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Childhood nutrition and adult bone tumours: A systematic review

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ABSTRACT

Explaining how a childhood nutrition can influence the development of adult bone cancer is an attractive review in some aspects of public health and preventive medicine. Skeletal growth is primarily determined in formative years and nutritional deficiencies during these years raises susceptibility to bone malignancies in future. This systematic review is aimed at reviewing how deficiencies in some of the macro- and micronutrients affect the bone health in the long run as well as the risks of cancer. This systematic review examines the link between childhood nutrition and later life bone cancers, following PRISMA guidelines, utilizing databases like PubMed and Scopus, and focusing on peer-reviewed studies from 2000-2023. Some of the important nutrients include; protein, calcium and magnesium they are vital in the development of bones as well as the strength of bones. Dietary protein requirement in children affects bone mineralization and insulin-like growth Factor I IGF-I. Calcium is necessary for the development of bones and teeth and also phosphorus needed for DNA synthesis. Lack of these nutrients can make the bones to become weak and acts as a stage where diseases such as osteoporosis can be developed and this makes those affected to be at a higher risk of getting bone cancers like osteosarcoma. Also, various deficiencies including zinc, phosphorus, potassium and other vitamins and minerals affect bone formation and remodelling. These risks increase probably due to the increased intake of fast foods which have led to nutritional imbalances. Digital public health literacy interventions for improving childhood nutrition education and security have to be an all-inclusive program. Measures should also help consumers meet their needs of other essential nutrients especially in the interest-bearing regions. Proper childhood nutrition is essential for establishing strong skeletal foundations, potentially reducing the risk of bone cancers in later life. Ensuring adequate intake of vital nutrients during the formative years can significantly contribute to lifelong bone health and lower the incidence of bone malignancies. Childhood obesity and reduced fruit/vegetable intake are increasing, and nutritional awareness is low even among literates. Public awareness campaigns targeting students about proper nutrition and its role in preventing bone cancer are needed to address health issues and to better long-term outcomes.

Keywords: childhood nutrition, bone cancers, skeletal development, public health, osteosarcoma, macronutrients, micronutrients

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INTRODUCTION

Understanding the link between childhood nutrition and the development of adult bone cancers presents a compelling narrative in the realm of public health and preventive medicine. It is well-established that the formative years are crucial for skeletal development, with nutritional deficits during this period potentially setting the stage for a host of long-term health complications, including susceptibility to bone malignancies in adulthood. This relationship is substantiated by various studies suggesting that deficiencies in essential macronutrients and micronutrients during critical growth phases can severely impact skeletal health, consequently increasing cancer risk later in life [1].

The developmental stage of childhood is marked by rapid growth and the need for a sustained supply of nutrients. Protein, a vital macronutrient, plays an instrumental role in this process. Adequate protein intake during childhood is essential for building and maintaining bone density and integrity [2]. Protein not only serves as a cornerstone for muscle development but is also integral to skeletal health. Lack of sufficient protein has been associated with conditions like osteoporosis, where diminished bone density heightens the risk of fractures. These fractures and bone vulnerabilities may predispose individuals to bone cancers, considering that weakened bone structures create a permissive environment for malignancies.

There is a pronounced increase in the incidence of childhood obesity with its disastrous consequences and a decrease in the incidence of fruit and vegetable intake among college students. The concept of intermittent fasting and health is slowly vanishing among children. There should be a thrust for intake of different types of fruits with mineral content like Sitaphal and specific banana types in children. There is a lack of awareness even among literates about nutrition and health [3-11]. A public awareness among students about nutrient intake and bone cancer is the order of the day.

LITERATURE REVIEW

The purpose of this systematic review will therefore be to analyse the link between childhood nutrition status and bone cancers in later life. The method used in the study complied with the PRISMA statement or the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA).

Searches

The following international electronic databases were accessed for the identification of papers for the current study: PubMed, Scopus, Web of Science, and Google Scholar. These terms included Childhood nutrition, Bone health, Bone cancer, Osteosarcoma, Micronutrients, Macronutrients, vitamins, and minerals. The search was restricted to articles that were published in English in the period between January 2000, and December 2023.

Inclusion criteria

Study type:

Original research articles which have undergone peer review, cohort, case control and systematic reviews.

Population:

Research which directly concerns human subjects, or samples.

