biology and life sciences forum

MDPI

*Proceeding Paper*

# Dietary Intake of Vitamin D in Young University Students from Leicester, England †

**Antonio Peña-Fernández [1,2,*], Edna Segura [3], María de los Ángeles Peña [4] and Manuel Higueras [3]**

1 Department of Surgery, Medical and Social Sciences, Faculty of Medicine and Health Sciences, University of Alcalá, Ctra. Madrid-Barcelona, Km. 33.600, 28871 Alcalá de Henares, Madrid, Spain
2 Leicester School of Allied Health Sciences, De Montfort University, Leicester LE1 9BH, UK
3 Scientific Computation & Technological Innovation Center (SCoTIC), Universidad de La Rioja, 26006 Logroño, La Rioja, Spain; edna-viviana.segura@alum.unirioja.es (E.S.); manuel.higueras@unirioja.es (M.H.)
4 Departamento de Ciencias Biomédicas, Universidad de Alcalá, Ctra. Madrid-Barcelona, Km. 33.600, 28871 Alcalá de Henares, Madrid, Spain; angeles.pena@uah.es
* Correspondence: antonio.penafer@uah.es

† Presented at the 3rd International Electronic Conference on Nutrients, 1–15 November 2023; Available online: https://iecn2023.sciforum.net/.

**Abstract:** About 30–40% of the general population in the United Kingdom (UK) has been reported to have vitamin D deficiency during winter months, representing a public health risk. The aim of this study was to assess the dietary intake of vitamin D in university students at De Montfort University (DMU, UK). Nutrient intake data were collected from 111 (20.45 yrs old; 78 female) DMU students (41 Asian, 41 African and 27 European; 2 unclassified). The dietary intake of vitamin D was slightly higher in male participants (4.287 vs. 3.853 µg/day; *p*-value = 0.196), which could be attributed to the generally higher intake of food products rich in this vitamin, specifically cereals (436.165 vs. 308.750 g/day; *p*-value = 0.002), meat (271.553 vs. 193.063 g/day; *p*-value = 0.016) and bacon (4.911 vs. 1.551 g/day; *p*-value = 0.024), intakes of which were significantly higher in males. The dietary intakes of vitamin D recorded are lower than the amount of 10 µg/day recommended by the UK's National Health Service. Intake did not show statistical differences according to ethnic background (Asian (3.708) < African (4.109) < European (4.199); all in µg/day), which might reflect poor and similar dietary habit/choices when students transition from home to university regardless of ethnic background. Our results suggest some prevalence of hypovitaminosis D in DMU students which should be tackled to prevent diseases related to vitamin D deficiency.

**Keywords:** vitamin D; dietary intake; vitamin D deficiency; university students; ethnic background; Leicester



**Citation:** Peña-Fernández, A.; Segura, E.; Peña, M.d.l.Á.; Higueras, M. Dietary Intake of Vitamin D in Young University Students from Leicester, England. *Biol. Life Sci. Forum* **2023**, *29*, 22. https://doi.org/10.3390/IECN2023-15531

Academic Editor: Egeria Scoditti

Published: 31 October 2023



## 1. Introduction

Vitamin D represents a group of fat-soluble secosteroid hormones responsible for increasing the intestinal absorption of important minerals including calcium (Ca), magnesium (Mg) and phosphate ($PO_4^{2-}$), and maintaining their homeostasis to support bone metabolism [1,2]. Vitamin D deficiency is becoming common worldwide and has been defined as *globally endemic hypovitaminosis D* [2]. Thus, for example, Dunlop et al. [3] detected that 32% of young Australian adults aged 18–24 years had serum 25-hydroxyvitamin D (also known as calcidiol or calcifediol, 25(OH)D, which is used as a biomarker of vitamin D status) concentrations below 50 nmol/L, the most widely accepted cut-off for vitamin D deficiency [4]. Further, 32.6% of 103 healthy university students (22.3 years old; 48.3% male, 26.1% female) living in the Canary Islands (Spain) had vitamin D deficiency (<50 nmol/L), indicating that even individuals in countries close to the equator with high levels of sunshine suffer vitamin D deficiency, possibly because individuals living in these countries try to avoid skin exposure to sunlight [5]. In relation to the United Kingdom (UK), about 30–40% of the general population has been reported to have vitamin D deficiency (concentrations below 25 nmol/L) during winter months [1]. As such, monitoring vitamin D status is of the upmost importance to identify risks, especially in children and young individuals. These risks would be even higher in European countries as only a few food items are fortified with vitamin D [4].

