# Full fat milk consumption protects against severe childhood obesity in Latinos☆,☆☆

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## ARTICLE INFO

## ABSTRACT

Consumption of non- or low-fat dairy products is recommended as a strategy to lower the risk of childhood obesity. However, recent evidence suggests that consumption of whole fat dairy products may, in fact, be protective against obesity. Our objective was to determine the association between milk fat consumption and severe obesity among three-year-old Latino children, a population with a disproportionate burden of obesity and severe obesity. 24-hour-dietary recalls were conducted to determine child intake in San Francisco based cohort recruited in 2006–7. Mother-child dyads were weighed and measured. The 24-hour recall data was analyzed to determine participants' consumption of whole milk, 2% milk, and 1% milk. The milk consumption data was used to calculate grams of milk fat consumed. The cross-sectional association between milk fat intake and severe obesity (BMI ≥ 99th percentile) was determined using multivariable logistic regression. Data were available for 145 children, of whom 17% were severely obese. Severely obese children had a lower mean intake of milk fat (5.3 g vs. 8.9 g) and fewer drank any milk (79% versus 95% for not severely obese children (p < 0.01)). Among the potential confounders assessed, maternal BMI and maternal marital status were associated with severe obesity and were included in a multivariate model. In the multivariate model, higher milk fat consumption was associated with lower odds of severe obesity (OR 0.88 CI 0.80–0.97). Higher milk fat consumption is associated with lower odds of severe obesity among Latino preschoolers. These results call into question recommendations that promote consumption of lower fat milk.

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## 1. Introduction

### 1.1. High fat dairy consumption and obesity

The American Academy of Pediatrics (AAP) and the American Heart Association (AHA) recommend that children ages 2 and older consume skim or 1% milk rather than 2% or whole milk (Gidding et al., 2005, 2006; Daniels et al., 2008). These recommendations are justified by the fact that skim and 1% milk contain fewer calories and less saturated fat than 2% and whole milk, a nutrient profile that is thought to be protective against obesity and cardiovascular risk. The recommendation that children consume 1% or skim milk has broad impacts on nutrition programs serving low-income children in the United States such as the Special Supplemental Nutrition Program for Woman, Infants and Children (2014) (WIC) and school and child care meal programs (2016), all of which promote consumption of low-fat or skim milk.

However, evidence supporting the benefits of lower fat milk over full fat milk is lacking.

Recent research has questioned the link between saturated fat consumption and long-term cardiovascular risk in adults (Chowdhury et al., 2014; Siri-Tarino et al., 2015). Furthermore, recent studies in adults have found that high fat dairy consumption is actually associated with a *lower* risk of both obesity and diabetes mellitus (Kratz et al., 2013; Holmberg and Thelin, 2013; Rautiainen et al., 2016). However, few studies have been published that examine the association of higher vs. lower fat milk on children's weight and metabolic health. The small number of studies examining this question have either found no association between full-fat milk consumption and weight (O'Connor et al., 2006; Berkey et al., 2005) or have found that full-fat milk consumption is protective against excess weight (Huh et al., 2010; Scharf et al., 2013; Bigornia et al., 2014; Vanderhout et al., 2016). Huh et al. found that higher intake of whole milk at age 2 was associated with a slightly *lower* BMI-z score at age 3 with no such association found for reduced fat milk (Huh et al., 2010). Similarly, a study of participants in the Early Childhood Longitudinal Study found that children who consumed 2% or whole milk were *less* likely to be overweight at ages 2 and 4 than those who consumed skim or low-fat milk (Scharf et al., 2013). In addition, Bigornia et al. found that 10 year olds in the highest quartile of full-

fat milk intake had *lower* total body fat mass at age 13 compared to those in the lowest quartile (Bigornia et al., 2014). Finally, a recent cross-sectional study of Canadian children ages 12 to 72 months found that consumption of whole milk (vs. 1% or skim) was associated with lower BMI-z score (Vanderhout et al., 2016).

