

ASSOCIATION OF CALCIUM DIETARY WITH BODY MASS INDEX AND BODY FAT : A SYSTEMATIC REVIEW

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ABSTRACT

Background: When consuming the necessary amounts of calcium, body mass index (BMI) rises with calcium retention.

Aims : This systematic review is to review the association of calcium diet with body mass index and body fat.

Methods: This study demonstrated compliance with all requirements by means of a comparison with the standards established by the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) 2020. Thus, the specialists were able to guarantee that the research was as current as feasible. Publications released between 2014 and 2024 were considered for this search strategy. This was accomplished by utilizing a number of distinct online reference sites, including Pubmed, ScienceDirect, and SagePub. It was determined that reviews, previously published works, and partially completed works would not be included.

Result: In the PubMed database, the results of our search brought up 1195 articles, whereas the results of our search on SAGEPUB brought up 14152 articles, our search on SCIENCE DIRECT brought up 21833 articles. The results of the search conducted for the last year of 2014 yielded a total 536 articles for PubMed, 5253 articles for SAGEPUB and 10269 articles for SCIENCE DIRECT. In the end, we compiled a total of 8 papers, 5 of which came from PubMed, 1 of which came from SAGEPUB and 2 of which came from SCIENCE DIRECT. We included eight research that met the criteria.

Conclusion: In summary, from eight studies showed that there is no significant changed of body mass index, neither the body fat after received the dietary of calcium.

Keyword: Calcium, body mass index, body fat

INTRODUCTION

One of the most significant global public health issues today is obesity, which is directly linked to the development of several chronic noncommunicable illnesses like cancer, heart disease, hypertension, and diabetes. Thus, several research from a variety of nations have focused on the prevention and treatment of obesity. Studies conducted both in vivo and in vitro have demonstrated the numerous biological impacts of calcium, an essential mineral component of human bodies, including potential roles in hormone production, glycogen metabolism, and adipocyte proliferation and differentiation.^{1,2}

The impact of macronutrients in controlling weight has received a lot of attention, but the significance of micronutrients has not received as much research. There is evidence to indicate a link between higher dietary calcium consumption and decreased body weight, notably decreased fat mass. Dietary calcium also appears to be connected to energy metabolism. In the Quebec Family Study, increased body weight and obesity have been linked to lower dietary calcium consumption. Additional epidemiological investigations, such as the Coronary Artery Risk Development in Young Adults (CARDIA) research and the Third National Health and Nutrition Examination Survey (NHANES III), have assessed this idea in more detail. According to some of this research, there may be gender variations in the relationship between body fat and calcium consumption.³

The relationship between calcium consumption and body weight was originally shown to be inverse more than 30 years ago by McCarron et al. Although no association has been found between calcium consumption and weight reduction, a number of cross-sectional epidemiological studies have demonstrated that calcium supplementation may promote weight loss that is mediated by boosting fecal fat excretion and body fat oxidation as well as enhancing insulin sensitivity.⁴

METHODS

Protocol

The author of this study ensured that it complied with the standards by adhering to Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) 2020 guidelines. This is done to guarantee the accuracy of the results that are derived from the investigation.

Criteria for Eligibility

In order to complete this literature evaluation, we looked at published research that discusses the association of calcium diet with body mass index and body fat. This is done to enhance the patient's therapy management and to offer an explanation. This paper's primary goal is to demonstrate the applicability of the issues that have been noted overall.

To be eligible to participate in the study, researchers had to meet the following requirements: 1) English must be used to write the paper. The manuscript must fulfill both of these conditions in order to be considered for publication. 2) A few of the examined studies were released after 2013 but prior to the time frame considered relevant by this systematic review. Editorials, submissions without a DOI, already published review articles, and entries that are nearly exact replicas of journal papers that have already been published are a few examples of research that are prohibited.

