11-2018

Dairy intake and body composition: Summary

Children's Mercy Kansas City

Office of Evidence Based Practice (EBP) – Critically Appraised Topic: Dairy Intake and Body Composition

Specific Care Question In pediatric patients, does dairy foods help in the prevention and/or treatment of obesity?

Question Originator
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Literature Summary

Background. About one-third of children and adolescents in the United States are either overweight or obese (Klish et al., 2018). Diet, physical activity, and behavioral interventions are all used in the treatment of overweight or obesity. The 2007 AAP guideline on the Prevention, Assessment, and Treatment of Child and Adolescent Obesity recommends eating a diet rich in calcium as part of a healthy diet to prevent and treat obesity (Expert Committee, 2007). More recently, a systematic review by Kouvelioti, Josse, and Klentrou (2017) found the consumption of dairy products likely benefits bone structure and development, but it does not appear to affect body composition or body size in children and adolescents. The purpose of this review is to determine if dairy foods help in the prevention and/or treatment of overweight and obesity in the pediatric population.

Study characteristics The literature search timeframe included 2007 to present. The search for suitable studies was completed on 6/23/2018. The team leads reviewed the 112 titles and abstracts found in the search and identified 17 articles believed to answer the question. After an in-depth literature analysis 14 articles specifically looked at dairy intake in the prevention and/or treatment of obesity. Thirteen of the studies selected were included in a systematic review by Kouvelioti et al. (2017). Only randomized control trials (RCT) were included. A meta-analysis could not be performed due to the heterogeneity of the studies.

Key results. No recommendation can be made on the use of dairy to prevent and/or treat obesity in pediatric patients. Thirteen studies showed no difference in body weight or compositions and only one study showed a positive outcome of weight loss or improved body composition (see Table 1).

Even though a specific recommendation could not be made regarding dairy as an intervention for treating obese patients the end-user of this review should be aware the concerns with the literature findings. The risk of bias for the randomized trials is serious due to the inability to blind participants on the type of dairy intake which could have led to change in the behavior of participants. As with most long-term studies, subjects did not continue to follow up to the end of the study period resulting in attrition bias. The studies had very serious inconsistency due to the large amount of heterogeneity (examples include different populations, interventions, follow-up time, and outcomes). Also, the studies compared dairy consumption in multiple forms vs. habitual diet, placebo, or sugar-sweetened beverages. From the included studies, it is not clear if calcium was being studied or dairy products. Many confounders make it difficult to isolate the effect of either component.

Summary by Outcome

Changes in body weight or composition. The outcomes from the included studies on the effect of dairy intake on body weight or composition are separated into two groups: (a) positive effect on body weight or composition. Studies in the positive effect group show a decrease in body weight or composition or (b) no effect on body weight or composition.

Positive Effect (decrease weight) with dairy intake. Albala et al. (2008) randomized 98 children aged 8-10 years into two groups. Group 1 (n = 50) met with a nutritionist and were given instructions on removing sugar-sweetened beverages from their diet while consuming at least 3 portions (200mL each) of milk beverages per day. The second group (n = *48*) were given no instructions and consumed a habitual diet. At 16 weeks, the milk group had a significant increase (p = .04) in lean body mass (LBM) versus control; 0.92 ± 0.10 vs. 0.62 ± 0.11 kg, respectively. There was also a significant increase in height for boys, p = .05. Blinding was not possible in this study and may have contributed to participant bias.

No effect on body weight or body composition with dairy intake. Cadogan, Eastell, Jones, & Barker (1997) randomized 82 girls with a mean age of 12.2 years into a milk group (n = 44) and a control (n = 38). The intervention comprised of one pint of whole or reduced fat milk which was delivered to the subject's house each day for 18 months. The control groups were asked to continue with their habitual diet habits. At 18 months, both groups showed similar increments in height, weight, lean body mass, and fat body mass (p-value not provided by the study). Blinding was not possible in this study and may have contributed to participant bias.

Chan, Hoffman, and McMurry (1995) randomized 48 white females aged 9-13 were compared in a group that was instructed to consume at least 1200 mg calcium daily (n = 24) versus a group that consumed their habitual diet (n =24). After one year the difference on lean body mass or percentage of percent body fat between groups was not statistically significant ($p > 0.05$). Blinding was not possible in this study and may have contributed to participant bias.

Cheng et al. (2005) compared 195 children (mean age 11 years) consuming different amounts of calcium. Group 1 (n = 49) consumed 1,000 mg calcium carbonate + 200 IU (5 µg) vitamin D daily, Group 2 (n = 49) consumed 1,000 mg calcium carbonate daily + vitamin D placebo, Group 3 (n = 49) consumed 1,000 mg Ca daily from cheese, Group 4 (n = 49) consumed calcium placebo + vitamin D placebo. At two years there were no significant effects on body size and composition, $p > 0.05$. Blinding was not possible in this study and may have contributed to participant bias. There was also a 35% drop out rate.

Du et al. (2004) randomized 757 females aged 10 years from 9 primary schools into three groups. Group 1 (n = 238) consumed 330 ml of ultra-heat-treated (UHT) milk, fortified with 560 mg of Calcium, Group 2 (n = 260) consumed 330ml of UHT milk fortified with Ca plus 5 or 8 µg vitamin D, consumed by subject every school day, and Group 3 (n = 259) received no supplementary milk and consumed their habitual diets over the 24-month study. The two supplemental groups had significant increase in height (0.6%), sitting height (0.8%), and weight (2.9%), $p < .05$. Change in BMI was not reported. This study reported that extreme values within the data sets were removed according to a defined set of criteria not outlined in the article.

Gibbons et al. (2004) examined high calcium dairy drinks in 159 children aged 8 to 10 years. The children were divided into two groups, Group 1 (n = 74) consumed a high calcium dairy drink (HCDD) (calcium 1200mg per day) while Group 2 (n = 80) consumed a control drink (calcium 600mg per day). After 30 months, weight difference between groups was not significantly different, $p = .548$. The lean mass difference between groups was not significantly different, $p = 0.823$. Fat mass difference between groups after 30 months was not significant ($p = .531$).

Kelishadi et al. (2009) randomized 120 subjects (aged 4.8 to 6.2) into three groups. Group 1 (n = 40) consumed a dairy-rich diet, with most of their calcium coming from low-fat and regular milk, cheese, and yogurt, as well as liquid and solid curd. Group 2 (n = 40) was on a calorie restricted diet that was based on calorie requirement for height, and Group 3 (n = 40) was given no recommendations on dietary change. After 36 months, there was no difference in body composition between the three groups, $p > 0.05$. Blinding was not possible in this study and may have contributed to participant bias.

Lappe et al. (2017) divided 274 adolescent girls (mean age 13.5 years) into two groups. Over 12 months, Group 1 was asked to consume low-fat milk (skim, 1% or 2%) or low-fat yogurt servings achieving $\geq$1200 mg calcium/day. Group 2 was asked to continue their usual diet of $\leq$ 600 mg calcium/day. The study failed to detect a statistically significant difference between groups in BMI percentile ($p = .47$) or weight change ($p = .58$). For the dairy group, the study also failed to detect a statistically significant change with waist circumference ($p = .44$), hip circumference ($p = .07$), or abdominal girth ($p = .78$). Blinding was not possible in this study and may have contributed to participant bias.

Lappe, Rafferty, Davies, and Lypaczewski (2004) compared 59 children (mean age 9 years), grouped to consume a habitual diet (n = 32) versus consuming at least 1,500 mg of calcium per day (n = 27) mainly through dairy. There was no difference in fat mass at 24 months (p = .53) or BMI at 24 months (p = 1.0). The study had high risk of bias due to the randomization of the study was not disclosed, per-protocol analysis was used, and blinding was not possible.

Lau, Lynn, Chan, Lau, and Woo (2004) randomized 344 adolescents aged 9 to 10 into three groups. Group 1 (n = 122) consumed a normal diet, Group 2 (n = 100) consumed 40 g calcium in the form of a milk powder beverage, and Group 3 (n = 102) consumed 80 g calcium in the form of a milk powder beverage. There was no statistically significant change in fat mass after 18 months (p = .32). Blinding was not possible in this study and may have contributed to participant bias.

Merrilees et al. (2000) randomized 73 females aged 15 to 16 years of age into two groups. Group 1 (individual group size not reported) had supplemented dairy delivered to them that would provide at least 1,000 mg/day calcium and Group 2 was to consume a normal diet. After three years, there was no difference in the changes between the two groups for height, weight, body fat and lean muscle (p-value not provided by study). The study had high risk of bias due to the randomization of the study was not disclosed, per-protocol analysis was used, and blinding was not possible.

St-Onge, Goree, and Gower (2009) randomized 45 overweight children (mean age 9 years) into to two groups, high-milk intake (≥ 4 servings of low or non-fat milk) (n = 21) and low-milk intake (≤1 serving of low or non-fat milk) (n = 24). The study occurred over 12 weeks. Both groups increased in weight and height (p > 0.05). Both groups saw a reduced BMI but it was not significant between the two groups, p = .057. There was no difference found between waist circumferences (p ≥ 0.05). The study had high risk of bias due to the randomization of the study was not disclosed, per-protocol analysis was used, and blinding was not possible.

