A GLOBAL REPRESENTATION OF VITAMIN D STATUS IN HEALTHY POPULATIONS


*Corresponding author
B. Dawson-Hughes
Department of Agriculture Human Nutrition, Research Center on Aging, Tufts University, 711 Washington Street, Boston, MA 02111, USA
Email: bess.dawson-hughes@tufts.edu
Author affiliations

D.A. Wahl, D.D. Pierroz and J. Stenmark
International Osteoporosis Foundation, Nyon, Switzerland

C. Cooper
MRC Lifecourse Epidemiology Unit, University of Southampton and NIHR Musculoskeletal Biomedical Research Unit, University of Oxford, UK

P.R. Ebeling
NorthWest Academic Centre, University of Melbourne, Western Health, St. Albans, Victoria, Australia

M. Eggersdorfer and E. Stöcklin
Nutrition Science & Advocacy and Research & Development Human Nutrition, DSM Nutritional Products, Kaiseraugst, Switzerland

J. Hilger and K. Hoffmann
Mannheim Institute of Public Health, Social and Preventive Medicine, Mannheim Medical Faculty, Heidelberg University, Mannheim, Germany

R. Josse
Division of Endocrinology and Metabolism, University of Toronto, St Michael’s Hospital Health Centre, Toronto, Canada

A. Mithal
Medanta Medicity, Sector 38, Gurgaon, India

J.A. Kanis
WHO Collaborating Centre for Metabolic Bone Diseases, University of Sheffield Medical School, UK

B. Dawson-Hughes *
Jean Mayer USDA Human Nutrition Research Center on Aging at Tufts University, Boston, USA
Abstract

Purpose This paper visualizes the available data on vitamin D status on a global map, examines the existing heterogeneities in vitamin D status and identifies research gaps.

Methods A graphical illustration of global vitamin D status was developed based on a systematic review of the world wide literature published between 1990 and 2011. Studies were eligible if they included samples of randomly selected males and females from the general population and assessed circulating 25-hydroxyvitamin D (25OHD) levels. Two different age categories were selected: children and adolescents (1-18 years) and adults (>18 years). Studies were chosen to represent a country based on a hierarchical set of criteria.

Results In total, 200 studies from 46 countries met the inclusion criteria, most coming from Europe. Forty-two of these studies (21%) were classified as representative. In children, gaps in data were identified in large parts of Africa, Central and South America, Europe, and most of the Asia/Pacific region. In adults, there was lack of information in Central America, much of South America, and Africa. Large regions were identified for which mean 25OHD levels were below 50 nmol/L.

Conclusions This study provides an overview of 25OHD levels around the globe. It reveals large gaps in information in children and adolescents and smaller but important gaps in adults. In view of the importance of vitamin D to musculoskeletal growth, development, and preservation, and of its potential importance in other tissues, we strongly encourage new research to clearly define 25OHD status around the world.

Keywords: vitamin D status, vitamin D deficiency, 25OHD, IOF
Introduction

Vitamin D status in an individual is dependent on numerous genetic, lifestyle and geographical factors that include age, gender, skin pigmentation, sunlight exposure, latitude, the use of sunscreen, dietary habits and supplement intake [1]. It is best measured by serum concentration of 25-hydroxyvitamin D levels, also known as 25OHD levels [2].

Very low levels of 25OHD have been documented in different subgroups of the population worldwide [1, 3-6], which have clinical implications. Vitamin D plays an important role in the skeletal growth and development, and in bone health throughout life. It promotes calcium absorption [7] and reduces bone loss through the regulation of parathyroid hormone levels [8]. As a consequence, vitamin D deficiency has been linked to reduced bone mineral density [9, 10] and higher risk of osteoporotic fractures [11]. Although further investigation is necessary, vitamin D supplementation may reduce the risk of other diseases, such as colorectal cancer [12], diabetes [13], infection [14] and it may help to decrease fractures and falls [15] [16]. The loss of muscle mass and strength observed in vitamin D deficient individuals puts them at higher risk of falls and therefore fragility fractures.

The International Osteoporosis Foundation took the initiative to describe the vitamin D status in the general population in different countries based on a systematic review and to present the data on a global map. The aims of the study were to provide a general overview of vitamin D status in countries for which data were available, examine the existing heterogeneities in vitamin D status, and identify research gaps.

Methods

The data used in this project are based on a systematic literature review conducted by the Mannheim Institute of Public Health, Germany. The methods used generally follow the PRISMA Statement (Preferred Reporting Items for Systematic reviews and Meta-Analyses) [17]. Here, we provide a short summary of the methods used in this review. The methods are described in more detail elsewhere [18].

Eligible criteria

A systematic search was conducted in PubMed/Medline and EMBASE to identify articles on vitamin D status in the global population. Eligible studies included samples of randomly selected persons from the general population in countries throughout the world. The outcome of interest was the mean or median 25OHD level measured in serum or plasma. There were no limitations based on the type of assay used. Studies were required to have a cross-sectional design or to include a population-based cohort. Other study types like clinical trials, case-control studies, case reports or case series, reviews or qualitative studies were excluded. Articles had to be written in English and published between Jan 1st 1990 and 28th Feb 2011.

Abstract and full publication screening

2,566 articles were identified from both databases. Two independent researchers screened the articles were by with a good agreement for excluding studies (kappa coefficient of 0.719). Disagreements were discussed and resolved. After review, 273 articles were eligible and included in a large database which provided, in part, the following information: mean or median 25OHD levels, population characteristics, study location, assay type, number of participants and age groups.

Data filtering

In a second review process, studies on institutionalized elderly only, those on newborn babies and those having an age range that largely overlapped the two age categories (1-18 years and > 18 years) were removed. When published repeatedly, the same cohort was not presented more than once. In contrast, studies reporting sub-analysis of a cohort (number of participants and age range different from the root
paper) were retained. Studies originating from England, Northern Ireland and Scotland were grouped as United Kingdom. In the end, our database included 200 studies from 46 countries.

