

Prevention of Osteometabolic Diseases Begins in Childhood: The Relevance of Healthy Ageing

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ABSTRACT

Introduction: the present study aimed to work on providing information to students from elementary schools (from 1st to 9th grades) in the region of Ribeirão Preto - SP on how to lead a healthy life. Given this, it demonstrated the effectiveness of taking measures that positively influenced overall health and how they actively operate in their aging process. After the final tabulation and analysis of the obtained data, four thousand copies of an eight-page booklet were made with didactic activities to reinforce learning about osteometabolic diseases and their prevention among students and were distributed in schools that agreed to participate in the research. The study has aimed at the benefits of guidance on a healthy lifestyle, which can be composed of diversified healthy food intake, regular physical exercise, and daily doses of exposure to sunlight to obtain vitamin D throughout the week. We showed the students that putting the given guidelines into practice is important, as soon as possible, a routine that is related to the overall well-being of their organism, since they are in an important stage of learning and skeletal development.

Keywords: Metabolic bone diseases; Disease prevention; Healthy lifestyle; Child; Adolescent.

Introduction

According to important studies and scientific research, there is increasing evidence of a high prevalence of vitamin D deficiency at global levels, affecting approximately 30% to 50% of children and adults, which reflects a public health problem and concern.¹ In addition, recent research has proven that vitamin D is necessary not only for the maintenance of bone health but also for the prevention of several other diseases, such as cardiovascular diseases, insulin resistance, respiratory diseases, and cancer, among others².

Vitamin D is known for its main role in the body to regulate the homeostasis of calcium-phosphorus metabolism and, consequently, help mineralize and strengthen bone structures, along with the parathyroid hormone (PTH). This vitamin exerts its main effects by interacting with its high-affinity receptor (vitamin D receptor), along with the enzymatic activities that metabolize vitamin D, present in various types of cells in the human body, acting strongly in various tissues (e.g., adipose tissue, muscle, and pancreas), which justifies its importance in various physiological functions³.

Vitamin D can be found in nature in two conditions, namely cholecalciferol (vitamin D₃) and ergocalciferol

(vitamin D₂). Cholecalciferol is responsible for approximately 90% of endogenous cutaneous synthesis, from exposure to sunlight to the incidence of ultraviolet B (UVB) rays, which is the main source of vitamin D for humans. Ergocalciferol, on the other hand, is obtained from exogenous sources (they represent only about 10%) from the diet: fatty fish (e.g., salmon, fresh herring, sardines, tuna), eggs, fortified milk, and liver⁴.

Bone tissue is extremely dynamic, composed of three main cells (osteoblasts, osteocytes, and osteoclasts), minerals (calcium and phosphorus), and an organic matrix formed of collagen and non-collagen proteins.⁵ The function of osteoblasts is to synthesize and mineralize the protein matrix; on the other hand, osteoclasts, multinucleated cells, associated with cells of the hematopoietic lineage (monocytes and macrophages), promote bone reabsorption, diluting the mineral tissue, which leads to the release of calcium and phosphorus in the extracellular fluid. Finally, osteocytes are osteoblastic cells within the mineralized bone whose role is to participate in the regulation of the bone reabsorption or neoformation process⁶.

In this way, these cells keep the skeleton in a continuous remodeling process and are under the

control of several factors that, in balance, command an orderly remodeling sequence^{5,7}. Adult bone mineral density portrays the result of two processes, namely the peak of acquisition of bone mass during adolescence and the maintenance of this bone mass during later years⁷.

The most common disease that affects the bones is osteoporosis, which is defined as an intrinsic skeletal problem resulting in bone fragility (low mineral density) and increased risk of fracture, which may result in osteopenia, characterized by the gradual loss of bone mass. Also, it is worth noting that rickets (or rickets), a disease that also involves bone metabolism, is identified from the weakening of bones in children, due to an inadequate serum concentration of vitamin D⁷.

The human skeleton has a mechanism of bone renewal, also called bone turnover or bone remodeling. This process makes the bones of the human body match the different functional demands and the different strength variations of certain movements. When a force and/or pressure is applied, the osteocytes immediately communicate with the neighboring cell complex, warning that the tissue needs to adapt to the stimulus. Thus, every day, bone turnover adapts the skeleton to be useful, which means that the more sports and exercises are performed, for example, and the sooner this habit takes effect, the better the mineral health of children will be over time, as the young skeleton is renewed entirely and continuously about every four to five years⁸.

