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Musculoskeletal Differences Between Males and Females

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SUMMARY

There are obvious differences in appearance between men and women, which account for differences in sports performance and injury incidence and location. The recent greater exposure of women to high-level sports has produced an increase in the absolute numbers of injuries in women. However, there are marked anatomic differences between men and women in the musculoskeletal system. For example, women naturally have more subcutaneous fat than men, in a characteristic distribution over the buttocks and thighs and behind the upper arms, giving them a more rounded appearance. Skeletal differences are evident in the pelvis, which has larger inlet and outlet to allow for childbirth. Muscle size and muscle development is less in women, due to the physiologic effects of sex hormones. Relaxin in women plays a role in ligament and tendon laxity, allowing women to be generally more supple than men. At times, these anatomic differences are accentuated by feminine fashion, and by the wearing of dress shoes with high heels.

Key Words: Anatomy, Musculoskeletal system, Sex hormones

INTRODUCTION

From the viewpoint of an anatomist, a sport scientist, or a physiologist, there are obvious differences in appearance between men and women. For example, the distribution of subcutaneous fat is obvious. Women naturally have more subcutaneous fat than men, in a characteristic distribution over the buttocks and thighs and behind the upper arms, giving them a more rounded appearance. Skeletal differences are predominantly in the pelvis, which has larger inlet and outlet to allow for childbirth. This wider pelvis often contributes to knee, ankle, and foot problems. Muscle size and bulk is less in women, due to the effects of the normal sex hormones. Men, given their greater levels of testosterone, have larger and stronger muscles, with a greater potential for muscle development. In addition to the effects of the sex hormones, relaxin in women plays a role in ligament and tendon laxity, allowing women to be generally more supple than men.

With the increase in the number of women and girls taking part in sport at all levels, from school teams to the Olympic Games, there appears to be an increase in the number of female athletes being injured. While women's sports were once characterized by slow, determined play, they are now pursued with vigor, expertise, and increasing strength. Whether this alone is the factor for the apparent increase in injuries to female athletes is open to debate. Much of the published literature supports the belief that injury rates are sport- rather than gender-specific.[1,2] However, in many sports, women have higher injury rates than men,[3,4] suggesting that the anatomic and physiologic differences between the two genders plays a significant role in the type and incidence of injury.

Anatomic Differences

The interest in the anatomic and physiologic differences between men and women stems from the original empirical observation that women are more prone to ligamentous and tendon injuries than men. While there are more women participating in all kinds of sport than before, it is unlikely that this factor alone would account for the increase in injury among women. For example, a number of studies show that women have a significantly higher risk of damaging their anterior cruciate ligament (ACL) than men.[5–7] There are significant differences between the male and female

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skeleton, and some others which are suggested, but not proven. The female pelvis differs from the male pelvis, having larger and more rounded pelvic inlet and outlet, and more widely set hips. This results in femoral anteversion, increased quadriceps angle (Q angle, the angle formed by a line drawn from the anterior superior iliac spine to the center of the patella, and a line drawn through the center of the patella and the tibial tuberosity), genu valgum, and external tibial torsion. The wide pelvis contributes to an increase in the Q angle.

Quadriceps angles measuring up to 17° are normal for men and women. To better understand the importance of this angle, we must examine the normal alignment of the pelvis and leg. Standing in the neutral position, the weight-bearing line should pass through the anterior superior iliac spine, the center of the patella, and the second metatarsal of each leg. The hips are neither internally or externally rotated, nor flexed or extended. Both anterior superior iliac spines of the pelvis should be level. In the feet, the subtalar joint is neither pronated nor supinated, and the midtarsal joint is maximally pronated. The tibia is perpendicular to the subtalar joint, and the ankle joint is neither plantarflexed nor dorsiflexed. The knees should be together, with the medial femoral condyles touching, as should the medial malleoli at the ankle.

Widening of the Q angle, often seen in women, may result in valgus deformity at the knees (genu valgum or knock knee)—in which the individual, standing in neutral position, has the knees together, but has wide separation of the ankles, often with resultant overpronation of the ankle joint. Genu varum, or bow leg, is the opposite, with a gap at the knees when the ankles are held together. Genu recurvatum, or posterior bowing of the knees, is more common in women. Increase in the Q angle results in an uneven action of the quadriceps muscles on the knee. There is a greater force through the vastus lateralis muscle, which may pull the patella laterally in the trochlear groove of the femur, narrowing the lateral joint space. The increase in force through the vastus lateralis muscle also results in relative weakness of the vastus medialis muscle, which may result in lateral knee pain, patellar instability, and, in some cases, patellar dislocation. Malalignment of the patella is best confirmed by either conventional plain radiography of the patella in the skyline view, or by computed tomography. Radiographs define the position of the patella relative to the femoral condyles. They show narrowing of the joint space, subluxation, or dislocation.

