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Socio-Economic Factors in Bone Health Among Children with Dairy and Milk Allergy or Lactose Intolerance: A GIS Approach

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Objective: To investigate the relationship between dairy allergies/lactose intolerance, geography (socio-economic location analysis), and bone health in children.

Hypothesis:

#1. Children with dairy allergy or lactose intolerance have a healthy weight regardless of the socioeconomic environment.

#2. Children with dairy allergy or lactose intolerance will be at higher risk for poor bone health later in life when certain social and economic components of disease formation are being met.

Background

- Nearly 80% of the body's peak bone mass develops from the time a child is born up until adolescence (Hidvegi et al. 2003).
- Lactase deficiency affects nearly 70% of individuals worldwide. The popularity of this deficiency leads to lactose intolerance in 15% of Caucasians, 50% of Mexican-Americans, 80% of African Americans, and nearly 100% of Asian and Indian-Americans (Heyman, 2006).
- Lactose intolerant individuals can avoid undesirable symptoms with management strategies. It is recommended that dairy products remain in the diet and are not eliminated (Bailey et al., 2013; Brown-Riggs, 2015a; Byers & Savaiano, 2013; Fulgoni et al.; 2007).
- Low income areas and minority areas in the U.S. tend to have less access to nutritional foods and supermarkets, and have a higher prevalence of convenience stores. Studies show that convenience store goods are more expensive. These factors limit the residents to shopping in stores with higher prices and smaller selections of healthy foods (Beaulac, Kristjansson, & Cummins; 2009).
- Consuming the appropriate 3 servings of dairy every day provides the body with 73-75% of the calcium given in a US diet (Byers & Savaiano, 2005; Jackson & Savaiano, 2001).
- With ninety-eight percent of calcium within the human body being stored in the bone, calcium contributes heavily to the growth of a human's skeleton. When calcium metabolism is interrupted, bone health is negatively impacted (Ahmad & De Kiewiet, 2014).
- African Americans only consume 83% of the daily calcium, 50% of potassium, and 27% of the vitamin D needed, which is less than Hispanic Americans and Caucasians (Brown-Riggs, 2015b). Low consumption of these essential nutrients leads to diminished bone health (Ahmad & De Kiewiet, 2014; Jackson & Savaiano, 2001).
- One of the earliest studies looking at the relationship between calcium intake, lactose intolerance, neighborhood economics and exposure to environmental hazards concluded that data suggest that low dietary calcium is one of the two major contributors to pose significant health risks to urban minority children (Bruening et al. 1999).
- Additional findings suggest that even in areas with abundance of quality foods, African-Americans still face multiple barriers to proper nutrition due to limited purchasing power (Walker and Cunningham 2014).

Study Area

- Orangeburg county is located in South Carolina in a predominately rural area.
- 62.1% Black/African American, 34.9% White, 1.0% Asian, 0.6% American Indian and Alaska Native
- Persons in poverty: Orangeburg = 30.8% U.S = 14.5%
- Median household income: Orangeburg = $33,615 U.S. = $55,775
- Obesity prevalence for children 2-17 in Orangeburg county is significantly higher than that of SC at 22.5 vs. 16.7 (SCDHEC).

Materials and Methods

- Secondary data of children between the ages of 1 and 10 years was obtained from the Pediatric Clinic in Orangeburg South Carolina during the summer of 2016. All patients with diagnosed milk/dairy allergy or lactose intolerance were selected from the comprehensive database along with demographic information, history of bone breaking, and BMI.
- The query used key search words such as: milk allergy, milk protein allergies, dairy allergy, lactose intolerance, vitamin D deficiency, fractures and searched only recent patients ages 1 and 10 who have been seen between 01/01/2014-07/01/2016.
- Geocoded addresses of patients were created in ESRI Business Analyst software based on geographic masking technique to insure confidentiality, and mapped to analyze spatial relationship.
- The socio-economic variables used were: poverty, race, median household income, number of households receiving food stamps/SNAP, and eating behaviors.
- Local supermarkets, grocery stores, and dollar stores were visited to record and compare prices of dairy products
- Primary data was collected through a 21 question emailed & mailed survey regarding the child's health status, eating behaviors and bone health. It was administered through the Solution Reach software, which is linked to the Orangeburg Pediatric Clinic's emailing list.
- The selected sample of children with dairy allergies or lactose intolerance from the secondary data were surveyed as the experimental group. A randomly (Randomizer.Org) selected sample of 100 families with children 1 to 10 years of age was surveyed as a control group.
- Data was analyzed using the SAS On Demand Software

