Association of Bovine Milk and Curd Intake with the Prevention and Management of Osteoporosis among Postmenopausal Women: A Narrative Review

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Abstract

Osteoporosis is a progressive skeletal disorder characterised by reduced bone mineral density, deterioration of bone microarchitecture and increased susceptibility to fragility fractures. Postmenopausal women are particularly vulnerable because declining oestrogen concentrations accelerate bone resorption. Adequate intake of calcium, high-quality protein, phosphorus and vitamin D is important for preserving skeletal health, and bovine milk and fermented milk products such as curd or yogurt provide several of these nutrients within a single food matrix. This narrative review evaluates the association of bovine milk and curd intake with bone mineral density, bone turnover and fracture risk among postmenopausal women. Randomised trials and meta-analyses generally indicate that milk or fortified dairy interventions produce modest improvements in bone mineral density, particularly among women with low habitual calcium intake. Observational research also associates yogurt consumption with higher hip bone mineral density and, in some studies, a lower risk of hip fracture. However, findings for milk consumption and fracture prevention are inconsistent across populations. Variations in baseline nutritional status, vitamin D fortification, dairy type, serving size, ethnicity, lifestyle and residual confounding may explain these differences. Milk and curd should therefore be regarded as nutrient-dense components of a comprehensive osteoporosis-prevention strategy rather than independent treatments or cures. Women with established osteoporosis or high fracture risk require clinical evaluation, appropriate exercise, fall prevention and pharmacological therapy when indicated. More long-term randomised trials are required, particularly in South Asian populations, to determine the effects of culturally consumed bovine milk and household-prepared curd on fractures and bone microarchitecture.

Keywords: bovine milk; curd; yogurt; dairy products; osteoporosis; postmenopausal women; bone mineral density; calcium; vitamin D; fracture prevention

1. Introduction

Osteoporosis is a systemic skeletal disorder in which loss of bone mass and deterioration of bone microarchitecture increase bone fragility and the probability of fractures. Although ageing affects bone health in both sexes, postmenopausal women experience a particularly rapid phase of bone loss because ovarian oestrogen production declines markedly after menopause. Oestrogen deficiency increases osteoclast formation and activity, while bone formation does not increase sufficiently to compensate for accelerated resorption. Consequently, the lumbar spine, femoral neck and hip become especially vulnerable to osteoporosis and fragility fractures.

The burden of osteoporosis is substantial in India. A systematic review and meta-analysis of Indian studies reported pooled osteoporosis prevalence estimates of approximately 29% at the lumbar

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spine and 29% at the femoral neck among postmenopausal women. Osteopenia was also common, indicating that a large proportion of women may enter older age with compromised skeletal reserves (Anupama *et al.*, 2022). (PubMed)

Nutrition is one of the modifiable determinants of bone health. Calcium, protein, phosphorus, magnesium, potassium and vitamin D contribute directly or indirectly to bone mineralisation, calcium homeostasis, muscle strength and fall prevention. Bovine milk and curd provide calcium, phosphorus and high-quality protein, while fortified milk may also supply vitamin D. Curd, commonly known as *dahi* in South Asia, is produced by fermenting milk with lactic acid bacteria. It is broadly comparable to yogurt, although commercial yogurt generally contains standardised starter cultures, whereas household curd may have a more variable microbial composition.

The biological value of dairy foods is not limited to their calcium concentration. Their combination of calcium, protein, phosphorus and other nutrients may produce effects that differ from those of isolated calcium supplementation. Nevertheless, the assumption that milk alone prevents or cures osteoporosis is an oversimplification. Bone strength is influenced by genetics, age, body weight, hormonal status, vitamin D status, physical activity, smoking, alcohol use, medicines, comorbidities and fall risk.

The purpose of this review is to critically examine the relationship of bovine milk and curd intake with osteoporosis prevention and management among postmenopausal women and to identify the clinical implications and limitations of the available evidence.