The association between an increased Q angle and patellofemoral tracking problems and anterior knee pain, including the patellofemoral pain syndrome, accounts for the higher incidence of patellofemoral problems in women than in men. There is, however, no apparent relationship with anterior cruciate ligament (ACL) damage,[8] though there does appear to be a significantly higher incidence of knee injuries in women, especially ACL injury.[5–7] This may be due to the configuration of the intercondylar notch; some studies have shown that athletes with smaller intercondylar notch dimensions are more likely to damage the ACL,[9–12] and the dimensions of the intercondylar notch are smaller in females than males.[11] However, other authors have shown no significant difference in intercondylar notch size,[10] and have shown no difference in the incidence of ACL tears between men and women. At present, there is no definite evidence of a systematic difference in intercondylar notch size between men and women.

Women are more prone to foot problems, especially bunions and deformities of the lesser toes. It is difficult to be sure whether these foot problems are hereditary and gender-specific, or due to the wearing of high-heeled shoes. As the bunion enlarges, it pushes on the metatarso-phalangeal joint, bending the phalanges inward and resulting in hallux valgus deformity. In addition, it may cause widening of the space between the first and second metatarsals, valgus deformity of the second toe, and large callous formation around the first metatarso-phalangeal joint. The use of high-heeled dress shoes may also result in shortening of the Achilles tendon, with resultant tendon problems.

Physiologic Differences

Men have greater muscle mass and are generally stronger than women, due to the influence of the male hormone testosterone. Women, in general, have less muscle bulk and are weaker. They are also less likely to want to strengthen their muscles, especially those of the arms and shoulder girdle. There are gender differences in the balance between muscle groups. For example, women have decreased muscle strength ratios between the quadriceps and hamstring groups than men.[13] In addition, the quadriceps muscle group is the predominant stabilizer of the knee in women, whereas the hamstring group is more prominent in men.[14] For women, knee stability is more dependent upon ligament strength, whereas in men, the strength of their thigh muscles is more important.[15] These observations do not necessarily have any bearing on the incidence of knee injury.[16]

The idea is widely held that women, who tend to be more supple than men, have increased ligamentous laxity, but this is not supported in the literature.[17–18] Recent work on glenohumeral joint laxity does show that women exhibit significantly more anterior joint laxity, while men show significantly greater posterior joint laxity.[19] Undoubtedly, hormones play a significant part in ligament and tendon laxity. The role of cyclical estrogen and progesterone production throughout their fertile life on women's musculoskeletal system is not fully understood. A study of ACL injuries based on the three phases of the menstrual cycle (follicular [days 1–9], ovulatory [days 10–14], and luteal [days 15 to end of cycle]) has shown significantly more injuries than expected in the ovulatory phase of the cycle, and, in contrast, significantly fewer in the follicular phase.[20]

The role of estrogen on the maintenance of bone mass is as important as the role of exercise and dietary calcium. After menopause, the rate of bone mineral loss accelerates because of the fall in serum estrogen level. However, female athletes are more prone to stress fractures, because of their unique hormonal environment, in addition to their anatomic pelvic and leg differences.[21] While exercise-induced amenorrhea is a recognized contributor to low bone mass and stress

fracture, the cyclical changes in estrogen and progesterone also play an important role. During pregnancy, increasing levels of relaxin, which increase ligamentous laxity to facilitate changes in the sacroiliac joints and the symphysis pubis to allow for enlargement of the pelvic outlet during childbirth, also affect the other ligaments of the female body. This increased level of relaxin persists into the puerperium, making female athletes more prone to ligamentous injury during and immediately after pregnancy.[22]

CONCLUSIONS

The once popularly-held belief that female athletes were smaller and weaker than men, and therefore more prone to injury, is incorrect. There are small male athletes and tall, strong female athletes. The differences that determine the differences in athletic achievement, and the incidence of some injuries, are gender- and sport-based. They are determined by the fact that women bear children, and are anatomically and physiologically equipped to do this. The shape of the female pelvis gives rise to significant biomechanical differences, which affect not only the pelvis and hips, but also the entire lower limb, giving rise to problems with the knees, ankles, and feet. Sometimes, these anatomic differences are accentuated by feminine fashion, and by the wearing of dress shoes with high heels. Furthermore, the influence of female hormones, especially estrogen and relaxin, on the ligaments and tendons contributes to an increase in incidence of some musculoskeletal injuries in female athletes.

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