After examination of the database, two different age categories were selected: children and adolescents (1-18 years) and adults (>18 years). Mean serum or plasma 25OHD levels were extracted and reported as gender-specific means weighted by sample size where possible. Median levels of 25OHD were included when mean levels were not reported in a study. When data were classified by specific seasons, winter values were chosen. Values in ng/ml were converted to nmol/L by a multiple of 2.496.

Four colour codes according to mean (or median) 25OHD levels were used:

- **GREEN** >75 nmol/L
- **YELLOW** 50-74 nmol/L
- **ORANGE** 25-49 nmol/L
- **RED** <25 nmol/L

For each study, the mean or median vitamin D levels (nmol/L) were reported from the literature and a study colour code was assigned.

**Rationale for the colour coding of countries**

For both age categories, the rationale for assigning a colour code to a specific country was based on the following hierarchical selection criteria:

1. Representative of the entire country, population-based, and based on a weighted mean of these studies
2. Representative of a region/city of the country, population-based, based on a weighted mean of these studies
3. Based on a weighted mean of multiple studies, non-population-based
4. Based on a single study

Country colour was based on the 25OHD level (either weighted mean or median) of one or more representative studies, if available. If not available, it was based on one or more studies fitting the second criterion cited above, and so forth. A study was considered representative if it represented the entire population for a certain age and sex group in a certain country, region or city. Studies with a selection bias, which excluded individuals for example on the basis of health status, ethnicity, physical abilities, language, smokers and social economic status, were classified as non-representative. However, for some studies such information was not described in the text.

**Design of the figures**

The software FlashWorldMap.com was used to produce the maps

**Results**

This analysis involves 200 studies from 46 countries. Forty two of the 200 studies (21%) were considered representative. Details of these studies for each contributing country are provided in Tables 1 (children and adolescents) and 2 (adults). The largest number of studies was conducted in Europe (48.0%), followed by North America (27%) and the Asia-Pacific region (16.5%). Of the 46 countries contributing data, 20 (43%) had at least one study that was classified as representative. Fig 1 and Fig 2 show the vitamin D status in children and adolescents, and adults, respectively, in different countries. The countries are colour-coded according to the serum levels of 25OHD reported in Table 1 (children and adolescents) and Table 2 (adults) and the ranges of 25OHD represented by each colour are described in the two figures.
**Fig 1** Vitamin D status in children and adolescents (1-18 years) around the world

When available, winter values were used to calculate the mean 25OHD levels.

**Fig 2** Vitamin D status in adults (> 18 years) around the world

When available, winter values were used to calculate the mean 25OHD levels.
Discussion

This project provides a ‘snap shot’ or summary of 25OHD levels around the globe, as identified in publications since the year 1990. The maps form a core or platform upon which additional information can and should be added. The number of published papers describing 25OHD levels is escalating and the geographic diversity of incoming data is broadening. As a result, we can anticipate having a more comprehensive picture of global vitamin D status in coming years. Updating of the accompanying tables, in which information from each country is ordered chronologically, will also allow for a qualitative assessment of secular trends in 25OHD since 1990, within regions and overall. We can expect to see rises in 25OHD levels as awareness and concern about vitamin D deficiency grows, and as recommendations for vitamin D supplementation appear in more and more government documents, position statements and clinical practice guidelines for bone health [19-21]. This trend would only be accelerated should vitamin D be proven to modify risk of non-musculoskeletal diseases, such as diabetes, infection, or cancer, as has been suggested by many observational studies [22].

Examination of the current maps enables one to identify regions where information on 25OHD levels is lacking. The most striking gap is in children and adolescents. The systematic search did not identify studies in this age range in Central America, northern and central regions of South America, most of Africa, much of Europe, and in Australia. This information gap needs attention in view of the importance of vitamin D in bone and muscle growth and development. In regions where data were available, the predominant colour code for children and adolescents was orange, indicating mean 25OHD levels in the 25 to 49 nmol/L range. These values are below those recommended by the Institute of Medicine (50 nmol/L) the International Osteoporosis Foundation and the US Endocrine Society (75 nmol/L) [19-21].

Among adults, most regions offer some data and their colour codes are approximately evenly split between orange (25 to 49 nmol/L) and yellow (50 to 74 nmol/L). Areas where information was not identified include Central America, South America (with the exception of Brazil), and much of Africa. With the known role of vitamin D in preserving bone health, it is important to fill these gaps so that appropriate measures can be implemented to correct inadequate 25OHD levels. Information gaps in both age groups would ideally be filled with survey data based on random sampling of a country or region. In the meantime, any and all data from specific regions will make some contribution to defining vitamin D status globally.

Despite using data from a systematic literature review, the maps have limitations. One limitation is that adequate information is not available. An extreme example is that for a few countries, one single small study confined to a limited region of the country and to a narrow age range was used to colour the country (e.g., Argentina). This is of course not a complete picture of the country. Other countries have many studies, representative and non-representative. For example, New Zealand is coloured orange based on the one available representative sample of subjects residing in the city of Auckland. As indicated in the table, other studies from this country involving healthy populations and subjects measured in summer consistently reported higher 25OHD levels in the range of yellow and green. In view of the diversity in quantity and quality of data used in this study, it is important that the tables be used in conjunction with the maps and that the maps are interpreted with caution.

Several limitations are inherent in the way that the published data were presented. For example, 25OHD measurements were sometimes made in specific seasons (i.e., winter or summer) and at other times made without reference to season. When the option was available, we used the winter measurement, representing the worst case scenario, for the map colouration; however 25OHD levels by season, when available, are provided in the table. There was inconsistency across studies in the age groupings, such that we were not always able to break out the levels by our predefined age categories of children and adolescents 1-18 years and adults >18 years. Another limitation is that some of the studies represented small regions within large countries with diverse latitudes; thus they did not fairly represent the whole
nation with respect to the contribution of sun exposure (skin synthesis) to 25OHD levels. Additionally, information on body size, clothing habits, and skin pigmentation was not consistently available.

