Puberty & Adolescence
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- **Puberty** – biological transition from the reproductively immature to the reproductively mature condition.

- **Adolescence** – socio-cultural transition from the dependent to the independent state. Assumption of the adult role in society.
Puberty & Emotional Conflict

- Time of adjustment to changing bodies.
- Surging hormones.
- Conflict common for all but severe for individuals with gender dysphoria as secondary sex characteristics of an identity they do not accept become apparent.
Puberty Suppression

- Use of drugs to block hormonal changes of puberty.
  - Typically these are gonadotropin agonists which prevent the production of FSH & LH and thus preventing production of estrogen and/or androgen typically associated with puberty.
  - Luprolide (Lupron) – intramuscular injection and Histrelin – (Suprellin) – subdermal implant are most common drugs used.
Puberty Suppression

- These drugs were first used in cases of precocious puberty (less controversial) and later for individuals with severe physical and intellectual limitations to prevent growth and body maturation (very controversial).

- More recently used to block development of secondary sex characteristics in youth with gender dysphoria.
Puberty Suppression

- Stop the typical sex-differential changes of body structure (which are permanent).
- Suppressing drugs can be stopped and development occur at a later time if desired.
- Buys time for extended determination of individual’s gender identity and for decisions about how body type fits the identity.
- Long-term physical consequences of suppressing drugs still not known.
The disparity between the age of biological maturation (puberty) and the age at which a person is expected to assume the adult role (adolescence) in Western society has increased over time.
The onset of puberty

Change in Age of Puberty?

- Rose Frisch’s data:
  - 1835 - avg. age of menarche = 16.5 yrs
  - 1900 = 14 yrs.
  - 1980 = 12.9 yrs

- Data are US and Western European based. Include data from girls in Denver where high altitude delays pubertal development and menarche.
Body fat level at menarche has stayed relatively constant between 1840 and today.

Obese girls experience menarche earlier than non-obese girls.

Intense athletic or dance training that keeps body fat low delays puberty.
Rats kept lean through restricted feeding experience delayed puberty (Kennedy)
Continued Decline in Age of Puberty?

- The human studies of changing age of puberty we have addressed so far have used menarche as the measure of puberty.
- Menarche is only one aspect of pubertal development for girls.
- Before we can address whether the age of puberty has continued to decline, we need to understand the stages of pubertal development.
Stages of Development

- Medical norms are based on a study by James Tanner (T) of children residing in a British orphanage.
- Concern that these data may be influenced by the sample population.
- But T’s data are the basis of norms used by most medical practitioners in Western society.
Stages of Development

1. Start of the adolescent growth spurt
   A. Typically the first sign of puberty in both girls and boys.
   B. Starts about 2 years earlier for girls than boys.
C. Girls - spurt begins between 7.5 and 12.5 years and lasts about 5 years.
D. Growth spurt controlled by estrogens, androgens and growth hormone.
Stages of Development

2. Thelarche (budding of the breasts)
   A. Areola increases in size
   B. Increased fat deposition
   C. Happens about 1 year after the start of the growth spurt (8.5-13.5 years.)
   D. Effect of estrogen and prolactin
Stages of Development

3. Simultaneous

- **Adrenarche** – start of adrenal cortical hormone production particularly the sex steroids.

  - Androgen increase has significant effects
    - First physical sign of adrenarche - **pubic hair formation** - an androgen effect
    - May also be the start of **sexual attraction** (McClintock & Herdt – reading under sex drive/sex behavior)
3. Simultaneous

- and the peak of the growth spurt –
  - involves estrogens, androgens and growth hormone
- 0.5 years after thelarche (9-14 years)
4. **Underarm hair formation** – an androgen effect
   - 1-1.5 years after adrenarche (10-15.5 years)
Stages of Development

5. Menarche

- about 1.5 years after adrenarche (10.5-15.5 years)
- average age in the United States = 12.5 years
  - 10% of US girls experience menarche before age 11
  - 90% experience menarche by age 13.75
Variability in Timing of Puberty

- T’s data showed great variability in the rate of passage through puberty and even in the order of events.
Continued Decline in Age of Puberty?