Thus, the aim of our study was two-fold: (a) to assess the dietary intake of vitamin D in a young population of university students at De Montfort University (DMU, UK) to identify potential deficiencies in this relevant group of the population which has been studied little in epidemiological studies; and (b) to investigate the effectiveness of a previously validated food frequency questionnaire (specifically, the European Prospective Investigation into Cancer and Nutrition Norfolk Food Frequency Questionnaire, EPIC-Norfolk FFQ) which was specifically tailored to include individuals from different ethnic backgrounds, as DMU has a diverse student population mainly comprising Black, Asian and minority ethnic groups.

## 2. Material and Methods

A total of 111 (20.45 ± 1.16 yrs old; 78 female) DMU students voluntarily participated in this nutritional and biomonitoring study between 2015 and 2016; specifically, the students were from three major ethnic backgrounds (determined using the continent on which they born: 41 in Asia, 41 in Africa and 27 in Europe), following previous methods described by our team in Peña-Fernández et al. [6,7].

The participants completed a validated variant of the Nutrition Norfolk Food Frequency Questionnaire (FFQ, version 6, CAMB/PQ/6/1205) [8], which includes more than 130 food items and also records the portion. The FFQ used was appropriately adapted to include different popular food items from the different ethnic backgrounds studied, following previous experiences of developing FFQs [9] and guidance on popular foods in the UK [10]. Collected FFQs were processed using Nutritics® software (v.5.7 Research Edition, Nutritics Ltd., Dublin, Ireland), as briefly described in Peña-Fernández et al. [6,7].

Body weight and height were measured using a digital scale (Tanita SC 330-S, London, UK). Body mass index (BMI) was calculated as weight in kilograms divided by squared height in meters to identify individuals as underweight or obese, depending on their ethnic background [11].

Statistical analyses were performed using the free software R-project, version 4.1.0 [12]. Significance scores were based on Kruskal–Wallis test for nonparametric multiple comparisons; a one-way analysis of variance was used for normal multiple comparisons. For normality, the Shapiro–Wilk test was used. Differences were considered statistically significant at $p$-values lower than 0.05.

## 3. Results and Discussion

The dietary intake of vitamin D was slightly higher in male participants (4.287 vs. 3.853 µg/day; $p$-value = 0.196), which could be attributed to the generally higher intake of food products known to contribute to dietary vitamin D intake (which include milk and dairy, cereals, meat, fish, eggs, cakes, fortified foods and drinks and dietary supplements [13]. Thus, intakes of cereals (436.165 vs. 308.750 g/day; $p$-value = 0.002) and meat (271.553 vs. 193.063 g/day; $p$-value = 0.016) were significantly higher in male participants. Bacon (4.911 vs. 1.551 g/day; $p$-value = 0.024) was the only red meat product that showed a significantly higher intake in males; meanwhile, the intakes of beef (53.513 vs. 38.935 g/day; $p$-value = 0.136), pork (11.348 vs. 10.174 g/day; $p$-value = 0.996) and lamb (16.75 vs. 11.197 g/day; $p$-value = 0.358) were also higher in male participants but were non-significant. Similarly, the intakes of eggs (17.625 vs. 16.998 g/day; $p$-value = 0.860), dairy products (319.78 vs. 274.95 g/day; $p$-value = 0.119) and fish (72.656 vs. 53.907 g/day; $p$-value = 0.826) were higher in male participants. However, the consumption of oily fish (13.406 vs. 10.056 g/day; $p$-value = 0.857), the fish food products with the highest content of vitamin D, was higher in female participants, although without showing statistical differences.

The dietary intakes of vitamin D recorded were similar/within the same order of magnitude to those described in adults (19–62 years-old) mostly recruited at the university of Chester, Northern England (average = 9.7 μg/day; range = 0.5–129.5) [1]. However, and despite a comprehensive analysis of diet in DMU students, our results should be considered preliminary as further analysis will be needed to explore the differences and amounts of consumption of vitamins and supplements as they can affect the dietary intake of micronutrients.

The intakes of calcidiol (25(OH)D3; 0.0321 vs. 0.0333 mg/day; $p$-value = 0.690) and cholecalciferol (also known as vitamin D3; 0.8677 vs. 0.7698 mg/day; $p$-value = 0.684) were very similar and higher in male counterparts, respectively, although without statistical differences, which could be explained by the differences in the intakes of eggs and meat explained previously [2,14], although further analysis would be needed.

