Adolescent health

Epidemiology

Physical and cognitive development
• What is an adolescent - definitions
• Why adolescents are important – epidemiology
• The main causes of mortality and morbidity
• Physical and cognitive development - brain growth and behaviour
Definition

• WHO defines adolescents as those people between 10 and 19 years of age.
• The Convention on the Rights of the Child, all person under the age of 18 years.
• Other overlapping terms are
  
  *Youth* - 15–24 years
  *young people* -10–24 years  is a term used by WHO and others to combine adolescents and youth.
In high-income countries and, increasingly, low-income and middle-income countries, birth rates have declined while child survival has increased.

Hence, there is a larger cohort of adolescents and young people today (just under 2 billion) than ever before, of whom 86% live in low-income and middle-income countries.
• Adolescence is a key phase of human development.
• The rapid biological and psychosocial changes that take place during the second decade affect every aspect of their lives.
• These changes make adolescence a unique period in the life-course in its own right, as well as an important time for laying the foundations of good health in adulthood.
Developmental theorists have long identified adolescence as a crucial period of psychological and biological change, second only to early childhood in the rate and breadth of developmental change.
Adolescence

Epidemiology
Morbidity and mortality in the adolescent age group
In 2014, there are 1.2 billion adolescents aged 10–19 in the world, accounting for 16.4 percent of the global population.

The vast majority of adolescents (88%) live in low and middle income countries, where 82% of the global population live. Low income countries are home to nearly one out of every six adolescents.
Mortality

2000 & 2012

Mortality rates per 1,000,000 population


Age

0–4 years 16.3
5–9 years 1.8
10–14 years 1.0
15–19 years 1.5
20–24 years 2.1
25–59 years 4.7
All ages 8.6

2012

10.0
1.4
0.9
1.3
1.6
4.0
7.9
Figure 1. Top 10 causes of death among adolescents by sex
Filter options:
1. Cause
   - All Causes
2. Age
   - 10 to 19

WHO region:
- Africa
- Americas
- Eastern Mediterranean
- Europe
- Global
- High-income countries
- South-East Asia
- Western Pacific

Regional focus on mortality: Global
Top 5 causes of mortality (per 100,000 10 to 19 year olds) by sex, 2000 & 2012

- Road injury: 10.222
- HIV/AIDS: 8.283

[Tableau Visual](http://public.tableausoftware.com/shared/3JW3RBSZ3?:display_count=no&:showVizHome=no)
3. Mortality rates (per 100,000 10 to 19 year olds). Cause: HIV/AIDS

Filter options:
1. Cause
   - HIV/AIDS
2. Age
   - 10 to 19

WHO region:
- Africa
- Americas
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- South-East Asia
- Western Pacific

Regional focus on mortality: Global
Top 5 causes of mortality (per 100,000 10 to 19 year olds) by sex, 2000 & 2012

<table>
<thead>
<tr>
<th>Causes</th>
<th>2000</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Both sexes</td>
<td>Females</td>
</tr>
<tr>
<td>Deaths per 100,000 population</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Road injury: 10.222
- HIV/AIDS: 8.283

Hover for instruction
Mortality in adolescents by WHO Regions 2000 & 2012 aged 10 to 19 years

3. Mortality rates (per 100,000 10 to 19 year olds). Cause: Self-harm

Filter options:

1. Cause
   - Self-harm

2. Age
   - 10 to 19

WHO region
- Africa
- Americas
- Eastern Mediterranean
- Europe
- Global
- High-income countries
- South-East Asia
- Western Pacific

Regional focus on mortality: Global

Top 5 causes of mortality (per 100,000 10 to 19 year olds) by sex, 2000 & 2012

<table>
<thead>
<tr>
<th>Causes</th>
<th>Sexes</th>
<th>2000</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Road injury</td>
<td>Both sexes</td>
<td>10.222</td>
<td>10.090</td>
</tr>
<tr>
<td>HIV/AIDS</td>
<td>Both sexes</td>
<td>8.283</td>
<td>8.180</td>
</tr>
<tr>
<td>Self-harm</td>
<td>Both sexes</td>
<td>5.098</td>
<td>5.569</td>
</tr>
</tbody>
</table>
Mortality in adolescents by WHO Regions 2000 & 2012 aged 10 to 19 years

