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Letter to the Editor

Response: food fortification as a means to increase vitamin D intake

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We thank Itkonen & Lamberg-Allardt[1] for their interest in our paper on the determinants of serum 25-hydroxyvitamin D (25(OH)D) concentration in a population sample of children aged 6–8 years from Finland[2].

Itkonen & Lamberg-Allardt criticised us for misleading the readers concerning the time of data collection and not stressing the changes in recommendations on vitamin D fortification and intake after that time. We studied serum 25(OH)D concentration and especially the determinants of it and risk factors for serum 25(OH)D concentration <50 nmol/l at baseline of the Physical Activity and Nutrition in Children study in the period 2007–2009. We have described these issues in the Methods section in our paper. In 2010, after the collection of our baseline data, the Finnish recommendation for vitamin D fortification was increased from 0·5 to 1 μg/100 g for fluid milk products and from 10 to 20 μg/100 g for spreads[3]. The Nordic and Finnish recommendations for vitamin D intake were also increased in 2014 to further ensure sufficient serum levels of vitamin D in Nordic populations[4,5]. Moreover, nowadays all children aged 2–18 years in Finland are recommended to use 7·5 μg/d of vitamin D supplements year round regardless of their dietary intake of vitamin D[5]. These changes are discussed in our original paper. We found that milk, mostly fortified with vitamin D, was the most important source of vitamin D in children, and the consumption of milk products was the strongest determinant of serum 25(OH)D. In addition, children who drank at least 450 g/d of milk had a 72–74 % lower risk of having serum 25(OH)D concentration <50 nmol/l compared with those who drank <300 g/d of milk. After doubling the recommended level of vitamin D fortification in Finland in 2010, milk and other food products fortified with vitamin D are likely to be even stronger determinants of serum 25(OH)D. These are the same issues Itkonen & Lamberg-Allardt underlined in their letter.

Itkonen & Lamberg-Allard stated that the effects of vitamin D fortification have already been studied in Finnish children and adults[6–9], and from this point of view they suggested that our study would not provide any new data. However, we want to emphasise that the aim of our study was not to investigate the effects of fortification on vitamin D status. Instead, we aimed to study many determinants of serum 25(OH)D that included not only the consumption of fortified foods but also the consumption of other foods, supplement use, body composition, physical activity, sedentary behaviour, socio-economic status, skin type, daylight time and travels to sunny countries. Indeed, one of the strengths of our study is that we investigated a large number of possible determinants of vitamin D status in children, and very few such studies are available. As pointed out by Itkonen & Lamberg-Allardt, studies on the effects of increase in vitamin D fortification on serum 25(OH)D are still needed.

Itkonen & Lamberg-Allardt wondered why we did not present data on vitamin D status at our 2-year follow-up in 2009–2011. However, the new Finnish recommendations for vitamin D fortification were given in April 2010 and the latest Finnish recommendations for supplement use among children in 2011. Dairy industry increased vitamin D fortification for different products gradually after the recommendations. The recommendations were given during our 2-year follow-up, and therefore it is not possible to study the effects of increased vitamin D fortification or supplement use on vitamin D status based on our 2-year follow-up data. We are carrying out the 8-year follow-up study, and the data will be available for analysis in 2018. The 8-year follow-up data will be appropriate for studying vitamin D status at that time.

Itkonen & Lamberg-Allardt also expressed their concern about the analytical assay that we used for assessing serum 25(OH)D concentration. Serum 25(OH)D concentration was analysed by the LIAISON® 25 OH Vitamin D TOTAL Assay (DiaSorin Inc.), which was used in Eastern Finland Laboratory Centre Joint Authority Enterprise (ISLAB) at the time of data analysis. This method has been reported to give slightly lower serum 25(OH)D concentrations than other methods, especially the older liquid chromatography tandem MS (LC-MS/MS)[10,11] as Itkonen & Lamberg-Allardt stated. We also discussed this methodological issue in our original paper. Later on, candidate reference methods for serum 25(OH)D have been developed[12,13]. Itkonen & Lamberg-Allardt were also longing for information on external quality control for the method used. ISLAB has been participating in the Vitamin D External Quality Assessment Scheme (DEQAS) since 2008 with DiaSorin LIAISON 25(OH)D assay meeting the performance targets, the fact that was unfortunately not mentioned in our original paper. The closest DEQAS survey was carried out in January 2011, soon after analysing the study samples, and it showed a 6·2 % positive bias from the mean value of all methods, 7·1 % positive bias from the mean of the LIAISON method and a 1·1 % negative bias from the LC-MS/MS method. On the other hand, Farrell *et al.*[14] demonstrated that the LIAISON method showed the best performance characteristics among the most common immunochemical methods as compared with the LC-MS/MS methods. In our study, blood samples were collected and laboratory analyses were performed before the

recommendations of the vitamin D standardisation programme, which was organised in 2010[15]. At the moment, the LIAISON assay can be found from the Centers of Disease Control and Prevention Vitamin D Standardization-Certification Program (VDSCP) – Total 25hydroxyvitamin D Certified Procedures[16]. There is still no full consensus on the cut-offs for the insufficient level of serum 25(OH)D concentration. More importantly, the optimal serum level of 25(OH)D, especially in children, remains unclear. We want to emphasise that our aim was not to determine the level for insufficiency, and therefore we did not use this term in our paper but presented the distribution of serum 25(OH)D concentration in our study population.

