

THE IMPACT OF DAIRY CONSUMPTION ON WEIGHT FLUCTUATIONS AND OBESITY RISK THROUGHOUT MENOPAUSE: A COMPREHENSIVE SYSTEMATIC REVIEW

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ABSTRACT

Introduction: The perimenopausal transition poses significant physiological changes and an elevated risk of obesity among women, with studies demonstrating weight gain and metabolic disruptions during this phase. Dairy products, recommended in the typical diet, remain contentious in their impact on weight despite their nutrient-rich composition. Our systematic review aims to address this uncertainty by synthesizing existing evidence on the association between dairy consumption, weight change, and obesity risk during the menopausal transition, shedding light on the nuanced effects of different dairy products and informing tailored dietary interventions for optimal health during this critical life stage.

Method: The researchers in this study followed the 2020 Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) guidelines to ensure that their work met the required standards. This was done to ensure the precision and reliability of the conclusions derived from the research.

Result: This systematic review investigated final 20 articles. After looking at the titles and summaries, we found 10 papers that fit our criteria. At first, we excluded several articles because they were written in review style and case reports. But after reading the full papers carefully, we included five papers in our final analysis. These papers included analytical cohort, randomized, crossover study, and prospective study.

Conclusion: In conclusion, incorporating yogurt into the diet may benefit perimenopausal women by reducing weight gain and obesity risk, but further investigation is needed to understand the underlying mechanisms. Additionally, controlled-feeding studies showed limited effects of short-term consumption of 2% fat milk on cardiometabolic risk factors in postmenopausal women with abdominal obesity, raising questions about disparities with epidemiological findings associating dairy consumption with reduced risk of metabolic disorders. Longitudinal cohort studies found no evidence supporting the beneficial effects of dairy intake on bone health in middle-aged women, while higher total dairy intake, mainly from high-fat sources, was associated with less weight gain over time in women with normal BMI at baseline. Further well-powered trials are needed to comprehensively understand dairy's role in preventing weight gain and obesity across different life stages.

Keyword: Dairy consumption, menopause, obesity, pre-menopause

INTRODUCTION

The transition to menopause, known as perimenopause, signifies a crucial stage in a woman's life. During this phase, there's considerable fluctuation in reproductive hormone levels, leading to various physiological shifts and metabolic disruptions. Reduced estrogen levels during perimenopause have been linked to alterations in fat distribution and an elevated risk of obesity among women in this stage.¹ Statistics from the CDC indicate that 43.3% of women aged 40–59 in the US are obese. Studies such as the Healthy Women Study and the Study of Women's Health Across the Nation have demonstrated weight gain and increased fat mass during the menopausal transition, further accentuating the risk of conditions like diabetes, cardiovascular disease (CVD), and metabolic syndrome (MetS).²

Dairy products constitute a significant component of the typical diet, with the 2020–2025 Dietary Guidelines for Americans recommending three servings daily. Despite concerns about their saturated fat content, the impact of dairy foods on weight remains contentious.³ Notably, dairy fat contains short-chain fatty acids, which studies suggest may mitigate obesity risk. Additionally, dairy products are rich in essential nutrients like proteins, minerals, and vitamin D, which could aid in weight management. However, research on the relationship between dairy consumption and weight change has yielded inconsistent findings.⁴

While some studies have shown that incorporating 2–4 servings of total dairy into an energy-restricted diet leads to greater weight and fat mass loss, others have found no significant impact on weight change. Long-term observational studies have similarly provided mixed results, although higher dairy intake has been associated with reduced risks of abdominal obesity and being overweight.^{5,6} The variability in findings regarding total dairy consumption and weight may stem from differences in individual dairy products. Fermented dairy products like cheese and yogurt, in particular, have attracted attention for their potential health benefits. Yogurt, rich in probiotics, has been linked to favourable modulation of gut microbiota and protection against obesity. Studies comparing different dairy products have shown that increasing yogurt intake is associated with lower weight gain, while no such association is observed with milk or cheese consumption.⁷

The menopausal transition presents a critical period in women's lives, marked by significant physiological changes and an increased risk of obesity. Dairy foods are integral to the typical diet, yet their relationship with weight change and obesity risk during this transition remains uncertain. To address this gap, we conducted a comprehensive systematic review aiming to synthesize existing evidence on the association between dairy consumption, weight change, and obesity risk among women undergoing the menopausal transition. Our review explores the diverse effects of different dairy products and their potential contributions to weight management during this crucial life stage. By elucidating the nuanced relationship between dairy foods and weight outcomes in perimenopausal women, this systematic review aims to inform dietary recommendations and interventions tailored to promote optimal health during the menopausal transition.

