

SCIENTIFIC OPINION

Calcium and vitamin D and bone strength

Scientific substantiation of a health claim related to calcium and vitamin D and bone strength pursuant to Article 14 of Regulation (EC) No 1924/2006¹

Scientific Opinion of the Panel on Dietetic Products, Nutrition and Allergies

(Question No EFSA-Q-2008-116)

Adopted on 2 October 2008

PANEL MEMBERS

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SUMMARY

Following an application from Yoplait Dairy Crest Limited submitted pursuant to Article 14 of Regulation (EC) No 1924/2006 via the Competent Authority of United Kingdom, the Panel on Dietetic Products, Nutrition and Allergies was asked to deliver an opinion on the scientific substantiation of a health claim related to calcium and vitamin D and bone strength.

The scope of the application was proposed to fall under claims referring to children's development and health.

The constituents subject of the health claim are calcium and vitamin D, both of which are well recognised nutrients and are measurable in foods by established methods. This evaluation applies to calcium and vitamin D naturally present in foods and those forms authorised for addition to foods (Annex II of the Regulation (EC) No 1925/2006). The Panel considers that the constituents that are the subject of the health claim (calcium and vitamin D) are sufficiently characterised.

The claimed effect is that calcium and vitamin D 'are needed for building stronger bones' in children and adolescents. The proposed target population for the health claim is children and adolescents (up to 18 years). Normal growth and development of bone to achieve maximum peak bone mass at maturity helps to maximise bone strength. The Panel considers that normal growth and development of bone is beneficial to children's health.

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A total of 16 publications were considered pertinent to the health claim by the applicant – 5 reports from authoritative bodies and reviews, and 11 human studies, including 8 intervention studies and three observational studies.

Reports from authoritative bodies and reviews show that there is good consensus on the roles of calcium and vitamin D in growth and development of bone.

Calcium is an important structural component of bone. Adequate calcium intake throughout childhood and adolescence is needed to achieve maximum bone mass in young adulthood which is an important determinant of bone mineral status in later life. The growth and development of bone is related to the quantity of calcium consumed and recommended intakes of calcium to meet requirements for growth and development of bone in children and adolescents have been established by various authorities. Inadequate calcium intake may contribute to impaired bone development in early life. Calcium intakes may be inadequate in sub-groups of children and adolescents in some EU countries, especially in girls.

Adequate status for vitamin D is required for efficient calcium absorption and for the maintenance of normal blood levels of calcium and phosphate that are in turn needed for the normal mineralisation of bone. The serum 25(OH)D, or calcidiol, level is a good marker of nutritional status for vitamin D. Synthesis of vitamin D in the skin by the action of sunlight is insufficient to meet requirements in European countries, especially during winter months when there is little sunlight exposure. Adequate intake of vitamin D throughout childhood and adolescence is needed to achieve a vitamin D status that is sufficient for normal bone mineralisation and sub-optimal vitamin D status has been shown to reduce bone mineral accretion in children and adolescents. Recommended intakes of vitamin D have been established for children and adolescents by several expert committees. Sub-optimal vitamin D status has been reported in sub-groups of children and adolescents in many European countries, particularly in winter months, indicative of inadequate vitamin D intake.

The human observational and intervention studies support the association between serum 25(OH)D as an indicator of nutritional status for vitamin D and bone mineral density (BMD) and/or bone mineral content (BMC) in children and adolescents and an effect of combined supplementation of the usual diet with calcium and vitamin D on bone mass (BMD and BMC). There was no clear indication of a specific dose response between calcium intake or vitamin D status and BMC or BMD, and separate effects of vitamin D and calcium could not be distinguished in these studies.

The Panel concludes that, on the basis of the evidence provided, cause and effect relationships are established separately between the intakes of calcium and vitamin D and normal growth and development of bone in children and adolescents. Recommended intakes of calcium and vitamin D to meet requirements for normal growth and development of bone in children and adolescents have been established. Intakes of calcium and vitamin D may be inadequate in sub-groups of children and adolescents in a number of EU countries.

