Dietary Patterns with Special Reference to Calcium Intake in 2–16-year-old Urban Western Indian Children

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Abstract

Background: It is important to establish good dietary practices in childhood that promote adequate calcium intake throughout life and reduce the risk of osteoporotic fractures in later life. Objectives: To assess dietary patterns of 2–16-year-old children with special reference to calcium and suggest strategies and develop recipes suitable to identified patterns to increase dietary calcium intake. Methods: We studied 220 schoolchildren (2–16 years) around Pune city, India. The study duration was June 2013–July 2014. Height and weight were measured using standard protocols. Dietary intake was assessed by 24-h diet recall on 3 nonconsecutive days. Dietary patterns were derived by cluster analysis in two age groups; children (2–9 years) and adolescents (10–16 years). As per the dietary patterns, calcium-rich recipes were developed. Results: Among children, “rice-pulse” (RP) and “wheat, milk, and milk products” (WM) patterns were observed. Among adolescents, RP, “wheat, milk, and bakery” (WMB), and “mixed food” patterns were observed. Children who consumed “WM” and “WMB” patterns had greater intake of calcium (P < 0.05) than children consuming other dietary patterns. The daily calcium intake of whole group was 53% of the recommended dietary allowance. From this, 30% calcium came from milk. Each serve of the developed recipe provided an average of 254 mg of calcium. Conclusion: Majority of children had cereal-pulse-based dietary patterns. By replacing foods from existing dietary patterns with calcium-rich foods, the dietary calcium content may be increased in a sustainable manner.

Key words: Calcium intake, dietary pattern, Indian children, plant food

INTRODUCTION

Adequate calcium intake during childhood and adolescence is necessary for the attainment of peak bone mass and in turn helps in reducing osteoporosis-related fractures. Of the Indian population, 31% are children and adolescents from 2 to 16 years of age. The proportion of children who achieve the recommended calcium intake decline after the 2nd year of life, reaching its lowest between the ages of 12 and 19 years. This nadir occurs during the period in which accumulation of bone mineral is at its peak and calcium requirements are at their highest. This emphasizes the importance of establishing good dietary practices in childhood that promote adequate calcium intake throughout life.

Calcium adequacy in diet is directly related to dairy consumption. It has been reported that diets from developing countries are predominantly cereal-based and the contribution of milk and milk products to the calcium content in diet is negligible. Foods such as green leafy vegetables, legumes, and cereals provide calcium but in lower amounts per serving than do the dairy foods. Furthermore, components such as phytates in cereals and oxalates in spinach reduce the bioavailability of calcium. Thus, in addition to low calcium content, the bioavailability of calcium may be low depending on the overall dietary pattern. Therefore, it is necessary to study dietary patterns and to develop strategies to improve the content and bioavailability of calcium from plant-based diets.

Dietary pattern analysis helps understand the prevailing dietary habits and plan suitable strategies for overcoming the nutritional deficiencies if any. Few studies have reported...
cereal, millet, or cereal-green leafy vegetable-based dietary patterns in urban adolescent girls[^12] and rural preschool Indian children.[^13-15] However, studies describing urban children’s dietary patterns to estimate calcium inadequacies are scarce. Thus, the objectives of this study were to assess dietary patterns of 2–16-year-old apparently healthy Indian children and adolescents with special reference to calcium content and bioavailability. Further also to suggest strategies and develop recipes to increase the calcium content and bioavailability in the identified dietary patterns.

**Materials and Methods**

**Sample selection**

We studied 220 children (2–16 years of age) from different schools in Pune city, Western India. The sample size of 220 was determined based on the variation in dietary calcium intake from the previous studies in children to achieve 83% power with level of significance of 5% to detect a difference of more than 10%.

From the list of schools in Maharashtra state covering entire age range and different socioeconomic classes, twenty schools were selected randomly and approached for permissions. Of these, three were randomly selected for the study. From the class of fifty students in each standard from preschool to tenth, a total of 220 children were enrolled. The duration of the study was from June 2013 to July 2014.

Children with a history of fracture or prolonged immobilization within the past 12 months and any major systemic disease were excluded. Written informed consent from parents and assent from the children were obtained before the study. This cross-sectional study was approved by the Institutional Ethics Committee.

