Toolkit

Calcium and vitamin D intakes across dietary patterns

Comparing intake of omnivorous and plant-based dietary patterns

A systematic review in 2022 found that dietary calcium intakes were slightly lower in vegans when compared to vegetarians and meat-eaters[1]. However, more than one third of studies reported intakes below the estimated average requirements for all dietary patterns, indicating inadequate intakes in the general population. Similarly, vegetarians and vegans may be at slightly higher risk of vitamin D deficiency due to reduced intake of foods such as fish and eggs, however dietary sources cannot be relied upon for any dietary patterns and all European populations are at risk of deficiency regardless of diet[2,3].

All European populations are at risk of vitamin D deficiency regardless of diet

Plant-based diets and bone health

Low calcium intake is common

Several large investigations have been carried out to explore the impact of plant-based dietary patterns on bone health[4,5,6,7]. These studies have raised concerning headlines due to the higher risk of total bone fracture found for those on vegan diets when compared to meat-eaters. There were however many contributing factors in these results that were not directly related to dietary pattern. For example, in one study, a 30% increased risk of fracture found in vegans disappeared when adjusting for calcium intake[6]. Another study found that vegetarians had an increased risk of fracture, but also consumed less protein, iron, iodine, niacin, selenium, vitamin B12 and vitamin D, plus they only achieved a daily average of 22.6g of fibre and similar levels of saturated fat to meat-eaters[7]. Although these vegetarians had lower rates of heart disease, cancer and type 2 diabetes, the results suggest that they were not achieving a high-quality diet supportive of bone health[7]. In fact, studies investigating postmenopausal women have found a protective effect of healthy plant-based diets compared to unhealthy plant-based diets on bone loss and risk of osteoporosis[8,9].

As well as the potential for low levels of certain nutrients, those on a fully plant-based diet had a lower body mass index (BMI) which has been linked to increased bone fracture regardless of dietary pattern[10]. In addition, most results related to females, rather than males, who also had lower use of hormone replacement therapy, low levels of vitamin D and B12 supplementation and higher levels of physical activity, which has the potential to increase impact fracture rates, although this was not explored. These investigations highlight the importance of a high-quality diet, appropriate supplementation, use of fortified foods and a bone-healthy lifestyle on any dietary pattern. These factors may be of even more importance when following a plant-based dietary pattern.

High-quality diet, supplementation, use of fortified foods and a bone-healthy lifestyle are crucial

Ways to meet calcium and vitamin D requirements on a plant-based diet

Sources

It is important for everyone to meet calcium and vitamin D requirements regardless of dietary preferences.

It is possible to meet calcium requirements on a planned plant-based diet with the use of fortified products alongside naturally calcium-rich plants.

Plant-based alternatives to dairy products, such as soya, almond and oat drinks, are regularly fortified with calcium and have a similar bioavailability to cow's milk[11]. Naturally calcium-rich plant foods can also support dietary intake but are not recommended to be relied upon as main sources due to their lower calcium content. Some plant foods with a higher calcium content also contain higher levels of phytates and oxalates which adversely impact absorption, such as spinach and rhubarb, and these are not recommended to be used as calcium sources[11]. Table 1 displays the calcium content of various animal and plant-based foods[11].

Calcium content of various animal and plant-based foods[12,16]

Table 1

Food	Quantity	Calcium content (mg)
Cow's milk	100ml	120
Cheddar cheese	30g	222
Yogurt (whole)	120g	193
Calcium-fortified plant-based alternative to milk	100ml	120-189
Calcium-fortified plant-based alternative to yoghurt or custard	100g	120-211
Calcium-fortified coconut cheese	30g	45-221
Calcium-set tofu (uncooked)	100g	350-400
Calcium fortified cereals	30g	136-174
Calcium-fortified bread	50g	179
Wholemeal	50g	430
Orange	120g	29
Broccoli (boiled)	85g	36
Kale (boiled)	100g	150
Spring greens	75g	56
Tahini	15g	102
Dried figs	50g	75
Almonds	30g	81

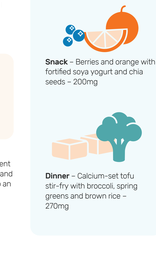
Mitigation strategies

Table 2 provides some food sources of vitamin D, however dietary intake should not be relied upon for sufficient levels.