The following wording reflects the scientific evidence: “calcium and vitamin D are needed for normal growth and development of bone in children.”

The Panel considers that in order to bear the claim a food should be at least a source of calcium and vitamin D as per Annex to Regulation 1924/2006. Such amounts can be easily consumed as part of a balanced diet. The target population is children and adolescents (up to 18 years). No Tolerable Upper Intake Levels (UL) have been established for calcium in children and adolescents; the UL for calcium in adults is 2500 mg/day; UL have been established for vitamin D in children and adolescents (25µg/day up to age 10 years; 50µg/day for age ≥11 years).

Key words: calcium, vitamin D, bone, growth, development, children, adolescents

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BACKGROUND

Regulation (EC) No 1924/2006² harmonises the provisions that relate to nutrition and health claims and establishes rules governing the Community authorisation of health claims made on foods. As a rule, health claims are prohibited unless they comply with the general and specific requirements of that Regulation and are authorised in accordance with this Regulation and included in the lists of authorised claims provided for in Articles 13 and 14 thereof. In particular, Articles 14 to 17 of that Regulation lay down provisions for the authorisation and subsequent inclusion of reduction of disease risk claims and claims referring to children's development and health in a Community list of permitted claims.

According to Article 15 of that Regulation, an application for authorisation shall be submitted by the applicant to the national competent authority of a Member State, who will make the application and any supplementary information supplied by the applicant available to European Food Safety Authority (EFSA).

Steps taken by EFSA:

- The application was received on 11/02/2008.
- The scope of the application was proposed to fall under claims referring to children's development and health.
- During the check for completeness³ of the application, the applicant was requested to provide missing information on 10/03/2008.
- The applicant provided the missing information on 23/05/2008.
- The scientific evaluation procedure started on 15/06/2008.
- During the meeting on 02/10/2008 the NDA Panel, after having evaluated the overall data submitted, adopted an opinion on the scientific substantiation of a health claim related to calcium and vitamin D and bone strength.

TERMS OF REFERENCE

EFSA is requested to evaluate the scientific data submitted by the applicant in accordance with Article 16 of Regulation (EC) No 1924/2006. On the basis of that evaluation, EFSA will issue an opinion on the scientific substantiation of a health claim related to: calcium and vitamin D and bone strength.

EFSA DISCLAIMER

The present opinion does not constitute, and cannot be construed as, an authorisation to the marketing of calcium and vitamin D, a positive assessment of its safety, nor a decision on whether calcium and vitamin D are, or are not, classified as a foodstuff. It should be noted that such an assessment is not foreseen in the framework of Regulation (EC) No 1924/2006.

² European Parliament and Council (2006). Regulation (EC) No 1924/2006 of the European Parliament and of the Council of 20 December 2006 on nutrition and health claims made on foods. Official Journal of the European Union OJ L 404, 30.12.2006. Corrigendum OJ L 12, 18.1.2007, p. 3–18.

³ In accordance with EFSA "Scientific and Technical guidance for the Preparation and Presentation of the Application for Authorisation of a Health Claim"

It should also be highlighted that the scope, the proposed wording of the claim as considered by EFSA in this opinion may be subject to changes pending the outcome of the authorisation procedure foreseen in Article 17 of Regulation (EC) No 1924/2006.

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1. Information provided by the applicant

Applicant's name and address: Yoplait Dairy Crest Ltd, Claygate House, Claygate, Surrey, KT10 9PN, UK.

1.1. Food/constituent as stated by the applicant

Calcium and vitamin D in yogurt, drinking yogurt, and fromage frais matrix. The claim made by the applicant relates to calcium and vitamin D directly and not to the food product in which they are found.

1.2. Health relationship as claimed by the applicant

Calcium and vitamin D are nutrients whose functions are complementary and essential for strong bones. Calcium and vitamin D are critical for bone health for all age groups including children and adolescents.

1.3. Wording of the health claim as proposed by the applicant

Calcium and vitamin D, as part of a healthy diet and lifestyle, build stronger bones in children and adolescents.