An important limitation of this project and of any inter-study comparison of 25OHD levels is the well described variability in 25OHD assays. Since the first 25OHD assay was developed 30 years ago [23], the analytical options have expanded from the original competitive protein binding assay to include radioimmunoassay, chemiluminescent assay, high-performance liquid chromatography and liquid chromatography mass spectrometry/mass spectrometry. Unfortunately, serum 25OHD levels vary by up to 20 to 40%, depending upon which assay is used [24-27]. Part of the variability can be attributed to the fact that not all of the assays detect 25OHD₂ as effectively as they detect 25OHD₃. As a result, in those regions where vitamin D₂ is used in most supplements, total 25OHD levels will tend to be underestimated.

To address the assay problem, many laboratories around the world participate in a quarterly quality assurance and surveillance program, the Vitamin D External Quality Assessment Scheme (DEQAS) which we strongly encourage. Standard reference material consisting of known amounts of 25OHD₂ and 25OHD₃ in human serum is now available through the U.S. National Institute of Standards and Technology (NIST; SRM972; www.NIST.gov/srm). The use of this material should make inter-laboratory comparisons more readily interpreted and allow for the detection of intra-laboratory changes over time. An important initiative, the vitamin D standardization program (VDSP), is currently under way to make the measurement of 25OHD accurate and comparable over time, location and laboratory [28]. The first goal of VDSP is to standardize 25OHD values currently being measured in national health surveys to the NIST standards. Australia, Canada, Germany, Ireland, Mexico, South Korea, United Kingdom and the U.S. are participating in this process. A second goal is to design studies to cross-calibrate data from national surveys in which 25OHD measurements have already been completed. The longer range goal is to enable the use of standardized 25OHD values in individual research laboratories and in clinical care.

Conclusion

In conclusion, this study provides an overview of 25OHD status around the globe. It reveals large gaps in information in children and adolescents and smaller but important gaps in adults. In view of the importance of vitamin D to overall musculoskeletal health and of its potential importance in other tissues, we strongly encourage new research worldwide to define 25OHD status. Deficiency must first be identified before it can be appropriately addressed. Knowledge of specific data gaps may help to motivate regional policy makers and granting agencies to define the vitamin D status of their population as they decide how to allocate scarce research resources.

Acknowledgments

The authors would like to thank the invaluable advice from Professors Noriko Yoshimura, Edith Lau, Jean-Philippe Bonjour, Sunil Wimalawansa, Steven Boonen, Paul Lips and the late Philip Sambrook from the IOF Committee of Scientific Advisors; Professor Peter Weber, Doctors Angelika Friedel and Franz Roos from the DSM Nutrition Science & Advocacy for their intellectual input; and DSM for supporting the work through an unrestricted educational grant.

Disclosure

Drs Manfred Eggersdorfer and Elisabeth Stöcklin are employed by DSM Nutritional Products Ltd. Professor Cyrus Cooper has received honoraria and consulting fees from Amgen, Eli Lilly, Medtronic, Merck, Novartis and Servier. All the other authors have nothing to disclose.
Table 1 Country colour codes of vitamin D status in children and adolescents

