REVIEW ARTICLE

CONTENTS

Collagen supplementation and bone health – a narrative review

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ABSTRACT

Osteoporosis is a known skeletal chronic disease which decreases bone mass, damages bone microarchitecture and increases the risk of fragility fractures. Non pharmacological interventions, such as nutritional changes play a significant supportive role in bone health maintenance along with pharmacological treatments. Collagen is a key organic component of the bone matrix, which subjects it to intensive research as a potential dietary supplement, especially in individuals with low bone mass. The review aims to critically evaluate and summarize novel studies between 2020 and 2025 that described the significance of oral collagen supplementation, especially in individuals with poor bone health. A narrative review of human studies published from 2020 to 2025 was conducted. Inclusion criteria included observational studies, randomized controlled trials, systematic reviews, meta-analyses, and clinical guidelines focusing on the evaluation of oral collagen peptide or hydrolyzed collagen supplementation and bone related outcomes. Preclinical and animal studies were excluded. The prevailing evidence suggests that oral collagen has a beneficial supportive effect on bone health, particularly in individuals with early bone loss. Due to the heterogeneous nature of currently available literature and limited studies on fracture outcomes, collagen supplementation can not be considered as a replacement therapy but rather an adjunctive treatment to established osteoporosis regimes.

KEY WORDS: bone density, collagen peptides, dietary supplements, osteopenia, postmenopause

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INTRODUCTION

Osteoporosis is a known skeletal chronic disease which decreases bone mass, damages bone microarchitecture and increases the risk of fragility fractures [1]. Osteoporotic fractures are a leading cause of disability, morbidity and increased mortality rate - especially among the elderly population. This generates immense economic burden on healthcare systems worldwide [2]. With the current aging population, incidences of osteoporosis and osteopenia are expected to increase further which highlights the urgency and importance of effective therapeutic and preventive strategies. Current clinical guidelines emphasize that management of osteoporosis should not be solely based on pharmacological interventions, but healthcare workers should rather have a comprehensive approach inclusive of non pharmacological treatment such as fall prevention, physical activity, and appropriate supplementation [3,4]. Optimal intake of vitamin D, calcium and dietary protein are key determinants of bone health. However, there is a growing interest in the role of other nutritional components that influence bone health including organic compounds that play a key role in maintaining the structure of bone matrix.

Bone integrity is not solely determined by the bone mineral density (BMD) but rather by their overall properties which include microarchitecture, material content of the bone tissue, turnover rate and microdamage accumulation [1]. Approximately 90% of organic bone matrix is composed of Type I collagen which plays a key role in providing elasticity and tensile strength while serving as a scaffold for the hydroxyapatite deposition.

Age-related disorders of collagen synthesis, its post-translational modifications and cross-link forma-

tion adversely affect the mechanical properties of bones which increase the risk of fractures, regardless of bone mineral density [2]. Oral forms of hydrolyzed and specific bioactive collagen peptides are increasingly being recommended as vital supplementation to enhance bone and muscle health. Collagen supplements have been used as known agents to improve skin and hair conditions for a known period of time however the impact of collagen on bone health and the prevention of osteoporosis is a subject of ongoing research [5, 6].

AIM

The narrative review aims to critically evaluate the effects of collagen supplementation on bone mineral density, bone turnover markers and related bone health outcomes in the adult population with marked emphasis on individuals with osteopenia and postmenopausal women based on clinical evidence published between 2020 and 2025.

MATERIALS AND METHODS

This narrative review was conducted based on a structured evaluation of studies involving human participants published between January 2020 and 2025. Publications meeting the inclusion criteria included randomized controlled trials, observational studies, systematic reviews, meta-analyses, and clinical practice guidelines assessing oral supplementation with collagen peptides or hydrolyzed collagen on bone parameters.

Major biomedical databases and key references were searched to identify publications. Studies involving adult participants were included whereas animal and in vitro studies were excluded. As the current review is narrative in nature, emphasis was placed on critical interpretation of key study methodology, population characteristics, and significant clinical evidence.

REVIEW AND DISCUSSION

BIOLOGICAL RATIONALE FOR COLLAGEN SUPPLEMENTATION IN BONE HEALTH

Bone tissue is continuously remodelled by a coordinated process of resorption brought upon by osteoclasts and formation of new bone material arising from osteoblasts. Collagen type I is an essential component of the bone matrix contributing to its strength and resistance to crack propagation. Disturbances in the collagen structure may lead to increased bone fragility, despite the preserved mineral content [2]. Dietary collagen supplementation provides key amino acids such as proline and glycine along with bioactive peptides which influence bone metabolism. Research shows that collagen-derived peptides can influence osteoblast differentiation and extracellular matrix, thereby contributing to the strengthening of bone structure [7-9]. Delving into the mechanisms - collagen supplementation should be treated as a supportive building substrate intervention rather than a direct antiresorptive or anabolic therapy.

