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COMMENTARY

Dr Khan and colleagues have provided an excellent review and scientific analysis of the available evidence on the osteoporosis component of the female athlete triad and have brought to light some important concepts regarding the triad definitions, prevalence, and clinical relevance in the athlete population. Over the last decade since the initial Triad Consensus Conference in 1992, there has been much research on disordered eating and inadequate energy availability, amenorrhea, and bone health concerns in the female athlete, which has greatly enhanced our understanding of the pathogenesis of the various components of the triad, and has helped us to better prevent and treat athletes with these medical concerns. Because of the advances in our understanding and management of the triad, an update on the ACSM Position Stand is warranted and is underway.

The components of the triad as initially described were meant to alert athletes and their health care team, as well as parents, coaches, and the public to the potential dangers of these medical disorders, their interrelationships and comorbidities, and to serve as an assessment of risk rather than as strict diagnostic criteria for a medical syndrome. It is important to emphasise that each of the components of the triad lie on a spectrum. While it is acknowledged that osteopenia in the young female athlete is more common than osteoporosis, it is important to realise the potential that exists for the development of osteoporosis if the other interrelated components of the triad are not recognised and adequately treated. Furthermore, there is much research that is needed assessing the prevalence of osteopenia and osteoporosis in the female athlete population.

The original intent of the term osteoporosis as a component of the triad was to represent the end point on a spectrum of bone health that could be the potential result of disordered eating and/or amenorrhea. Dr Khan and colleagues are correct in that the original description of osteoporosis as a component of the triad was indeed prior to the World Health Organization (WHO) definition of osteoporosis based on bone mineral density criteria. With this new definition, fewer young athletes will fit this criteria for osteoporosis, but the future potential for osteoporosis still exists and is a significant concern. It is also important to recognise that the WHO criteria was developed to serve as guidelines for management of osteoporosis in postmenopausal women, and no specific criteria has been developed and uniformly accepted for diagnosis and management of osteoporosis in premenopausal women, including the young female athlete. Whether the actual definition of the triad needs to be changed to better represent the available data on the prevalence of osteoporosis in the female athlete population, or a clarification and emphasis on the triad spectrum of disorders and comorbidities, is a topic for further discussion amongst our colleagues in ACSM.

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Intensive training in girls

Intensive training in elite young female athletes

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Effects of intensive training on growth and maturation are not established

Parents, coaches, sport administrators, healthcare professionals, and the broader public have been alarmed by reports that intensive physical training in female athletes, initiated at young ages, may delay subsequent growth and maturation, and perhaps even reduce final adult stature.

GROWTH, MATURATION, AND DEVELOPMENT

Whereas growth specifically refers to the increase in the size of the body as a whole, and of its parts, maturation refers to progress towards the biologically mature state. Maturation differs from growth in that, although various biological systems mature at different rates, all individuals reach the same end point, becoming fully mature. Maturation therefore has two components, timing and tempo. Development refers to the acquisition of behavioral competence and is culture specific. Growth, maturation, and development occur simultaneously and interact. Growth and maturation are characterised by individual variation and, although under genetic and neuroendocrine control, environmental factors, including sport, may also have an influence.[1] Our understanding of the effect that sports training has on the growing child is limited because of the difficulty in distinguishing the independent effects of training from those of normal growth.[2] Only when a child is repeatedly measured from childhood through to adolescence can independent effects be identified. To date, there are limited numbers of such longitudinal studies, and hence most of our knowledge has been gained from cross sectional studies. The cross sectional nature of such studies obviously has made inferences that training delays puberty or reduces adult stature problematic.

BODY SIZE

On average, young female athletes from most sports have statures that equal or exceed the median for the normal population. Female basketball players, volleyball players, tennis players, rowers, and swimmers have been to shown to have mean statures above the 50th centile of the reference populations from 10 years onwards.[3] However, gymnasts consistently present mean values below the 50th centile, with a secular trend for decreased stature: today’s elite female gymnasts are, on average, shorter than the gymnasts of 20 years ago.[4] Figure skaters also have shorter statures. Ballet dancers tend to have shorter statures during childhood and early adolescence, but catch up with non-dancers in late adolescence.[3]

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In general, female athletes tend to have body masses that equal or exceed the reference medians. Gymnasts, figure skaters, and ballet dancers consistently have lighter body mass. However, gymnasts and figure skaters have appropriate body mass for their height, whereas ballet dancers and distance runners have low body mass for their height. Although female athletes from a number of sports tend to be heavier than reference populations, they also, in general, have lower percentage body fat.

