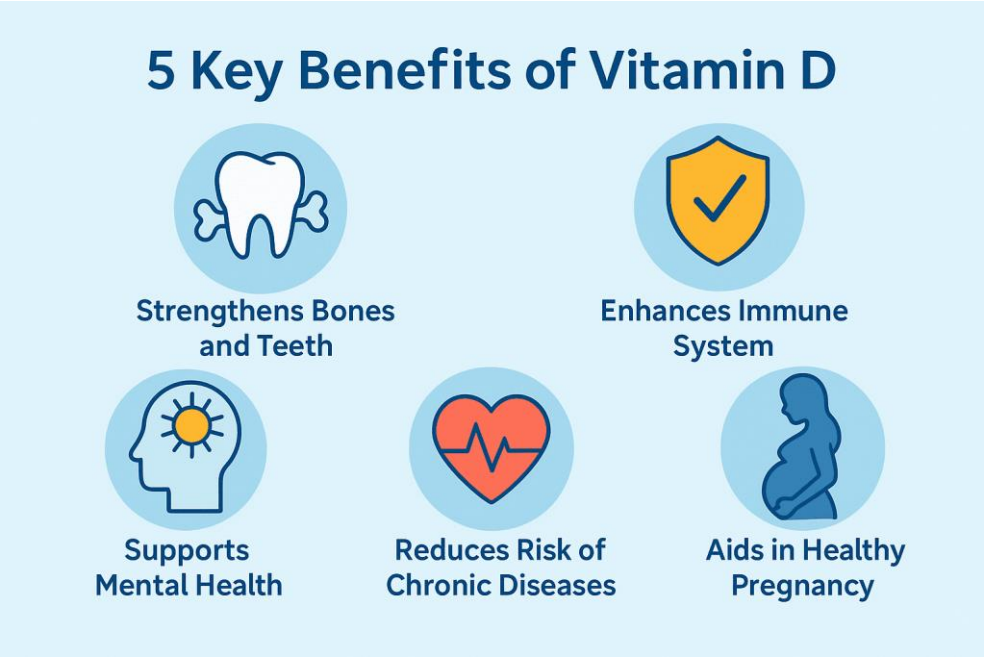
Vitamin D is essential for bone health by promoting the absorption of calcium from the diet and facilitating bone mineralization.[1]

Vitamin D deficiency can lead to rickets in children and osteomalacia/osteoporosis in children and adults, and increase the risk of falls and fractures in the elderly.[2,3]



What is the main source of vitamin D?

a) Food.

b) Dietary supplements.

c) Sun exposure.

d) Medicines.

As endogenous cutaneous synthesis through exposure to ultraviolet B (UVB) solar radiation is the primary source of vitamin D, deprivation of sunlight exposure may negatively influence bone mineral density.[4]

Previous studies reported high prevalence of vitamin D deficiency in the Portuguese Navy active-duty military personnel (42.2% in a sample of 735 subjects during winter):[5–7]

- Some Navy occupational settings are associated with a higher prevalence of vitamin D deficiency: onboard (vs. ashore), indoors (vs. outdoors) and mixed shift (vs. day shift).[7]
- Onboard workers, from those working indoors and on mixed shifts, showed a significantly higher prevalence of vitamin D deficiency ($p = 0.000$).[7]

