The growing dancer: Physiological challenges

By Siobhan Mitchell

This information sheet is Part 1 of a two-part series dedicated to the adolescent dancer. Part 2 addresses the psychological and social changes adolescence brings for young dancers.

This information sheet provides an overview of the physiological changes which happen at puberty, such as increases in height and weight and development of secondary sexual characteristics, and the implications of these changes for young dancers.

Puberty presents both opportunity and challenge for young dancers. On one hand, dancers benefit from improvements in strength, motor skills, and the activation of new motivational tendencies. On the other, sudden changes in size and shape can disrupt flexibility and co-ordination, adversely impacting dance performance and increasing risk of injury. With the onset of puberty, many dancers also become anxious and more self-conscious about their shape and appearance; placing them at greater risk for the development of affective (i.e., emotional) disorders, specifically those related to physical attributes and performance.

This information sheet examines the physical, morphological, and functional changes that accompany puberty, including the differences between boys and girls. It also discusses the implications that such changes may bring for performance and injury risk.

Puberty

- The process of physical changes through which the child is transformed into its adult state, capable of sexual reproduction
- A hormonally driven process resulting in marked changes physique, form, and function; including notable increases in height and weight, sexual dimorphism, and the appearance of secondary sex characteristics.
- Plays an important role in the activation, reorganization, and rewiring of brain structures; profoundly impacting emotions, motives and drives (Blakemore, Burnett, & Dahl, 2010; Rosenfield, 1991; Tanner, 1962).

Adolescence

- A transitional period of growth and development that occurs between childhood and adulthood.
- Whereas puberty describes only physical maturation, adolescence encompasses physical, cognitive, and socio-emotional maturity (Blakemore et al., 2010).
- Not a single event but a series of interrelated changes which occur over a long interval of time and span several domains of growth and development (Dorn, Dahl, Woodward, & Biro, 2006).

Biological basis of puberty

Early adolescence is characterised by physical changes to the body resulting from the onset of puberty, these changes have a biological basis. Puberty, itself, involves three distinct hormonal events, namely:

- **Adrenarche**
- **Gonadarche**
- **Activation of the growth axis** (starting the growth spurt)

The timing of these events is illustrated in Figure 1; highlighting the gender differences in the onset of each event, and the specific pubertal events and physical changes which are initiated (Blakemore et al., 2010; Petersen & Taylor, 1980).

Developing a greater awareness of when these hormonal events are likely to occur can enable dance educators to better understand the biological and physical development of their students and to consider this within training and evaluation.

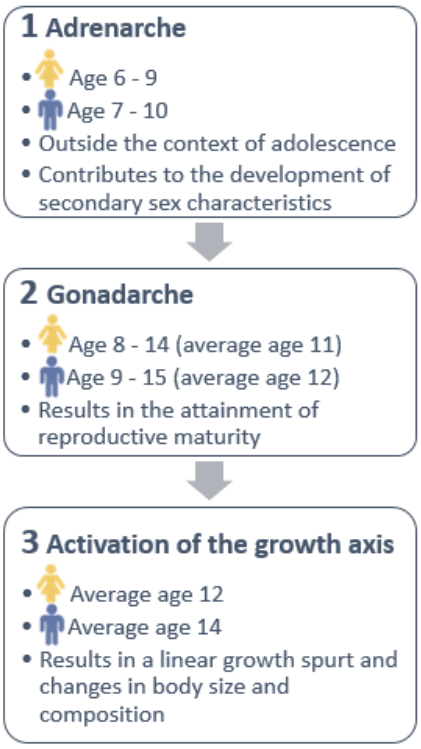

Figure 1. Hormonal events at puberty

Physical changes

Many physical changes take place during puberty:

- Increase in height and weight
- Changes in the accumulation and distribution of body fat and lean mass
- Development of a variety of secondary sexual characteristics (e.g. breast development)
- Shifts in body proportions.