Therefore, individuals who usually practice physical activities tend to have larger and more mineralized bones. On the other hand, sedentary people have thinner, less dense, and less mineralized bones, which can consequently change the bone mechanics, in other words, modify the adaptation to mechanical stimulation⁹.

Due to cellular physiological adaptation, through the practice of physical exercises, many cells respond with the stimulation of hormones and internal chemical mediators of bone turnover, which among them are parathyroid hormone, calcitonin, vitamin D₃, and estrogens. The action of these mediators is continuous and correlated with serum levels of calcium and phosphorus⁸.

Studies carried out in Spain and other countries have shown that serum levels of vitamin D were generally insufficient and that the average dietary intake was far below the recommended level. Dairy products and breakfast cereals are two types of food most used among the population, and although they are not a natural source of vitamin D, they serve as a strategy to help increase the intake of this vitamin and therefore improve the nutritional status of individuals². In summary, dietary intake rich in vitamin D nutrients, such as fatty fish (like salmon and tuna), liver, fortified milk, egg yolk, cheese, and mushrooms, is essential for

maintaining vitamin D concentrations in the body¹⁰.

According to the literature, there is a high prevalence of hypovitaminosis D among overweight adolescents, which leads to consequential metabolic changes over time, such as increased blood pressure and a high prevalence of metabolic syndrome¹¹. Therefore, the constant performance of physical exercises is recommended, since this habit has biological effects that regulate bone metabolism, and exposure to ultraviolet rays (UVB) in small portions of the body area such as the face, hands, and legs, lasting approximately 20 minutes every day, are capable of activating the synthesis of vitamin D. However, the rate of cutaneous synthesis of this vitamin decreases with aging, and it is less effective in people with dark skin and those who uninterruptedly use sunscreen lotion¹².

On the other hand, the amount of time for optimal synthesis of vitamin D is still uncertain. However, it is known that in only 15 minutes of direct sunlight exposure, the body can generate 20,000 IU of vitamin D. Several factors influence this vitamin D generation, among them, skin pigmentation and latitude or amount of exposed skin, making it difficult to verify the exact amount of 25-hydroxyvitamin D (25(OH)D) that is synthesized in one person, although being positively related to the individuals' bone health¹³.

Currently, there is a debate about the serum value of 25(OH)D that translates to appropriate vitamin D status, but relevant studies indicate that values greater than 30 ng/mL are necessary to optimize efficient calcium absorption and also ensure bone density. A deficit is defined as values below 20 ng/mL of 25(OH)D and insufficiency in values below 30 ng/mL, following the recommendations of the Society for Adolescent Health and Medicine¹⁴.

Faced with such explanations, it is noteworthy that the present research was based on the idea of analyzing how vitamin D absorption, healthy food intake, regular physical exercise habits, and all its peculiarities are being practiced in schools as essential forms of metabolic bone diseases prevention because the sooner individuals start with healthy lifestyle habits, the better will be their bone quality.

Materials and Methods

The present study was approved by the Research Ethics Committee (CAAE: 40786620.6.0000.5419 – protocol number: 4.472.117) of the School of Dentistry of Ribeirão Preto, University of São Paulo. A total of 11 elementary schools (education levels I and II*) located in the city of Ribeirão Preto - SP, from the public network (one municipal school and five state schools) and the private network (five schools), were included to participate in this research utilizing the voluntary will to participate in the study project through an invitation letter signed by the authors and sent to the schools' directors.

The project consisted of applying a questionnaire with questions that addressed the following topics, with a focus on what the student's daily life routine was at school: (1) regular and safe exposure to sunlight; (2) healthy food intake; and (3) regular practice of physical exercises. The questions were answered by the pedagogical coordinator, vice-principal or principal of the schools through meetings held on the Google Meet platform and also via email. Signatures of free and informed consent terms were also collected from people who answered the questionnaire, in addition to the school's authorization form to make the project viable. The questions were prepared based on readings of scientific articles found mainly on the PubMed website and were based on aspects that are positively correlated with the bone mineral quality of individuals (figure 1).

