

# BMJ Open Vitamin D status in the active duty Navy military personnel: protocol for a systematic review

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## ABSTRACT

**Introduction** Vitamin D is critical for bone health and its deficiency has been linked to increased incidence and severity of multiple diseases. Even so, vitamin D inadequacy is a major public health problem worldwide. The main source of vitamin D is endogenous cutaneous synthesis through exposure to solar ultraviolet B radiation, which is influenced by several factors, including occupational. The active duty Navy military personnel may be prone to vitamin D inadequacy, but a worldwide overview of vitamin D status in this specific population is still lacking.

**Methods and analysis** The CoCoPop mnemonic will be used for determining the inclusion criteria. Scopus, Web of Science and PubMed/Medline will be searched for all studies including 25-hydroxyvitamin D concentrations of the active duty Navy military personnel. Data extraction and quality assessment (Joanna Briggs Institute's and Downs and Black checklists) will be performed by two reviewers and data will be synthesised in narrative, tabular and map formats.

**Ethics and dissemination** This study will not involve human or animal subjects and, thus, does not require ethics approval. The outcomes will be disseminated via publication in a peer-reviewed scientific journal and presentation at a scientific conference.

**PROSPERO registration number** CRD42022287057.

## INTRODUCTION

Vitamin D is critical for bone health as it promotes dietary calcium absorption and bone mineralisation; its deficiency may cause rickets in children and osteomalacia and osteoporosis in children and adults.<sup>1–4</sup> Vitamin D deficiency has also been linked to increased incidence and severity of multiple diseases such as infections, diabetes, cardiovascular disease, autoimmune diseases such as inflammatory bowel disease and multiple sclerosis, and cancer.<sup>5–10</sup> Unfortunately, vitamin D inadequacy is a major public health problem worldwide, even in low-latitude countries.<sup>11–14</sup>

The main source of vitamin D is endogenous cutaneous synthesis through exposure to solar ultraviolet B radiation.<sup>15</sup> This production of vitamin D is naturally dependent on

## STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ This study will adhere to globally accepted systematic review methods for evidence screening, quality assessment and data analysis.
- ⇒ The CoCoPop mnemonic (condition, context and population) will be used for determining the inclusion criteria.
- ⇒ This study will summarise data published in full articles written in English, Portuguese, Spanish or French.
- ⇒ It is anticipated that some heterogeneity will exist within the collected data, which will be acknowledged in the data analysis and discussed accordingly.

several factors, namely atmospheric (eg, cloudy sky), geographical (eg, latitude), temporal (eg, season), individual (eg, skin pigmentation) and behavioural (eg, use of sunscreen).<sup>1 15–21</sup> Systematic reviews and recent studies indicate that indoor and shift workers, particularly those on night shifts, are at increased risk of vitamin D deficiency.<sup>22–28</sup>

Some studies showed that the prevalence of vitamin D deficiency rises during military basic training.<sup>29 30</sup> Merging high physical and psychological demands with inadequate nutrition and/or sleep disruption places the active duty Navy military personnel at high risk for vitamin D deficiency.<sup>31</sup> The lack of exposure to the sun when living and working in a warship or a submarine also increases the risk of vitamin D deficiency.<sup>32</sup> For these reasons, vitamin D levels should be routinely assessed on all active duty Navy military personnel, especially those in predeployment and postdeployment mobilisation phases.<sup>33</sup>

Despite the adverse occupational context for vitamin D levels, a worldwide overview of vitamin D status in the active duty Navy military personnel is lacking. The main objective of this systematic review is to provide a worldwide overview of the prevalence of vitamin D deficiency, insufficiency and sufficiency in

the active duty Navy military personnel in response to the question ‘What is the vitamin D status in the active duty Navy military personnel?’. Additionally, the Navy occupational settings will be described and, whenever the case, measures implemented to treat or prevent vitamin D inadequacy will be listed.

## METHODS AND ANALYSIS

The methods for this systematic review, including review question, search strategy, inclusion and exclusion criteria and quality assessment, are established within this protocol prior to the conduct of the review. The study protocol was prospectively registered with PROSPERO, within which the start and end dates are listed as 1 July and 30 September 2022, respectively. Authors will adhere to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 reporting guidelines.<sup>34</sup> This protocol has followed the PRISMA Protocols 2015 reporting guidelines.<sup>35</sup>

### Search strategy and selection criteria

As in systematic reviews of observational epidemiological studies reporting prevalence data, the CoCoPop mnemonic (condition, context and population) will be used in determining the inclusion criteria.<sup>36</sup> The condition will be vitamin D status (serum 25-hydroxyvitamin D (25(OH)D); vitamin D deficiency is defined as 25(OH)D <20 ng/mL or <50 nmol/L, insufficiency as 25(OH)D of ≥20 and <30 ng/mL or ≥50 nmol/L and <75 nmol/L, and sufficiency as 25(OH)D of ≥30 ng/mL or ≥75 nmol/L, according to Endocrine Society).<sup>37</sup> The context will not be delimited, as it is important to consider all space and time settings. The population will be active duty Navy military: active duty is comparable to working at a full-time job and begins when a military member reports to a duty station after completion of training (basic, officer training, tech school); active duty Navy military work for the military full time, may live on a military base and can be deployed at any time. Non-experimental and experimental studies that include 25(OH)D concentrations (baseline values in interventional studies) will be considered. If prevalence

rates are not explicit in the article, they will be calculated according to available data. Furthermore, the most up-to-date and comprehensive version will be selected for studies that will report the same results in multiple articles.