**Anthropometric parameters**

Standing height was measured to the nearest millimeter using a portable stadiometer (Leicester Height Meter, Child Growth Foundation, UK), and weight was measured using an electronic scale to the nearest 100 g. The height for age, weight for age, and body mass index for age Z-scores were calculated using Indian reference values.[^15]

**Dietary assessment**

Dietary intake was assessed by 24-h recall on three random, nonconsecutive days including a Sunday using the multiple pass approach.[^16,17] Each child/parent was asked about food and beverage intake for each day, and recipes of the food items were also recorded. In case of toddlers and younger children, diet recalls were collected from their mothers/caretakers when appropriate. In case where there was an atypical day or an outlying observation, re-entry for that particular day with a new recall was done.

For estimating portion sizes, standard serving plates, cups, and spoons were used to record amounts of individual food items consumed by each child. The portion size was also obtained by the average of actual weights (single-pan weighing balance with a least count of 5 g) of one serving of each food item from their households. This was performed for each routine food item consumed during a week’s time. Thirty randomly selected households were visited to verify the reported food consumption and recipes to confirm the diet recalls. On a subsample, we have verified the dietary intakes of children from different age groups and Socio Economic (SE) groups on two occasions, and intraclass correlation coefficient ranged from 0.81 to 0.98 for different nutrient and food intakes.

Daily nutrient intakes were calculated using a cooked food database (CDiet version 1.0) and raw foods database of National Institute of Nutrition (NIN), India, and USDA.[^18-21] Through the CDiet software, comparison of the intake was performed with the recommended dietary allowances (RDAs) for Indians as given by the Indian Council of Medical Research.[^22]

**Developing recipes for improving the calcium content of dietary patterns**

The most commonly consumed food items under each food group were enlisted and other calcium-rich food item choices were identified using the nutritive values by NIN, India [Table 1].[^20] The traditional recipes as described by the mothers were then modified using these calcium-rich food choices. Further, to improve the amount of bioavailable calcium in the recipes, food processing methods known to increase bioavailability were used.[^23-26] In addition, it has been reported that an acidic medium in the gut helps in calcium absorption; thus, Vitamin C-rich foods were used for the same.[^7] Nutrient contents of traditional recipes have been reported previously.[^19,27-29] Nutrient contents of the newly developed recipes were estimated using the previous recipes considering the moisture correction.

**Table 1: Strategies to increase the calcium content and bioavailability from children’s diet**

| Food group                  | Existing food choices                              | Suggested calcium-rich foods to add              | Food processing to improve calcium bioavailability |
|-----------------------------|---------------------------------------------------|------------------------------------------------|-------------------------------------------------|
| Cereals and millets         | Wheat, refined flour, rice                        | Finger millet, sorghum, pearl millet            | Germination, fermentation, malting               |
| Legumes/split pulses        | Red gram dal, green gram dal, cowpea, moth bean, whole green gram | Soybean, horse gram, Bengal gram, kidney beans | Germination, fermentation                        |
| Green leafy vegetables      | Fenugreek leaves, spinach, dill                   | Amaranth leaves, cauliflower leaves, *Colocasia* leaves, mint leaves, curry leaves | Use of Vitamin C-rich foods                     |
| Miscellaneous (nuts/seeds)  | Mustard seeds, cumin seeds                        | Sesame seeds, garden cress seeds, omum, dry coconut |                                                     |
**Statistical methods**

All statistical analyses were performed using SPSS software (version 16.0, 2007, SPSS Inc., Chicago, IL, USA). Normality of the data was checked using Kolmogorov–Smirnov test. Differences in means were tested using Student’s t-test and one-way ANOVA. In case of nonnormal variables, Mann–Whitney U-test and Kruskal–Wallis test were performed to test differences between means. For the identification of dietary patterns, k-mean cluster analysis was performed as below.

To understand the pattern of children and adolescents’ daily dietary habits, k-mean cluster analysis was performed. Considering the variety of foods consumed, dietary intake data were classified into the following major food groups, rice, wheat, refined cereals, millets, milk and milk products, sprouted pulses, non-sprouted pulses, fruits and salads, all vegetables, nonvegetarian foods, and fried foods and sweets. Individual food items were classified into a food group based on their major ingredients, for example, plain rice, rice flakes, puffed rice were categorized under rice. Thus, for each child, dietary intake of each food group was obtained as amount in grams of rice, vegetable, milk, etc.