1.4 Specific conditions of use as proposed by the applicant

The target population is children and adolescents (up to 18 years).

Products carrying this claim contain a minimum combination of 15% calcium RDA (120mg) and 15% vitamin D RDA (0.75µg) per 100g. Regulation (EC) 1924/2006 specifies that a "significant amount" of a nutrient must be present in order to make a nutrition or health claim, in the case of minerals and vitamins the definition of "source of vitamins and minerals", provides quantification of "significant amount", which is at least 15% RDA per 100g of ready to consume product. For calcium this is equivalent to 120mg per 100g and for vitamin D 0.75µg per 100g.

2. Assessment

2.1. Characterisation of the food/constituent

The food constituents subject of the health claim are calcium and vitamin D, both of which are well recognised nutrients and are measurable in foods by established methods. Vitamin D occurs naturally in foods as vitamin D₃ (cholecalciferol). Both vitamin D₃ and vitamin D₂ (ergocalciferol) are authorised for addition to foods (Annex II of the Regulation (EC) No 1925/2006). Calcium occurs naturally in foods in many forms which are well utilised by the body. In addition, different forms of calcium are authorised for addition to foods (Annex II of the Regulation (EC) No 1925/2006). This evaluation applies to calcium and vitamin D naturally present in foods and those forms authorised for addition to foods (Annex II of the Regulation (EC) No 1925/2006).

The Panel considers that the food/constituents that are the subject of the health claim (calcium and vitamin D) are sufficiently characterised.

2.2. Relevance of the claimed effect to human health

The claimed effect is that calcium and vitamin D are needed ‘for building stronger bones’ in children and adolescents. The proposed target population for the health claim is children and adolescents (up to 18 years). Normal growth and development of bone to the maximum peak bone mass at maturity that is possible within the genetic potential of the individual helps to maximise bone strength.

The Panel considers that normal growth and development of bone is beneficial to children’s health.

2.3. Scientific substantiation of the claimed effect

The following databases were searched: Medline, EMBASE and Cochrane databases on the following dates: Medline was searched on 9 November 2007 (<www.ncbi.nlm.nih.gov/medline/>); MBASE was searched on 9 November 2007 (<www.embase.com/>); Cochrane was searched on 9 November 2007 (<www.cochrane.org/>). Search terms were “calcium” and “vitamin D” and “bone health” or “bone density” or “bone development” in Embase. References were then restricted to those indexed under “child” or “children” or “child” or “adolescents” or “girls” or “boys”, but not indexed under “review”. “Human studies” were used as a filter. The search was confined to the period, 1987 to date (November 2007). Hand searching of current journals and the reference lists of identified papers and key reviews were searched for additional references.

Of the 385 publications identified by the search, a total of 16 were considered pertinent by the applicant - 5 reports from authoritative bodies and reviews, and 11 human studies including:

- 5 human studies (RCT) on effect of combined supplementation of the usual diet with calcium and vitamin D on bone mass (BMD or BMC) (Chan *et al.*, 1995 Cheng *et al.*, 2005; Debar, 2006; Du *et al.*, 2004; Moyer-Mileur *et al.*, 2003)
- 6 human studies on effect of vitamin D supplementation/status when calcium levels were measured and similar on bone mass (BMD or BMC): 2 RCT (El-Hajj Fuleihan *et al.*, 2006; Viljakainen *et al.*, 2006), 1 prospective study (Lehtonen-Veromaa *et al.*, 2002) and 3 cross-sectional studies (Outila *et al.*, 2001; Talwar *et al.*, 2007; Tylavsky *et al.*, 2007)

One mechanistic observational study was also presented (Abrams *et al.*, 2005).

The evidence provided by consensus opinions/reports from authoritative bodies and reviews shows that there is good consensus on the roles of calcium and vitamin D in growth and development of bone.