### 1.2. Latinos and obesity

Latino children in the United States have higher rates of obesity than non-Hispanic white children (Ogden et al., 2014), and this disparity emerges before 5 years of age (Rendall et al., 2012). Latino children are also particularly susceptible to severe obesity (Lo et al., 2014a, 2014b) which carries an even greater risk of metabolic sequelae (Lo et al., 2014b; Li et al., 2016; Freedman et al., 2007). Low-income children are also at greater risk of obesity (Singh et al., 2008; Singh et al., 2010) compared to children from higher income families. Thus, understanding how nutritional recommendations and policies may be impacting the risk of severe obesity in low-income Latino children is critical. However, few published studies have evaluated the link between milk fat consumption and weight in low-income Latino children. Consequently, we sought to determine the association of milk fat consumption with weight in low-income, Latino three-year-olds living in San Francisco, California.

## 2. Methods

### 2.1. Study design

We conducted a cross-sectional analysis of data from a birth cohort study of Latino children and mothers to evaluate the association between milk fat consumption and weight at child age 3 years. Please see Wojcicki et al. (2011) for full details of this cohort study.

### 2.2. Participant recruitment and eligibility

Latina mothers were recruited during prenatal visits at two San Francisco Hospitals: San Francisco General and the University of California San Francisco. Mothers were eligible if they self-identified as Latina and were English or Spanish-speaking. Mothers were excluded if they had any of the following medical conditions: drug or alcohol abuse, pre-gestational diabetes or gestational diabetes requiring insulin treatment, polycystic ovarian disease, anorexia nervosa or bulimia, or if they had a health problem that they anticipated would prevent them from breastfeeding. Infants were excluded if they had special health care needs or an Apgar score of <7 at 5 min.

### 2.3. Procedures

At child age 3 years, mothers and children met in-person with a bilingual research assistant from the study. Children were weighed and measured as previously described (Wojcicki et al., 2011). Mothers were also weighed and measured. Child dietary intake was determined via a single 24-hour dietary recall using a multiple-pass method performed by a trained research assistant. All data were collected between May 2009 and June 2010. Dietary intake data were entered into the *Food Processor* dietary intake analysis program (ESHA Research, Salem, Oregon 2012, version 10.12.0) by an experienced dietary technician. The *Food Processor* program was used to determine total caloric intake and total fat intake in 24 h for each participant. The dietary technician reviewed each recall to determine the child's total daily intake in ounces of whole milk, 2% milk, 1% milk and skim milk. After the milk data for each dietary recall was entered, there was quality assurance conducted on each recall to confirm that the entered data matched the raw data. The value for ounces of each type of milk consumed was multiplied by the fat content in grams/ounce of the type of milk (whole, 2%, 1% and skim milk) to determine milk fat in grams. Flavored milk was not

included in the analysis due to added sugar content which is likely to have independent effects on adiposity.

### 2.4. Assessment of covariates

At study entry the following variables were assessed via an in-person interview by a bilingual research assistant: highest educational level attained, marital status, country of origin, years in the United States, and preferred language.

### 2.5. Statistical analysis

Maternal and child BMI were calculated and child BMI percentile was determined using the Center for Disease Control (CDC) growth charts. The association between milk fat consumption in grams and child weight status was analyzed using logistic regression models. Milk fat consumption in children was not normally distributed. We first conducted bivariate regression analyses to determine whether there was an association between total grams of milk fat consumed and the following weight categories: 1) BMI ≥ 85th percentile (overweight, obese, and severely obese), BMI ≥ 95th percentile (obese and severely obese), and BMI ≥ 99th percentile (severely obese) (Freedman et al., 2007). We only found a significant association between milk fat consumption and severe obesity. Thus, our subsequent analyses focused on comparing severely obese children (BMI ≥ 99th percentile) to those who were not severely obese (all children with BMI < 99th percentile). To determine which covariates to include in our models, we first conducted bivariate logistic regression looking at the association of each of the following potential confounding demographic variables with the outcome of severe child obesity: child gender, maternal BMI, maternal education level (less than or greater than a high school education), maternal marital status, mother's preferred language, and mother's total years in the United States. We also examined the following potential nutritional confounders: total calories, total fat, and total ounces of milk consumed. Significant covariates (p < 0.05) were retained in the final multivariate model. *Stata Statistical Software*: *Release 12*. College Station, TX: StataCorp LP was used for all analyses.

We used descriptive statistics to determine the percentage of all children, severely obese children, and non-severely obese children who had consumed any milk as well as any whole, 2%, 1% or skim milk. We used a chi-squared test to determine the significance of differences in milk consumption patterns between severely obese and not severely obese children. We used simple means to compare milk-fat intake between severely obese and non-severely obese children and used a *t*-test to determine the significance of this difference.