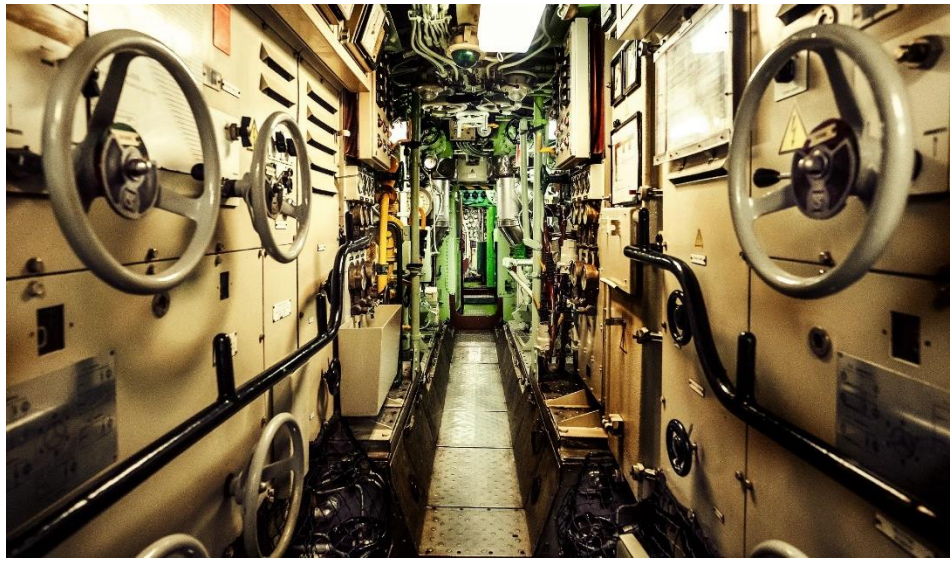
The majority of studies report a significant reduction in vitamin D levels of 15–47% during 1–2 months submarine patrols due to limited sunlight exposure.[5]

In an unpublished study with 56 Portuguese active-duty submariners, the prevalence of vitamin D deficiency was 46.4%, but vitamin D levels decrease was not universally observed after a 78-day submarine patrol.

NRP Tridente.

Submariners work and live several periods during their working lifes exposed to occupational factors that may adversely affect bone health:[8–10]

- Lack of sunlight exposure;
- Relatively high carbon dioxide content in breathed air;
- Confined environment that limits physical activity;
- Restricted diet with reduced access to perishable food.



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A previous study reported a significant decrease in tibial speed of sound in 32 young (22.8 ± 3.8 years), healthy male submariners, following 30 days of submersion in a non-nuclear submarine, using diesel-electric propulsion (from 4,081 ± 17 to 4,044 ± 16, $p<0.02$) and until four weeks after return to shore (4,011 ± 1, $p<0.0005$ from baseline) with a return to baseline levels at the six-month follow-up (4,100 ± 19).[8]

quantitative ultrasound measurements of speed of sound produce an index of "bone strength", reflecting both quantitative (mineralization) and qualitative (elasticity, microarchitecture, and fatigue damage) properties of bone.

Another study, involving 462 submariners aged 20–91 years, found no difference in Bone Mineral Density (BMD; lumbar spine and femoral neck, measured by dual-energy X-ray absorptiometry (DXA)) compared to the civilian population, and found no relationship between submersion time and BMD.[11]

However:[11]

- Submersion time, in years, was self-reported; and
- An association between working in diesel submarines and lower BMD was identified.

Nonmodifiable risk factors for osteoporosis include the following, except:

a) Personal history of fracture as an adult;

b) History of fracture in a first-degree relative;

c) Advanced age;

d) Male sex.

Main objective

Evaluate the BMD of Portuguese Navy submariners.

Secondary objectives

Evaluate some health indicators of Portuguese Navy submariners.

Evaluate the relation between submersion time and BMD of Portuguese Navy submariners.

Potentially modifiable risk factors for osteoporosis include the following, except:

a) No cigarette smoking;

b) Estrogen deficiency (e.g. menopause);

c) Low lifelong calcium intake;

d) Alcoholism.

Portuguese Navy submariners aged 50 or more years were invited to:

- Complete a questionnaire,
- Provide a blood sample, and
- Undergo a DXA scan.

Email invitations reached all active-duty Portuguese Navy submariners over 49 years of age and all members of the Portuguese Submariners Association.

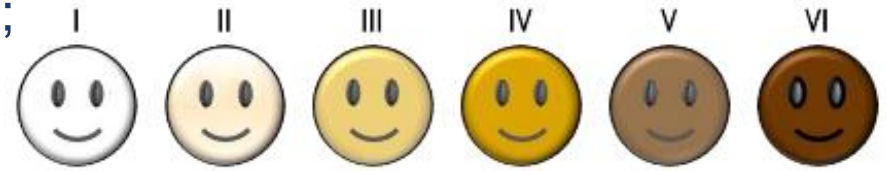
Voluntary participant recruitment took place between July 2023 and December 2024.

There were no incentives for recruitment or retention.