**Results**

A total of 220 children (105 boys, 115 girls) with a mean age of 9.6 ± 3.9 years were studied. As dietary patterns during childhood are likely to be different from those during adolescence,[30] study subjects were classified into two groups as children (2–9 years) and adolescents (10–16 years).[31,32] Majority of the study group children were within reference range for their height for age Z-score (HAZ) (81%) and weight for age Z-score (WAZ) (72%), indicating normal growth status. Overall, around 75% of children and adolescents consumed cereal-pulse-based diets with low total and bioavailable calcium intake. Figure 1 shows the calcium intake as percent RDA from milk source and plant source in children and adolescents.

**Dietary patterns**

**Children**

Two dietary patterns were obtained in children. The clusters were named based on the food groups predominant in each cluster. Eighty-one percent had the “wheat and milk and milk products” (WM) dietary pattern while 19% children had “rice and pulse pattern” (RP). The consumption of all other food groups was similar between the two groups as tested by Mann–Whitney U-test (Table 2).

The daily mean energy intake in children from “RP” pattern was 1616 ± 468 Kcals/day and 1342 ± 423 Kcals/day in children from “WM” pattern. However, the protein intake was similar and 36 ± 14 and 33 ± 11 g/day in children from “RP” and “WM” patterns, respectively. The intake of calcium was significantly greater in children from “WM” pattern, with a mean of 479 ± 222 mg/day than 351 ± 196 mg/day in “RP” pattern children due to significantly greater intake of milk and milk products (P < 0.05). The calcium intake was 44% (14% from milk and milk products) of RDA in children from “RP” pattern and was significantly lower (P < 0.05) than the 60% (38% from milk and milk products) consumed by children.

![Figure 1: Dietary sources of calcium in children and adolescents.](image)

**Table 2: Food group intake (g/day) across the dietary patterns in children and adolescents**

| Food groups               | Children*       | Adolescents**  |
|---------------------------|-----------------|----------------|
|                          | RP (n=21)       | MF (n=53)      |
|                          | WM (n=91)       | WMB (n=32)     |
| Wheat                    | 80 (33-120)     | 104 (31-180)   |
|                          | 120 (57-214)    | 83 (15-181)    |
| Rice                     | 433 (394-600)*  | 267 (133-333)* |
|                          | 133 (67-196)    | 502 (442-600)* |
| Refined cereal           | 36 (5-60)       | 19 (3-48)      |
|                          | 31 (5-63)       | 13 (2-40)      |
| Non-sprouted pulses      | 128 (93-207)*   | 62.5 (24-93)   |
|                          | 67 (33-98)      | 180 (92-234)*  |
| Milk and milk products   | 0 (0-125)       | 0 (0-58.75)    |
|                          | 167 (50-300)*   | 0 (0-54)       |
| Non-vegetarian foods     | 0 (0-33)        | 22 (0-49)*     |
|                          | 15 (0-34)       | 0 (0-5)        |
| Fruits and salads        | NA              | 0 (0-60)       |
|                          | NA              | 6 (0-51)       |
| All vegetables           | 35 (18-82)      | 0 (0-60)       |
|                          | 52 (26-94)      | 6 (0-51)       |
| Fried foods and sweets   | 2 (0-17)        | 51 (24-70)     |
|                          | 0 (0-23)        | 67 (30-92)     |

*Values are median, figures in parenthesis indicate IQR, *Significantly different than the other food pattern, significance tested by Mann-Whitney U-test, P<0.05, **Values are median, figures in parenthesis indicate IQR, *Significantly different than MF dietary pattern, *Significantly different than the rice and pulse dietary pattern, #Significantly different than wheat and milk and milk products dietary pattern, significance tested by Kruskal-Wallis test, P<0.05. IQR: Interquartile range, RP: Rice and pulse pattern, NA: Not available, WM: Wheat and milk and milk products pattern, WMB: Wheat, milk, and bakery pattern, MF: Mixed food.
from “WM” pattern. The significance of difference in nutrient intake between the two diet patterns was tested by Student’s $t$-test. Thirty-eight percent children from RP pattern and 10% from “WM” pattern had HAZ $<-2$ (stunting); similarly, 62% children from RP and 25% children from WM dietary pattern had WAZ $<-2$ (underweight) ($P < 0.05$).