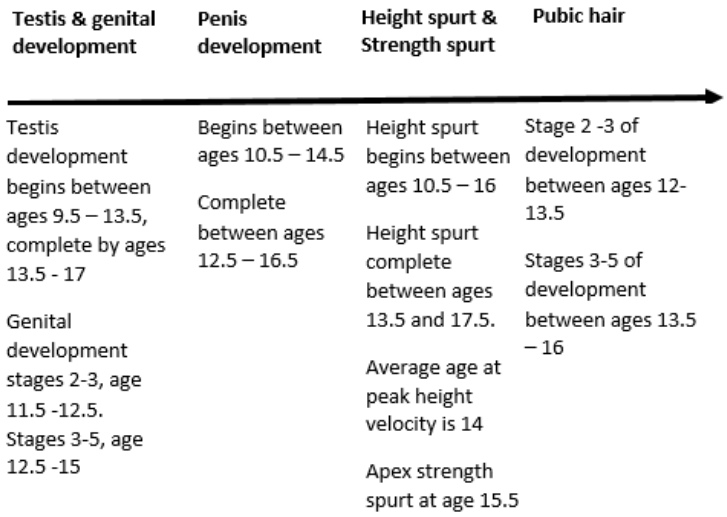

Figure 2. Average sequence of events for boys at puberty in relation to age.

The sequence of these changes varies significantly between boys and girls. Similarly to the timing of biological changes, a greater understanding of the sequence of specific physical changes can help to inform training practices with adolescent dancers.

Diagrams of the sequence of events at puberty show the averages for boys (Figure 2) and girls (Figure 3) in relation to age. The figures alongside indicate the range of ages within which some of the changes take place and the numbers (below) refer to the stage of development.

- Girls tend to mature around 2 years in advance of boys and so will experience physical changes at an earlier age.

- The growth spurt is likely to have the most significant implications for training and performance. For example, during and after the most rapid periods of growth, increased risk of injury, reduced flexibility, co-ordination and balance are likely.

- For young female dancers, age of menarche often begins in delay of general population norms, with an average age of 13.1 – 13.9 compared to 12.4 – 12.8 (Burckhardt, Wynn, Krieg, Bagutti, & Faouzi, 2011; Hamilton, Hamilton, Warren, Keller, & Molnar, 1997; Steinberg et al., 2008).

- Many people believe that engagement in professional dance training results in delayed maturation. While participation in any activity that results in a negative energy balance (i.e., less energy in than expended) can inhibit growth and maturation, there is limited evidence to suggest that dance, per se, is a cause of delayed maturity. Rather, it appears that dance, as an activity, selects for those individuals who possess the most ideal (functional and aesthetic) physiques. As late developing females tend to possess more linear physiques (i.e., lower body mass, higher ratio of lean mass to fat mass), it is not surprising that these individuals are more proportionally represented in dance.

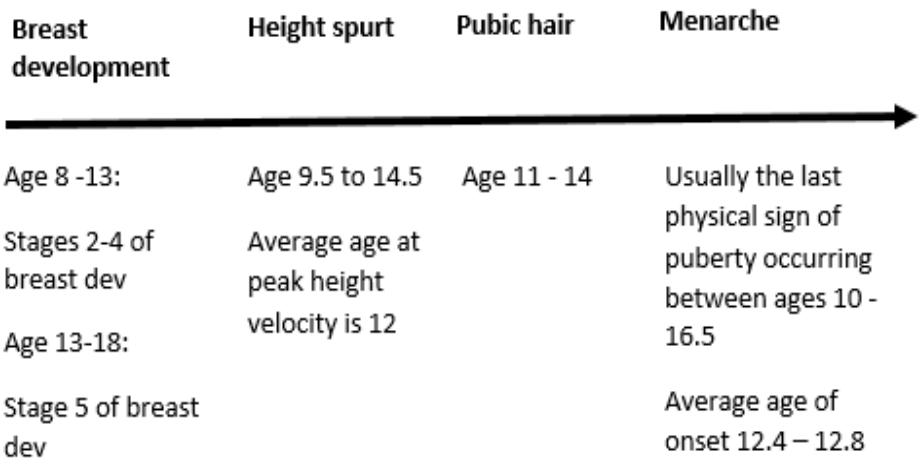

Figure 3. Average sequence of events for girls at puberty in relation to age.

- An awareness of when the growth spurt is likely to happen for your students and an understanding of the additional challenge and increased injury risk associated with adapting to these changes, during the 'relearning period' (Bowerman et al, 2015) will enable realistic expectations of progress during this period and will also enable you to adapt training accordingly.
- More visible changes, such as breast development for girls, are important to consider in terms of adjustment to new physical proportions and the potential for increased self-consciousness.