Questionnaire

1. Personal data:

- age;
- military category (officer vs sergeant vs seaman);
- skin type (Fitzpatrick scale)).



2. Occupational setting (ashore vs onboard vs no longer at service; indoors vs outdoors vs not applicable; day shift vs night shift vs mixed shift vs not applicable).

3. Sun exposure (≥30 min, 09:00–15:00, wearing only a t-shirt and shorts, without sunscreen).

Questionnaire

4. Vitamin D-rich food (eg, cod liver oil, fatty fish, oysters, liver, eggs, butter and/or milk fortified with vitamin D) or vitamin D supplements/medication intake (number of days in the last 30 days; 4-point Likert scale—0 days, 1–10 days, 11–20 days and 21–30 days).

5. Habits:

- Tobacco (number of cigarettes per day; 3-point Likert scale—0, 1–5 and >5);
- Coffee (number of coffees per day; 3-point Likert scale—0, 1–2 and >2);
- Alcohol (alcohol consumption; 3-point Likert scale—none, 1 glass of wine at lunch and dinner, and more than the last option).

Questionnaire

6. Anthropometric data (weight in kilograms and height in metres).

7. Diseases (e.g. alcoholism, diabetes mellitus, liver cirrhosis, hyperparathyroidism, inflammatory bowel disease, lymphoma, rheumatoid arthritis, vitamin D deficiency; open answer).

8. Medications (open answer).

9. Fragility bone fracture (e.g., previous bone fracture without associated trauma or resulting from low-intensity trauma; yes or no).

Blood parameters

Vitamin D profile (serum 25(OH)D, calcium, phosphorus and parathyroid hormone (PTH)).

Glycaemic profile (serum glucose and glycated hemoglobin (HbA1c)).

Lipidic profile (serum total cholesterol, low-density lipoprotein cholesterol (LDL-cholesterol), high-density lipoprotein cholesterol (HDL-cholesterol) and triglycerides).

Blood samples

Clinical Pathology Service (Lisbon) of the Portuguese Armed Forces Hospital.

- 25(OH)D and PTH (chemiluminescence; Alinity® (Abbott);
- Calcium (Cresolphtalein complexone; Cobas c303® (Roche));
- Phosphorus (Phosphomolybdate UV; Cobas c303® (Roche));
- Glucose (reference enzymatic reaction with Hexokinase; Cobas c303® (Roche));
- Total cholesterol and triglycerides (colorimetric enzymatic reaction; Cobas c303® (Roche));
- LDL-cholesterol and HDL-cholesterol (colorimetric enzymatic homogeneous reaction; Cobas c303® (Roche));
- HbA1c (high-voltage capillary electrophoresis technique; Capillarys 3® (Sebia)).

Reference values

25(OH)D: vitamin D deficiency (<20 ng/mL), insufficiency (20–29.9 ng/mL), and sufficiency (30–100 ng/mL).[12]

Calcium: reference value 8.1–10.4 mg/dL.

Phosphorus: reference value 2.7–4.5 mg/dL.

PTH: reference value 15–68.3 pg/mL.

Glucose: <100 mg/dL (normal), 100–125mg/dL (pre-diabetics), and >125 mg/dL (diabetics).

HbA1c: normal if <5.7%.

Reference values

Total cholesterol: atherogenic risk (low <200 mg/dL, moderate 200–240 mg/dL, elevated >240 mg/dL).

LDL-cholesterol: atherogenic risk (very-low <100 mg/dL, low 100–129 mg/dL, moderate 130–160 mg/dL, elevated >160 mg/dL).

HDL-cholesterol: atherogenic risk (low >55 mg/dL, moderate 35–55 mg/dL, elevated <35 mg/dL).

Triglycerides: reference value 40–160 mg/dL.

Bone mineral density

BMD was evaluated by DXA in the lumbar spine and femoral neck, except in case of previous frailty fracture and orthopedic surgery.

Imageology Service (Lisbon) of the Portuguese Armed Forces Hospital (X-ray Bone Densitometer General Electric Lunar Prodigy 8743):

- Due to equipment failure, it was also necessary to use other external equipments.

Osteopenia was defined as a T-score between −2.4 and −1.1, while osteoporosis was defined as a T-score ≤ −2.5.

