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## Is vitamin D deficiency a major global public health problem?

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### Abstract

Vitamin D deficiency is a major public health problem worldwide in all age groups, even in those residing in countries with low latitude, where it was generally assumed that UV radiation was adequate enough to prevent this deficiency, and in industrialized countries, where vitamin D fortification has been implemented now for years. However, most countries are still lacking data, particularly population representative data, with very limited information in infants, children, adolescents and pregnant women. Since the number of recent publications is escalating, with a broadening of the geographic diversity, the objective of the present report was to conduct a more recent systematic review of global vitamin D status, with particular emphasis in at risk groups. A systematic review was conducted in PubMed/Medline in April-June 2013 to identify articles on vitamin D status worldwide published in the last 10 years in apparently healthy individuals. Only studies with vitamin D status prevalence were included. If available, the first source selected was population-based or representative samples studies. Clinical trials, case-control studies, case reports or series, reviews, validation studies, letters, editorials, or qualitative studies were excluded. A total of 103 articles were eligible and included in the present report. Maps were created for each age group, providing an updated overview of global vitamin D status. In areas with available data, the prevalence of low vitamin D status is a global problem in all age groups, in particular in girls and women from the Middle East. These maps also evidenced the regions with missing data for each specific population groups. There is striking lack of data in infants, children and adolescents worldwide, and in most countries of South America and Africa. In conclusion, vitamin D deficiency is a global public health problem in all age groups, particularly in those from the Middle East.

### Keywords

vitamin D deficiency; infants; children; adolescents; adults; elder; pregnancy

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## Introduction

Vitamin D is an essential fat-soluble vitamin for calcium maintenance homeostasis, for bone health and for preventing falls and fractures, and it has also been related to hypertension, diabetes, metabolic syndrome, cancer, autoimmune and infectious diseases, among others (1). These conditions are major public health problems worldwide.

Several reviews have found high prevalence of vitamin D deficiency worldwide (2–4), even in countries with low latitude, where it was generally assumed that UVB radiation was adequate enough to prevent vitamin D deficiency, and in industrialized countries, where vitamin D fortification has been implemented now for years; although substantial fortification has only occurred in a few countries. However, prevalence of vitamin D deficiency worldwide is still uncertain, as there is data lacking from many countries. About 1 billion people have low vitamin D levels and this is found in all ethnicities and age groups (1).

The available reviews illustrate the lack of data in most countries, particularly population representative data, with very limited information in infants, children, adolescents and pregnant women. However, the number of recent publications in this area is escalating, with a broadening of the geographic diversity. Therefore, the objective of the present report was to conduct a systematic review of recent literature on global vitamin D status, with a particular emphasis on at risk groups.

## Methods

### Identification and selection of studies

A systematic review was conducted in PubMed/Medline in April-June 2013 to identify articles on vitamin D status worldwide published in the last 10 years. Two independent reviewers performed the search using the keywords “vitamin D status or deficiency or insufficiency” or any form for “25(OH)D”.

### Eligibility criteria

Only studies in English with data on low vitamin D status prevalence, as determined from serum 25(OH)D levels measured by any method, in apparently healthy individuals were included. If available, the first source selected was population-based studies. If not available, cross-sectional studies were used. Clinical trials, case-control studies, case reports or series, reviews, validation studies, letters, editorials, or qualitative studies were excluded. When available, the data was specified by gender, age, skin pigmentation and season of the year. A total of 3226 articles were identified; after the initial review, 2860 did not meet the inclusion criteria. An additional 263 were excluded after title and abstract reviewing due to very small sample size; a larger sample from the same country was found; use of non-healthy population; no data on prevalence of vitamin D status or duplicated. A total of 103 articles were eligible and included in the present report.