METHODS

Protocol

The researchers in this study followed the 2020 Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) guidelines to ensure that their work met the required standards. This was done to ensure the precision and reliability of the conclusions derived from the research.

Criteria for Eligibility

For inclusion in the study, published articles had to meet particular requirements. They had to be research papers written in English, focusing on the impact of dairy consumption on weight fluctuations and obesity risk throughout menopause. The studies had to meet the following criteria: articles need to have been published after 2016 but within the applicable timeframe for this systematic review. Articles falling into categories like editorials, lacking a DOI, review articles that were already published, or duplicating previously published journal papers were excluded from the assessment.

Search Strategy

We conducted a comprehensive literature search using PubMed, Wiley Journal Database, and ScienceDirect focusing on studies published from 2015 to 2024. The search terms employed were as follows: *menopause AND dairy consumption AND weight change AND obesity risk*. Moreover, we performed cross-referencing of relevant articles to reveal additional research. The evaluation of study quality, methodology, interventions, and results was undertaken independently by the researchers, resolving any differences through discussion and agreement. Furthermore, both researchers collected and compared discoveries from all studies, considering the potential for conducting a meta-analysis if deemed feasible.

Inclusion and exclusion criteria

Inclusion criteria for the studies were as follows: (1) original research that assesses on the impact of dairy consumption on weight fluctuations and obesity risk throughout menopause; (2) Randomized Controlled Trials (RCTs) or observational studies (cohort or case-control studies); (3) availability of relevant data. Exclusion criteria were as follows: (1) ongoing studies or studies without available data; (2) duplicate publications. In cases of duplicate publications, the most recent article was chosen; (3) Non-English language studies were excluded.

Data Retrieval

The authors conducted a thorough examination of relevant studies, specifically selecting those that met precise inclusion criteria. They focused on original, unpublished papers in English to ensure a refined and high-quality selection. The analysis covered essential information, such as study particulars, authors, publication dates, locations, and research methodologies, aligning with the study's objectives.