Secondary Sample Demographics

The query returned 92 results (2.61% of the Pediatric clinic population) with 64.13% being African American, 32.61% Caucasian, 1.09% Latino, and 2.17% unknown/other

- The sample consisted of about 42.39% females and 57.61% males.
- Nearly 61% of the study population resided in Orangeburg, while others resided in towns surrounding Orangeburg city.
- Out of the 92 patients, 29 (31.52%) children were diagnosed as lactose intolerant and 68.48% as having dairy/milk/milk protein allergies
- Of the BMI's that were available, more than half (59.21%) of children were classified as healthy. 1.32%, 15.79%, and 23.68% of the children were classified as underweight, overweight, and obese, respectively.

Results

Households By Income
The largest group: <$15,000 (25.5%)
The smallest group: $200,000+ (1.0%)

Indicator ▲	Value	Difference
<$15,000	25.5%	+13.0%
$15,000 - $24,999	13.8%	+3.7%
$25,000 - $34,999	13.4%	+3.3%
$35,000 - $49,999	14.1%	+0.8%
$50,000 - $74,999	15.4%	-2.3%
$75,000 - $99,999	8.4%	-3.9%
$100,000 - $149,999	6.7%	-6.7%
$150,000 - $199,999	1.7%	-3.6%
$200,000+	1.0%	-4.4%

Race and Ethnicity
The largest group: Black Alone (61.39)
The smallest group: Pacific Islander Alone (0.02)

Indicator ▲	Value	Difference
White Alone	34.32	-36.20
Black Alone	61.39	+48.60
American Indian/Alaska Native Alone	0.58	-0.39
Asian Alone	1.04	-4.42
Pacific Islander Alone	0.02	-0.17
Other Race	1.06	-5.70
Two or More Races	1.58	-1.74
Hispanic Origin (Any Race)	2.20	-15.72

Chart 1 (left). Household income in the study area (Orangeburg, SC) was looked at and compared to the national average. About 25.5% of Orangeburg's population receives a household income of less than $15,000 a year, which is 13% lower than the national average. In total, about 66.8% of the population recieves lower than the national household income.

Chart 2 (right). Race and ethnicity in the study area (Orangeburg, SC) was looked at and compared to the national average. Orangeburg is populated with 61.39% African Americans which is 48.60% higher than the national average and only 34.32% Caucasians/Whites which is 36.20% lower than the national average.

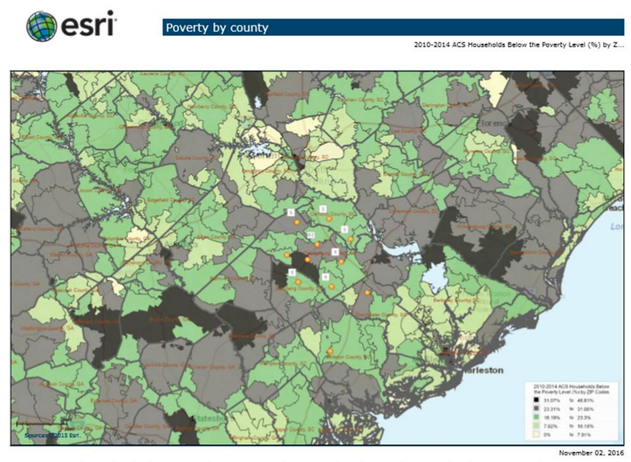

Figure 1. The patients studied all live where poverty is a major factor. The map shows poverty levels in Orangeburg. Majority of the patients are located in the heart of Orangeburg where the households are about 23.31% - 31.06% below poverty level. Other patients are located where households are about 16.19% to 23.3% below poverty level.