<table>
<thead>
<tr>
<th>Country</th>
<th>Refs</th>
<th>Representative</th>
<th>Age</th>
<th>Sex</th>
<th>N</th>
<th>25OHD (nmol/L)*</th>
<th>Season</th>
<th>Study colour code*</th>
<th>Country colour code*</th>
<th>Country colour code rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argentina</td>
<td>[29]</td>
<td>No</td>
<td>8.5</td>
<td>M+F</td>
<td>42</td>
<td>24.5</td>
<td>Winter</td>
<td>RED</td>
<td>RED</td>
<td>Based on a single study</td>
</tr>
<tr>
<td>Austria</td>
<td>[30]</td>
<td>NA</td>
<td>4-19</td>
<td>M+F</td>
<td>1143</td>
<td>26.4 (+)</td>
<td>NA</td>
<td>ORANGE</td>
<td>ORANGE</td>
<td>Based on a single study</td>
</tr>
<tr>
<td>Canada</td>
<td>[31]</td>
<td>Yes</td>
<td>3-5</td>
<td>M+F</td>
<td>282</td>
<td>48.3</td>
<td>Mixed</td>
<td>ORANGE</td>
<td>ORANGE</td>
<td>Representative of a region/city of the country, population-based</td>
</tr>
<tr>
<td></td>
<td>[32]</td>
<td>No</td>
<td>9-16</td>
<td>M+F</td>
<td>878</td>
<td>45.9</td>
<td>Winter</td>
<td>ORANGE</td>
<td>ORANGE</td>
<td>Based on a single study</td>
</tr>
<tr>
<td>China</td>
<td>[33]</td>
<td>Yes</td>
<td>12-14</td>
<td>M</td>
<td>649</td>
<td>33.4</td>
<td>Winter</td>
<td>ORANGE</td>
<td>ORANGE</td>
<td>Representative of a region/city of the country, population-based</td>
</tr>
<tr>
<td></td>
<td>[34]</td>
<td>NA</td>
<td>1-2</td>
<td>F</td>
<td>131</td>
<td>42.3</td>
<td>Winter</td>
<td>ORANGE</td>
<td>ORANGE</td>
<td>Based on a single study</td>
</tr>
<tr>
<td>Denmark</td>
<td>[35]</td>
<td>No</td>
<td>12.5</td>
<td>F</td>
<td>59</td>
<td>24.4</td>
<td>Winter</td>
<td>RED</td>
<td>RED</td>
<td>Based on a single study</td>
</tr>
<tr>
<td>Finland</td>
<td>[36]</td>
<td>NA</td>
<td>11.4</td>
<td>F</td>
<td>64</td>
<td>39.9</td>
<td>Mixed</td>
<td>Winter</td>
<td>ORANGE</td>
<td>ORANGE</td>
</tr>
<tr>
<td>Iceland</td>
<td>[37]</td>
<td>No</td>
<td>16-20</td>
<td>F</td>
<td>259</td>
<td>43.9</td>
<td>Winter</td>
<td>ORANGE</td>
<td>ORANGE</td>
<td>Based on a single study</td>
</tr>
<tr>
<td>India</td>
<td>[38]</td>
<td>No</td>
<td>11-14</td>
<td>M</td>
<td>64</td>
<td>40.8</td>
<td>Winter</td>
<td>ORANGE</td>
<td>ORANGE</td>
<td>Based on a single study</td>
</tr>
<tr>
<td>Iran</td>
<td>[39]</td>
<td>No</td>
<td>7-18</td>
<td>M</td>
<td>424</td>
<td>11.6.3</td>
<td>Winter</td>
<td>GREEN</td>
<td>YELLOW</td>
<td>Based on a weighted average</td>
</tr>
<tr>
<td></td>
<td>[40]</td>
<td>NA</td>
<td>11-15</td>
<td>F</td>
<td>539</td>
<td>60.4</td>
<td>Winter</td>
<td>YELLOW</td>
<td>GREEN</td>
<td>Based on a weighted average</td>
</tr>
<tr>
<td></td>
<td>[41]</td>
<td>No</td>
<td>14-18</td>
<td>F</td>
<td>414</td>
<td>74.9</td>
<td>Winter</td>
<td>YELLOW</td>
<td>GREEN</td>
<td>Based on a weighted average</td>
</tr>
<tr>
<td>Ireland</td>
<td>[42]</td>
<td>NA</td>
<td>11-13</td>
<td>F</td>
<td>15</td>
<td>39.0</td>
<td>Winter</td>
<td>ORANGE</td>
<td>ORANGE</td>
<td>Based on a single study</td>
</tr>
<tr>
<td>Israel</td>
<td>[43]</td>
<td>Yes</td>
<td>0-20</td>
<td>M+F</td>
<td>195</td>
<td>57.3</td>
<td>Mixed</td>
<td>YELLOW</td>
<td>YELLOW</td>
<td>Representative of the entire country, population-based</td>
</tr>
<tr>
<td>Jordan</td>
<td>[44]</td>
<td>NA</td>
<td>4-5</td>
<td>M+F</td>
<td>93</td>
<td>55.8</td>
<td>Mixed</td>
<td>YELLOW</td>
<td>YELLOW</td>
<td>Based on a single study</td>
</tr>
<tr>
<td>Mongolia</td>
<td>[45]</td>
<td>No</td>
<td>1-3</td>
<td>M+F</td>
<td>79</td>
<td>24.5 (+)</td>
<td>NA</td>
<td>RED</td>
<td>RED</td>
<td>Based on a single study</td>
</tr>
<tr>
<td>Netherlands</td>
<td>[46]</td>
<td>No</td>
<td>8-13</td>
<td>M+F</td>
<td>307</td>
<td>69.7</td>
<td>NA</td>
<td>YELLOW</td>
<td>YELLOW</td>
<td>Based on a single study</td>
</tr>
<tr>
<td>New Zealand</td>
<td>[47]</td>
<td>No</td>
<td>5-14</td>
<td>M+F</td>
<td>1585</td>
<td>50.0</td>
<td>Mixed</td>
<td>YELLOW</td>
<td>YELLOW</td>
<td>Based on a weighted average</td>
</tr>
<tr>
<td></td>
<td>[48]</td>
<td>NA</td>
<td>1-2</td>
<td>M+F</td>
<td>193</td>
<td>52.0</td>
<td>Mixed</td>
<td>YELLOW</td>
<td>YELLOW</td>
<td>Based on a weighted average</td>
</tr>
<tr>
<td></td>
<td>[49]</td>
<td>NA</td>
<td>1-2</td>
<td>M+F</td>
<td>233</td>
<td>53.3 (+)</td>
<td>Mixed</td>
<td>YELLOW</td>
<td>YELLOW</td>
<td>Based on a weighted average</td>
</tr>
<tr>
<td>Nigeria</td>
<td>[50]</td>
<td>NA</td>
<td>0.63-9</td>
<td>M+F</td>
<td>218</td>
<td>66.9</td>
<td>Mixed</td>
<td>YELLOW</td>
<td>YELLOW</td>
<td>Based on a single study</td>
</tr>
<tr>
<td>Poland</td>
<td>[35]</td>
<td>No</td>
<td>12.6</td>
<td>F</td>
<td>61</td>
<td>30.6</td>
<td>Winter</td>
<td>ORANGE</td>
<td>ORANGE</td>
<td>Based on a single study</td>
</tr>
<tr>
<td>UK</td>
<td>[51]</td>
<td>Yes</td>
<td>Childs</td>
<td>M</td>
<td>854</td>
<td>65.5</td>
<td>Mixed</td>
<td>YELLOW</td>
<td>YELLOW</td>
<td>Representative of the Entire country, population-based</td>
</tr>
<tr>
<td></td>
<td>[52]</td>
<td>Yes</td>
<td>12,15</td>
<td>M</td>
<td>505</td>
<td>62.3</td>
<td>Mixed</td>
<td>YELLOW</td>
<td>YELLOW</td>
<td>Based on a single study</td>
</tr>
<tr>
<td></td>
<td>[53]</td>
<td>Yes</td>
<td>12-15</td>
<td>M+F</td>
<td>1015</td>
<td>64.3</td>
<td>Mixed</td>
<td>YELLOW</td>
<td>YELLOW</td>
<td>Based on a single study</td>
</tr>
<tr>
<td>USA</td>
<td>[54]</td>
<td>Yes</td>
<td>1-19</td>
<td>M+F</td>
<td>8541</td>
<td>66.8 (+)</td>
<td>Mixed</td>
<td>YELLOW</td>
<td>YELLOW</td>
<td>Representative of the entire country, population-based, and based on a weighted average</td>
</tr>
<tr>
<td></td>
<td>[55]</td>
<td>Yes</td>
<td>1-11</td>
<td>M+F</td>
<td>4558</td>
<td>68</td>
<td>Mixed</td>
<td>YELLOW</td>
<td>YELLOW</td>
<td>Based on a weighted average</td>
</tr>
<tr>
<td></td>
<td>[56]</td>
<td>Yes</td>
<td>12-19</td>
<td>M+F</td>
<td>3528</td>
<td>62.0</td>
<td>Mixed</td>
<td>YELLOW</td>
<td>YELLOW</td>
<td>Based on a weighted average</td>
</tr>
<tr>
<td></td>
<td>[57]</td>
<td>Yes</td>
<td>6-21</td>
<td>M+F</td>
<td>382</td>
<td>69.9</td>
<td>Mixed</td>
<td>YELLOW</td>
<td>GREEN</td>
<td>Based on a weighted average</td>
</tr>
<tr>
<td></td>
<td>[58]</td>
<td>No</td>
<td>4-8</td>
<td>F</td>
<td>168</td>
<td>93.8</td>
<td>Mixed</td>
<td>YELLOW</td>
<td>GREEN</td>
<td>Based on a weighted average</td>
</tr>
<tr>
<td></td>
<td>[59]</td>
<td>NA</td>
<td>9-11</td>
<td>F</td>
<td>22</td>
<td>74.4</td>
<td>Mixed</td>
<td>YELLOW</td>
<td>GREEN</td>
<td>Based on a weighted average</td>
</tr>
<tr>
<td></td>
<td>[60]</td>
<td>NA</td>
<td>7-18</td>
<td>F</td>
<td>735</td>
<td>66.2</td>
<td>Mixed</td>
<td>YELLOW</td>
<td>GREEN</td>
<td>Based on a weighted average</td>
</tr>
<tr>
<td></td>
<td>[61]</td>
<td>NA</td>
<td>4-8</td>
<td>F</td>
<td>76</td>
<td>88.2</td>
<td>Mixed</td>
<td>YELLOW</td>
<td>GREEN</td>
<td>Based on a weighted average</td>
</tr>
<tr>
<td></td>
<td>[62]</td>
<td>NA</td>
<td>12-18</td>
<td>F</td>
<td>370</td>
<td>53.7</td>
<td>Mixed</td>
<td>YELLOW</td>
<td>GREEN</td>
<td>Based on a weighted average</td>
</tr>
</tbody>
</table>