*Adequacy of Vitamin D Intake According to Sex and Ethnic Background*

The dietary intakes of vitamin D recorded are lower than the amount of 10 μg/day recommended by the UK's National Health Service (PHE) [15] and much lower than the 15 μg/day recommended dietary allowance described by the United States National Institutes of Health (IOM, 2011 [16]). Although our results cannot be extended to the general young adult population, our findings would be logical as the mean UK dietary vitamin D intake for adults aged 19–64 recorded by the National Diet and Nutrition Survey in 2020 is below to 3 μg/day (PHE) [17].

The ranges recorded for males (0.252–10.719 μg/day) and females (0.338–18.151 μg/day) highlight that some DMU individuals would be at risk of vitamin D deficiency, which should be further explored by measuring levels of serum 25-hydroxyvitamin D to identify individuals at risk, especially male participants. Our results are in agreement with similar reports described in the literature. Thus, 99% of 198 university male students 18–23 years old from Murcia (southern Spain) were shown to have a dietary vitamin D intake below the recommended 600 IU/day [18]. However, only three (1.5%) of these male students had deficient levels of serum vitamin D (below 30 nmol/L), which the authors explain as a function of sufficient sun exposure. Thus, monitoring the levels of 25(OH)D in the serum of these participants would be needed to identify individuals at risk.

Moreover, the intakes did not show statistical differences according to ethnic background (Asian (3.708) < African (4.109) < European (4.199); all in μg/day), which might reflect poor and similar dietary habit/choices when they transition from home to university regardless of their ethnic background. Differences in vitamin D status by ethnicity have been described previously in Europe, including in the UK, and in other developed countries such as the US [19]. Although controversial, an increased prevalence of being at risk of deficiency has been associated with increasing skin pigmentation. However, we observed similar intakes of vitamin D between students of African and European origin. Future studies should consider non-modifiable lifestyle factors, such as latitude and cultural clothing practices, which can affect the dietary intake of this vitamin and other micronutrients [20].

## 4. Conclusions

Although our results should be considered preliminary until the levels of serum 25-hydroxy-vitamin D are assessed, our results suggest some prevalence of hypovitaminosis D in DMU individuals. A higher intake of foods naturally rich and fortified in vitamin D may be recommended in this young adult population to prevent future risks and diseases related to vitamin D deficiency.

**Author Contributions:** Conceptualization, A.P.-F.; methodology, A.P.-F., E.S., M.d.l.Á.P. and M.H.; validation, A.P.-F.; formal analysis, A.P.-F., E.S. and M.H.; investigation, A.P.-F., E.S., M.d.l.Á.P. and M.H.; resources, A.P.-F., E.S., M.d.l.Á.P. and M.H.; data curation, A.P.-F., E.S. and M.H.; writing—original draft preparation, A.P.-F.; writing—review and editing, A.P.-F., E.S., M.d.l.Á.P. and M.H.; visualization, A.P.-F., E.S., M.d.l.Á.P. and M.H.; supervision, A.P.-F. and M.H.; project administration, A.P.-F. and M.d.l.Á.P.; internal funding acquisition, A.P.-F. and M.d.l.Á.P. All authors have read and agreed to the published version of the manuscript.

**Funding:** This research received no external funding. This project was funded by the Leicester School of Allied Health Sciences, De Montfort University (Leicester, UK).

**Institutional Review Board Statement:** The study was conducted in accordance with the Declaration of Helsinki, approved by the DMU Research Ethics Committee (Ref. 1674; 11 January 2016) and subsequently amended and approved in 2017.

**Informed Consent Statement:** Informed consent was obtained from all subjects involved in the study.

**Data Availability Statement:** The data presented in this study are available upon request from the corresponding author. The data are not publicly available due to further processing for a future submission as a manuscript.