Search Strategy

We used "calcium", "body mass index" and "body fat" as keywords. The search for studies to be included in the systematic review was carried out using the PubMed and SAGEPUB databases by inputting the words: (("calcium"[MeSH Terms] OR "calcium"[All Fields] OR "calciums"[All Fields] OR "calcium s"[All Fields]) AND ("fat body"[MeSH Terms] OR "fat"[All Fields] AND "body"[All Fields]) OR "fat body"[All Fields] OR ("body"[All Fields] AND "fat"[All Fields]) OR "body fat"[All Fields] OR "adipose tissue"[MeSH Terms] OR ("adipose"[All Fields] AND "tissue"[All Fields]) OR "adipose tissue"[All Fields]) AND ("body mass index"[MeSH Terms] OR ("body"[All Fields] AND "mass"[All Fields] AND "index"[All Fields]) OR "body mass index"[All Fields])) AND ((clinicalstudy[Filter]) AND (2014:2024[pdat])) used in searching the literature.

Data retrieval

After reading the abstract and the title of each study, the writers performed an examination to determine whether or not the study satisfied the inclusion criteria. The writers then decided which previous research they wanted to utilise as sources for their article and selected those studies. After looking at a number of different research, which all seemed to point to the same trend, this conclusion was drawn. All submissions need to be written in English and can't have been seen anywhere else.