(M) Males; (F) Females; (M+F) Combined data for males and females; (NA) No information available.

*Published 25OHD means (or medians if means not available) are presented with the exception of studies marked with a (+). For these studies, the 25OHD level is a mean weighted for sample size. If weighted means couldn’t be calculated, a simple mean was taken.

& Colour codes: RED, < 25nmol/L; ORANGE 25-49nmol/L; YELLOW 50-74nmol/L; GREEN ≥75nmol/L
Male data from references 38 and 40 were considered outliers and were excluded from the weighted mean 25OHD levels.

**Table 2** Country colour codes of vitamin D status in adults.

<table>
<thead>
<tr>
<th>Country</th>
<th>Refs</th>
<th>Representative</th>
<th>Age</th>
<th>Sex</th>
<th>N</th>
<th>25OHD (nmol/L)*</th>
<th>Season</th>
<th>Study colour code*</th>
<th>Country colour code*</th>
<th>Country colour code rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>[63]</td>
<td>No</td>
<td>60+</td>
<td>M</td>
<td>437</td>
<td>70.2 (+)</td>
<td>NA</td>
<td>YELLOW</td>
<td>YELLOW</td>
<td>Based on a weighted average</td>
</tr>
<tr>
<td></td>
<td>[64]</td>
<td>No</td>
<td>20-92</td>
<td>M</td>
<td>861</td>
<td>70.3</td>
<td>Mixed</td>
<td>YELLOW</td>
<td>YELLOW</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[65]</td>
<td>No</td>
<td>51-77</td>
<td>F</td>
<td>253</td>
<td>72.2</td>
<td>NA</td>
<td>YELLOW</td>
<td>YELLOW</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[66]</td>
<td>No</td>
<td>51-79</td>
<td>M+F</td>
<td>880</td>
<td>52.8</td>
<td>NA</td>
<td>YELLOW</td>
<td>YELLOW</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[67]</td>
<td>No</td>
<td>78</td>
<td>M+F</td>
<td>70</td>
<td>33</td>
<td>NA</td>
<td>YELLOW</td>
<td>YELLOW</td>
<td></td>
</tr>
<tr>
<td>Austria</td>
<td>[30]</td>
<td>NA</td>
<td>65-85</td>
<td>M+F</td>
<td>78</td>
<td>9.5</td>
<td>NA</td>
<td>Winter</td>
<td>RED</td>
<td>Based on a weighted average</td>
</tr>
<tr>
<td></td>
<td>[68]</td>
<td>No</td>
<td>21-76</td>
<td>M+F</td>
<td>1089</td>
<td>52.2</td>
<td>Winter</td>
<td>YELLOW</td>
<td>ORANGE</td>
<td></td>
</tr>
<tr>
<td>Belgium</td>
<td>[69]</td>
<td>No</td>
<td>70-90</td>
<td>F</td>
<td>245</td>
<td>56.4</td>
<td>NA</td>
<td>YELLOW</td>
<td>YELLOW</td>
<td>Based on a weighted average</td>
</tr>
<tr>
<td></td>
<td>[70]</td>
<td>No</td>
<td>70-87</td>
<td>F</td>
<td>129</td>
<td>43.2</td>
<td>NA</td>
<td>YELLOW</td>
<td>YELLOW</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[72]</td>
<td>No</td>
<td>20+</td>
<td>M</td>
<td>270</td>
<td>71.5</td>
<td>NA</td>
<td>YELLOW</td>
<td>YELLOW</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[73]</td>
<td>No</td>
<td>24-65</td>
<td>M+F</td>
<td>126</td>
<td>73.5</td>
<td>NA</td>
<td>YELLOW</td>
<td>YELLOW</td>
<td></td>
</tr>
<tr>
<td>Brazil</td>
<td>[74]</td>
<td>Yes</td>
<td>65+</td>
<td>M+F</td>
<td>250</td>
<td>52.4</td>
<td>NA</td>
<td>Mixed</td>
<td>YELLOW</td>
<td>Representative of the entire country, population-based</td>
</tr>
<tr>
<td>Cameroon</td>
<td>[75]</td>
<td>No</td>
<td>60-86</td>
<td>M+F</td>
<td>152</td>
<td>52.7</td>
<td>NA</td>
<td>YELLOW</td>
<td>YELLOW</td>
<td>Based on a single study</td>
</tr>
<tr>
<td>Canada</td>
<td>[76]</td>
<td>No</td>
<td>20-79</td>
<td>M+F</td>
<td>3458</td>
<td>67.7 (+)</td>
<td>Mixed</td>
<td>YELLOW</td>
<td>YELLOW</td>
<td>Based on the entire country, population-based</td>
</tr>
<tr>
<td></td>
<td>[77]</td>
<td>No</td>
<td>27-89</td>
<td>M+F</td>
<td>188</td>
<td>57.3</td>
<td>Mixed</td>
<td>YELLOW</td>
<td>YELLOW</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[78]</td>
<td>No</td>
<td>68-82</td>
<td>M+F</td>
<td>195</td>
<td>66.7</td>
<td>Mixed</td>
<td>YELLOW</td>
<td>YELLOW</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[79]</td>
<td>No</td>
<td>46.8</td>
<td>M+F</td>
<td>741</td>
<td>64.9</td>
<td>NA</td>
<td>Winter</td>
<td>RED</td>
<td></td>
</tr>
<tr>
<td>China</td>
<td>[80]</td>
<td>NA</td>
<td>40-40</td>
<td>M+F</td>
<td>2018</td>
<td>31.7</td>
<td>Mixed</td>
<td>ORANGE</td>
<td>ORANGE</td>
<td>Based on a weighted average</td>
</tr>
<tr>
<td></td>
<td>[81]</td>
<td>NA</td>
<td>40-65</td>
<td>M+F</td>
<td>720</td>
<td>33.1</td>
<td>Mixed</td>
<td>ORANGE</td>
<td>ORANGE</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[82]</td>
<td>No</td>
<td>19-40</td>
<td>M+F</td>
<td>16</td>
<td>43.9</td>
<td>Mixed</td>
<td>ORANGE</td>
<td>ORANGE</td>
<td></td>
</tr>
<tr>
<td>Czech Republic</td>
<td>[83]</td>
<td>No</td>
<td>62.3</td>
<td>F</td>
<td>47</td>
<td>58.2</td>
<td>NA</td>
<td>YELLOW</td>
<td>YELLOW</td>
<td>Based on a single study</td>
</tr>
<tr>
<td>Denmark</td>
<td>[84]</td>
<td>Yes</td>
<td>35-65</td>
<td>M+F</td>
<td>125</td>
<td>25.5</td>
<td>Mixed</td>
<td>ORANGE</td>
<td>ORANGE</td>
<td>Representative of a region/city of the country, population-based</td>
</tr>
<tr>
<td></td>
<td>[85]</td>
<td>NA</td>
<td>50-82</td>
<td>F</td>
<td>315</td>
<td>57.0</td>
<td>Mixed</td>
<td>ORANGE</td>
<td>ORANGE</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[86]</td>
<td>NA</td>
<td>17-87</td>
<td>F</td>
<td>2316</td>
<td>62.0</td>
<td>Mixed</td>
<td>ORANGE</td>
<td>ORANGE</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[87]</td>
<td>No</td>
<td>45-58</td>
<td>F</td>
<td>510</td>
<td>24.0</td>
<td>NA</td>
<td>Winter</td>
<td>RED</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[88]</td>