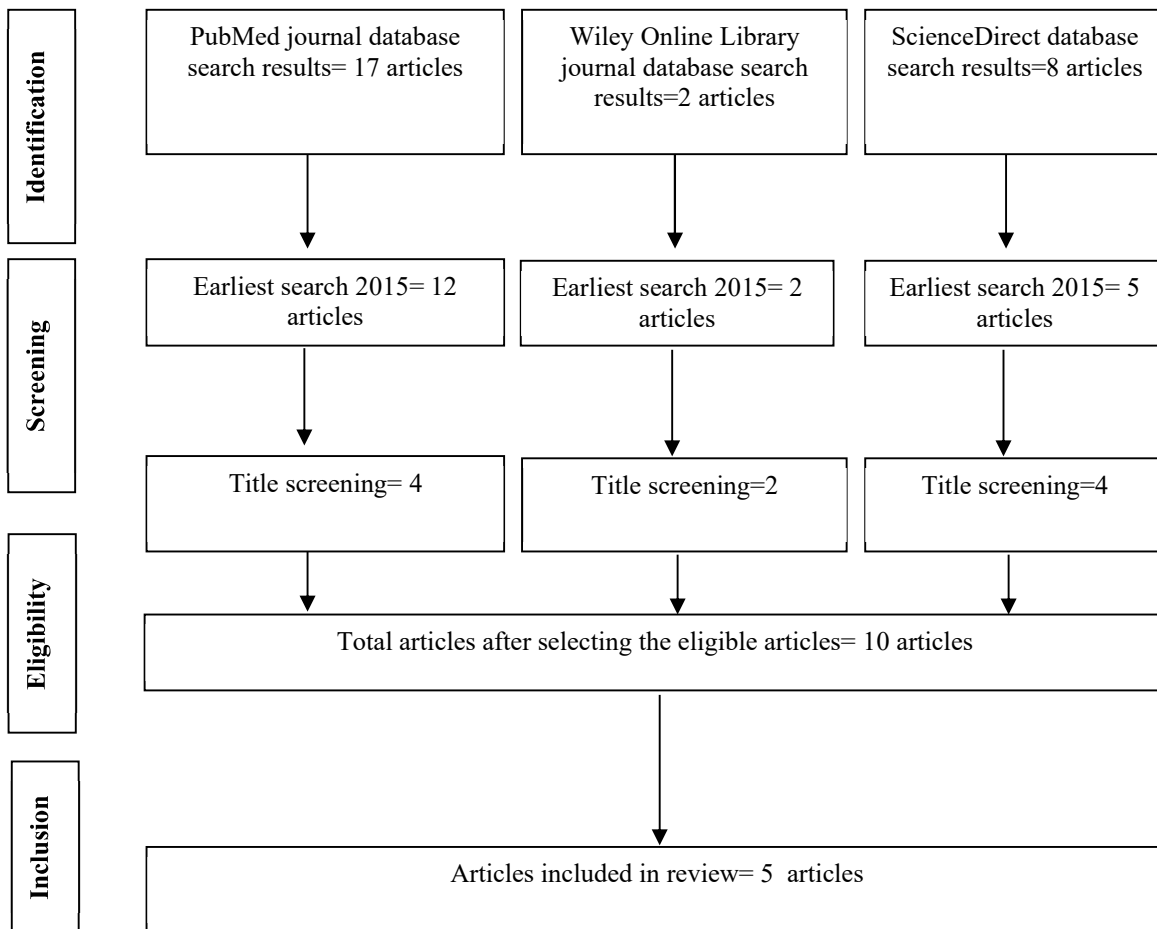


Figure 1. Article search flowchart

Yuan M et al., 2023. ⁸	USA	Analytical cohort.	The NHS II was launched in June 1989, with the enrollment of 116,429 registered nurses aged 25–42 y.	In longitudinal analyses, those with the highest yogurt intakes had the lowest weight gain at every exam. This was not the case for other forms of dairy. After adjusting for potential covariates, those consuming 2.0 servings/wk of yogurt (compared with <1.0 serving/ month) had a 31% (RR: 0.69; 95% CI: 0.64, 0.74) lower risk of obesity. The highest total dairy intake (2.0 servings/d compared with <1.0) was associated with only a 12% (RR: 0.88; 95% CI: 0.82, 0.95) reduction in obesity risk. Higher activity levels and alternative healthy eating index scores were independently associated with statistically significant reductions in risk of obesity, but higher intakes of yogurt strengthened these beneficial associations.
Drouin-Chartier wt al., 2015. ⁹	Canada	Randomized crossover study.	27 women with abdominal obesity consumed two 6-week diets based on the National Cholesterol Education Program (NCEP),	The MILK diet had no significant effect on LDL-C, triglycerides, LDL size, CRP and cell adhesion molecule concentrations and on indicators of insulin sensitivity. The MILK diet reduced HDL-C, adiponectin, endothelin and fasting glucose levels as well blood pressure (all $P \leq 0.01$), but those changes were comparable to those seen with the NCEP milk-free diet (all between-diet $P \geq 0.07$). Finally, the MILK diet was associated with lower VLDL apolipoprotein B fractional catabolic rate (-13.4%; $P = 0.04$) and plasma sterol concentrations (-12.0%; $P = 0.04$) compared with the control NCEP milk-free diet.
Wallace et al., 2020. ¹⁰	USA	The SWAN cohort is composed of community based, multiethnic women across the menopausal transition	3,302 pre- or early perimenopausal women aged between 42 and 53 years who had an intact uterus, at least one ovary, and no hormone usage in the last 3 months prior to screening from 5 clinical sites in the United States	At baseline, FDP consumers had lower abdominal fat mass and larger bone size at the radius and tibia. Parathyroid hormone and β -carboxyterminal cross-linked telopeptide of type I collagen levels were inversely correlated with FDP consumption. In the longitudinal analysis, FDP consumption (mean of the two assessments) was associated with attenuated loss of radius total vBMD and of Ct vBMD, area, and thickness. There was no difference in aBMD and at the tibia. These associations were independent of total energy, calcium, or protein intakes. For other dairy products categories, only milk consumption was associated with lower decrease of aBMD and of failure load at the radius.
Purdue-Smithe et al., 2019. ¹¹	USA	Prospective study.	The NHS2 is a prospective study of 116,429 female U.S. registered nurses who were 25-42 years old in 1989 when they responded to a mailed baseline questionnaire.	Food frequency questionnaires were used to assess dietary intake. In Cox proportional hazards models adjusting for age, smoking, and other factors, total baseline dairy intake of ≥ 4 servings/day versus < 4 servings/week was associated with 23% lower risk of early menopause (95% confidence interval (CI): 0.64, 0.93; P -trend = 0.08). Associations appeared to be limited to low-fat dairy foods (≥ 2 servings/day versus < 3 servings/month HR: 0.83; 95% CI: 0.68, 1.01; P -trend = 0.02), whereas high-fat dairy intake was not associated with early menopause.
Rautiainen S et al., 2016. ¹²	USA	Prospective cohort study.	We studied 18,438 women aged ≥ 45 y from the Women's Health Study who were free of cardiovascular disease, cancer, and diabetes and had initial body mass index	During a mean follow-up of 11.2 y, 8238 women became overweight or obese. Multivariable-adjusted mean 6 SD changes in body weight during the follow-up (18 y) were 1.90 \pm 0.09, 1.88 \pm 0.08, 1.86 \pm 0.09, 1.82 \pm 0.09, and 1.65 \pm 0.09 kg in quintiles 1–5 of total dairy intake, respectively (P -trend = 0.003). Greater intake of high-fat dairy products, but not intake of low-fat dairy products, was associated with less weight gain (P -trend = 0.004). In multivariable-adjusted analyses, lower risk of becoming overweight or obese was observed in the highest quintile of high-fat dairy product intake (HR: 0.92, 95% CI: 0.86, 0.99). Dietary or supplemental

(BMI; in kg/m²) calcium or vitamin D was not associated with risk of becoming overweight or obese. from 18.5 to 25 at baseline.