Main food sources of vitamin D[13]

Table 2

Food	Vitamin D (µg per 100g)
Cod liver oil	210
Mackerel, raw	8.2
Salmon, raw	7.1
Salmon, grilled	5.9
Egg yolk	4.9
Fortified plant-based drinks	0.75



Supplementation advice

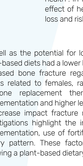
Sufficient calcium can most often be achieved through diet alone, which provides the benefits of a food matrix with additional and complementary nutrients. Calcium supplementation is usually only required in specific circumstances where dietary calcium is deficient. There have been some concerns over the safety of taking high dose calcium supplementation[14], however the UK's national health service (NHS) recommends that calcium supplementation up to 1500mg per day is unlikely to cause harm[15].

As most Europeans do not reach dietary recommendations for vitamin D, fortification programmes and supplements play a key role in supporting intakes. In the UK, it is recommended that in addition to at-risk groups such as older adults, pregnant and breastfeeding women and those with darker skin pigmentation should take a daily 400 IU (10µg) supplement all year round, all adults should consider doing the same, particularly in the autumn and winter[16].

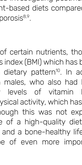
Ways to increase calcium and vitamin D on a plant-based or dairy-free diet:

Choose a calcium and vitamin D fortified plant-based milk alternative throughout the day in cereal or porridge, hot drinks and cooking.

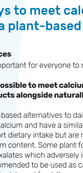
Add a calcium and vitamin D fortified plant-based alternative to yogurt to your breakfast, snacks and desserts.



Choose tofu that is calcium-set, indicated by the word 'calcium' in the ingredients list in the form of calcium sulphate or similar.



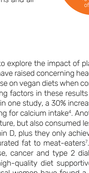
Regularly add low-oxalate leafy green vegetables such as spring greens, kale and broccoli to meals.



Top up with additional calcium-rich plants such as oranges, almonds, dried figs and tahini.

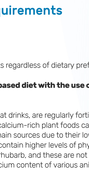
Consider taking a 400 IU (10µg) Vitamin D supplement during the winter season, and all year round if falling into an at-risk population.

Calcium-rich plant-based meal ideas (approximate values)



Breakfast – Porridge made with fortified almond drink and flax seed topped with chopped dried figs and almonds – 320mg

Lunch – Wholewheat wrap with rocket salad, hummous and tahini dressing – 160mg



Snack – Berries and orange with fortified soya yogurt and chia seeds – 200mg

Dinner – Calcium-set tofu stir-fry with broccoli, spring greens and brown rice – 270mg