PHYSIQUE OF YOUNG ATHLETES

Successful early adolescent and adolescent athletes (about 12–18 years of age) tend to have, on average, somatotypes similar to adult athletes in their respective sports.[5] Compared with adult female athletes, young female athletes tend to be less endomorphic, less mesomorphic, and more ectomorphic. The latter component reflects the role of growth in the transition from late adolescence into young adulthood. Physique is a significant contributor to success in many sports, and may be of particular importance in aesthetic sports such as gymnastics, figure skating, and diving, where performance scores may be influenced by how the judges perceive the athlete's physique.[6]

MATURATION OF YOUNG ATHLETES

Maturity differences among young female athletes are most apparent during the transition from childhood to adolescence, and particularly during the adolescent growth spurt. During childhood, the skeletal ages of gymnasts are average or on time for chronological age. As they enter adolescence, most are classified as average and late maturing, with few early maturing girls. In later adolescence, most gymnasts are classified as late maturing.[3] Gymnasts and ballet dancers tend to attain menarche later than the normal population and girls in other sports.[7] Early and average maturing girls are systematically represented less among gymnasts as girls pass from childhood through adolescence, probably reflecting the selection criteria of the sport, and perhaps the performance advantage of later maturing girls in gymnastics activities. Ballet dancers and distance runners show a similar maturity gradient in adolescence. In contrast, young female swimmers tend to have skeletal ages that are average or advanced in childhood and adolescence.[3]

STATURE AND REGULAR TRAINING

The smaller size of elite gymnasts is evident long before any systematic training starts[8] and is in part familial. In our own studies we have found that gymnasts have parents who are shorter than average.[9] There is also a size difference between those who persist in the sport and those who drop out.[10] Female athletes in volleyball, diving, distance running, and basketball show rates of growth in height that, on average, closely approximate rates observed in non-athletic children,[3] which are well within the range of normally expected variation among youth.[11] Most recent studies have found no evidence to suggest training causes changes in anthropometric variables.[12–15] Available data also indicate no effect of sport training on the age at peak height velocity or the growth rate of height during the adolescent spurt.[3] Data are insufficient to warrant that intensive training may delay the timing of the growth spurt and stunt the growth spurt in female gymnasts. Many confounding factors are not considered, especially the rigorous selection criteria for gymnastics, marginal diets, short parents, and so on. Female gymnasts, as a group, show the growth and maturation characteristics of short, normal, slow maturing children with short parents. Although we believe that training does not compromise adult stature, others suggest an opposite view. A short term longitudinal study in which the adult stature of gymnasts and swimmers were predicted concluded that gymnasts were failing to obtain full familial height.[16] However, decreasing predicted adult height during puberty is a characteristic of slow or late maturation, confirmed by the late onset of menarche in these subjects.[16] Other studies of gymnasts, over longer time periods, have also observed lags in adolescent growth but then report subsequent catch up growth.[2 10] Lindholm's group[17] found that six of 21 Swedish gymnasts studied over a five year period ended up 3.5–7.5 cm shorter than their predicted adult stature. Final height was predicted from parental heights. Although this protocol gives a target adult height, one would expect 95% of daughters to fall within a 9 cm range of this value. Thus, the final heights of these Swedish gymnasts[17] are, in fact, well within the range of variation expected with the stature prediction method used.

In contrast with height, body mass can be influenced by regular training for sport, resulting in changes in body composition. Reduced skinfold levels have been observed in growing female athletes and are dependent on continued, regular activity or training, or continued energy restriction. This situation often occurs in sports such as gymnastics, ballet, figure skating, and diving. However, it is difficult to separate specific effects of training on fat mass from expected changes that occur with normal growth and sexual maturation during adolescence.