## Levels used for vitamin D status

There has been a long debate on the cutoff points for vitamin D status. The Institute of Medicine considers inadequate if 25(OH)D levels are <50 nmol/L (<20 ng/mL) (5). However, many consider inadequate/insufficient if levels are <75 nmol/l (30 ng/mL). For the present analysis, the cutoff points used were: <30 nmol/l (12 ng/mL); <50 nmol/l (<20 ng/mL) and <75 nmol/l (30 ng/mL). When studies used different cut-off points, it was specified.

Maps of vitamin D status worldwide were created for each age group. Corresponding detailed tables can be found in the online version.

## Results

Figure 1 shows the prevalence of low vitamin D status in infants worldwide. A total of 12 studies were found; 3 in America, 1 in Europe, 1 in Africa, 6 in Asia, and 1 in Oceania. The highest prevalence of vitamin D deficiency was found in neonates from the Middle East. Figure 2 illustrates the prevalence of low vitamin D status in children worldwide. A total of 17 studies were found; 5 in America, 2 in Europe, 1 in Africa, 8 in Asia and 1 in Oceania. Again, the highest prevalence of vitamin D deficiency was found in children from the Middle East. A total of 15 studies were found reporting the prevalence of low vitamin D status in adolescents (Figure 3); 5 in America, 2 in Europe (1 representing 9 countries), 7 in Asia, 1 in Oceania and none in Africa. The highest prevalence of vitamin D deficiency was found in girls from the Middle East. In adults, a total of 32 studies were found; 7 in America, 9 in Europe, 2 in Africa, 11 in Asia, 3 in Oceania (Figure 4). As with the other age groups, adults from the Middle East had higher deficiency rates, particularly in women. In pregnant and lactating women, a total of 17 studies were found; 2 in America, 6 in Europe, 1 in Africa, 7 in Asia, 1 in Oceania (Figure 5). Very high deficiency rates were found in those from the Middle East. In elders, a total of 31 studies were found; 9 in America, 10 in Europe, 1 in Africa, 9 in Asia, 2 in Oceania (Figure 6). Most countries reported high vitamin D deficiency prevalence.

## Discussion

This review provides an updated overview of global vitamin D status. In areas with available data, the prevalence of low vitamin D status is a global problem in all age groups, even in countries with sun exposure all year round. It is important to note that the problem is greater in the Middle East, particularly in girls and women. The data also pinpoint the regions with missing data for each specific population groups. There is a striking lack of data in infants, children and adolescents, and in most countries of South America and Africa.

In general, this high prevalence of low vitamin D status may be related to several issues, such as less vitamin D photosynthesis in response to UVB in individuals with high skin melanin content or due to aging, use of extensive skin coverage and scarce exposure to sunlight, which has often been described in individuals from Africa, the Middle East and Central and South America. Moreover, a low vitamin D intake and high rates of obesity worldwide can also contribute to the problem. Season appears to be a small component to

the problem worldwide, as countries with long winters have less deficiency rates overall compared to sunny countries, which is probably related to the fortification of staples, consumption of fatty fish and regular use of vitamin D supplements.

There are several limitations of the present report. The data from vitamin D status was derived from a variety of methods used in the different reports. This measurement is difficult, with large variations between methods and between laboratories using the same methods. In addition, there is lacking representative data from many countries, which precludes the ability to accurately assess vitamin D status from such countries; this is particularly important in countries with different latitudes within its territory.

In conclusion, the available data indicates that vitamin D deficiency is a global public health problem, in all age groups, particularly in those from the Middle East.

## Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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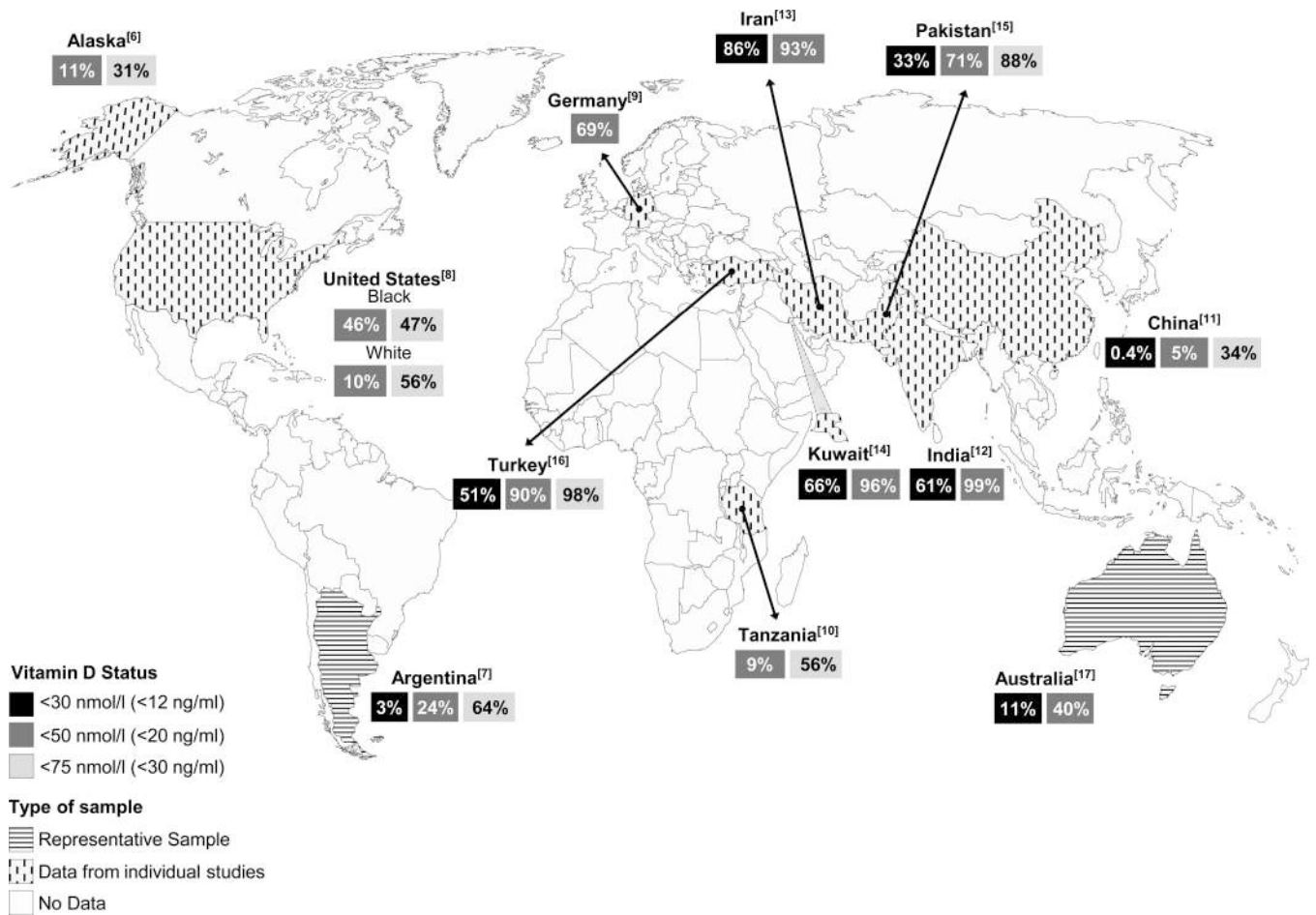