2. Nutritional Composition of Bovine Milk and Curd Relevant to Bone Health

2.1 Calcium

Calcium is the principal mineral component of hydroxyapatite crystals, which provide rigidity and compressive strength to bone. When dietary calcium intake is inadequate, parathyroid hormone secretion may increase to maintain circulating calcium concentrations, partly by stimulating calcium mobilisation from the skeleton.

Milk and curd are concentrated and relatively bioavailable dietary sources of calcium. Their calcium is consumed together with lactose, casein-derived peptides and phosphorus, which may support intestinal utilisation and skeletal retention. The absolute calcium content varies according to animal species, processing, dilution and serving size. Consequently, dietary recommendations should be based on the labelled or measured nutrient content rather than assuming that every form of milk or curd provides an identical amount.

2.2 Protein

Approximately half of bone volume consists of protein, predominantly type I collagen. Dietary protein supplies amino acids required for collagen formation, muscle maintenance and the production of growth-related factors such as insulin-like growth factor-1. Adequate protein intake is particularly important in older women because sarcopenia, weakness and impaired balance increase fall and fracture risk.

Milk contains casein and whey proteins with a favourable indispensable-amino-acid profile. Curd retains most of the protein present in the original milk and may be easier for some older adults to consume because of its texture and reduced lactose content. Evidence reviews generally indicate

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that adequate or moderately higher protein intake supports bone and muscle health when calcium intake is sufficient, rather than causing clinically important skeletal calcium loss (Rizzoli *et al.*, 2018).

2.3 Phosphorus, potassium and micronutrients

Phosphorus combines with calcium in the mineral phase of bone. Potassium-rich foods may support a less acidogenic dietary pattern, although the clinical effects of individual minerals cannot be separated easily from the overall diet. Milk also supplies vitamin B_{12}, riboflavin and, depending on feeding practices and fortification, vitamins A and D.

Natural bovine milk is not necessarily a rich source of vitamin D. The vitamin D content of milk differs substantially between countries because fortification policies vary. Therefore, the skeletal effects observed in populations consuming routinely fortified milk may not be reproduced where unfortified milk is predominantly consumed.

2.4 Fermentation and the potential importance of the dairy matrix

Fermentation converts part of the lactose in milk to lactic acid, often making curd or yogurt better tolerated than fluid milk by people with lactose maldigestion. Fermentation may also alter milk proteins and produce bioactive peptides. Probiotic organisms and fermentation products could influence intestinal barrier function, inflammation and mineral absorption through the gut–bone axis.

These mechanisms are biologically plausible, but evidence that ordinary household curd produces clinically meaningful improvements in bone density or fracture risk through probiotic pathways remains limited. Most human research has examined commercial yogurt or fermented milk preparations rather than traditional Indian curd. The findings should therefore not be considered completely interchangeable.

3. Effects of Milk Intake on Bone Mineral Density

Bone mineral density measured by dual-energy X-ray absorptiometry is one of the most widely used surrogate indicators of skeletal strength. Although bone mineral density does not capture every aspect of bone quality, lower values are associated with greater fracture risk.

A randomised trial among 200 postmenopausal Chinese women with habitually low calcium intake evaluated milk powder supplying approximately 800 mg of additional calcium per day. Women receiving the milk supplement experienced less bone loss than women in the control group. The intervention also influenced biochemical indicators of calcium and vitamin D metabolism. These findings suggest that milk supplementation may be particularly useful when habitual calcium intake is inadequate (Lau *et al.*, 2001). (PubMed)

A systematic review and meta-analysis of randomised controlled trials concluded that dairy-product interventions produced significant improvements in bone mineral density among healthy postmenopausal women. The effects were generally modest and differed by skeletal site, intervention composition and study duration. The authors regarded dairy intake as a potentially useful public-health measure for preventing postmenopausal bone loss, although the evidence did not establish that dairy foods alone prevent fractures (Shi *et al.*, 2020). (PubMed)

