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Research Article

Research on Calcium Food Intake of Young Gymnasts

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Abstract: This paper aims to study the calcium food intake of young gymnasts and the relationship among calcium nutrition, exercise and bone mineral status. 13 elite young gymnasts aged 11~12 with 3 to 7 years of training experience are chosen as subjects. At the same time, 14 young students at the same age are selected as control group. Dietary survey is made to investigate their calcium and protein intakes status. The calcium intakes of young gymnasts are 515.3±218.0 mg/d, which are only 51.5% of calcium reference intakes. The BMC, bone area and BMD of young gymnasts are all significantly lower than those of young students by 23, 14 and 11%, respectively ($p<0.05$). It concludes that the calcium intakes of young gymnasts are lower than Chinese calcium reference intakes. The BMC and BMD of young gymnasts are lower than those of young students at the same age. Perhaps it is related to their heavy training load, the high requirement of calcium and the long-term inadequate calcium intake. Therefore, we suggest that young gymnasts can appropriate to eat more calcium rich food (milk or dairy products) to improve the calcium intakes and then to add BMC and BMD.

Keywords: Calcium food, exercise performance, intake, young gymnasts

INTRODUCTION

Nutrition is an important part of sport performance for young athletes (e.g., gymnasts), in addition to allowing for optimal growth and development. Macronutrients, micronutrients and fluids in the proper amounts are essential to provide energy for growth and activity (Corwin and Hartman, 2006). Among the environmental factors influencing the peak bone mass of healthy human, nutrition and sports are two important factors which act as regulating role. The Bone Mineral Density (BMD) after youth depends on the peak bone mass and the subsequent bone loss rate during youth. Although sports can stimulate bone formation, promote the increase of Bone Mineral Content (BMC) and bone mineral density and also can prevent osteoporosis, some researchers find that the bone mineral content of excellent gymnasts is usually lower than their peers. In other words, the influence of sports on skeletal development is in fact not so considerable. Research shows that more than 90% of the peak bone mass is obtained before the age of 18 and adolescence is the best stage for the calcium intakes and sports to promote the bone mineral content (Rowkands *et al*., 2004).

The mineral found in the largest quantity in the body is calcium, making up 1.5 to 2.0% of the body weight. Most of the calcium (99%) is found in the skeleton where it forms salts primarily with phosphorus. Much of the remaining 1% is found in the extracellular fluids where it plays important roles in neuromuscular transmission and blood coagulation. A small, but significant amount is found inside muscle fibers where its release from the sarcoplasmic reticulum initiates the muscle contraction process (Barrow and Saha, 1988). Plasma calcium concentration is maintained within a narrow range (2.2 to 2.5 mmol/L) by two hormones, parathyroid hormone (PTH) and calcitonin. PTH release is stimulated when plasma calcium decreases to below normal. PTH then stimulates:

- Bone resorption, which increases the release of calcium from bones
- Tubular reabsorption of calcium from the filtrate in the kidneys
- Activation of vitamin D, which facilitates increased absorption of calcium in the small intestine

The result is restoration of the plasma calcium concentration. Calcitonin release, simulated by increased plasma calcium concentration, restores plasma calcium by stimulating increased calcium uptake for bone formation (Carbon *et al*., 1990).

Because bone serves as a calcium reservoir, inadequate dietary calcium intake may have a negative effect on bone mass. This is especially true during growth when bones are increasing in length as well as mass. Adequate intake for calcium is greatest (1300 md/d) during adolescence (ages 9 to 18 years) (Goldberg and Pecora, 1994). Adults (19 years old and older) have an adequate intake for calcium of 1000 mg/d. The age at

which peak bone mass is achieved varies according to the bone site measured. Cross-sectional studies suggest Bone Mineral Density (BMD) at the proximal femur and lumbar vertebrae reaches its peak at age 18 years and peak trabecular and cortical BMD of the distal forearm is reached at 15 and 16.5 years, respectively, in females. However, longitudinal research suggests peak BMD in the lumbar vertebrae and forearm bones is reached at 29.5 and 28.3 years, respectively.

