Adolescent Health and Well-being

Hormones and Your Teenager

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Introduction:
While we have all experienced puberty, it is unlikely that anyone would voluntarily choose to go through puberty again. Puberty is a physical event, and part of adolescence, but adolescence spans a longer period of time. Puberty generally takes place between 8 and 15 years, with marked individual variation and thus would be expected to have a major impact on the middle years. Adolescence is generally defined as the second decade of life. Adolescence involves major psychosocial, behavioural and cognitive change, and final maturation of the brain is not complete until the early to mid twenties. The tasks of adolescence include acceptance of a mature body image, achievement of independence from family and integration with the peer group, development of social competency, the achievement of a sexual identity and mature sexuality, completion of secondary education and decisions about vocation, and development of a personal belief system which includes moral and ethical values. These are enormous tasks and often the young person faces additional challenges. Such challenges may be from within, such as physical or mental health problems or from without, such as family break-up, involvement in peer driven risky behaviour and even the effects of climate change. A further addition to the mix is individual resilience and how a young person manages to cope with and learn from adverse experiences that come their way.

Puberty:
Puberty is the time it takes for an individual to move from the physical appearance and the hormone levels of childhood to full adult physical development and reproductive capacity, accompanied by adult levels of puberty hormones. In evolutionary terms, this is development of a body which can both perform adult tasks, and ensure the future of the species. In humans there is a significant disconnect between completion of puberty and the optimal time for reproduction. The puberty transformation is achieved by changes in puberty hormones – the three main ones are testosterone and oestradiol produced by the testes and ovary respectively and growth hormone from the pituitary gland, a small pea sized gland in the centre of the brain. Even in early childhood testosterone and oestradiol are measurable in the blood, but at very low levels. There is also a significant gender difference with boys while still in the womb experiencing a surge in testosterone levels in the second trimester of pregnancy, to levels as high as those found in mid-puberty. It is believed that this surge is responsible for some early brain programming which in turn accounts for some of the gender behavioural and cognitive traits on group studies.

Hormones are substances produced in one part of the body but which travel in the blood to all parts of the body and can influence all the organs in the body including the brain. Hormones transmit their messages by attaching to special receptors on cells. Receptors for testosterone and oestradiol are found in almost all parts of the body, including the brain. So puberty hormones potentially have effects on parts of the body which might not be seen as targets for puberty change.
There is a great deal that we know about puberty and also some major unknowns. For example, we understand the physical changes and hormone changes of puberty but as yet do not understand what triggers the cascade of hormone events which start with activation of brain neurons which in turn stimulate the pituitary to send messages to the ovaries and testicles. While we have yet to define the trigger for puberty, we do have some knowledge about what might influence the timing of puberty.

The most important unknown about puberty is what are the longitudinal effects of puberty hormones on behaviour, physical and mental health and wellbeing. This fact may come as a surprise, as the observations of millions of parents are unlikely to be wrong about an effect of some type. The precise connection between puberty hormone and adolescent health and wellbeing is unknown because it is very challenging to keep adolescents in a long term study which requires multiple collections of biological samples in which to measure hormones. Studies have previously used adolescent self-report of their physical developmental stage. Newer techniques which use smaller blood volumes, and also urine and saliva are now available which means for the first time ever, this question might be answered.

There are other important facts related to puberty. Most importantly it is a word that adolescents never want to hear, having a high embarrassment factor. From our own focus group studies, growth and development are more acceptable but generally it is a topic that they wish adults would not raise. The earliest physical signs of puberty, on which we generally base an estimation of puberty development, are very subtle and private: a breast bud in the female (initially smaller than a 5 cent piece), and in the male a shift in testicular volume from 3 to 4 mls. These changes set up the start of the most physically diverse period in the whole of life, and that is because of the great variation in the timing of onset of puberty and the speed in which a young person travels through puberty. During adolescence there are major but normal variations in development that would never be tolerated at any other developmental stage. For instance it is normal for a girl to experience the first period at any age between 9 and 16 years. Such a range of normality would not be possible in childhood development.

**The specific events of puberty:**
The onset of puberty as determined by the earliest rise in testosterone or oestradiol in the blood varies between 8-13 years in females and 9-13.5 years in males, with a median age of onset is around 10-11 years. Onset is to a significant degree is controlled by genes can be affected by internal or external events. Earlier puberty onset is seen in overweight girls, but not in overweight boys, and in overseas adoptees. A later onset of puberty is seen in malnutrition (including anorexia nervosa and other eating disorders). This occurs because the body perceives that there are inadequate fat stores to support pregnancy and lactation (irrelevant in the situation but programmed as part of evolution). Poorly treated or severe chronic disease can also delay the onset of puberty and is seen in cystic fibrosis, inflammatory bowel disease and kidney failure as examples. There are also disease processes which cause abnormally early or late puberty with extreme hormone disturbances and which require urgent specialist assessment. Earlier puberty has, in epidemiological studies which describe a group and not an individual, been associated with depression, earlier sexual debut and high prevalence of breast cancer in females and a later puberty with lower bone density and anxiety in males.