- BMD below the expected for the age and sex was defined as Z-score < −2.0.

Navigation and Submersion time

Navigation and submersion hours were provided by the Portuguese Submarine Squadron Secretariat or by the Records Section of the Personnel Directorate's Situation and Staff Division.

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Statistical analysis – IBM® SPSS® Statistics version 29

Body Mass Index (BMI) was calculated, classifying individuals with BMI ≥ 30 as obese.

Categorical variables (absolute and relative frequencies) and continuous variables (median, interquartile range (IQR), minimum, and maximum).

Spearman correlation test: to assess associations between non-linear variables.

The median test: to compare the medians of independent samples.

A significance level of 5% was considered.

Risk factors for osteoporosis in men include the following, except :

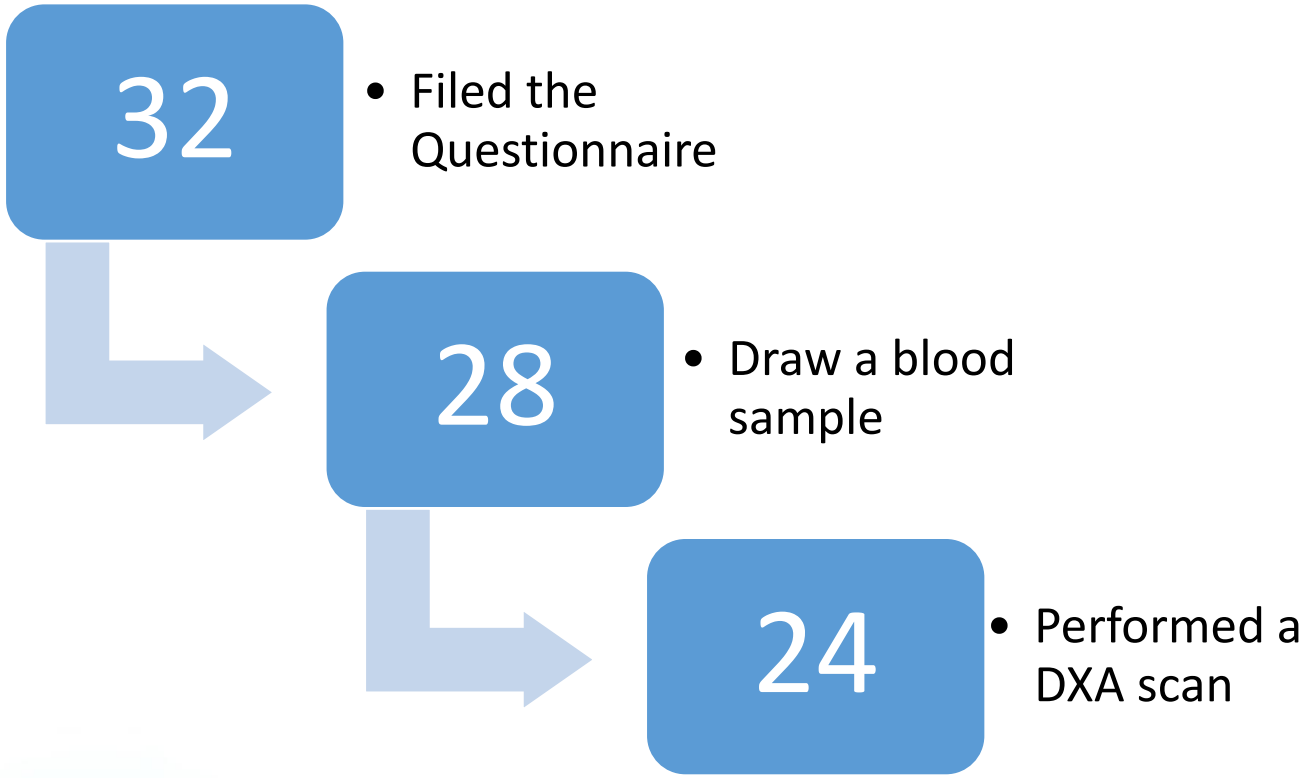
a) Age older than 50 years;

b) Physical inactivity;

c) Corticosteroid use;

d) Previous fragility fracture.