RANDOMIZED CONTROLLED TRIALS IN POSTMENOPAUSAL WOMEN WITH OSTEOPENIA

Most clinically relevant conclusions regarding collagen supplementation can be drawn from randomized controlled trials carried out in postmenopausal women with osteopenia. A controlled trial conducted by Argyrou and colleagues examined the effectiveness of vitamin D supplementation in monotherapy and taking vitamin D with 5g/day collagen-derived peptides for a period of 12 months. Women taking vitamin D concomitantly with collagen peptides showed significantly favourable changes in bone turnover parameters, suggesting a modulatory effect on the bone remodelling process [10].

Similarly, Lampropoulou-Adamidou and colleagues expanded the scope of the study by including the assessment of bone mineral density at both sites using dual-energy X-ray absorptiometry, as well as the evaluation of volumetric BMD and bone geometry using peripheral quantitative computed tomography. A minor but statistically significant improvement in BMD and geometric volume parameters was seen in the group supplemented with vitamin D and collagen combined. This suggests an improvement in bone quality that could not be determined by DXA testing alone [11].

These results are clinically significant as bone geometry and volumetric density play a key role in shaping bone strength. However, these studies had their limitations contributed by a small sample size, combined supplementation (collagen plus calcium and vitamin D) and the absence of fracture outcomes.

OBSERVATIONAL AND LONG-TERM EVIDENCE

Long-term observations obtained from clinical studies demonstrate that collagen exerts a sustained effect on bone structure. Zdzieblik et al. found that postmenopausal women who continued supplements containing particular bioactive collagen peptides maintained or gradually improved their BMD over the course of a

long-term follow-up [12]. Although the study lacked a control group and was of observational nature, findings suggest that prolonged collagen supplementation is feasible and might be a contributing factor of sustained skeletal health.

SYSTEMATIC REVIEWS AND META-ANALYSES

Recent systematic reviews and meta-analyses have enabled the synthesis of the growing body of evidence regarding the effects of collagen supplementation on musculoskeletal health. Based on meta-analysis published 2025, collagen peptide supplementation was linked to modest yet statistically significant increases in bone mineral density and markers of bone turnover. This was particularly seen in individuals suffering from osteopenia and in studies evaluating vitamin D and collagen supplementation combined [5].

In a similar manner, a comprehensive systematic review investigated how the effects of collagen type I hydrolysate supplementation affect bone, muscle, and joint health.The strength of the authors' final clinical conclusions was limited by the notable variation in collagen formulation, dosages, duration of intervention, and outcome measures across studies, despite the fact that they found encouraging signals regarding improved bone metabolism [13].

COLLAGEN SUPPLEMENTATION COMBINED WITH PHYSICAL ACTIVITY

Collagen supplementation in combination with structured exercise regimens has been the subject of multiple randomized clinical trials in recent years. Collagen supplementation combined with resistance training or weight-bearing exercise promotes positive musculoskeletal adaptations, such as enhanced tendon properties, muscle strength, and functional performance, according to studies done on athletes and physically active people [14-17]. Given the strong correlation between muscle strength, fall risk, and fracture incidence, the results of these studies are clinically relevant even though they were not specifically designed to evaluate effects on osteoporosis. These findings lend credence to the idea that collagen supplementation bears the potency to depict positive outcomes when combined with appropriate mechanical loading as part of a broader lifestyle intervention.

SAFETY AND CLINICAL CONTEXT

Oral collagen supplementation is generally well tolerated, according to both observational and randomized studies. Serious treatment-related complications are rare, whereas mild gastrointestinal symptoms are the most common side effect of collagen supplementation [12,13]. Collagen dosages in bone health studies usually fall between 5 and 10 g daily. Based on the latest guidelines, it is not recommended to replace pharmacological treatment with oral collagen supplements in patients at high risk of fractures and injuries [3,4]. Rather collagen supplementation should be considered as supportive therapy within a comprehensive approach to osteoporosis treatment which includes calcium and Vitamin D optimization, adequate protein intake and evidence based pharmacotherapy [18, 19].

CONCLUSIONS

Between 2020 and 2025, oral collagen supplementation was repeatedly studied in the context of bone metabolism, with most studies reporting only modest benefits. Some improvements in bone mineral density were observed, particularly in postmenopausal women with osteopenia . The uncertain findings reported in meta-analyses and systematic reviews highlight the need for broader, carefully planned randomized trials that focus specifically on fracture-related outcomes and collagen supplementation. Without further concrete studies based in clinical settings the results rather stay inconclusive. Nevertheless, collagen supplements pose no harm and should be considered as an adjunct therapy for osteoporosis, but they do not hold the potency to replace established medical treatments. It's essential to follow established clinical guidelines with the treatment protocols that have been well-researched and continue to provide effective outcomes in terms of bone health.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

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