Paediatric nature:

Children and adolescents up to 18 years old.

Exposure:

Protein, fat, carb and their ratio and vitamins and minerals which a child should take on daily basis.

Outcome:

Information on life-style, diet and resources for bone health effects such as density, osteoporosis and the number of diagnosed bone cancer cases in adulthood.

Quality:

A comprehensive reporting of statistical data, the minimisation of confounding factors and the reporting of methods in detail.

Exclusion criteria

Non-peer-reviewed articles:

Publications which are not published in scholarly journals and books include theses, conference abstracts, and reports.

Lack of specificity:

Excluded were those papers which did not address the relationship between childhood diet and/or nutrition and bone health or more to cancer.

Language:

Some of the articles are not in English language.

Publication date:

Test: Scholarly articles or journals published and before the year 2000.

Data extraction and analysis

Studies were selected according to the aims of the research with regard to study type, participants, nutritional status, bone health status and cancer incidence and mortality. The quality of the studies was evaluated based on criteria that were developed in the context of Cochrane Collaboration where necessary meta-analysis was conducted as a form of analysis utilising the random-effect model due to the observed heterogeneity (Figure 1).

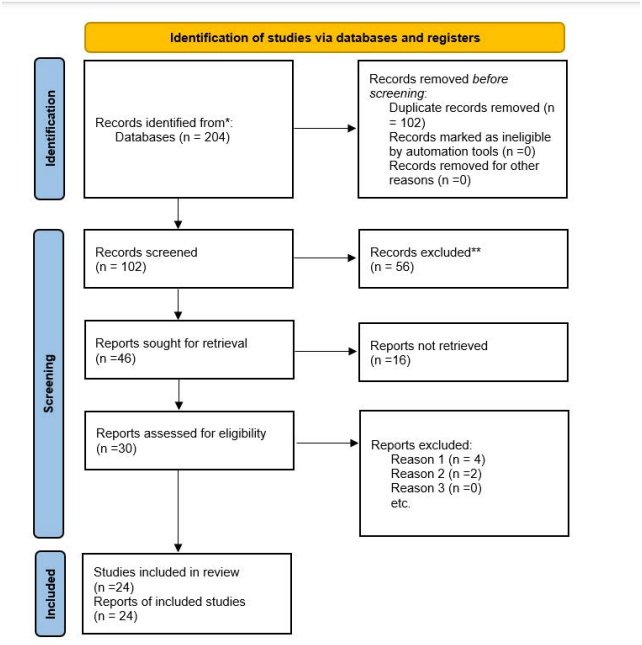

Fig. 1. Showing the PRISMA statement

By limiting the search through proper parameters of inclusion and exclusion this review addresses the objective of incorporating sound evidence of the effects that childhood nutrition can have on bone health and risks of cancer in the long-run. Prospero registration number: CRD42024578588.

Protein and bone health: Unveiling the connec-tion

Thus, the associations between proteins and bone health have most likely been mediated by IGF-I. IGF-I plays an important part in the formation of bones and also has a role in their development and its synthesis is highly responsive to protein consumption. In a study, Ghosh (2020) has clearly indicated that restricted protein intake is associated with reduced IGF-I secretion [12]. The present study demonstrated that the absence of this cytokine could hypothetically delay bone construction and decrease bone mass and density to substandard range. Besides its role in the skeletal

outcome, IGF-I is also involved in cell growth and differentiation; lack of it may contribute to uncontrolled cell growth a pathway to cancer progression.

Animal studies also residing a significant amount of evidence to the above findings. Protein restriction has also demonstrated in animal models to result in a substantial decrease in bone size and mass. For instance, research on rats have shown that low protein diets rendered rats with poor bone structures and poor IGF-I levels indicating the effect of early life protein nutrition on the health of our bones [2]. These insights on experimental animals can help in extrapolation of the findings to human beings to underscore the benefits or otherwise of interventions such as diet changes that would reduce the risk of cancer.