Although there are many vitamins and minerals required for good health, particular attention should be devoted to ensuring that athletes consume proper amounts of calcium, vitamin D and iron. Calcium is important for bone health, normal enzyme activity and muscle contraction. The daily recommended intake of calcium is 1000 mg/d for four- to eight-year-olds and 1300 mg/day for nine- to 18-year-olds (Robinson *et al*., 1993). Calcium is contained in a variety of foods and beverages, including milk, yogurt, cheese, broccoli, spinach and fortified grain products. A gymnast needs calcium and vitamin D to encourage strong bones and should be part of your gymnast's daily diet. This not only helps build a strong frame to avoid breaks, but helps them avoid osteoporosis later in life.

Calcium is important for the growth of teenagers. In our research, we try to study the impact of calcium food on the bone growth of young gymnasts. Besides, the relationship among calcium nutrition, exercise and bone mineral status is also discussed in this study. In order to increase the persuasive power, 14 young students at the same age are selected as control group.

RESEARCH OBJECTS AND METHODS

Research objects: 13 rhythmic gymnasts of Beijing Sport University are selected as research objects. The gymnasts are 11 to 12 years old and their mean age is 11.69±0.68. The training age is 3 to 7 years. At the same time, we choose 14 young students at the same age as the control group. All research objects are healthy and have no metabolic diseases, liver and kidney diseases and fracture.

Research methods: In our research, we use the dietary survey to study the impact of calcium food on the bone growth of young gymnasts. Combined bookkeeping and weighing, the dietary survey continuously records 3 days' diet of our research objects. The results are obtained by the nutrition calculator which is developed by National Institute for Nutrition and Food Safety. Bone Mineral Content (BMC) and Bone Mineral Density (BMD) are measured by Dual-Energy X-Ray Absorptiometry (DEXA). The middle phalanx is selected as the measurement location. Besides, bone area, height and weight are also measured. The statistical software SPSS 12.0 is employed to analyze the measured data.

Recognition that dietary mineral sources were essential to health began in the latter part of the 19th century. However, use of mineral salts (for example, magnesium) for therapeutic purposes dates back at least two centuries. Recommended Dietary Allowances (RDA) have been established for only the following seven minerals: calcium, phosphorus, magnesium, iron, zinc, selenium and iodine. Additionally, Estimated Safe and Adequate Daily Dietary Intake (ESADDI) has been established for five other trace minerals. Minerals are inorganic chemical elements commonly found in the foods we consume. Approximately 4% of the human body mass is composed of 21 minerals that are essential for life. Those minerals found in larger quantities (more than 5 g) in humans are classified as macrominerals whereas those found in smaller quantities (less than 5 g) are known as trace minerals. Macrominerals include (in descending order of magnitude) calcium, phosphorus, potassium, sulfur, sodium, chlorine and magnesium.

Although other minerals are very important to human body, with the limitation of the length of article, we just study the impact of calcium on the bone growth of young gymnasts. Hence, only the calcium intake is measured in our research.

RESEARCH RESULTS

Dietary intake status: The intake difference of energy, protein and calcium between young gymnasts and students is not statistically significant ($p>0.05$), but the fat intake of young gymnasts is obviously higher than that of young students ($p<0.05$). It can be observed from Table 1.

Bone Mineral Content (BMC): The BMC, bone area and BMD of young gymnasts are all significantly lower than those of young students by 23, 14 and 11%, respectively ($p<0.05$), which can be concluded from Table 2.

