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ORIGINAL PAPER

Dietary Sources of Calcium Among Parents and Their Early Adolescent Children in the United States by Parent Race/Ethnicity and Place of Birth

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Abstract Dietary calcium sources may differ by race/ethnicity and dietary acculturation. A cross-sectional, convenience sample including 587 United States (US) Asian, Hispanic and non-Hispanic White parent–child (10–13 years) pairs completed a calcium food frequency questionnaire. Calcium sources were ranked by mean percent contribution to total adjusted calcium intake, and compared by ethnic group and parents' location of birth. Five foods (fluid milk, cheese, milk on cereal, yogurt, and lattes) represented 49 % of total calcium intake for parents. The same foods (except lattes) represented 55 % of total calcium for early adolescent children. Fluid milk provided the largest mean percentage of intake for all race/ethnic groups among parents and children. Several food sources of calcium were greater for foreign-born versus US-born Asian or Hispanic parents and children. Understanding calcium food sources and changes in dietary patterns that affect calcium intake among parents and children is important to better promote adequate intake.

Keywords Dietary acculturation · Dietary calcium sources · Parents · Early adolescent children

Background

Calcium intake of children and adults in the United States (US) is generally lower than daily recommendations [1, 2], especially for children aged 9–13 and 14–18 years and those who are non-White [2]. Adequate calcium is important for the development of peak bone mass in children and may be related to prevention of bone loss among adults [3–5]. Milk and milk products provide about 50 % of total calcium intake within the US and are the leading sources of dietary calcium for those ages 2 years and older [6–8]. However by adulthood, the contribution of milk and milk products decreases substantially compared to childhood [9]. Yeast breads, meats, nuts, beans, vegetables, and fruits also contribute substantially to total calcium intake [8].

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Conceptual Framework

Dietary acculturation is a process by which immigrants adopt the dietary practices of the host country [10] possibly leading to changes in nutrient sources over time. For children in immigrant families, the family may represent traditional dietary practices, whereas, the school and peer groups may represent the dietary practices of the host country. Existing cross-sectional studies have shown that acculturation may affect intake of foods which are significant sources of dietary calcium including dairy foods or meal patterns that affect dairy food intake [11–17]. Interpretation of the findings from these studies is difficult because of the diversity in acculturation measures used and differences in dietary patterns among the various Hispanic/Latino or Asian populations.

While dietary sources of calcium have been reported for children and adults, comparative studies across race/ethnic groups are less common [8, 18]. Little is also known about how calcium sources in families with children change as the family diet becomes more acculturated to "Western-type" eating patterns. The purpose of this study was to: (1) identify major dietary calcium sources and document differences among Asian, Hispanic, and non-Hispanic White (NHW) parents and children, and (2) determine how dietary sources of calcium differ within race/ethnic group by a measure of dietary acculturation (whether the responding parent is foreign-born or US born). This information will be useful to professionals who promote adequate calcium intake among families.

Methods

Respondents

This cross-sectional, nine-state study involved collection of self-administered questionnaire data from a convenience sample of children (10–13 years) and the adult responsible for food acquisition and preparation in the household (98 % of respondents were parents). Other inclusion criteria were: (1) having lived in the US for at least 12 months; (2) able to read or speak English; and (3) self-identifying as NHW, Hispanic or Latino, Asian or Asian American.

Parents and children were recruited through fliers; announcements in bulletins or newsletters, or through personal contacts; and presentations at group events. A total of 661 matched parent–child pairs from nine states (Arizona, California, Colorado, Hawaii, Michigan, Minnesota, Oregon, Utah, and Washington) completed questionnaires in 2006–2007. Parent and child questionnaires both assessed calcium intake using a calcium-specific food frequency questionnaire (FFQ) [19]. The study protocols were approved by the Institutional Review Board of all participating universities. Prior to data collection, each parent and child provided written informed consent and assent, respectively.

Data Collection

Self-administered questionnaire data were collected across the states using a standardized data collection protocol to ensure consistency in methods. Parents and children took an average of 30 and 20–30 min, respectively, to complete the questionnaire. In return for participation, parents and children were each given cash, gift certificates/cards or merchandise (ranging in value from $5–$20 USD) per each institution's remuneration guidelines. All questionnaires were completed in English.