The literature search will be performed using a peer-reviewed search strategy. The search strategy will be reviewed according to Peer Review of Electronic Search Strategies guidelines.<sup>38</sup> Published literature will be identified by searching the following bibliographic databases from inception to 30 June 2022: Scopus, Web of Science and PubMed/Medline. The search strategy (table 1) will consist of both controlled vocabularies, such as the National Library of Medicine’s Medical Subject Headings and keywords. The main search concepts will be vitamin D and Navy military personnel. Retrieval will be limited to human studies, where possible, and no other filters will be applied. If the full texts cannot be retrieved, the papers will be excluded. Full articles written in languages other than English, Portuguese, Spanish or French will also be excluded. Studies in veterans will be excluded.

### Data extraction

Two reviewers will independently screen titles and abstracts, review full texts and extract data using a standard extraction form. Disagreements will be resolved by consensus, with a third reviewer acting as arbitrator if required. Extracted data will include general information (authors; year of publication), study characteristics (research design; study setting—latitude, season and country), population characteristics (sample size; distribution by age, sex, rank or years of military service, ethnicity and other relevant variables for vitamin D status available), Navy military occupational setting (warship or submarine type; ashore vs onboard; indoor vs outdoor), vitamin D data (method/assay used for measurement of 25(OH)D; mean (SD), median (IQR) and/or range of 25(OH)D concentrations; cut-off points for vitamin D deficiency, insufficiency and sufficiency; prevalence of vitamin D deficiency, insufficiency and sufficiency) and,

**Table 1** Search strategy

Database	Expression
Scopus	(‘Vitamin D’ OR ‘Vitamin D Deficiency’ OR ‘25-Hydroxyvitamin D 2’ OR ‘Cholecalciferol’ OR ‘Ergocalciferol’ OR ‘Calcifediol’ OR ‘25-hydroxyvitamin D’ OR ‘25-hydroxy vitamin D’ OR ‘25(OH)D’ OR ‘25OHD’) AND (‘military personnel’ OR ‘military’ OR ‘Navy personnel’ OR ‘sailor*’ OR ‘marine*’ OR ‘submariner*’ OR ‘coast guard’)
Web of Science	(‘Vitamin D’ OR ‘Vitamin D Deficiency’ OR ‘25-Hydroxyvitamin D 2’ OR ‘Cholecalciferol’ OR ‘Ergocalciferol’ OR ‘Calcifediol’ OR ‘25-hydroxyvitamin D’ OR ‘25-hydroxy vitamin D’ OR ‘25(OH)D’ OR ‘25OHD’) AND (‘military personnel’ OR ‘military’ OR ‘Navy personnel’ OR ‘sailor*’ OR ‘marine*’ OR ‘submariner*’ OR ‘coast guard’)
PubMed/Medline	(‘Vitamin D’[MeSH] OR ‘Vitamin D Deficiency’[MeSH] OR ‘25-Hydroxyvitamin D 2’[MeSH] OR ‘Cholecalciferol’[MeSH] OR ‘Ergocalciferol’[MeSH] OR ‘Calcifediol’[MeSH] OR ‘25-hydroxyvitamin D’ OR ‘25-hydroxy vitamin D’ OR ‘25(OH)D’ OR ‘25OHD’) AND (‘Military Personnel’[MeSH] OR ‘military’ OR ‘Navy personnel’ OR ‘sailor*’ OR ‘marine*’ OR ‘submariner*’ OR ‘coast guard’)

if applicable, intervention characteristics (intervention, groups, outcome).

### Risk of bias (quality) assessment

Two reviewers will independently conduct the critical appraisal of all studies. Joanna Briggs Institute's critical appraisal checklist for studies reporting prevalence data will be used for observational epidemiological studies reporting prevalence.<sup>39</sup> In the case of experimental studies (randomised or non-randomised), a quality assessment will be made using the Downs and Black checklist.<sup>40</sup>

### Data synthesis

Data will be synthesised in narrative, tabular and map formats to provide a better description of the main findings, for example, sample sizes, quality assessment and vitamin D status according to world location. If data permit, subgroup analyses will be made by Navy occupational setting.

### Patient and public involvement

No patients will be involved in this study.

### Ethics and dissemination

This study will summarise already published data and will not involve human or animal subjects directly (secondary research study), thus will not require ethics approval. Results of the study will be disseminated via publication in a peer-reviewed scientific journal and presentation at a scientific conference. In case of protocol amendments, the PROSPERO record will be updated with information regarding the nature and the rationale of the changes made.

**Contributors** MH is the guarantor. MH developed the search strategy and drafted the manuscript. MH, DR, ES-L, SV and FS contributed to the development of the selection criteria, data extraction criteria and quality assessment strategy. MH, DR, ES-L, SV and FS read, provided feedback and approved the final manuscript.

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**Competing interests** None declared.

**Patient and public involvement** Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

**Patient consent for publication** Not required.

**Provenance and peer review** Not commissioned; externally peer reviewed.

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