Insufficient vitamin D intake and low serum levels of 25(OH)D were relatively common among Finnish children in 2007–2009. Since then, valuable changes in the national nutrition policy have been made in 2010s to improve vitamin D status in Finland, but more studies of the effects of these changes are needed, as Itkonen & Lamberg-Allardt pointed out. However, we suggest that the vitamin D fortification of food products could be an effective way to improve vitamin D status also in other countries in northern latitudes where the cutaneous synthesis of vitamin D induced by sunlight is limited.

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References

1. Itkonen ST & Lamberg-Allardt C (2016) Food fortification as a means to increase vitamin D intake. *Br J Nutr* **115**, 2075–2076.
2. Soininen S, Eloranta AM, Lindi V, *et al.* (2016) Determinants of serum 25-hydroxyvitamin D concentration in Finnish children: the Physical Activity and Nutrition in Children (PANIC) study. *Br J Nutr* **115**, 1080–1091.
3. National Nutrition Council (2010) Report of Finnish experts of vitamin D. http://www.ravitsemusneuvottelukunta.fi/attachments/vrn/d-vitamiiniraportti2010.pdf (accessed July 2016) (in Finnish).
4. Nordic Council of Ministers (2014) *Nordic Nutrition Recommendations 2012. Integrating Nutrition and Physical Activity*, 5th ed. Copenhagen: Nordic Council of Ministers.
5. National Nutrition Council (2014) *Finnish Nutrition Recommendations 2014*. Helsinki: Juvenes Oy.
6. Lamberg-Allardt C & Viljakainen H, a Working Group (2006) Follow-up study on the vitamin D status in the Finnish population 2002 and 2004, reports of the Ministry of Social Affairs and Health (D-Vitamiinitilanteen Seurantatutkimus 2002–2004) (in Finnish with English Summary). http://ec.europa.eu/food/safety/docs/labelling_nutrition-supplements-responses-finland_annex3_en.pdf (accessed July 2016).
7. Piirainen T, Laitinen K & Isolauri E (2007) Impact of national fortification of fluid milks and margarines with vitamin D on dietary intake and serum 25-hydroxyvitamin D concentration in 4-year-old children. *Eur J Clin Nutr* **61**, 123–128.
8. Välimäki V-V, Löyttyniemi E & Välimäki MJ (2007) Vitamin D fortification of milk products does not resolve hypovitaminosis D in young Finnish men. *Eur J Clin Nutr* **61**, 493–497.
9. Lehtonen-Veromaa M, Möttönen T, Leino A, *et al.* (2008) Prospective study on food fortification with vitamin D among adolescent females in Finland: minor effects. *Br J Nutr* 100, 418–423.
10. Carter GD, Berry JL, Gunter E, *et al.* (2010) Proficiency testing of 25-hydroxyvitamin D (25-OHD) assays. *J Steroid Biochem Mol Biol* **121**, 176–179.
11. Carter GD (2011) Accuracy of 25-hydroxyvitamin D assays: confronting the issues. *Curr Drug Targets* **12**, 19–28.
12. Tai SS, Bedner M, Phinney KW, *et al.* (2010) Development of a candidate reference measurement procedure for the determination of 25-hydroxyvitamin D_3 and 25-hydroxyvitamin D_2 in human serum using isotope-dilution liquid chromatography-tandem mass spectrometry. *Anal Chem* **82**, 1942–1948.
13. Stepman HC, Vanderroost A, Van Uytfanghe K. *et al.* (2011) Candidate reference measurement procedures for serum 25-hydroxyvitamin D_3 and 25-hydroxyvitamin D_2 by using isotope-dilution liquid chromatography-tandem mass spectrometry. *Clin Chem* **57**, 441–448.
14. Farrell CJ, Martin S, McWhinney B. *et al.* (2012) State-of-the-art vitamin D assays: a comparison of automated immunoassays with liquid chromatography-tandem mass spectrometry methods. *Clin Chem* **58**, 531–542.
15. Binkley N & Sempos CT, Vitamin D Standardization Program (2014) Standardizing vitamin D assays: the way forward. *J Bone Miner Res* **29**, 1709–1714.
16. Centers of Disease Control and Prevention (2016) VDSCP – Vitamin D Certified Procedures. http://www.cdc.gov/labstandards/pdf/hs/CDC_Certified_Vitamin_D_Procedures.pdf (accessed July 2016).

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