References

1. Neufingerl N, Eilander A. Nutrient Intake and Status in Adults Consuming Plant-Based Diets Compared to Meat-Eaters: A Systematic Review. Nutrients. 2021;14(1):29. Published 2021 Dec 23.doi:10.3390/nu14010029. Accessed 15.11.2024. Available from: https://pubmed.ncbi.nlm.nih.gov/35010504/
2. Gallchoir A.U., Ryan,M. Vitamin D and its status in vegetarians and vegans. Problems of Biological Medical and Pharmaceutical Chemistry. 2021. Vol. 24 , N. 11 , P. 20-27. doi:10.29296/25877313-2021-11-04 Accessed 15.11.2024. Available from: https://journals.eco-vector.com/1560-1936/article/view/70896
3. Dussaint L, Andersen E, Zandstra J. Geographical differences in vitamin D status, with particular reference to European countries. Proc Nutr Soc. 2005;64(4):493-501. doi:10.1079/PNS2005479.Accessed 15.11.2024. Available from: https://pubmed.ncbi.nlm.nih.gov/16248482/
4. Tong TYN, Appleby PN, Armstrong MEG, et al. Vegetarian and vegan diets and risks of total and site-specific fractures: results from the prospective EPIC-Oxford study. BMC Med.2020;18(1):353. Published 2020 Nov 23. doi:10.1186/s12916-020-01791-5. Accessed 15.11.2024. Available from: https://pubmed.ncbi.nlm.nih.gov/33222682/
5. Webster, J., Greenwood, D.C. & Cade, J.E. Risk of hip fracture in meat-eaters, pescatarians, and vegetarians: results from the UK Women's Cohort Study. BMC Med 20, 275 (2022). https://doi.org/10.1186/s12916-022-02468-0. Accessed 15.11.2024. Available from: https://bmcmedicine.biomedcentral.com/articles/10.1186/s12916-022-02468-0#Abs1#
6. Thorpe DL, Beeson WL, Knutsen R, Fraser GE, Knutsen SF. Dietary patterns and hip fracture in the Adventist Health Study 2: combined vitamin D and calcium supplementation mitigated increased hip fracture risk among vegans. Am J Clin Nutr. 2021;114(2):488-495. doi:10.1093/ajcn/nqab055. Accessed 15.11.2024. Available from: https://pubmed.ncbi.nlm.nih.gov/33954950/#website 3. Greenwood DC, Cade JE. Risk of hip fracture in meat-eaters, pescatarians, and vegetarians: a prospective cohort study of 472,794 UK Biobank participants. BMC Med. 2022;20(1):225. Published 2022 Jun 27. doi:10.1186/s12916-022-02427-9. Accessed 15.11.2024. Available from: https://pubmed.ncbi.nlm.nih.gov/35761256/
7. Yu J, Li Y, Wang Z, et al. Association of plant-based dietary patterns with the risk of osteoporosis in community-dwelling adults over 50 years: a cross-sectional study. Osteoporos Int.2023;34(12):2179-2193. doi:10.1007/s00198-023-06780-2. Accessed 15.11.2024. Available from: https://pubmed.ncbi.nlm.nih.gov/37656219/
8. Ghodsi M, Omidvar S, Shahraki Z, Ibrahim S, Nouri M, Ganjali SP. Healthy plant-based diet index as a determinant of bone mineral density in osteoporotic postmenopausal women: A case-control study. Front Nutr. 2023;9:1083485. Published 2023 Jan 12. doi:10.3389/fnut.2022.1083485. Accessed 15.11.2024. Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC9879057/
9. De Lain C, Kerin JA, Dilkin A, et al. Body mass index as a predictor of fracture risk: a meta-analysis. Osteoporos Int. 2005;16(11):1331-1338. doi:10.1007/s00198-005-1865-1. Accessed15.11.2024. Available from: https://pubmed.ncbi.nlm.nih.gov/15928804/
10. Shkembi B, Huppertz T. Calcium Absorption from Food Products: Food Matrix Effects. Nutrients. 2021;14(1):180. Published 2021 Dec 30. doi:10.3390/nu14010180. Accessed 15.11.2024. Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC8746888/
11. Public Health England. Composition of Foods Integrated Dataset (CoFID). 2015. Updated 2021. Accessed 15.11.2024. Available from: www.gov.uk/government/publications/composition-of-foods-integrated-dataset-cofid
12. Food Standards Agency (FSA) (2002) McCance and Widdowson's The Composition of Foods, 6th summary edition. Cambridge: Royal Society of Chemistry. Accessed 15.11.2024. Availablefrom: https://www.researchgate.net/publication/237423305_McCance_and_Widdowson's_The_Composition_of_Foods_-_Sixth_Edition
13. Li K, Wang SF, Li ST, et al. The good, the bad, and the ugly of calcium supplementation: a review of calcium intake on human health. Clin Interv Aging. 2019;13:2443-2452. Published 2018 Nov30.10.2147/CIA.S170123. Accessed 15.11.2024. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6274476/
14. National Health Service (NHS) Vitamins and minerals. Calcium. 2020. Accessed 15.11.2024. Available from: https://www.nhs.uk/conditions/vitamins-and-minerals/calcium/
15. British Dietetic Association (BDA) Food Fact Sheets. Calcium. Accessed 03.01.2024. Available from: https://www.bda.uk.com/resource/calcium.html