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Is puberty starting earlier than before?

PERSPECTIVES

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Entering puberty early or late can have long-term effects on health. We do not know enough about what induces puberty and what factors contribute to its onset.

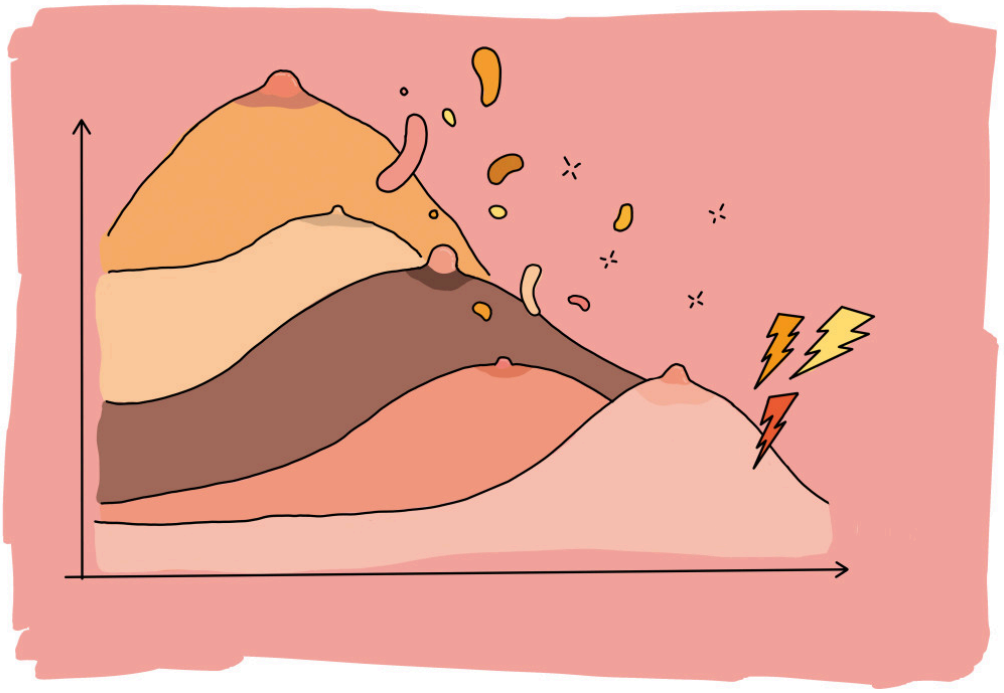

Illustration: Sylvia Stølan

Over the past three decades, studies from Europe and the United States have shown a tendency towards earlier puberty onset in girls, with a greater change in the age of breast development compared to the first menstruation (menarche) (1, 2). The change in the age of puberty onset in boys has been more ambiguous (3), but some studies have shown similar trends (4). It has been suggested that this secular trend is due to obesity (5) and/or exposure to endocrine disrupting chemicals (6).

Conducting puberty studies can be challenging due to the need for intimate examinations, and recruiting a representative sample of healthy individuals in the relevant age group is therefore difficult. Girls can be asked to state the timing of their first menstruation, but this is a late-occurring pubertal milestone. Puberty assessments of girls should therefore include an assessment of breast development, as breast budding defines the onset of puberty (Tanner stage B2). Puberty onset in boys is defined as having at least one testicle with a volume of ≥ 4 ml measured by comparative palpation using a Prader orchidometer.

Prior to our study, the only data describing the development of puberty timing in Norway relates to age at menarche. Brudevoll et al. published data for the period 1861–1974, indicating that the average age at menarche in Oslo went from 15.6 years in 1861 to 13.3 years in 1940 (7). In Norway, only marginal changes in age at menarche have been reported in recent decades, with a stable age just above 13 years between the post-war period and the Bergen Growth Study 1 (2003–06) (8).

New Norwegian reference for puberty development

The Bergen Growth Study 2 is the first study in Norway where the purpose is to establish references for puberty development. Almost 1200 healthy children and adolescents aged 6–16 were recruited from six different schools in the Bergen area in 2016. Female puberty was evaluated by breast development, which was assessed both clinically and with ultrasound, and through direct questions about the occurrence of menarche. For male puberty we used ultrasound to calculate testicular volume. Tanner staging of pubic hair was assessed for both sexes. In addition, several anthropometric measurements were recorded, and blood samples were taken.