RESULT

This systematic review investigated final 20 articles. After looking at the titles and summaries, we found 10 papers that fit our criteria. At first, we excluded several articles because they were written in review style and case reports. But after reading the full papers carefully, we included five papers in our final analysis. These papers included analytical cohort, randomized, crossover study, and prospective study.

Study by Yuan et al, was determined to examine the distinct connections between various dairy products, either individually or in conjunction with overall dietary habits and physical activity, regarding weight gain and the risk of obesity among perimenopausal women participating in NHS II. Researcher provided an overview of the baseline characteristics of 35,152 participants, illustrating that those with higher yogurt consumption tended to exhibit greater physical activity levels, adopt healthier dietary patterns, and consume more total energy. Additionally, higher yogurt intake correlated with increased intake of total protein, carbohydrates, and alcohol but reduced fat consumption. Notably, individuals with elevated yogurt intake also consumed more total dairy, milk, and cheese, with milk accounting for nearly half of the total dairy intake. Conversely, those in the lowest yogurt intake category tended to consume fewer fruits and vegetables but more sugar-sweetened beverages and were more likely to be current smokers.

Although weight gain persisted throughout the 12-year timeframe, the rate of gain tended to decrease over time. Adjusted for potential confounding variables, most intervals did not display a significant difference in weight change among the three total dairy intake groups. However, higher total dairy intake was associated with statistically significant lower weight gain immediately following menopause. Additionally, participants with the highest yogurt intake exhibited the lowest adjusted weight gain throughout the entire menopausal transition, while those in the lowest yogurt intake group consistently demonstrated the highest weight gain over the 12-year period. Conversely, the relationship between milk intake and weight change was inconsistent. Furthermore, higher cheese intake was generally associated with greater weight gain, though not all differences were statistically significant. However, consistently lower weight gains were observed in individuals consuming the lowest amounts of cheese over the 12-year period.

Furthermore, researcher explored the association between dairy intake and the risk of obesity during the 12-year menopausal transition using Cox regression analysis. After excluding individuals with obesity at baseline, a total of 38,901 women were included, among whom 6085 developed incident obesity during follow-up. The initial multivariable model revealed an inverse relationship between total dairy consumption and obesity risk, with those consuming the highest amounts experiencing a 10% lower risk of obesity compared to those with the lowest intake. Similarly, higher yogurt consumption was associated with significantly lower obesity risk, with moderate intake also showing a notable reduction in risk. Conversely, a somewhat U-shaped relationship was observed between milk and cheese consumption and obesity risk. Additionally, the analysis of joint categories of different dairy foods and physical activity levels revealed nuanced associations, suggesting that yogurt consumption may further modify obesity risk in active individuals.

To gain insight into the effects of milk consumption on cardiometabolic health, Drouin-Chartier et al conducted a randomized crossover controlled study. The investigation focused on postmenopausal women with abdominal obesity and aimed to assess various cardiometabolic parameters associated with Metabolic Syndrome (MetS), including blood lipids, cholesterol and glucose regulation, blood pressure, endothelial function, inflammation, VLDL apoB, and HDL apoA-1 kinetics.

During the MILK diet phase, spanning six weeks, there was a notable decrease in plasma HDL-C levels (-16.2%; $P < 0.001$), while no significant impact was observed on total and LDL-C levels. Consequently, the total/HDL-C ratio increased significantly compared to baseline (+15.9%; $P < 0.001$). Changes in LDL-C and HDL-C mirrored those seen after the control NCEP diet, with no significant difference between diets. However, the reduction in total plasma cholesterol was more pronounced after the NCEP diet than after the MILK diet ($P = 0.01$). Plasma sterol levels were significantly lower following the MILK diet compared to the NCEP diet ($P = 0.04$), while no difference was observed in lathosterol concentrations. Additionally, plasma apo A-I concentrations decreased less after the MILK diet compared to the NCEP diet, though not statistically significant. Neither diet affected measures of LDL particle size.

