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Calcium Deficiency in children and the linkage to height: A Review

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ABSTRACT

The height in adolescence has regularly been a widely attentive discussion among Thai parents. This review paper set one's sights on height in children and how it is linked to calcium intake from various forms. Calcium comes in many forms ranging from milk to tablet supplements. Calcium together with vitamin D, two things that always come in a pair when talking about one or the other. As a matter of fact, calcium and vitamin D work side by side to protect the bone. Dairy products do show an effect in increasing children's height. Although, the height of children cannot only rely on calcium, in fact, height in children is a combination of many aspects. This review paper aims to discuss the relationship between calcium, with the help of ergocalciferol (vitamin D2) and cholecalciferol (vitamin D3), and height in children. Further research could be made into the impact of calcium supplementation and its association with height in children.

Keywords: Height, Children, Calcium, Vitamin D, Ergocalciferol, Cholecalciferol, Deficiency.

INTRODUCTION

"Drinking milk will make you grow taller", a phrase that grew up with me. This made me curious whether the 'myth' is true or not. This led me to researching about this query I have a true passion in. The main objective of this research project is to find out whether my hypothesis about consuming dairy products or calcium tablets will have any effect on the height in adolescence. Furthermore, after intense research, vitamin D2 and D3 also work closely with calcium. This review paper aims to discuss the effects on height of calcium deficiency.

The element 'Calcium'

Calcium (Ca) is an element in group 2 or sometimes known as alkaline earth metal has an atomic number of 20 and an atomic mass of 40. Calcium is most widely known to have a link to bones and height. As predicted, Calcium has a vital role in building and maintaining bones.

A study by V Matkovic investigates Calcium metabolism and Calcium requirements during skeletal modeling and consolidation of bone mass in young individuals. The study result stated that the highest requirements for calcium are during infancy and adolescence. To meet high calcium requirements, infants and adolescence have higher calcium absorption. In another study by Ruth Black, Sheila Williams, Ianthe Jones, Alisa Goulding, calcium intake and bone health were investigated in children who avoid drinking cow's milk. The results reveal that milk avoiders aged 3-10 calcium intake were low (443+/- 230 mg Ca/d). Milk avoiders were overall shorter, had smaller skeletons and lower total-body bone mineral content. The reasons for milk avoidance were intolerance, bad taste and lifestyle choices. In another similar study by J.E.P. Rockell, S.M. Williams, R.W. Taylor, A.M. Grant, I.E. Jones, A. Goulding, investigated the bone and body composition in young children with a history of prolonged milk avoidance. 46 Caucasian children aged 6.1- 10.1 were short in stature, evaluated body mass index and low bone mineral density. J.E.P. Rockell, S.M. Williams, R.W. Taylor, A.M. Grant,

I.E. Jones, A. Goulding research showed similar results with Ruth Black, Sheila Williams, Ianthe Jones, Alisa Goulding. From both of these research it can be assumed that calcium deficiency has a direct linkage to height, higher than should be body mass index and bone mineral content in children. This bone mineral assumption can be further strengthened with another study by Leann Matlik, Dennis Savaiano, George McCabe, Marta Vanloan, Carolyn L. Blue, Carol J. Boushey. The purpose of their study was to determine associations among perceived milk intolerance in 10- to 13-year-old female adolescents. The results showed that spinal bone mineral content was significantly lower in the girls with self-imposed restriction of dairy foods due to perceived milk intolerance.

Another attestation that calcium can be gained from drinking milk is by Flavia Fayet Moore, Peter Petocz nutrition research which based their investigation on Australian children who were drinkers of plain and flavored milk. The results were that they were the ones who had the highest intake of Calcium.

Ergocalciferol (Vitamin D2)

Ergocalciferol or vitamin D2 can be found naturally in plants. Commonly vitamin D2 is usually fortified into food such as cow's milk, breakfast cereal, yoghurt, margarine, sun irradiated mushrooms and orange juice. Ergocalciferol also comes in the form of dietary supplement. Ergocalciferol is indicated for rickets, hypoparathyroidism, and familial hypophosphatemia.

