Raging teenage hormones – fact or fiction?

By Aviva Lowy

We associate adolescence with moodiness, emotional outbursts and risk-taking. If the ‘twos’ are terrible, the ‘teens’ can be traumatic. And more often than not, this time of upheaval is blamed on the raging hormones of puberty.

“Puberty is a tremendously dramatic physical event,” says Professor Kate Steinbeck, Medical Foundation Chair in Adolescent Medicine. “Puberty hormones are produced in increasing amounts and cause the familiar physical changes of adolescence. There are receptors for oestradiol and testosterone, the main puberty hormones in most organs of the body. This includes in the parts of the brain which are especially associated with mood and behaviour.”

So it’s not unreasonable to think that puberty hormones play a big part in explaining the trials of being a teenager. However, we just don’t know the degree of that effect, which is why Steinbeck embarked on the ARCHER study (Adolescent Rural Cohort on Hormones, Health, Environments, Education, Relationships) looking at the true longitudinal effects of puberty hormones on adolescent health, wellbeing and mood.

“In preparation for this study we did two systematic reviews of what is known about the effects of puberty hormones and basically, the data are just not there to confirm the role of puberty hormones on mood and behaviours.

‘Assumptions and attributions are made, but when you look at the studies, these were either not designed to answer the questions or were poorly designed or were cross-sectional,’ says Steinbeck.

‘We have been able to measure puberty hormones in the blood for over 40 years, but the frequency of blood sampling we needed to do was just not acceptable to determine the individual variability of puberty hormone change so we measured puberty hormones in urine using highly accurate mass spectrometry,’ says Steinbeck, who believes the impediment to this research was not just the technical capability but also the difficulty in recruiting adolescents into such an intensive cohort study.

The ARCHER study, based in Sydney’s School of Rural Health in Dubbo and Orange, has at last managed to do that. With 350 adolescents recruited, the investigators will be able to measure the pattern and timing of puberty hormones in individuals over three years.

‘The start of puberty can vary between the ages of eight and 13 in girls, and nine and 14 in boys. There is a wide variation in when puberty starts and also a wide variation in the time it takes to go through puberty, from having the physical development of a child to the physical development of an adult.

‘It is really impossible to understand the effect of puberty hormones unless you follow young people individually throughout their puberty. Hopefully, then we can show statistically that different puberty patterns have different effects,’ says Steinbeck.

Of the 350 children recruited to the program,
only 3% have been lost, which is an excellent retention rate for any study, let alone one requiring regionally dispersed teenagers to provide three-monthly urine samples - and all the logistics that entails.

So far, 97% of the samples have been collected. Steinbeck jokes that she believes they are all urine and no one has substituted apple juice, however she won’t know for sure until the sampling in completed because it is only then that all the hormone assays will be done using the same machine.

“We can measure very low levels of puberty hormones in the urine which is of both technical and research interest. There is a lot of discussion about how accurate our previous lab techniques were at detecting low (early puberty) testosterone and estradiol levels. In the first year of the study when we were developing our essays, we looked at a subgroup of samples and it was only in less than 5% of samples that we couldn’t measure any level of puberty hormones. This showed our methods were on the right track. The other interesting finding in these preliminary data is that puberty hormones don’t apparently increase in a smooth line. It’s more of a stop start progression’.

“We’ve known for some time that the timing of puberty onset can have long-term effects. Most people can give some indication as to whether their puberty was similar to their peers, or earlier or later, but of course this method is much less accurate than hormone measures. For example, girls who started their periods earlier compared to their peers are more at risk of depression, obesity and breast cancer. And we know that those who describe a later puberty are more at risk for anxiety and possibly lower bone density.’

It’s hardly a win:win situation. But Steinbeck hypothesises that a more significant risk factor than age of puberty onset will be the speed of puberty or perhaps even instability of hormone levels as these rise.

“We see mood disorders in pregnancy and in menopause where there is rapid change in hormone levels, and also prior to menstruation. These are three normal physiological conditions where moodiness appears to be related to hormone change. And there is reasonable evidence that men who abuse anabolic steroids, which are testosterone-like compounds, suffer moodiness, aggression and even psychosis. But there is absolutely no evidence in normal community samples that the general presence of these hormones cause that.’

But it is more than moodiness that is associated with the teenage years. Everything from mental health to physical health begins to deteriorate.

‘Over the past 50 years we’ve made tremendous improvements in early childhood wellbeing through better pregnancy care, immunisation programs and improved nutrition. Early childhood intervention programs have also produced increases in children’s wellbeing and learning improvements. But as young people reach adolescence, many indicators of good health start to worsen, a pattern that continues into early adulthood’.

‘It is tempting to think that that mental health is the major health problem during adolescence. It certainly is the most common problem overall as a third of adolescents will experience some problem with mental wellbeing. But I’m also concerned with risk-taking behaviours. Death through unintentional injury is the greatest cause of teenage death around the world and much of that mortality is related to risk-taking behaviours. Also the control of chronic illness often deteriorates during adolescence, also contributing to poorer health.’

The really worrying issue with teenage health problems is that, rather than being transient, these often persist past adolescence, establishing a pattern for the rest of that person’s life.

‘The major causes of morbidity and mortality in adults are tobacco, overweight and inactivity, and most of those health risk behaviours start in adolescence. Activity levels fall off in the teenage years. Puberty is a risk time for overweight and obesity. And if you are a lifelong smoker, you most likely started as a teenager,’ says Steinbeck.

‘My research interest is to consider at an individual level all the risk factors that might cause a deterioration in adolescent health and wellbeing and then to look at how we might intervene to improve health outcomes.’

How much puberty hormones figure in all this, we’ll soon know. ‘We might find that we are attributing too much to puberty and ignoring the fact that the behaviour, the mood, the risk taking, might in fact reflect something else going on in that young person’s life and to dismiss it as “just hormones” might be very unwise.

‘Whatever we find I suspect that there’s going to be no simple answer. That’s number one. Number two, we may be surprised how little puberty affects health and wellbeing, provided other indicators of potential problems are not part of that young person’s life. We know that what are termed the psycho-social determinants of health may also interfere with adolescent well-being and behavior. These could be poverty, isolation, being out of school, family disruption, drug or alcohol use in the adolescent or their parent, and parental mental illness. There are all situations that can affect a person’s physical and mental health. We want to show just what is attributable to puberty hormones and what is not.’

Once Steinbeck has defined the true impact of puberty in her cohort, she will continue to follow the group as they go through middle adolescence, looking at sleep, activity, cognition and risk-taking behaviour. She’ll also be looking at depression, self-harm, anxiety and what is changing for parents as well...

‘We’re continuing to monitor such things as risk-taking in parents. We want to know how much parental risk-taking behaviour around substance abuse and driving as examples might impact on similar adolescent behaviours.’

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**The ARCHER Team**

A study like ARCHER is impossible without a committed team of investigators. The original idea for the ARCHER study came from a discussion between the Dean, Bruce Robinson, and Catherine Hawke, as an opportunity to develop research undertaken in rural campuses. “Associate Professor Catherine Hawke in particular has played a major role in the development of the study from its inception. She is the only study investigator who is based locally. Together with Karen Paxton, our project manager, who has also been with ARCHER from the beginning, she has helped achieve the continuation of a unique study,” said Kate Steinbeck.