These physical changes at puberty significantly alter a young dancers' body and in turn, have implications for performance, technical ability and injury risk. A key event for young dancers is the growth spurt resulting from activation of the growth axis (for a description of the adolescent growth spurt, see Daniels, Rist, & Rijven, 2001). Though individuals of the same chronological age may vary by up to several years in terms of their biological maturation (chronological age is not a good indicator of physical development at puberty), the average time for this growth spurt to take place among non-dancers is around age 12 in girls and age 14 in boys and takes on average around 3 years from beginning to completion (Malina, Bouchard & Bar-Or., 2004). This age is especially significant as it coincides with a time when most dancers commence more serious training, a greater number of hours of training each week, and take on new physical challenges in training e.g. many young ballet dancers begin pointe work at this age.

Implications for performance

Most changes to physical performance are attributed to the timing of growth spurts and/or anatomical and functional changes in the joints which occur during adolescence (Malina, Bouchard, & Bar-Or, 2004). Basic physical changes such as increases in height, body fat and muscle mass have a **temporary** but significant effect upon physical performance in a number of ways:

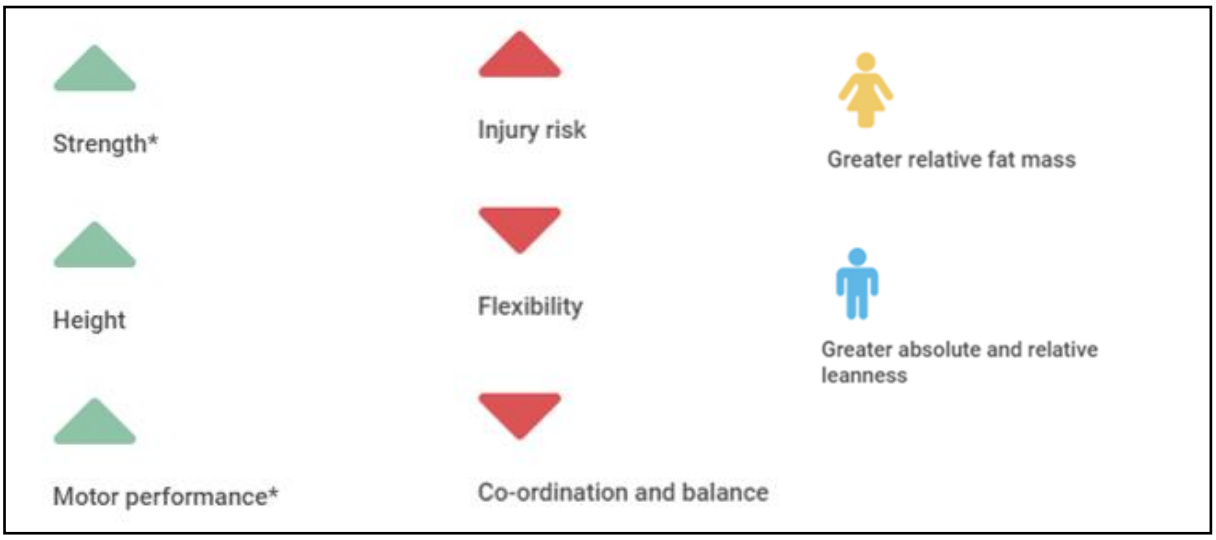

Figure 4. Implications of growth upon physical performance and capacity

Gender Differences

Gender differences are also important to consider.

- Girls mature, on average, around 2 years in advance of boys.
- *Sex differences are notable in both strength and motor performance.
- Gender differences in these physical parameters become noticeable around age 14 and may be increasingly challenging for young dancers as these physical factors are key to maintaining and improving dance technique and performance.

In girls **strength** and **motor performance** (i.e. the ability to perform physical skills) have been shown to peak during adolescence and even to decline, while the opposite can be seen in males where strength and motor performance tend to increase throughout adolescence (Espenschade, 1940; Jones, 1938, 1949; Malina et al., 2004). For male dancers these changes will be advantageous, enabling greater power and strength for grand allegro movements and could be emphasised during this period. While for female dancers, some will be at their peak strength and motor performance benefitting their dance performance, and for others who experience reduced strength and motor performance, encouragement may be needed to develop these aspects.