**Adolescents**

In adolescents, three dietary patterns were identified. Adolescents from the first pattern consumed moderate amounts of foods from all food groups in comparison to adolescents from other two patterns, and hence, this group was named as "mixed food" (MF) dietary pattern. The second pattern was named as “RP” dietary pattern and the third as “wheat, milk, and bakery” (WMB). In all, 49% had “MF” pattern, 21% had “RP” pattern, and 30% had “WMB” pattern [Table 2, significance of difference was tested by Kruskal–Wallis test]. The mean daily energy intake was significantly ($P < 0.05$) lower in adolescents from “MF” pattern (1314 ± 395 Kcal) than from WMB (1956 ± 388 Kcal) and “RP” pattern (1768 ± 420 Kcal). Similarly, adolescents from “MF” pattern had significantly lower protein intake (30 ± 10 g) than from “WMB” (51 ± 13 g) and RP (39 ± 13 g) patterns. The significance of difference in nutrient intake between the three diet patterns was tested by one-way ANOVA.

The percent RDA calcium intake was 93% (44% from milk and milk products) in adolescents from “WMB” pattern and was significantly ($P < 0.05$) greater than in adolescents from “RP” (35%, 6% from milk and milk products) and “MF” pattern (40%, 5% from milk and milk products). However, the percent RDA calcium intake in adolescents from “RP” and “MF” pattern was similar ($P > 0.1$). Among the three dietary patterns, the percentage of stunting was 10% in adolescents from “WMB,” 28% from “MF,” and 29% from “RP” pattern. Similarly, in adolescents from “WMB” pattern, 6% were underweight, 32% from “MF” pattern, and 27% from “RP” pattern ($P < 0.05$). The percent adolescents with BAZ $<-2$ were similar in all three patterns.

**Recipe formulation**

Since most children and adolescents consumed inadequate amounts of calcium, and majority of the calcium came from nonmilk calcium sources, it was necessary to suggest strategies to increase the calcium content and bioavailability from the existing dietary patterns. Table 1 describes the foods commonly consumed by the children and strategies suggested to increase the dietary calcium content and bioavailability. There were an estimated increase of 34% in calcium content after addition of the suggested foods and a further increase of around 20% after use of the suggested food processing techniques [Figure 2]. Twenty-five recipes were devised using calcium-rich foods and food processing techniques known to increase calcium bioavailability [Table 1 and Appendix 1 available online]. From these recipes, 15 meals and five snacks were formulated as per the defined dietary patterns [Appendix 2 available online]. The average energy provided by one serving of the newly devised recipes was 286 ± 76 Kcal, protein was 11 ± 4 g, and calcium was 254.4 ± 22.3 mg. On an average, 42% of RDA of calcium in children and 32% of RDA of calcium in adolescents were achieved by consumption of one serving of any of the recipes. Thus, adding one serving of any recipe to the daily diet would enhance the total calcium intake reaching more than 75% RDA.

**DISSCUSSION**

We found that, overall, around 76% children and 80% adolescents did not meet the RDA for calcium. The mean calcium intake was 57% of the RDA in children and 53% in adolescents. Of the RDA achieved, in children, 33% of calcium was from milk, while in adolescents, only 18% was from milk. The mean intake of milk and milk products was 143 ml; only 22 children had daily milk and milk products intake above 400 ml, while the RDA of milk for 2–16-year-old children is 500 ml/day.[24] Similar low intakes of milk have been reported in rural Indian children.[33] Stunting (HAZ $<-2$) was noted in 19% and 28% of the study children were underweight (WAZ $<-2$).

Our study children consumed either (i) RP as major staple or (ii) WM or (iii) MFs. The diets from RP pattern were more deficient in calcium. Although dietary patterns with reference to calcium have been scarcely studied, similar to our findings, Tupe and Chiplonkar have also reported cereal-pulse-based dietary patterns in Indian girls.[12] Various Indian researchers have shown cereal as a staple food in majority of children.[9,33,34] Similarly, Henry-Uneze and Okonkwo have reported cereal-pulse-based diets in 12–19-year-old Nigerian children.[35]

Further, our results suggest that in comparison to children, adolescents consumed lower amounts of calcium and considerably inadequate amounts of milk and milk products. Similar to our results, a decrease in milk intake during early adolescence was reported in 10–19-year-old girls from the United States.[16–18] In Spanish children, inadequate consumption of milk and milk products was reported in girls with increasing age and in boys after 14 years of age.[39]
Requirement of calcium is greater during adolescence than childhood or adulthood. During the adolescent growth spurt, 37% of total body bone mineral is accrued and intake of milk during adolescents is associated with the amount of bone accrual. The inadequate intake of total as well as milk calcium may put them at a risk of low peak bone mass accrual.