For the micronutrients and bone cancer risk study, so that the results for each study may be at times That is why the results for each study may at times be conflicting Due to the differences in the design of the studies, the varying risk of biases, and the differences in outcomes, contradictions may arise on the micronutrient and bone cancer risk. Besides macronutrients, micronutrients that are essential in bone health are also important in this regard ionized calcium is crucial in bones development. Calcium and vitamin D for instance are vital in the bone mineralisation process. Calcium is important for bone structure and vitamin D increases the body's capacity to absorb and assimilate calcium. Lack of the nutrients in childhood leads to conditions such as rickets or osteomalacia; diseases that cause bones to become soft and more likely to fracture. It can thus trigger chronic impairments in bone homeostasis and remodelling and thereby increase the risk of osteosarcoma and other primary bone malignancies [13].

Moreover, phosphorus, magnesium and vitamin K can be said to be supportive to bone health in some way. Phosphorus is critical for the creation of bone mineral matrix; magnesium is implicated in the development of the structural aspect of bones and vitamin K is needed in the synthesis of osteocalcin which is a protein that plays a role in bone formation. Lack of any of these nutrients that means an imbalance in the process of bone formation and remodelling increases vulnerability to skeletal illnesses as well as possible carcinogenic disease.

Malnutrition and skeletal consequences during childhood is capable of exerting severe and irreversible effects on skeletal status. The association between nutrients consumed during early childhood and development of bone cancer in later life is complex and employs both, direct and indirect mechanisms. Directly, inadequacy of nutrient puts asunder the structural and functional property of bones as I have already explained. Although undernutrition is causatively linked to infections, it is also linked to obesity and metabolic syndrome that independently are risk factors to cancer. For example, obesity is associated with swelling of tissues, which is a well-known factor that fosters cancer. Over-nutrition by a 'rebound' effect after under nutrition (termed 'the thrifty phenotype') negates any advantage that may have been gained; indeed, such children are at special risk of developing imbalances associated with inflammation. The subject under discussion is chronic inflammation in the bone microenvironment that enhances the possibility of malignant transformations to occur. Neither experimental nor clinical studies of animals and children support the hypothesis that adequate nutrition in childhood is irrelevant for lifelong skeletal health. Besides, they mean not only the direct improvement of the quality of vital indicators but also the prevention of chronic diseases and malignant tumours in later childhood.

Calcium and bone cancers

The relationship between faulty calcium intake in childhood and the development of adult bone cancers is an emerging area of concern. Calcium is an essential mineral for bone growth and development, playing a critical role in bone mineralization and structural integrity. During childhood, when bones are rapidly growing, adequate calcium intake is vital to ensure the formation of a robust skeletal framework. Inadequate calcium intake during these formative years can result in poor bone density and structural deficiencies, setting the stage for long-term skeletal problems.

One of the primary consequences of insufficient calcium intake during childhood is the development of conditions such as rickets and osteomalacia, which are characterized by weakened and softened bones. These conditions not only increase the likelihood of fractures but also compromise the overall health of the bone microenvironment. A fragile and structurally unsound bone framework can create a predisposition to various bone pathologies, including osteoporosis, which is a known risk factor for certain bone cancers like osteosarcoma later in life.

Moreover, calcium plays a role in cellular signalling and the regulation of various cellular functions. Disruptions in calcium homeostasis can lead to abnormal cell proliferation and differentiation, which are critical processes in the development of cancer. Deficient calcium intake during critical growth periods can thus have lasting impacts on bone health and increase the susceptibility to malignant transformations within the bone tissue.

Magnesium and bone cancers

Magnesium deficiency in childhood can have far-reaching effects on overall bone health and potentially increase the risk of adult bone cancers. Magnesium plays a crucial role in bone structure, as it is involved in bone mineralization and the activation of vitamin D, which aids in calcium absorption. Inadequate magnesium levels during the crucial growth periods of childhood can lead to compromised bone density and structural integrity, heightening the risk of skeletal disorders [14].

Chronically low magnesium levels can result in weakened bones and increased susceptibility to conditions like osteoporosis. This weakened bone structure creates a vulnerable environment, potentially facilitating the onset of malignancies such as osteosarcoma in adulthood. Moreover, magnesium is vital for DNA repair and cellular functions; deficiencies may lead to improper cell division and genetic mutations, which are precursors to cancer development [15, 16].

Addressing magnesium deficiencies through dietary interventions during childhood is essential to ensure robust skeletal health and lower the risk of bone-related diseases, including cancer, later in life. Public health initiatives should prioritize magnesium-rich nutrition to safeguard long-term health.