Moreover, we find that BMC is proportional to the height and weight, but not calcium intake. This result can be observed from both gymnasts and students. Use of mineral supplements by athletes is common in the United States. In one study of Ironman triathletes, the four most widely used mineral supplements were, in descending order, iron, zinc, calcium and selenium. Daily mineral supplement use by marathon runners was reported as following: calcium, 7%, zinc, 4% and iron, 2.3%. In another study of elite female marathon runners, 21% took zinc supplements and 18% took

Table 1: Dietary intake status

	Gymnasts	Students
Number	13	14
Energy (kcal/d)	1621.8±435.5	1812.2±382.2
Protein (g/d)	65.6±18.7	67.2±29.1
Fat (g/d)	75.9±28.9	50.3±27.0
Calcium (mg/d)	515.3±218.0	549.2±244.2

Table 2: Bone mineral content status

	Gymnasts	Students
Number	13	14
BMC (g)	0.663±0.208	0.856±0.188
BMD (g/cm^2)	0.312±0.051	0.350±0.043
Bone area (cm^2)	2.076±0.383	2.426±0.271

copper supplements. In this study, we examine the effects of exercise on mineral requirements and homeostasis, dietary intakes by athletes and effects of supplementation for calcium.

Calcium balance and physical activity: Calcium balance is the relationship between calcium intake and calcium loss. If the intake of calcium exceeds the amount lost, the person is in positive calcium balance. Negative calcium balance occurs when calcium losses exceed calcium intake. Positive calcium balance is required for bone growth whereas negative calcium balance leads to loss of BMD and bone mass. Calcium loss is the sum of the calcium excreted in the feces, urine and sweat. In most studies of calcium balance, only fecal and urinary calcium are actually measured whereas the dermal calcium is estimated as 60 mg/d. However, this may lead to an underestimation of actual calcium loss because of incomplete collection of excreta and dermal loss estimates that are too low. One study has reported sweat calcium losses during exercise of 57 mg/d.

Calcium balance studies of subjects from infancy through age 30 years were undertaken to determine the threshold calcium intake (calcium intake above which calcium retention is not enhanced by increasing calcium intake). Threshold calcium intake was estimated to be 1090 mg/d for infants (0 to 1 years old), 1390 mg/d for children (2 to 8 years old), 1480 mg/d for adolescents (9 to 17 years old) and 957 mg/d for young adults (18 to 30 years). Adolescents with calcium intakes in the lowest quartile (below 682 mg/d) were in negative calcium balance whereas young adults with calcium intakes in the first and second quartiles (below 963 mg/d) were also in negative calcium balance.

There is considerable evidence that both calcium intake and physical activity affect bone density of female adults. Bone Mineral Content (BMC) and BMD of the radius at distal and midshaft sites are significantly greater in women who are premenopausal (20 to 50 years) who have lifetime calcium intakes greater than 500 mg/d compared to women with lower lifetime calcium intakes. Women with high levels of lifetime physical activity (longer than 45 min/d, 4 to 7 d/wk of moderate to strenuous activities) also have significantly greater radial BMC and greater BMD at the distal site than women with moderate or low lifetime physical activity. Other studies have also reported significant associations between current or lifetime calcium intake and BMD. Two studies found vertebral BMD was significantly associated with physical activity in young adult females. In other studies, calcaneal BMD was reported to be significantly higher in young women who were very active as children and radial BMD was found to be higher in young adult females who had participated in sports at age 12 years. Weight-bearing activity was significantly related to change in BMD of boys aging 8 to 16 years and girls before adolescence, but not adolescent girls. However, two other studies found no significant relationships between either current calcium intake or physical activity of young adult females and BMD at several sites.

ANALYSIS AND DISCUSSION

Gymnasts are often considered to be extraordinary athletes. Their sport requires perfect timing, intense focus and power that can only come from having a lean, muscular body. Compared to swimming or long-distance running, gymnastics is considered to be an "anaerobic" sport which requires short, intense bursts of power rather than endurance. Gymnasts need to concentrate on foods containing protein and carbohydrates to build muscle and have access to quick energy and should avoid foods high in fat. Gymnasts are typically young, with their careers beginning as early as age three and lasting no longer than the early 20's.