With meager milk intakes, majority of dietary calcium was derived from plant foods in children as well as adolescents. It is thus necessary to suggest strategies to increase the total calcium content in their diets. However, these changes need to be made keeping in mind children’s habitual dietary patterns. We have demonstrated that with the choice of calcium-rich foods, the estimated calcium content of the diet may be increased. The new recipes provide 254 mg of calcium, 287 Kcal energy, and 11 g protein per serving. One serving of the suggested recipe provides 42% of the calcium RDA in children and 32% in adolescents. Using various food processing techniques such as soaking, fermentation, germination, and malting, the calcium bioavailability of plant foods may be increased. These techniques are especially applicable to cereals and pulses. They can be used effectively in any population where the staple food groups are plant based.

One of the limitations of our study is that the calcium bioavailability was not examined in a laboratory; however, the estimations of bioavailability were made based on our previous work as well as other literature. Our strength is that the suggested modifications, meals are a food-based approach, hence, may be a sustainable strategy for improving Indian children’s dietary calcium intake. In addition, dietary patterns in 2–16-year-old children with special reference to calcium have been described for the first time.

**Conclusion**

Majority of children had cereal-pulse based dietary patterns. By replacing foods from existing dietary patterns with calcium rich foods and using food processing methods, the dietary calcium content may be increased in a sustainable manner. This strategy can be used effectively in any population where the staple food groups are plant based.

**Financial support and sponsorship**

Nil.

**Conflicts of interest**

There are no conflicts of interest.

**References**

1. The Registrar General & Census Commissioner, Ministry of Home Affairs, Government of India. C-13 Single Year Age Returns by Residence and Sex. New Delhi India; March, 2016. Available from: http://www.censusindia.gov.in/2011census/C-series/C-13.html. [Last cited on 2016 Mar 09; Last accessed on 2016 Mar 09].
2. Greer FR, Krebs NF; American Academy of Pediatrics Committee on Nutrition. Optimizing bone health and calcium intakes of infants, children, and adolescents. Pediatrics 2006;117:579-85.
3. Heaney RP, Abrams S, Dawson-Hughes B, Looker A, Marcus R, Markovic V, et al. Peak bone mass. Osteoporos Int 2000;11:985-1009.
4. Weaver CM, Heaney RP. Food sources, supplements, and bioavailability. In: Weaver CM, Heaney RP, editors. Calcium in Human Health. New Jersey: Humana Press; 2006. p. 129-42.
5. Narasinga Rao BS, Deoshale YG, Pant KC, Gopalan C, Ramasastri BB, Balasubramanyam SC, editors. Nutritive Value of Indian Food. Hyderabad: Indian Council of Medical Research, National Institute of Nutrition; 2007. p. 27-31.
6. Schönfeldt HC, Gibson Hall N. Dietary protein quality and malnutrition in Africa. Br J Nutr 2012;108 Suppl 2:S69-76.
7. Gibson RS, Perlis L, Hotz C. Improving the bioavailability of nutrients in plant foods at the household level. Proc Nutr Soc 2006;65:160-8.
8. Kulsum A, Lakshmi AJ, Prakash J. Dietary adequacy of Indian children residing in an Urban slum – Analysis of proximal and distal determinants. Ecol Food Nutr 2009;48:161-77.
9. Sanwalka NJ, Khadilkar AV, Mughal MZ, Sayyad MG, Khadilkar VV, Shirrole SC, et al. A study of calcium intake and sources of calcium in adolescent boys and girls from two socioeconomic strata, in Pune, India. Asia Pac J Clin Nutr 2010;19:324-9.
10. Dror DK, Allen LH. The importance of milk and other animal-source foods may be increased. These techniques are especially applicable to cereals and pulses. They can be used effectively in any population where the staple food groups are plant based.