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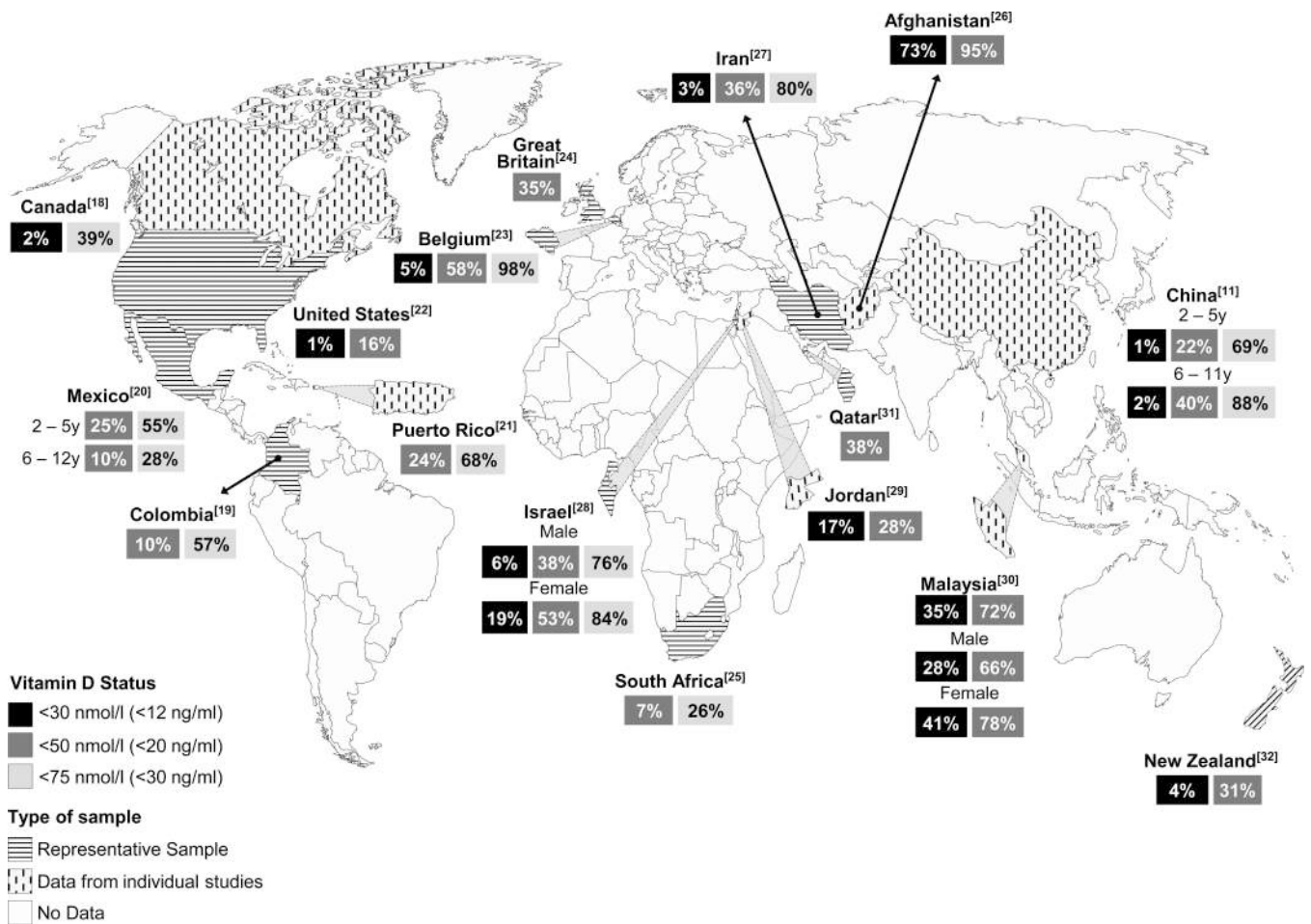
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### Highlights

