Short Communication

Changes in body composition of Indian lactating women: a longitudinal study

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Background and Objectives: Lactation places enormous demands on maternal bone mineral homeostasis. Indian middle class women (MSC) consume energy dense food supplements to meet these demands post-partum (PP) along with restricted physical activity (PA). Effects of these changes on body composition (BC) of PP women have not been studied. To examine longitudinal changes in: a) bone mineral density (BMD) at total body (TB), AP-spine (APS) and dual femur neck regions (DF) b) BC by body weight, lean mass, fat mass using dual energy X-ray absorptiometry (DXA) at baseline, 6-months and 1-year in urban MSC women. **Methods and Study Design:** 76-primi-parous (28±3.2 yrs) randomly selected PP women (<7-days) were studied; 70 reassessed at 6-months and 42 1-yr PP. Data on anthropometry, BC, BMD at TB, APS & DF by DXA collected (baseline, 6-months, 1-yr PP). **Results:** Weight, waist and body mass index (BMI) decreased both at 6-month & 1-yr PP with respect to baseline ($p<0.05$). BC changes showed increase in android fat % at 1-yr by 10% over baseline ($p<0.05$). BMD with initial decline at 6-months (-2.8%, -2.3% and -2.3% respectively) recovered partially by 1-yr (+2.5% +1.2% and +4.8% respectively) at DF and TB with complete recovery at APS ($p<0.05$). **Conclusion:** These urban relatively sedentary MSC women consumed fat rich food PP with higher android fat retention and partial recovery of BMD at DF and TB at 1-year. Modifications in activity and dietary nutrient intakes may be necessary to prevent cardiovascular and bone health related risks.

Key Words: body composition, bone mineral density, lactation, android fat percentage, urban Indian women

INTRODUCTION

Lactation places enormous demands on maternal bone mineral homeostasis and to fulfil these additional requirements there is an increased need of nutrients, especially of calcium, during lactation. About 250-400 mg of calcium from the mother is transferred to her infant daily through breast milk.[1] Previous studies have reported 3-10% decrease in bone mineral density (BMD) during lactation; this loss is recovered upon weaning and resumption of menstruation.[2,3] Furthermore, studies have also found that recovery in BMD is not influenced by supplemental dietary calcium.[4-6]

Breast feeding is a common practice in India and is often lengthy, extending up to 2 years post-partum (PP).[7] Among urban middle socio-economic class (MSC) women from western India, it is a common practice to consume energy dense food supplements post-partum, for the perceived belief of meeting the additional nutritional demands placed on the mother by lactation.[8] Further, most women adopt relatively sedentary behaviour post-partum.[9,10] There is paucity of data on changes in body composition and the relationship of these changes to dietary intake and sedentary behaviour in the post-partum period in urban Indian middle class women.

Effects of lactation on body composition (BC) are reported in a few previous studies from developed countries; changes have been reported in the BC at different regions using techniques such as skin fold thickness/waist hip measurements or by monitoring weight changes.[11] Using dual energy X-ray absorptiometry (DXA), Kulkarni et al[7] studied changes in BC in a group of under privileged Indian women. These investigators reported an initial decline with subsequent recovery in BMD at total body (TB), AP spine (APS), dual femur (DF) and forearm, by 18 months follow up post-partum; these results were similar to earlier studies from western parts of the world.[1,4] However, they did not observe any changes in DXA measured fat mass or lean body mass (LBM) during the 18 month follow up period. To the best of our knowledge, effect of PP lactation related changes on bone and body composition have not been examined longitudinally in urban MSC Indian women.

Hence, the aims of this longitudinal study were to examine changes in: a) bone mineral density at total body, APS and dual femur, b) body composition as assessed

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by body weight, LBM, fat mass using DXA at baseline, 6 months and 1 year in MSC urban Indian women.

METHODS

Subjects

In this longitudinal observational study, 76 apparently healthy (mean age 28±3.5 yr) PP women (within a week 3.0±1.1 days after delivery) participated voluntarily. Recruitment of the women was randomly performed during the study period of December 2010 to June 2013. These women were admitted for full term delivery at a tertiary level health care centre which drains a population residing in affluent areas of Pune, India (i.e. areas without slum clusters, low income housing schemes but including areas with high land prices as published by Government agencies (Ministry of Urban Development, Lands Division).[12] The mean monthly per capita income of the MSC women was 14,551±8,344 Indian rupees (235±135 USD) indicating they belong to MSC according to Kuppuswami's scale.[13] The research protocol was approved by the Institutional Ethics Committee and a written informed consent was obtained from all women, after the consent form was read out to them in local language.

