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ORIGINAL ARTICLE

A Cross-Sectional Study of Postpartum Changes in Bone Status in Indian Mothers

Neha Kajale[1] · **Anuradha Khadilkar**[1] · **Shashi Chiplonkar**[1] · **Zulf Mughal**[2] · **Vaman Khadilkar**[1] · **Nina Mansukhani**[1]

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About the Author

Neha Kajale is a Research Scholar at Hirabai Cowasji Jehangir Medical Research Institute, Jehangir Hospital, Pune. Her primary area of work includes bone health and metabolic health of young Indian urban lactating mothers postpartum. She has also worked on childhood growth and growth hormone deficiency. She has published six articles in national and international peer-reviewed journals. She has also received several awards at various national and international conferences such as NSI, IDA, and ICCBH 2015.

Abstract

Background Bone turnover is high during lactation. However, studies on bone status of Indian urban mothers are scarce. Hence, the objective was to conduct a cross-sectional study on the lactation-related changes in bone health status of Indian mothers postpartum using Dual X-ray Absorptiometry (DXA) at 3 time points: within a week of delivery, at 1- and 3-years postpartum. We also explored the association of dietary calcium intake, physical activity, serum vitamin D status, and dietary traditional food supplements (Dietary Food supplements) with bone health.

Methods A cross-sectional study was conducted; 300 full-term, healthy primiparous women (28.6 ± 3.4 year) were randomly selected and categorized into 3 groups: 128 mothers within 7 days of delivery (Group A), 88 with 1-year-old children (B), and 84 with 3-year-old children (C). Anthropometry, lactation history, physical activity, diet, biochemical tests (vitamin D, parathyroid hormone), body composition, areal bone mineral density (a-BMD) at total body (TB), AP spine (APS), and dual neck femur (DF) were assessed by DXA (GE-Lunar DPX).

Results Significantly higher APS-BMD (mean ± SD) was observed in Group C (1.107 ± 0.098 g/cm^2) than that in A (1.045 ± 0.131 g/cm^2) ($p < 0.05$). When adjusted for breastfeeding practices, mean (±standard error) APS-BMD was lowest in women in Group A (1.024 ± 0.013 g/cm^2),

Neha Kajale is a Research Scholar at Hirabai Cowasji Jehangir Medical Research Institute, Jehangir Hospital, Pune.

✉ Anuradha Khadilkar
anuradhavkhadilkar@gmail.com

1 Growth and Endocrine Unit, Jehangir Hospital, Hirabai Cowasji Jehangir Medical Research Institute, 32, Sasoon Road, Pune 411001, India

2 Department of Paediatric Endocrinology, Royal Manchester Children's Hospital, Manchester M13 9WL, UK

but was higher at 1-year (1.079 ± 0.02 g/cm^2) and at 3-years postpartum (1.111 ± 0.019 g/cm^2), though differences were significant only between groups A and C ($p < 0.05$). Most mothers from all 3 groups consumed inadequate amount of nutrients except dietary fat and showed low physical activity. Multiple regression analysis indicated that dietary calcium, moderate physical activity, serum vitamin D, and consumption of dietary food supplements were not significant predictors of APS-BMD ($p > 0.1$).

Conclusion Prevalence of nutrient and vitamin D deficiencies, low physical activity, and poor sunlight exposure were major concerns in Indian lactating mothers; improvement in bone mass at APS was observed at 3-years which was most likely due to physiologic changes.