Fortified dairy products may have advantages over unfortified products in women with concurrent calcium and vitamin D insufficiency. A meta-analysis by Liu *et al.* (2020) reported improvements in total, lumbar-spine, arm and femoral-neck bone mineral density following

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combined calcium and vitamin D interventions. In subgroup analyses, calcium- and vitamin-D-fortified dairy products produced favourable effects on total and lumbar-spine bone mineral density. (RSC Publishing)

Nevertheless, not all studies demonstrate benefit. Data from the Study of Women's Health Across the Nation found no significant association between dairy intake and reduced femoral-neck or lumbar-spine bone loss across the menopausal transition. Dairy intake was also not associated with lower fracture risk in that cohort (Wallace *et al.*, 2020). (PubMed)

The contrast between trials and cohort studies may partly reflect baseline nutrition. Supplementation is more likely to produce a measurable response in women who initially consume little calcium or protein. In well-nourished populations, adding more dairy may provide limited incremental benefit.

4. Curd, Yogurt and Fermented Dairy Products

Observational studies frequently suggest that yogurt consumption is positively associated with skeletal health. In a study of older adults, Laird *et al.* (2017) reported that greater yogurt consumption was associated with higher bone mineral density and better physical-function scores. The association was particularly evident at the hip, a clinically important site for osteoporotic fractures. (Springer)

A systematic review of fermented milk products among postmenopausal women found that yogurt was the fermented dairy product most consistently associated with favourable skeletal outcomes. Greater yogurt intake was associated in some studies with higher bone mineral density and reduced hip-fracture risk. Short-duration interventions also reported reductions in certain bone-resorption markers, although effects on bone-formation markers were less consistent (Ong *et al.*, 2020). (PubMed)

Several characteristics may explain why yogurt or curd sometimes appears more favourable than fluid milk:

1. Fermentation reduces lactose content and may improve tolerance.
2. Curd is often consumed with meals, potentially improving regularity of intake.
3. Yogurt may provide live microorganisms and fermentation-derived metabolites.
4. Thick yogurt may contain more protein per serving than ordinary fluid milk.
5. Yogurt consumers may also follow healthier dietary and physical-activity patterns.

The last explanation is particularly important. Most evidence for yogurt is observational; therefore, yogurt intake may act as a marker of an overall healthier lifestyle. Although statistical adjustment reduces confounding, it cannot eliminate it completely.

Furthermore, traditional curd differs from commercial yogurt in culture composition, fermentation time, milk source and storage conditions. Direct clinical trials of household-prepared bovine curd in postmenopausal South Asian women remain scarce. A beneficial association observed with standardised yogurt cannot automatically be attributed to all locally prepared curd products.

5. Dairy Intake and Osteoporotic Fracture Risk

5.1 Milk and fracture risk

The relationship between milk consumption and fracture risk is less consistent than its relationship with bone mineral density. A meta-analysis of prospective cohorts found no overall

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association between milk intake and hip-fracture risk among women (Bischoff-Ferrari *et al.*, 2011). Other cohort research has reported protective associations, particularly where milk consumption was compared with very low or absent intake.

In the Framingham Original Cohort, higher milk and combined milk-plus-yogurt intake were associated with a lower risk of hip fracture among older adults. Adjustment for femoral-neck bone mineral density attenuated the relationship, suggesting that at least part of the association may have been mediated through bone density (Sahni *et al.*, 2014). (PubMed)

A systematic review by Hidayat *et al.* (2020) found geographical variation. Milk intake was associated with lower hip-fracture risk in some American cohorts but not in Scandinavian populations. Differences in vitamin D fortification, baseline calcium intake, dairy-consumption patterns and lifestyle may have contributed to these contrasting findings. (PubMed)