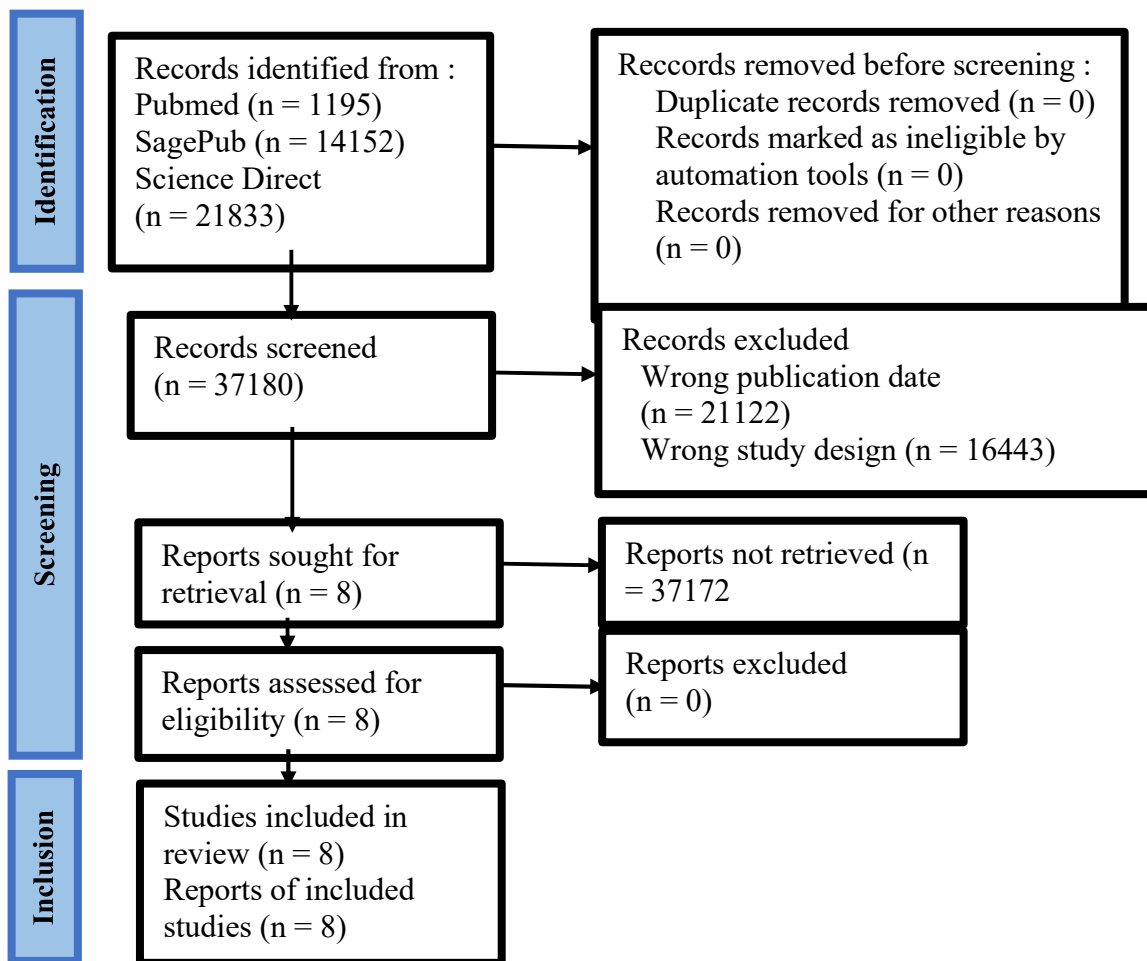


Figure 1. Prisma Flow Diagram

Only those papers that were able to satisfy all of the inclusion criteria were taken into consideration for the systematic review. This reduces the number of results to only those that are pertinent to the search. We do not take into consideration the conclusions of any study that does not satisfy our requirements. After this, the findings of the research will be analysed in great detail. The following pieces of information were uncovered as a result of the inquiry that was carried out for the purpose of this study: names, authors, publication dates, location, study activities, and parameters.

Quality Assessment and Data Synthesis

Each author did their own study on the research that was included in the publication's title and abstract before making a decision about which publications to explore further. The next step will be to evaluate all of the articles that are suitable for inclusion in the review because they match the criteria set forth for that purpose in the review. After that, we'll determine which articles to include in the review depending on the findings that we've uncovered. This criteria is utilised in the process of selecting papers for further assessment. In order to simplify the process as much as feasible when selecting papers to evaluate. Which earlier investigations were carried out, and what elements of those studies made it appropriate to include them in the review, are being discussed here.

RESULT

In the PubMed database, the results of our search brought up 1195 articles, whereas the results of our search on SAGEPUB brought up 14152 articles, our search on SCIENCE DIRECT brought up 21833 articles. The results of the search conducted for the last year of 2014 yielded a total 536 articles for PubMed, 5253 articles for SAGEPUB and 10269 articles for SCIENCE DIRECT. In the end, we compiled a total of 8 papers, 5 of which came from PubMed, 1 of which came from SAGEPUB and 2 of which came from SCIENCE DIRECT. We included eight research that met the criteria.

Gomes, et al⁵ (2019) showed that in individuals with type 2 diabetes and low habitual Ca consumption (<600 mg/d), the consumption of around three servings of fat-free milk and 1200 mg of dietary Ca/d improved weight reduction, improved body composition, and promoted glycaemic management.

Lappe, et al⁶ (2017) showed that there is no evidence to support the use of dairy products as a weight-gain or body-fat reduction strategy in overweight teenage girls; instead, the dairy group increased body fat comparable to that of the control group.

Bendtsen, et al⁷ (2018) showed that in overweight and obese adults with a habitual calcium intake of around 1000 mg/day, consumption of a high-dairy diet did not increase fecal fat or accelerate weight and fat-mass reduction beyond calorie restriction during a 24-week period. On the other hand, this research suggests that Papillibacter has a role in modifications in body composition.

Celik, et al⁸ (2016) showed that increasing the consumption of dairy products did not enhance weight reduction in women on a weight-loss program when compared to calorie restriction alone.