Inclusion and exclusion criteria

Women who were primi-gravid, had a normal full term pregnancy, without any known disease conditions such as gestational diabetes mellitus/pregnancy induced hypertension/hyperthyrioidism/preeclumpsia were included in the study.

Exclusion criteria were: multi-parous women, women with twins, and women of infants diagnosed with intra uterine growth restriction or small for gestational age after examination and confirmation from paediatrician/ gynaecologist.[14] Women with a preterm delivery (gestational age <37 weeks) were also excluded from study.

Anthropometry

Height and weight were measured with participants in light clothes without shoes. Standing height was measured using a portable stadiometer (Leicester Height Meter, Child Growth Foundation, UK, range 60-207 cm) to the accuracy of 1 mm. Weight was measured using an electronic digital scale to the nearest 0.1 kg and body mass index (BMI) was calculated as weight in kg/height in meter square. Waist (circumference between the lowest rib and the iliac crest at the end of gentle expiration) and hip circumference (maximal circumference at the level of the trochanters) were measured using a non-stretchable tape to the nearest 1 mm. Clinical health assessment was performed and blood pressure was measured by a clinician using sphygmomanometer on the day of enrolment using standard protocol.[15]

Socio-demographic information and lactation history

A structured and pretested questionnaire (intra class correlation coefficient =0.75, *p*=0.001) was administered to collect information on socio-demographic factors such as age, education, occupational status etc.[16] Details of delivery, information on history of lactation regarding whether baby was breast fed exclusively or partially,[17] were recorded. Exclusive breastfeeding was defined when the infant received breast milk only and no other solids or liquids with the exception of vitamins, minerals, medicines or oral rehydration solution;[17] Partial breastfeeding 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.[17] According to duration post-delivery, study period was defined as "lactation"-period from baseline to 6 month PP where infant was exclusively breast fed and "weaning" was defined as period from 6 month - 12 months PP where complimentary food was introduced to baby along with breast feeding.[18]

Physical activity assessment

Data on habitual physical activity were collected using a validated structured questionnaire.[19] 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.[20] Activities such as office work, commuting, baby care, cooking and household cleaning were considered as light activity. Time spent in exercise (e.g., yoga, walking and gym) was considered as moderate activity.[20] Watching television, afternoon nap and other leisurely activities were categorized as inactivity. Sunlight exposure was recorded using standardised questionnaires and coded in categories viz. <15 mins, 15-30 mins, 30-45 mins and >45 mins.

Dietary assessment

Dietary intakes were assessed by 24-hour diet recall on three non-consecutive days, including a Sunday. Women were asked about the intake of food items using standard cups and spoons by a trained investigator through face-to-face interview. Traditional food supplement (TFS) intakes were recorded. These TFS consisted of ghee (clarified butter), edible gum (acacia), dry fruits and nuts such as (almonds, cashew, dry dates, pistachio nuts, jaggery) to form dry powder mix/round balls (laddoos). This preparation was consumed as "supplement" in addition to their normal diet once/twice per day. Daily dietary intakes of nutrients were calculated using C-Diet version 2.0,[21] based on Indian cooked foods database[22] and the nutritive value tables of raw foods.[23, 24]

Biochemistry

A venous blood sample (total 8 mL) was collected after an overnight fast (not less than 10 hours and not more than 14 hours) 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 mins and the serum separated and frozen at –70°C until analysis. Serum vitamin D, as reflected by serum 25-hydroxyvitamin D concentration[25] (25-OH D <20 ng/mL=deficiency, DLD Diagnostika GmbH, Hamburg, Intra assay -CV <5%, Inter assay CV <7.8%) and serum parathyroid hormone (>66.5 pg/mL=hyperparathyroidism, DRG instruments GmbH, Germany; Intra assay -CV <4.8%, Inter assay -CV <3.2%), serum calcium and serum phosphorus were estimated using ELISA technique by standard protocols using standard kits. Serum Alkaline Phosphatase (normal range 20-130 IU/L) was estimated by pNNN – kinetic (p-nitrophenylphosphate) method DimensionâRxL Max clinical chemistry system.

