Original Research

Calcium Intake during Pregnancy among White and African-American Pregnant Women in the United States

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Key words: calcium, prenatal nutrition, antacids, dietary recommendations

Objective: To characterize the calcium intake in a racially mixed cohort of pregnant women, including the contribution of supplementation and antacids.

Methods: A cohort of women was interviewed twice during their pregnancies. The interviews included a food frequency questionnaire and questions on calcium supplementation and antacid intake. Pregnant women seeking prenatal care at a Pittsburgh hospital in the first trimester were enrolled. 454 women were enrolled and did not miscarry; 385 completed two interviews and were of white or African-American race.

Results: Mean and median intakes of calcium were 1671 mg/day and 1482 mg/day. 36% of the women were under the former RDA level (1200 mg/day) for calcium, while 26% were under the current AI (1000 mg/day). Six percent were taking in less than 600 mg/day, and 15% over 2500 mg/day, the tolerable upper limit. Young women were particularly likely to have low intakes (12% of those less than 21 years of age had less than 600 mg/day). Black women were slightly overrepresented among those with low intake (8% *vs.* 5% of whites), but, overall, their intake was quite similar to whites. Milk and cheese provided more calcium than other food items. Many women took antacids, especially during the second half of pregnancy, and these were a major source of calcium for some members of the cohort.

Conclusions: Although mean and median calcium intake in the cohort were above the AI, many women had calcium intakes that were too high or low. Dairy products provided the most calcium for most pregnant women, and antacids were an important source for many.

INTRODUCTION

In females, skeletal growth continues until approximately age 20, but bone mineral content may accrue until age 35. Calcium is a nutrient central to this process. During pregnancy, calcium nutrition may be especially important for women's own bone health and that of their babies. During a full-term pregnancy, the fetus takes approximately 30 g from the mother, which may occur at the expense of the mother's bones if calcium intake is insufficient [1,2]. In addition, women who consume more calcium during pregnancy may have higher levels of calcium in their breast milk [3], and babies born to women with higher calcium intakes may have better bone mineralization and lower blood pressure in later life [4], though this may or may not be a causal association. Calcium supplementation has also been hypothesized to reduce chances of pregnancy-induced hypertension and preeclampsia, but the evidence is mixed [5–7].

Many pregnant women do not consume sufficient amounts of calcium [2]. The US recommended dietary allowance (RDA) for pregnant women was 1200 mg/day until 1997; currently, the adequate intake (AI) is 1000 mg/day for women between 19 and 30 [8–10]. The 1994-96 USDA Continuing Surveys of Food Intake, a 24-hour population-based food recall survey, showed a median calcium intake of 612 mg/day for women in this age range, though it was much higher (1154 mg/day) for pregnant women in general. Consuming too much calcium is possible; very high intakes may lead to kidney stones or renal

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insufficiency (milk-alkali syndrome), and may interfere with iron absorption [10]. Because the AI is the same for pregnant and nonpregnant women, and because dietary sources are sufficient in a well-balanced diet, specific calcium supplementation is not necessarily recommended during pregnancy. However, many women are prescribed a multivitamin/mineral supplement containing 200–400 mg of calcium during this time, and compliance was reported to be good in a culturally diverse, low-income population [11].

Racial differences are often seen in nutrition. A dietary study of low socioeconomic status women of childbearing age showed that white women consumed more calcium than blacks, though both groups were substantially below the AI [12]. Similarly, NHANES II showed that mean dietary intake for white women aged 18–39 was 642 mg/day, *versus* 467 mg/day for black, non-Hispanic women [13]. However, in a group of black and white non-pregnant adolescents, black girls had higher dietary calcium intakes, though, again, most girls were below the RDA.[14] Many African-Americans are lactose intolerant [15], which has been associated with reduced milk consumption; a higher proportion of African-American than white female military recruits reported drinking milk less than daily (72% *vs.* 55% for women under 25) [16].