The results obtained in the aforementioned questionnaire were passed on in the form of an educational poster and a booklet, both of an informative and educational nature, in a didactic and very illustrative way, so that students pay more attention, with information on how children and adolescents can

carry out a balanced diet, regular exercise practices and adequate exposure to the sunlight in the school environment. Thus, the posters were made available to each participating school and 4.000 didactic booklets were distributed among them, to reach the largest number of students with information regarding the measures to be adopted for the prevention of osteometabolic diseases and to have a healthy aging process, with better bone quality.

Results

Eleven schools of elementary education I and II were evaluated, namely: one municipal school ($n = 1$), five state schools ($n = 5$) and five private schools ($n = 5$). Most schools are within the appropriate parameters to enable an improvement in the quality of life of their students, essentially in the school environment.

The questions addressed in the questionnaire were divided by topics, making a general analysis of the 11 schools that were part of the research under discussion. The results obtained from the interviews are shown below in the form of stacked bar graphs

1. Does the school have a nutritionist?
2. Do students usually attend school lunches? Do you offer school lunches?
3. If the previous answer is yes, are the foods canned?
4. Is diversified food during the week?
5. Do you have a school canteen? If so, are soft drinks, fried foods, snacks and/or sweets sold?
6. Did the students perform physical exercises in sunlight?
7. Are any areas of the school exposed to sunlight?
8. Are physical education classes structured (balls, ropes, shuttlecocks, etc.)?
9. How many days a week is physical education offered?
10. How many hours a week are physical exercises done?
11. Are students interested in performing physical education?
12. Does the teacher have a pre-programmed activity for the students or do they choose the activities?
13. Are all physical education classes practical, or are there also theoretical classes?
14. Does the school have covered and/or open courts?
15. Do students learn about osteometabolic diseases throughout their training?
16. Does the school usually receive institutions from outside to explain this subject to students?

Figure 1. Questionnaire. Some questions were asked to the pedagogical coordinators, vice-principals and/or principals of the schools to analyze the students' school routine, regarding food (lunch and school canteen), exposure to sunlight and practice of physical exercises.

* In Brazil, the age range for students in elementary education I is 6 to 10 years old, while the range for students in elementary education II, in turn, is 11 to 14 years old. That is, fundamental education, in general, serves both children and adolescents, since according to the Brazilian Statute of Children and Adolescents (ECA – Estatuto da Criança e do Adolescente), a person over 12 years old can already be considered an adolescent.

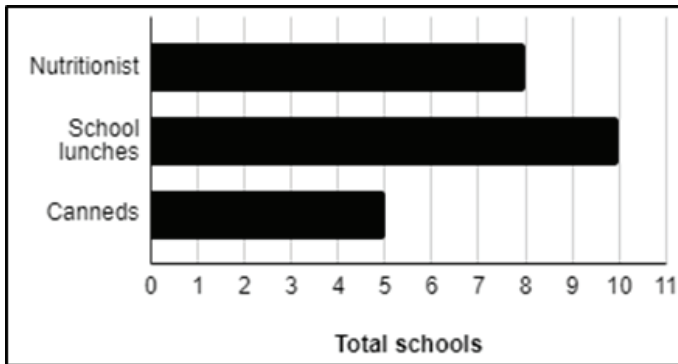


Figure 2. Healthy food intake. Number of schools that have a nutritionist to help with the menu to serve the students, referring to school regular lunches. By the way, in five of them, the foods are canned.

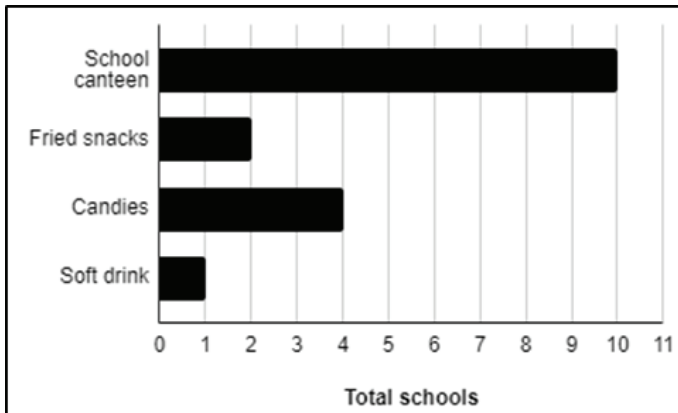


Figure 3. Canteens. Types of food and drinks sold in the school cafeteria.