Volek et al. (2003) randomized 28 boys (13 to 17 years of age) into two groups. Group 1 (n =14) received three severings per day of 1% milk and Group 2 (n= 14) received unfortified apple juice alternated with grape juice. Both groups engaged in a 12-week resistance-training program. Body composition was not significantly different between the two groups, p > 0.5. Participant randomization was not disclosed and blinding was not possible.

Weaver et al. (2011) randomized 25 girls with a mean BMI of 33 kg/m^2 and 17 boys with a BMI of 28 kg/m^2. Group 1 (n = 22) consumed 756 mg calcium per day, while Group 2 (n = 20) received an additional 650 mg calcium per day (largely dairy). When weight loss was compared after 9 weeks, there was no difference in weight loss between the groups (p = .83). Blinding was not disclosed and may have contributed to participant bias.

Search Strategy and Results (see PRISMA diagram)
("Milk"[Majr] OR "Dairy Products"[Majr]) AND ("Weight Loss"[Mesh] OR "Anti-Obesity Agents"[Mesh] OR "Obesity/prevention and control"[Mesh] OR "Obesity/diet therapy"[Mesh]) AND (child OR children OR infant OR pediatric* OR paediatric* OR adolescence) ("Dairy Products"[Majr]) AND ("Weight Loss"[Mesh] OR "Anti-Obesity Agents"[Mesh] OR "Obesity/prevention and control"[Mesh] OR "Obesity/diet therapy"[Mesh]) AND (child OR children OR infant OR pediatric* OR paediatric* OR adolescence)
Search return: 106 Team Leads Selected: 17

Studies Included in this Review (in Alphabetical Order)

Albala et al. (2008)
Cadogan et al. (1997)
Chan et al. (1995)
Cheng et al. (2005)

Du et al. (2004)
Gibbons et al. (2004)
Kelishadi et al. (2009)
Lappe et al. (2004)
Lappe et al. (2017)
Lau et al. (2004)
Merrilees et al. (2000)
St-Onge et al. (2009)
Volek et al. (2003)
Weaver et al. (2011)

Studies Not Included in this Review with Exclusion Rationale (in Alphabetical Order)

Authors (YYYY)	Reason for exclusion
Alonso et al. (2009)	None pediatric study
Matkovic, Fontana, Tominac, Goel, and Chesnut 3rd (1990)	Did not evaluate weight gain or loss
Renner et al (1998)	Did not evaluate body composition or weight loss

Method Used for Appraisal and Synthesis

The Cochrane Collaborative computer program, Review Manager (Higgins & Green, 2011)[a] was used to synthesize the 13 included studies. GRADEpro GDT (Guideline Development Tool) is the tool used to create the Summary of Findings Tables for this analysis.

[a]Higgins, J. P. T., & Green, S. e. (2011). *Cochrane Handbook for Systematic Reviews of Interventions [updated March 2011]* (Version 5.1.0 ed.): The Cochrane Collaboration, 2011.

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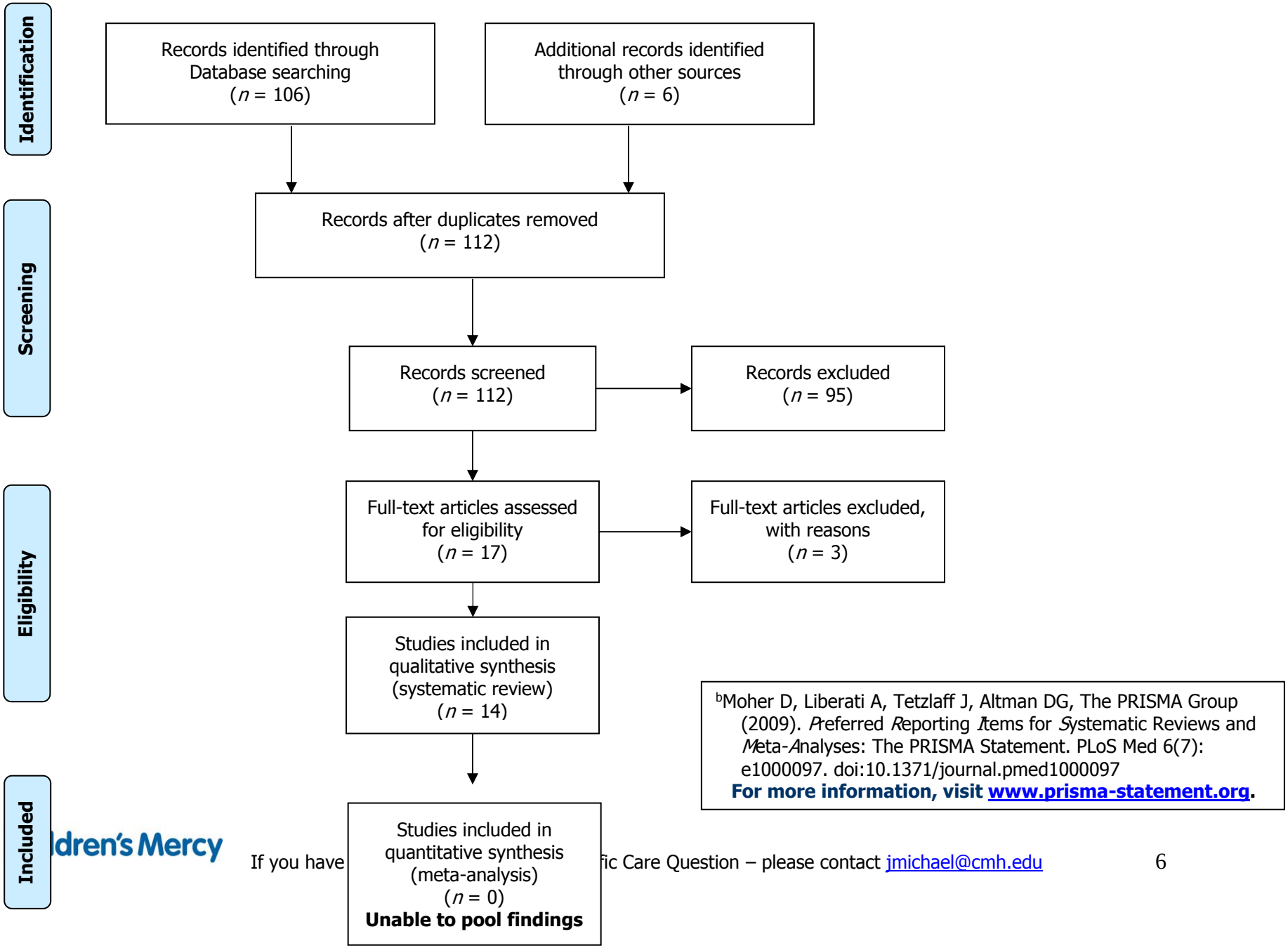
Acronyms Used in this Document

Acronym	Explanation
BMI	Body Mass Index
HCDD	High Calcium Dairy Drink
LBM	Lean Body Mass
UHT	Ultra-Heat Treated

Date Developed/Updated
November 1, 2018

Figure 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRIMSA)[b]



[b]Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). *P*referred *R*eporting *I*tems for *S*ystematic Reviews and *M*eta-*A*nalyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097
For more information, visit www.prisma-statement.org.

Table 1.
Summary Table

	N	Sex	Age (years)	Country	Weight	Duration	Intervention	Main Findings on Body Composition
Albala et al., (2008)	93	Male and Female	8-10	Chile	Overweight or obese (>85th percentile of BMI-for-age)	16 weeks	Dairy (3 servings, 600ml 1.5% fat milk per day)	Significant increase in LBM (3.72%; 0.92 ± 0.10 vs. 0.62 ± 0.11 kg) (p = .04); Significant increase in height only in boys (p = .05);
Cadogan et al. (1997)	80	Female	11.8-12.5	United Kingdom	Not stated	18 months	Dairy (whole or reduced-fat 568 ml milk, average consumption 486 ml/day	Nonsignificant effects on body size and composition (p > 0.05)
Chan et al. (1995)	46	Female	9-13	United States	Not stated	1 years	Dairy (milk, cheese, yogurt)	Nonsignificant effects on lean body mass or percentage of body fat (p > 0.05)
Cheng et al. (2004)	173	Female	10-12	Finland	Not stated	2 years	Dairy (mainly low-fat cheese	Nonsignificant effects body size and composition (p > 0.05)
Du et al. (2004)	698	Female	9.7-10.4	China	Not stated	2 years	Dairy (milk fortified with calcium with or without vitamin D)	Significant increase in height (0.6%), sitting height (0.8%), weight (2.9%) (p < .05)
Gibbons et al. (2004)	123	Female	8-10	New Zealand	Not stated	30 months	Dairy (80 gm milk powder)	Nonsignificant effects between the two group in body composition (p > 0.05)
Kelishadi et al. (2009)	95	Male and Female	4.8-6.2	Iran	Obese (>95th percentile of BMI-for-age	36 months	Dairy (milk, cheese, yogurt-rich diet);	Nonsignificant effects between the three groups in decreased Body Mass Index standard deviation (p > .05).
Lappe et al. (2004)	59	Female	9.1-9.9	United States	Normal weight	2 years	Calcium-rich foods (mainly dairy)	Nonsignificant effects (p > 0.05)
Lappe et al. (2017)	274	Female	13.5	United States	Normal weight	12 months	Diary (low-fat milk or yogurt)	Nonsignificant effects on body fat gain over 12 months (p > 0.45)
Lau et al. (2004)	324	Male and Female	9-10	China	Not stated	18 months	Dairy (milk powder enriched with calcium)	No significant differences in weight, height, lean body mass, and fat mass (p > 0.05)
Merrilees et al (2000)	73	Female	15-16	New Zealand	Not stated	3 years	Dairy (mostly milk)	Nonsignificant effects on body size and composition (p > 0.05)