Calcium is an important structural component of bone. Adequate calcium intake throughout childhood and adolescence is needed to achieve maximum peak bone mass in young adulthood which is an important determinant of bone mineral status in later life. The growth and development of bone is related to the quantity of dietary calcium consumed and recommended intakes of calcium to meet requirements for growth and development of bone in children and adolescents have been established by various authorities. Inadequate dietary calcium intake may contribute to impaired bone development in early life. Available evidence indicates that calcium intakes may be inadequate in sub-groups of children and adolescents in some EU countries, especially in girls (COMA, 1991; COMA, 1998; DGE, 2000; FNB, 1999; Food Safety Authority of Ireland, 1999; National Health and Medical Research Council, 2006; Nordic Council of Ministers, 2004; Norman *et al.*, 2007; Theobald, 2005; WHO, 2003).

Adequate status for vitamin D is required for efficient calcium absorption and for the maintenance of normal blood levels of calcium and phosphate that are in turn needed for the normal mineralisation of bone. The serum 25(OH)D, or calcidiol, level is a good marker of status for vitamin D. Synthesis of vitamin D in the skin by the action of sunlight is insufficient to meet requirements in European countries, especially during winter months when there is little sunlight exposure. Adequate intake of vitamin D throughout childhood and adolescence is needed to achieve a vitamin D status that is sufficient for normal bone mineralisation and sub-optimal vitamin D status has been shown to reduce bone mineral accretion in children and adolescents. Recommended intakes of vitamin D have been established for children and adolescents by several expert committees. Sub-optimal vitamin D status has been reported in sub-groups of children and adolescents in many European countries, particularly in winter months, indicative of inadequate vitamin D intake (Andersen *et al.*, 2005; Cashman, 2007; Cheng *et al.*, 2003; COMA, 1998; Cranney *et al.*, 2007; DGE, 2000; El-Hajj Fuleihan 2006; Food and Nutrition Board, 1999; Food Safety Authority of Ireland, 1999; Guillemant *et al.*, 2001; Holick, 2007; Lanham-New *et al.*, 2007; Lehtonen-Veromaa *et al.*, 2002; National Health and Medical Research Council, 2006; Nordic Council of Ministers, 2004; Outila *et al.*, 2001; COMA, 1991; Viljakainen *et al.*, 2006, AFSSA, 2001).

The human observational and intervention studies support the association between serum 25(OH)D as an indicator of status for vitamin D and bone mineral density (BMD) and bone mineral content (BMC) in children and adolescents and an effect of combined supplementation of the usual diet with calcium and vitamin D on bone mass (BMD and BMC). There was no clear indication of a specific dose response between calcium intake and vitamin D status and BMC or BMD and separate effects of vitamin D and calcium could not be distinguished in these studies (Chan *et al.*, 1995; Cheng *et al.*, 2005; DeBar *et al.*, 2006; Du *et al.*, 2004; El-Hajj Fuleihan *et al.*, 2006; Lehtonen-Veromaa *et al.*, 2002; Moyer-Mileur *et al.*, 2003; Outila *et al.*, 2001; Talwar *et al.*, 2007; Tylavsky *et al.*, 2007; Viljakainen *et al.*, 2006).

The Panel considers that cause and effect relationships are established separately between the intakes of calcium and vitamin D and normal growth and development of bone in children and adolescents. Recommended intakes of calcium and vitamin D to meet requirements for normal growth and development of bone in children and adolescents have been established. Available evidence shows that the intakes of calcium and vitamin D may be inadequate in sub-groups of children and adolescents in a number of EU countries.

The Panel notes that the evidence presented does not establish that it is necessary for calcium and vitamin D to be consumed together in the same food in order to obtain the claimed effect.

2.4 Panel's comments on the proposed wording

Taking into account the scientific evidence presented, the Panel considers that the following wording reflects the scientific evidence: 'calcium and vitamin D are needed for the normal growth and development of bone in children'.

2.5 Conditions and restrictions of use

The Panel considers that in order to bear the claim a food should be at least a source of calcium and vitamin D as per Annex to Regulation 1924/2006. Such amounts can be easily consumed as part of a balanced diet.

The target population is children and adolescents (up to 18 years).