FAMILY OF FOUR RECOMMENDED DAIRY INTAKE COST

12 SERVINGS/DAY		336 SERVINGS/MONTH			4,032 SERVINGS/YEAR					
		Supermarket Price ($)			Grocery Store Price ($)			Dollar Store Price ($)		
Food Item	Servings/ Container	Average	1 month	1 year	Average	1 month	1 year	Average	1 month	1 year
DAIRY PRODUCTS										
Whole Milk – Half gallon	8	$1.01	$42.42	$509.04	$1.58	$66.36	$796.32	$2.73	$114.66	$1375.92
Fat Free Skim Milk – Half Gallon	8	$1.01	$42.42	$509.04	$1.58	$66.36	$796.32	Not available	Not available	Not available
2 % Milk – Half Gallon	8	$1.01	$42.42	$509.04	$1.58	$66.36	$796.32	$2.73	$114.66	$1375.92
1 % Lowfat Milk – Half Gallon	8	$1.01	$42.42	$509.04	$1.58	$66.36	$796.32	Not available	Not available	Not available
Yogurt (Chobani 5.3 oz.)	1	$1.00	$336.00	$4032.00	$1.00	$336.00	$4032.00	Not available	Not available	Not available
(Yoplait 6.0 oz.)	1	$0.58	$194.88	$2338.56	$0.58	$194.88	$2338.56	Not available	Not available	Not available
Egg Nog – 1 quart	8	$2.50	$105.00	$1260.00	Not available	Not available	Not available	Not available	Not available	Not available
DAIRY FREE PRODUCTS										
Silk Soy Milk – Half Gallon	8	$3.28	$137.76	$1653.12	$3.15	$132.30	$1587.60	Not available	Not available	Not available
Silk Almond Milk – Half Gallon	8	$2.56	$107.52	$1290.24	$3.12	$131.04	$1572.48	Not available	Not available	Not available
Silk Coconut Milk – Half Gallon	8	$2.56	$107.52	$1290.24	$2.93	$123.06	$1476.72	Not available	Not available	Not available
Lactaid Lactose Free Milk – Half Gallon	8	$3.58	$150.36	$1804.32	$3.76	$157.92	$1895.04	$3.33	$139.86	$1678.32
Silk Yogurt – 5.3 oz.	1	$1.18	$396.48	$4757.76	Not available	Not available	Not available	Not available	Not available	Not available
Coconut Milk Yogurt – 5.3 oz.	1	$1.58	$396.48	$4757.76	Not available	Not available	Not available	Not available	Not available	Not available
Silk Egg-Nog – 1 quart	8	$2.58	108.36	$1300.32	Not available	Not available	Not available	Not available	Not available	Not available

Chart 3: BUSINESS ENVIRONMENT. Prices for dairy and dairy free products were found in the Orangeburg area. In order to supply a family of four with their recommended dairy intakes (3 servings/day), it can cost two to three times more for those with dairy/milk allergies or intolerance who have to purchase dairy free products instead of dairy products.

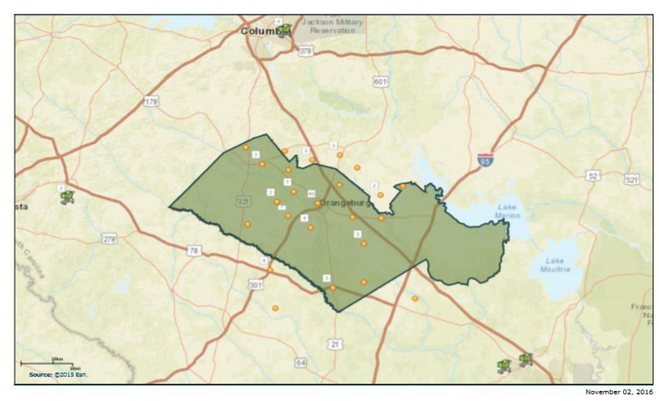

Figure 2. This map outlines the Orangeburg area. The shopping carts on the map show locations of the closest stores that carry dairy-free products. These stores include Kroger, Earth fare, Publix, and Trader Joe's all located in either Aiken, Columbia, or Summerville, South Carolina which are all 45-60 minutes away. Even with a limited accessibility of dairy-free products, patients in the Orangeburg area still remain healthy.