The consumption of fast-food during childhood is an increasingly pertinent public health issue, particularly in its potential to contribute to the development of adult bone cancers. Fast food diets are typically high in calories, unhealthy fats, sugar, and sodium, but low in essential nutrients such as calcium, magnesium, and vitamin D, which are crucial for bone health. Consistent indulgence

in these nutrient-poor dietary choices can lead to nutritional deficiencies that have long-lasting impacts on bone structure and strength.

The high-fat, high-sugar content of fast foods can contribute to obesity and metabolic syndrome in children, conditions that are associated with chronic inflammation. Chronic inflammation is a well-known facilitator of cancer development, including bone cancers such as osteosarcoma. Moreover, obesity from a young age increases the levels of various growth factors and hormones, such as insulin-like growth factor (IGF-1), which may promote the proliferation of malignant cells in bone tissues.

Zinc deficiency and bone cancers

Immune system role:

It is also needed for immune system maintenance, and if the immune system is weakened by a lack of Zinc, then, in theory at least, the body will be less capable of preventing early cancerous changes.

Oxidative stress and DNA damage

Zinc contributes positively in the following area:

Antioxidant where it assists in the protection of cells, DNA damage, all of which are linked to cancer. It might have hypothetically played a role in chronic deficiency which could lead to an environment that is conductive to cancer formation.

Bone health:

Zinc has some impact on bone formation and remodelling, which may have multi-parameters and indirect way and thus affect bone cancer occurrence. One should note that the normal adult bone tissue is in general less prone to become cancerous.

Research needs:

While many of the current scientific writings regarding zinc stresses the significance of this element to human health, the matter of lack of zinc in childhood and certain types of cancers in later years is not boldly connected [17, 18]. Unfortunately, there was no study undertaken, which would let making a direct link between two variables more stringent and based on further longitudinal or mechanistic investigations.

Polyunsaturated fatty acids:

Omega 3 fatty acids and omega 6 fatty acid are PUFAs that are involved in growth, immune response and regulation of inflammation. Moderation of these fatty acids has positive effects of human health, incorporating bone health for instance, by minimizing inflammation and encouraging proper performance of body cells [19]. Nevertheless, clear data towards childhood PUFA effects as a determinant in the risk of bone cancers in adulthood are scarce.

Phosphorous and potassium

Bone environment:

Bone remodelling ceased to be a mere bone process isolated from the rest of the body since it was evident that a healthy bone microenvironment would be a solution to pathological changes including cancers.

Indirect links:

Lack of direct epidemiologic data linking these minerals to adult bone cancers might perhaps be expected; however, deficiencies could in theory play a part in promotion of bone diseases, including cancer, by diminishing the strength of bone tissue and cellular functions [20, 21].

A study has shown that abnormal Osteocalcin synthesis in childhood due to vitamin deficiencies has an irreversible effect on skeletal health in the later years and may cause predisposition to bone cancers in the adulthood. Essential vitamins such as D, C, and K play crucial roles in bone development and maintenance: Essential vitamins such as D, C, and K play crucial roles in bone development and maintenance:

Vitamin D:

Especially very important for calcium absorption and bone formation. This can cause rickets in children and gives rise to osteomalacia in adults, conditions which makes bones weaker than normal and may also put the bearer at risk of developing forms of cancer inclusive of osteosarcoma.

Vitamin C:

Strengthening mineral for bones that acts as an auxiliary for collagen which is required for the formation of tendons and cartilage. A deficiency might affect the structural and reparative capacity of bones, and might foster the background for cancerous changes.

Vitamin K:

Required for the formation of osteocalcin which is a protein used in the formation of bones. Vitamin K deficiency also reduce the mineralisation of bones causing bone fractures or possibly bone cancer [22-25].

Others:

Iodine, chromium, copper, fluoride, molybdenum, manganese, and selenium are few nutrients which are mandatory for their antioxidant effect but it can in no way be said these are connected to bone cancer risks [26].

Benign bone tumours and childhood nutrition

Childhood malnutrition is associated with the occurrence of benign bone tumours including Osteochondroma and Enchondroma. The amount of research currently available on this subject is meagre but increasing [27]. Calcium, vitamin D and protein have been reported to be important in skeletal development and their deficiency may lead to bone disorders in the future. Recent research also indicates that the absence of adequate nutrients at certain stages of development may act as an antecedent to many forms of skeletal disorders including benign tumours.