No Tolerable Upper Intake Levels (UL) have been established for calcium in children and adolescents; the UL for calcium in adults is 2500 mg (SCF, 2003). UL have been established

for vitamin D in children and adolescents (25µg/day up to age 10 years; 50µg/day for age ≥11 years; SCF, 2002).

CONCLUSIONS AND RECOMMENDATIONS

On the basis of the data presented, the Panel concludes that:

- The food/constituents that are the subject of the health claim (calcium and vitamin D) are sufficiently characterised.
- The claimed effect is that calcium and vitamin D ‘are needed for building stronger bones’ in children and adolescents. Normal growth and development of bone is beneficial to children’s health.
- Cause and effect relationships are established separately between the intakes of calcium and vitamin D and normal growth and development of bone in children and adolescents; recommended intakes of calcium and vitamin D to meet requirements for normal growth and development of bone in children and adolescents have been established.
- Intakes of calcium and vitamin D may be inadequate for normal growth and development of bone in sub-groups of children and adolescents in a number of EU countries.
- The following wording reflects the scientific evidence: ‘calcium and vitamin D are needed for the normal growth and development of bone in children’.
- In order to bear the claim a food should be at least a source of calcium and vitamin D as per Annex to Regulation 1924/2006. Such amounts can be easily consumed as part of a balanced diet. The target population is children and adolescents (up to 18 years).
- No Tolerable Upper Intake Levels (UL) have been established for calcium in children and adolescents; the UL for calcium in adults is 2500 mg/day; UL have been established for vitamin D in children and adolescents (25µg/day up to age 10 years; 50µg/day for age ≥11 years).

DOCUMENTATION PROVIDED TO EFSA

Health claim application on calcium and vitamin D and strong bones pursuant to Article 14 of the Regulation (EC) No 1924/2006 (Claim serial No: 0036-UK). June 2008. Submitted by Yoplait Dairy Crest Ltd.

REFERENCES

- European Parliament and Council, 2006. Regulation (EC) No 1924/2006 of the European Parliament and of the Council of 20 December 2006 on nutrition and health claims made on foods. Official Journal of the European Union OJ L 404, 30.12.2006. Corrigendum OJ L 12, 18.1.2007, p. 3–18.
- European Parliament and Council, 2006. Regulation (EC) No 1925/2006 of the European Parliament and of the Council of 20 December 2006 on the addition of vitamins and minerals and of certain other substances to foods. Official Journal of the European Union OJ L 404, 30.12.2006, p. 26-38.

SCF (Scientific Committee on Food), 2002. Opinion of the Scientific Committee on Food on the Tolerable Upper Intake Level of Vitamin D. Expressed on 4 December 2002. <http://ec.europa.eu/food/fs/sc/scf/out157_en.pdf>

SCF (Scientific Committee on Food), 2003. Opinion of the Scientific Committee on Food on the Tolerable Upper Intake Level of Calcium. Expressed on 4 April 2003. <http://ec.europa.eu/food/fs/sc/scf/out194_en.pdf>

Reports of authoritative bodies/Reviews

AFSSA (Agence Française de Sécurité Sanitaire des Aliments), 2001. Apports Nutritionnels Conseillés pour la population française, Vitamine D, 3e édition. Editions Tec & Doc, p.229-236.

Cashman KD, 2007. Vitamin D in childhood and adolescence. *Postgrad. Med. J.* 83, 230-5.

Cranney A, Horsley T, O'Donnell S, Weiler H, Puil L, Ooi D, Atkinson S, Ward L, Moher D, Hanley D, Fang M, Yazdi F, Garrity C, Sampson M, Barrowman N, Tsertsivadze A and Mamaladze V, 2007. Effectiveness and Safety of Vitamin D in Relation to Bone Health. Evidence Report/Technology Assessment No. 158 (Prepared by the University of Ottawa Evidence-based Practice Center (UO-EPC) under Contract No. 290-02-0021. In *AHRQ Publication No. 07-E013.*, Rockville, MD: Agency for Healthcare Research and Quality. August: 2007.