<td>No</td>
<td>71.6</td>
<td>F</td>
<td>53</td>
<td>47.8</td>
<td>NA</td>
<td>Winter</td>
<td>ORANGE</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[89]</td>
<td>No</td>
<td>20-29</td>
<td>F</td>
<td>16</td>
<td>64.9</td>
<td>Mixed</td>
<td>ORANGE</td>
<td>ORANGE</td>
<td></td>
</tr>
<tr>
<td>Estonia</td>
<td>[90]</td>
<td>Yes</td>
<td>25-70</td>
<td>M+F</td>
<td>367</td>
<td>43.7</td>
<td>Winter</td>
<td>ORANGE</td>
<td>ORANGE</td>
<td>Representative of a region/city of the country, population-based</td>
</tr>
<tr>
<td>Fidji Islands</td>
<td>[91]</td>
<td>NA</td>
<td>15-44</td>
<td>F</td>
<td>511</td>
<td>76.0</td>
<td>Winter</td>
<td>GREEN</td>
<td>GREEN</td>
<td>Based on a single study</td>
</tr>
<tr>
<td>Finland</td>
<td>[92]</td>
<td>Yes</td>
<td>30+</td>
<td>M+F</td>
<td>6937</td>
<td>42.9</td>
<td>NA</td>
<td>Mixed</td>
<td>ORANGE</td>
<td>Representative of the entire country, population-based, and based on a weighted average</td>
</tr>
<tr>
<td></td>
<td>[93]</td>
<td>Yes</td>
<td>30+</td>
<td>M+F</td>
<td>6219</td>
<td>43.4</td>
<td>NA</td>
<td>Mixed</td>
<td>ORANGE</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[94]</td>
<td>No</td>
<td>30-97</td>
<td>M</td>
<td>2736</td>
<td>43.4</td>
<td>NA</td>
<td>Mixed</td>
<td>ORANGE</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[95]</td>
<td>No</td>
<td>30+</td>
<td>M+F</td>
<td>3299</td>
<td>45.1</td>
<td>Mixed</td>
<td>ORANGE</td>
<td>ORANGE</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[96]</td>
<td>No</td>
<td>40-69</td>
<td>M+F</td>
<td>6241</td>
<td>45.2</td>
<td>Mixed</td>
<td>ORANGE</td>
<td>ORANGE</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[97]</td>
<td>NA</td>
<td>31-43</td>
<td>M</td>
<td>4907</td>
<td>43.6</td>
<td>Mixed</td>
<td>ORANGE</td>
<td>ORANGE</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[98]</td>
<td>NA</td>
<td>20-64</td>
<td>M</td>
<td>126</td>
<td>45.0</td>
<td>Mixed</td>
<td>ORANGE</td>
<td>ORANGE</td>
<td></td>
</tr>
<tr>
<td>France</td>
<td>[99]</td>
<td>NA</td>
<td>35-65</td>
<td>M+F</td>
<td>1569</td>
<td>61.0</td>
<td>Winter</td>
<td>YELLOW</td>
<td>YELLOW</td>
<td>Based on a weighted average</td>
</tr>
<tr>
<td></td>
<td>[100]</td>
<td>No</td>
<td>35-65</td>
<td>M</td>
<td>1191</td>
<td>79.5</td>
<td>Winter</td>
<td>YELLOW</td>
<td>YELLOW</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[101]</td>
<td>No</td>
<td>18-62</td>
<td>F</td>
<td>70</td>
<td>80.9 (+)</td>
<td>Winter</td>
<td>YELLOW</td>
<td>YELLOW</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[102]</td>
<td>No</td>
<td>18-76</td>
<td>F</td>
<td>94</td>
<td>71.5 (+)</td>
<td>Winter</td>
<td>YELLOW</td>
<td>YELLOW</td>
<td></td>
</tr>
<tr>
<td>Gambia</td>
<td>[103]</td>
<td>No</td>
<td>25+</td>
<td>F</td>
<td>112</td>
<td>44.7</td>
<td>NA</td>
<td>ORANGE</td>
<td>ORANGE</td>
<td>Based on a single study</td>
</tr>
<tr>
<td>Germany</td>
<td>[104]</td>
<td>Yes</td>
<td>18-79</td>
<td>M</td>
<td>1763</td>
<td>45.2</td>
<td>NA</td>
<td>ORANGE</td>
<td>ORANGE</td>
<td>Representative of the entire country,</td>
</tr>
<tr>
<td>Country</td>
<td>Age</td>
<td>Gender</td>
<td>Study Type</td>
<td>Weighted Average</td>
<td>Population-based, and based on a weighted average</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------</td>
<td>-----</td>
<td>--------</td>
<td>------------</td>
<td>------------------</td>
<td>-----------------------------------------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Greece</td>
<td>60-89</td>
<td>M+F</td>
<td>Mixed</td>
<td>NA</td>
<td>Orange</td>
<td>Yellow</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iceland</td>
<td>30-85</td>
<td>M+F</td>
<td>Mixed</td>
<td>NA</td>
<td>Orange</td>
<td>Yellow</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>India</td>
<td>18+</td>
<td>M+F</td>
<td>Winter</td>
<td>NA</td>
<td>Orange</td>
<td>Yellow</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iran</td>
<td>20-74</td>
<td>M</td>
<td>Winter</td>
<td>NA</td>
<td>Orange</td>
<td>Yellow</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ireland</td>
<td>Elderly</td>
<td>M+F</td>
<td>Represented of the entire country, population-based</td>
<td>NA</td>
<td>Orange</td>
<td>Orange</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Israel</td>
<td>20+</td>
<td>M+F</td>
<td>Winter</td>
<td>NA</td>
<td>Orange</td>
<td>Yellow</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Italy</td>
<td>65+</td>
<td>M+F</td>
<td>Mixed</td>
<td>NA</td>
<td>Orange</td>
<td>Yellow</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Japan</td>
<td>46-80</td>
<td>M</td>
<td>Winter</td>
<td>NA</td>
<td>Orange</td>
<td>Yellow</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jordan</td>
<td>29-38</td>
<td>F</td>
<td>Mixed</td>
<td>Orange</td>
<td>Orange</td>
<td>Orange</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Korea (South)</td>
<td>40+</td>
<td>M+F</td>
<td>Mixed</td>
<td>Orange</td>
<td>Orange</td>
<td>Orange</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lebanon</td>
<td>65-85</td>
<td>M+F</td>
<td>Mixed</td>
<td>Orange</td>
<td>Orange</td>
<td>Yellow</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Malaysia</td>
<td>50-65</td>
<td>F</td>
<td>Winter</td>
<td>NA</td>
<td>Orange</td>
<td>Yellow</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Netherlands</td>
<td>65-88</td>
<td>M+F</td>