> ***«Our results may indicate that puberty starts earlier in Norway now than 10–15 years ago»***

The Tanner assessment of breast development is usually performed by clinical palpation and inspection, and is especially challenging in girls who are overweight or obese. Ultrasound can distinguish adipose tissue from mammary gland tissue and may therefore be useful for assessing puberty in girls who are overweight (9). We identified six different ultrasound stages of breast development based on the breast morphology and composition of glandular, adipose and connective tissue (10). Puberty references from ultrasound examinations of the breast have never previously been published. For the boys, the use of ultrasound allows for a more direct measurement of testicular volume, without added volume from surrounding structures such as the epididymis, or from pathology such as a hydrocele. Testicular volume was calculated as an ellipsoid based on length, width and depth measurements (11).

Data from the Bergen Growth Study 2 showed that the average age for onset of puberty in girls was 10.4 years (Tanner stage B2), which is comparable with other northern European studies (12). With regards to menarche timing, we observed a significantly decreased mean age at occurrence for the entire cohort from 13.3 years in the first growth study (2003–06) to 12.9 years (2016). For the girls of Norwegian origin, we also found a small but significant decrease corresponding to 2.8 months. Our results thus indicate that puberty starts earlier in Norway now than 10–15 years ago. This finding should be followed with future studies. For the boys, modelling of testicular volume for age was done to construct the references (13). This is the first published growth curve for testicular volume from Norway and shows that the average age at onset of puberty is 11.7 years among healthy boys. Testosterone levels started to increase at the same age (14). This is comparable to the onset of puberty at 11.6 years observed in Dutch boys (measured using ultrasound in 2007–09) (15) and 11.7 years in Danish boys (measured using a Prader orchidometer in 2006) (4).

«Early menarche is associated with a higher risk of breast cancer, cardiovascular disease, mental illness and increased mortality»

Normal age for puberty onset is defined within ±2 standard deviation of the mean. Ages outside this range should be considered as early or late puberty. Based on our findings from the Bergen Growth Study 2, we recommend maintaining the current threshold values set out in the paediatrics manual of 8–13.5 years for girls and 9–14.5 years for boys (16). The current growth charts used in Norway contain a panel for puberty references from Denmark (1991–93) which are set to be replaced with our new Norwegian references. No major changes will incur for male puberty, but references for female puberty will reflect the current and somewhat earlier onset of puberty observed in Norway.

What influences the timing of puberty onset?

Many complex factors affect the onset of puberty. Genetics are thought to explain 50–75 % of the variation, while the rest is attributed to lifestyle factors such as nutrition, general health, psychosocial stress, perinatal factors, body composition and environmental factors such as endocrine disruptors (6). The trend towards earlier puberty is often seen in connection with the parallel obesity epidemic among adolescents. Early studies on endocrine disruptors as a cause of earlier puberty onset initially shed light on the period immediately before puberty. More recent studies have demonstrated that exposure to such chemicals in the fetal and neonatal period are also relevant to puberty timing. The effect of various stressors depends on the period of occurrence and exposure. For example, prepubertal malnutrition or overnutrition (increased fat mass) in girls can lead to late or early puberty respectively (17, 18), while intrauterine growth retardation is associated with early puberty (19).

In the same way, psychosocial stress preceding or during puberty can lead to delayed menarche (20), while accelerated puberty has been described in girls who experience such stress in early postnatal life or as an infant (21). There is less research in the field on boys, and therefore little is known about what affects their timing of puberty onset.

Implications of earlier onset of puberty

Early puberty, particularly in girls, has been associated with adverse effects on adult health. At the population level, observations indicate that early menarche is associated with increased mortality (22) as well as a higher risk of breast cancer (23), cardiovascular disease (24) and mental illness (25). In addition, early puberty has been shown to be associated with more frequent and prolonged adolescent-related risky behaviour (26, 27). In boys, however, there are few studies that refer to the health implications of early puberty. *Later*

puberty has been found to have a protective effect on testicular cancer (28), but it has also been linked to being bullied, low self-esteem and psychosocial anxiety (29).

Age at puberty onset is therefore an important aspect of Norwegian public health. Further aims of our research include examining whether body composition and/or the presence of endocrine disruptors in the blood affect the onset and development of puberty by looking at accurate, objective measurements of secondary sexual development and hormone profiles, and further exploring genetic mechanisms.

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