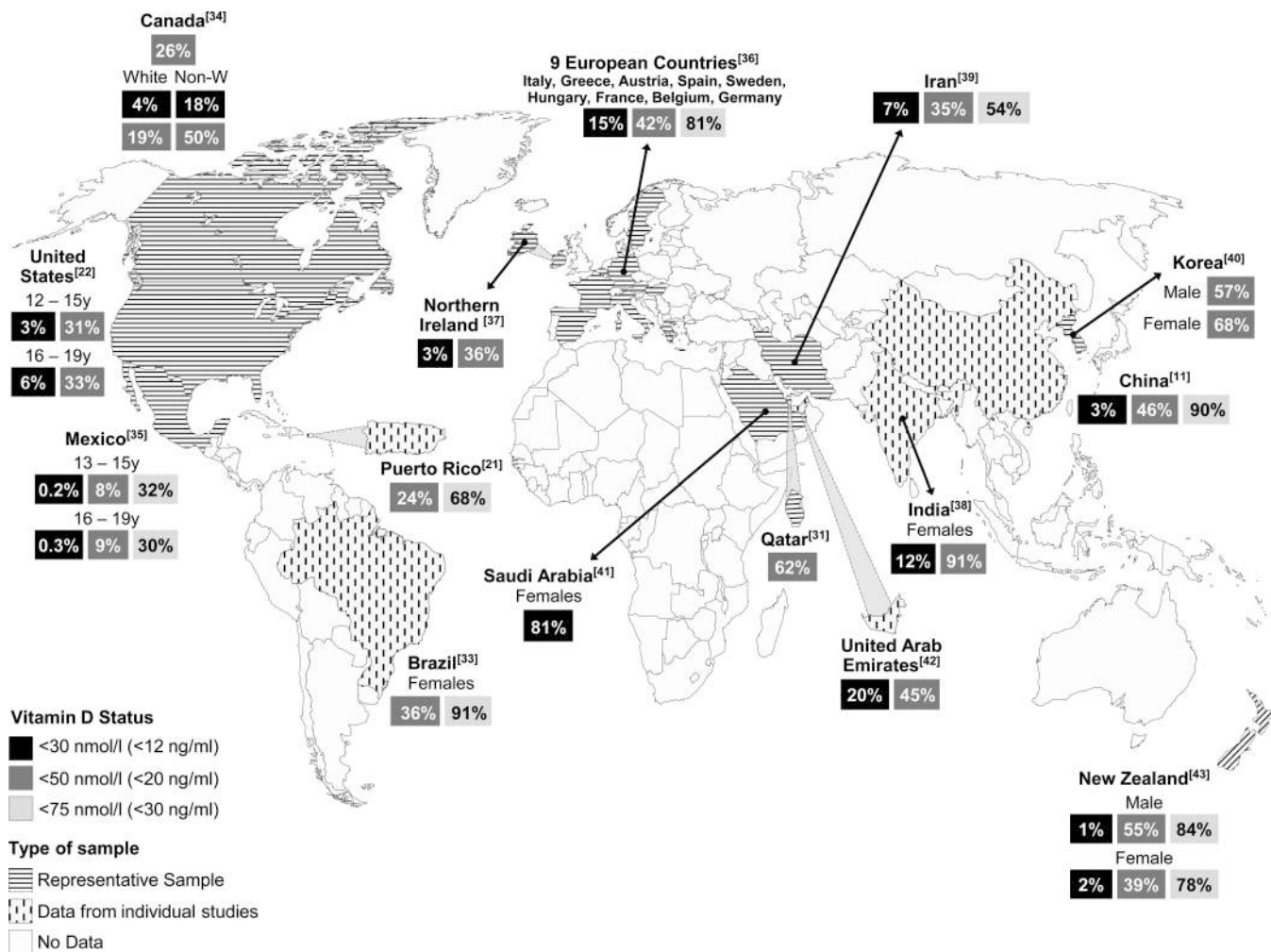
- Vitamin D deficiency is a major public health problem worldwide in all age groups.
- Low vitamin D status is a problem even in countries with sun exposure all year round.
- This problem is particularly high in the Middle East, specially among girls and women.
- There is striking lack of vitamin D status data in infants, children and adolescents
- There is also lack of data in most countries of South America and Africa.