<td>Mixed</td>
<td>Orange</td>
<td>Yellow</td>
<td>Yellow</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>New Zealand</td>
<td>35-64</td>
<td>M</td>
<td>Mixed</td>
<td>Orange</td>
<td>Green</td>
<td>Yellow</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>40+</td>
<td>F</td>
<td>Winter</td>
<td>NA</td>
<td>Orange</td>
<td>Yellow</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Country</td>
<td>Gender</td>
<td>Age Group</td>
<td>Methodology</td>
<td>Weighted Average</td>
<td>Color</td>
<td>Notes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------</td>
<td>--------</td>
<td>-----------</td>
<td>-------------</td>
<td>------------------</td>
<td>-------</td>
<td>-------</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Norway</td>
<td>M+F</td>
<td>65-74</td>
<td>Population-based, weighted average</td>
<td>67.2</td>
<td>Mixed</td>
<td>Based on a weighted average</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>65-74</td>
<td>Population-based, weighted average</td>
<td>59.0</td>
<td>Mixed</td>
<td>Based on a weighted average</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>M+F</td>
<td>65-74</td>
<td>Population-based, weighted average</td>
<td>53.0</td>
<td>Mixed</td>
<td>Based on a weighted average</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saudi Arabia</td>
<td>F</td>
<td>65-74</td>
<td>Population-based, weighted average</td>
<td>68.0</td>
<td>Mixed</td>
<td>Based on a weighted average</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>South Africa</td>
<td>M+F</td>
<td>65-74</td>
<td>Population-based, weighted average</td>
<td>70.0</td>
<td>Mixed</td>
<td>Based on a weighted average</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spain</td>
<td>M+F</td>
<td>65-74</td>
<td>Population-based, weighted average</td>
<td>62.0</td>
<td>Mixed</td>
<td>Based on a weighted average</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>65-74</td>
<td>Population-based, weighted average</td>
<td>54.0</td>
<td>Mixed</td>
<td>Based on a weighted average</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>M+F</td>
<td>65-74</td>
<td>Population-based, weighted average</td>
<td>48.0</td>
<td>Mixed</td>
<td>Based on a weighted average</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sweden</td>
<td>M+F</td>
<td>65-74</td>
<td>Population-based, weighted average</td>
<td>60.0</td>
<td>Mixed</td>
<td>Based on a weighted average</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>65-74</td>
<td>Population-based, weighted average</td>
<td>52.0</td>
<td>Mixed</td>
<td>Based on a weighted average</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>M+F</td>
<td>65-74</td>
<td>Population-based, weighted average</td>
<td>46.0</td>
<td>Mixed</td>
<td>Based on a weighted average</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Switzerland</td>
<td>M+F</td>
<td>65-74</td>
<td>Population-based, weighted average</td>
<td>65.0</td>
<td>Mixed</td>
<td>Based on a weighted average</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>65-74</td>
<td>Population-based, weighted average</td>
<td>57.0</td>
<td>Mixed</td>
<td>Based on a weighted average</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>M+F</td>
<td>65-74</td>
<td>Population-based, weighted average</td>
<td>51.0</td>
<td>Mixed</td>
<td>Based on a weighted average</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>United Kingdom</td>
<td>M+F</td>
<td>65-74</td>
<td>Population-based, weighted average</td>
<td>60.0</td>
<td>Mixed</td>
<td>Based on a weighted average</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>65-74</td>
<td>Population-based, weighted average</td>
<td>52.0</td>
<td>Mixed</td>
<td>Based on a weighted average</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>M+F</td>
<td>65-74</td>
<td>Population-based, weighted average</td>
<td>46.0</td>
<td>Mixed</td>
<td>Based on a weighted average</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>USA</td>
<td>M+F</td>
<td>65-74</td>
<td>Population-based, weighted average</td>
<td>65.0</td>
<td>Mixed</td>
<td>Based on a weighted average</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>65-74</td>
<td>Population-based, weighted average</td>
<td>57.0</td>
<td>Mixed</td>
<td>Based on a weighted average</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>M+F</td>
<td>65-74</td>
<td>Population-based, weighted average</td>
<td>51.0</td>
<td>Mixed</td>
<td>Based on a weighted average</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Title</td>
<td>Gender</td>
<td>Age</td>
<td>Population</td>
<td>Region/City of the Country</td>
<td>Population-Based Data for a Region/City of the Country</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>--------</td>
<td>--------</td>
<td>-------</td>
<td>------------</td>
<td>----------------------------</td>
<td>----------------------------------------------------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vietnam</td>
<td>Yes</td>
<td>18-87</td>
<td>205</td>
<td>F</td>
<td>GREEN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[230]</td>
<td></td>
<td></td>
<td>432</td>
<td>F</td>
<td>GREEN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>182</td>
<td>F</td>
<td>YELLOW</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(M) males; (F) females; (M+F) combined data for males and females; (NA) No information available.