Because most gymnasts are young and there is not a lot of research on the effects of supplements on young athletes, little is known about the effects of supplements on growth and development. However, two supplements seem to be beneficial for gymnasts--a multivitamin and a calcium supplement. The multivitamin can act as assurance for getting the 14 vitamins and 19 minerals needed for good health and calcium is critical for bone growth and strength. Having enough calcium can help prevent stress fractures, common in gymnasts. Many gymnasts avoid dairy products, a good source of calcium, for fear of putting on weight. Competitive gymnasts practicing four to five hours a day might benefit from energy bars as a snack, especially those that contain more carbohydrate than protein. These are best used for energy before practice or for recovery after working out. In this study, we try to show how gymnasts keep a positive calcium balance. In other words, as a gymnast, how to eat the calcium food is a key issue.

Calcium rich food: Calcium is an important component of a healthy diet. Although it is a mineral that is essential for life, the majority of Americans do not get adequate calcium on a daily basis. Calcium is the fifth most abundant element by mass in the human body. Calcium is a key factor to keeping your body running smoothly. It is essential for numerous functions, including building and maintaining bones and teeth, the transmission of nerve impulses and the regulation of the heart's rhythm. Calcium is also used in muscle contraction, blood clotting and the maintenance of cell membranes.

Calcium plays an important role in building stronger bones early in life and keeping them strong later in life. Consuming adequate calcium and vitamin D and performing regular, weight-bearing exercise are important to build maximum bone density and strength. Such "weight-bearing" exercises include walking, dancing, jogging, weightlifting, stair-climbing, racquet sports and hiking. Calcium is essential to good health and getting enough can help you reduce the risk of osteoporosis. People typically lose bone as they age, despite consuming the recommended intake of calcium necessary to maintain optimal bone health. Teenagers, young women and post-menopausal women in particular are most often consuming far less than calcium than their body needs.

Dietary sources are the best way to attain optimal calcium intake. Calcium requirements depend in part upon whether the body is growing or making new bone or milk. Dietary requirements vary throughout life and are greatest during periods of growth and pregnancy. Diets high in sodium increase calcium losses in the urine.

Many foods contain calcium, but dairy products are the most significant source. Foods and beverages high in calcium include milk and other dairy products. If drinking 3-1/3 cups of milk a day does not appeal to you, you can get calcium from a range of other dairy and nondairy sources. Milk is actually only one of many sources of calcium. Other dairy products such as yogurt, most cheeses and buttermilk are excellent sources of calcium and are available in low-fat or fat-free versions. Most populations get about half their dietary calcium from milk and other dairy products.

There are many foods, besides dairy products, that contain calcium. Dark green leafy vegetables also contain calcium, but it is not as readily absorbed as calcium from dairy sources. Dairy products are high in calcium, while certain green vegetables and other foods contain calcium in smaller amounts. These include leafy green vegetables, broccoli, nuts, seeds, beans, cheese and dried figs. Other sources of calcium are salmon and sardines canned with their soft bones.

Milk and dairy products are the biggest sources of calcium, but eating a variety of foods is the best way to get an adequate amount. Now more than ever there are a wide variety of foods and beverages that contain calcium. There are many that are fortified with calcium. Some juices, breakfast foods, soymilk, cereals, snacks, breads and bottled water have been fortified with this necessary nutrient.

Calcium is an essential nutrient our body needs every day. It is one of the most important elements in the diet because it is a structural component of bones, teeth and soft tissues and is essential in many of the body's metabolic processes. Calcium is the most plentiful mineral found in the human body. Remember, calcium is important for several body functions, so getting enough is imperative for good health.

It is much better to get calcium from foods (which also provide other nutrients) than from calcium supplements. If you have difficulty eating enough foods rich in calcium, you might need to consider a calcium supplement, especially if you are at risk of developing osteoporosis. It’s a good idea to discuss this with your doctor or other registered healthcare professional. If you do take calcium supplements, make sure you don’t take more than the amount recommended on the bottle. Too much calcium may cause gastrointestinal upsets, such as bloating and constipation.

How much calcium do gymnasts need: If you're a gymnast, you need to be concerned about taking in enough calcium, because inadequate calcium consumption can weaken your bones, increase your risk of stress fractures and inhibit proper muscle functioning. Under-consumption of calcium can also raise your chances of developing osteoporosis, which is currently an epidemic in the United States and Great Britain.