COMA (Committee on Medical Aspects of Food and Nutrition Policy), 1998. Nutrition and bone health: with particular reference to calcium and vitamin D. Report of the Subgroup on Bone Health, Working Group on the Nutritional Status of the Population of the Committee on Medical Aspects of the Food Nutrition Policy. *Rep. Health. Soc. Subj. (Lond.)*. 49: iii-xvii, 1-24.

COMA (Committee on Medical Aspects of Food and Nutrition Policy), 1991. Panel on Dietary Reference Values. Dietary reference values for food energy and nutrients for the UK. *Rep. Health. Soc. Subj. (Lond.)*. 41, 1-210

DGE (German Nutrition Society), ÖGE (Austrian Nutrition Society), SGE (Swiss Society for Nutrition Research), SVE (Swiss Nutrition Association), 2000. Reference Values For Nutrient Intake. 1st edition.

FNB (Food and Nutrition Board) 1999. Dietary Reference Intakes: Calcium, Phosphorus, Magnesium, Vitamin D and Fluoride. National Academic Press. 250-87.

Food Safety Authority of Ireland, 1999. Recommended Dietary Allowances for Ireland: Food Safety Authority of Ireland, Abbey Court, Dublin, Ireland.

Holick MF, 2007. Vitamin D deficiency. *N. Engl. J. Med.* 357, 266-81.

Lanham-New S, Thompson RL, More J, Brooke-Wavell K, Hunking P, Medici E, 2007. Review: Importance of vitamin D, calcium and exercise to bone health with specific reference to children and adolescents. British Nutrition Foundation, *Nutrition Bulletin*. 364-377.

National Health and Medical Research Council, 2006. Nutrient Reference Values for Australia and New Zealand, including Recommended Dietary Intakes., ed. D.o.H.a.A. Australian Government: Attorney General's Department, Robert Garran Offices, National Circuit, Canberra, ACT - <<http://www.ag.gov.au/cca>>.

Nordic Council of Ministers, 2004. Nordic Nutrition Recommendations. Integrating nutrition and physical activity. Nord 2004: 4th edition. Copenhagen, Denmark.

- Norman AW, Bouillon R, Whiting SJ, Vieth R, Lips P, 2007. 13th Workshop consensus for vitamin D nutritional guidelines. *J. Steroid. Biochem. Mol. Biol.* 103, 204-5.
- SACN (Scientific Advisory Committee on Nutrition), 2007. Update on Vitamin D. Position statement by the Scientific Advisory Committee on Nutrition (SACN).
- Theobald H, 2005. Dietary calcium and health. British Nutrition Foundation, *Nutrition Bulletin.* 30, 237-277.
- WHO (World Health Organization), 2003. Prevention and management of osteoporosis. Report of a WHO Scientific Group 2003. Technical Report Series (No. 921). Geneva, Switzerland.