*Published 25OHD means (or medians if means not available) are presented with the exception of studies marked with a (+). For these studies, the 25OHD level is a mean weighted for sample size. If weighted mean couldn’t be calculated, a simple mean was taken.

& Colour code: RED, < 25nmol/L; ORANGE 25-49nmol/L; YELLOW 50-74nmol/L; GREEN ≥75nmol/L

(a) A previous study of the same cohort [231] reported median 25OHD levels of 20.6 nmol/L. This does not affect the colour of the overall country.

(b) Unknown number per gender – overall study population is 976.

(c) Unknown number – subset of 1311 people measured in winter

(d) Unknown number – the entire cohort for the 4 regions in the UK represented 924 individuals.

(e) Mean 25OHD was not stated in the publication but it was calculated using the information provided.
97. Lamberg-Allardt CJ, Outila TA, Karkkainen MU, Rita HJ, Valsta LM (2001) Vitamin D deficiency and bone health in healthy adults in Finland: could this be a concern in other parts of Europe? J Bone Miner Res 16:2066-2073


188. Macdonald HM, Mavroeidi A, Barr RJ, Black AJ, Fraser WD, Reid DM (2008) Vitamin D status in postmenopausal women living at higher latitudes in the UK in relation to bone health, overweight, sunlight exposure and dietary vitamin D. Bone 42:996-1003


Figure 1
Figure 2

- Green: >75 nmol/L
- Yellow: 50-74 nmol/L
- Orange: 25-49 nmol/L
- Red: <25 nmol/L
Author/s:
Wahl, DA; Cooper, C; Ebeling, PR; Eggersdorfer, M; Hilger, J; Hoffmann, K; Josse, R; Kanis, JA; Mithal, A; Pierroz, DD; Stenmark, J; Stöcklin, E; Dawson-Hughes, B

Title:
A global representation of vitamin D status in healthy populations.

Date:
2012

Citation:
Wahl, DA; Cooper, C; Ebeling, PR; Eggersdorfer, M; Hilger, J; Hoffmann, K; Josse, R; Kanis, JA; Mithal, A; Pierroz, DD; Stenmark, J; Stöcklin, E; Dawson-Hughes, B, A global representation of vitamin D status in healthy populations., Arch Osteoporos, 2012, 7 pp. 155 - 172

Persistent Link:
http://hdl.handle.net/11343/220606

File Description:
Accepted version