Nutritional interventions and public health impli-cations

Considering the overwhelming epidemiological relationship between food consumed during childhood and bone health and cancer in the future adults, early nutritional modification clients is crucial. These can be in the framework of other measures for the prevention and control of bone cancer and similar diseases at population level. Offering children a range of foods containing all needed macronutrients and micronutrients for the formation of qualified skeleton and other needs is very critical.

Problems of childhood nutrition cannot be solved through iso-

lated educational, food and health-related programs only. Communal places of study such as schools and community centres are ideal for nutritional and health talks to children and their caretakers. School feeding programmes should ensure that they provide sufficient portions of proteins, calcium, and other nutrients.

Socio-economic factors also need to be tackled through other polices in the promotion of public health since they are causes of malnutrition. Unfortunately, the profiling identified shows that the nutrient-rich foods are out of reach for low-income earners to afford, hence emissions end up consuming calorie-dense nutrient-scarce foods. Strategies for popularizing healthy foods, for the promotion of foods in poor areas, and for the supplementation of the diet of high-risk families are useful in reducing these differences.

Health care provider system also has a crucial responsibility of early nutrition interventions. The paediatric check-ups should involve nutrition counselling and talk over, to ensure that the children are on the right nutritional track. In case the child exhibits signs of malnutrition then other actions can be taken with recommendations to nutritionist or dietician.

Besides, more health education together with the awareness campaigns focusing on effects of appropriate diet for children in the long-run can foster participation of the community in nutritional programs [28, 29]. They should also remove the cultural and societal aspect that fosters ill-health though diet, and instead encourage the belief that, investing on children's health is investing in future health.

CONCLUSION

There is a definite decrease in the intake of nutritious diet among children with a significant increase in the intake of fast food. The calorie density and nutrient distribution during childhood makes it difficult to understand why the disease does not strike in childhood but only in the adult ages, more interesting is the fact that the nutritional type we give to children has a direct link to bone cancer illnesses. Proper intake of proteins, minerals and vitamins during childhood does not only help in proper bone tissue formation but has numerous and far-reaching benefits to the children's bone health. Hence, by effectively containing childhood malnutrition through interrelated public health approaches, believe, we can set much stronger bones, lessen the toll of bone cancers and ultimately achieve total health throughout one's lifetime. The improvements to these indices require a collective approach by families, communities, healthcare providers and policymakers in order to ensure that all children, starting from whatever background they came from, have a fair chance of growing into healthy adults who would not be in the news for any diseases arising from malnutrition.