St-Onge et al. (2009)	45	Male and Female	8-10	United States	Overweight or obsess (>85th percentile of BMI-for-age	16 weeks	Dairy (0-1% fat milk)	Nonsignificant effects ($p > 0.05$)
Volek et al. (2003)	28	Male	13-17	United States	Not stated	12 weeks	Dairy (3 servings, 708 ml 1% fat milk)	Body size and composition: nonsignificant effects ($p > 0.05$)
Weaver et al. (2011)	38	Female	9.1-9.9	United States	Normal weight	2 years	Calcium-rich foods (mainly dairy)	Nonsignificant effects on body composition ($p > 0.05$)

Figure *2*

Risk of Bias Summary

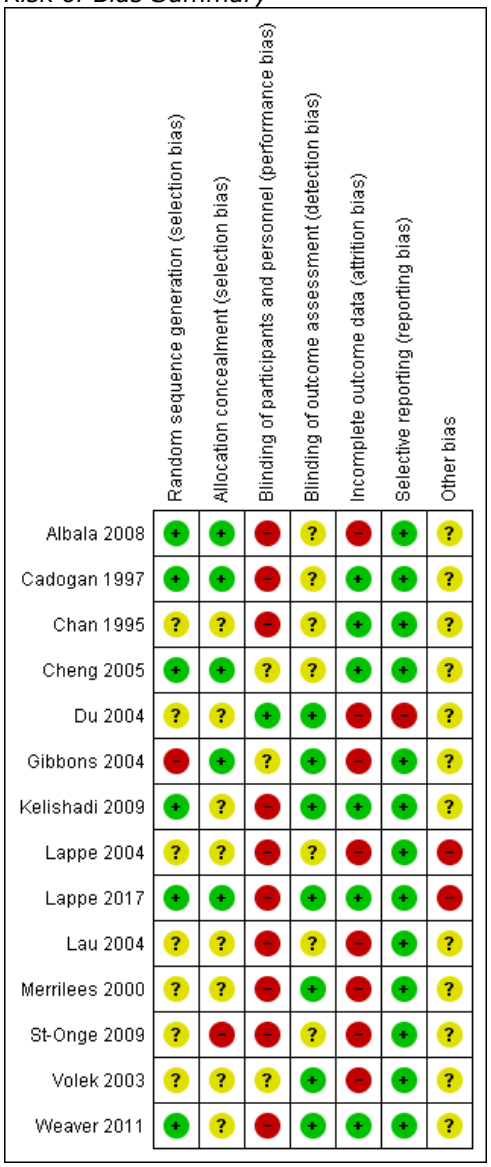


Table *2.*

Albala 2008

Methods	RCT
Participants	**Setting:** Santiago, Chile July 2004-December 2005 **Randomized into study: *N* =** 98 children • **Group 1: *n* =** 47 • **Group 2: *n* =** 46 **Completed Study: *N*=** 93 • **Group 1: *n* =** 47 • **Group 2: *n* =** 46 **Gender, males:** • **Group 1: *n* =** (%) 48.9% • **Group 2: *n* =** (%) 56.5% **Age, years (mean) (SD):** 8-10 years • **Group 1:** 8-10 years • **Group 2:** 8-10 years **Inclusion Criteria:** • BMI greater than the 85th percentile for sex and age based on Centers for Disease Control and Prevention growth charts. • Prepubertal (Tanner Stage 1;28) • Consuming two or more servings/day of sugar-sweetened beverages (SSBs). **Exclusion Criteria:** • Serious underlying medical condition • Lactose intolerance • Allergy to milk protein • Taking prescription medications that might affect body weight. **Power Analysis:** According to the intention-to-treat principle, we included data from the 93 subjects who completed follow-up assessments. The study was designed to provide 80% power to detect an effect size of 0.60 with the use of 5% type I rate. Statistical significance was defined as $p < .05$.
Interventions	• **Group 1:** A nutritionist visited the homes of children to deliver the milk beverages, provide instructions to the family about consuming the delivered beverages, and encourage parents to remove SSBs from their homes. Children were counseled to drink 3 portions(200 ml each) per day and not consume SSBs. Portions were given to siblings as needed so not to compete with study participant. The members of the household were encouraged not to consume SSBs. • **Group 2:** No instructions regarding food or beverage choices were given and there was no contact other than to conduct assessments.

Outcomes	**Primary outcome(s):** • Change in percentage body fat
Notes	• Accretion of lean mass was larger in the intervention group than the control group *P* = .04). • For boys, but not for girls, height increased more in the intervention group than in the control group (*P* = .01).

Bias	Scholar's Judgment	Support for judgment
Random sequence generation (selection bias)	Low Risk	Eligible child was assigned to intervention or control group using a computer-generated set of random numbers. Random assignment was stratified by height-for-age *z* score
Allocation concealment (selection bias)	Low Risk	The sequence of random numbers was concealed from personnel conducting recruitment until after the group assignment
Blinding of participants and personnel (performance bias)	High Risk	No blinding could have influenced participant's behavior
Blinding of outcome assessment (detection bias)	Unclear Risk	Not discussed by authors
Incomplete outcome data (attrition bias)	High Risk	Per-protocol was used
Selective reporting (reporting bias)	Low Risk	The study protocol is available and the pre-specified outcomes have been reported
Other bias	Unclear Risk	

Cadogan 1997

Methods	RCT
Participants	**Setting:** Local schools in Sheffield, United Kingdom **Randomized into study:** *N* = 82 • **Group 1 (Milk Group):** *n* = 44 • **Group 2 (Control Group)**: *n* = 38 **Completed Study: *N*=** 80 • **Group 1 (Milk Group):** *n = 43* • **Group 2 (Control Group):** *n* = 37 **Gender, males:** *N* = 0 • **Group 1 (Milk Group):** *n* = 0 (% • **Group 2 (Control Group):** *n* = 0 (%) **Age, years (mean) (SD):** 12.2 (0.3) • **Group 1 (Milk Group):** 12.2 (0.3)

	• **Group 2 (Control Group):** 12.1 (0.3) **Inclusion Criteria:** • Non-smokers • Adolescent females • Caucasian • No special dietary regimens **Exclusion Criteria:** • History of bone disease • Taking medication known to influence calcium metabolism **Power Analysis:** The authors did not disclose power analysis
Interventions	• **Group 1 (Milk Group):** 568 ml (one pint) of whole or reduced fat milk. Subjects asked to consume as much of the pint as possible as a daily supplement • **Group 2 (Control Group):** Continue with their daily diets
Outcomes	**Primary outcome(s):** • Changes in bone mass and density **Secondary outcome(s)** • Anthropometric and body composition variables • Biochemical indices of skeletal growth
Notes	Similar changes over 18 month in anthropometric and body composition variables with no significant difference. Cannot make a table on anthropometrics because the data is presented as a figure. Types of milk selected by subjects in the Milk Group: • 36/44 semi-skimmed milk • 6/44 whole milk • 2/44 skimmed milk No difference in bone density

Bias	Scholar's Judgment	Support for judgment
Random sequence generation (selection bias)	Low Risk	Randomized permuted blocks stratified by pubertal stage was used
Allocation concealment (selection bias)	Low Risk	A statistician who took no part in the study in the execution of the trial randomized subjects
Blinding of participants and personnel (performance bias)	High Risk	No blinding could have influenced participant's behavior.
Blinding of outcome assessment (detection bias)	Unclear Risk	Not reported

Incomplete outcome data (attrition bias)	Low Risk	Missing outcome data balanced in numbers across intervention groups. 1 subject dropped out of milk and control group. Intent to treat
Selective reporting (reporting bias)	Low Risk	They reported on their outcomes well
Other bias	Unclear Risk	funded by UK Dairy industry

Chan 1995

Methods	Randomized control trial

Participants	**Setting:**
	• General Community in Salt Lake City, Utah
	Randomized into study: *N* = 48
	• **Group 1**: *n* = 24
	  ○ Dairy
	• **Group 2:** *n* = 24
	  ○ Control
	Completed Study:
	• **Group 1:** *n* = 22
	  ○ Dairy
	• **Group 2:** *n* = 24
	  ○ Control
	Gender, males:
	• none
	Age, years
	• Group 1: 11.1 +- 0.9
	• Group 2: 11.2 +-1.0
	
	Inclusion Criteria:
	• White female
	• Healthy (no chronic disease)
	• Aged 9-13
	• Tanner stage 2
	• 10th and 90th percentile of weight and height
	