Gastrointestinal problems are a common side effect of pregnancy, and many women take antacids, especially in the third trimester [17,18]. If the antacids used are those containing calcium, these medications could provide a significant additional amount of this nutrient to pregnant women.

Limited data are available on calcium intake by pregnant women in the United States, and most studies rely on samples of fewer than 100 pregnant women and are not able to make ethnic comparisons. Part of the reason for setting an AI for calcium instead of an estimated average requirement and a recommended dietary allowance was lack of data of this type [10]. In addition, most published reports have ignored the contribution of antacids to calcium intake of pregnant women, relying on either diet alone or diet and supplements. The purpose of this paper is to describe all sources of calcium in a group of pregnant white and African-American women.

Table 1. Foods Used to Assess Dietary Calcium in 385 Pittsburgh, PA, Pregnant Women, 1992-5

Food	Definition of medium portion size
Milk	1 cup
Yogurt	1 cup
Cheeses (hard, medium, soft)	2 oz.
Ice Cream	1 scoop
Eggs	2 eggs
Doughnuts, cookies, cake	1 doughnut, 3 cookies, 1 slice of cake
White bread, rolls, crackers	2 slices bread, 2 rolls, 3 crackers
Whole wheat and dark breads	2 slices
Cornbread, grits, tortillas	1 piece, 1/2 cup, 1 tortilla
Pizza	1 slice
Mixed dishes with cheese	1 cup
Small fish with bones	3 oz.
Greens, broccoli, and okra	1/2 cup

MATERIALS AND METHODS

A longitudinal study of lead, bone density, and calcium was conducted. The study population has been described elsewhere [19]. Four hundred and ninety-eight women seeking prenatal care at Magee Women's Hospital Outpatient Clinic in Pittsburgh were enrolled from 1992–5. Of these, 44 women miscarried. Of the remaining 454 women, 385 completed two interviews, 185 of whom were African-American and 200 of whom were white. Women were interviewed by study personnel twice during the pregnancy, once soon after enrollment (average week of gestation: 13.8, range: 8–18), and a second time late in the pregnancy (average week: 36.6, range: 31–46).

Dietary calcium was assessed through a food frequency questionnaire; participants were asked about their frequency of intake and size of portions of the foods listed in Table 1. The

Table 2. Characteristics of a Cohort of 385 Pittsburgh, PA Pregnant Women, 1992-5

	African-American		White	
	N	%	N	%
Age				
18–20	50	27.0	41	20.5
21–25	81	43.8	82	41.0
26–30	29	15.7	41	20.5
over 30	25	13.5	36	18.0
Parity				
0	54	29.2	93	46.5
1	74	40.0	52	26.0
2 or more	57	30.8	55	27.5
Education				
<High school	30	16.2	38	19.0
High school	78	42.2	82	41.0
>High school	77	41.6	80	40.0
Income range[1]				
<$10000	99	63.9	66	36.5
$10000–15000	25	16.1	40	22.1
$15000–25000	12	7.7	44	24.3
$25000–40000	15	9.7	22	12.2
>$40000	4	2.6	9	5.0
Smoking status[2]				
non-smoker	127	69.8	112	56.6
smoker	55	30.2	86	43.4
BMI				
<21	34	18.4	57	28.5
21–25	52	28.1	72	36.0
25–30	48	26.0	38	19.0
>30	51	27.6	33	16.5

[1] Missing data on 50 women.

[2] Missing data on 6 women.

foods were taken from a reduced food frequency questionnaire, which has been validated, and, for calcium, tracks closely with reports from diet records [20]. These are the major contributors to calcium in the standard U.S. diet [21]; no questions were asked about fortified foods or soy. The greatest increase in sales of fortified juices occurred after this study was conducted [22]. At the first interview, women were asked about their intake since becoming pregnant; at the second interview, they were asked about their habits since the first interview.