A separate systematic review concluded that greater milk and total dairy consumption was not consistently associated with a lower risk of osteoporosis or hip fracture (Malmir *et al.*, 2020). More recent dose–response analyses have also raised the possibility that increasing milk intake does not continuously reduce fracture risk and may show neutral or unfavourable associations at some intake levels. These findings should be interpreted cautiously because observational dose–response analyses remain vulnerable to residual confounding and differences in dietary assessment (Mishra *et al.*, 2023). (PubMed)

5.2 Yogurt or curd and fracture risk

A meta-analysis of dairy products and hip fracture found that higher yogurt and cheese intake was associated with lower hip-fracture risk in cohort studies, whereas total dairy and milk showed no consistent overall association (Bian *et al.*, 2018). (Springer)

Ong *et al.* (2020) similarly concluded that, among the fermented milk products evaluated in postmenopausal women, yogurt demonstrated the most consistent inverse association with hip fracture. However, the number of studies was limited, serving definitions differed and observational designs could not prove causality.

5.3 Evidence from institutionalised older adults

One of the strongest food-based intervention studies was conducted among older residents of aged-care facilities. Increasing milk, yogurt and cheese intake to improve calcium and protein consumption significantly reduced falls and fractures. The findings demonstrate that correcting inadequate calcium and protein intake through dairy foods can produce clinically meaningful outcomes in nutritionally vulnerable older populations (Iuliano *et al.*, 2021). (PubMed)

Although the trial was not restricted to postmenopausal women, its results are relevant because women constituted a large proportion of aged-care populations and commonly experience both osteoporosis and undernutrition. The magnitude of benefit may not be reproduced in healthy, community-dwelling women who already consume sufficient calcium and protein.

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6. Summary of Major Evidence

Study	Design and population	Dairy exposure	Principal finding
Lau *et al.* (2001)	Randomised trial; postmenopausal Chinese women with low calcium intake	Calcium-rich milk powder	Milk supplementation slowed bone loss
Laird *et al.* (2017)	Observational study of older adults	Yogurt intake	Higher yogurt intake was associated with greater hip BMD and better physical function
Bian *et al.* (2018)	Systematic review and meta-analysis	Milk, yogurt, cheese and total dairy	Yogurt and cheese showed inverse associations with hip fracture in cohort studies; milk findings were inconclusive
Ong *et al.* (2020)	Systematic review of fermented dairy	Yogurt, fermented milk and cheese	Yogurt showed the most consistent favourable relationship with BMD and hip-fracture risk
Shi *et al.* (2020)	Meta-analysis of randomised trials in postmenopausal women	Dairy interventions	Dairy produced modest improvements in BMD
Wallace *et al.* (2020)	Prospective menopausal-transition cohort	Total and individual dairy foods	No significant reduction in BMD loss or fractures
Liu *et al.* (2020)	Meta-analysis of randomised trials	Calcium- and vitamin-D-fortified dairy and supplements	Fortified dairy improved several BMD outcomes
Iuliano *et al.* (2021)	Cluster-randomised trial in aged-care residents	Additional milk, yogurt and cheese	Increased dairy intake reduced falls and fractures
Mishra *et al.* (2023)	Dose–response meta-analysis of prospective cohorts	Milk and other dairy products	Fracture associations varied according to dairy type and dose

The collective evidence is more convincing for modest preservation of bone mineral density than for universal prevention of hip fractures. (PubMed)

7. Role of Milk and Curd in Osteoporosis Prevention

Milk and curd can contribute to primary prevention by helping postmenopausal women meet requirements for calcium and protein. Their potential value is greatest when habitual dietary intake is inadequate because of food insecurity, restrictive diets, poor appetite, low dairy consumption or limited access to other calcium-rich foods.

A practical dietary pattern may include moderate portions of milk, unsweetened curd or yogurt, together with pulses, green vegetables, nuts, seeds, eggs or other protein sources according to personal and cultural preferences. Milk and curd should not displace fruits, vegetables, whole grains and other nutrient-dense foods.