**Conflicts of Interest:** The authors declare no conflict of interest.

## References

1. Watkins, S.; Freeborn, E.; Mushtaq, S. A validated FFQ to determine dietary intake of vitamin D. *Public Health Nutr.* **2021**, *24*, 4001–4006. [CrossRef] [PubMed]
2. Sosa, M.; Gómez de Tejada, M.J. Cholecalciferol or calcifediol in the management of vitamin D deficiency. *Nutrients* **2020**, *12*, 1617. [CrossRef]
3. Dunlop, E.; Boorman, J.L.; Hambridge, T.L.; McNeill, J.; James, A.P.; Kiely, M.; Black, L.J. Evidence of low vitamin D intakes in the Australian population points to a need for data-driven nutrition policy for improving population vitamin D status. *J. Hum. Nutr. Diet.* **2023**, *36*, 203–215. [CrossRef] [PubMed]
4. Holick, M.F. Vitamin D deficiency. *N. Engl. J. Med.* **2007**, *357*, 266–281. [CrossRef]
5. González-Padilla, E.; López, A.S.; González-Rodríguez, E.; García-Santana, S.; Mirallave-Pescador, A.; Marco, M.; Henríquez, M.S. High prevalence of hypovitaminosis D in medical students in Gran Canaria. Canary Islands (Spain). *Endocrinol. Nutr. (Engl. Ed.)* **2011**, *58*, 267–273. [CrossRef] [PubMed]
6. Peña-Fernández, A.; Ali, N.; Millington, D.; Lobo-Bedmar, M.C.; Haris, P. Human biomonitoring research at De Montfort University: School and university participants' recruitment experience. In Proceedings of the 12th International Technology, Education and Development Conference, Valencia, Spain, 5–7 March 2018; INTED2018 Proceedings, pp. 6258–6262.
7. Peña-Fernández, A.; Higueras, M.; Segura, E.; Evans, M.D.; Peña, M.A. Inadequacies of iron dietary intake of in normal- and over-weight young university students from Leicester, England. *Biol. Life Sci. Forum* 2023, *submitted for publication*.
8. Bingham, S.; Welch, A.; McTaggart, A.; Mulligan, A.; Runswick, S.; Luben, R.; Day, N. Nutritional methods in the European Prospective Investigation of Cancer in Norfolk. *Public Health Nutr.* **2001**, *4*, 847–858. [CrossRef] [PubMed]
9. González-Muñoz, M.J.; Peña, A.; Meseguer, I. Monitoring heavy metal contents in food and hair in a sample of young Spanish subjects. *Food Chem. Toxicol.* **2008**, *46*, 3048–3052. [CrossRef] [PubMed]
10. McCance, R.A.; Widdowson, E.M. *McCance and Widdowson's the Composition of Foods*; Royal Society of Chemistry: London, UK, 2014.
11. Centre for Public Health Excellence at NICE (UK) & National Collaborating Centre for Primary Care (UK). *Obesity: The Prevention, Identification, Assessment and Management of Overweight and Obesity in Adults and Children*; National Institute for Health and Clinical Excellence (UK): London, UK, 2006.
12. R Core Team. *R: A Language and Environment for Statistical Computing*; R Foundation for Statistical Computing: Vienna, Austria, 2021. Available online: https://www.R-project.org/ (accessed on 10 September 2023).
13. Weir, R.R.; Carson, E.L.; Mulhern, M.S.; Laird, E.; Healy, M.; Pourshahidi, L.K. Validation of a food frequency questionnaire to determine vitamin D intakes using the method of triads. *J. Hum. Nutr. Diet.* **2016**, *29*, 255–261. [CrossRef] [PubMed]
14. Nuti, R.; Gennari, L.; Cavati, G.; Pirrotta, F.; Gonnelli, S.; Caffarelli, C.; Tei, L.; Merlotti, D. Dietary Vitamin D Intake in Italian Subjects: Validation of a Frequency Food Questionnaire (FFQ). *Nutrients* **2023**, *15*, 2969. [CrossRef] [PubMed]
15. Scientific Advisory Committee on Nutrition. Vitamin D and Health Report. 2016. Available online: https://www.gov.uk/government/publications/sacn-vitamin-d-and-health-report (accessed on 10 September 2023).
16. IOM (Institute of Medicine). *Dietary Reference Intakes for Calcium and Vitamin D*; The National Academies Press: Washington, DC, USA, 2011.
17. Public Health England. National Diet and Nutrition Survey. 2021. Available online: https://www.gov.uk/government/collections/national-diet-and-nutrition-survey (accessed on 10 September 2023).

18. Rudnicka, A.; Adoamnei, E.; Noguera-Velasco, J.A.; Vioque, J.; Cañizares-Hernández, F.; Mendiola, J.; Torres-Cantero, A.M. Vitamin D status is not associated with reproductive parameters in young Spanish men. *Andrology* **2020**, *8*, 323–331. [CrossRef] [PubMed]
19. Herrick, K.A.; Storandt, R.J.; Afful, J.; Pfeiffer, C.M.; Schleicher, R.L.; Gahche, J.J.; Potischman, N. Vitamin D status in the United States, 2011–2014. *Am. J. Clin. Nutr.* **2019**, *110*, 150–157. [CrossRef] [PubMed]
20. O'Neill, C.M.; Kazantzidis, A.; Kiely, M.; Cox, L.; Meadows, S.; Goldberg, G.; Cashman, K.D. A predictive model of serum 25-hydroxyvitamin D in UK white as well as black and Asian minority ethnic population groups for application in food fortification strategy development towards vitamin D deficiency prevention. *J. Steroid Biochem. Mol. Biol.* **2017**, *173*, 245–252. [CrossRef] [PubMed]