Measurement of bone parameters and body composition

Bone mineral content (BMC), bone area (BA) and BMD were measured at three sites: Total Body (TB), at the AP spine (APS - L1-L4) and at the dual femurs (DF-femoral neck, wards, trochanters and total hip) using the Lunar DPX-PRO total body pencil beam Densitometer (GE Healthcare, WI) using a medium mode scan (software encore 2005 version 9.30.044). The precision of the lunar DPX for repeat measurements in adults is 1.1% for total body,[26] 1.04% for lumbar spine BMD and 2.13% for femoral neck BMD.[27] Measurements were standardized by running daily quality assurance scans. All scans and scan analyses were performed by the same operator. *T*-scores and *Z*-scores (age-matched) were computed by the DXA machine software using the lunar reference database.

Statistical analysis

Analyses were performed using SPSS software for Windows (version 16.0, 2001, SPSS Inc, Chicago, IL). Repeated measures ANOVA was used to estimate the differences in anthropometry, biochemistry, body composition and nutrient intakes and percent changes at 3 time points (baseline, 6 month and 1 year). Significance level was set at $p<0.05$.

Sample size and power of the study

Based on standard deviation of spine BMD from previous studies,[28] sample size was estimated to be 74 to detect the differences at baseline and end line at 5% level of significance and 3% margin of error so as to achieve a power of 90%.

RESULTS

General characteristics of participant women

We studied 76 women with mean age 28±3.2 years and height 160±5.3 cm at baseline. Of these, 70 women were followed up at 6 month (mean 190±6 days) and 42 were followed till 1 year (385±6 days) postpartum. Out of 34 drop outs at 1 year, about 10 women moved out of the city and 24 did not respond to repeat follow up calls. Hence, data are presented on 42 subjects who completed assessments at all 3 points. These 42 women were similar in height, weight, BMI at baseline from rest of the 34 who could not come for 1 year follow ups ($p>0.1$). Seventy-six% of women exclusively breast fed their babies for 6 months. Table 1 shows anthropometric, biochemical and body composition measurements at baseline, 6 months and 1 year PP on 42 subjects. At baseline, 46% women were obese and 27% women were overweight (according to Asian BMI cut offs).[29] As one of the inclusion criteria was women without pre eclumpsia, blood pressure measurements of these women were within reference range (mean systolic blood pressure (SBP), 116±7 mmHg and diastolic blood pressure(DBP), 75±5 mmHg).

Serum 25 OH D concentrations were low (less than 20 ng/mL) in all women. Furthermore, serum 25 OH D concentrations were lower at 6 months and 1 year than baseline values (Table 1). This may possibly be due to voluntary sunshine avoidance; about 88% women were exposed to sunlight only for less than 15 mins/day; sunlight exposure did not increase significantly during rest of the year (96% at 6 months and 98% at 1 year had sunlight exposure of less than 15 mins/day).

Body composition parameters are also shown in Table 1; the total fat% decreased from baseline to 1 year PP ($p<0.05$). However, android fat% increased at 6 months

Table 1. Anthropometric, biochemical parameters & DXA measured body composition of study population

Parameter	Baseline (A)	6 monthly (B)	1 year (C)
Biochemical parameters			
Weight (kg)	63±8.7	58±8.6[a]	58±9.4[a]
BMI (kg/m^2)	25.4±3.5	23.5±3.6[a]	23.7±3.9[a,b]
Waist (cm)	100±6.9	99±5.2[a]	92 ±6.5[a]
Hip (cm)	105±6.5	99±9.3	96±9.7
Serum 25 OH D (ng/mL)	17.7±9.1	13.4±6.3	13.9±11.4
Serum PTH (pg/mL)	42.0±14.8	59.9±8.5	34.3±10.6[b]
Serum ALP (IU/L)	149±10	116±6.7[a]	97.6±5.2[a,b]
Serum Calcium (mg/dL)	8.3±0.5	8.6±0.5[a]	8.3±0.3[b]
Serum Phosphorus (mg/dL)	4.2±0.6	3.5±0.6[a]	3.5±0.5[a]
Body composition			
Android %fat	43.6±6.5	47.8±7.2[a]	46.7±8.0[a]
Gynoid %fat	52 .0±4.0	50.4±5.7[a]	49.7±6.0[a]
Total %fat	42.3±4.9	42.8±5.4	41.1±6.7[b]
Lean (%)	56.1±5.0	55.7±5.2	56.5±6.5
TBBMD (g/cm^2)	1.13±0.106	1.11±0.107[a]	1.11±0.107[a,b]
APS BMD (L1-L4) (g/cm^2)	1.08±0.116	1.05±0.109[a]	1.10±0.097[a,b]
DF neck BMD (g/cm^2)	0.959±0.117	0.932±0.115[a]	0.953±0.114[b]