Ideas about how much calcium you really need are changing. For years, nutritionists and medical experts have recommended an intake of about 800 mg of calcium per day for most people and 1200 mg per day for males and females aged 11-24, a time period when bone accumulation is the greatest. However, scientists have gradually realized that calcium absorption diminishes as people get older. For that reason, the National Institute of Health in the United States is now calling for intakes of 1000 mg per day for men aged 25 or older and females between the ages of 25-50, 1000-1500 mg per day for women who have stopped menstruating, 1500 daily mg for women over the age of 65 and 1200-1500 mg for males and females aged 11-24.

These higher intakes may do more than build better bones. Scientific evidence suggests that calcium-rich diets may represent a drug-free way to keep high blood pressure under control; as many as one out of two individuals may be able to lower blood pressure by taking in extra calcium. Lofty levels of calcium may also reduce the risk of colon cancer, probably because calcium binds with cancer-promoting bile acids in the large tine. Fortunately, calcium-rich diets don't seem to increase one's chances of developing kidney stones; in fact, they may actually reduce the risk!

The easiest way to consume enough calcium is to eat yoghurt; just three cups of the stuff gives you over 1200 mg of the important mineral, which is an adequate daily intake for most people. Milk and calcium-fortified orange juice are also good; each supplies about 300 mg per cup. Calcium-processed tofu and spinach are the other major calcium sources; tofu yields about 260 mg per quarter-pound and spinach provides 245 mg per cup.

What about calcium supplements? If you're eating enough of the above foods, you don't need them, but

experts are recommending that those who rely on calcium pills should take them with meals and in doses of 500 mg or less. If you also take iron supplements, you should take the calcium and iron at different meals, since calcium can interfere with iron absorption.

Individuals with lactose intolerance tend to shy away from milk and yoghurt as their sources of calcium, but such persons can try some of the low-lactose or lactose-free dairy products currently on the market or rely on products which aid lactose digestion. All in all, taking in enough calcium is a very bright idea for gymnasts who want to perform at their highest level.

Calcium and stress fractures: The stress fracture is an injury that can be a threat to young athletes at the prime of their careers. A stress fracture occurs when the stress on a bone results in bone fatigue, resulting in a partial or sometimes complete break of the bone. This injury usually occurs when an athlete is at the height of his/her competitive season or when training becomes more intense and the stress caused by training and other factors becomes too much on bones. For one to maintain healthy bones, a sound diet that meets the Recommended Dietary Allowances for calcium is very important. However, recent studies show that overall dietary balance may play a much larger role in maintaining bone health.

Studies done recently on the effect of stress fractures in young women have focused on (but are not limited to) these elements of the triad. One of the most heavily studied areas has been the link between amenorrhea and the incidence of stress fractures. The connection between amenorrhea and a decrease in bone density comes partly from low levels of the hormones, estrogen and progesterone. Both of these hormones are needed in normal levels to help calcium deposit into bone and to maintain bone density. A majority of athletes studied who reported a history of stress fractures had some history of amenorrhea and oligomenorrhea (infrequent menstruation). Another component of the triad, disordered eating, may also play a role in amenorrhea, which has been linked to the incidence of stress fractures. Dietary intake and disordered eating patterns have been linked to amenorrhea in a number of studies. A concept that has been developed supporting the link between dietary intake and amenorrhea is called "energy drain". The human body must choose which functions it will tend to first. Things such as growth and development all come before reproduction and menstruation on the list of priorities. If calorie intake is too low, hormones such as estrogen and progesterone are lower on the list of priorities and may not be produced in amounts high enough to allow for menstruation to occur.