Both the MILK and NCEP regimens similarly reduced plasma adiponectin levels, while plasma CRP remained unaffected. MILK consumption led to significant reductions in systolic (-4.1%) and diastolic (-5.2%) blood pressure compared to

baseline, with comparable reductions observed after the NCEP diet. Moreover, plasma endothelin concentrations decreased similarly during both treatments. Post-diet levels of VCAM-1, ICAM-1, and E-selectin were comparable between MILK and NCEP diets. Both diets resulted in similar reductions in plasma fasting glucose levels compared to diet-specific baseline values, with no significant differences observed in other markers of glucose regulation or insulin sensitivity indices between treatments.

With limited long-term clinical trial data available for premenopausal women, this study aimed to investigate the relationship between dairy intake and bone health outcomes using SWAN data. Table 1 presents the baseline characteristics of SWAN participants for bone mineral density (BMD) and fracture analyses. Higher dairy consumption at baseline was associated with characteristics such as taller stature, higher weight, nonsmoking status, alcohol consumption, premenopausal status, and slightly increased physical activity compared to peers. Additionally, non-Hispanic white individuals tended to consume more dairy compared to other ethnic groups. However, no significant differences were observed in baseline age, body mass index (BMI), femoral neck and lumbar spine BMD, calcium supplement use, or fracture history among dairy intake groups.

No significant differences were found across the four cumulative averaged dairy intake groups, even after adjusting for potential confounding variables. Similar results were obtained in sensitivity analysis using the simple average of dairy intakes at baseline, Visit 5, and Visit 9. Again, no significant differences were observed across the four dairy intake groups during the 10-year follow-up period. Throughout the 10-year follow-up, a total of 64 women experienced 72 nontraumatic fractures related to osteoporosis. However, there were no significant differences in the hazard ratios (HR) or relative risks of nontraumatic fractures across cumulative averaged dairy intake groups in fully adjusted models. Similarly, no differences in HR of nontraumatic fractures were noted when using the simple average of dairy intakes.

In a subsequent analysis, no significant associations were found between plasma 25-hydroxyvitamin D levels and the risk of early menopause. This suggests that any observed associations with vitamin D intake may be explained by other components present in dairy. To address this question, the present study investigates the risk of early menopause in relation to various dairy food intakes among participants of the NHS2.

Over a 20-year follow-up period, 2,049 women experienced early menopause. Those reporting higher dairy intake at baseline were generally younger, more physically active, nonsmokers, and had a higher BMI compared to those reporting lower intake. Dairy consumption was positively associated with calcium, vitamin D, and alcohol intake, and inversely associated with vegetable protein intake. In age-adjusted analyses, women consuming ≥ 4 servings of total dairy per day had a 26% lower risk of early menopause compared to those consuming < 4 servings per week. Similarly, higher intake of low-fat dairy foods was associated with a 24% lower risk. However, no significant association was found for high-fat dairy intake.

After adjusting for BMI, smoking, and other factors, the estimates for total and low-fat dairy intake remained similar but slightly attenuated. Further adjustment for total vitamin D and calcium intake revealed a 23% lower risk for those consuming ≥ 4 servings of total dairy per day. Similar trends were observed for low-fat dairy foods.

Additional analyses considering specific dairy items showed consistent findings. For instance, each serving per day of skim milk was associated with a 6% lower risk of early menopause. High intake of yogurt was associated with a 14% lower risk, while other individual dairy foods did not show significant associations. Analyses using cumulative averages of dairy intake yielded similar results to those using baseline intake. Similarly, findings for dairy intake during adolescence were consistent with those observed in adulthood.

Rautiainen et al in 2016 aimed to prospectively study the relationship between dairy product consumption and the risk of overweight or obesity in middle-aged and elderly women, considering both low-fat and high-fat dairy intake as well as specific types of dairy products. Additionally, we examined how dietary and supplemental calcium and vitamin D, key nutrients found in dairy, were associated with this risk.

Over an average follow-up of 11.2 years, 8,238 out of 18,438 women became overweight or obese. Women with higher total dairy intake at baseline tended to be younger, more physically active, and had higher calorie intake and healthier lifestyle habits compared to those with lower intake. Regarding weight change, significant trends were observed for total and high-fat dairy intake, where higher consumption was associated with less weight gain over time. However, no significant trend was found for low-fat dairy intake. Adjusting for baseline BMI and dietary fiber did not change the results significantly.

In terms of the risk of becoming overweight or obese, age-adjusted analyses showed that higher total dairy and high-fat dairy intake were associated with a lower risk, while higher low-fat dairy intake was associated with a higher risk. However, after adjusting for other lifestyle and dietary factors, the associations for total and high-fat dairy intake weakened, while the risk associated with low-fat dairy intake increased. Sensitivity analyses showed similar results. Specific types of dairy products also showed varying associations with the risk of overweight or obesity. Higher consumption of skimmed milk, sherbet, and yogurt was associated with an increased risk, although some associations attenuated after adjusting for baseline BMI.