25 OH D: 25 hydroxyvitamin D; PTH: serum parathyroid hormone; ALP: serum alkaline phosphatase; TBBMD: total body bone mineral density; APS: anterio posterior spine bone mineral density; DF neck BMD: dual femur neck bone mineral density.
The data shown (mean±SD) on 42 subjects who completed all three assessment time points.
[a] Significantly different from Group A ($p<0.05$), [b] Significantly different from Group B ($p<0.05$).

PP ($p<0.05$) and remained elevated at 1 year ($p<0.05$). Gynoid fat% decreased both at 6 months and 1 year PP ($p<0.05$). Lean mass remained unchanged from baseline to 1 year, that is, throughout the study period. BMD decreased at 6 months at all the sites -TB, APS and DF regions. The losses in BMD at all the sites recovered ($p<0.05$) at 1 year from 6 month; although the TB BMD and DF BMD did not fully recover to baseline values. The APS BMD recovered above baseline levels at 1 year ($p<0.05$).

Nutrient intakes at baseline were highest ($p<0.05$) for all nutrients that is energy, protein, fat, calcium and phosphorus (Table 2). Except for fat, 100% women at all three time points consumed inadequate micronutrients such as calcium, iron and zinc. Eighty-five% of women consumed energy dense traditional foods rich in saturated fats for an average of about 47±45 days post-partum.

At baseline, that is immediate postpartum, women were inactive for 50% of time of the day (820±130 mins/day) and only 10% of time (158±114 mins/day) was spent in light activity. None of the women undertook physical exercise or participated in moderate daily activities immediately postpartum. Level of light activity increased at 6 months (780±211 mins/day) and 1 year PP (925±130 mins/day). However, only 1-2% time of the day was spent in moderate activities at either 6 months (17±19 mins/day) or 1 year PP (12±20 mins/day).

The percentage change in bone health and body composition parameters at "lactation" (0-6 months PP)/ "weaning" (6-12 months PP) and 1 year from baseline (0-12 months PP) are described in Figure 1.

DISCUSSION

Among these urban, relatively sedentary middle socioeconomic class women from western India, who consumed fat dense food PP, we found that there was significant increase (by 11%) in percentage of android fat at 6 months which remained elevated at 1 year. There was a decline in BMD and subsequent recovery at TB, APS and DF sites. However, at TB and DF this recovery in BMD was incomplete one year post the delivery.

As reported previously,[8] urban Indian women consume

Table 2. Nutrient intakes of study population

Parameter	RDA† for lactating women (0-6 months)	Baseline (A) (mean±SD)‡	RDA for weaning women (6-12 months)	6 monthly (B) (mean±SD)	1 year (C) (mean±SD)
Energy (kcal)	2500	2528±495	2420	2334±445[a]	2020±368[a,b]
Protein (g)	75	60±12	68	59±13	51±12[a,b]
Fat (g)	30	95±27	30	67±15[a]	55±17[a,b]
Calcium (mg)	1200	1090±398	1200	864±251[a]	675±302[a,b]
Phosphorus (mg)	1200	1406±304	1200	1331±306	1173±256[a,b]
Ca/P ratio	1:1	0.76±0.2	1:1	0.65±0.2[a]	0.55±0.2[a,b]
Iron (mg)	25	12.8±3.4	25	10.7±2.8[a]	10.0±2.8[a]
Zinc (mg)	12	7.3±1.6	12	6.6±1.9	6.0±1.7[a]

†RDA: Recommended Dietary Allowances (ICMR 2010, India).
‡Data shown in mean±SD.
[a] Significantly different from Baseline group (A) ($p<0.05$), [b] Significantly different from 6 monthly group (B) ($p<0.05$).