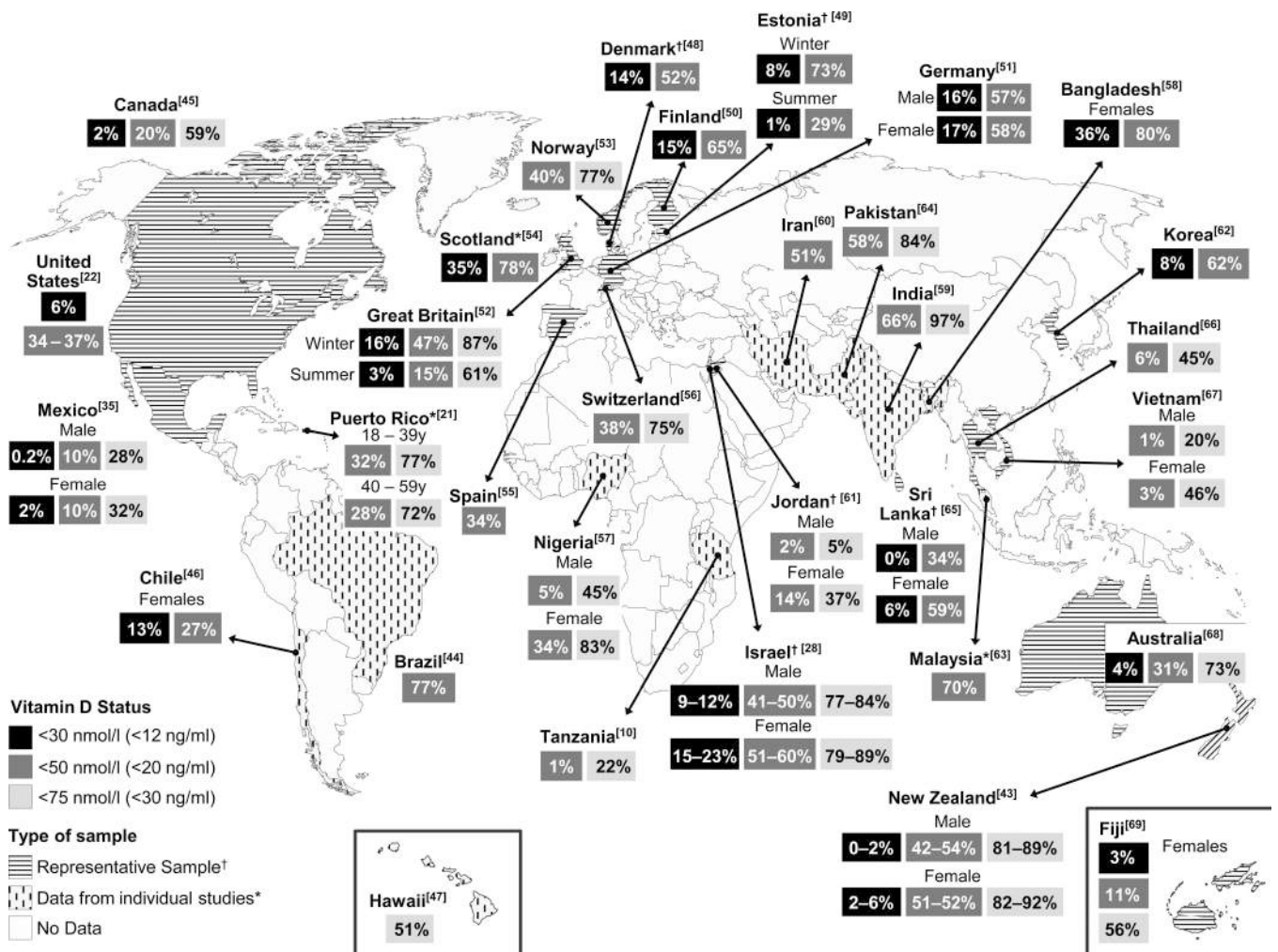
**Figure 1.** Prevalence of low vitamin D status in infants worldwide.