	Exclusion Criteria:
	• Involved in team sports

	Power analysis: no reported

Interventions	**Group 1 and 2:**
	• examined at the beginning of the study and every 3 months for 1 year
	• weight and height recorded at each visit
	• Routine acidity assess by questionnaire at each visit
	• Blood draw at the start and end of study for determinations of serum levels of:
	  ○ Calcium
	  ○ Phosphate
	  ○ Vitamin D
	  ○ Alkaline phosphate
	  ○ Magnesium
	  ○ Albumin
	• First morning urine collected at each visit
	• Fasting labs for:
	  ○ Calcium
	  ○ Creatinine
	  ○ Hydroxyproline
	• Bone mineral density determined by single photon and dual-energy x-ray
	• Record a 3-day dietary history and food frequency at beginning and after 3, 9 and 12 months of study
	Group 1:
	• Supplemented weekly with dairy products to at least 1,200 mg calcium daily
	  ○ Supplements selected by participant under guidance of dietary staff
	  ○ Specifically labelled for participant use
	  ○ All unused products removed and counted
	• Dairy products included: milk, cheese and yogurt
	• Dropped from study if failed to meet 2 weekly consecutive intakes of 1,200mg
	Group 2:
	• Usual diet

Outcomes	**Primary Outcomes**:
	• Bone mineral content and density
	• Body Composition
	  ○ Lean body mass
	  ○ Body fat

Notes	**Group 1**:
	• Lean body mass kg
	  ○ Baseline: 24.7 ± 3.9
	  ○ 12 months: 29.0 ± 4.1
	  ○ Difference is about 4.3 gain in lean body mass
	• % body fat
	  ○ Baseline: 29.7 ± .9

	○ 12 months: 31.3 ± 9.3 ○ Difference is ~ 1.7 gain in body fat **Group 2:** • Lean body mass kg ○ Baseline: 26.2 ± .3 ○ 12 months: 30.0 ± 3.3 ○ Difference is ~ 3.8 gain in lean body mass • % body fat ○ Baseline: 28.9 ± 6.4 ○ 12 months: 30.1 ± 6.0 ○ Difference is ~ 1.2 gain in body fat

Bias	Scholar's judgment	Support for judgment
Random sequence generation (selection bias)	Unclear Risk	Not given
Allocation concealment (selection bias)	Unclear Risk	Not given
Blinding of participants and personnel (performance bias)	High Risk	No blinding could have influenced participant's behavior
Blinding of outcome assessment (detection bias)	Unclear Risk	Not given
Incomplete outcome data (attrition bias)	Low Risk	intent to treat
Selective reporting (reporting bias)	Low Risk	Specified primary outcomes are reported

Cheng 2005

Methods	Randomized control trial
Participants	**Setting:** 61 schools in the city of Jyväskylä and its surroundings in Central Finland. **Randomized into study:** *N* = 195 • **Group 1:** 1,000 mg calcium carbonate + 200 IU (5 µg) vitamin D daily; *n = 49* • **Group 2:** 1,000 mg calcium carbonate daily + vitamin D placebo; *n = 49* • **Group 3:** 1,000 mg Ca daily from cheese; *n = 49* • **Group 4:** Calcium placebo + vitamin D placebo; *n= 49* **Completed Study:** *N = 126*

	• **Group 1:** 1,000 mg calcium carbonate + 200 IU (5 µg) vitamin D daily *n = 36* • **Group 2:** 1,000 mg calcium carbonate daily + vitamin D placebo *n = 32* • **Group 3:** 1,000 mg calcium daily from cheese *n* = 27 • **Group 4:** Calcium placebo + vitamin D placebo *n = 31* **Gender, males:** *n* = 0 **Age, years (mean) (SD):** • **Group 1:** 1,000 mg calcium carbonate + 200 IU (5 µg) vitamin D daily: 11.0 ± 0.6 • **Group 2:** 1,000 mg calcium carbonate daily + vitamin D placebo: 11.2 ± 0.8 • **Group 3:** 1,000 mg Ca daily from Cheese: 11.2 ± 0.8 • **Group 4:** Calcium placebo + vitamin D placebo: 11.3 ± 0.7 **Inclusion Criteria:** • No history of: ○ Serious medical conditions ○ Medication known to affect bone metabolism ○ Sexual development at Tanner stage I to II as determined by a public health nurse ○ Age: 10-12 years ○ Dietary calcium intake less than the Finnish national recommendation of 900 mg/d. **Exclusion Criteria:** • Not referenced by the authors. • **Power Analysis:** Author reported study was designed with adequate power but the number was not given. Power based on primary outcome of Bone Mineral Content (BMC).
Interventions	• **Group 1:** 1,000 mg calcium carbonate + 200 IU (5 µg) vitamin D daily • **Group 2:** 1,000 mg calcium carbonate daily + vitamin D placebo • **Group 3:** 1,000 mg calcium daily from cheese • **Group 4:** Calcium placebo + vitamin D placebo
Outcomes	**Primary outcome(s):** • Bone Mineral Content (BMC) • Bone indexes of the hip, spine, and whole body by dual-energy X-ray absorptiometry • Bone indexes of the radius and tibia by peripheral quantitative computed tomography **Secondary outcome(s)** • Calcitropic hormones • Leptin • Bone resorption and formation markers • Calcium excretion **Safety outcome(s):** None
Notes	**Results**

	• No overall significant difference (group x time interaction) were found in iPTH, leptin, or markers of bone turnover between the groups.
	• "No significant interactions of group by time in changes in body weight, height, fat mass (FM), lean tissue mass (LTM), bone area, BMC, or areal bone mineral density (aBMD) of the whole body were found. Similar results were observed for the femoral neck, total femur, and L2-L4 as measured by dual-energy x-ray absorptiometry scan."
	• **Growth and intervention**
	  ○ All groups had a similar growth in bone mass and body composition.
	  ○ Before menarche, the growth velocities (rate of change with time) peaked at 16.7 month (11.5 y old) for height, at 9.1 month (12.1 y old) for body weight, at 13.5month (11.8 y old) for LTM, and at 17.7 month(11.4 y old) for FM.
	  ○ The magnitudes of peak growth velocities were 0.6 cm/month for height, 0.5 kg/month for weight, 0.2 kg/month for LTM, and 0.1 kg/month for FM.

Bias	Scholar's Judgment	Support for judgment
Random sequence generation (selection bias)	Low Risk	"Assignments were then generated by a computer program in blocks of randomly varying size."
Allocation concealment (selection bias)	Low Risk	"Study group assignments were placed in double-sealed envelopes and recorded in a log."
Blinding of participants and personnel (performance bias)	Unclear Risk	"...(the dairy group was blinded only to the researchers because a nurse gave the girls the supplies),..." "The investigators were unblinded at the conclusion of the trial."
Blinding of outcome assessment (detection bias)	Unclear Risk	"The investigators were unblinded at the conclusion of the trial."
Incomplete outcome data (attrition bias)	Low Risk	Attrition of participants explained in detail and an intention-to-treat analysis was performed
Selective reporting (reporting bias)	Low Risk	Study protocol is not available but it is clear that the published reports include all expected outcomes
Other bias	Unclear Risk	

Du 2004

Methods	Randomized control trial
Participants	**Setting:** Beijing, China; 9 primary schools **Randomized into study:** *N = 757* • **Group 1:** Milk + calcium, *n = 238* • **Group 2:** Milk + calcium + vitamin D, *n = 260* • **Group 3:** Control - no supplemental milk, *n = 259* **Completed Study:** *N= 698* • **Group 1:** Milk + calcium, *n = 209*

	• **Group 2:** Milk + calcium + vitamin D, *n = 242* • **Group 3:** Control - no supplemental milk, *n = 240* **Gender, males:** No males - study was all female (girls) **Age, years (mean) (SD):** • **Group 1:** mean = 10.1 (0.4) • **Group 2:** mean = 10.1 (0.3) • **Group 3**: mean = 10.0 (0.3) **Inclusion Criteria:** • girls, age 10, from 9 primary schools • girls were assessed to be free of any disease that might affect bone development **Exclusion Criteria:** Not discussed in article **Power Analysis:** No mention of a power analysis being done
Interventions	• **Group 1:** 330ml of ultra-heat-treated (UHT) milk, fortified with 560 mg of Ca; consumed by subject every school day for 24 months • **Group 2:** 330ml of UHT milk fortified with Ca plus 5 or 8 µg cholecalciferol, consumed by subject every school day for 24 months • **Group 3:** received no supplementary milk and consumed their habitual diets over the 24-month study period. • Subjects received milk supplements in the morning, either before lessons began or at the first break • Consumption of milk was supervised by the teacher in charge • Compliance records were kept by the student in charge of the trail in each class, and checked regularly by the project staff • Measurements were made at the start of the trial (baseline), mid-trial (after 12 months), and at the end of the trial (after 24 months) • Dietary and physical activity data were also collected at two additional times during summer months to assess for any seasonal variations • Baseline dietary intake occurred at the start of the study using a 7 day recall technique; a 3 day recall procedure was used at 12 months, 24 months, and during 2 summer data collection points
Outcomes	**Primary outcome(s):** • Dietary assessment • Physical activity • Bone mass and body composition - bone mineral content (BMC), bone area (BA), bone mineral density (BMD) • Biochemistry measures - plasma 25(OH)D concentration to detect vitamin D deficiency, serum intact parathyroid hormone (PTH), total Ca concentration in plasma and urine, urinary creatinine • Height and sitting height • Weight
Notes	**Results:** • Subject receiving the milk supplement consumed on average between 54 and 59% more Ca per day than those in the control group.