A research by Marja Ala-Houhala, T. Koskinen, M. Koskinen and J.K. Visakorpi investigated the consequences of ergocalciferol on children by doing a double-blinded study on 51 healthy prepubertal school children over a duration of 13 months. Twenty four children were supplemented with 400IU of vitamin D2 5-7 times weekly, while 27 received a placebo. At the end of the study, mean 25-hydroxyvitamin D levels in the supplemented group were significantly higher than those in the placebo group. Although the supplementation caused no alternations in the weight or height gain or bone mineral content of the distal radius of the children, and thus subclinical rickets could not be shown.

From a research by Sara M. Pietras, Busayo K. Obayan and Mona H. Cai, more than 40% of the population may be vitamin D2 deficient. Moreover, concerns about ergocalciferol, the only pharmaceutical vitamin D available in the United States, maybe less effective than cholecalciferol is also controversial. Following the concern about ergocalciferol as a supplement, a research by Lisa Houghton and Reinhold Vieth stated their perspective by including a study of rickets conducted 70 years agos that was an evidence for pharmacopoeias to officially regard ergocalciferol and cholecalciferol to be equivalent and interchangeable. The emergence of 25-hydroxyvitamin D as a measure of vitamin D statutes provides an objective and quantitative measure of the biological response to vitamin D administration. As a result, cholecalciferol has proven to be a more potent form of vitamin D in humans because of their efficacy at raising serum 25-hydroxyvitamin D. In contrast, ergocalciferol should not be regarded as a nutrient suitable for supplementation or fortification.

Cholecalciferol (Vitamin D3)

Cholecalciferol or vitamin D3 can be found naturally in animal sourced foods such as fresh salmon, herring, mackerel, sardines, cod liver oil, butter and egg yolks. Pharmacies in Thailand are now selling a wide range of different brands of Vitamin D3 tablet supplements which can be found and bought easily. Often said to take one tablet per day (each of 5 micrograms/ 200IU) to help maintain absorption of calcium and phosphorus, support bones, teeth, muscles and for normal cell division. Women who are pregnant and children under the age of 10 are advised not to cholecalciferol tablet supplement. The ingredients in vitamin D3 tablets are olive oil, gelatin, glycerol, distilled water and cholecalciferol.

Many researchers have been investigating the effectiveness of cholecalciferol and comparing it to ergocalciferol, a majority of published researches agree that cholecalciferol is more efficacious than ergocalciferol. Here are two researches that prove this belief:

Firstly, in a research by H M Trang, D E Cole, L A Rubin, A pierratos, S Sio and R Vieth claims that vitamin D3 is more effective in increasing serum 25-hydroxyvitamin D than vitamin D2 with cholecalciferol mean (+/- SD) serum 25 (OH)D increased from 41.3+/-13.0 nmol/L before to 64.6+/-17.2 nmol/L after treatment comparing to

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ergocalciferol which the 25 (OH)D concentration increased by only from 41.3+/-13.0 nmol/L to 57.4+/-13.0 nmol/L. The researchers concluded that the assumption that vitamin D2 and D3 have equal nutritional value is probably wrong and should be reconsidered.

A second research titled Vitamin D3 is more potent than vitamin D2 in humans by Robert P. Heaney, Robert R. Recker, James Grote, Ronald L. Horst and Laura A. G. Armas was published in March of 2011. The design of this research uses a single-blinded trial using 33 healthy adults. Calciferols were dosed at 50,000IU per week for 12 weeks. Principal outcome variables were area under curve for incremental total 25-hydroxyvitamin D [25(OH)D] and change in calciferol content of fat. Subcutaneous fat content of D2 rose by 50micrograms per kilogram in the D2-treated group, and D3 content rose by 104 micrograms per kilogram. Cholecalciferol is approximately 87% more potent in raising and maintaining seron 25(OH)D concentrations and produces 2- to 3-fold greater storage of vitamin D than does equimolar ergocalciferol. Given its greater potency and lower cost, Cholecalciferol should be the preferred treatment option when correcting vitamin D deficiency.