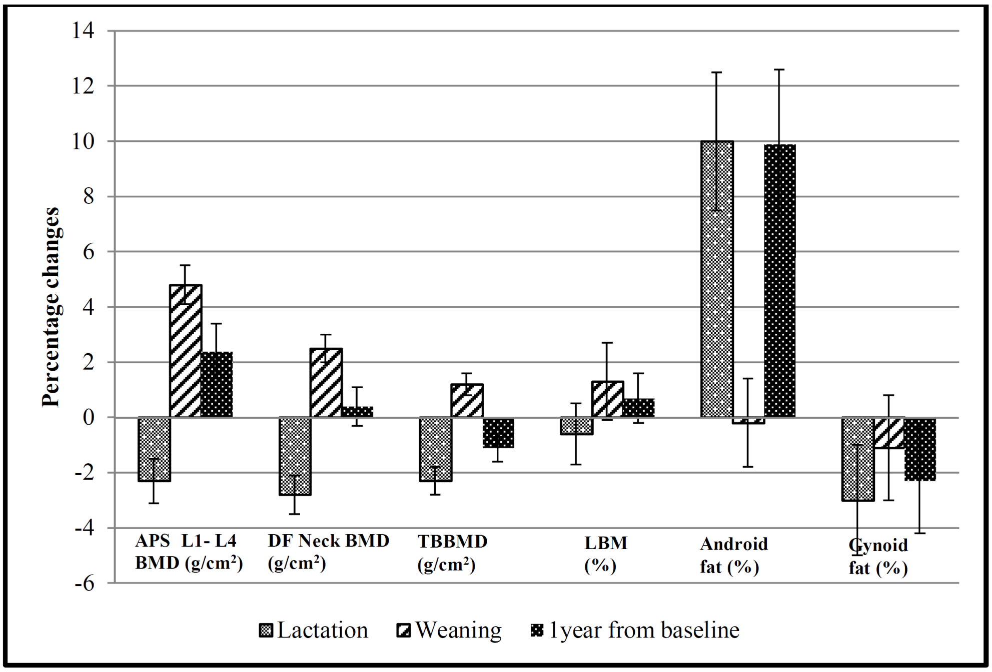

Figure 1. Percentage change in bone health and body composition at different phases post partum. Lactation: 0-6 months; weaning: 6-12 months; 1 year from baseline: 0-12 months.

energy rich foods and are relatively sedentary after parturition. Common barriers to performing physical activity include lack of time due to baby care and absence of motivation for weight reduction;[30,31] there was also a perception that strenuous activity would curtail the volume of breast milk produced. To the best of our knowledge, this marked sedentary behaviour in the PP period has not been previously published at least in the Indian context.

In the present study, all women consumed dietary fat approximately 2-3 times above the recommended amounts. These women also consumed high fat/energy dense foods containing energy above 84% and proteins above 75% of Indian Recommended Dietary Allowances (RDA) at all the three time points. Further, 73% women were overweight (as judged by their BMI) during the study period. In spite of low physical activity, we found that the lean body mass was unchanged at the end of a year. In a study performed by Motil et al,[32] the LBM was preserved during lactation in well-nourished women. We also found similar results in our study cohort.

In India, very few foods are rich in vitamin D (oily fish/animal liver/eggs) and their consumption is limited.[23] Less than 10% of daily need for vitamin D is fulfilled through dietary intake,[33] also, there is no fortification for vitamin D available in India. None of the participants reported consumption of vitamin D supplementation during the study period. About 88% women from study cohort reported sunlight exposure below 15 minutes per day. The probable reason for low sunlight exposure may be low outdoor physical activity among these women. Along with low sunlight exposure majority of the women (75% at baseline, 80% at 6 month and 71% at 1 year PP) also had low serum 25 OH D concentrations. Similar vitamin-D status has been reported during postpartum period in other Indian and western studies.[34,35]