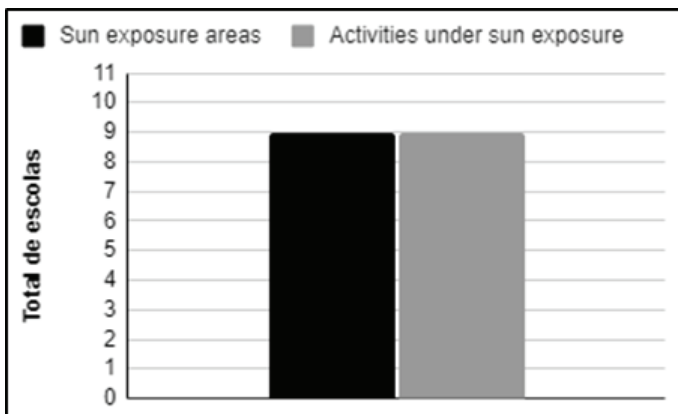


Figure 4. Exposure to sunlight. Number of schools that have green areas to enable students to regularly practice physical exercise under sunlight.

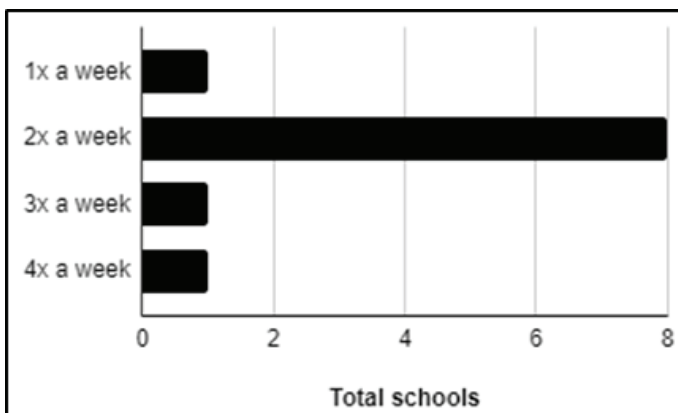


Figure 5. Regular practice of physical exercises. The amount of practical physical education classes during the week.

Discussion

In most of the schools analyzed (n = 8), practical physical education classes are well structured and take place twice a week (figure 5), with materials available that enable and encourage the practice of physical exercise among children and adolescents. These classes last an average of 50 minutes, and most students actively participate. In line with several recent studies, constancy in performing physical activities plays a significant role in balancing bone tissue and preventing fractures⁹.

Most of the schools (n = 9) have many green areas, which can be assumed that students during recess (time to eat and relax) and/or physical education classes get sun exposure at some point during the day (figure 4). This is extremely important since a positive relationship was found between the category of optimal serum levels of vitamin D and the practice of sports and/or aerobic activity outdoors in children and adolescents, as one of the protective factors against the deficit of vitamin D¹⁴.

In addition, concerning the food and drinks offered in schools that have a cafeteria (n = 10), in general, despite baked snacks and juices, some offer fried snacks (n = 2), candies (n = 4), and soft drinks or other sweet drinks (n = 1), which are unhealthy foods that should not be part of the nutrition routine of children and adolescents (figure 3).

Regarding the schools that offer regular school lunches (n = 10) (figure 1), all have a considerable variety of natural foods. However, in the five state schools analyzed the prepared foods are mixed, which means that they intersperse canned foods (such as beans, meat, sardines, and tomato sauce) and natural foods (such as fruits, vegetables, and salad). On the other hand, the municipal and the five private schools prepare and offer to the students only natural foods, a positive point to be emphasized. Concerning state schools, a favorable topic is that all have a nutritionist to help make the menu, provided by the Board of Education of the State of São Paulo.