3. Mortality rates (per 100,000 10 to 19 year olds). Causes: Lower respiratory infections

Filter options:
1. Cause
   - Lower respiratory infections
2. Age
   - 10 to 19

WHO region:
- Africa
- Americas
- Eastern Mediterranean
- Europe
- Global
- High-income countries
- South-East Asia
- Western Pacific

Regional focus on mortality: Global

Top 5 causes of mortality (per 100,000 10 to 19 year olds) by sex, 2000 & 2012

<table>
<thead>
<tr>
<th>Causes</th>
<th>Both sexes</th>
<th>Females</th>
<th>Males</th>
<th>2000</th>
<th>Females</th>
<th>Males</th>
</tr>
</thead>
<tbody>
<tr>
<td>Road injury</td>
<td>10.222</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HIV/AIDS</td>
<td>8.283</td>
<td></td>
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<tr>
<td>Self-harm</td>
<td>5.992</td>
<td></td>
<td></td>
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<tr>
<td>Other causes</td>
<td></td>
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<tr>
<td>Total deaths</td>
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</tr>
</tbody>
</table>

Deaths per 100,000 population
Mortality in adolescents by WHO Regions 2000 & 2012 aged 10 to 19 years

3. Mortality rates (per 100,000 10 to 19 year olds). Cause: Maternal conditions

Filter options:
1. Cause
   - Maternal conditions

2. Age
   - 10 to 19

WHO region:
- Africa
- Americas
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Deaths per 100,000 population

Regional focus on mortality:
Top 5 causes of mortality (per 100,000 10 to 19 year olds) by sex, 2000 & 2012

<table>
<thead>
<tr>
<th>Causes</th>
<th>2000</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Both sexes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Females</td>
<td></td>
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<tr>
<td>Males</td>
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<tr>
<td>Both sexes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Females</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Males</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Road injury: 10.222
- HIV/AIDS: 8.283
- Self-harm: 6.992
Of every 100 adolescent deaths globally in 2012, 70 occurred in just two regions—43 in the Africa Region and 27 in the South-East Asia Region, with overall mortality rates in 10-19 year olds of 282 and 102 per 100,000 respectively.

The lowest rates are in high income countries: 31 per 100,000.

War-related deaths in 15-19 year old males increased from 8 to 39 per 100,000 in the Eastern Mediterranean Region, while in the African Region they dropped from 26 to 1 per 100,000.

1 of every 6 deaths among adolescents in the African Region is due to HIV.

Males’ higher mortality rates often reflect more deaths from road injuries and interpersonal violence.
Malawi

- 10-24 yrs – 5.4 million
- 33% of the total population
- 31% females enrolled in secondary school
- 34% of males enrolled in secondary school
- 1% male and female in tertiary education
- 12% women married by 15
  50% women married by 18
- 104/1000 births are to women aged 15-19 (adolescent fertility rate)
- 18% adolescents using tobacco aged 13-15
- HIV prevalence age 15-24 4.9% female, 2.1% male
- 16% 15 -19 years think wife beating ok under certain circumstances
Population by age groups and sex (absolute numbers)
Morbidity
What are DALYs?

- Disability-adjusted life years (DALYs) are a measure of the years of healthy life lost due to ill health, disability or premature death. They estimate the gap between current health status and an ideal health status, with the entire population living to an advanced age free of disease and disability.

- For a specific health condition, DALYs are calculated as the sum of the years of life lost (YLL) due to premature death plus disability (YLD) for people living with the health condition.

- DALYs provide a particularly useful basis for defining overall public health priorities during adolescence. By combining estimates of morbidity and mortality, they indicate the total impact of adolescent health problems and health-related behaviours across the life-course and on public health in general.
Teenage Pregnancy and Childbearing

Around the world, many women ages 15 to 19 are currently pregnant or have already given birth. This scenario is especially true in rural areas, where girls are married young and pressured to start having children immediately. In Zimbabwe, Senegal, and Colombia, more than one in five teenagers from rural areas have begun childbearing.

Source: ICF International, Demographic and Health Surveys.
Teenagers from the poorest households are more likely to become pregnant or give birth than those from the wealthiest households. In Zimbabwe, Senegal, Colombia, and Peru, more than one-quarter of teens ages 15 to 19 from the poorest 20 percent of households have begun childbearing. And in Peru, the rate of early childbearing is nearly six times greater among those from the poorest households compared to the wealthiest.