Measures: Calcium Intake

Calcium intake (estimated mg/day) was measured using a semi-quantitative, calcium specific FFQ (n = 80 items or groups of items) developed and validated for Asian, Hispanic, and NHW children [19]. Categories of foods included beverages; dairy products; vegetables, grains, and nuts; combination foods; seafood; and other foods. For each food item or group of items, a portion size that was commonly used was listed with a question asking how often the food item was consumed during the past month. The number of frequency responses ranged from four and seven responses ranging from "Never or less than once per month" to "Four or more servings per day." A calcium value was assigned to each food item on the FFQ based on frequency of consumption, serving size, and amount of calcium allocated to each food item. The instrument performed well when used with adult women as estimates for calcium intake were comparable to those obtained from 2-day food records ($r = 0.52$) [20].

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Table 1 Characteristics of Asian, Hispanic and NHW parents of children 10–13 years

Characteristics of parents/household	Total n = 587 n (%)[a]	Asian n = 108 n (%)[a]	Hispanic n = 212 n (%)[a]	NHW n = 267 n (%)[a]	*P* value[b]
Age group of parent					<0.001
18–40 years	280 (47.9)	39 (36.1)	152 (72.4)	89 (33.5)	
41–51+ years	304 (52.1)	69 (63.9)	58 (27.6)	177 (66.5)	
Gender of parent					0.051
Males	62 (10.7)	14 (13.2)	12 (5.7)	36 (15.7)	
Females	519 (89.3)	92 (86.8)	198 (94.3)	229 (86.4)	
Education of parent					<0.001
High school or less	169 (29.1)	12 (11.1)	122 (59.2)	35 (13.2)	
Some college or technical school	185 (31.9)	31 (28.7)	64 (31.1)	90 (33.8)	
4-year college or advanced degree	226 (39.0)	65 (60.2)	20 (9.7)	141 (53.0)	
Parent birthplace					<0.001
Foreign-born	394 (68.5)	62 (57.9)	106 (52.7)	13 (4.9)	
US-born	181 (31.5)	45 (42.1)	95 (47.3)	254 (95.1)	
Years lived in US					<0.001
≤10 years	47 (9.0)	12 (12.0)	35 (18.0)	0 (0.0)	
>10 years	473 (91.0)	88 (88.0)	159 (82.0)	226 (100.0)	
Language spoken at home					<0.001
No English	62 (11.9)	12 (12.0)	50 (25.8)	0 (0.0)	
Another language more than English	46 (8.8)	15 (15.0)	31 (16.0)	0 (0.0)	
Another language and English equally	70 (13.5)	13 (13.0)	56 (28.8)	1 (0.4)	
English more than another language	60 (11.5)	20 (20.0)	29 (14.9)	11 (4.9)	
English only	282 (54.2)	40 (40.0)	28 (14.4)	214 (94.7)	

NHW non-Hispanic White, *SD* standard deviation

[a] Numbers do not always add up to 100 % due to rounding and missing data

[b] *P* value according to Chi square analysis ($P < 0.05$)

Data Analysis

Data were analyzed using SAS software (SAS Institute Inc., Cary, NC, USA, copyright 2002–2008, version 9.2) and SPSS (PASW Statistics, Chicago, IL, USA, copyright, 2010, version 18). Data from parents not specifying race/ethnicity (n = 24) and whose calcium intakes were outside established cutpoints (<100 or >2500 mg/day) (n = 15 parents, n = 22 children) [21], and missing data for parent's place of birth (n = 13) were excluded from analysis for a final sample size of 587.

Total calcium intakes were calculated from responses on questionnaires from both parents and children. Reported consumption of calcium-rich foods among individuals was used to calculate calcium content and then adjusted for total calcium intake. The percentage of calcium provided by each food in the respondent's diet was determined. Then, all data from all respondents (with the exception of those with missing food data) were used to calculate a mean percent contribution to total calcium intake for each food source of calcium. Food sources of calcium were arranged in descending order.