Individual studies

- Abrams SA, Griffin IJ, Hawthorne KM, Chen Z, Gunn SK, Wilde M, Darlington G, Shypailo RJ, Ellis KJ, 2005. Vitamin D receptor Fok1 polymorphisms affect calcium absorption, kinetics, and bone mineralization rates during puberty. *J. Bone Miner. Res.* 20, 945-953.
- Andersen R, Molgaard C, Skovgaard LT, Brot C, Cashman KD, Chabros E, Charzewska J, Flynn A, Jakobsen J, Karkkainen M, Kiely M, Lamberg-Allardt C, Moreiras O, Natri AM, O'Brien M, Rogalska-Niedzwiedz M and Ovesen L, 2005. Teenage girls and elderly women living in northern Europe have low winter vitamin D status. *Eur. J. Clin. Nutr.* 59, 533-541.
- Chan GM, Hoffman K, McMurry M, 1995. Effects of dairy products on bone and body composition in pubertal girls. *J. Pediatr.* 126, 551-556.
- Cheng S, Tylavsky F, Kroger H, Karkkainen M, Lyytikainen A, Koistinen A, Mahonen A, Alen M, Halleen J, Vaananen K, Lamberg-Allardt C, 2003. Association of low 25-hydroxyvitamin D concentrations with elevated parathyroid hormone concentrations and low cortical bone density in early pubertal and prepubertal Finnish girls. *Am. J. Clin. Nutr.* 78, 485-492.
- Cheng S, Lyytikainen A, Kroger H, Lamberg-Allardt C, Alen M, Koistinen A, Wang QJ, Suuriniemi M, Suominen H, Mahonen A, Nicholson PH, Ivaska KK, Korpela R, Ohlsson C, Vaananen KH and Tylavsky F, 2005. Effects of calcium, dairy product, and vitamin D supplementation on bone mass accrual and body composition in 10-12-y-old girls: a 2-y randomized trial. *Am. J. Clin. Nutr.* 82, 1115-1126.
- DeBar LL, Ritenbaugh C, Aickin M, Orwoll E, Elliot D, Dickerson J, Vuckovic N, Stevens VJ, Moe E, Irving LM, 2006. Youth: a health plan-based lifestyle intervention increases bone mineral density in adolescent girls. *Arch. Pediatr. Adolesc. Med.* 160, 1269-1276.
- Du X, Zhu K, Trube A, Zhang Q, Ma G, Hu X, Fraser DR, Greenfield H, 2004. School-milk intervention trial enhances growth and bone mineral accretion in Chinese girls aged 10-12 years in Beijing. *Br. J. Nutr.* 92, 159-68.
- El-Hajj Fuleihan G, Nabulsi M, Tamim H, Maalouf J, Salamoun M, Khalife H, Choucair M, Arabi A, Vieth R, 2006. Effect of vitamin D replacement on musculoskeletal parameters in school children: a randomized controlled trial. *J. Clin. Endocrinol. Metab.* 91, 405-12.
- Guillemant J, Le HT, Maria A, Allemandou A, Peres G, Guillemant S, 2001. Wintertime vitamin D deficiency in male adolescents: effect on parathyroid function and response to vitamin D3 supplements. *Osteoporos. Int.* 12, 875-9.
- Lehtonen-Veromaa MK, Mottonen TT, Nuotio IO, Irjala KM, Leino AE, Viikari JS, 2002. Vitamin D and attainment of peak bone mass among peripubertal Finnish girls: a 3-y prospective study. *Am. J. Clin. Nutr.* 76, 1446-53.

- Moyer-Mileur LJ, Xie B, Ball SD, Pratt T, 2003. Bone mass and density response to a 12-month trial of calcium and vitamin D supplement in preadolescent girls. *J. Musculoskelet. Neuronal Interact.* 3, 63-70.
- Outila TA, Karkkainen MU, Lamberg-Allardt CJ, 2001. Vitamin D status affects serum parathyroid hormone concentrations during winter in female adolescents: associations with forearm bone mineral density. *Am. J. Clin. Nutr.* 74, 206-10.
- Tylavsky FA, Ryder KM, Li R, Park V, Womack C, Norwood J, Carbone LD, Cheng S, 2007. Preliminary Findings: 25(OH)D Levels and PTH Are Indicators of Rapid Bone Accrual in Pubertal Children. *J. Am. Coll. Nutr.* 26, 462-70.
- Talwar SA, Swedler J, Yeh J, Pollack S, Aloia JF, 2007. Vitamin-D nutrition and bone mass in adolescent black girls. *J. Natl. Med. Assoc.* 99, 650-7.
- Viljakainen HT, Natri AM, Karkkainen M, Huttunen MM, Palssa A, Jakobsen J, Cashman KD, Molgaard C, Lamberg-Allardt C, 2006. A positive dose-response effect of vitamin D supplementation on site-specific bone mineral augmentation in adolescent girls: a double-blinded randomized placebo-controlled 1-year intervention. *J. Bone Miner. Res.* 21, 836-44.

GLOSSARY / ABBREVIATIONS

BMC	Bone mineral content
BMD	Bone mineral density
RCT	Randomised controlled trial
RDA	Recommended daily allowance
UL	Tolerable Upper Intake Levels