	• There was an increase in height, sitting height and body weight after 2 years in the girls in the two supplemented groups were significantly greater compared with the girls in the control group 3.

Bias	Scholar's Judgment	Support for judgment
Random sequence generation (selection bias)	Unclear Risk	Although the randomization was not identified, the nine schools involved in the study were randomly assigned to one of the three study groups
Allocation concealment (selection bias)	Unclear Risk	Not enough information provided; although milk was distributed by a healthcare worker at the schools
Blinding of participants and personnel (performance bias)	Low Risk	Milk was packaged in color-coded cartons but the identity of the supplement was unknown to both subjects and investigators
Blinding of outcome assessment (detection bias)	Low Risk	Lab analyses were completed in Australia, in random sample order and without the knowledge of the intervention group from which they came
Incomplete outcome data (attrition bias)	High Risk	Measurements of some outcomes were not taken on every subject
Selective reporting (reporting bias)	High Risk	All identified outcomes were reported on; however: • Some measurements (total body measurements) were made on a sample of only half the subjects, selected randomly. • Extreme values of the data sets were removed according to a defined set of criteria (not identified in the article).
Other bias	Unclear Risk	

Gibbons 2004

Methods	Randomized controlled trial
Participants	**Setting:** New Zealand, 3 primary schools **Randomized into study:** *N* = 159 • **Group 1:** High Calcium Dairy drink (HCDD) *n* = 77 • **Group 2:** Control drink *n* = 82 **Completed Study:** *N* = 123 • **Group 1:** HCDD *n* = 58 • **Group 2:** Control drink *n* = 65 **Gender, males:** *n* = 105 (49%) • **Group 1:** *n* = 36 • **Group 2:** Control drink: *n* = 39 **Age, years (mean):** • **Group 1:** 9.4 years • **Group 2:** 9.4 years **Inclusion Criteria:**

	• Children aged 8-10 years of age **Exclusion Criteria:** • Allergy to dairy products • Major disease, including significant psychological problems • Children taking any medication that influenced bone growth or metabolism (steroids, anticonvulsants, thiazide diuretics or vitamin D) **Power Analysis:** Power calculations indicated the 75 subjects per group were necessary to provide sufficient power to the study.
Interventions	**All participants:** • Met with research nurses at research center at baseline and then every 6 months for the first 18 months while having supplement (6, 12, 18); then at 12 months after supplementation was finished (30 month). • Bone mineral density (BMD), bone mineral content (BMC) and bone size were measured at each visit. • Each child completed a calcium food frequency questionnaire to determine dietary calcium intake at each visit. • Medical questionnaires were completed at baseline and at 30 month visit to check medication use, medical history, previous fractures, family history and caffeine intake. • Female participants were asked about menarche history. • Pubertal stage was assessed by as self-administered Tanner questionnaire at baseline, 18 and 30 months. • Each child was asked to drink two sachets of the product mixed in hot or cold water per day, morning, and afternoon. The children were asked to complete a tick sheet after they consumed the drink and return it to the study coordinator each month to measure compliance.
Outcomes	**Primary outcome:** • Bone density • Bone growth • Bone size. **Secondary outcomes:** • Height • Weight • Lean Mass • Fat Mass

Notes	**Summary of results:**
	• The study did not find significant changes in the height and weight of participants, mean values of both groups and genders remaining between the 50th and 75th percentiles for the measurements.
	• There was no difference between groups after 30 months
	  • Body weight p = .548
	  • Lean mass p = .823
	  • Fat mass p = .531

Bias	Scholar's Judgment	Support for judgment

Random sequence generation (selection bias)	High Risk	Children were randomized using heel ultrasound values at baseline for stratification
Allocation concealment (selection bias)	Low Risk	The product was delivered to the children fortnightly at school or monthly for 18 months to participants home
Blinding of participants and personnel (performance bias)	Unclear Risk	The children were blinded to the study product as the both looked and tasted the same. Article did not state who prepared the product for delivery or who delivered the product
Blinding of outcome assessment (detection bias)	Low Risk	Article states that assessors were blinded to which group participants were in when taking all measurements
Incomplete outcome data (attrition bias)	High Risk	High dropout rate -- 54%
Selective reporting (reporting bias)	Low Risk	Reported on primary outcomes outlined in aim of study statement
Other bias	Unclear Risk	

Kelishadi 2009

Methods	Randomized controlled trial
Participants	**Setting:** Children identified as obese and referred to the Obesity Research Clinic, Preventative Pediatric Cardiology Department, Isfaha Cardiovascular Research Center in Isfahan, Iran between October 2003 to October 2006. **Randomized into study:** *N* **=** 120 subjects • Dairy Rich (DR): *n* = 40 • Calorie Restricted: *n* = 40 • No Recommendations: *n* = 40 **Completed Study:** • Dairy Rich: *n* = 36 • Calorie Restricted: *n* = 31 • No Recommendations: *n* = 32 **Gender, males:** Not disclosed by the authors. **Age, years (mean):** • Dairy Rich: 5.4 ± 0.2 • Calorie Restricted: 5.5 ± 0.7 • No Recommendations: 5.7 ± 0.3 **Inclusion Criteria**: • "...body mass index (BMI) ≥ age and sex-specific 95th percentile, according to the revised Centers for Disease Control and Prevention (CDC) growth charts" • "...being in the prepubertal stage (Tanner stage 1)." **Exclusion Criteria**: • Pubertal stage ≥ SMR 1

	• Syndromal obesity • Endocrine disorders • Presence of any physical disability • History of chronic medication use **Power Analysis**: Sample size of 90 (30 per group) to reach power of 95%
Interventions	**All participant:** • Attended six consecutive monthly family-centered education sessions about healthy lifestyle (healthy nutrition and increasing physical activity) that were conducted by a pediatrician and a nutritionist **Dairy Rich**: • Dairy-rich diet (800 mg ca/d), with no change in energy or macronutrient intake, was recommended to the children of this group (DR: dairy-rich diet group) • Children were advised to obtain most of their calcium from low-fat and regular milk, cheese, and yogurt, as well as liquid and solid curd **Calorie Restricted**: • Caloric restriction regimen with an energy content restricted to the calorie requirement for height **No Recommendations**: • No dietary recommendation other than what was discussed in the healthy lifestyle education sessions
Outcomes	**Primary Outcome(s)**: Body mass index standard deviation score (BMI SDS) **Secondary Outcome(s)**: Waist Circumference, Triglycerides, HDL-C, Insulin, and HOMA-R **Safety Outcome(s)**: None identified
Notes	• In all groups, body mass index-standard deviation score (BMI-SDS) and waist circumference decreased significantly after the 6-month trial, but had a sustained significant rise during the follow-up period to the end of the study • Authors did not include gender of participants.

Bias	Scholar's Judgment	Support for judgment
Random sequence generation (selection bias)	Low Risk	"Research assistants working with the project conducted random allocation by computer generated random numbers, using the children's record numbers in our clinic."
Allocation concealment (selection bias)	Unclear Risk	Not reported by author
Blinding of participants and personnel (performance bias)	High Risk	Participants were educated and met with team on different days. Blinding of personnel evaluating patients in follow-up visits was not explained
Blinding of outcome assessment (detection bias)	Low Risk	In order to conceal allocation to the study group assignments, all follow-up procedures were conducted by a physician and a research assistant who were not included in the intervention team. These outcome assessors and data analysts were unaware of group allocation
Incomplete outcome data (attrition bias)	Low Risk	Authors explain why patients dropped out of the study over time in a figure

Selective reporting (reporting bias)	Low Risk	Study protocol is not available but it is clear that the published reports include all expected outcomes, including those that were pre-specified.
Other bias	Unclear Risk	

Lappe 2004

Methods	Randomized clinical trial
Participants	**Setting:** Creighton University at Omaha metropolitan city. Study duration is 2 years. Year is unknown. **Study participants**: (Girls) were recruited through Girl Scout Council. **Randomized into study:** *N* = 63 • **Group 1:** Calcium Rich diet *n = 31* • **Group 2:** Regular Diet *n = 32* **Completed Study: *N=59*** • **Group 1:** Calcium Rich *n =27 (Total 4 excluded, 2 moved out, 2 lost to follow up)* • **Group 2:** Regular Diet *n =32* **Gender, all female participants:** **Age, years (mean) (SD):** • **Group 1,** Calcium Rich diet: 9.5 ± 0.4 • **Group 2,** Control Group: 9.5 ± 0.3 **Inclusion Criteria:** • Must be girls • Age 9 years old **Exclusion Criteria:** • Lactose intolerance • Milk allergy • Corticosteroid or anticonvulsant therapy • Familial hypercholesterolemia • Mental or physical handicaps • Cancer • Rheumatoid arthritis, asthma, or any other significant health problem reported by the parents • Usual dietary intake of more than 1,100 mg of calcium per day • Body mass index (BMI) in the 85th percentile or more for age and sex (BMI20) • Participated in organized team sports three or more times per week **Power Analysis:** not done
Interventions	**Both groups:** • Calcium intake, as well as other nutrient intake, was assessed using 3-day (Sunday-Tuesday) diet diaries. Assessment of usual dietary intake, height, weight, Tanner stage, physical activity, and medical and social history was made on all participants at baseline and every 3 months

	Group 1: High Calcium diet, n = 27 • Participants in this group received at least 1,500 mg of calcium per day mainly through calcium-fortified foods 2 years. • In addition to the 3-day diet diary, the girls in the calcium-rich group were asked to complete a daily checklist to assure they consumed at least 1,500 mg calcium per day. These checklists were submitted at each quarterly visit **Group 2:** Control group: *n* = 32 • Continued with regular diet. • They received copy of the National Dairy Council publication, Guide to Good Eating, and briefly discussed the importance of overall good nutrition.
Outcomes	**Primary outcome(s):** • Weight • BMI • Lean body mass • Fat Mass
Notes	• Although the participants in the treatment group consumed nearly twice as much dietary calcium primarily from dairy foods they did not have greater increases in body weight, body mass index, or fat or lean mass than the control group. • Too much dependence on self-reported diaries with parents help. • G**i**rls who consumed the calcium-rich diet also significantly increased their intake of 8/14 essential nutrients.