Results



32 male submariners accepted to participate in this study.

5 dropped out after completing the questionnaire.

3 dropped out after undergoing a blood draw.

24 subjects underwent a DXA scan.

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Results – Questionnaire

Age Median (IQR) [Min;Max]	57 (52–64) [50;82]
Category n (%)	
Officer	15 (46.9)
Sergeant	10 (31.3)
Sailor	7 (21.9)
Workplace n (%)	
Ashore	16 (50.0)
Not at duty	16 (50.0)
Workstation n (%)	
Indoors	15 (46.9)
Outdoors	1 (3.1)
Not applicable	16 (50.0)
Work shift n (%)	
Day shift	15 (46.9)
Mix shift	1 (3.1)
Not applicable	16 (50.0)

Skin type n (%)	
II	4 (12.5)
III	13 (40.6)
IV	14 (43.8)
V	1 (3.1)
Sun exposure n (%)	
0 days	8 (25.0)
1–10 days	14 (43.8)
11–20 days	4 (12.5)
21–30 days	6 (18.8)
Vitamin D-rich food intake n (%)	
0 days	1 (3.1)
1–10 days	23 (71.9)
11–20 days	3 (9.4)
21–30 days	5 (15.6)

Supplements or medication intake n (%)	
0 days	28 (87.5)
1–10 days	1 (3.1)
21–30 days	3 (9.4)
Tobacco n (%)	
None	27 (84.4)
>5 cigarettes	5 (15.6)
Coffee n (%)	
None	1 (3.1)
1–2 coffees	20 (62.5)
>2 coffees	11 (34.4)
Alcohol n (%)	
None	8 (25.0)
One glass at meals	14 (43.8)
More	10 (31.3)

BMI Median (IQR) [Min;Max]	27.90 (25.77–30.67) [22.06;38.30]
Diseases n (%)	
Yes	19 (59.4)
» Obesity	10 (31.3)
» Hypertension	9 (28.1)
» Dyslipidaemia	8 (25.0)
» Diabetes	2 (6.3)
No	13 (40.6)
Medication n (%)	
Yes	15 (46.9)
No	17 (53.1)
Frailty fracture n (%)	
Yes	1 (3.1)
No	31 (96.9)

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Results – Blood Analysis

Parameter | Reference value	Median (IQR) [Min;Max]) (n=27)
Glucose | <100 mg/dL	96 (92–103) [88;112]
HbA1c | <5.7%	5.4 (5.3–5.4) [5.0;7.0] [1]
Triglycerides | 40-160 mg/dL	94 (78–133) [43;180]
Total cholesterol | <200 mg/dL	189 (158–208) [110;261] [2]
HDL-cholesterol | >55 mg/dL	53 (47–57) [31;91]
LDL-cholesterol | <130 mg/dL	119 (82–137) [38;183]
25(OH)D | 30–100 ng/mL	25.0 (15.9–29.1) [8.3;65.5]
Calcium | 8.1–10.4 mg/dL	9.4 (9.1–9.8) [8.8;10.3]
Phosphorus | 2.7–4.5 mg/dL	3.09 (2.90–3.31) [2.60;4.13]
PTH | 15–68.3 pg/mL	69.3 (50.5–89.9) [28.9;109.9]

[1] Two subjects missing. [2] One subject missing.

HDL-cholesterol, 25(OH)D, and PTH median values were out of the respective reference values.

Only Calcium levels were within the reference interval in all participants.

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Results – Blood Analysis

		n (%)
Glucose (mg/dL)	Normal <100	17 (63.0)
	Pre-diabetic 100–125	10 (37.0)
HbA1c (%) [2 unknown]	Normal <5.7	21 (77.8)
	Elevated ≥5.7	4 (14.8)
Triglycerides (mg/dL)	Normal 40–160	24 (88.9)
	Elevated >160	3 (11.1)
Total cholesterol (mg/dL) [1 unknown]	Low risk <200	17 (63.0)
	Moderate risk 200–240	8 (29.6)
	Elevated risk >240	1 (3.7)
HDL-cholesterol (mg/dL)	Low risk >55	7 (25.9)
	Moderate risk 35–55	17 (63.0)
	Elevated risk <35	3 (11.1)
LDL-cholesterol (mg/dL)	Very low risk <100	8 (29.6)
	Low risk 100–129	9 (33.3)
	Moderate risk 130–160	9 (33.3)
	Elevated risk >160	1 (3.7)
25(OH)D (ng/mL)	Deficiency <20	9 (33.3)
	Insufficiency 20–29.9	13 (48.1)
	Sufficiency ≥30	5 (18.5)
Phosphorus (mg/dL)	Low <2.7	3 (11.1)
	Normal 2.7–4.5	24 (88.9)
PTH (pg/mL)	Normal 15–68.3	13 (48.1)
	Elevated >68.3	14 (51.9)