Something that draws attention is that the very subject addressed in this research on osteometabolic diseases and their prevention is little worked in the schools. Only three schools received other institutions, mainly Universities, to address a certain topic of the few mentioned above, making it necessary to show the relevance of this subject today. Therefore, projects like this one, are useful to promote health, and reinforce the communication between the University and society in general. It is about an exchange of knowledge: in addition to the simple learning acquired in the school, the search for healthy habits passes through the student's community, because among them, their family, neighbors, and friends learn too¹⁵.

The work carried out by this study may have been extremely important for the lives of children

and adolescents, positively impacting on changing their habits. It is noteworthy that both a diet rich in vitamin D, as well as daily sun exposure and constant physical activity are relevant to developing sufficient bone mineral quality to prevent or reduce the risk of developing osteometabolic diseases in the future, in adulthood and, principally, in senile age. This implies that vitamin D, well known for the function of regulating skeletal homeostasis, also has several other functions, such as the improvement of immunocompetence and immunomodulation, which explains its significant role in the protective health effect by preserving people's well-being and strengthening self-care¹⁶.

Throughout the growth process, the human skeleton "gains bone" each year, helping to maintain the acquired bone mass and therefore decreasing the likelihood of falls and/or fractures. Some practices can make the level of bone density higher, such as proper nutrition and physical activity, as the peak of this bone density occurs between the second and third decade of life. With the ingestion of calcium, incorporated for bone mineral quality in the daily lives of individuals, 75% of its amount is absorbed in the intestines of children and this absorption is increased by the active metabolites of vitamin D. Given the above-mentioned, there is the formation of a calcium reserve that will be used throughout aging, mainly in reducing the risk of fractures and preventing osteometabolic diseases, such as osteoporosis¹⁷.

One of the limitations of the study was the number of participating schools. At first, the project aimed to work with more than 15 schools, but due to various obstacles such as carrying out the study amid a COVID-19 pandemic and the consequent difficulty in getting to and from schools. In addition, there was no correspondence of e-mails or phone calls by many of the schools originally aimed and also no acceptance to participate in the research.

It is worth noting that only one municipal school was worked on, as the Municipal Education Office of Ribeirão Preto has failed to send the invitation letters to the principals so that other schools could participate in time.

However, despite the participation of the schools analyzed, it should be noted that a negative point of the work carried out was the application of the questionnaire to the direction and coordination of the school, which may have tended, to a certain extent to bias, the results obtained. New methodologies and studies should be applied to fill this gap and obtain

more comprehensive and solid results for stronger and more faithful statistics.

The present work led some information to children and adolescents from schools of elementary education I and II in the city of Ribeirão Preto - SP about the importance of a balanced diet (rich in several nutrients, mainly in vitamin D), regular physical exercises (for stronger musculature and bones) and adequate daily exposure to the sun, which is 90% of the main sources of vitamin D, since it is known that the healthier the lifestyle, the greater the individual's bone quality.⁸ In addition, it brought knowledge about osteometabolic diseases and their characteristics, and how they can influence the aging of young people.

More specifically, it is about teaching the benefits of guidance on a healthy lifestyle that positively influences bone health, which can be composed of regular physical exercises at an intensity compatible with the individual's age and body weight, a balanced diet, and daily doses of exposure to sunlight to obtain vitamin D, by the proposal to transmit to children and adolescents this knowledge, aiming the prevention of osteometabolic diseases, so that they have more chances to guarantee healthy aging.

The expectation of the authors after the end of this study is that the schools that have participated in the research will continue to address these aforementioned issues with their students, providing educational resources to reinforce the importance of a healthy lifestyle. Therefore, students are encouraged to take the knowledge acquired in the school environment to their homes, influencing their family members or friends outside the school and adopting these measures daily.

Conclusion

Most of the analyzed schools follow the parameters that provide an improvement in the quality of life of their students, such as adequate and well-diversified food throughout the week and practice of physical activities under sunlight, for example, in green areas and at safe times of the day for not harm their skin, in addition to only physical education theoretical classes, providing them, additionally, good equipment for practicing sports and/or games.

Despite the good scenario observed, there always be some improvements that can be made, such as the absolute abolition of unhealthy food from school cafeterias, the development of more green areas for students' recreation in sunlight and, of course, more planning for practical physical exercises classes beyond classics sports and games.

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