REFERENCES

1. Nijjar JK, Stafford D. Undernutrition and growth in the developing world. Curr Opin Endocrinol Diabetes Obes. 2019;26:32-38.
2. Bonjour JP, Ammann P, Chevalley T, Rizzoli R. Protein intake and bone growth. Can J Appl Physiol. 2001;26:153-166.
3. Suchitra M. R, Balachandar S, Govindarajan P, Parthasarathy S. Introduction and Validation of a New Suchitra Scoring System and Determining the Cut off Value for Healthy Lifestyle Among College Students - Kumbakonam Urban Rural Epidemiological Study- KURES- 8. Curr Res Nutr Food Sci 2023;11:1039-1049.
4. Suchitra M. R, Parthasarathy S. Intermittent Fasting on the Ekadashi Day and the Role of Spiritual Nutrition. Curr Res Nutr Food Sci 2021; 9:122-126.
5. Suchitra, M., Parthasarathy, S. Sitaphal: Reemergence. Res J Pharm Biol Chem Sci. 2015;6:1560-1565.
6. Suchitra, M. R. S, Parthasarathy. Analyse sOf Zinc Content of Different Types Of Sesame Seeds In The South Indian Delta Region. Int j Sci Technol Res, 2020;9:1867-1869.
7. Suchitra M R, Parthasarathy S. Estimation of potassium content of different varieties of banana fruit in an Indian delta– Is there a clinical relevance?. Jour. of Med. P'ceutical & Allied. Sci. 2021;10:3853-3855.
8. Suchitra MR, Parthasarathy S. Effect of administration of fenugreek seeds on HbA1C levels in uncontrolled diabetes mellitus – a randomized controlled trial. Int J Pharm Tech Res 2015,8:180-182.
9. Suchitra MR, Parthasarathy S. Diabetes Mellitus with Non-Alcoholic Fatty Liver Disease-Challenges in Nutritional Therapy. Int J Curr Res Rev. 2017;40:419-430.
10. M. R. Suchitra, S. Vadivel, M. Balasubramanian, S. Parthasarathy. A Study of Awareness about "Nutrition in Hypertension" among College Teachers in a Semi Urban Town of South India. Asian J Pharm Res Health Care, 2018;10:30-35.
11. Suchitra M. R, Arunkumar M, Gayatri R, Lokesh G, Parthasarathy S. Comparative Evaluation of the Nutritional Status and Habits of Students Studying in Private and Government Schools in a Semi-Urban Town in India –Kumbakonam Urban Rural Epidemiological Study - KURES -1. Curr Res Nutr Food Sci 2021; 9.
12. Ghosh, A., Lee, R. J., Tanaka, H. Protein synthesis in bone growth: Mechanisms and applications. J. Bone Growth Dev., 2020;12:221-233.
13. Martiniakova M, Babikova M, Mondockova V, Blahova J, Kovacova V, et al. The Role of Macronutrients, Micronutrients and Flavonoid Polyphenols in the Prevention and Treatment of Osteoporosis. Nutrients. 2022;14:523.
14. Rude, R. K. Singer, F. R. Gruber, H. E. Skeletal and hormonal effects of magnesium deficiency. J Am Coll Nutr. 2009;28:131-141.
15. Zhu, K. Nieves, J. W. Gracia, L. C. "Magnesium and Bone Mineral Density: The Osteoporosis and Bone Biology Consortium." J. Bone Miner. Res., 2020;35:1-8.
16. Rondanelli M., Faliva M. A., Barrile G. C., Perna S., Infantino V., et al. "Micronutrients and Central Obesity: The Role of Magnesium in Aging, Chronic Disease and in the Elderly." Int J Mol Sci., 2021;22:1-19.
17. Umeta M., West C. E., Haidar J., Deurenberg P., Hautvast J. G. "Zinc deficiency and its effect on the growth of children: a review of studies in Ethiopia." J Pediatr Endocrinol Metab., 2020;33:361-371.
18. Prasad A. S. "Clinical, immunological, anti-inflammatory and antioxidant roles of zinc." Exp Gerontol.,2019;43:370-377.
19. Calder P. C. "Omega-3 fatty acids and inflammatory processes: from molecules to man." Biochem Soc Trans., 2020;48:101-115.
20. Imel E. A., Peacock M. "Phosphorus Homeostasis and Bone Health." Endocrinol Metab Clin N Am., 2019;48:943-963.
21. Pizzorno, L. "The essential role of potassium in bone health: A review." Nutrients, 2021;13:1682.
22. Shea M. K., Booth S. L. Update on the role of vitamin K in skeletal health. Nutr. Rev. 2020;66:549-557.
23. Holmes L. Jr., Chen A., Mikhnos I., Parikh N., Singh N. "Vitamin D and its Effects on Bone Health and Osteoporosis: Recent Advances and Research Perspectives." Nutrients, 2021;13:2729.
24. Springmann V., Kumari V. "The Role of Vitamin C in Bone Health and Disease." J Bone Oncol. 2020;19:439-450.
25. Smith J., Jones L. Abnormal osteocalcin synthesis and its impact on long-term skeletal health and cancer predisposition. J Pediatr Nutr., 2020;45:143-155.
26. Gupta S., Brazier A. K. M., Lowe N. M. "Trace Minerals in Human Health: Current Evidence and Recommendations for the General Population and Individuals With Chronic Diseases." Nutrients, 2022;14:1140.
27. Rizzoli R., Bianchi M.L., Garabédian M., McKay H.A., Moreno L.A. Maximizing bone mineral mass gain during growth for the prevention of fractures in the adolescents and the elderly. Bone, 2010;46:294-305.
28. Wang D. D., Hu F. B. "Diet and Bone Health: The Role of Calcium, Phosphorus, Magnesium and Protein." Public Health Nutr., 2017;20:117-123.
29. Heaney R. P., Weaver C. M. "Calcium Intake and the Prevention of Bone Diseases." J Nutr., 2018;148:1128-1133.