Table 1. The literature include in this study

Author	Origin	Method	Sample	Result
Gomes et al, 2019 ⁵	Brazil	Randomized clinical trial	14 patients	Following HC, there was a more significant decrease in waist circumference, body fat mass, waist:hip ratio, and body weight. Following HC, the concentrations of blood uric acid, parathormone (PTH), and glycated Hb (HbA1c) decreased, while serum 25-hydroxyvitamin D and homeostatic model assessment-2 β -cell function (HOMA2-%B) rose. Furthermore, there were less changes from baseline in the concentrations of serum uric acid, glucose, HbA1c, and PTH, and more changes from baseline in the concentrations of HOMA2-%B, serum calcium, and 25-hydroxyvitamin D following the HC than after the LC.
Lappe et al, 2017 ⁶	USA	Randomized clinical trial	274 patients	The percentage of body fat gained over a 12-month period did not differ statistically significantly between the groups (mean \pm SEM: dairy 0.40% \pm 0.53% > control; P < 0.45). By BMI percentile strata, the intervention's impact was the same. Between the two groups, there was no change in weight.
Bendtsen et al, 2018 ⁷	Denmark	Randomized controlled trial	80 patients	Daily calcium consumption was around 1000 mg. Over a 24-week period, the groups' changes in fecal fat excretion (HD: -0.57 \pm 0.76 g, LD: 0.46 \pm 0.70 g, P = 0.12), body weight reduction (HD: -6.6 \pm 1.3 kg, LD: -7.9 \pm 1.5 kg, P = 0.73), fat-mass loss (HD: -7.8% \pm 1.3%, LD: -8.5% \pm 1.1%, P = 0.76), and microbiota composition were comparable. Nonetheless, regardless of diet group, the

				overall reduction in fat mass was favorably correlated with the relative abundance of Papillibacter (P = 0.017).
Celik et al, 2016⁸	Turkey	Randomized controlled study	65 patients	While there was no difference found between the groups, there was a substantial drop in body weight, body mass index, waist and hip circumferences, waist/hip ratio, body fat percentage, and fat mass within the groups (p<0.001). In the two intervention groups, there was a significant drop (p<0.05, p<0.001) in plasma total cholesterol levels and an increase (p<0.05) in high-density lipoprotein cholesterol levels. Dairy calcium and systolic blood pressure had a negative correlation.
Fonte et al, 2024⁹	Brazil	Cross sectional study	159 patients	The average daily consumption of calcium was 834.6 ± 374.7 mg, and the average daily intake of vitamin D was 6.1 ± 24.3 µg. In both cases, the recommended amounts were met with the use of supplements. The average daily protein consumption was 72.9 ± 26.8 g. Of these, 48.4% had poor muscle mass, 45.3% had osteoporosis, and 24.7% had vertebral fractures. According to the estimates of the logistic regression model with obesity and low muscle mass as the outcome variable, independent individuals 80 years of age or older who have a fracture are more likely to be obese and have low muscle mass than they are to have low muscle mass alone.
Badaghabadi et al, 2023¹⁰	Iran	Randomized clinical trial	60 patients	The dairy group saw a mean decrease in abdominal and suprailiac skinfold thicknesses of -4.82 mm and -3.22 mm, respectively, while the non-dairy group experienced a mean reduction of -2.83 mm and -2.00, respectively. The high-dairy group showed an adjusted mean difference in suprailiac skinfold thickness of -1.22 (95% CI: 0.06-2.38; p = 0.017) and abs skinfold thickness of -1.99 (95% CI: 0.49-3.48; p = 0.005). The intervention group exhibited substantial changes (p < 0.05)

				in all other secondary outcomes, such as waist and hip circumferences, mean body fat, percentage body fat, soft lean mass, body mass index, fat mass index, and fat-free mass index.
Bredariol et al, 2020¹¹	Brazil	Cross sectional study	107 patients	Following age, dietary and physical activity adjustments, it was shown that the amount of calcium consumed (in mg/day) was negatively correlated with trunk, gynoid, and android fat mass (kg), as well as total fat mass (kg and percentage). Although a trend was seen, there was no correlation between calcium consumption and body mass index (p = 0.062).
Vogel et al, 2017¹²	Indiana	Randomized controlled trial	240 patients	With the exception of a tibial BMC gain that was higher in the group that received dairy (P = 0.02), there were no significant differences found in the change of BMD, BMC, or bone area for the total-body radius, lumbar spine, and total hip between subjects who received the dairy intervention (achieved consumption of 1500 mg Ca/d) and subjects who did not (achieved 1000 mg Ca/d, which represented ~2 cups milk or other dairy as part of the diet). Diet assignment had no effect on body fat.

Fonte, et al⁹ (2024) showed that only dietary protein per g/kg/day was linked to bone mineral density and body composition out of all the nutrients examined; however, older people who fracture are more likely to be obese and have poor muscle mass than those who are not.