Women were asked if they had ever taken antacids or calcium supplements, and those who answered yes were then asked about the time periods when they were used, both before and after pregnancy, as well as the regularity, quantity, brands, and frequency of use. At the second interview, women were asked if they had used antacids and supplements since the first interview; if so, the same questions were repeated. Similar to the dietary intake, data reported are for use since becoming pregnant and between the two interviews.

Dietary calcium intake was calculated from the food frequency questionnaires using the DIETSYS Version 3.0 software developed by Block [23]. Intake from supplements was estimated from the manufacturers' product information provided in the 1992–1995 editions of the *Physicians' Desk Reference* [24]. Descriptive statistics were generated using SAS software. For differences in proportions *t* tests and ANOVAs were performed, and Kruskal-Wallis tests for differences in medians.

At both interviews, participants were asked if they currently smoked and, if so, how many cigarettes a day. Women rated frequency, severity, and duration of nausea or vomiting during early pregnancy, which was converted to a four-level scale.

All protocols used in this study were approved by the Institutional Review Board at Magee Women's Hospital.

RESULTS

Characteristics of the study population are given in Table 2. Median total calcium levels were well above the then RDA 1200 mg/day and the current AI of 1000 mg/day (Table 3). A long right-hand tail distorted the means, so medians and nonparametric statistics are used in this report (Fig. 1). Two

Table 3. Daily Calcium Intake in a Cohort of 385 Pittsburgh, PA Pregnant Women, 1992–5

	N	Dietary calcium		Total calcium	
		Median intake mg/day	*p*-value	Median intake mg/day	*p*-value
Overall	385	1243		1482	
Race					
Black	185	1236		1421	
White	200	1258	0.56	1556	0.14
Age					
18–20	91	1168		1396	
21–25	163	1320		1500	
26–30	70	1178		1644	
over 30	61	1238	0.65	1670	0.35
Parity					
0	147	1361		1565	
1	126	1192		1447	
2 or more	112	1203	0.40	1467	0.51
Education					
<High school	68	1176		1384	
High school	160	1192		1444	
>High school	157	1320	0.12	1653	0.13
Income range					
<$10000	164	1243		1525	
$10000–15000	65	1203		1357	
$15000–25000	56	1324		1614	
$25000–40000	37	1236		1465	
>$40000	13	1514	0.92	1735	0.76
Smoking status					
non-smoker	239	1238		1454	
smoker	140	1254	0.96	1535	0.35
Nausea		(first interview)		(first interview)	
1(severe)	81	1250		1470	
2	52	1411		1511	
3	77	1098		1295	
4(none)	165	1237	0.28	1374	0.20