Source: ICF International, Demographic and Health Surveys.
Prevalence of Child Marriage

Child marriage, defined as marriage before age 18, is practiced in all regions of the world. This harmful traditional practice not only violates the human rights of girls and young women, but also threatens their health and well-being. Nearly half of all women ages 20 to 24 in South Central Asia and Western Africa were married by age 18, putting them at a higher risk for early pregnancy and maternal disability and death, and limiting their access to education and employment. Although the prevalence of child marriage is lower in other regions, such as Southeast Asia and Western Asia, nearly one in five girls in those two regions was married by age 18. And in the poorest regions of the world—particularly Eastern Africa, Western Africa, and South Central Asia—more than one in 10 girls were married by age 15.

Sources: PRB estimates based on ICF International, Demographic and Health Surveys; and UNICEF, Multiple Indicator Cluster Surveys.
Adolescence

Physical changes
Linear growth

The growth spurt in adolescence

**Height-for-age GIRLS**
5 to 10 years (z-scores)

**Height-for-age BOYS**
5 to 10 years (z-scores)
### Pubertal changes

<table>
<thead>
<tr>
<th>Breast</th>
<th>Stage 1</th>
<th>Stage 2</th>
<th>Stage 3</th>
<th>Stage 4</th>
<th>Stage 5</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Breast Stage 1" /></td>
<td><img src="image2" alt="Breast Stage 2" /></td>
<td><img src="image3" alt="Breast Stage 3" /></td>
<td><img src="image4" alt="Breast Stage 4" /></td>
<td><img src="image5" alt="Breast Stage 5" /></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pubic hair</th>
<th>Stage 1</th>
<th>Stage 2</th>
<th>Stage 3</th>
<th>Stage 4</th>
<th>Stage 5</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image6" alt="Pubic hair Stage 1" /></td>
<td><img src="image7" alt="Pubic hair Stage 2" /></td>
<td><img src="image8" alt="Pubic hair Stage 3" /></td>
<td><img src="image9" alt="Pubic hair Stage 4" /></td>
<td><img src="image10" alt="Pubic hair Stage 5" /></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Genital development and pubic hair</th>
<th>Stage 1</th>
<th>Stage 2</th>
<th>Stage 3</th>
<th>Stage 4</th>
<th>Stage 5</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image11" alt="Genital Stage 1" /></td>
<td><img src="image12" alt="Genital Stage 2" /></td>
<td><img src="image13" alt="Genital Stage 3" /></td>
<td><img src="image14" alt="Genital Stage 4" /></td>
<td><img src="image15" alt="Genital Stage 5" /></td>
<td></td>
</tr>
</tbody>
</table>
The growth spurt in adolescence, increase in height, acquisition of muscle mass, distribution of body fat, skeletal maturation and secondary sexual characteristics.
Adolescence

Neurodevelopmental changes
Physical, cognitive and emotional development

<table>
<thead>
<tr>
<th>Physical development</th>
<th>Cognitive development</th>
<th>Social and emotional development</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Early adolescence</strong> (age 10–14 years)</td>
<td>Growth in capacity for abstract thought; mostly interested in present with little thought about the future; expansion of and increased importance placed on intellectual interests; deepening of moral thinking</td>
<td>Struggle with sense of identity; feel awkward about themselves and their body; worry about being normal; realise that parents are not perfect; have heightened conflict with parents; become increasingly influenced by peer group; have a raised desire for independence; return to childish behaviour when stressed; are prone to mood swings; test rules and limits; become more private; have a growing interest in sex</td>
</tr>
<tr>
<td>Puberty: growth of body hair, increased perspiration and oil production in hair and skin; great physical growth (both height and weight); breast and hip development and onset of menstruation (girls); growth in testicles and penis, wet dreams, and deepening of voice (boys)</td>
<td>Continued growth in capacity for abstract thought; increased capacity for setting goals; interest in moral reasoning; think about the meaning of life</td>
<td>Have intense self-involvement, alternating between high expectations and poor self-identity; continue to adjust to changing body; worry about being normal; tend to distance themselves from their parents; have a continued drive for independence; are driven to make friends and have a greater reliance on them (popularity can be an important issue); have a heightened capacity for emotional regulation; experience feelings of love and passion; have increasing interest in sex</td>
</tr>
<tr>
<td><strong>Late adolescence</strong> (age 15–19 years)</td>
<td></td>
<td>Have a firmer sense of identity, including sexual identity; have increased emotional stability, concern for others, and independence and self-reliance; still place importance on peer relationships; develop more serious relationships; regain some interest in social and cultural traditions</td>
</tr>
<tr>
<td>Physical growth slows for girls but continues for boys</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Young adulthood</strong> (age 20–24 years)</td>
<td>Ability to think ideas through from beginning to end; ability to delay gratification; examination of inner experiences; increased concern for the future; continued interest in moral reasoning</td>
<td></td>
</tr>
<tr>
<td>Young women are typically fully developed physically; young men continue to gain height, weight, muscle mass, and body hair</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Adapted from a US Office of Population Affairs table, by permission of the American Academy of Child and Adolescent Psychiatry, from which the original information was obtained.