Keywords Lactation · Postpartum · Bone health · Body composition · Indian mothers

Abbreviations

a-BMD	Areal bone mineral density
BMC	Bone mineral content
TB	Total body
APS	Anterior–posterior spine
DF	Dual femur
DXA	Dual-energy X-ray absorptiometry
LBM	Lean body mass
DFS	Dietary food supplement
NDS	No dietary food supplement
RDA	Recommended dietary allowances

Introduction

During lactation, maternal demand for calcium is high as the baby mainly depends on the maternal skeleton for its mineral supply (around 250 mg of calcium per day in breast milk) [1]. In addition to mobilization of calcium from the mother's bones, other adaptations include increased dietary calcium intake, increased efficiency of intestinal calcium absorption, and increased conservation of calcium in the kidneys [2]. Thus, there is a decrease in maternal bone mineral density during the initial period of lactation and recovery of bone loss at various sites post weaning in women consuming a diet sufficient in calcium [3, 4] (Ca intake >1200 mg/day). However, low intake of dietary calcium, i.e., below recommended dietary allowance (RDA), is well documented [5, 6] among lactating women. In apparently healthy South Indian women (non-pregnant, non-lactating), along with low bone mass [7], deficiency of Vitamin D and secondary hyperparathyroidism [8] have also been reported in earlier studies.

Postpartum back pain has been reported due to restricted movements and increased spinal load during pregnancy [9]. Most Indian mothers consume traditional dietary supplements (Dietary Food supplements—DFS, Appendix 1) rich in calcium during the initial days of lactation [10, 11]. Dietary Food supplements are thought to increase calcium intake, relieve (or reduce) backache, and repair damaged tissues postpartum [12]. However, the effect of such supplement consumption on bone density of these mothers has been scarcely investigated.

Thus, our aim was to execute a cross-sectional study on the lactation-related changes in bone health status in Indian mothers postpartum using dual-energy X-ray absorptiometry (DXA) at three time points: (1) within week of delivery (group A), (2) at 1–2 years (group B) and (3) at 3–4 years (group C), postpartum. We measured bone mineral content (BMC) and areal bone mineral density (a-BMD) at the anterior–posterior lumbar spine (APS), femur (F), and total body (TB). We also explored the factors affecting a-BMD such as nutrient intake, intake of Dietary Food supplements, vitamin D status, and breastfeeding practices.

Methods

Selection of Participants

A cross-sectional study was conducted in urban postpartum mothers. Based on the standard deviation of spine BMD from previous studies [4], sample size was estimated to be 83 per group to detect the differences in groups at 5 % level of significance and 5 % margin of error so as to achieve a power of 80 %. Considering the possible non-availability of women for measurements during the immediate postpartum period, we approached a larger number of women for group A, and all those who agreed were assessed. Hence, 128 primiparous mothers within 1 week of delivery (Group A) in a tertiary level health care hospital in Pune city, India, were enrolled for the study. Further, mothers of singletons, coming to different pediatric clinics or school nurseries were approached and those satisfying the inclusion/exclusion criteria voluntarily participated in the study. Eighty-eight mothers had 1- to 2-year-old children (group B) and 84 mothers had 3- to 4-year olds (Group C). Exclusion criteria were multiparous mothers, mothers with twins, mothers with any pre-existing conditions such as gestational diabetes or pre-eclumpsia, and mothers of infants diagnosed with Intrauterine Growth Restriction/Retardation (IUGR) or Small for Gestational

Age (SGA) after confirmation from pediatrician/gynecologist [13]. Research protocol was approved by the institutional ethics committee and all participants gave written informed consent.

Anthropometry

Mothers' weight was measured on the date of enrolment (DOE) in light clothes, without shoes, using an electronic digital scale (Salter, India) to the nearest 0.1 kg. Pre-pregnancy weight recorded by the gynecologist around 1 month before pregnancy was obtained from medical records. Standing height was measured using a stadiometer (Leicester Height Meter, Child Growth Foundation, UK, range 60–207 cm) to the accuracy of 1 mm. Body mass index (BMI) was calculated as weight in kg/height in meter square. Mother's postpartum change in weight till the date of enrolment over pre-pregnancy weight was computed.