One factor that may override a diet low in calories and nutrients and its effects on bone mineral density is the high-impact nature of the sport. Gymnastics is an example of this. Some studies have shown that gymnasts have higher bone mineral densities than non-gymnasts and other athletes, despite lower calorie intakes and histories of amenorrhea. Despite this, however, gymnasts still do suffer from stress fractures. A diet that is low in overall nutrients can have serious consequences for the young athlete. Ninety-nine percent of total body calcium is stored in bone. A diet that is low in calcium can put the athlete at risk for developing bone-related injuries. Even if a young female athlete is menstruating and eats enough calories, calcium requirements are still just as important for maintaining overall bone health. The Recommended Dietary Allowances for calcium are currently 1,300 mg/day for males and females age 9-18 and 1000 mg/d for males and females age 19-30. For females who are estrogen-deficient and not menstruating, it has been recommended that they increase their calcium intake to total 1, 500 mg/d.

It is important to approach keeping a healthy bone mineral density through prevention in all young athletes. An eating plan that is sufficient in calories as well as calcium is the best dietary measure to take for preventing a decrease in bone mass. A diet rich in calcium is extremely important for increasing bone mass. Too much salt, protein, phosphorous, caffeine and alcohol have a negative effect on the amount of calcium that the body is able to absorb. One notable source of phosphorous is soft drinks. Phosphorous and calcium compete with one another for absorption in the body. Not only is this a problem, but soft drinks in most cases replace milk as a beverage throughout the day, which can even further create an overall calcium deficiency.

Stress fractures can easily shorten the life span of an athlete's career. Many different factors go into causing stress fractures. Diet can play an important role in helping to lower the potential for stress fractures. With a balanced diet that contains plenty of calories and calcium, athletes can help decrease their risk for stress fractures and increase their promise for athletic success.

Calcium and heart diseases: A report published in 2010 and widely reported in the media, found a possible link between calcium supplements and an increased risk of heart disease-particularly in older women. The levels of calcium intake of participants in the trials reviewed were up to 2,400 mg a day, achieved by taking supplements. (The RDI is between 1,000 and 1,300 mg per day for adults depending on age.).

Calcium intake at levels of 2,000 mg or more through supplementation may be of concern. This area requires further research, but currently associations such as Osteoporosis Australia and the British Heart Foundation recommend continuing calcium supplementation if recommended by your doctor and suggest that you discuss any concerns you may have with your registered healthcare professional.

On the other hand, participation in gymnastics can help maintain a healthy body, which is pivotal to preventing numerous health ailments. Conditions include asthma, cancer, obesity, heart disease and diabetes. Being involved in gymnastics helps encourage a healthy lifestyle including regular physical activity and eating a better balanced diet. Therefore, it is very important for gymnasts to take a reasonable amount of calcium from calcium rich food or calcium supplementation.

CONCLUSION

Calcium is required for the normal development and maintenance of the skeleton as well as for the proper functioning of neuromuscular and cardiac function. It is stored in the teeth and bones where it provides structure and strength. Low intakes of calcium have been associated with a condition of low bone density called osteoporosis which is quite common in western cultures and which often results in bone fracture. It is one of the major causes of morbidity amongst older Australians and New Zealanders, particularly postmenopausal women. Calcium intake throughout life is a major factor affecting the incidence of osteoporosis, however other factors, notably adequate vitamin D status and exercise, also play a role.

Both calcium intake and physical activity are important factors influencing peak bone mass in young gymnasts. However, not all young athletes consume the recommended dietary intake for calcium of 1200 mg/d. Because low dietary calcium intake is associated with an increased risk of stress fractures, gymnasts should consume diets than contain adequate calcium. Dairy products are primary sources of calcium in the diet. Other good sources of calcium include green leafy vegetables (for example, broccoli, turnip greens), tofu, canned fish and calcium-fortified foods (for example, orange juice, fruit drinks). Calcium supplementation appears to be more beneficial in preventing bone loss when women are 60 years older than immediately after menopause, however, it almost has no effect on young gymnasts.

Besides, in our research, we find that the BMC and BMD of young gymnasts are lower than those of young students at the same age. Perhaps it is related to their heavy training load, the high requirement of calcium and the long-term inadequate calcium intake. Therefore, we suggest that young gymnasts can appropriate to eat more calcium rich food (milk or dairy products) to improve the calcium intakes and then to add BMC and BMD.

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