Female Gymnasts: does the training reduce growth rates, delay maturation and increase the risk of long-term skeletal injury?

http://www.sportsinjurybulletin.com/archive/female-gymnasts-injury.html

Editorial Note: This article is informational and it may help provide answer to questions concerning delayed puberty of female figure skaters:

- *Are parents are encouraging their children and coaches selecting for physical characteristics that are considered positive attributes to being successful in a sport?*
- *Does the nutrition/ diet and physical training require to succeed in the sport affect the athletes growth – size, shape, height, and weight?*

On average, young female athletes in most sports are taller than individuals in the non-athletic population. For example, female basketball players, volleyball players, tennis players, rowers, and swimmers are taller than average, from the 10th year of life onwards.

However, female figure skaters, ballet dancers, and gymnasts are usually shorter than the average female during childhood and early adolescence (1). Ballet dancers actually catch up with the regular population in late adolescence, but gymnasts do not.

In addition, today's female gymnasts are actually shorter, compared with the fabled gymnasts of 20 years ago (2). Female athletes in most sports also tend to be heavier than females in the population at large, but this is partially a consequence of their greater height; in fact, female athletes tend to have lower percentages of body fat and greater percentages of lean tissue, compared with non-athletic women.

Unlike most athletes, female gymnasts actually have lighter body masses than females in the general population (as do female figure skaters, ballet dancers, and distance runners). However, gymnasts and figure skaters possess appropriate body masses for their heights, while ballet dancers and distance runners do not.

Is it the training that makes them smaller?

Thus, female gymnasts are not underweight for their heights, but they are unusually small in stature, compared with both other athletes and the general population. Does the diminutive size of gymnasts increase their risk of injury?

Does their reduced size mean that their skeletal systems are also less well-developed, compared with female athletes in other sports? As it turns out, the "skeletal ages" of gymnasts are often average or "on time for chronological age" during childhood, but by late adolescence most gymnasts' skeletons may be classified as late-maturing.

Gymnasts also tend to reach menarche later than young women in the general population, and later than young females in other sports. For example, young female swimmers have skeletal ages which are average or advanced in childhood and adolescence, compared with sedentary females(3).

To summarize, female gymnasts tend to be short, they begin to menstruate later than usual, and their skeletons are rather non-robust. What is responsible for all of this?

Some sports-medicine experts believe that specific – but not well-identified – characteristics of gymnastics training do indeed hinder growth. For example, researchers from Deakin University in Australia and Western Washington University in the United States who analysed 35 clinical reports (cross-sectional, historical, and prospective cohort studies) found that élite-level gymnasts may indeed be at increased risk of adverse effects on growth(4).

This group found that adolescent-female-gymnasts' skeletal systems matured at decreased rates during periods of regular gymnastics training, but then began to catch up during periods of reduced training or else retirement, suggesting that something about gymnastics training was affecting growth and maturation.

The Deakin-Washington researchers found that the greater the number of years of gymnastic training, the greater the reduction in growth; they also found that gymnasts tended to have more problems with their spinal growth, compared with elongation of the bones in the arms and legs (5).

Injuries to the distal radius

In addition, a special concern for gymnasts has been the possibility that the great stresses placed on the forearms during gymnastics training may lead to reduced growth in the radius, one of the two key bones in the forearm.

The rationale behind this concern is that stress-related injuries to the distal radius are rather common in female gymnasts; potentially, these injuries could lead to premature closures of the radial growth plates and thus abnormal growth of the bone.

In one review, distal-radius stress was found in 10-85% of all female gymnasts, and abnormal ulnar-radial length differences (which can occur when the distal radial growth plate closes too early) were detected in up to 20% of the gymnastic wrists which were radiographed.

Four studies actually revealed significant correlations between training intensity and ulnar-radial length differences (URLD), suggesting a possible "dose-response" relationship, and three studies found greater URLD in gymnasts, compared with non-gymnasts (6).

Australian Researchers don't agree

Nonetheless, many experts believe that gymnastics is taking a bad rap, and they have evidence to support their contention from a recent investigation carried out with male gymnasts, who also are shorter than the population at large.

Researchers from the Department of Human Biology and Movement Science at RMIT University in Melbourne, Australia, measured height, sitting height, leg length, lengths and breadths of the humerus, radius, femur, and tibia, diet, serum insulin-like growth factor (IGF-1), testosterone, and cortisol in pre-pubertal and early pubertal gymnasts and similar-aged, normally active non-gymnasts; measurements were taken every three to four months over an 18-month period(7).