Socio-Demographic Information and Lactation History

A structured and pretested questionnaire (intraclass correlation coefficient = 0.75, $p = 0.001$) was designed to collect information on socio-demographic factors such as age, education, occupational status, etc., [14]. Details of delivery and information on history of lactation regarding whether baby was breastfed exclusively or partially [15] were recorded. *Exclusive breastfeeding* (EBF) was defined when the infant received only breast milk and no other solids or liquids with the exception of vitamins, minerals, medicines, or oral rehydration solution [15]; *partial breastfeeding* (PBF) was defined when the infant received breast milk in addition to complementary foods; *complementary foods* included milk, infant formula, gruel or semi-solid foods given in addition to breast milk [15].

Physical Activity Assessment

Data on habitual physical activity were collected using a validated structured questionnaire [16]. Information about duration in minutes of major daily activities such as sleep, sitting, standing, walking, exercise, recreation, and occupational activity were used to classify an individual into level of physical activity groups: inactivity, light and moderate activity [17]. Activities such as office work, commuting, cooking, and household cleaning were considered as light activity. Time spent in exercise (e.g., yoga, walking, and gym) was considered as moderate activity [17]. Watching television, afternoon nap, and other leisurely activities were categorized as inactivity. Sunlight exposure was recorded using standardized questionnaires and coded in categories viz. <15 min, 15–30 min, 30–45 min and >45 min.

Biochemistry

A venous blood sample (total 8 mL) was collected after an overnight fast (not less than 10 h and not more than 14 h) from each participant using plain mineral-free vacutainers (BD Franklin Lakes, NJ USA) for serum estimations. Samples in plain vacutainers were immediately centrifuged at 2500 rpm for 15 min, and the serum was separated and frozen at −70 °C until analysis. Serum vitamin D, as reflected by serum 25-hydroxyvitamin D concentration [18] (25-OH D < 50 nmol/L = deficiency, DLD Diagnostika GmbH, Hamburg, Intra assay—CV < 5 %, Inter assay CV < 7.8 %), and Serum Parathyroid hormone (>66.5 ng/L = hyperparathyroidism, (DRG instruments GmbH, Germany; Intra assay—CV < 4.8 %, Inter assay—CV < 3.2 %) were estimated with ELISA technique by standard protocols using standard kits.

Dietary Assessment

Dietary intake was assessed by 24-h recall on three non-consecutive days, including a Sunday. Mothers were asked about the intake of food items using standard cups and spoons by a trained investigator through face-to-face interview. Traditional foods such as fenugreek seeds, gum, and dry fruits are commonly consumed by most Indian lactating mothers in different forms such as laddoos, porridges, and dry powder form for increasing calcium intake (Appendix 1). Participants were asked about their consumption (quantity/day and duration) of dietary food supplements. Daily dietary intakes of nutrients by mothers were calculated using C-Diet version 2.0 [19] based on Indian cooked foods database [20] and the nutritive value tables of raw foods [21, 22]. According to intake of dietary food supplements, mothers were post-classified into two groups, viz. taking dietary food supplement (DFS) and not taking dietary food supplement (NDS).

DXA Measurements

Lean body mass (LBM) and percentage fat mass for total body, bone mineral content (BMC), bone area (BA), and areal bone mineral density (a-BMD) were measured at anterior–posterior lumbar spine (L1-L4), and at the dual femur (for femoral neck) using Lunar DPX—PRO total body pencil beam densitometer (GE Healthcare, WI, USA) using a medium mode scan (software Encore 2005 version 9.30.044 Wisconsin, USA). For correcting the bone density for bone size, areal bone mineral density was calculated using the formula: BMD = BMC/BA. The precision of the

Lunar DPX for repeat measurements in adults is 1.04 % for lumbar spine BMD, 2.13 % for femoral neck BMD [23], and 1.1 % for total body [24]. Measurements were standardized by running daily quality assurance scans. All scans and scan analyses were performed by the same operator. T scores (young adult) and Z scores (age matched) were calculated using manufacturer's data provided with DXA machine. T score is the value of standard deviations above or below the mean for a healthy 30-year-old adult of the same sex and ethnicity as that of the patient, and Z score is the number of standard deviations above or below the norm for a person of the patient's age, sex, weight, and ethnic origin. Osteoporosis in adults is defined on the basis of T score (Osteopenia-T score < -1, Osteoporosis, T score < -2.5). The formula for T score calculation used was

$$\text{T score} = \frac{\text{Subject's BMD value} - \text{Mean young normal BMD value}}{\text{Young normal BMD standard deviation}}.$$