Bias	Scholar's Judgment	Support for judgment
Random sequence generation (selection bias)	Unclear Risk	How participants were randomized was not discussed
Allocation concealment (selection bias)	Unclear Risk	Insufficient information. Unable to judge high or low
Blinding of participants and personnel (performance bias)	High Risk	No blinding could have influenced participant's behavior
Blinding of outcome assessment (detection bias)	Unclear Risk	Insufficient information. Unable to judge high or low
Incomplete outcome data (attrition bias)	High Risk	Study used per protocol analysis
Selective reporting (reporting bias)	Low Risk	Data includes all possible outcomes
Other bias	High Risk	Depends on self-reported diaries. No control over food intake except by reviewing diary and super-market purchase. 57/59 were non-Hispanic white. Study may not be applicable to other race since food habits differs from one to another

Lappe 2017

Methods	Randomized control trial
Participants	**Setting:** Single site - Osteoporosis Research Center, Creighton University, Omaha, NE from May 2008-Sept 2013 **Randomized into Study:** *N* = 274 • **Group 1:** Dairy; *n* = 136 • **Group 2:** Control; *n* = 138 **Completed Study:** *N* = 274 • **Group 1:** *n* = 136 • **Group 2:** *n* = 138 **Gender:** all female **Mean age, years:** • **Group 1:** 13.5 • **Group 2:** 13.5 **Inclusion criteria:** • Healthy girls aged 13 or 14 and > 1.5 years post menarche • Habitual dietary calcium intake ≤ 600 mg/d • Willingness to increase dietary calcium intake for 1 year • BMI >50th and <98th percentiles for age and sex **Exclusion criteria:** • Menarche before age 10 y • History of lactose intolerance or milk allergy • Dieting behavior with weight loss >4.5 kg in the last 3 months • Weight >136 kg or metal in the skeleton (pins, rods) because of dual energy X-ray absorptiometry (DXA) limitations • Current pregnancy • Chronic disease or disorder such diabetes, polycystic ovarian syndrome, thyroid disease, eating disorder, seizures, or cancer • Steroids, contraceptives, antidepressants, Accutane, high dose Vitamin A, or weight-reducing or seizure medications • A total body bone mineral content (BMC) z score <-2.0 measured by DXA • individual's or a sibling's participation in a dietary study in the last 5 y **Power:** This study was designed to detect a 2.8% between-group difference in percentage of body fat measured at 1 y and assumed a 4% SD with 90% power, a 5% type I error rate, and a 2-factor fixed effects ANOVA with covariate adjustment for baseline percentage of body fat correlating with outcome at an *r* value of 0.50; based on these assumptions a sample size of 228 participants was needed with 38 participants in each arm of the striated BMI population groups.
Interventions	• **Group 1:** Asked to consume low-fat milk (skim, 1% or 2%) or low-fat or yogurt servings providing ≥1,200 mg calcium/day • **Group 2:** Asked to continue on their usual diet of ≤ 600 mg Ca/day

	Dietary compliance assessed by multiple-pass 3-d dietary recall using Nutrition Data System for Research software. Study nurses received training from University of Minnesota and obtained certification to use the data system for research.
Outcomes	Primary Outcome: • Change in percentage of body fat at 0, 6, and 12 months Secondary Outcomes: • Change in BMI percentile and weight at 0, 6, and 12 months Exploratory Outcomes: • Trunk fat mass, percentage trunk fat, lean mass • Waist circumference, hip circumference, abdominal girth
Notes	• There were more Caucasians (*n = 223*) versus other races African American (*n = 32*) and Other (*n = 19*) • Hip circumference was 1.7 cm greater in the dairy group at baseline • The dairy group completed daily recording of dairy intake whereas the control group did nothing comparable, which may create a bias in that the dairy group focused more on their intake • Baseline diet and physical activity levels were similar between groups

Bias	Scholar's Judgment	Support for judgment
Random sequence generation (selection bias)	Low Risk	The study statistician used a computer-generated scheme to randomly assign eligible girls
Allocation concealment (selection bias)	Low Risk	See above
Blinding of participants and personnel (performance bias)	High Risk	blinding was not possible in this study and may have contributed to performance bias
Blinding of outcome assessment (detection bias)	Low Risk	assessors were not blinded to treatment group but measurements were objective and unlikely to be affected by lack of blinding
Incomplete outcome data (attrition bias)	Low Risk	intent-to-treat completed as planned with multiple imputation with fully conditional specification and predictive mean-matching method used to analyze missing data (5 subjects)
Selective reporting (reporting bias)	Low Risk	outcomes reported as expected
Other bias	High Risk	see notes

Lau 2004

Methods	Randomized control trial
Participants	**Setting:** 9-10 year old girls in 3 schools located in Shatin (a region of Hong Kong) **Randomized into study:** *N* = 344 (group assignment data not provided) • **Group 1:** Control

	• **Group 2:** 40 g calcium powder • **Group 3:** 80 g calcium powder **Completed Study:** *N* = 324 (20 dropped out before their first follow-up visit) • **Group 1:** *n* = 122 • **Group 2:** *n* = 100 • **Group 3:** *n* = 102 **Gender, males:** • All girls school **Age, years** (mean) (SD): • **Group 1:** 10 years (SD = 0.3) • **Group 2:** 10 years (SD = 0.3) • **Group 3:** 10 year (SD = 0.3) **Inclusion Criteria:** • Aged 9-10 years old **Exclusion Criteria:** • History of metabolic bone disease • Major medical disorders or allergy to milk • Receiving steroid hormones, heparin, thyroxine, or anticonvulsants • Already on calcium supplements • Suffering from any genetic disorders • Weight and height were below the 3rd percentile or above the 97th percentile for Hong Kong children **Power Analysis:** Authors did not provide a power analysis
Interventions	• **Group 1: C**ontrol, usual diet with no placebos • **Group 2:** 40 grams of milk powder (1 sachet, 40 grams per sachet) containing 200 kcals, 5 grams protein, 20.3 grams carb, 11.2 grams fat, 1.3 ug vitamin D, 650 mg calcium, 420 mg phosphorus, and 48 mg magnesium. The 40 grams was dissolved in 250 ml water and served at school. • **Group 3:** 80 grams of milk powder (2 sachets, 40 grams per sachet) containing 400 kcals, 10 grams protein, 40.6 grams carb, 22.4 grams fat, 2.6 ug vitamin D, 1,300 mg calcium, 840 mg phosphorus, and 96 mg magnesium. One of the 40 gram sachet was dissolved in 250 ml water and served at school and the other 40 gram packet was sent home to be mixed and consumed at home in the evening. • Groups 2 and 3 received sachets, prior to holidays, for ingestion at home.
Outcomes	**Primary outcome(s):** • Effects of milk powder supplementation in enhancing bone accretion **Secondary outcome(s)** • Energy, macronutrient, micronutrient intake • Sports activity • Height, weight, fat mass, lean body mass **Safety outcome(s):** none listed

Notes	• 344 students were randomized to one of three groups, 20 dropped out before the first follow up visit therefore 324 were analyzed (the researchers are calling this an intent to treat even though 344 were initially randomized) • In the results section, per-protocol analysis was conducted on 285 children with complete follow up • No significant differences in weight, height, lean body mass, and fat mass when comparing all 3 groups • Compliance rate was higher with group 2 (40 g at school) versus group 3 (40 g at school and extra 40 g at home)

Bias	Scholar's Judgment	Support for judgment
Random sequence generation (selection bias)	Unclear Risk	The author's state the subjects were randomized, however insufficient information about the sequence generation process to permit judgment
Allocation concealment (selection bias)	Unclear Risk	Insufficient information about allocation concealment to permit judgment
Blinding of participants and personnel (performance bias)	High Risk	Neither participants nor personnel were blinded, both knew which group they were in based on if and how much milk powder was provided/drank, no placebo was provided
Blinding of outcome assessment (detection bias)	Unclear Risk	Insufficient information about outcome assessment to permit judgment
Incomplete outcome data (attrition bias)	High Risk	Twenty students dropped out before the first follow up appointment and were not included in the analysis
Selective reporting (reporting bias)	Low Risk	Primary outcome is reported
Other bias	Unclear Risk	