SEXUAL MATURATION

The limited longitudinal data for girls active in sport compared with non-athletic girls indicate no effect of training on the timing and progress of secondary sexual characteristics (development of breast and pubic hair).[18] The interval between ages at peak height velocity and menarche (1.2–1.5 years) for girls active in sport and non-active girls also does not differ, and is similar to that of non-athletic girls.[12] Most discussions of the potential influence of training on sexual maturation have focused on the later mean age at menarche, often observed in female athletes.[2 3] Typically, training for sport was indicated as the factor responsible for this finding, with the inference that training "delayed" menarcheal onset. Unfortunately, most studies of athletes do not consider other confounding factors known to influence menarche.[7] Thus, given the many factors known to influence menarche, sport training per se has yet to be proven beyond reasonable doubt to be the causative factor for later menarche in female athletes.

CONCLUSIONS

Concerns have centred on the suggestion that intensive training causes growth retardation and pubertal delay in female athletes, specifically gymnasts. Interestingly, male gymnasts also have consistently short statures and late maturation, but these trends are not attributed to intensive training.[3 9] From our review of the literature, training does not appear to affect growth and maturation. It is more likely that young athletes select themselves, or are selected by coaches and sport systems, into their specific sports. Therefore, in general, the differences observed in stature between athletes and non-athletes are mainly the result of nature rather than nurture. With regard to pubertal development, the evidence suggests that the tempo is slowed down in some sports, but it has not yet been possible to identify whether this is an effect of nature or nurture. To clearly show that intensive training is a factor, future studies must be longitudinal, and be able to partition constitutional factors and the other components of the sport environment of female athletes before causality can be established.

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Pregnancy in sport

Banning pregnant netballers—is this the answer?

S White

A forum on a ban of pregnant netballers considered that the ban was discriminatory and that pregnant women should have the right to make decisions about competing in sporting activities

A recent move by Netball Australia to ban all pregnant netballers at all levels from participating in their sport has been met with a mixture of outrage and sympathy. Those who advocate a woman's right to make decisions about her own pregnancy, including sports participation, have been vocal in their disagreement with this ban. Sporting administrators in fear of litigation and some sporting competitors concerned about playing against a pregnant opponent have welcomed the ban.

The introduction of the ban had an immediate effect, with a national level netballer announcing her pregnancy (first trimester) and applying to the Human Rights and Equal Opportunity Commission for a lifting of the ban on the basis of discrimination. The case is pending.

Such a controversial situation prompted the Australian Sports Commission to hold a national forum with a range of experts and interested parties invited to contribute. Firstly, the available medical evidence was discussed. Associate Professor Caroline Finch, Chair of the National SportSafe Committee and a leading epidemiologist in the area of sports injury, reported that there is not a single case of an adverse outcome in pregnancy related to sports participation in the world literature. Admittedly there are no specific studies on pregnancy and contact sports, but numerous studies have looked at aerobic activities and fetal outcome.

A number of papers now concur that women who take moderate exercise (less than four times a week) in fact have larger babies than non-exercisers or more extreme exercisers.[1] None of these studies recorded any problems in terms of labour, delivery, or Apgar scores in any of the groups. There are now even a few studies of cognitive behaviour in newborns and 1 year old and 5 year old children all showing that those whose mothers exercised during pregnancy functioned as well as, or better than, those whose mothers did not.[2]

> Current available evidence suggests that sport and exercise, if anything, has a beneficial effect on the fetus/child.

In terms of contact in sport, the only large body of literature that considers fetal injury in relation to contact is in motor vehicle accidents and domestic violence, neither of which could be considered comparable to a game of netball. To further attempt to quantify a possible risk from sporting contact, Finch used data from two large epidemiological studies on the incidence of types of sporting injuries. In both studies, less than 2% of all injuries, in a range of sports, involved the chest or abdomen and in both studies all contacts were considered minor.

Finch conceded that there is room for more research in this area, but the current available evidence suggests that sport and exercise, if anything, has a beneficial effect on the fetus/child.

Professor Wendy Brown discussed public health issues, in particular female participation rates in sport. Professor Brown is the principal investigator with the Australian Longitudinal Study of Women's Health, involving 40 000 participants. Part of the study focused on sports participation and showed that the