Glycaemic profile: 37.0% with abnormal fasting glucose levels and 14.8% with elevated HbA1c.

Low risk lipid profile: total cholesterol (63.0%), HDL-cholesterol (25.9%) and LDL-cholesterol (62.9%) levels within normal ranges.

Only 5 (18.5%) submariners were vitamin D sufficient.

Results – DXA scan

	BMD (g/cm^2) Median (IQR) [Min; Max]	T-score Median [Min;Max]	Z-score Median [Min;Max]
Lumbar spine (n=23)	1.171 (1.022–1.263) [0.823; 1.517]	-0.2 [-2.4; 2.5]	-0.1 [-2.1; 2.0]
Femoral neck (n=24)	0.948 (0.836–0.990) [0.725; 1.196]	-0.8 [-2.2; 1.4]	0.15 [-1.3; 2.2]

Four (16.7%) submariners had lumbar spine osteopenia and seven (29.2%) submariners had femoral neck osteopenia; overall osteopenia prevalence was 41.7%.

Only one submariner presented a (lumbar spine) BMD below the expected for the age and sex.

Nobody had osteoporosis.

Results – Submerssion hours & BMD

Submariners' navigation hours (7 missing values): 1,134 to 18,648 h (median 11,784 h).

Submariners' submersion hours (4 missing values): 2,262 to 13,686 h (median 7,587 h).

Spearman correlation coefficient	Lumbar spine (n=23)			Femoral neck (n=24)		
	BMD	T-Score	Z-Score	BMD	T-Score	Z-Score
Navigation Hours (n=17)	-0.265	-0.225	-0.157	**-0.451**	-0.254	-0.153
Submersion Hours (n=20)	**-0.307**	-0.215	-0.170	**-0.469**	-0.184	-0.149

The associations between navigation and submersion hours and lumbar spine and femoral neck BMD, T-Scores, and Z-Scores were all negative, without statistical significance.

Submersion hours showed a moderate correlation with lumbar spine and femoral neck BMD; the same correlation was observed between navigation hours and femoral neck BMD.

BMD measurement is recommended in the following patients:

a) Women and men aged ≥ 65 years;

b) Women and men aged ≥ 70 years;

c) Women aged ≥ 65 years and men aged ≥ 70 years;

d) Women aged ≥ 70 years and men aged ≥ 65 years.

32 male submariners with an age range of 50–82 years and:

- Low sun exposure (none in the last 30 days: 25%),
- Low vitamin-D rich food intake (less than 11 days in the last 30 days: 75%), and
- Low vitamin D supplements or medication intake (none in the last 30 days: 87.5%).

This triad represents a considerable risk for vitamin D deficiency, especially relevant in a life period when the risk of fractures increases due to bone loss related to normal aging and increased fall risk.[13,14]

American Endocrine Society recommends empiric vitamin D supplementation in the general population aged 75 years and older due to the potential to lower the risk of all-cause mortality.[14]

That is not the case in the general population aged 50 to 74 years, assuming that the Recommended Daily Allowance is followed:[14]

- 600 IU [15 µg] daily for those aged 50 to 70 years;
- 800 IU [20 µg] daily for those older than 70 years;
- Vitamin D mean intake of Portuguese male aged 65–74 years, based on diet only, is just 3.13 µg/day.[15]

This highlights the value of:[16,17]

- Vitamin D food fortification policies in Portugal,
- The need to test individuals at high risk of vitamin D deficiency, and
- The recommendation to provide 400 to 800 IU of vitamin D per day to avoid clinical vitamin D deficiency and maintain calcium homeostasis in healthy individuals.