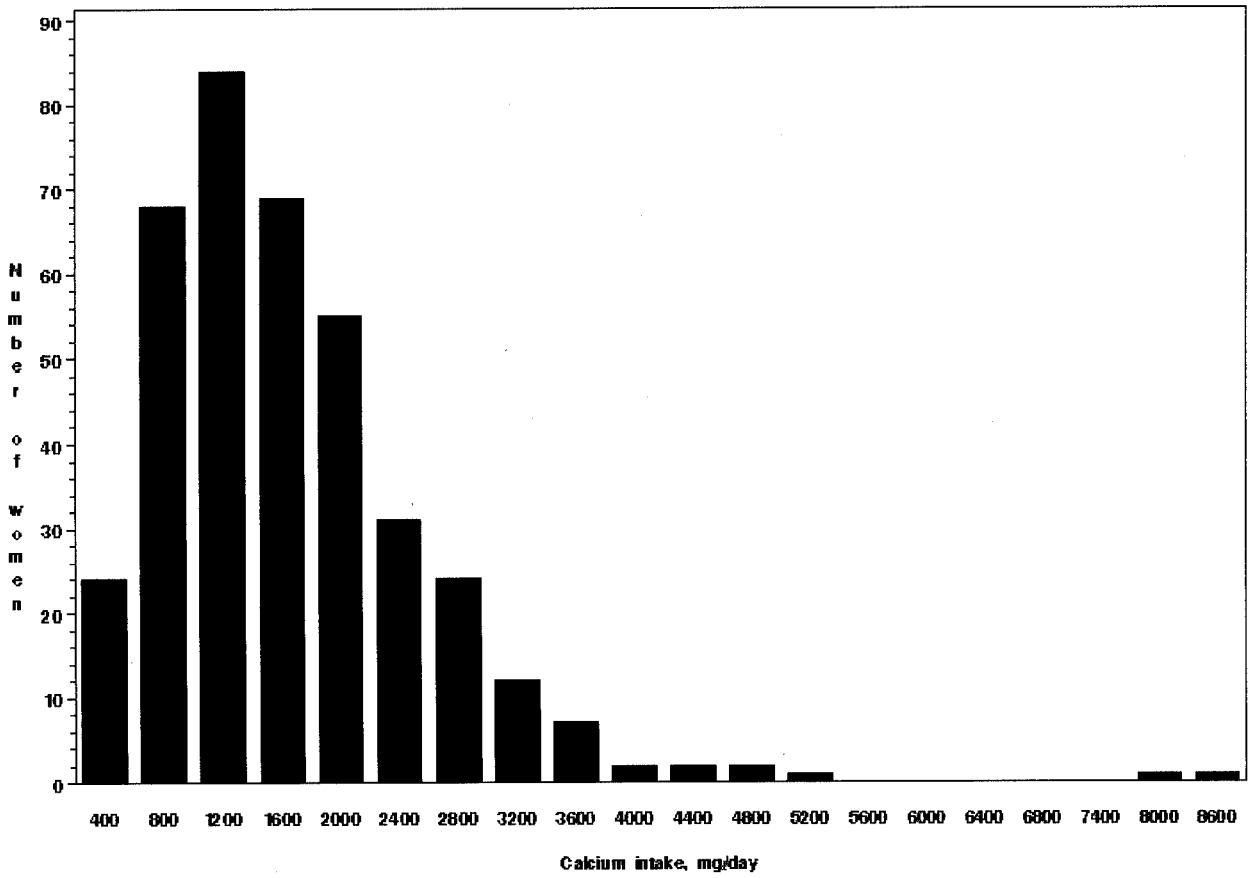

Fig. 1. Total calcium intakes (mg/day) in a cohort of 385 Pittsburgh, PA pregnant women. Mean of two interviews.

women above 8000 mg/day might represent over-reporting (these women reported drinking four to eight glasses of milk a day, as well as secondary sources). A significant proportion of women reported very low or high calcium intake (Table 4). Young women and smokers were most likely to have low intakes: more than 10% of the youngest women consumed less than 600 mg/day of calcium. Around an eighth of the women consumed more than 2500 mg/day, with these women more likely to be black, nulliparous, and in their late twenties, though no group was statistically different on this point. Weight gain during pregnancy was 2.3 kg (0.23, 4.5) higher among women consuming over 2500 mg/day, but pre-pregnancy BMI was not different.

No clear age-related patterns emerged for calcium intake in this young population. Smokers and nonsmokers differed little on median intakes ($p = 0.35$). More educated women tended to consume more calcium. Women with severe nausea might be expected to take in less food and therefore less calcium, but median intakes were similar across levels. Intakes did not vary by parity.

Diet contributed the most calcium to most women's total intakes; however, some women took in a fairly large amount from antacids (Table 5). This was especially true at the second interview, where about a quarter of the entire sample was getting more than 10% of their calcium from antacids. Among women taking antacids, antacids accounted for around 20% of calcium intake at the first visit and 30% at the second visit At the first interview, median calcium intakes for women taking antacids was 1572 mg/day, while for women not taking antacids it was 1374 mg/day ($p = 0.19$). At the second interview, 2030 mg/day was reported by women using antacids, and 1189 mg/day by women not using antacids ($p < 0.0001$). More white than black women reported using antacids, ($p = 0.01$) and women who were still experiencing a lot of nausea in the second and third trimester ($n = 28$) used a large amount of antacids, with median intakes 1000 or more mg/day, double that of other women. Most women reported taking their prenatal vitamins, which provided about 8% of overall calcium. Few women (around 2%) reported supplement use apart from vitamins and antacids.