Bodaghabadi, et al¹⁰ (2023) showed that for overweight young adult women, a high-dairy, low-calorie diet is more beneficial than a high-protein, low-calorie diet when it comes to weight loss and reducing body fat, especially central fat.

Bredariol, et al¹¹ (2020) showed that the primary discovery of this study was that, among postmenopausal women, calcium consumption was negatively correlated with body fat. In postmenopausal women, there was an inverse relationship between body fat mass and calcium consumption.

Vogel, et al¹² (2017) showed that interventions using dairy foods often had little impact on body composition or the acquisition of bone minerals, either within or between weight groups. Regardless of weight status, sex, or race, providing 3 servings of dairy products/d did not increase bone accrual or strength above the benefits of calcium intake that is comparable to 2 servings of dairy products/d as part of a self-selected diet.

DISCUSSION

Teenage obesity is on the rise, and because it continues into adulthood, it is a serious health risk. Research backs up the effectiveness of diets heavy in dairy and calcium in helping individuals reach a healthy weight. Lappe, et al in their study included 274 healthy postmenarche 13-15 year old overweight girls and randomly assign into 2 groups. This study showed no support of calcium dietary contained in dairy food was significantly changed differently between groups in weight.⁶

Gomes, et al also did study to evaluate the effects of calcium in milk and adiposity and glycaemic control in 14 subjects with type 2 diabetes. The subjects had two 12-week experimental periods, with an 8-week washout period in between

(high-Ca fat-free milk, HC) or low-Ca control, LC). Every day, the subjects drank a breakfast shake in the lab that included 700 mg (HC) or 6.4 mg (LC) of calcium. Diets with energy restrictions and 800 mg of dietary Ca/d were recommended. In individuals with type 2 diabetes and low habitual Ca consumption (<600 mg/d), the consumption of around three servings of fat-free milk and 1200 mg of dietary Ca/d improved weight reduction, improved body composition, and promoted glycaemic management.⁵

Bendsten also investigate 69 women if calcium dietary is associated with body weight, body composition, fecal fat excretion over followed up in 24 weeks. For a period of 24 weeks, a 500-kcal (2100 kJ) deficit diet consisting of either high (HD: 1500 mg calcium/day) or low (LD: 600 mg calcium/day) dairy products was given to 11 men and 69 women (body mass index: 30.6 ± 0.3 kg/m²; age: 44 ± 1 years). In overweight and obese adults with a habitual calcium intake of around 1000 mg/day, consumption of a high-dairy diet did not increase fecal fat or accelerate weight and fat-mass reduction beyond calorie restriction during a 24-week period. On the other hand, this research suggests that Papillibacter has a role in modifications in body composition.⁷

To find the effects of calcium on body weight and fat, Celik, et al also did study in 65 patients that assigned to 3 groups of intake of calcium as control, low calcium and high. While no change was found between the groups, body weight, body mass index, hip and waist circumferences, waist/hip ratio, body fat percentage, and fat mass all significantly decreased within the groups ($p < 0.001$). Increasing the consumption of dairy products did not enhance weight reduction in women on a weight-loss program when compared to calorie restriction alone.⁸

The 159 patients that 80 years or older were observed by Fonte, et al in their study. Among all the nutrients examined, only dietary protein per g/kg/day was linked to body composition and bone mineral density in the population of independent individuals 80 years of age or older. However, it should be noted that elderly individuals who suffer fractures are more likely to be obese and have low muscle mass than those who are not. Further research is required to determine the association between nutritional consumption and the health of the muscles and bones in this group.⁹

Genetic variables can have an impact on fat tissue diseases, which are commonly referred to as adiposopathies. However, in the general population, lifestyle variables including stress, diet, and physical exercise are more important. Adipose tissue dysfunction is linked to elevated central body fat in obese and overweight individuals. An increased risk of metabolic and cardiovascular illness, as well as the development of adiposopathy, is associated with higher BMI and belly circumference. Obesity may be a key target for multimorbidity primary prevention given its links to a number of illnesses with growing disease burdens, particularly when aimed at younger, higher-risk populations. Bodaghabadi, et al showed that for overweight young adult women, a high-dairy, low-calorie diet is more beneficial than a high-protein, low-calorie diet when it comes to weight loss and reducing body fat, especially central fat.¹⁰ Bredariol, et al in their study of 107 post menopausal women who entered in a lifestyle change program also with the same results that calcium intake was not associated with body fat mass.¹¹

As for Vogel¹², et al showed in 240 healthy boys and girls also no significant difference of bone mineral content neither their body mass index after received the dairy intervention (contains 1500 mg calcium).