Vitamin D status requires separate consideration. Because most unfortified bovine milk and traditional curd contain limited vitamin D, dairy intake does not automatically correct vitamin D deficiency. Sunlight exposure, vitamin-D-rich foods, fortified products or medically supervised supplementation may be needed.

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Calcium and vitamin D work together in skeletal metabolism. An updated meta-analysis reported that calcium-plus-vitamin-D supplementation reduced total and hip fractures, although benefits were influenced by adherence, residential setting and baseline nutrient status (Weaver *et al.*, 2016). (Springer)

Prevention should also include:

- regular weight-bearing and resistance exercise;
- adequate dietary protein;
- maintenance of a healthy body weight;
- avoidance of smoking;
- limitation of excessive alcohol consumption;
- correction of visual impairment;
- review of sedative and bone-depleting medicines;
- home-based fall-risk reduction; and
- bone-density screening when clinically indicated.

8. Role in the Management of Established Osteoporosis

The term "management" should not imply that milk or curd can reverse established osteoporosis independently. Dietary calcium and protein support the effectiveness of osteoporosis management, but women with a previous fragility fracture, very low bone mineral density or high calculated fracture risk generally require evidence-based pharmacological treatment.

The Endocrine Society recommends pharmacological therapy for postmenopausal women at high fracture risk, particularly those with a recent fracture. Bisphosphonates are commonly used as initial treatment, while denosumab, anabolic agents, selective oestrogen-receptor modulators, menopausal hormone therapy or romosozumab may be considered according to individual risk, age, comorbidities and contraindications. Calcium and vitamin D are recommended as adjuncts rather than replacements for osteoporosis medicines (Eastell *et al.*, 2019). (Endocrine)

Milk and curd may support management in several ways:

1. **Meeting calcium requirements:** Food-based calcium may reduce dependence on large supplemental doses.
2. **Supporting protein intake:** Dairy protein can help preserve muscle mass and functional capacity.
3. **Improving meal quality:** Curd is often acceptable to older women with poor appetite or chewing difficulty.
4. **Supporting medicine effectiveness:** Adequate calcium and vitamin D are necessary during most anti-osteoporosis treatments.
5. **Reducing fall vulnerability:** Improved protein and energy intake may support strength, although dairy alone cannot prevent falls.

Dietary improvement should occur alongside diagnostic evaluation, treatment of secondary causes, exercise prescription and monitoring of bone mineral density.

9. Sources of Inconsistency in the Evidence

9.1 Baseline calcium and protein intake

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Women consuming very little calcium are more likely to respond to dairy supplementation than women already meeting requirements. Studies that do not stratify participants according to baseline intake may underestimate benefits in deficient groups.

9.2 Vitamin D status and fortification

Milk is routinely fortified with vitamin D in some countries but not in others. Consequently, "one serving of milk" may represent a calcium-and-vitamin-D intervention in one population and a calcium-only food in another.

9.3 Dairy type

Fluid milk, curd, yogurt, cheese, cream and butter have substantially different nutrient profiles. Combining them as "total dairy" may obscure product-specific associations. Butter and cream, for example, provide comparatively little calcium and protein per unit of energy.

9.4 Fat and added sugar

Full-fat dairy contributes more saturated fat and energy, while flavoured yogurt may contain considerable added sugar. These characteristics may influence cardiometabolic health and body weight. Plain curd, unsweetened yogurt and low-fat milk may be preferable where energy intake or cardiovascular risk requires control, although individual nutritional needs should be considered.

9.5 Observational confounding

People who regularly consume yogurt may exercise more, smoke less, have higher incomes or follow healthier diets. Conversely, people with poor health may deliberately increase milk consumption after receiving medical advice, creating reverse causation.