We did not observe an increase in overall fat percentage (total fat%), however, android fat% increased both at 6 months and 1 year PP. We observed a corresponding decline in gynoid fat% at 6 months and 1 year PP. Increased fat mass at truncal region using skin fold thickness method[36] or MRI technique[37] has been reported previously. Increased android fat% potentially has a pathogenic role in cardiovascular morbidity and increases metabolic risk.[38] The observed changes in android fat% may be due to relative inactivity PP and consumption of energy and fat dense diet. The dietary fat intakes reported by a study from Southern India on underprivileged women were much lower as compared to our study cohort.[7]

As seen in previous studies,[1,4,28] we also observed decrease in BMD at TB and DF at 6 months followed by incomplete recovery after weaning. In contrast, increase in APS bone density at 1 year was higher than at baseline. Thus, lactation has site specific changes at the skeletal sites measured which is confirmed from our as well as other studies.[28] However, mean BMD at all the sites reported by our study cohort was lower than western counterparts at baseline[39] indicating low bone mass accrual among Indian women.

The primary shortcoming of our study was limited study duration; following the women up beyond 12 months may be required to determine if “catch up” in BMD occurs at TB/DF sites. Despite the fact that under nourished women from lower socio economic group from south India[7] showed complete recovery of bone mineral density at 18 months PP at all sites, we could only assess these women till one year post-partum. Thus, longer follow up would also possibly allow us to assess the recovery pattern PP for changes in body composition, particularly to observe whether the increase in android fat% persists. Another shortcoming was study dropouts at 1 year follow-up; however, the power of the study after considering the dropouts was still over 70%, and the statistical significance thus holds true.

We believe that our study has important implications; we have reported that the bone mineral density of urban MSC Indian women was lower than that of their western counterparts. If there is persistent failure in ‘catch-up’ of BMD then it might have implications for bone health of PP middle class Indian women. The accumulation of android fat may lead to increased cardio metabolic risk in future. Based on the results of our study, we would recommend moderate physical activity during PP period and mothers would be well advised to stay away from consumption of fat rich foods to avoid future cardio vascular implications. Further longitudinal studies are required to confirm these results.

In conclusion, we found that these urban relatively sedentary middle socio economic class (MSC) women from western India, consumed dietary fat rich food PP. Vitamin D deficiency was very prevalent. They had an increase in android fat, which remained elevated one year PP. The decline in BMD and subsequent recovery at TB and DF was incomplete at one year after delivery. A modification in the regimen of this category of women may be necessary to prevent cardiovascular and bone health related risks.

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AUTHOR DISCLOSURES

No competing interests are reported.

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Short Communication

Changes in body composition of Indian lactating women: a longitudinal study

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印度哺乳期妇女体成分变化的纵向研究

背景与研究目的：哺乳期母体对矿物质需求巨大。印度中产阶级女性消费高能量密度食物来满足产后有限的体力活动的需要。产后妇女这些改变对体成分变化的影响还没有被研究。本研究的目的是研究下列纵向变化，用双能 X 线骨密度仪（DXA）测量城市中产阶级妇女基线、产后 6 个月和产后 1 年时的全身、腰椎和双测股骨颈区的骨密度（BMD），和体重、瘦组织和脂肪组织等体成分。**方法与研究设计**：随机选取 76 名产后 7 天之内的初产妇（年龄：28±3.2 岁）进行研究，产后 6 个月有 70 位、产后 1 年有 42 位参与重新评估。分别在基线、产后 6 个月和 1 年时用 DXA 测量产妇全身、腰椎和双股骨颈区的体成分和 BMD。**结果**：与基线相比，产妇在产后 6 个月和 1 年体重、腰围和体质指数均下降（$p<0.05$）。体成分的改变显示：产后 1 年 android 脂肪百分比比基线增加了 10%以上（$p<0.05$）。全身、腰椎和双侧股骨颈区的 BMD 在产后 6 个月时分别下降了-2.8%、-2.3% 和-2.3%，在产后一年时，双侧股骨颈区和全身部分恢复（分别为+2.5%和+1.2%），而腰椎完全恢复（+4.8%，$p<0.05$）。**结论**：这些城市相对久坐的中产阶级妇女，产后摄入高脂肪食物与产后 1 年较高的 android 脂肪保留和双侧股骨颈区和全身的骨密度部分恢复有关。为预防心血管和骨骼健康相关风险，修正体力活动和膳食营养摄入可能是必要的。

关键词：体成分、骨密度、哺乳期、android 脂肪比例、印度城市妇女