At baseline, the gymnasts were shorter than members of the control group, primarily because of reduced leg lengths, not sitting heights (sitting heights are basically trunk statures). In addition, the lengths and breadths of the humerus, radius, femur, and tibia were smaller in the gymnasts, compared with controls.

However, no difference was found between the groups in levels of IGF-1, a compound which promotes growth, nor in concentrations of cortisol, which can retard growth and interfere with bone accretion. The truly key finding was that after 18 months of follow-up, no differences were found between the groups for changes in height, sitting height, leg length, humerus-radius-femur-tibia size, IGF-1 levels, or cortisol.

In other words, the short stature of the male gymnasts was due to "selection bias" rather than gymnastics training. Gymnastics work did not slow growth in the gymnasts; rather, the individuals were already short when they began their gymnastics training, possibly because of inherited factors. Indeed, research has found that gymnasts have parents who are shorter than average(8).

Ex-gymnasts get bigger!

To keep things interesting, a similar study carried out with female gymnasts added a few new twists to the story (9). In research carried out at the Department of Endocrinology at the University of Melbourne, sitting height and leg length were measured in 83 active female gymnasts, 42 retired gymnasts, and 154 healthy control individuals.

The study determined that active female gymnasts had delayed bone age (by about 1.3 years), reduced overall height, diminished sitting height, and lower leg length. However, when the analysis was narrowed to just gymnasts training for less than two years, the deficit was found only in leg length, and indication that females with shorter legs went into the sport and that gymnastics might then begin to whittle away at spinal growth.

In fact, only the deficit in sitting height (a reflection of the length of the spine) worsened during the two years of follow-up (after the initial two-year period). An interesting trend, however, was that in 13 gymnasts who were monitored during the immediate 12 months after their retirement, sitting-height growth accelerated, resulting in a considerable reduction in the deficit in sitting height.

In fact, adult gymnasts who had been out of the sport for eight years exhibited no deficits in sitting height, leg length, or menstrual function, an indication that the growth-retarding effects of gymnastics were not permanent.

The Australian researchers involved in this study wisely concluded that the short stature of active gymnasts is partly due to selection bias (individuals with shorter legs go into the sport) and partly due to some aspect of participation in the sport (after all, sitting height was downgraded by the gymnastics training). However, there did not appear to be any long-term skeletal problems.

Gymnastics training may even do some good

Indeed, some research has suggested that gymnastics training carried out at a young age (especially before puberty) may actually confer residual benefits on bone density in adulthood and thus may decrease the risk of osteoporosis and bone fracture in later life.

In research completed at the Department of Medicine at the University of Melbourne, scientists measured bone-mineral density with dual-energy X-ray absorptiometry in 45 active, pre-pubertal female gymnasts whose average age was 10.4 years, in 36 retired female gymnasts aged 25 years, and in 50 controls (10).

As it turned out, bone-mineral densities were actually higher in the active, pre-pubertal gymnasts at weight-bearing sites, compared with controls, and these differences increased in magnitude over a 12-month period during which the gymnasts trained actively. In fact, over 12 months the increase in bone-mineral density was up to 85% greater in the gymnasts, compared with non-gymnasts.

Among retired gymnasts, bone-mineral density was significantly higher than in control subjects at all sites examined, except for the skull (perhaps because gymnasts are taught never to land squarely on their pates); up to 20 years of retirement did nothing to lessen this gymnastic advantage.

All bets are off, however, if there is a deficiency of nutrient and/or calorie intakes during gymnastic training. When that is the case, overall growth will be stunted, maturation (including sexual maturation) will be delayed, and the skeletal system may indeed end up being sub-par.

Gymnasts must make sure their diets are completely adequate in calories, protein, carbohydrate, vitamins, minerals, and anti-oxidants.

Conclusions

So what's the bottom line? Gymnasts are shorter than "normal" individuals and other athletes, but much of the height difference is caused by genes, not the gym.

The only real mechanism which has been proposed to account for a ***gymnastics-related slowing of growth rate has been bony growth-plate damage in response to the stresses and high impacts of gymnastics training.*** There is some evidence to support this mechanism, but it is confined to the radius of the arm and thus does not apply to the leg-length and sitting-height differences which have been observed in gymnasts.

There is simply no convincing evidence to suggest that gymnastics training forces gymnasts' growth plates to close down prematurely. ***There is, however, evidence to show that some gymnasts grow at slow rates during training and engage in "catch-up" growth once gymnastics training ceases, suggesting that gymnastics can temporarily stunt growth.***

We believe that in many cases the cause of such slowdowns may be related to poor diet, however, rather than the rigors of gymnastics training per se.

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