Analysis of variance (ANOVA) with post hoc analysis (Duncan's multiple range test) and Chi square or *t* tests were used to compare demographic variables and calcium intakes. ANOVA with post hoc analysis (Tukey's HSD test) was also used to determine differences in mean percent contribution to total calcium from food and across ethnic groups and among parents and children. Parent's birthplace (US-born or foreign-born) was used as a proxy measure of dietary acculturation and independent *t* tests were used to determine differences in food sources of calcium by parental birthplace. A *P* value of <0.05 was considered statistically significant.

Results

Parents were primarily (89 %) female (Table 1). Educational level was fairly evenly distributed among respondents. However, a higher proportion of Hispanic parents had only a high school education or less (59 %) compared to Asian (11 %) and NHW parents (13 %), while a higher proportion

Table 2 Selected characteristics of Asian and Hispanic parents of early adolescent children (10–13 years) by birthplace

Characteristics of parents/household	Asian parents by birthplace		*P* value[b]	Hispanic parents by birthplace		*P* value[b]
	Foreign-born (n = 62) n (%)[a]	US-born (n = 45) n (%)[a]		Foreign-born (n = 106) n (%)[a]	US-born (n = 95) n (%)[a]	
Education of parent			0.420			<0.001
High school or less	10 (16.1)	2 (4.4)		75 (73.5)	39 (41.5)	
Some college or technical school	15 (24.2)	16 (35.6)		16 (15.7)	46 (49.0)	
4-year college or advanced degree	37 (59.7)	27 (60.0)		11 (10.8)	9 (9.6)	
Employment status of parent			0.459			<0.001
No formal employment	19 (31.1)	5 (11.1)		46 (45.5)	11 (11.7)	
Part-time employment	9 (14.8)	6 (13.3)		16 (15.8)	16 (17.0)	
Full-time employment	33 (54.1)	34 (75.6)		37 (36.6)	67 (71.3)	
Years lived in US			0.156			<0.001
≤10 years	11 (19.0)	1 (2.4)		30 (30.6)	3 (3.4)	
>10 years	47 (81.0)	40 (97.6)		68 (69.4)	86 (96.6)	
Language spoken at home			<0.001			<0.001
No English	12 (20.7)	0 (0.0)		47 (48.0)	0 (0.0)	
Another language more than English	15 (25.9)	0 (0.0)		22 (22.5)	8 (9.0)	
Another language and English equally	12 (20.7)	1 (2.4)		17 (17.3)	36 (40.4)	
English more than another language	14 (24.1)	6 (14.6)		9 (9.2)	20 (22.5)	
English only	5 (7.4)	34 (82.9)		3 (3.1)	25 (28.1)	

[a] Numbers do not always add up to 100 % due to rounding and missing data

[b] *P* value according to Chi square analysis ($P < 0.05$)

of Asian (60 %) and NHW parents (53 %) had a 4-year degree compared to Hispanic parents (10 %) ($P < 0.001$). Foreign-born Hispanic parents (n = 106) reported having lower levels of education and less employment compared to US-born Hispanic parents (n = 95) (Table 2). The majority of both Asian (88 %) and Hispanic (82 %) parents in this study reported having lived in the US for 10 or more years, therefore this characteristic was not useful in assessing extent of dietary acculturation (Table 1). The mean age of the early adolescent child was 11.6 (standard deviation of 1.1) and 44.3 % were males (data not shown).

Table 3 presents the mean daily calcium intakes of parents and early adolescent children based on the calcium-specific FFQ. Overall, NHW parents and children tended to have higher calcium intakes from dairy foods and from milk compared to Asian and Hispanic parents and children, while both Hispanic and NHW children had higher total calcium intake compared to Asian children. No differences were noted in calcium intakes between Asian parents and children by parent birthplace; however, Hispanic parents and children had higher calcium intakes when parents were foreign-born compared to US-born.

While the calcium-specific FFQ included 80 items or groups of items, a fairly small number of foods represented about half of the total calcium intake for parents and children. Five foods (fluid milk as a beverage, cheese, milk on cereal, yogurt and lattes) represented 49 % of total calcium for parents while four of the same foods (except lattes) represented 55 % of total calcium for children (data not shown). Other foods making relatively large contributions (2–5 %) to total calcium included hot chocolate, pizza, cheeseburgers, green leafy vegetables, tacos and bread/toast/pita bread for both parents and children. Thirty-five different additional foods contributed to the remaining intakes of calcium, and reflected small contributions varying between 0.10 and 1.99 % of the total calcium intake for both parents and children.