Regarding calcium and vitamin D intake, higher calcium supplement use was associated with a lower risk of overweight or obesity, but this association disappeared after adjusting for BMI. Higher dietary vitamin D intake tended to be associated with a higher risk, but this association also weakened after adjusting for BMI.

DISCUSSION

In this study of perimenopausal women by Yuan et al, higher total dairy intake was associated with a reduced risk of obesity, although yogurt showed an even stronger association with less weight gain over a 12-year period around menopause. Interestingly, there appeared to be a U-shaped relationship between milk and cheese intake and obesity risk. Physical activity and adherence to a healthy diet were independently associated with reduced obesity risk, but higher yogurt intake further decreased this risk beyond these factors.⁸

Short-term interventions examining total dairy intake and weight change suggest an inverse relationship, especially under hypocaloric conditions. However, longitudinal studies on habitual dairy intake and weight change are limited. While total dairy intake was not consistently linked to reduced annualized weight gain in our analysis, it was associated with a lower risk of obesity. These findings contrast somewhat with the Women's Health Study, which found a significant inverse association between total dairy consumption and weight change.⁸

Yogurt consumption has consistently been associated with lower adiposity indexes in cohort studies, suggesting potential weight-reducing effects. Yogurt's unique properties, including its calcium content, acidity, probiotics, and satiating nature, may contribute to its beneficial effects on weight management. However, these associations remained even after adjusting for lifestyle factors, indicating independent benefits of yogurt on obesity prevention. In contrast, milk consumption did not show a clear association with weight gain or obesity risk in our analysis. Adjusting for baseline BMI attenuated any observed associations, suggesting that individual characteristics may influence the relationship between milk intake and weight change. Further research is needed to explore the impact of different types of milk on obesity risk in perimenopausal women.⁸

Regarding cheese intake, large longitudinal studies in the US found no significant association with weight change or obesity. However, findings from a Swedish study suggested a lower risk of weight gain associated with regular cheese intake. Our analysis did not find a consistent association between cheese intake and weight gain, although moderate cheese consumption was linked to a lower risk of obesity in nonobese perimenopausal women. Differences in consumption levels and types of cheese across populations may influence these varying results.⁸

A 2011 systematic review suggested potential benefits of dairy intake in reducing metabolic syndrome (MetS) risk, while emphasizing methodological differences across studies and the necessity for high-quality randomized clinical trials for confirmation.¹² However, a recent meta-analysis of 20 randomized controlled trials found no significant impact of either high-fat or low-fat dairy intake on LDL-C, HDL-C, CRP, or blood pressure, contrasting with epidemiological findings associating milk intake with favorable lipid profiles.¹²

Clinical studies revealed that high-fat dairy intake increased plasma glucose levels, opposing epidemiological evidence linking total dairy and cheese intake to reduced type 2 diabetes risk. This discrepancy warrants further investigation. Although both milk and a National Cholesterol Education Program (NCEP) diet reduced plasma glucose in postmenopausal women, the mechanisms behind these effects remain unclear.¹³

Concerning cardiovascular risk factors, milk consumption alongside an NCEP diet did not significantly alter plasma CRP or endothelin-1 levels but did reduce blood pressure, aligning with previous population studies. Focusing solely on milk consumption provides clarity in attributing observed effects, yet the study's small sample size may have limited the detection of subtle changes in cardiometabolic risk factors, highlighting the need for longer-term investigations.⁹

The transition through menopause is a significant period for women's health, extending beyond reproduction. Limited data exist on whether early nutritional strategies can effectively mitigate bone loss during and after menopause. Previous research suggested a potential critical window before menopause for calcium supplements, but similar associations were not found in this study regarding dairy intake. Sensitivity analyses adjusting for hormone use did not alter the results, although dairy intake was generally low among participants, especially among non-White women.¹⁴

The role of dairy consumption in preserving bone mineral density (BMD) or preventing fractures remains uncertain. Meta-analyses have not consistently linked milk consumption with hip fracture risk. Recent studies suggest associations between yogurt and cheese consumption and lower hip fracture risk, but the evidence for milk is inconclusive.¹⁵ While this study did not find significant associations between dairy intake and fractures, methodological differences compared to other studies may explain discrepancies, including variations in sample size and fracture definitions.¹⁰