More mapping data collected found that eating behaviors within the Orangeburg population show that many of our patients outside of Orangeburg do try to eat healthy. The central location of Orangeburg shows an area where majority of people do not try to eat healthy. It was shown that majority of the patients were located where 17.34%-32.83% of households in the Orangeburg area receive food stamps/SNAP. Not one area in Orangeburg showed 0%-9.8% of households receiving food stamps. This indicates a need for monetary benefits in the Orangeburg area and shows that even though poverty is affecting the area, the citizens can still remain healthy.

CHART 4: PRIMARY DATA SURVEY REPORTINGS

Survey Reporting	LI/MA Patients n = 30	Control Patients n = 33
Diagnosis of CMA, LI, or both	77%	0%
Milk Tolerance = Very Easy	20%	82%
Milk Tolerance = Hard or Cannot be Tolerated	47%	3%
Nutritional Supplements - Calcium	7%	0%
Nutritional Supplements – Vitamin D	7%	3%
Nutritional Supplements – Calcium + Vitamin D	10%	3%
No Nutritional Supplements	57%	79%
Necessity of Special School Food Accommodations	57%	9%
History of Broken Bone or Bone Disorder	3%	9%
Dental Cavities – 0	53%	42%
Dental Cavities – 1	16%	18%
Dental Cavities – 2 or more	30%	27%

Survey results indicated that the total sample was 46% female and 51% male (3% unknown). Age ranges showed 11% of patients to be ages 1-2 years, 27% of patients to be ages 3-5 years, and 59% of patients to be ages 6-10 years (3% unknown). Racial and ethnic differences in the total sample showed 53% of the sample to be Black/African American, 40% to be White/Caucasian, and 2% to be American Indian or Alaskan Native, Asian Pacific Islander, and Hispanic or Latino (1% unknown).

CHART 5: PRIMARY DATA RESPONSES REGARDING SYMPTOMS AFTER DAIRY CONSUMPTION

Symptoms	*LI/MA Patients n = 30*	*Control Patients n = 33*
Skin irritation	40.00%	0.00%
Hives	16.67%	0.00%
Wheezing	10.00%	0.00%
Vomiting	33.33%	0.00%
Diarrhea	43.33%	0.00%
Runny nose	10.00%	0.00%
Watery eyes	3.33%	0.00%
Bloating	26.67%	0.00%
Stomach Aches	43.33%	0.00%
Gas	43.33%	9.09%
Nausea	30.00%	0.00%

Discussion/Conclusions

- In an area with low household incomes (as compared to the national average), high poverty levels, poor eating behaviors, and people needing SNAP benefits, over half of the study population with dairy allergies or intolerance were still found to be healthy. On top of these socio-economical factors within the Orangeburg population, it can be very expensive to buy dairy-free items as seen in Chart 1. Also, there is limited accessibility to dairy free products in Orangeburg. The only location in Orangeburg that was found to sell dairy free products beyond milk was Walmart, selling Silk yogurt and Silk egg nog. The closest areas that sell a variety of dairy free products are all 45-60 minutes away, as shown in Figure 3. Because 59.21% of the subjects were found to be healthy, this study was successful in proving that children with dairy allergy or lactose intolerance can have a healthy weight regardless of the socioeconomic environment**.**
- Lactose intolerance and cow's milk protein allergy are both capable of negatively impacting one's health because milk and dairy products contain essential nutrients needed in the body. However, not every child who is lactose intolerant or dairy allergic is susceptible to negatively impacted bone health. This study disproved the hypothesis that children with dairy allergy or lactose intolerance will be at higher risk for poor bone health later in life and proved that because children with lactose intolerance or milk/dairy allergy closely monitor and manage their health, they may be found to be healthier and to have less bone fractures and bone disorders than children without these health concerns.
- It was observed that life-threatening allergies were more likely to be recorded by the pediatric clinic than lactose intolerance, which is not life-threatening. It was also observed that the pediatric clinic takes very limited information on fractures due to the fact that when a child has a fracture, the child immediately goes to the hospital to see an orthopedist rather than the pediatric clinic.

Future Direction

- Promote awareness to create a better understanding of the possible relationship between metabolic bone diseases, food allergies, lactose intolerance, and geography with a focus on populations identified by literature "at risk."
- Identify risk factors that increase one's chances of having metabolic bone diseases.

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