Ranked Dietary Calcium Sources for HISPANIC, Asian and NHW Parents and Children

Significant differences were observed in the mean percent contribution of some foods to calcium intakes across race/ethnic groups (Table 4). Overall, seven foods contributed 39 to 50 % of the total parental calcium intake from foods,

Table 3 Calcium intake by race/ethnicity and parent birthplace

	Parent calcium intake [mean mg/day (SD)]			Child calcium intake [mean mg/day (SD)]		
	Total dietary calcium[a]	Calcium from dairy foods	Calcium from milk	Total dietary calcium	Calcium from dairy foods	Calcium from milk
Race/ethnicity						
Asian n = 108	870 (440)[a]	318 (264)[a]	234 (272)[a]	953 (464)[a]	638 (416)[a]	500 (367)[a]
Hispanic n = 212	884 (462)[a]	424 (309)[b]	279 (245)[a]	1,101 (501)[b]	686 (419)[a]	490 (348)[a]
NHW n = 267	1,155 (512)[b]	621 (393)[c]	413 (347)[b]	1,165 (519)[b]	824 (463)[b]	632 (411)[b]
ANOVA *P* value	$P < 0.0001$	$P < 0.0001$	$P < 0.0001$	$P = 0.0012$	$P < 0.0001$	$P < 0.0001$
Parent birthplace						
Asian Foreign-born, n = 62	848 (446)	317 (266)	251 (287)	989 (436)	671 (404)	539 (355)
Asian US-born, n = 45	905 (439)	324 (264)	214 (254)	896 (502)	589 (434)	442 (381)
t test *P* value	$P = 0.510$	$P = 0.885$	$P = 0.491$	$P = 0.308$	$P = 0.319$	$P = 0.178$
Hispanic Foreign-born, n = 106	996 (501)	479 (355)	325 (282)	1,170 (508)	728 (440)	537 (360)
Hispanic US-born, n = 95	713 (359)	344 (238)	218 (183)	961 (430)	605 (363)	429 (318)
t test *P* value	$P < 0.0001$	$P = 0.002$	$P = 0.002$	$P = 0.002$	$P = 0.032$	$P = 0.027$

[a] Means with different superscript letters in the same column by race/ethnicity are significantly different ($P < 0.05$) by ANOVA followed by Duncan's multiple range test. *P* values < 0.05 indicate significant differences by birthplace according to *t* test results

Table 4 Percentage of total calcium intake derived from food sources among Asian, Hispanic and NHW parents and children

Food source	Parents [Mean (SE) % of total calcium][a]			Food source	Children [Mean (SE) % of total calcium][a]		
	Hispanic (n = 212)	Asian (n = 108)	NHW (n = 267)		Hispanic (n = 212)	Asian (n = 108)	NHW (n = 267)
Milk*	16.5 (1.1)^{xy}	13.5 (1.5)^{x}	18.1 (1.0)^{y}	Milk***	25.0 (1.5)^{x}	36.0 (2.1)^{y}	36.0 (1.3)^{y}
Cheese**	11.0 (0.6)^{x}	5.3 (0.9)^{y}	13.3 (0.6)^{z}	Milk w/cereal***	12.0 (0.7)^{x}	7.1 (1.0)^{y}	11.0 (0.6)^{x}
Milk w/cereal**	6.7 (0.5)^{x}	4.1 (0.7)^{y}	7.1 (0.4)^{x}	Cheese***	8.8 (0.6)^{x}	4.1 (0.8)^{y}	9.1 (0.5)^{x}
Tofu***	0.3 (0.3)^{x}	5.6 (0.4)^{y}	0.8 (0.2)^{x}	Yogurt*	3.8 (0.4)^{xy}	4.8 (0.6)^{x}	3.3 (0.4)^{y}
Yogurt*	5.4 (0.5)^{x}	5.8 (0.7)^{xy}	6.8 (0.4)^{y}	Taco***	3.2 (0.2)^{x}	1.1 (0.3)^{y}	1.5 (0.2)^{x}
Latte	4.7 (0.7)^{y}	4.4 (1.0)^{y}	3.6 (0.6)^{x}	Tofu***	0.3 (0.2)^{x}	2.8 (0.2)^{y}	0.6 (0.2)^{y}
Taco***	3.5 (0.2)^{x}	1.0 (0.3)^{y}	1.6 (0.2)^{y}	Pizza*	2.6 (0.2)^{xy}	2.0 (0.3)^{x}	2.7 (0.2)^{y}
Total % contribution	44.6	38.6	49.6	Total % contribution	55.7	57.9	64.2