Statistical Analysis

Data were analyzed using the SPSS software for Windows (version 16.0, SPSS Inc, Chicago, IL). Mothers were categorized into 3 groups: Group A, within a week postpartum (2.6 ± 2.0 days); Group B, 1–2 years postpartum (18 ± 5 months); Group C, 3–4 years postpartum (40 ± 5.6 months). Differences in anthropometry, biochemistry, bone parameters, and nutrient intakes were assessed using ANOVA.

General linear model with univariate analysis was used to test the predictors for bone health and to test the differences in means after adjusting for breastfeeding practices and dietary food supplement intake. Level of significance was set at $p < 0.05$.

Results

General Characteristics of Participant Mothers

Most mothers were highly educated and half of them were working women. Above 90 % of mothers from all groups were graduates. More than 65 % mothers belonged to Upper Socio Economic Class as per Kuppuswami's socio-economic scale [25]. Group A mothers had significantly higher weight and BMI ($p < 0.05$) than the Group B and C mothers (Table 1). Postpartum (PP) change in weight (that is, weight on date of enrollment—pre-pregnancy weight) was also significantly higher in Group A than in Group B ($p < 0.01$) and Group C ($p < 0.01$). Majority of mothers from all groups (A—70 %, B—80 %, and C—85 %) consumed dietary food supplements in addition to their normal diet for more than 1 month postpartum. The average duration of consumption of dietary food supplements among mothers was 47 ± 45 days. Mothers who did not consume dietary food supplements, that is NDS group mothers, consumed additional milk products immediately postpartum. Hence dietary calcium intake of both the groups was similar (951 ± 358 mg/day vs 944 ± 294 mg/day, $p > 0.1$). Around 73 % mothers from Group A breastfed their babies on the day of enrollment. Fifty-eight percentage mothers from group B and 65 % from Group C had exclusively breastfed their babies for the first 6 months. Average duration of breast feeding in Group B was 15.5 ± 5.7 months and Group C was 15.0 ± 7.3 months. Around 90 %mothers from Group A and 81 % from Group B reported sunlight exposure of less than 15 min/day, whereas 40 % mothers from group C had sunlight exposure of 15 to 30 min/day. Similarly, within Group A, maximum inactivity of 866 (266) min/day [median (IQR)] was reported by mothers. Light household activity was similar among groups B and C—810 (150) min/day, whereas moderate activity/exercise (walk/yoga/gym) for more than 30 min was reported in only 5 % mothers from Groups A and B and 14 % among group C.

Group A consumed significantly higher amount of macro-nutrients and micro nutrients than group B and C ($p < 0.05$) (Table 1). Overall, except dietary fat, majority of mothers had less nutrient intake (mainly energy, protein, calcium, iron, and zinc) than the respective Recommended Dietary Allowances (RDA) [26]. Around 95 % mothers from group A consumed a protein-deficient diet postpartum. Similarly, 76 % mothers from Group A consumed inadequate amount of dietary calcium. Almost 100 % mothers from all the 3 groups consumed dietary iron and zinc below the RDA.

Group B and group C mothers had significantly higher ($p < 0.05$) vitamin D concentrations than group A (Table 2). Prevalence of vitamin D deficiency [if serum 25-hydroxyvitamin D (25OHD) <50 nmol/L] in group A (83 %) was higher than in group B (68 %) and group C (57 %). This was in line with greater sunlight exposure among groups B and C than in group A (Table 1). Hyperparathyroidism (S.PTH > 66.5 ng/L) was observed in 13 % mothers from group A. Similarly, hyperparathyroidism was also seen in 28 and 18 % mothers from groups B and C.