Of dietary sources, the greatest proportion was from milk, followed by cheeses, bread, and mixed dishes, a pattern that was consistent across groups. Most women drank whole or 2% milk. Women who took in less than the 600 mg/day of calcium had a smaller proportion of calcium from milk, and a greater proportion from bread, cheese, and mixed dishes. Women who consumed over 2500 mg/day calcium drank more 2% milk; mean intake was 1.8–1.9 servings per day, as opposed to half

Table 4. Percent of Women with Calcium Intakes in Extreme Groups in a Cohort of 385 Pittsburgh, PA Pregnant Women, 1992–5

	<600 mg/day		>2500 mg/day	
	%	*p*-value	%	*p*-value
Overall	6		15	
Race				
Black	8		17	
White	5	0.15	13	0.30
Age				
18–20	12		11	
21–25	6		16	
26–30	3		19	
over 30	3	0.05	13	0.55
Parity				
0	7		17	
1	7		13	
2 or more	4	0.38	13	0.64
Education				
<High school	7		9	
High school	6		18	
>High school	6	0.90	14	0.18
Income				
<$10000	7		16	
$10000–15000	5		11	
$15000–25000	4		14	
$25000–40000	3		11	
>$40000	8	0.81	23	0.67
Smoking status				
non-smoker	4		15	
smoker	8	0.06	16	0.73

a serving among women below that level. Women who had intakes over 2200 mg/day (top 25%) when antacids were counted, but not from diet alone, took in significantly lower amounts of calcium from milk and soft cheeses than women who were exceeded this level from diet alone.

Ten percent of African-American women and 6% of white women reported being lactose intolerant or allergic to milk. For those reporting lactose intolerance, median dietary calcium intake was 1195 mg/day for those reporting lactose intolerance, similar to the 1244 mg/day for those not; $p = 0.47$. However, thirteen percent of lactose intolerant women had calcium intakes below 600 mg, while 6% of women not reporting lactose intolerance were in this low group ($p = 0.10$).

Few racial differences were evident in amount of calcium or choice of calcium-containing foods. Median dietary intake was 1236 mg/day among African-American women and 1258 mg/day among white women, while median total calcium intake was 1421 mg/day and 1556 mg/day ($p = 0.14$), respectively. A slightly higher proportion of black women were in both the group consuming >2500 mg/day and the group consuming <600 mg/day (Table 4). Black women were more likely to have whole milk as the largest source of calcium (54% *vs.* 46%) and less likely to have skim milk as their primary source (2% *vs.* 11%). Black women were also more likely to have soft cheese as their primary source (15% *vs.* 7%). For the secondary source, black women were more likely to have soft cheeses (45% *vs.* 24%) and less likely to have hard cheeses (17% *vs.* 30%).

DISCUSSION

This analysis suggests the importance of including supplementation and antacid use in assessing calcium intake. A sizable proportion of our population (over one-fourth) used antacids, which provided an important contribution to their calcium intake. This percentage using antacids is higher than some studies have reported, though similar to others [25, 26]. Some subgroups, such as those with nausea, consumed a substantial amount of calcium through antacids. However, ten women at the first interview and 23 women at the second interview were using non-calcium-containing antacids. Among these, one woman at the first interview and ten at the second could have been brought above the AI if they had consumed the median amount of calcium-containing antacids instead. Emphasizing the use of calcium-containing antacids for gastrointestinal symptoms may provide a good supplemental source for some women.