9.6 Fracture as a multifactorial outcome

Fractures are determined not only by bone density but also by falls, vision, balance, muscle strength, medicines, home hazards and trauma. A dietary intervention may improve bone density without producing a detectable reduction in fractures during a short study period.

9.7 Duration of research

Changes in bone turnover markers can occur within weeks, whereas meaningful differences in bone density and fractures may require years. Many dairy trials are too short or too small to evaluate fracture outcomes reliably.

10. Safety and Practical Considerations

10.1 Lactose intolerance

Women with lactose maldigestion may tolerate curd or yogurt better than fluid milk because fermentation reduces lactose content. Small divided portions of milk, lactose-free milk or hard cheese may also be considered. Complete dairy exclusion is not always necessary, but individual tolerance should guide intake.

10.2 Milk-protein allergy

True bovine milk-protein allergy requires avoidance of bovine dairy products. Although less common in adults than in children, it should not be confused with lactose intolerance.

10.3 Renal disease and nephrolithiasis

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Women with chronic kidney disease, hypercalcaemia or a history of certain kidney stones require individualised advice regarding calcium, phosphorus, protein and vitamin D. High-dose supplementation should not be initiated without clinical supervision.

10.4 Energy and saturated-fat intake

Large quantities of full-fat milk or sweetened curd may contribute excess energy. Product selection and portion size should be integrated into the woman's overall cardiovascular, metabolic and weight-management plan.

10.5 Food safety

Milk should be pasteurised or adequately boiled, and curd should be prepared and stored hygienically. Contaminated raw milk or improperly stored curd may cause food-borne illness, particularly in older adults.

11. Implications for South Asian and Indian Populations

Milk and curd are culturally familiar foods in India and may be feasible vehicles for increasing dietary calcium and protein. Nevertheless, regional differences are important. Household milk may be obtained from cows or buffaloes, and the nutrient composition differs by species and fat content. Dilution, skimming, boiling, fermentation and serving size further influence nutrient intake.

Traditional Indian curd deserves separate investigation. Most international literature concerns commercial yogurt manufactured using standardised cultures. Household *dahi* may contain different bacterial communities and may vary from one preparation to another. Future Indian studies should document:

- whether the product is made from cow or buffalo milk;
- calcium, protein, fat and vitamin D content;
- starter culture and fermentation method;
- portion size and frequency of intake;
- habitual dietary calcium and protein;
- serum vitamin D concentration;
- menopausal duration;
- physical activity and sunlight exposure; and
- bone density and incident fragility fractures.

Given the high reported burden of osteopenia and osteoporosis among Indian postmenopausal women, culturally acceptable food-based interventions warrant investigation, particularly among women with low incomes, low calcium intake and limited access to osteoporosis services. (PubMed)

12. Research Gaps and Future Directions

Further research should move beyond simple comparisons of "high" and "low" dairy intake. Priority areas include:

1. Long-duration randomised trials comparing milk, curd and non-dairy calcium sources.
2. Trials among postmenopausal women with documented low calcium intake.
3. Direct comparison of fortified and unfortified milk.
4. Standardised studies of Indian household curd.
5. Measurement of volumetric bone density, cortical structure and trabecular microarchitecture.

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6. Evaluation of muscle strength, falls and physical function alongside bone density.
7. Documentation of incident vertebral, hip and other fragility fractures.
8. Investigation of interactions among dairy intake, vitamin D status, exercise and osteoporosis medication.
9. Cost-effectiveness studies in rural and resource-limited communities.
10. Examination of whether probiotic strains or fermentation metabolites influence the gut–bone axis.

Future studies should distinguish association from causation and should report funding sources and possible dairy-industry involvement transparently.

13. Conclusion

Bovine milk and curd are nutrient-dense foods capable of contributing calcium, phosphorus and high-quality protein to the diets of postmenopausal women. Randomised trials and meta-analyses generally support modest benefits of milk and dairy interventions for bone mineral density, particularly among women with low baseline calcium intake. Fortified dairy products may provide additional benefits where calcium and vitamin D insufficiency coexist.