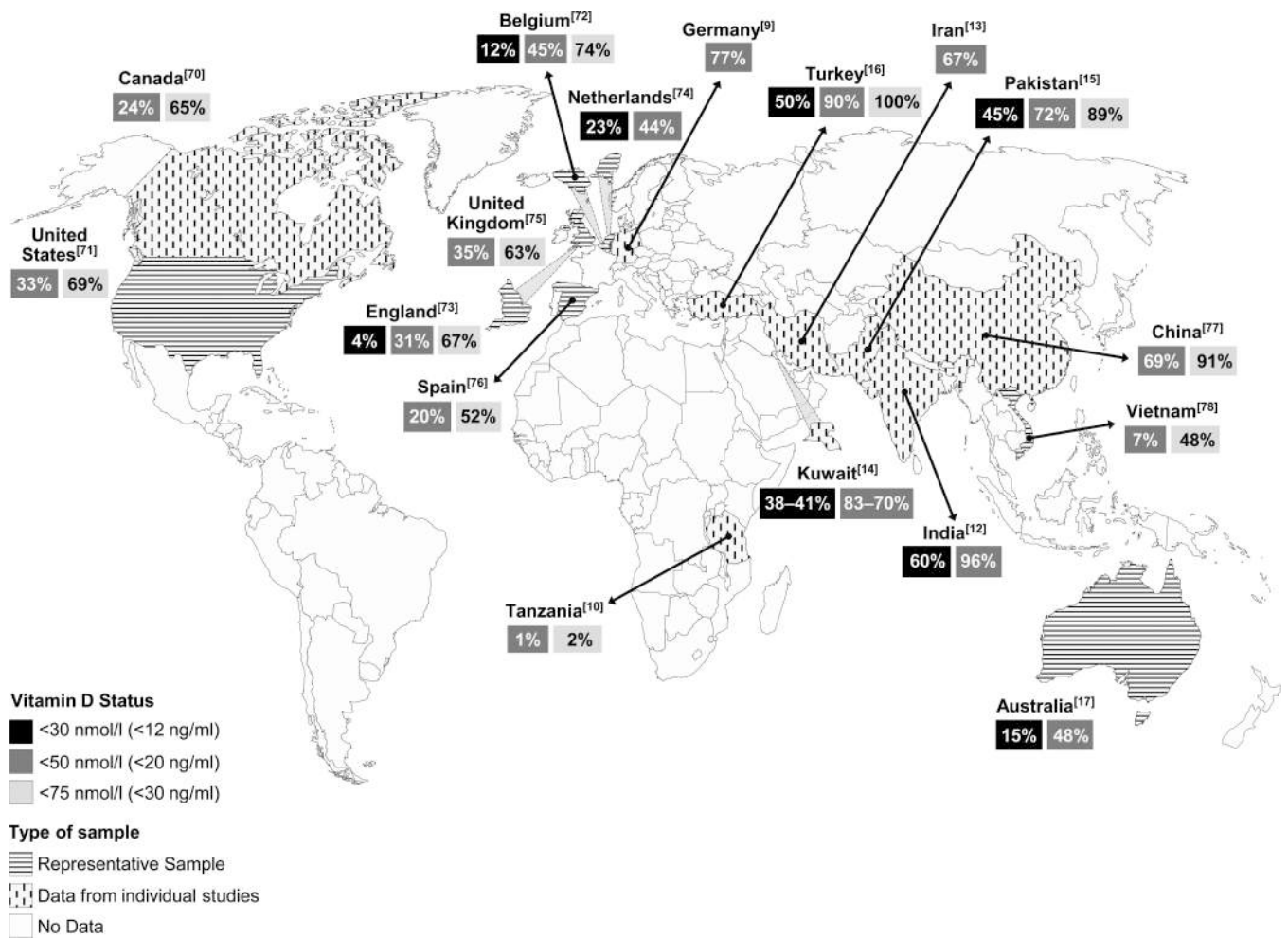
**Figure 2.**  
Prevalence of low vitamin D status in children worldwide.