Sex differences in relation to physical performance can be attributed to greater relative fatness in girls and greater leanness in boys, which exert opposite effects on performance. The former has a negative effect on most motor performance tasks and the latter has a positive effect, attributed to increase in size and muscle tissue (Thomas & French, 1985). For both male and female dancers, overall there is likely to be a decrease in technical skill and control, decreased coordination and balance and changes to alignment necessitated by increased limb length relative to the spine which will be challenging for a young dancer to adapt to (Bowerman, Whatman, Harris, & Bradshaw, 2015; Daniels, Rist, & Rijven, 2001).

Flexibility is a particularly important component in dance and can be disrupted by growth of the lower extremities and the trunk during growth spurts (Malina et al., 2004). While average flexibility is reported to increase in girls age 11 - 14 before reaching a plateau, young dancers may not be as flexible as they or their teachers would expect or want for training. It is clear that growth can affect flexibility for young dancers due to the fact that the skeletal system matures in advance of soft tissues. Due to the nature of dance movements any loss in flexibility may be especially evident and challenging to adapt to. These changes will impact upon some of the core dance movements, for example, reduced strength and flexibility will result in lower leg extensions, reduced balance and coordination will affect pirouettes and balance positions and as technical control decreases, risk of injury increases (Daniels et al., 2001).

- **Adapting the focus of training during this time can help young dancers both physically and psychologically. For example, focussing on development of musicality and artistry as well as working through the relearning period on the more technical aspects will help young dancers to feel they are still progressing with their training and takes the focus away from the challenges of adjusting to a changing body which can easily become negative and frustrating.**

- **It may be especially helpful to emphasise how movements feel as opposed to how they look during this time, to reduce training load and adapt exercises for students experiencing their most rapid periods of growth.**

- **Flexibility is most responsive to training during childhood and as a dance teacher this is the ideal stage of development in which to promote this attribute. Due to an asynchrony between skeletal and soft tissue growth at adolescence, flexibility can be disrupted, during this period the focus can be shifted to maintaining flexibility rather than promoting it.**

- **These changes inevitably lead to young dancers struggling with movements which they are used to being able to perform, this can increase risk of physical injury and psychological effects such as loss of confidence, reduced motivation and increased self-consciousness.**

- **It is important that young dancers understand that these changes, such as reduced flexibility, are temporary.**

Implications for injury risk

In addition to these functional and physical changes, there are challenges and increased injury risk associated with adapting to these changes. During this 'relearning period' young dancers must relearn technique and re-programme this technique to adjust to new biomechanical challenges, such as decreased strength, power and flexibility and rapid change in limb length (Bowerman et al., 2015; Phillips, 1999). During this period of rapid growth, susceptibility to injury is increased. Factors such