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2. Greer FR, Krebs NF; American Academy of Pediatrics Committee on Nutrition. Optimizing bone health and calcium intakes of infants, children, and adolescents. Pediatrics 2006;117:579-85.
3. Heaney RP, Abrams S, Dawson-Hughes B, Looker A, Marcus R, Markovic V, et al. Peak bone mass. Osteoporos Int 2000;11:985-1009.
4. Weaver CM, Heaney RP. Food sources, supplements, and bioavailability. In: Weaver CM, Heaney RP, editors. Calcium in Human Health. New Jersey: Humana Press; 2006. p. 129-42.
5. Narasinga Rao BS, Deoshale YG, Pant KC, Gopalan C, Ramasastri BB, Balasubramanyam SC, editors. Nutritive Value of Indian Food. Hyderabad: Indian Council of Medical Research, National Institute of Nutrition; 2007. p. 27-31.
6. Schönfeldt HC, Gibson Hall N. Dietary protein quality and malnutrition in Africa. Br J Nutr 2012;108 Suppl 2:S69-76.
7. Gibson RS, Perlis L, Hotz C. Improving the bioavailability of nutrients in plant foods at the household level. Proc Nutr Soc 2006;65:160-8.
8. Kulsum A, Lakshmi AJ, Prakash J. Dietary adequacy of Indian children residing in an Urban slum – Analysis of proximal and distal determinants. Ecol Food Nutr 2009;48:161-77.
9. Sanwalka NJ, Khadilkar AV, Mughal MZ, Sayyad MG, Khadilkar VV, Shirrole SC, et al. A study of calcium intake and sources of calcium in adolescent boys and girls from two socioeconomic strata, in Pune, India. Asia Pac J Clin Nutr 2010;19:324-9.
10. Dror DK, Allen LH. The importance of milk and other animal-source foods may be increased. These techniques are especially applicable to cereals and pulses. They can be used effectively in any population where the staple food groups are plant based.

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nutrients, antinutrients, in vitro iron and calcium bioavailability and in vitro starch and protein digestibility of some legume seeds. LWT Food Sci Technol 2007;40:1292-9.

27. Sanwalka NJ, Khadilkar AV, Chiplonkar SA. Development of non-dairy, calcium rich vegetarian food products to improve calcium intake in vegetarian youth. Curr Sci 2011;101:657-63.

28. Chiplonkar SA, Kawade R. Effect of zinc-and micronutrient-rich food supplements on zinc and Vitamin A status of adolescent girls. Nutrition 2012;28:551-8.

29. Kulkarni SA, Ekbote VH, Sonawane A, Jeyakumar A, Chiplonkar SA, Khadilkar AV. Beneficial effect of iron pot cooking on iron status. Indian J Pediatr 2013;80:985-9.

30. Madruga SW, Araújo CL, Bertoldi AD, Neutzling MB. Tracking of dietary patterns from childhood to adolescence. Rev Saude Publica 2012;46:376-86.

31. Ulijaszek SJ. The international growth standard for children and adolescents project: Environmental influences on preadolescent and adolescent growth in weight and height. Food Nutr Bull 2006;27 4 Suppl Growth Standard: S279-94.

32. Wang Y, Moreno LA, Caballero B, Cole TJ. Limitations of the current world health organization growth references for children and adolescents. Food Nutr Bull 2006;27:175-88.

33. Ahmed N. Dietary practices and nutritional status of pre-school children of Sivasagar, Assam. Int J Comput Appl Eng Sci 2012;2:266-9.

34. Kaur P, Dahiya S, Rana MK. Food and nutrient intake of pre-school children (2-6 year) of Sonepat district. J Dairy Foods Home Sci 2007;26:141-6.

35. Henry-Unamee HN, Okonkwo CN. Food consumption pattern and calcium status of adolescents in Nnewi, Nigeria. Pak J Nutr 2011;10:317-21.

36. Bowman SA. Beverage choices of young females: Changes and impact on nutrient intakes. J Am Diet Assoc 2002;102:1234-9.

37. Striegel-Moore RH, Thompson D, Affenito SG, Franko DL, Obarzanek E, Barton BA, et al. Correlates of beverage intake in adolescent girls: The National Heart, Lung, and Blood Institute Growth and Health Study. J Pediatr 2006;148:183-7.

38. Lytle LA, Seifert S, Greenstein J, McGovern P. How do children’s eating patterns and food choices change over time? Results from a cohort study. Am J Health Promot 2000;14:222-8.

39. Aranceta J, Pérez-Rodrigo C, Ribas L, Serra-Majem L. Sociodemographic and lifestyle determinants of food patterns in Spanish children and adolescents: The enKid study. Eur J Clin Nutr 2003;57 Suppl 1:S40-4.

40. Kalkwarf HJ, Khoury JC, Lanphear BP. Milk intake during childhood and adolescence, adult bone density, and osteoporotic fractures in US women. Am J Clin Nutr 2003;77:257-65.