**Figure 3.** Prevalence of low vitamin D status in adolescents worldwide.

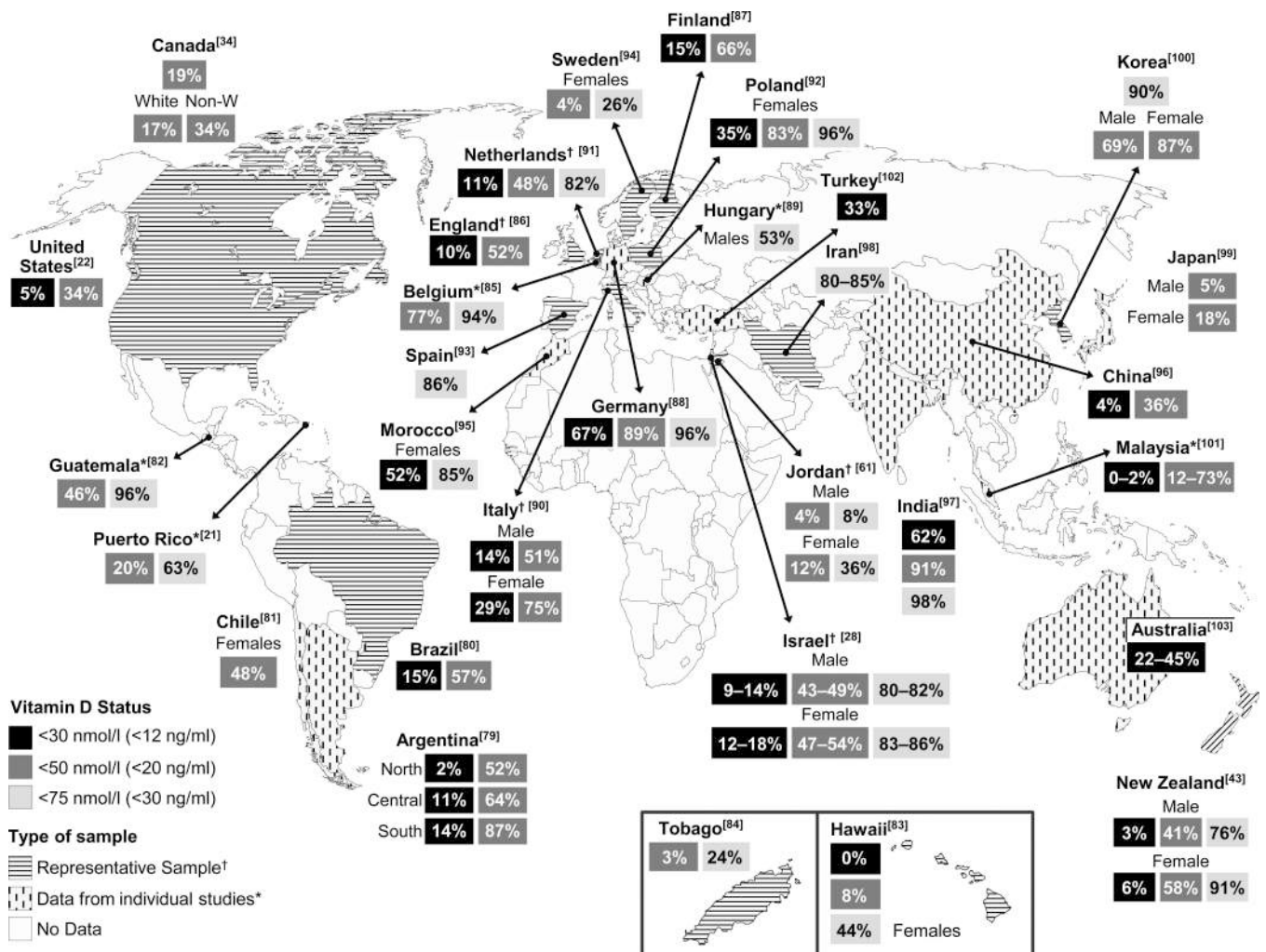


**Figure 4.** Prevalence of low vitamin D status in adults worldwide.



**Figure 5.** Prevalence of low vitamin D status in pregnant or lactating women worldwide.





**Figure 6.** Prevalence of low vitamin D status in elders worldwide.