This study is the first to investigate dairy consumption specifically in relation to early menopause risk. However, our findings align with a study in the NHS that found low-fat dairy and skim milk intake correlated with earlier menopause onset, especially among participants under 51 years old.¹¹ Conversely, another study in the European Prospective Investigation into Cancer and Nutrition cohort did not find significant associations with total dairy intake, possibly due to higher consumption

of high-fat dairy.¹⁸ Various mechanisms linking dairy constituents to ovarian aging have been proposed, including the role of vitamin D and inflammatory pathways. While vitamin D and calcium from dairy foods were inversely associated with early menopause risk in a recent analysis, plasma vitamin D levels did not correlate with early menopause risk in another study, suggesting other milk components may be at play.¹¹

Dairy products contain estrogen metabolites and progesterone, with different concentrations depending on fat content. Low-fat dairy products contain more hydrophilic conjugated estrogen metabolites, potentially influencing hormone levels related to ovarian aging. Androgens found in milk, such as testosterone, may also affect ovarian aging by influencing insulin-like growth factor 1 (IGF-1) levels, crucial for maintaining normal menstrual cycles in later reproductive years. Epidemiological evidence supports associations between dairy intake and plasma levels of estradiol, IGF-1, and reproductive outcomes, indicating the potential influence of dairy hormones on health risks.¹⁹ This findings for low-fat dairy intake persisted even after accounting for other nutrients, suggesting that hormonal components in milk likely explain our results.¹¹

In the study of middle-aged and older women initially of normal weight, we found that increased body weight over time was observed regardless of total dairy intake. However, those with higher dairy consumption, especially high-fat dairy, experienced less weight gain. Interestingly, this effect was not observed with low-fat dairy or specific dairy products like calcium or vitamin D.¹²

These results are specific to women initially of normal weight and may not apply to those who were already overweight or obese at baseline. Different baseline body weights could influence both dairy consumption patterns and the risk of weight gain. Despite adjustments for baseline BMI in our analyses, some factors like skimmed milk and sherbet intake still showed potential confounding effects.¹² Previous studies investigating dairy intake and weight change have produced inconsistent results, possibly due to variations in baseline obesity status across different populations.²⁰ Some randomized trials suggest short-term weight reduction with increased dairy intake, but long-term effects remain uncertain.²¹

In this findings suggest that higher intake of high-fat dairy products, rather than low-fat options, is associated with less weight gain and lower risk of becoming overweight or obese. This may seem contradictory given that low-fat dairy is typically recommended for weight management, but our study population consisted of women initially of normal weight who may not have been restricting energy intake. Dairy products contain various components like proteins, vitamin D, calcium, and phosphorus that could contribute to weight management. Calcium, for example, has been implicated in energy metabolism, but our analyses did not find associations with calcium or vitamin D intake and weight change when controlling for baseline BMI.¹²

CONCLUSION

In conclusion, study suggests that incorporating yogurt into the diet may be beneficial for perimenopausal women, as higher yogurt intake was associated with less weight gain and reduced obesity risk during this critical life stage. However, further investigation is warranted to elucidate the underlying mechanisms driving these associations. Additionally, controlled-feeding study indicated limited effects of short-term consumption of 2% fat milk within a low-fat prudent diet on cardiometabolic risk factors associated with MetS in postmenopausal women with abdominal obesity. This raises questions about the inconsistencies between our findings and those of epidemiological studies, which often associate dairy consumption with reduced risk of MetS, coronary heart disease (CHD), and type 2 diabetes. Further research is needed to reconcile these disparities.

Furthermore, longitudinal cohort study within the SWAN cohort found no evidence supporting the beneficial effects of dairy intake on bone mineral density loss or fracture risk among middle-aged women, irrespective of baseline menopausal status or method of dairy intake classification. Although our ability to directly compare adolescent and adult dairy intake was limited, our findings suggest that low-fat dairy products, including skim milk and yogurt, may represent modifiable risk factors for reducing the risk of early menopause. Study of middle-aged and older women with normal BMI at baseline found that higher total dairy intake, driven primarily by high-fat dairy intake, was associated with less weight gain over time. However, well-powered, longer-term randomized trials are needed to comprehensively understand the role of dairy products in preventing weight gain and reducing the risk of becoming overweight or obese. These findings highlight the importance of continued research in elucidating the complex relationship between dairy consumption and various health outcomes across different life stages.