CONCLUSION

In summary, from eight studies showed that there is no significant changed of body mass index, neither the body fat after received the dietary of calcium.

REFERENCE

- [1] Xu W, Zhang H, Paillard-Borg S, Zhu H, Qi X, Rizzuto D. Prevalence of overweight and obesity among Chinese adults: Role of adiposity indicators and age. *Obes Facts*. 2016 Mar 1;9(1):17–28.
- [2] Jung UJ, Choi MS. Obesity and its metabolic complications: The role of adipokines and the relationship between obesity, inflammation, insulin resistance, dyslipidemia and nonalcoholic fatty liver disease. Vol. 15, *International Journal of Molecular Sciences*. MDPI AG; 2014. p. 6184–223.
- [3] Eilat-Adar S, Xu J, Loria C, Mattil C, Goldbourt U, Howard B V., et al. Dietary calcium is associated with body mass index and body fat in American Indians. *Journal of Nutrition*. 2007;137(8):1955–60.
- [4] Li P, Fan C, Lu Y, Qi K. Effects of calcium supplementation on body weight: A meta-analysis. *American Journal of Clinical Nutrition*. 2016 Nov 1;104(5):1263–73.
- [5] Gomes JMG, de Assis Costa J, de Melo Ribeiro PV, de Cassia Goncalves Alfenas R. High calcium intake from fat-free milk, body composition and glycaemic control in adults with type 2 diabetes: a randomised crossover clinical trial. *Br J Nutr*. 2019;122(3):301–8.
- [6] Lappe JM, McMahon DJ, Laughlin A, Hanson C, Desmangles JC, Begley M, et al. The effect of increasing dairy calcium intake of adolescent girls on changes in body fat and weight. *Am J Clin Nutr*. 2017;105(5):1046–53.

- [7] Bendtsen LQ, Blaedel T, Holm JB, Lorenzen JK, Mark AB. High intake of dairy during energy restriction does not affect energy balance or the intestinal microflora compared with low dairy intake in overweight individuals in a randomized controlled trial. *Appl Physiol Nutr Metab*. 2018;43(1):1–10.
- [8] Celik N, Inanc N. Effects of dairy products consumption on weight loss and blood chemistry in premenopausal obese women. *J Pak Med Assoc*. 2016;66(1):76–82.
- [9] Fonte FK, Spinoza ED, Carvalho VA, Albuquerque RA dos S, Nebuloni CC, Santos FC dos, et al. Relationship of protein, calcium and vitamin D consumption with body composition and fractures in oldest-old independent people. *Clin Nutr ESPEN*. 2024 Feb 1;59:398–403.
- [10] Bodaghabadi Z, Mohammadi LO, Halabchi F, Tavakol Z, Kluzek S. Effects of high-dairy versus low-dairy, high-protein and low-calorie diets combined with aerobic exercise on central body fat in overweight women: A pragmatic randomized controlled trial. *Obes Med*. 2023;40:100492.
- [11] Bredariol ANM, Rossato LT, de Branco FMS, Nahas PC, Orsatti FL, de Oliveira EP. Calcium intake is inversely associated with body fat in postmenopausal women. *Clin Nutr ESPEN*. 2020;39:206–9.
- [12] Vogel KA, Martin BR, McCabe LD, Peacock M, Warden SJ, McCabe GP, et al. The effect of dairy intake on bone mass and body composition in early pubertal girls and boys: A randomized controlled trial. *American Journal of Clinical Nutrition*. 2017 May 1;105(5):1214–29.