## 3. Results

There were 201 mother-infant dyads enrolled in this cohort. We had BMI data and a complete 24-h dietary recall for 145 children at the 3-year-old visit or 72.1%. Table 1 presents the characteristics of the participants. In our cohort of children, 56% were normal weight (BMI 5th to <85th percentile), 14% were overweight (BMI ≥85th percentile to <95th percentile), 13% were obese (BMI ≥ 95th percentile to <99th percentile) and 17% were severely obese (BMI ≥ 99th percentile). Of the mothers, 93% were born outside the United States and spoke Spanish as a primary language, and 80% had a high school diploma or less. Mean maternal BMI was 28.8. The majority of mothers were single but living with a partner (59%), while only 28% were married.

Table 2 presents data on child milk intake. Nearly all of the children in the study (92%) had consumed some form of milk during the 24 h period. However, children who were severely obese were less likely to have consumed any milk (79% vs 95% p = 0.007). With regards to the type of milk consumed, 50% of children consumed 2% milk and 28% of children consumed whole milk. Only 15% of children consumed 1% or skim milk. Severely obese children had a tendency toward consuming

**Table 1**

Child and maternal characteristics in a study evaluating the association between milk fat consumption and severe obesity in 3-year-old Latino children living in San Francisco, CA n = 145.

| Variable | Mean | N (%) |
| --- | --- | --- |
| Child characteristics | | |
| Female | | 74 (51) |
| Normal weight (BMI <85th percentile) | | 81 (56) |
| Overweight (BMI 85th–<95th percentile) | | 19 (14) |
| Obese (BMI 95th–<99th percentile) | | 21 (13) |
| Severely obese (BMI ≥99th percentile) | | 24 (17) |
| Enrolled in WIC | | 133 (92) |
| Maternal characteristics | | |
| BMI | 28.8 | |
| Born outside the US | | 135 (93) |
| Primary Spanish speaker | | 135 (93) |
| Years in the US | 7.0 | |
| Mexican ethnicity | | 88 (61) |
| Guatemalan ethnicity | | 18 (12) |
| Salvadoran ethnicity | | 16 (11) |
| Honduran ethnicity | | 8 (6) |
| Nicaraguan ethnicity | | 7 (5) |
| Other ethnicity | | 8 (5) |
| High school diploma or less | | 116 (80) |
| Married | | 40 (28) |
| Single | | 20 (14) |
| Single living with a partner | | 85 (59) |

skim milk compared to those who were not severely obese (8% vs 2% p = 0.07). The total volume of milk consumption did not vary based on whether or not children were severely obese. However, severely obese children consumed fewer mean grams of milk fat (5.3 vs 8.9 p = 0.009).

Table 3 presents the results of the bivariate and multivariate logistic regression analyses. In bivariate analysis, only milk fat consumption (OR 0.88, CI 0.80–0.97, p = 0.01), maternal BMI (OR 1.07, CI 1.01–1.14, p = 0.023), and maternal marital status (OR 0.2, CI 0.04–0.89, p = 0.04) were significantly associated with severe obesity. Total fat intake, total caloric intake, total milk intake, maternal education, maternal language, and maternal years in the United States were not associated with the odds of severe obesity. Milk fat intake, maternal BMI, and maternal marital status were retained in the multivariate analysis and all remained significant. In our multivariate model, higher milk fat intake was associated with lower odds of severe obesity (OR 0.89, CI 0.81–0.97, p = 0.014) as was having a mother who was married (0R 0.21, CI 0.45–0.94, p = 0.04); higher maternal BMI was associated with greater odds of severe obesity (OR 1.07, CI 1.0–1.14, p = 0.05).