SE standard error, *NHW* non-Hispanic White

* $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$ according to ANOVA

[a] Percentages with different superscript letters in the same row for parents or in the same row for children are significantly different according to Tukey's HSD test

regardless of race/ethnicity. Fluid milk provided the largest mean percentage of total calcium intake among all groups, and for both parents and children. NHW parents obtained significantly more of their calcium (18.1 %) from milk than Asian parents (13.5 %) ($P < 0.05$). Cheese was the second largest contributor to mean percentage of total calcium intake for both Hispanic and NHW parents, while yogurt was the second largest contributor for Asian parents. NHW parents obtained significantly more of their calcium from cheese than other parents, with Hispanics having a significantly greater percentage of their calcium from cheese than Asians.

Like parents, seven foods provided between 56 and 64 % of the total child's calcium intake from foods. Fluid milk, cheese and yogurt were major dietary sources of calcium among children. However for Hispanic children, fluid milk was a slightly lower source of calcium. Milk with cereal was a better source for Hispanic and NHW children than for Asian children. Cheese was the third largest contributor to total calcium intake for Hispanic (8.8 %) and NHW children (9.1 %), but not for

Table 5 Comparison of mean percent contribution of food sources to total calcium among Asians and Hispanics grouped by location of birth (US-born vs. Foreign-born)

Food source	Mean (SE[a]) % of total calcium		Mean (SE) % of total calcium	
	Asian parents Foreign-born (n = 62)	Hispanic parents US-born (n = 45)	Foreign-born (n = 106)[b]	US-born (n = 95)
Milk	13.1 (1.9)	10.5 (2.1)	15.0 (1.5)	14.9 (1.5)
Tofu	7.1 (1.2)*	3.8 (0.6)	0.5 (0.2)	0.3 (0.1)
Yogurt	5.9 (1.0)	5.4 (1.0)	6.0 (0.7)	4.7 (0.6)
Dark green leafy vegetables	5.7 (1.0)**	2.6 (0.4)	1.9 (0.2)***	0.8 (0.2)
Latte	5.3 (1.4)	2.9 (1.0)	6.0 (1.1)	3.3 (1.0)
Cheese	4.2 (0.7)*	7.9 (1.4)	9.5 (0.8)**	13.3 (1.0)
Milk on cereal	3.7 (0.7)	4.8 (1.0)	5.5 (0.5)*	8.0 (0.8)
Bread/toast/pita	2.5 (0.4)	1.8 (0.2)	1.5 (0.2)	1.7 (0.2)
Pizza	2.1 (0.4)	1.7 (0.4)	1.0 (0.1)**	1.9 (0.2)
Taco	1.0 (0.3)	1.6 (0.2)	3.4 (0.4)	4.1 (0.5)
Cheeseburger	1.0 (0.2)	1.7 (0.4)	1.5 (0.2)***	5.4 (0.6)
Food source	Asian children of		Hispanic children of	
	Foreign-born parent (n = 62)	US-born parent (n = 45)	Foreign-born parent (n = 108)	US-born parent (n = 97)
Milk	38.7 (3.1)	31.4 (3.8)	25.7 (1.7)	25.0 (1.9)
Milk on cereal	7.1 (1.2)	8.0 (1.3)	11.7 (1.0)	13.1 (1.0)
Yogurt	4.5 (1.0)	5.0 (1.3)	4.7 (0.6)***	2.1 (0.4)
Cheese	3.7 (0.6)	5.1 (1.0)	6.7 (0.6)***	12.0 (0.8)
Tofu	3.2 (0.7)	2.4 (0.4)	0.3 (0.1)	0.1 (0.05)
Cocoa	26 (07)	16 (03)	33 (05)	23 (05)
Pizza	2.2 (0.3)	1.9 (0.2)	2.1 (0.3)**	3.7 (0.3)
Bread/toast/pita	2.1 (0.4)*	1.2 (1.5)	1.3 (0.2)	1.6 (0.2)
Dark green leafy vegetables	2.1 (0.3)	2.1 (0.5)	1.0 (0.1)*	0.5 (0.1)
Cheeseburger	1.9 (0.3)	2.2 (0.3)	2.0 (0.3)***	3.9 (0.4)
Taco	1.1 (0.3)	1.4 (0.3)	2.8 (0.3)*	3.8 (0.4)