As shown in Table 2, bone mineral density (BMD) and bone mineral content (BMC) at total body and dual femur neck regions were similar among the 3 groups ($p > 0.1$). At AP spine, both parameters (BMD and BMC) were significantly higher in Group B and C over group A.

After accounting for differences in BF practices, general linear model analysis indicated that vitamin D, moderate activity level, and Dietary Food supplements were not

Table 1 General characteristics of participant mothers

Parameter	Group A (1-week postpartum)	Group B (1-year postpartum)	Group C (3-year postpartum)
N	128	88	84
Age (years)	27.7 ± 3.5	29.4 ± 3.2[a]	29.3 ± 3.0[a]
Weight (on date of enrollment) (kg)	65.7 ± 10.7	57 .6 ± 10.7[a]	57.2 ± 11.4[a]
Height (cm)	157.9 ± 6.1	156.1 ± 5.4[!]	156.2 ± 6.4[!]
Waist (cm)	98.2 ± 9.5	90.4 ± 9.4[!]	88.2 ± 10.4[!]
BMI (kg/m^2)	26.3 ± 4.0	23.7 ± 4.4[a]	23.4 ± 4.1[a]
Postpartum weight change[c] (kg)[$]	9.0 (7–11)	3.0 (1–5.5)	6.5 (3–10)
Dietary food supplement (% women)	70	80	85
Partial breastfeeding (% women)	27	42	35
Sunlight exposure (<15 min) (% women)	90	81	60
Sunlight exposure (15–30 min/day) (% women)	8	19	40
Moderate physical activity (min/day)[$]	0 (27.5)	0 (15)	0 (15)
Inactivity (min/day)[$]	866 (266)	60 (105)	60 (90)
Light activity (min/day)[$]	60 (180)	810 (150)	810 (150)
Education (above 15 years) % women	93.2	94	90.3
Socio-economic status (above Rs. 40 k/month) % women	82	78.3	65
Nutrient intakes[d]			
Energy (Kcal)	2428 ± 490 (48 %)[e]	2001 ± 349[a] (37 %)	1920 ± 375[a] (55 %)
Protein (g)	56 ± 13 (95 %)	48 ± 10[a] (76 %)	41 ± 8[a,b] (100 %)
Fat (g)	89 ± 30	56 ± 17[a]	59 ± 17[a]
Calcium (mg)	949 ± 340 (76 %)	618 ± 256[a] (56 %)	530 ± 181[a] (75 %)
Iron(mg)	11.7 ± 3.2 (99 %)	9.7 ± 2.0[a] (100 %)	8.9 ± 1.9[a] (100 %)
Zinc (mg)	6.6 ± 1.6 (100 %)	5.6 ± 1.2[a] (100 %)	4.8 ± 1.1[a] (100 %)
Magnesium (mg)	484 ± 171	440 ± 100[!]	413 ± 133[a]
Phosphorus (mg)	1283 ± 276	1110 ± 215[a]	983 ± 190[a,b]

All reports are expressed as (Mean ± SD) or [$] Median (IQR)

[a] Significantly different then Group A, $p < 0.05$

[b] Significantly different then Group B, $p < 0.05$

[c] Postpartum change in weight = weight on date of enrollment—weight pre-pregnancy

[d] RDA 2010 ICMR

[e] Figures in parenthesis indicate percentage of mothers below RDA

[!] $p < 0.1$ than group A

significant predictors of AP spine BMD. The adjusted mean (±standard error) of AP spine BMD was lowest in women in Group A (1.024 ± 0.013 g/cm^2), but was higher at 1 year (1.079 ± 0.02 g/cm^2) and at 3-year postpartum (1.111 ± 0.019 g/cm^2), though the differences were statistically significant only between groups A and C ($p < 0.01$). Prevalence of osteoporosis (T score < −2.5) at AP spine among group A was 10 %, group B was 5 %, and among group C was 1.3 %. Osteopenia (T score < −1.0) [27] was seen in 45.5, 34.1, and 30 0.0 %, respectively, of mothers of group A, B, and C. However, there was no history of fracture among women in any of the groups. Percentage of lean body mass and percent fat was similar among groups A, B, and C ($p > 0.1$)

Discussion

In our cross-sectional study on postpartum mothers, we observed that bone status improved at 1- and 3-years postpartum at the lumbar spine; higher absolute BMD values were observed at 3 years as compared to those during immediate postpartum period. The observed increase in bone at the spine was, however, not influenced by nutrient intake, dietary food supplements, vitamin D status, and breastfeeding practices. However, no significant changes in bone mineral density at total body and dual femur were observed in the three groups.