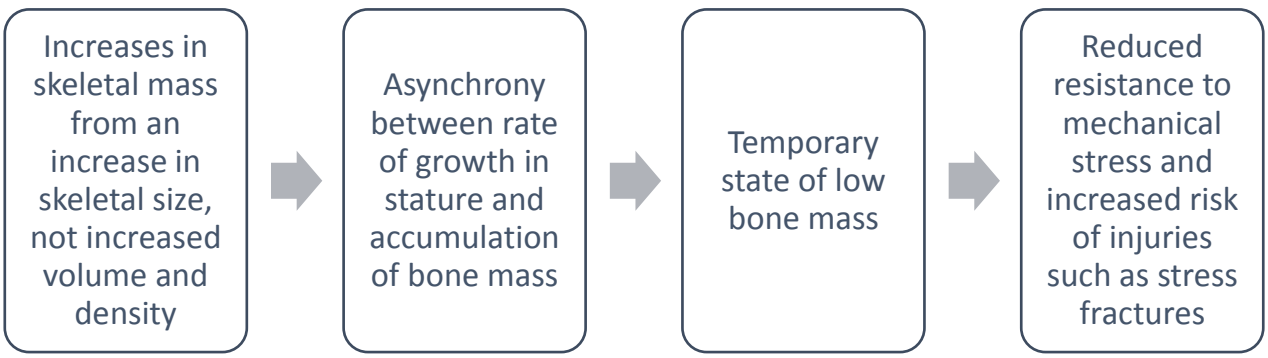

Figure 5. Skeletal growth and injury risk

as temporary low bone mass and adjustment to new biomechanical challenges can coincide with increased intensity of dance training.
Increases in the mass of the skeleton during puberty are mainly attributed to an increase in skeletal size, not to increased skeletal volume and density. The asynchrony between the rate of growth in stature and accumulation of bone mass reduces the bones' resistance to mechanical stress and therefore increases the risk of injuries such as stress fractures in high impact activities such as dance (Bonjour, Theintz, Buchs, Slosman, & Rizzoli, 1991; Bowerman et al., 2015; Fournier, Rizzoli, Slosman, Theintz, & Bonjour, 1997; Theintz et al., 1992). This is most severe at the point of most rapid growth, around age 11 - 12 for females, 13 - 14 for males, and can continue for 3 to 4 years. This coincides with increases in the intensity of dance training, leaving young dancers at high risk of overuse injuries (Bowerman et al., 2015; Fournier et al., 1997).

Young dancers' growth rates are also associated with injury risk (Bowerman, Whatman, Harris, Bradshaw, & Karin, 2014). Differences in foot length growth have been found to be associated with small to moderate increases in risk of lower extremity overuse injuries in elite adolescent ballet dancers. While the sample size in this study was small (N=46) and thus, further research is warranted to substantiate this risk, the study highlights rate of growth as a potential factor which contributes to increased injury risk in young dancers (Bowerman et al., 2014).

The timing of maturation can also have implications for injury risk, in particular for young female dancers who are delayed in maturation where the incidence of fractures has been reported to rise with increasing age at menarche (Warren, Gunn, Hamilton, Warren, & Hamilton, 1986). This increased risk of injury is associated with prolonged hypoestrogenism, referring to a lower than normal level of oestrogen, and is a well-recognised complication of weight loss, dieting and physical training in girls and young women (Tanchev, Dzherov, Parushev, Dikov, & Todorov, 2000; Warren et al., 1986). Delayed growth and maturation lead to a prolongation of the vulnerable growing years, exposing the growth plates to the influence of adverse mechanical factors such as pressure, impact and microtrauma for a longer period (Tanchev et al., 2000). Further injury risk factors identified in adolescent gymnasts, which may be applicable to young dancers, include skeletal immaturity, insufficient rest periods and repetitive movements (DePalma, 2006; Wyatt, 2015).

Summary

Puberty clearly represents a challenging time for young dancers and many of these challenges can be overcome with the guidance of the dance teacher. Awareness of the physical changes that dancers go through during puberty and gender differences, and how these changes impact upon performance and injury risk can equip dance educators to make this transition through puberty as adaptive as possible. There are several ways in which schools and teachers can work towards reducing risk of injury during adolescence. Monitoring and measuring growth and maturation can help to predict most rapid periods of growth, identify maturity timing and inform any adjustments to training schedule and load. Remaining mindful of additional risk factors such as insufficient rest, reduced flexibility and strength and individual differences in maturity timing can enable more personalised approaches to the training of young dancers.

While the physical changes of puberty present challenges to young dancers in terms of technique, performance and injury risk, further conflicts can arise between pubertal changes and physical appearance, which can become increasingly important for young dancers auditioning or being assessed. Desirability of pubertal changes may also depend on the gender of the individual. For example, in dance, pubertal changes may have more apparent advantages for boys, bringing the

benefits of strength and power (Buckroyd, 2000; Pickard, 2012). In particular, for young female dancers, the more overt changes such as breast development and increases in fat mass, alongside the temporary changes to their physical capabilities, can have a significant effect upon feelings of self-consciousness, self-confidence, body image and identity. Healthy adaptation to these physical changes is critical; adaptation at this point can heavily influence the trajectory of future psychological wellbeing.

Healthy adaptation to these physical changes is often effected by social context. Involvement in elite sport or dance at adolescence may place considerably higher pressure on successful and rapid adaptation to physical changes. These challenges will be discussed further in part 2 of this series dedicated to the adolescent dancer: *Psychological implications of puberty in dance.*

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