[a] *SE* standard error* $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$ according to independent *t* tests

[b] Sample size varies due to missing location of birth for parent and/or incomplete food data among Hispanic parents

Asians, whose third highest calcium source was yogurt (4.8 %). Like their parents, cheese was a greater source of calcium for NHW than for Hispanic children, but represented a greater source of calcium for NHW and Hispanic children than for Asian children. Among foods that may be considered more common in their native cultures, Asian children had greater intake of calcium from tofu than that of the Hispanic and NHW children. Similarly, Hispanic children had greater intake of calcium from tacos than Asian children.

Ranked Dietary Calcium Sources by Parent Location of Birth

Among foreign-born Asian parents, tofu and dark green leafy vegetables ranked significantly ($P < 0.05$) higher in mean contribution to calcium intake while cheese ranked significantly lower compared to US-born Asian parents (Table 5). Bread items were the only significantly ($P < 0.05$) different calcium source when Asian children of foreign-born parents were compared to Asian children of US-born parents, contributing nearly twice as much to the mean percentage of calcium intake for children of foreign- versus US-born parents.

There were more significant differences for Hispanics than for Asians in food sources contributing to total calcium when the data were examined by parental generation. US-born Hispanic parents obtained less total calcium intake from dark green leafy vegetables and more calcium from cheese, milk on cereal, pizza and cheeseburgers than did foreign-born Hispanic parents. Children of US-born Hispanic parents had a smaller contribution of total calcium from yogurt ($P < 0.001$)

and dark green leafy vegetables ($P < 0.05$) and more from cheese ($P < 0.001$), pizza ($P < 0.01$), cheeseburgers ($P < 0.001$) and tacos ($P < 0.05$) when compared to children of foreign-born Hispanic parents.

Discussion

This study showed several broad patterns in the contribution of calcium-rich foods to total calcium intake among Asian, NHW and Hispanic parents and their children. Calcium sources had interesting similarities and differences among various groups sampled in this study. One trend was the importance of dairy products as a primary dietary source of calcium for both parents and children, with dairy products being the top three calcium contributors among all three race/ethnic groups. Fluid milk provided the largest percentage of total calcium for all groups sampled in this study, which is consistent with results from other studies [8, 22]. Milk products make a substantial contribution to the calcium consumed by children and adults in the US [6–8]. National dietary guidance recommends dairy foods as preferred non-supplemental food sources of calcium [23] based on low-fat milk products being among the most calcium-dense foods.

Adults in the current study consumed a lower proportion of total calcium intake from milk compared to children. Other studies have reported that milk consumption decreases from childhood to adulthood [9]. Children in the current study consumed a relatively high proportion of calcium intake from tacos, pizza or cheese. Although the data does not identify the source of these foods, it may be that children are exposed more frequently to these foods through individual choices at home, school meal programs and eating out occasions. However, these foods may not have positive effects on overall diet quality because along with calcium, they are a major source of calories, fat and sodium among children [24, 25].

Another pattern from the data was that Asian parents consumed a generally lower total percentage of calcium from the most popular calcium-rich foods compared with Hispanic and NHW parents. However, the Asian children in this study consumed similar total percentages of calcium from these foods compared with the other children. Dairy products do not typically appear in traditional Asian diets or cultural food habits possibly because of lactose intolerance [26]. Instead, dietary calcium sources include small fish, soy products, and vegetables and fruits [27]. However, these foods generally provide less calcium per serving than do milk and other dairy products [28]. It is interesting that both Asian parents and children in this study seem to have embraced yogurt as a calcium source, perhaps due to the perception that it is easier for individuals with lactose intolerance to digest than other dairy foods [29].