Curd and yogurt show promising associations with higher hip bone mineral density and reduced hip-fracture risk, but much of this evidence is observational. The biological effects of commercial yogurt cannot be assumed to apply uniformly to household-prepared curd.

Evidence concerning milk and fracture prevention remains inconsistent. Milk and curd should therefore be recommended as components of a balanced, calcium- and protein-adequate diet rather than promoted as cures for osteoporosis. Established osteoporosis requires comprehensive fracture-risk assessment, resistance and weight-bearing exercise, fall prevention, adequate vitamin D and pharmacological therapy when clinically indicated.

The most defensible conclusion is that regular, moderate intake of suitable bovine milk or curd may assist in preventing nutrient-related bone loss and may support osteoporosis treatment, especially in women with inadequate dietary calcium and protein. It cannot replace diagnosis, medical treatment or other essential lifestyle measures.

References

- Anupama, D.S., Noronha, J.A., Acharya, K.K.V., Prabhu, M.M., Shetty, J., Shankar, R. and Nayak, B.S. (2022) ‘Burden of osteopenia and osteoporosis among postmenopausal women in India: A systematic review and meta-analysis’, *Journal of Mid-Life Health*, 13(2), pp. 107–114. doi: 10.4103/jmh.jmh-207-21.
- Bian, S., Hu, J., Zhang, K., Wang, Y., Yu, M. and Ma, J. (2018) ‘Dairy product consumption and risk of hip fracture: A systematic review and meta-analysis’, *BMC Public Health*, 18, article 165. doi: 10.1186/s12889-018-5041-5.
- Bischoff-Ferrari, H.A., Dawson-Hughes, B., Baron, J.A., Burckhardt, P., Li, R., Spiegelman, D., Specker, B., Orav, J.E., Wong, J.B., Staehelin, H.B., O’Reilly, E., Kiel, D.P. and Willett, W.C. (2011) ‘Milk intake and risk of hip fracture in men and women: A meta-analysis of prospective cohort studies’, *Journal of Bone and Mineral Research*, 26(4), pp. 833–839. doi: 10.1002/jbmr.279.

ISSN2277-3630(online),Published by International journal of Social Sciences & Interdisciplinary Research., under Volume: 15 Issue:06 in June-2026
https://www.gejournal.net/index.php/IJSSIR