Absolute bone mineral density values at the lumbar spine reported by Ghannam et al. were higher than those

Table 2 Biochemical, bone parameters, and lean mass in mothers

Parameter	Group A	Group B	Group C
S. 25OH-D (nmol/L) (% mother with deficiency = <50 nmol/L)	31.4 ± 20.2 (83)	40.9 ± 22.0[a] (68)	45.9 ± 21.4[a] (57)
S. Para Thyroid Hormone (ng/L) (% mothers > 66.5 ng/L = hyper parathyroidism)	39.83 ± 41.06 (13)	51.79 ± 41.53 (28)	37.69 ± 40.28 (18)
TB BMD (g/cm^2)	1.123 ± 0.101	1.112 ± 0.156	1.119 ± 0.066
TB BMC (kg)	2.20 ± 0.30	2.15 ± 0.28	2.19 ± 0.28
APS-BMD L1–L4 (g/cm^2)	1.045 ± 0.131	1.09 ± 0.118[a]	1.107 ± 0.098[a]
APS BMC L1–L4 (g)	48.94 ± 9.63	50.23 ± 7.21	51.7 ± 7.92[a]
DF Neck BMD (g/cm^2)	0.923 ± 0.108	0.924 ± 0.108	0.945 ± 0.107
DF Neck BMC (g)	3.94 ± 0.57	3.93 ± 0.54	4.01 ± 0.53
TB LBM (%)	54.6 ± 5.4	55.5 ± 7.9	56.7 ± 6.9
TB fat (%)	43.40 ± 5.77	42.03 ± 8.30	41.23 ± 8.30

Mean ± SD, [a] $p < 0.05$ than group A

Figures in parenthesis indicate the % mothers above/below the normal reference range

TB BMD Total body bone mineral density, *TB LBM* total body lean body mass, *TB BMC* total body bone mineral content, *APS BMD L1–L4* anterio posterio spine bone mineral density (L1–L4), *APS BMC L1–L4* anterior–posterior spine bone mineral content (L1–L4), *DF Neck BMD* Dual Femur mean neck bone mineral density, *DF Neck BMC* Dual Femur mean neck bone mineral content

obtained in our study subjects [28] indicating poor bone status among Indian women. In spite of these low BMD values, fractures were not reported in the study subjects; however, poor bone health may predispose these women to osteoporosis and risk of fracture in later life. Longitudinal studies have reported improvement in spine BMD after weaning as compared to the postpartum period [3, 29, 30]; although our study design was cross-sectional, we also found higher values of BMD at 3 years compared to that at 1-week postpartum. These results remained unchanged even after adjustment for weight. Higher APS-BMD values and decrease in the prevalence of osteopenia/osteoporosis as was seen in our study were probably due to the natural conservation of calcium during lactation, which possibly resulted in the improvement in bone status at spine even with low calcium intake [2].

Low bone status [28] along with high prevalence of hypo-vitaminosis D among lactating mothers as was seen in our subjects has also been reported by others. Our study also reports higher prevalence of vitamin D deficiency in Indian postpartum women in line with other studies [31–34]. In a Danish study, Møller et al. also reported higher prevalence of vitamin D deficiency along with secondary hyperparathyroidism around 1 year postpartum, although the incidence was lower than that in our study population [35].