- Research now suggests that the age of the onset of puberty may be declining but the age of menarche may not be.
  - For example, Coleman & Coleman (J. Adoles. 2002), evaluating data from 1948-present:
  - No evidence of further decline in age of menarche
    - there is controversy over this
  - Age of onset of puberty (especially thelarche) may have declined over this time
Race/Ethnicity and the Timing of Puberty

- Over the last 20 years, a number of studies have indicated ethnic differences in the timing of puberty in the US. (Herman-Giddens et al., Pediatrics, 1997; Chumlea et al., Pediatrics, 2003; Obeidallah et al., J. Res. Adoles, 2000)

- In most cases, the group differences are in the early stages of puberty, but some report earlier menarche.
Race/Ethnicity and the Timing of Puberty

- Rather than show clear ethnic/racial impact on timing of puberty, the data suggest that socioeconomic factors act as stressors that influence the timing of menarche independently or in interaction with race/ethnicity.
  - One possible indirect route – poor nutrition among the less affluent and an increase in obesity.
  - May also reflect environmental hazards (pesticides, hormones in foods) that speed development. Epigenetic effects that are transmitted from generation to generation.
Puberty and Adolescence

- Concern that early maturing girls will face pressures to engage in adult-like behaviors such as dating, sex, smoking and alcohol consumption before they are mature enough to make thoughtful decisions about these issues.

- Note that this connects physical maturation and sexuality for girls.

- No research has addressed timing of puberty in boys and no social concerns about sexuality and early maturing boys.
Early vs. On-Time Maturers

- Work done mainly with White girls and does not address any potential racial/ethnic differences.

- Typically, early maturation refers to experiencing menarche before your peer group. Often defined as menarche before 6th grade (a grade typically reached at age 11-12).
Early vs. On-Time Maturers

Negative Effects

- Early Maturers have been found to show:
  - Increased symptoms of menstrual distress
  - More worry about menstruation
  - Poorer preparation for menses
  - Increased risk of depression
  - More negative body image and disordered eating
  - Increased risk of substance abuse (alcohol, cigarettes, marijuana) – this effect may disappear in later adolescence
Early vs. On-Time Maturers

Negative Effects

- Early maturers have been found to show:
  - Higher risks for poor school performance and school behavior problems – especially if changing schools
  - But increased social popularity
  - Earlier onset of dating and sexual behavior may be before girl is mature enough to assert her desires
  - Evidence on increased risk of teen pregnancy and STDs mixed
    - Increased rate of HPV infection reported
Early vs. On-Time Maturers

Negative Effects

- Persistence of these effects into late adolescence or adulthood is debatable – body image issues may be permanent.
- If long-lasting, psychological or behavioral consequences can affect final educational level and career options as well as psychological well-being.
- As early puberty becomes more common, are we ready to support girls through this transition?
Cycles of estrogens, FSH and LH begin before puberty.

During puberty the amplitude of the changes in hormone levels increases.

Pre-puberty

Post-puberty
Endocrine Changes of Puberty

- Ovulation does not become a regular part of the monthly cycle for up to 2 years after menarche.
- Prepuberty, ovaries can make adult levels of estrogen but do not because FSH and LH levels are very low.
- FSH and LH levels are very low because GnRH is very low.
Endocrine Changes of Puberty

- Prepuberty - hypothalamus very sensitive to estrogen such that low estrogen inhibits GnRH.
  - estrogen $\rightarrow$ GnRH
Endocrine Changes of Puberty

- During puberty, the sensitivity of the hypothalamus to estrogen **DECREASES** such that more estrogen is required to inhibit GnRH.

  - ESTROGEN $\rightarrow$ GnRH
Body Fat & Estrogen

- Androgens rise with adrenarche
- Androgens are converted to estrogens in adipose (fat) tissue.
- As fat increases, more androgen is converted to estrogen.
Body Fat & Estrogen

Thus, estrogen levels can increase to a critical point that results in decreased hypothalamic sensitivity to estrogen and allow GnRH/LH/FSH levels to rise so that they can stimulate the ovary to produce adult levels of estrogen.
Body Fat and Estrogen

- Adipose tissue also produces other hormones thought to play a role in the timing of puberty.
- Leptin the best known.
- Probably not a trigger for puberty but required for pubertal changes to take place.
Body Fat & Regular Cyclicity

- Frisch - regular cyclicity requires higher body fat than menarche
- Severe dieting, stringent athletic training or illness that decreases body weight can all interfere with cyclicity
- Recent studies suggest that milder dieting may interfere with cyclicity as well
Exercise-Induced Amenorrhea

- Athletic training can result in amenorrhea (failure to menstruate)
- Ending strict training = return of cyclicity and menstruation
- During amenorrhea, GnRH, FSH, LH and estrogen levels are all suppressed (just like pre-puberty)
Exercise-Induced Amenorrhea

- Low estrogen increases risk of decreased bone density.
- Results in increased risk of stress fractures and can put woman at increased risk of osteoporosis.
- Fertility typically returns with renewed cyclicity.
- Bone damage can be permanent.
Exercise-Induced Amenorrhea

Cause of amenorrhea with exercise:

1. Low body fat?
2. Change in the muscle:fat ratio that can be accomplished through either a decrease of fat or an increase of muscle.
3. Nutritional deficit state: situation in which energy output exceeds energy input. Can result from dieting or increasing exercise without changing food intake.