**Table 2**

Child milk intake and milk fat intake among all children, severely obese children and not severely obese children in a study of low-income Latino 3-year-olds in San Francisco, CA. n = 145 (24 severely obese).

| Variable | All children n (%) | Severely obese n (%) | Not severely obese n (%) | p-Value |
| --- | --- | --- | --- | --- |
| Consumed % | | | | |
| Any milk | 134 (92) | 19 (79) | 115 (95) | 0.007[*] |
| Any whole milk | 41 (28) | 4 (17) | 37 (31) | 0.17[*] |
| Any 2% milk | 72 (50) | 8 (33) | 64 (53) | 0.08[*] |
| Any 1% milk | 18 (12) | 5 (21) | 13 (11) | 0.17[*] |
| Any skim milk | 4 (3) | 2 (8) | 2 (2) | 0.07[*] |
| Mean total milk consumed (oz)[a] | 12.5 | 10 | 13 | 0.16[**] |
| Mean milk fat consumed (g)[b] | 8.3 | 5.3 | 8.9 | 0.009[**] |

[a] oz = ounces.
[b] g = grams.
[*] p-Values from chi-square test comparing consumption of severely obese and not severely obese.
[**] p-Values from t-test comparing consumption of severely obese and not severely obese.

**Table 3**

Results of bivariate and multivariate logistic regression analyses to determine the association between milk fat consumption and severe obesity in low-income, Latino 3-year-olds living in San Francisco, CA n = 145.

| Variable | Bivariate results | | | Multivariate results | | |
| --- | --- | --- | --- | --- | --- | --- |
| | OR | CI | p | OR | CI | p |
| Milk fat intake (g)[a] | 0.88 | 0.80–0.97 | 0.01 | 0.89 | 0.81–0.97 | 0.014 |
| Total fat intake (g) | 0.97 | 0.95–1.01 | 0.16 | – | – | – |
| Total kcals | 1.0 | 1.0–1.0 | 0.1 | – | – | – |
| Total milk intake (oz)[b] | 0.95 | 0.89–1.01 | 0.11 | – | – | – |
| Maternal BMI | 1.07 | 1.01–1.14 | 0.023 | 1.07 | 1.0–1.14 | 0.05 |
| Maternal marital status (married vs not married) | 0.2 | 0.04–0.89 | 0.03 | 0.21 | 0.45–0.94 | 0.04 |
| Maternal education | 0.66 | 0.37–1.19 | 0.17 | – | – | – |
| Maternal language | 0.85 | 0.37–1.9 | 0.67 | – | – | – |
| Maternal years in US | 1.03 | 0.95–1.11 | 0.46 | – | – | – |

[a] g = grams.
[b] oz = ounces.

## 4. Discussion

To our knowledge, this is the first study to determine the association between milk fat consumption and severe obesity in low-income Latino preschoolers, a population with an extremely high burden of obesity and severe obesity. While the AAP and the AHA both recommend that children drink 1% or skim milk, we document that *higher* milk fat consumption is associated with a lower risk of severe obesity in our cohort. This association remained significant after controlling for maternal BMI and maternal marital status.

Our results are surprising and contradict the rationale for current dietary recommendations for children. However, they are consistent with several prior published studies that examined the link between milk fat and child weight. Huh et al. found that among US children in the Project Viva birth cohort, higher whole milk consumption at age 2 was associated with a slightly lower BMI z-score at age 3 (0.09 units per daily serving) whereas no such association was found with reduced fat milk intake (Huh et al., 2010). Similarly, Scharf et al. found that 2- and 4-year-old children in the Early Childhood Longitudinal Study (ECLS) who consumed 2% or whole milk had lower mean BMI z-scores than children who consumed 1% or skim milk and a lower adjusted odds of being overweight or obese (Scharf et al., 2013). In addition, children in the ECLS who drank 1% or skim milk at both 2 and 4 years of age were more likely to become overweight or obese in that two year interval than those who drank 2% or whole milk (Scharf et al., 2013). Further, Bigornia et al. found that among British children in the Avon Longitudinal Study of Parents and Children, those in the highest quartile of dairy fat intake at age 10 had lower risk of excess total body fat mass at age 13 and lower gains in BMI (Bigornia et al., 2014). Vanderhout et al. examined the association between milk fat percentage and BMI and found that children ages 12–72 months who drank whole milk had a lower BMI z-score that those who drank 1% milk (Vanderhout et al., 2016). In contrast to our results and the four aforementioned studies, O'Connor et al. examined data from the National Health and Nutrition Examination Survey from 1999 to 2002 and found no association between the type of milk consumed (meaning the percent milk fat) and child weight among two to five-year-olds (O'Connor et al., 2006). Similarly, Berkey et al. found that milk fat consumption was not associated with weight changes in adolescents, but did find that higher consumption of 1% or skim milk was linked to greater BMI increase (Berkey et al., 2005). Our study adds to the literature due to its focus on low-income Latino children as well as our determination of dairy fat consumption in preschoolers as a continuous variable rather than simply classifying children by the type of milk they typically drink.