NRP Arpão.

The majority of the submariners were:

- Non-smokers (84.4%),
- Coffee drinkers (96.9%), and
- Alcohol consumers (75.0%).

In a study with 742 male Dutch veteran submariners (median age 68 years (range 34–99 years)) only 10.3% were current smokers, and they had better self-reported vitality and health status than the general Dutch population.[18]

A Norwegian Navy study including 303 submariners reported that, compared to land-based personnel, vessel crews had a 50–60% higher risk of dying from non-malignant alcohol-related diseases and of being diagnosed with an alcohol-related cancer.[19]

- This can be linked to post-military service in the merchant fleet because study results for alcohol-related deaths and diseases indicate alcohol consumption similar to or lower than that of Norwegian males in general – Norwegian tradition of distributing rations of distilled spirits aboard Navy vessels was abandoned at the end of the 19th century – and an excess of alcohol-related cancers among Norwegian civilian seamen have been already observed.[19]

Unlike in the navies of the Nordic countries, in the Portuguese Navy is still permitted to serve alcoholic beverages while on board.

Prevalence of obesity (31.3%), hypertension (28.1%) and dyslipidemia (25.0%) were also significant.

A recent systematic review and meta-analysis estimated that the overall prevalence of some cardio-metabolic risk factors is higher in military personnel.[20]

In individuals assigned to U.S. small submarines, the prevalence of obesity was 17.8%.[21]

A Royal Navy study compared three submarine crews before and after submerged patrols of 12 or 6 weeks with a crew that remained ashore, observing modest improvements in serum lipids, glucose, and insulin, which were associated with a decrease in body weight.[22]

A Korean Navy study with 513 submariners and 4,577 non-submariners revealed that submariners have higher risks of metabolic syndrome, low high-density lipoprotein cholesterol, and impaired fasting glucose compared to non-submariners and found an increased risk of elevated blood pressure associated with submarine service in the subgroup with moderate or vigorous physical activity.[23]

In another Korean Navy study with 410 submariners (mean age 34.1±7.7 years) and 180 non-submariners (mean age 31.2±9.9 years), the prevalence of multimorbidity (≥2 chronic health problems) was significantly higher among submariners (32.2%) than non-submariners (11.7%); 51.0% versus 23.9% in those ≥40 years.[24]

If submarine service is significantly associated with a higher risk of multimorbidity and a greater disease burden, despite the absence of an evident dose–response relationship according to the duration of submarine service, special attention is needed to assess submariners and manage their health conditions, although the admitted "healthy soldier effect".[18,19,24]

NRP Barracuda

BMD measurement is recommended in the men age ≥ 50 years with any of the following specific risk factors, except:

a) Fracture during childhood;

b) Height loss;

c) Long-term glucocorticoid treatment;

d) Medical conditions associated with bone loss, as hyperparathyroidism.

One submariner reported a previous vertebral frailty fracture.

Regarding the risk of fractures because of service on diesel submarines, no statistically significant difference in the incidence of fractures was found between young (age range 18–42 years) male Israeli Navy submariners (n=457) and surface sailors (n=3,219):[25]

- However, information regarding submersion/navigation time was not included, which constitutes a limitation.
- This study also did not address the possibility of prolonged submersions affecting the risk of osteoporosis and fractures at older ages, and therefore cannot rule out such a risk.

Vitamin D status: 33.3% were vitamin D deficient and only 18.5% were vitamin D sufficient:

- This aligns with their characteristics described before, despite the "vitamin D winter" – blood drawing occurred during autumn and winter.
- The prevalence of vitamin D deficiency in Portugal is high, and blood sample collection during winter is associated with a higher risk of deficiency.[26]
- 96 Portuguese Navy active duty military personnel aged 50–64 years (winter): 36.5% were vitamin D deficient and 24.0% were vitamin D sufficient.[7]
- 532 Portuguese Navy military personnel aged 50-97 years (all seasons): 42.7% were vitamin D deficient and 23.1% were vitamin D sufficient.[6]

Calcium level was within the reference values in all cases – calcium deficiency is the leading risk factor for osteoporosis.[27]

An unpublished study observed a statistically significative decrease in the mean calcium level in all 11 Portuguese Navy submariners who underwent a 78-day submarine patrol.