Table 1: Developmental characteristics of adolescence and young adulthood

<table>
<thead>
<tr>
<th>Stages of Adolescent Development</th>
<th>EARLY 10-15 years</th>
<th>MIDDLE 14-17 years</th>
<th>LATE 16-19 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Growth of body</td>
<td>• Secondary sexual characteristics appear</td>
<td>• Secondary sexual characteristics advance</td>
<td>• Physically mature</td>
</tr>
<tr>
<td></td>
<td>• Rapid growth reaches a peak</td>
<td>• Growth slows down</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Has reached approximately 95% of adult growth</td>
<td></td>
</tr>
<tr>
<td>Growth of brain (Prefrontal cortex)</td>
<td></td>
<td>• Brain growth occurs</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>• Influence on social and problem solving skills</td>
<td></td>
</tr>
<tr>
<td>Cognition (ability to get knowledge through different</td>
<td>• Uses concrete thinking (“here and now”)</td>
<td>• Thinking can be more abstract (theoretical) but goes back to concrete thinking</td>
<td></td>
</tr>
<tr>
<td>ways of thinking)</td>
<td>• Does not understand how a present action has result in the future</td>
<td>under stress</td>
<td>• Most thinking is now abstract</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Better understands results of own actions</td>
<td>• Plans for the future</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Very self-absorbed</td>
<td>• Understands how choices and decisions now have an affect on the future</td>
</tr>
<tr>
<td></td>
<td>EARLY 10-15 years</td>
<td>MIDDLE 14-17 years</td>
<td>LATE 16-19 years</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>----------------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Psychological and social</td>
<td>• Spends time thinking about rapid physical growth and body image (how others see them)</td>
<td>• Creates their body image</td>
<td>• Plans and follows long term goals</td>
</tr>
<tr>
<td></td>
<td>• Frequent changes in mood</td>
<td>• Thinks a lot about impractical or impossible dreams</td>
<td>• Usually comfortable with own body image</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Feels very powerful</td>
<td>• Understands right from wrong (morally and ethically)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Experiments with sex, drugs, friends, risks</td>
<td></td>
</tr>
<tr>
<td>Family</td>
<td>• Struggles with rules about independence/dependence</td>
<td>• Argues with people in authority</td>
<td>• Moving from a child-parent/guardian relationship to a more equal adult-adult relationship</td>
</tr>
<tr>
<td></td>
<td>• Argues and is disobedient</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peer group</td>
<td>• Important for their development</td>
<td>• Strong peer friendships</td>
<td>• Decisions/values less influenced by peers in favour of individual friendships</td>
</tr>
<tr>
<td></td>
<td>• Intense friendships with same sex</td>
<td>• Peer group most important and determines behaviour</td>
<td>• Selection of partner based on individual choice rather than what others think</td>
</tr>
<tr>
<td></td>
<td>• Contact with opposite sex in groups</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sexuality</td>
<td>• Self-exploration and evaluation</td>
<td>• Forms stable relationships</td>
<td>• Mutual and balanced sexual relations</td>
</tr>
</tbody>
</table>
Brain development

A hallmark of adolescent brain development is **overproduction and pruning** which is thought to ensure that appropriate connectivity is established, with neurons and synapses that fail to make appropriate connections being lost.