Many women in our study appeared to consume high levels of calcium, especially when supplementation by prenatal vitamins and antacids was taken into account. For the entire cohort, median total calcium intake was 1482 mg/day and mean intake was 1671 mg/day, above the AI, indicating that prevalence of inadequacy is likely to be low in this population. However, these means are influenced by extreme values in the long right tail, some of which may have been over-estimates of intake. Three women were at more than 1.5 times the interquartile range past the 75th percentile; removing them changed the median to 1480 mg/day and the mean to 1626 mg/day. Several women were at levels so high that they might be harmful; in some cases, women may need to be informed of the risks of such levels. Nevertheless, one third of this study population was under the (former) RDA and one quarter was under the (current) AI.

Mean dietary intake in our study was 1463 mg/day; most previous studies have reported lower mean intakes. The highest reported value for US groups is the 1994-96 USDA Continuing Surveys of Food Intake, with 1154 mg/day for pregnant women [10], but mean intakes for women of this age are generally much lower [13, 14, 27]. International studies indicate mean dietary intakes between 750 mg/day and 1500 mg/day [28–30]; our study is near the upper end of this range. It is not clear what accounts for the generally high levels in our study. There may be problems with over-reporting or overestimation by the food frequency questionnaire. In general, the Block questionnaire tends to overestimate calcium intake [31]. In an elderly cohort, using all the calcium-containing items from the Block questionnaire overestimated mean intake slightly (637 mg/day *vs.*

Table 5. Calcium Intake from Non-Dietary Sources in a Cohort of 385 Pittsburgh, PA Pregnant Women, 1992–5

	N	Antacids						Antacids						Prenatal vitamins			
		Interview 1						Interview 2						Interview 1		Interview 2	
		% taking	*p*-value	median intake (mg/day)*	*p*-value	mean proportion of total calcium*	*p*-value	% taking	*p*-value	median intake mg/day*	*p*-value	mean proportion of total calcium*	*p*-value	% taking	*p*-value	% taking	*p*-value
Overall	385	10.4		222		21.7		28.5		500		30.3		90.2		84.1	
Race																	
Black	185	6.0		122		17.1		22.5		544		30.3		86.8		81.7	
White	200	14.6	0.01	225	0.27	23.4	0.26	34.0	0.01	500	0.97	30.3	0.99	93.2	0.04	86.2	0.25
Age																	
18–20	91	4.4		210		17.3		23.0		500		31.2		94.0		82.6	
21–25	163	11.7		225		22.5		23.8		470		30.4		86.4		79.6	
26–30	70	11.6		500		27.1		44.1		600		29.8		91.2		89.6	
over 30	61	14.8	0.16	209	0.69	17.0	0.56	31.7	0.01	495	0.99	29.9	1.00	93.3	0.2	91.7	0.09
Parity																	
0	147	8.2		193		19.8		27.5		440		28.1		97.8		90.8	
1	126	15.1		200		17.6		24.2		650		32.6		87.6		83.6	
2 or more	112	8.1	0.11	519	0.04	32.7	0.05	34.9	0.19	500	0.74	30.7	0.67	83.3	0.0004	75.7	0.0055
Education																	
<High school	68	6.0		174		17.0		28.1		814		41.0		88.9		75.0	
High school	160	10.0		310		23.9		29.3		550		29.1		90.7		84.3	
>High school	157	12.7	0.31	272	0.63	20.8	0.70	27.9	0.96	400	0.36	27.1	0.05	90.1	0.92	87.6	0.07
Income range																	
<$10000	164	8.5		217		19.0		30.9		600		31.9		85.5		79.5	
$10000–15000	65	10.7		165		23.4		20.0		330		26.8		90.8		87.5	
$15000–25000	56	12.5		495		29.7		26.8		600		29.7		96.2		89.3	
$25000–40000	37	18.9		337		20.4		35.3		520		29.9		93.9		91.2	
>$40000	13	23.1	0.26	200	0.74	11.9	0.49	46.2	0.24	448	0.97	29.2	0.95	91.7	0.2	83.3	0.24
Smoking status																	
non-smoker	239	8.8		209		23.5		23.4		400		26.3		90.6		87.2	
smoker	140	13.6	0.17	337	0.91	19.7	0.45	37.5	0.00	660	0.11	34.6	0.04	89.3	0.71	78.5	0.04
Nausea																	
1(severe)	81/13**	11.1		209		14.8		53.8		1000		51.5		84.2		69.2	
2	52/15	7.7		471		19.6		40.0		1240		51.9		90.4		71.4	
3	77/25	13.0		304		24.7		40.0		448		23.0		92.2		79.2	
4(none)	165/320	9.1	0.73	327	0.60	25.1	0.44	26.3	0.06	420	0.01	27.8	0.00	91.9	0.27	85.8	0.17