NRP Arpão.

Several studies showed an essential link between vitamin D and cardiovascular health, but although some observational studies found that the prevalence of hypovitaminosis D is significantly higher in adults with type 2 diabetes mellitus or indicated a positive association between vitamin D deficiency and reduction in HDL cholesterol/apolipoprotein A levels or elevation of total cholesterol/LDL cholesterol/triglycerides, some recent clinical research has not observed significant benefits with vitamin D supplementation.[28]

There is still a need to fully understand the mechanisms between vitamin D concentrations and several markers of cardiovascular disease, particularly in older adults, as an increase in cardiovascular diseases is observed with aging.[28]

24 submariners performed a DXA (lumbar spine, except one, and femoral neck).

Considering the age groups 50-59 years, 60-69 years, and 70 years or more, the mean BMD was worse than in the study of Gasier and collaborators.[11]

	Lumbar spine mean BMD		Femoral neck mean BMD	
Age group	Portugal	USA	Portugal	USA
50-59 years	n=12 1.151±0.157	n=32 1.247±0.027	n=12 0.960±0.132	n=32 1.007±0.023
60-69 years	n=8 1.176±0.202	n=32 1.209±0.025	n=9 0.906±0.160	n=34 0.938±0.021
≥70 years	n=3 1.175±0.034	n=24 1.201±0.035	n=3 0.965±0.014	n=38 0.931±0.022

	Osteopenia in submariners (any site)		Osteopenia in men
Age group	Portugal	USA	China
All	n=24 | 41.7%	n=105 | 49.5%	
50-59 years	n=12 | 33.3%	n=33 | 42.4%	55.88%
60-69 years	n=09 | 66.7%	n=34 | 58.8%	47.90%
≥70 years	n=00 | 00.0%	n=38 | 47.4%	48.48%

Gasier and collaborators reported a prevalence of osteopenia (15.7% (lumbar spine) and 40.4% (femur neck)) similar to the general public in the 50+ age group.[11]

- In Portugal, the prevalence of forearm DXA with osteopenia in a sample of 200 male adults was 39.5%.[29]
- In China, the crude prevalence of osteopenia in men was 48.14% (95% CI 48.13 to 48.15).[30]

There were no cases of osteoporosis in this study.

Gasier and collaborators also reported a prevalence of osteoporosis (4.8% (lumbar spine) and 4.2% (femur neck)) similar to the general public in the 50+ age group.[11]

	Osteoporosis in men	
Age group	Portugal	China[31]
50-59 years	3.9% (95% CI 2.11 to 7.09)	4.6% (95% CI 3.3 to 5.8)
60-69 years	4.31% (95% CI 2.64 to 6.95)	5.4% (95% CI 4.1 to 6.7)
≥70 years	11.48% (95% CI 7.72 to 16.73)	70-79 years | 12.3% (95% CI 9.0 to 15.5) ≥80 years | 21.9% (95% CI 9.7 to 34.1)

Submersion hours showed a moderate negative correlation with lumbar spine and femoral neck BMD, but without statistical significance.

A previous study reported a negative association between serving on a diesel submarine and total hip and femur neck BMD, although the authors did not find any association between time spent at sea and BMD of the lumbar spine, femur neck, or total hip in US submariners.[11]

More studies are needed to confirm that any adverse skeletal effects that may occur during periods of submergence are resolved during in-port and shore duty.

Study strengths and limitations

First study addressing BMD in Portuguese Navy submariners.

Objective data concerning submariners' navigation and submersion times.

Small and convenience sample – not representative.

- Low participation rate (20.5%) and high drop-out rate (25%).

DXA equipment failure – equipment heterogeneity.

Oficial data inconsistencies/missing.

Conclusions

In this first study with Portuguese Navy submariners, crude prevalence of osteopenia was 41.7% and submersion hours showed a moderate negative correlation with BMD at the lumbar spine and femoral neck, not statistically significant.

Although these findings are not generalizable, they highlight the need for future research and underscore the importance of occupational health services paying special attention to submariners.

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Cdr Navy Doctor Moisés Henriques | Thank you for your attention!

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