Our finding that higher milk fat consumption is associated with a lower risk of severe obesity is also consistent with studies in the adult literature. In a review paper published in 2012, Kratz et al. evaluated 16 studies published from 1999 to 2011 that examined the association

between dairy fat consumption and obesity (Kratz et al., 2013). Of these 16 studies, 11 found that high dairy fat consumption was associated with lower adiposity and 5 found no effect. None of the studies found that high dairy fat consumption was associated with higher adiposity. Two more recent cohort studies have also found dietary fat to be protective against obesity in adults. In a study conducted with adult male participants in Sweden, Holmberg et al. found that a dietary pattern which included a low intake of dairy fat (low-fat milk, no butter, seldom or little whipping cream) was associated with higher risk of developing central obesity while a dietary pattern which included a high intake of dairy fat (high fat milk, butter, and whipping cream) was associated with lower risk of developing central obesity (Holmberg and Thelin, 2013). Similarly, Rautiainen et al. examined data from 18, 438 women in the Women's Health Study and found that weight gain over time was inversely correlated with high-fat dairy consumption and that those in the highest quintile of high fat dairy consumption had a lower risk of becoming overweight or obese at follow-up; conversely, low-fat dairy consumption was not protective (Rautiainen et al., 2016).

Studies in the adult literature have also found that high fat dairy consumption may be protective against diabetes. Kratz et al. reviewed 8 studies published from 1999 to 2011 examining dairy fat consumption and diabetes incidence and noted that three studies found protective effects of dairy fat, one found inconclusive evidence, and four found no effect. None of the studies reviewed found that dairy fat consumption increased the risk of diabetes. Two more recent studies have also found that dairy fat consumption is protective against diabetes. Among participants in the Swedish Malmo Diet and Cancer Cohort study, those in the highest quintile of dairy fat intake developed diabetes at a lower rate than those in the lowest quintile (Ericson et al., 2015). Yakoob et al. studied circulating biomarkers of dairy fat intake in stored blood samples from two United States cohort studies and found that those in the highest quartiles of dairy fat biomarkers had a significantly lower risk of developing diabetes over time than those in the lowest quartile (Yakoob et al., 2016).

The mechanisms by which dairy fat consumption may be protective against obesity are unclear. However, milk fat is one of the few food sources of butyric acid which has anti-inflammatory (Kratz et al., 2013) effects, improves insulin sensitivity and increases energy expenditure in mice models (Gao et al., 2009). Thus, a possibility is that specific molecular properties of dairy fat are protective against obesity and metabolic dysfunction. Furthermore, full fat milk may have increased satiety for children in comparison with lower fat options (Samra, 2010; Scharf et al., 2013).

Our study has a number of important limitations. Our methodology was cross-sectional, and thus we cannot determine causality. It is also possible that reverse causality is at work in our results. Given the prevailing dietary recommendations, parents of severely obese children may have been counseled to introduce lower fat milk or to limit consumption of higher fat milk as a strategy to protect their children against further weight gain. Parents who were concerned about their child's weight may also have made this decision on their own based on general dietary advice received from health care providers, the media, or WIC. In addition, our data are subject to recall bias and social desirability bias. Furthermore, our study is based on a single 24 h dietary recall which may not be representative of typical intake and our results may be driven by residual confounding from unmeasured variables. Future, larger studies should also account of dairy fat from other dairy sources such as butter and cheese so as to better understand the role of total dairy fat in childhood obesity risk. For this study, we were particularly interested in the impact of milk fat from liquid milk given policies related to children's milk consumption such as the change in WIC regulations, which mandate that participants receive skim or 1% milk.

Notwithstanding these limitations, our study has important implications. We found that increased consumption of milk fat is associated with a lower risk of severe obesity in a population with very high rates of severe obesity. Our findings are consistent with four other studies that have examined the link between milk fat consumption and weight outcomes in children as well as several studies in adults. Our results, taken in context with the existing literature, point to a critical need for additional research on the effects of lower vs. full fat milk on child weight and risk for diabetes and cardiovascular disease. At this time, the AAP and AHA recommendations on milk intake for children cannot be considered evidence based.

## Transparency document

The Transparency document associated with this article can be found, in the online version.

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