Factors affecting height

The determination of height in children and adolescence is a combination of many factors, not only one. Although Calcium, ergocalciferol and cholecalciferol are large contributors without other also important factors, children will still not achieve their desirable height with just drinking milk. There are many advertisements in children-parent magazines promoting the benefits of drinking their brand of milk, most of them are true but some are over exaggerating the information presented thus causing confusions.

As everyone would already know, genetics is considered as a big part of height in children. Some may even say that more than 50 percent of the height in children comes from genetics. This is resulted from the trend where children who are tall usually have parents who are also tall. The traits are passed on from parent to offspring. From a research by Martin Benjamin, James Muyskens and Paul Saenger, highlights on parents who bring their children to see pediatricians and endocrinologists to get treated with synthetic growth hormone (hGH). Hence, the children get X-rayed to determine their bone age so the physician can conclude the possible height, give or take a few inches. This research stated that height is one of the most heritable traits. Some short children are normal for their family background: their height is largely determined by their genes. An interesting fact noted was about the average difference in height of identical twins of the same gender is only about one inch. Growth hormone deficiency may be congenital due to absence of pituitary gland: or it may be acquired as a result of brain tumor, trauma disrupting pituitary gland function (such as battering), infections (such as meningitis) or radiation therapy to the head and neck, for example, in leukemic children or children with brain tumors. Based on another research by Brian P. McEvoy and Peter M. Isscher, about 50 genes and regions of the genome have been associated with height. Although the two researchers suggested that height is more correlated with risk to certain diseases and various socio-economic outcomes.

Though genetics is an important fact affecting height in children, the environment the children are living in is also another vital part. An interesting case study about stunting and selection effects of famine by Tue Gorgens, Xin Meng, and Rhema Vaithianathan looked at the 1959-1961 Great Chinese Famine. This case study estimated that children under the age of five who survived the famine grew up to be 1 to 2 cm shorter, this result suggested that economic conditions leading to extreme scarcity of food can potentially affect height in children. A study research by Chavalittamrong B., Tarnpradub S., and Vanprapar N. glanced at the height and weight of high socioeconomic group Thai children living in the urban area. A total of 4371 high socioeconomic children from Bangkok Metropolis was studied. The weight for height were calculated in different percentiles. It was found that the height and weight of this selected population of children are higher, they are taller and heavier than children of other former studies. As seen from already conducted research, environment is extremely important but sometimes are overlooked by parents.

One final main contributor to height is the diet of the children. Children need to have enough nutrients in order to grow. Hence a research conducted in 2014 scrutinized the height of young men in Europe,

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Australia, New Zealand and USA. The researchers collected height data from 45 countries and compared them with long-term averages of food consumption. This research also discussed the ratio between the intake of high-quality proteins from milk products, pork meat and fish, and low-quality proteins from wheat. Likewise, this research mentions the possible genetic factors such as the distribution of Y haplogroup I-M170 and R1b-U106, or the phenotypic distribution of lactose tolerance emerge as comparably important. The available data on protein consumption from the FAOSTAT database (2000-2009) show that sale stature generally correlates positively with animal proteins, particularly with proteins from milk products, cheese, pork meat and fish. In plant proteins, the effect was clearly negative, and was particularly strong in proteins from wheat and cereals in general, but partly even in rice and vegetables. Although, total protein consumption is quite an insignificant dietary indicator because its relationship to male stature is very weak.

Conclusion

In conclusion, sufficient intake of calcium in any form is very important for not just a contributor to height in children but also for the maintenance of good bones. Calcium, ergocalciferol and cholecalciferol all work together to protect and maintain the bones. Deficiency in Calcium, Vitamin D2 and Vitamin D3 can lead to osteoporosis, osteomalacia, osteopetrosis, osteogenesis imperfecta, Paget disease of bone, fibrous dysplasia, and rickets. Further research could be made into the height in children and the alliance with calcium, ergocalciferol and cholecalciferol supplementation.

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