Merrilees 2000

Methods	Randomized controlled trial
Participants	**Setting:** Girls aged 15-16 at Christchurch Girls High School in New Zealand over a two-year period **Randomized into study:** *N* = 105 • Group 1 (control): *n* = not reported • Group 2 (supplemented): *n* = not reported **Completed study:** *n* = 91 (2-year supplementation phase); *n* = 73 (follow-up at year 3) • Group 1 (control): *n* = not reported • Group 2 (supplemented): *n* = not reported **Gender, males:** *n* = 0 **Age, years:** 15-16 years (no mean or median reported) **Inclusion criteria:** girls aged 15-16 with no exclusions (see exclusion criteria below) **Exclusion criteria:** • Thyroid disorders • Renal impairment

	• Hepatic dysfunction • Pregnancy • Oligomenorrhoea • Amenorrhoea • Current systemic illness • Eating disorder • Anorexia • Use of glucocorticoids, anticonvulsant agents or thiazide diuretics **Power analysis:** not reported

Interventions	• **Group 1:** Control
	• **Group 2:** Supplemented group received at least 1,000 mg/day of dairy products
	  ○ Dairy food products included milk, flavored milk, dairy dessert, cheese, or yogurt; low-fat options were available
	  ○ Subjects selected dairy products under the guidance of a dietician
	  ○ Dairy products were delivered to participants every 2 week

Outcomes	**Assessments:**
	• Both groups were assessed every 6 months with:
	  ○ Validated Dietary intake 3 day food record and a calcium food frequency questionnaire
	  ○ Compliance questionnaire to determine how many dairy products were consumed
	• Bone density, serum lipid and calcium levels and urine studies (hydroxyproline, creatinine, urine calcium and sodium excretion were measured at T0 and at 12, 18, 24 and 36 months

Notes	Change in body weight, body fat, and lean muscle as measured by dual-energy x-ray absorptiometry (DPX-L) total body scan:
	Weight (kg) (SEM):
	• Control
	  ○ Baseline: 58.7 (1.1)
	  ○ 2 years: 62.7 (1.0)
	  ○ Follow-up: 62.4 (0.2)
	• Supplemented
	  ○ Baseline: 55.8 (0.9)
	  ○ 2 years: 60.4 (1.1)
	  ○ Follow-up: 61.8 (2.8)
	Body Fat (g) (SEM):
	• Control
	  ○ Baseline: 16,764 (814)
	  ○ 2 years: 19,320 (722)
	  ○ Follow-up: 19,987 (824)
	• Supplemented
	  ○ Baseline: 14,748 (656)

	○ 2 years: 17,364 (706) ○ Follow-up: 18,066 (668) Lean Muscle (g) (SEM): • Control ○ Baseline: 38,533 (559) ○ 2 years: 38,654 (503) ○ Follow-up: 38,689 (573) • Supplemented ○ Baseline: 37,688 (622) ○ 2 years: 38,408 (714) ○ Follow-up: 38,443 (733) Limitations: • small sample size • single site • all female

Bias	Scholar's Judgment	Support for judgment
Random sequence generation (selection bias)	Unclear Risk	Insufficient information about the sequence generation process to permit risk judgment
Allocation concealment (selection bias)	Unclear Risk	Insufficient information about the concealment of allocation to permit risk judgment
Blinding of participants and personnel (performance bias)	High Risk	blinding not reported, participants in the control group may have been biased to consume more calcium
Blinding of outcome assessment (detection bias)	Low Risk	blinding of outcome assessors was not reported; however measurements were objective and would not be impacted
Incomplete outcome data (attrition bias)	High Risk	outcomes reported per protocol; 14 participants (10 in the supplemental group and 4 in the control group were lost to follow-up)
Selective reporting (reporting bias)	Low Risk	Pre-specified outcomes reported as expected
Other bias	Unclear Risk	methods poorly described, no funding reported, difficult to identify other sources of bias

St-Onge 2009

Methods	Randomized control trial

Participants	**Setting:** University of Alabama at Birmingham. Pittman General Clinical Research Center **Randomized into study:** *N* = 55 • 10 children dropped out, did not disclose from which group **Completed Study:** *N* = 45 • **Group 1:**High-milk diet *n* = 21 • **Group 2** Low-milk diet *n* = 24 **Gender, males:** • **Group 1:**High-milk diet *n* = 4 • **Group 2** Low-milk diet *n* = 5 **Age, years (mean):** • **Group 1:**High-milk diet, 9.2 • **Group 2** Low-milk diet, 9.6 **Inclusion Criteria:** • required to be low-milk and calcium consumers (≤1 serving of milk/d and <600 mg/d of calcium) • above 95th percentile for BMI for age • BMI fell within the 85th–95th percentile range only if they had a parent with type 2 diabetes or the child had fasting serum insulin concentrations ≥173.6 mol/L. • Waist circumference above the 95th percentile for age **Exclusion Criteria:** • Did not disclose • **Power Analysis:** Did not disclose

Interventions	• Baseline visit included dietary counseling, body composition assessment (height, weight, % body fat waist and hip circumferences, magnetic resonance imaging [MRI]), blood pressure measurement, and oral glucose tolerance test (OGTT)
	  ○ Nutrition counseling provided at week 1, 2, 4, 6, 8, and 12.
	  ▪ Asked if any study beverages were missed, if energy beverages were consumed, and if they were following the guidelines of 1 treat/d or 7/week
	  ▪ 24-h food recall format used to assess compliance with and knowledge of diet
	  ○ Fasting blood samples were also obtained at weeks 4, 8, and 12 and all baseline measurements were obtained at endpoint (week 16)
	• Healthy eating guidelines were given: eating 3 meals/d, eating slowly, portioning food out of large containers, using sugar-free and low-fat products, and making a goal to exercise 30-45min, 5 times/week
	
	Group 1:
	• High-milk diet (708 mL skim milk/day and 236mL 1% low fat chocolate milk/d)
	• Counseled to consume 3 x 236 mL of skim milk and one 236 mL of 1% low fat chocolate milk/d
	Group 2
	• Low-milk diet (600 mL sugar-sweetened beverage/day, 944 mL skim milk/week, and 1180 1% low fat chocolate milk/week)

	• Counseled to consume 3 X 200 mL of sugar-sweetened beverage/d, 4 X 236 mL of skim milk/week, and 5 X 236 mL of 1% low fat chocolate milk/week
Outcomes	**Primary outcome(s):** • greater weight loss **Secondary outcome(s)** • improvements in metabolic risk factors
Notes	Instructed to only drink non-energy beverages in addition to the study provided beverages provided. **Results**: • Children in both the high- and low-milk groups increased in weight and height (effect of time, both $P < .0001$) while tending to reduce BMI (effect of time, $P = .057$). Time and the time X beverage interaction did not affect waist circumference, % body fat, and BMI. • The beverage tested and the beverage 3 time interaction did not affect any of the metabolic variables measured in fasting children (blood pressure, serum lipids, glucose, and insulin) • There was a beverage X time interaction on insulin AUC, as assessed with an OGTT ($P = .044$). • High-milk consumption leads to lower insulin AUC than low-milk consumption. Beverage, time, and beverage X time interaction did not affect glucose AUC.

Bias	Scholar's judgment	Support for judgment
Random sequence generation (selection bias)	Unclear Risk	Did not disclose method of randomization
Allocation concealment (selection bias)	High Risk	During the baseline visit, the dietitian informed the child and parent to which beverage group the child was randomized
Blinding of participants and personnel (performance bias)	High Risk	Participants were aware of the group they were in
Blinding of outcome assessment (detection bias)	Unclear Risk	The study did address this outcome. They stated the same analyst analyzed pre- and post study scans, but did not disclose whether they were blinded.
Incomplete outcome data (attrition bias)	High Risk	Outcome data was based off of who completed the study. 10 children dropped out during the study.
Selective reporting (reporting bias)	Low Risk	All outcomes were reported
Other bias	Unclear Risk	The study appears to be free of other sources of bias

Volek 2003

Methods	Randomized control trial
Participants	**Setting:** Weight training facility in the U.S. **Randomized into study:** *N = 28*

	• **Group 1:** *n = 14* • **Group 2:** *n = 14* **Completed Study:** *N = 28* • **Group 1:** *n = 14* • **Group 2:** *n = 14* **Age, years** (mean) (SD): • **Group 1:** 14.7 +/- 1.7 • **Group 2:** 14.0 +/- 0.7 **Inclusion Criteria:** • Males • Age 13 to 17 years old • Enrolled in a resistance exercise program consisting of supervised 1-hour exercise sessions 3 days per week for 12 week **Exclusion Criteria:** • Subjects who consumed 3 servings (≥ 236mL) of fluid milk per day • Subjects who consumed ≥ 1500mg calcium/day • Extreme dietary practices • History of lactose intolerance • Goals of weight loss or weight gain • Use of nutritional supplements • Smoking
Interventions	• Group 1: Consume 3 servings (708mL or 24oz) of 1 % fluid milk per day • Group 2: Consume 3 servings (708mL or 24oz) of unfortified apple juice alternated with grape juice
Outcomes	Primary outcome: • examine the effects of increasing milk consumption on bone health (bone mineral and bone mineral densities) in response to resistance training in adolescent boys Secondary outcomes: • Body mass at week 12 • Lean body mass • Fat body mass