Pruning has been speculated to help with the “rewiring” of brain connections into adult-typical patterns, and could potentially represent relatively late opportunities for brain plasticity.
Myelination and synaptic pruning

Synapses are energetically costly, and declines in their numbers contribute to the increases in brain efficiency seen during adolescence, reflected by the declines in brain energy use.

Speed and efficiency of information flow across relatively distant regions are accelerated during adolescence because neuronal axons interconnecting certain brain areas become insulated with a white, fat-enriched substance called myelin, thereby markedly increasing the speed of electrical transmission along axons and at the same time reducing the energy needed to maintain this process.

Some of the synaptic pruning that is seen during adolescence appears in part experience dependent
Thinning of grey matter and increase myelination
Delayed maturation of PFC

Theories of adolescent brain development generally concur on the importance of delayed maturation of the PFC and other frontal regions for developmental immaturities in cognitive control, attentional regulation, response inhibition, and other relatively advanced cognitive functions.

Reward seeking was found to increase and peak in mid adolescence (i.e., approximately 14–15 years) and then to gradually decline into adulthood.

Adolescents were found to exhibit greater amygdala activation to emotion than adults and children, when studied.
This general pattern, of improved cognitive control and emotion regulation with maturation of the prefrontal cortex, suggests a linear increase in development from childhood to adulthood.
Adolescents are more sensitive to rewards and less sensitive to punishments than either children or adults, the reason for which is that regions of the brain important for processing rewards are especially active during adolescence, whereas the processing of aversive stimuli is often attenuated.

Thus, under some conditions, adolescent decision making appears to be influenced more by reward than by punishment or by consideration of the long-term consequences of their actions than are the decisions reached by adults.

Adolescents are especially prone to reaching risky decisions under exciting or emotionally charged situations that override the inhibitory control provided by still developing cognitive control regions.

Adolescents show adult levels of intellectual capability earlier than they show evidence of adult levels of impulse control.

As such, adolescents may be capable of making informed choices about their future but do not yet have full capacity to override impulses in emotionally charged situations that require decisions in the heat of the moment.

Unfortunately, judges, politicians and advocates are biased toward drawing a single line between adolescence and adulthood for different purposes under the law that is at odds with developmental cognitive neuroscience.
There is now strong evidence that the adolescent brain is much more plastic than previously believed, which challenges the notion that by the teen years, behaviours and responses are relatively fixed.

The new science says that there is ample opportunity during adolescence for effective policies and programs directed to adolescent behaviours to have lifelong impact

Even modest adjustments of developmental trajectories that are slightly off track during adolescence may yield substantially more benefit than waiting until those trajectories have diverged considerably later in life.

What new research tells us

<table>
<thead>
<tr>
<th>Adolescents should be discouraged from indulging in high-risk behaviors</th>
<th>Sensation seeking and risk taking are heightened in adolescence. This is seen in a variety of species.</th>
<th>Adolescents need structured opportunities to take risks, and there is a need for more effort in the area of harm reduction (e.g., Outward Bound). Graduated risk taking acknowledges developmental processes (e.g., graduated drivers licenses). Enhancing reward opportunities likely to be more effective than punishing interventions (e.g., Scared Straight, Drug Abuse Resistance Education [DARE]).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interventions need to emphasize the consequences of behaviors</td>
<td>There is a blunted response to punishment and a heightened response to rewards</td>
<td>Opportunities to cool down (e.g., the Interrupters approach of Cease Fire) hold promise. Interventions are needed to help adolescents manage reactivity and impulsivity.</td>
</tr>
<tr>
<td>Adolescents should be held responsible for their own decisions</td>
<td>In the heat of emotional arousal (hot cognition), adolescent reasoning is inherently different from adults.</td>
<td></td>
</tr>
</tbody>
</table>
Risk factors for *P. falciparum* infection in Eastern Uganda

- **Prevalence of malaria parasitaemia**
- **Percentage sleeping under a net**

**Females**

**Males**
Recap

• What is adolescent - definitions
• Why adolescents are important – epidemiology
• The main causes of mortality and morbidity
• Physical and cognitive development - brain growth and behaviour