* Among those taking.

** Number reporting first interview/second interview.

612 mg/day), while a 15-item questionnaire similar to the one used in this study underestimated calcium intake compared with seven-day diet records (mean daily intake 480 mg) [21]. The fact that those reporting high intakes also gained more weight suggests that their overall food consumption was higher, and indicates that over-reporting, if it occurred, was probably not limited to this group.

Many of the women were in the Women, Infants, and Children program (WIC), which includes milk and cheese. It is also possible that that the women themselves, especially those willing to participate in a study, were motivated to eat well, or the prenatal care staff was doing a good job of nutrition education. Magee required at least one session with a dietitian during prenatal care.

Racial differences were not significant in this study. Overall calcium intakes were very similar, except that white women were more likely to use antacids later in pregnancy. This is consistent with some studies, but not with others. Some studies have shown higher dietary calcium intakes in whites [12,13,32] and some in blacks [14]. The lack of differences may be due to drawing the sample from a generally urban, socioeconomically homogeneous sample. Eating outside the home has been increasing among both blacks and whites, and this may contribute to homogenization of diets [33]. Study participants may be generally motivated to good nutrition, or the prenatal care staff may have made women aware of nutrition and the WIC program. Also, only 10% of the African-American women reported lactose intolerance, while in the general population 75% of African-Americans have been reported to be lactose maldigesters [15], and even those women who reported lactose intolerance did not have substantially lower calcium intakes.

Socioeconomic status may be correlated with calcium intake. Block and Abrams reported that lower-income women of reproductive age were more likely than higher-income women to be below the RDA for calcium [34], and a similar pattern was reported for social class among British pregnant women [35, 36]. Our data corroborate this pattern with regard to education. Smokers in Britain are reported to have lower calcium intakes, though the difference was small, and both groups were below 1200 mg/day [37]. For our cohort, the differences went the opposite way, but were also small.

Haste *et al.* reported significant differences between calcium intake at 28 weeks and 36 weeks of gestation [37]. We interviewed women at two points, near the end of the first or beginning of the second trimester, and in the third trimester, and did not see differences for dietary or supplemental intake in any group, although antacid consumption was increased in all groups at the second interview. Women who took antacids had higher overall calcium intakes at the second interview.

CONCLUSIONS

Since bone mineral density reaches a peak around age 30 [1], good calcium intake during the reproductive years can ensure stronger bones for later years to avoid osteoporosis. Additionally, adequate calcium during pregnancy seems to protect against the mobilization of lead from its storage place in bone [19]. This population was predominantly low-income and low-education, yet compliance with prenatal vitamins was high, and the women had higher calcium levels than the general population. Pregnancy may be a good time to intervene with young women on nutrition, for their own and their babies' health, particularly emphasizing the importance of calcium. For those who are lactose intolerant or who experience severe nausea, calcium-containing antacids are an effective way to increase calcium intake. Strategies that can reach those with low education, particularly, are needed, given the substantial number of pregnant women who are still not getting enough calcium.

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