Anthropometric measurements, i.e., weight, BMI, and waist circumference, were significantly lower in women in group C than in group A. However, at 3 years, when mothers had completely stopped breastfeeding, PP retention in weight was significantly higher than in the other two groups. These results are in line with a study by Maddah et al. in Iranian population, which reports that at 3-years post-partum, primiparous women had more weight retention [36]. Nutrient intake of our mothers showed multiple nutrient deficiencies such as energy, protein, calcium, iron, and zinc deficiency in line with studies from other Asian countries [37].

Low physical activity and low sunlight exposure were reported by our study subjects. Similarly, in a study by Evenson et al. [38], very low moderate activity was reported at 12-month postpartum. Similar to Kulkarni et al. [39], we also found no significant change in the percent lean mass although their longitudinal study was performed on low-income group of Indian mothers.

There are previous reports on the intake of special dietary food supplements during lactation; these foods are believed to improve health and lactation performance [15, 40]. However, to the best of our knowledge, no study so far has reported the effect of dietary food supplements consumption on bone health of mothers. One of the limitations of our study is that the study design was cross-sectional and also we could not assess biochemical markers of bone turnover. However, our results are in line with other longitudinal studies.

In conclusion, dietary inadequacy of energy, protein, calcium, iron, and zinc was prevalent among mothers right after delivery and at 1- and 3-year postpartum. Despite vitamin D deficiency, improvement in bone status at the lumbar spine was observed at 1- and 3-year post-delivery; this was independent of mother's dietary calcium intake, physical activity, serum vitamin D status, and consumption of dietary food supplements among urban Indian mothers and was possibly due to physiologic changes during this period.

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Compliance with Ethical Standards

Conflict of interest All authors have no conflict of interest.

Ethical approval Research protocol was approved by the institutional ethics committee and all participants gave written informed consent.

Appendix

See Table 3.

Table 3 Commonly consumed Dietary food supplements with ingredient list and method of preparation

Item code	Food item	Ingredients	Method of preparation	Calcium (mg) per 100 g cooked weight
Laddoo				
1	Dink Laddoo	Edible gum, almonds, dry dates, poppy seeds[a], dry coconut, jaggery, ghee	Fry all the ingredients in ghee and mix together to make the small balls	50
2	Mix dry fruit Laddoo	Almonds, pistachio, dry dates, cashew nut, sugar, ghee		102
3	Methidana Laddoo	Fenugreek seeds[b], wheat flour, almonds, dry coconut, poppy seed, dry dates, ghee		84
4	Haliv Laddoo	Soaked garden cress seeds, fresh coconut		96
Porridges				
1	Khaskhas Kheer (sweet)	Poppy seeds, ghee, jaggery/sugar, milk	Soak poppy seeds overnight. Roast in ghee and add jaggery/sugar, milk	108
2	Khaskhas (Kheer) salty	Poppy seeds, salt, cumin, fresh coconut, oil	Soak poppy seeds overnight. Roast in ghee add salt and boil	356
3	Rice-moong Kheer	Rice flour, moong flour, ghee, sugar, milk	Roast rice and Moong flour in ghee, add milk sugar and boil	100
4	Sago Kheer	Sago, milk, sugar	Cook soaked sago, add milk, sugar boil	109
5	Ragi Kheer	Ragi flour[c], sugar, milk	Cook ragi flour in water. Add sugar, milk, boil	56
Green leafy vegetable				
1	Drum stick	Drum stick leaves, cumin, salt, fresh coconut, ghee	Cut the fresh drumstick leaves, sauté in oil/ghee, cumin seeds, mustard seeds and fresh coconut. Add salt	339
3	Methipala	Fenugreek leaves, mustard/cumin, salt, oil	Sauté methi leaves in oil, mustard/cumin seeds, season with fresh coconut. Add salt	475
3	Dill (Shepu)	Dill leaves, mustard, cumin seeds, oil, salt	Sauté dill leaves in oil, mustard/cumin seeds, salt	147

[a] Poppy seeds—*Papaver somniferum*

[b] Fenugreek seed—*Trigonellafoenumgraecum*

[c] Finger millet (Ragi) *Elucinecoracana*

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