- Eastell, R., Rosen, C.J., Black, D.M., Cheung, A.M., Murad, M.H. and Shoback, D. (2019) 'Pharmacological management of osteoporosis in postmenopausal women: An Endocrine Society clinical practice guideline', *Journal of Clinical Endocrinology and Metabolism*, 104(5), pp. 1595–1622. doi: 10.1210/jc.2019-00221.
- Feskanich, D., Meyer, H.E., Fung, T.T., Bischoff-Ferrari, H.A. and Willett, W.C. (2018) 'Milk and other dairy foods and risk of hip fracture in men and women', *Osteoporosis International*, 29(2), pp. 385–396. doi: 10.1007/s00198-017-4285-8.
- Hidayat, K., Du, X., Shi, B.M. and Qin, L.Q. (2020) 'Systematic review and meta-analysis of the association between dairy consumption and the risk of hip fracture: Critical interpretation of the currently available evidence', *Osteoporosis International*, 31(8), pp. 1411–1425. doi: 10.1007/s00198-020-05383-3.
- Iuliano, S., Poon, S., Robbins, J., Bui, M., Wang, X., De Groot, L., Van Loan, M., Zadeh, A.G. and Nguyen, T. (2021) 'Effect of dietary sources of calcium and protein on hip fractures and falls in older adults in residential care: Cluster randomised controlled trial', *BMJ*, 375, n2364. doi: 10.1136/bmj.n2364.
- Laird, E., Molloy, A.M., McNulty, H., Ward, M., McCarroll, K., Hoey, L., Hughes, C., Cunningham, C., Strain, J.J. and Casey, M.C. (2017) 'Greater yogurt consumption is associated with increased bone mineral density and physical function in older adults', *Osteoporosis International*, 28(8), pp. 2409–2419. doi: 10.1007/s00198-017-4049-5.
- Lau, E.M.C., Woo, J., Lam, V. and Hong, A. (2001) 'Milk supplementation of the diet of postmenopausal Chinese women on a low calcium intake retards bone loss', *Journal of Bone and Mineral Research*, 16(9), pp. 1704–1709. doi: 10.1359/jbmr.2001.16.9.1704.
- Liu, C., Kuang, X., Li, K., Guo, X., Deng, Q. and Li, D. (2020) 'Effects of combined calcium and vitamin D supplementation on osteoporosis in postmenopausal women: A systematic review and meta-analysis of randomized controlled trials', *Food & Function*, 11(12), pp. 10817–10827. doi: 10.1039/D0FO00787K.
- Malmir, H., Larijani, B. and Esmaillzadeh, A. (2020) 'Consumption of milk and dairy products and risk of osteoporosis and hip fracture: A systematic review and meta-analysis', *Critical Reviews in Food Science and Nutrition*, 60(10), pp. 1722–1737. doi: 10.1080/10408398.2019.1590800.
- Mishra, S., Baruah, K., Malik, V.S. and Ding, E.L. (2023) 'Dairy intake and risk of hip fracture in prospective cohort studies: Non-linear algorithmic dose–response analysis in 486,950 adults', *Journal of Nutritional Science*, 12, e96. doi: 10.1017/jns.2023.63.
- Ong, A.M., Kang, K., Weiler, H.A. and Morin, S.N. (2020) 'Fermented milk products and bone health in postmenopausal women: A systematic review of randomized controlled trials, prospective cohorts, and case-control studies', *Advances in Nutrition*, 11(2), pp. 251–265. doi: 10.1093/advances/nmz108.
- Rizzoli, R., Biver, E., Bonjour, J.P., Coxam, V., Goltzman, D., Kanis, J.A., Lappe, J., Rejnmark, L., Sahni, S., Weaver, C., Weiler, H. and Reginster, J.Y. (2018) 'Benefits and

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https://www.gejournal.net/index.php/IJSSIR

safety of dietary protein for bone health: An expert consensus paper', *Osteoporosis International*, 29(9), pp. 1933–1948. doi: 10.1007/s00198-018-4534-5.

- Sahni, S., Mangano, K.M., Tucker, K.L., Kiel, D.P., Casey, V.A. and Hannan, M.T. (2014) 'Protective association of milk intake on the risk of hip fracture: Results from the Framingham Original Cohort', *Journal of Bone and Mineral Research*, 29(8), pp. 1756–1762. doi: 10.1002/jbmr.2219.
- Shi, Y., Zhan, Y., Chen, Y. and Jiang, Y. (2020) 'Effects of dairy products on bone mineral density in healthy postmenopausal women: A systematic review and meta-analysis of randomized controlled trials', *Archives of Osteoporosis*, 15, article 48. doi: 10.1007/s11657-020-0694-y.
- Wallace, T.C., Jun, S., Zou, P., McCabe, G.P., Craig, B.A., Cauley, J.A., Liao, D. and Weaver, C.M. (2020) '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*, 27(8), pp. 879–886.
- Weaver, C.M., Alexander, D.D., Boushey, C.J., Dawson-Hughes, B., Lappe, J.M., LeBoff, M.S., Liu, S., Looker, A.C., Wallace, T.C. and Wang, D.D. (2016) 'Calcium plus vitamin D supplementation and risk of fractures: An updated meta-analysis from the National Osteoporosis Foundation', *Osteoporosis International*, 27(1), pp. 367–376. doi: 10.1007/s00198-015-3386-5.

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