Bias	Scholar's judgment	Support for judgment
Random sequence generation (selection bias)	Unclear Risk	Insufficient information provided by authors to judge random sequence generation
Allocation concealment (selection bias)	Unclear Risk	Insufficient information provided by authors to judge allocation concealment

Blinding of participants and personnel (performance bias)	Unclear Risk	Blinding not reported, participants in the control group may have been biased to consume more calcium
Blinding of outcome assessment (detection bias)	Low Risk	Blinding of outcome assessors was not reported; however measurements were objective and would not be impacted
Incomplete outcome data (attrition bias)	High Risk	Outcomes reported per protocol
Selective reporting (reporting bias)	Low Risk	Pre-specified outcomes reported as expected
Other bias	Unclear Risk	

Weaver 2011

Methods	Randomized control trial, double-blind, cross-over
Participants	**Setting:** Purdue University residence hall and run as a summer camp with two 3-weeks duration in 2011. **Randomized into study:** *N* = 42 • **Group 1:** Dairy intervention, *n* = 22 • **Group 2:** *n* = Calcium intervention, *n* = 20 **Completed Study**: N=38, 2 boys and 2 girls dropped out after first session (Dairy intervention, *n* = 21, calcium intervention, *n* = 17) • **Group 1:** *n* **=** Dairy Control, *n* = 10-11 • **Group 2:** *n* **=** Dairy intake, *n* = 10-11 • **Group 3:** *n* **=** Calcium control, *n* = 8-9 • **Group 4:** *n* **=** Calcium intake, *n* = 8-9 **Gender, males:** • **Group 1:** *n* **=** Dairy intervention, *n* = 10 (45%) • **Group 2:** *n* **=** Calcium intervention, *n* = 7, (35%) **Age, years (mean) (SD):** • **Group 1:** Dairy intervention, Girls (13.3 ±0.7), Boys (13.7 ±0.6) • **Group 2:** Calcium intervention, Girls (13.5 ±0.9), Boys (13.8 ±0.8) **Inclusion Criteria:** • Overweight (85th-100th percentile of BMI-for-age) • otherwise healthy girls aged 12-14 and boys aged 13-15 years **Exclusion Criteria:** • History of diabetes mellitus • Digestive malabsorption disorders, • Bone, liver or kidney disease

	Power Analysis: A priori power calculations for a ≥80.0% power determined a final sample size of 15 subjects in each of the crossover groups for the 2 dietary calcium sources. Study had a >80.0% power to detect changes with an calcium intake of 0.57 g/d for fecal fat excretion, 0.045 g/min for lipid oxidation and 0.06 kcal/min for PPEE, or <1 SD
Interventions	• **Group 1:** Control, Dairy calcium, 650 calcium/day • **Group 2:** Dairy calcium, additional 650 calcium/day (total 1300 calcium/day) • **Group 3:** Control calcium, 650 calcium/day • **Group 4:** Calcium, additional 650 calcium/day (total 1300 calcium/day))
Outcomes	**Primary outcome(s):** • Weight loss (Kg)
Notes	• All girls were overweight (>95th percentile). • 4 boys were at risk of being overweight (BMI 85th-95th percentile and 2 boys had a healthy body weight. • Weight Loss was not significantly different between the groups (*P* = .60)

Bias	Scholar's judgment	Support for judgment
Random sequence generation (selection bias)	Low Risk	Not described. But they maintained a very strict and similar baseline characteristics for all participants
Allocation concealment (selection bias)	Unclear Risk	Not described
Blinding of participants and personnel (performance bias)	High Risk	No blinding could have influenced participant's behavior
Blinding of outcome assessment (detection bias)	Low Risk	Not described but all outcome were assessed through laboratory testing and less likely to be influenced by study personnel
Incomplete outcome data (attrition bias)	Low Risk	Study reached power
Selective reporting (reporting bias)	Low Risk	All outcomes reported
Other bias	Unclear Risk	None

References marked with an asterisk indicate studies included the meta-analysis

*Albala, C., Ebbeling, C. B., Cifuentes, M., Lera, L., Bustos, N., & Ludwig, D. S. (2008). Effects of replacing the habitual consumption of sugar-sweetened beverages with milk in Chilean children–. *The American journal of clinical nutrition, 88*(3), 605-611.

Alonso, A., Zozaya, C., Vázquez, Z., Alfredo Martinez, J., & Martínez-González, M. (2009). The effect of low-fat versus whole-fat dairy product intake on blood pressure and weight in young normotensive adults. *Journal of Human Nutrition and Dietetics, 22*(4), 336-342.

Barlow, S. E. (2007). Expert committee and treatment of child and adolescent overweight and obesity: expert committee recommendations regarding the prevention. *Pediatrics, 120*(Suppl 4), S164-192.

*Cadogan, J., Eastell, R., Jones, N., & Barker, M. E. (1997). Milk intake and bone mineral acquisition in adolescent girls: randomised, controlled intervention trial. *Bmj, 315*(7118), 1255-1260.

*Chan, G. M., Hoffman, K., & McMurry, M. (1995). Effects of dairy products on bone and body composition in pubertal girls. *The Journal of pediatrics, 126*(4), 551-556.

*Cheng, S., Lyytikäinen, A., Kröger, H., Lamberg-Allardt, C., Alén, M., Koistinen, A., . . . Mahonen, A. (2005). Effects of calcium, dairy product, and vitamin D supplementation on bone mass accrual and body composition in 10–12-y-old girls: a 2-y randomized trial–. *The American journal of clinical nutrition, 82*(5), 1115-1126.

*Gibbons, M. J., Gilchrist, N. L., Frampton, C., Maguire, P., Reilly, P. H., March, R. L., & Wall, C. R. (2004). The effects of a high calcium dairy food on bone health in pre-pubertal children in New Zealand. *Asia Pacific journal of clinical nutrition, 13*(4).

*Kelishadi, R., Zemel, M. B., Hashemipour, M., Hosseini, M., Mohammadifard, N., & Poursafa, P. (2009). Can a dairy-rich diet be effective in long-term weight control of young children? *Journal of the American College of Nutrition, 28*(5), 601-610.

Klish, W. J. (2018). Definition; epidemiology; and etiology of obesity in children and adolescents. In A. G. Hoppin (Ed.), *UpToDate*. Retrieved November 1, 2018, from https://www.uptodate.com/contents/definition-epidemiology-and-etiology-of-obesity-in-children-and-adolescents?search=obesity%20in%20children&source=search_result&selectedTitle=1~150&usage_type=default&display_rank=1

*Kouvelioti, R., Josse, A. R., & Klentrou, P. (2017). Effects of Dairy Consumption on Body Composition and Bone Properties in Youth: A Systematic Review. *Current developments in nutrition, 1*(8), e001214.

Lappe, J. M., McMahon, D. J., Laughlin, A., Hanson, C., Desmangles, J. C., Begley, M., & Schwartz, M. (2017). The effect of increasing dairy calcium intake of adolescent girls on changes in body fat and weight. *The American journal of clinical nutrition, 105*(5), 1046-1053.

*Lappe, J. M., Rafferty, K. A., Davies, K. M., & Lypaczewski, G. (2004). Girls on a high-calcium diet gain weight at the same rate as girls on a normal diet: a pilot study. *Journal of the American Dietetic Association, 104*(9), 1361-1367.

*Lau, E., Lynn, H., Chan, Y., Lau, W., & Woo, J. (2004). Benefits of milk powder supplementation on bone accretion in Chinese children. *Osteoporosis international, 15*(8), 654-658.

*Matkovic, V., Fontana, D., Tominac, C., Goel, P., & Chesnut 3rd, C. (1990). Factors that influence peak bone mass formation: a study of calcium balance and the inheritance of bone mass in adolescent females. *The American journal of clinical nutrition, 52*(5), 878-888.

*Merrilees, M., Smart, E., Gilchrist, N., Frampton, C., Turner, J., Hooke, E., . . . Maguire, P. (2000). Effects of dairy food supplements on bone mineral density in teenage girls. *European journal of nutrition, 39*(6), 256-262.

*St-Onge, M.-P., Goree, L. L. T., & Gower, B. (2009). High-milk supplementation with healthy diet counseling does not affect weight loss but ameliorates insulin action compared with low-milk supplementation in overweight children. *The Journal of nutrition, 139*(5), 933-938.

*Volek, J. S., Gómez, A. L., Scheett, T. P., Sharman, M. J., French, D. N., Rubin, M. R., . . . Kraemer, W. J. (2003). Increasing fluid milk favorably affects bone mineral density responses to resistance training in adolescent boys. *Journal of the American Dietetic Association, 103*(10), 1353-1356.

*Weaver, C. M., Campbell, W. W., Teegarden, D., Craig, B. A., Martin, B. R., Singh, R., . . . Schoeller, D. A. (2011). Calcium, dairy products, and energy balance in overweight adolescents: a controlled trial–. *The American journal of clinical nutrition, 94*(5), 1163-1170.

*Xueqin, D., Zhu, K., Trube, A., Zhang, Q., Ma, G., Hu, X., . . . Greenfield, H. (2004). School-milk intervention trial enhances growth and bone mineral accretion in Chinese girls aged 10–12 years in Beijing. *British Journal of Nutrition, 92*(1), 159-168.