Several significant differences in intake of calcium-rich foods were observed in the current study among foreign-born compared to US-born parents and their children. In general, country of birth has been associated with changes in food consumption and, therefore, can be a predictor of dietary changes [30]. A review of dietary acculturation in Canada indicated that most ethnic groups attempted to follow their traditional eating patterns after immigration based on belief about healthfulness of the diet [31]. However, Asians compared to Hispanics in the current study showed fewer significant differences in calcium source by parent location of birth. This held true for both parents and their children with only one significant difference between calcium sources among Asian children and three significant differences between parents, compared to five differences among Hispanic parents and six differences among Hispanic youth. This may suggest differences in patterns of acculturation for Asians or greater adherence to traditional dietary patterns for this group. This result is somewhat limited in that the Asian sample was of mixed nationality. However, the FFQ included very common foods (tofu, rice, fish, soy, dark green leafy vegetables, etc.) considered to be typical across many Asian cultural groups. US-born Hispanic parents and their children consumed significantly more calcium from "Western-type" calcium sources (cheese, milk on cereal, pizza, and cheeseburgers) than their foreign-born counterparts, which may suggest greater dietary acculturation.

The quality, cost and year-round availability of dairy foods in US supermarkets may facilitate the incorporation of these foods into the family diet [32]. Among Hispanics, whole milk is considered part of traditional Hispanic meal patterns [33] and families may continue this pattern following immigration. In addition, children gain exposure and develop preferences for dairy products and "Western-type" food, through peers, school lunch and fast food [11, 29], thereby influencing family meal patterns. These factors may explain why smaller differences were observed in mean percent calcium contributed from milk, yogurt, and milk on cereal between more and less acculturated groups.

Education level, income and length of residence in the host country have been found to be positively correlated with level of acculturation [12, 34, 35] and may explain some differences and similarities observed between less and more acculturated groups. In the current study, foreign-born Hispanic parents had characteristics indicating they were generally less acculturated (i.e. lower education, employment and English language ability) than US-born Hispanic parents, and thus may explain lower adoption of US foods. In the current study, nearly 70 % of Hispanic foreign-born parents and over 80 % of Asian foreign-born parents reported having lived in the US more than 10 years. Therefore, given the lower adoption of US foods, length of

residence may not have made an important contribution to dietary acculturation for foreign-born Hispanic parents and their children. Overall, the results from this study indicate that changes in dietary behaviors associated with acculturation appeared to follow a pattern of biculturalism to some extent [36, 37]. Based on this pattern, individuals and families retain aspects of their culture-of-origin identity, while establishing a positive relationship with the dominant US culture [38].

The limitations of the current study include a non-random convenience sample of parents and children completing questionnaires only available in English which limits the ability to generalize results. Furthermore, inclusion criteria for subjects' ethnicity was narrowed to focus on those (Asian, Hispanic and NHW) having been identified at highest risk of osteoporosis based on results from the National Osteoporosis Risk Assessment [39]. Selection of an appropriate measure of acculturation was important because in some studies the relationship between dietary change and acculturation was dependent on the acculturation measure used [16]. In the present study, parent birthplace was the most appropriate measure of acculturation because most parents (88 % of Asian and 82 % of Hispanic parents) reported having lived in the US more than 10 years and a low proportion of Asian parents reported speaking no English at home. Therefore, this measure allowed for an even distribution of parent/child pairs among groups.

New Contributions to the Literature

This study provides a unique comparison across ethnic groups of the primary sources of dietary calcium among a multi-state sample of Asians, Hispanics and NHW parents and their adolescent children. Research examining reported sources of calcium among parents and their adolescent children and comparing those sources by ethnic group is currently not well documented in the literature. New information from this study showed (1) the importance of dairy products as a primary dietary source of calcium for both parents and children among all three race/ethnic groups, (2) that Asian parents consume a generally lower total percentage of calcium from the most popular calcium-rich foods compared with Hispanic and NHW parents, and (3) Asians compared to Hispanics showed fewer significant differences in calcium source by parent location of birth suggesting differences in patterns of acculturation. Because resources may be important when making dietary changes, additional research is needed to understand changes in diet in the context of socio-economic status among diverse cultural groups.

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