REFERENCES

- [1] Lizcano F., Guzmán G. Estrogen deficiency and the origin of obesity during menopause. *BioMed Res Int.* 2014;2014 - PMC – PubMed
- [2] Hales C.M., Carroll M.D., Fryar C.D., Ogden C.L. 2017. Prevalence of obesity and severe obesity among adults: United States, 2017-2018 key findings data from the National Health and Nutrition Examination Survey.
- [3] Dietary guidelines for Americans 2020-2025 9th Edition. U.S. Department of Agriculture and U.S. Department of Health and Human Services; 2020. [Internet]

- [4] W. Stonehouse, T. Wycherley, N. Luscombe-Marsh, P. Taylor, G. Brinkworth, M. Riley, Dairy intake enhances bodyweight and composition changes during energy restriction in 18-50-year-old adults- a meta-analysis of randomized controlled trials, *Nutrients* 8 (7) (2016) 394.
- [5] J.R. Benatar, K. Sidhu, R.A.H. Stewart, Effects of high and low fat dairy food on cardio-metabolic risk factors: a meta-analysis of randomized studies, *PLoS One* 8 (10) (2013), e76480.
- [6] L. Schwingshackl, G. Hoffmann, C. Schwedhelm, T. Kalle-Uhlmann, B. Missbach, S. Knüppel, et al., Consumption of dairy products in relation to changes in anthropometric variables in adult populations: a systematic review and meta-analysis of cohort studies, *PLoS One* 11 (6) (2016), e0157461.
- [7] M. Wicinski, J. Gębalski, J. Gołębiowski, B. Malinowski, Probiotics for the treatment of overweight and obesity in humans-a review of clinical trials, *Microorganisms* 8 (8) (2020) 1–26.
- [8] Yuan M, Hu FB, Li Y, et al. Dairy Foods, Weight Change, and Risk of Obesity During the Menopausal Transition. *J Nutr.* 2023;153(3):811-819. doi:10.1016/j.tjnut.2023.01.001
- [9] Drouin-Chartier JP, Gagnon J, Labonté MÈ, et al. Impact of milk consumption on cardiometabolic risk in postmenopausal women with abdominal obesity. *Nutr J.* 2015;14:12. Published 2015 Jan 21. doi:10.1186/1475-2891-14-12
- [10] Wallace TC, Jun S, Zou P, et al. Dairy intake is not associated with improvements in bone mineral density or risk of fractures across the menopause transition: data from the Study of Women's Health Across the Nation. *Menopause.* 2020;27(8):879-886. doi:10.1097/GME.0000000000001555
- [11] Purdue-Smithe AC, Whitcomb BW, Manson JE, et al. A Prospective Study of Dairy-Food Intake and Early Menopause. *Am J Epidemiol.* 2019;188(1):188-196. doi:10.1093/aje/kwy212
- [12] Rautiainen S, Wang L, Lee IM, Manson JE, Buring JE, Sesso HD. Dairy consumption in association with weight change and risk of becoming overweight or obese in middle-aged and older women: a prospective cohort study. *Am J Clin Nutr.* 2016;103(4):979-988. doi:10.3945/ajcn.115.118406
- [13] Crichton GE, Bryan J, Buckley J, Murphy KJ. Dairy consumption and metabolic syndrome: a systematic review of findings and methodological issues. *Obes Rev: Off J Int Assoc Study Obes.* 2011;12:e190–201
- [14] Benatar JR, Sidhu K, Stewart RA. Effects of high and low fat dairy food on cardio-metabolic risk factors: a meta-analysis of randomized studies. *PLoS One.* 2013;8:e76480.
- [15] Huth PJ, Park KM. Influence of dairy product and milk fat consumption on cardiovascular disease risk: a review of the evidence. *Adv Nutr.* 2012;3:266–85.
- [16] Mozaffarian D. Dairy foods, obesity, and metabolic health: the role of the food matrix compared with single nutrients. *Adv Nutr* 2019;10:917S-923S.
- [17] Bian S, Hu J, Zhang K, Wang Y, Yu M, Ma J. Dairy product consumption and risk of hip fracture: a systematic review and meta-analysis. *BMC Public Health* 2018;18:165.
- [18] Carwile JL, Willett WC, Michels KB. Consumption of low-fat dairy products may delay natural menopause. *J Nutr.* 2013;143(10):1642–50.
- [19] Harris HR, Chavarro JE, Malspeis S, et al. Dairy-food, calcium, magnesium, and vitamin D intake and endometriosis: a prospective cohort study. *Am J Epidemiol.* 2013;177(5):420–30
- [20] Wang H, Troy LM, Rogers GT, Fox CS, McKeown NM, Meigs JB, Jacques PF. Longitudinal association between dairy consumption and changes of body weight and waist circumference: the Framingham Heart Study. *Int J Obes (Lond)* 2014;38:299–305.
- [21] Martinez-Gonzalez MA, Sayon-Orea C, Ruiz-Canela M, de la Fuente C, Gea A, Bes-Rastrollo M. Yogurt consumption, weight change and risk of overweight/obesity: the SUN cohort study. *Nutr Metab Cardiovasc Dis* 2014;24:1189–96.