The duration of puberty can vary from two to five years. The tempo or speed with which puberty is traversed is thus highly variable. While there is an impression that the earlier puberty starts the quicker the young person travels through puberty, this has not been confirmed on longitudinal studies.
The height growth spurt is an early puberty event in girls and the start of periods a late puberty event. Therefore once a female has her first period she has generally completed 90-95% of height growth. The height growth spurt is a late puberty event in males and thus in late primary school girls are often taller than boys. Because boys have a later height growth spurt they grow for longer and ultimately on average are taller than girls.

Both males and females obviously gain weight during puberty to match their height gain. The final body composition differs as a result of puberty hormone change. Males gain relatively more muscle or lean mass as a result of testosterone and girls relatively more fat as a result of oestradiol. Thus there is not only a difference in fat percentage, but also a difference in fat distribution, with girls having a more lower body fat distribution and boys depositing what fat they have around the middle. It is this deep, inside abdominal fat which tends in later life to be associated with heart disease risk factors such as high cholesterol and high blood pressure. Thus gender differences in cardiovascular risk factors begin in puberty. In females the most dramatic weight gain is in the 12 months just before and just after the onset of periods. Girls gain on average 10 kg and this gain may be much greater in overweight girls. Suddenly jeans they have worn no longer fit and young teenagers may need strong reassurance about the normality of this change. In boys the gain in muscle is a late puberty event and many males may not ‘bulk up’ until their early twenties. Body hair and beard growth also occur later in puberty. All these three events require near adult testosterone levels.

In summary males during puberty gain on average 30 cm and 30kg, and females 20 cm and 20 kg and puberty hormones in both increase 20-30 fold. This is rapid compared to the slow and steady growth of 6cm and 4-5 kg per year in earlier childhood. We assume that those in the middle years take these changes in their stride but there is no good research on the physical and psychological effects of these rapid body changes. Most research has focussed on frank body image disorder.

Physical vulnerability: Parents and teachers are aware of the acute physical sensitivity that young people develop about their body, with a strong and early onset need for privacy. At this stage of puberty the young teenager is hyper-sensitive to physical change, is acutely aware of even minor physical changes which may unexpectedly cause anxiety and stress, and are the only age group to easily recognise their own face when the picture is presented upside down.

There is evidence of specific musculoskeletal vulnerability in adolescence, with the appearance of injuries not seen in children or adults. Such injuries include avulsion fractures and damage to the growth plates (which are made of cartilage) at the ends of bones. Avoidance of overtraining and protective equipment are important strategies to prevent injury. Growing pains are often diagnosed during this period of rapid growth in the middle years. The cause of these pains remains unclear, and persistent or recurrent pain must always be assessed by a doctor. There is also the impression that during this active growth phase adolescents are more vulnerable to the effects of physical illness. It is usually the adolescent in the family who has the more prolonged physical reaction to an illness such as the common cold. Adolescents often have a more extreme response to other viruses such as glandular fever, when compared with other age groups. They may have prolonged physical symptoms after an apparently transient illness, such as gastroenteritis or laryngitis. In extreme cases this may result in debility, depression and school refusal, which absolutely requires expert assessment.
Summary:
The physical and hormonal events of puberty are dramatic. There are clear gender differences which are an integral part of puberty. There is a diversity of physical development during the middle years. While birthday age is likely to continue as the traditional way of separation into school, sport and other groups, developmental stage not age should be at the forefront of thinking for all who work with or live with adolescents. It is important to tune in to thinking about developmental stage in a young person and ask how it may impact on behaviour and wellbeing. Early developers may be criticised or punished for rough or stupid behaviour because assumptions about age are based on size. Late developers might find it hard to keep up with friendship groups as these groups develop different social interests. There is a clear need to better understand how the changes of puberty hormones affect the middle years, both physically, emotionally and behaviourally – not so that we can medically intervene to alter the events of puberty – but rather so we can support young people at particularly vulnerable times. This is likely to be particularly important in the areas of mental health, particularly depression and anxiety, and in risky behaviours.

I am currently leading, with a large group of other investigators from the University of Sydney, a longitudinal study in Dubbo and Orange. The ARCHER study is planned to answer for the first time ever how puberty hormones impact on behaviour, health and wellbeing by starting early enough in physical development and by using newer techniques to measure puberty hormones. The ARCHER study is currently enrolling in Grades 5, 6 and 7, and many schools will be approached to help with the recruitment process. The study itself is carried out at the Research Offices of the Schools of Rural Health.