Adolescent Health 1

Adolescence: a foundation for future health

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This is the first in a Series of four papers about adolescent health

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Adolescence is a life phase in which the opportunities for health are great and future patterns of adult health are established. Health in adolescence is the result of interactions between prenatal and early childhood development and the specific biological and social-role changes that accompany puberty, shaped by social determinants and risk and protective factors that affect the uptake of health-related behaviours. The shape of adolescence is rapidly changing—the age of onset of puberty is decreasing and the age at which mature social roles are achieved is rising. New understandings of the diverse and dynamic effects on adolescent health include insights into the effects of puberty and brain development, together with social media. A focus on adolescence is central to the success of many public health agendas, including the Millennium Development Goals aiming to reduce child and maternal mortality and HIV/AIDS, and the more recent emphases on mental health, injuries, and non-communicable diseases. Greater attention to adolescence is needed within each of these public health domains if global health targets are to be met. Strategies that place the adolescent years centre stage—rather than focusing only on specific health agendas—provide important opportunities to improve health, both in adolescence and later in life.

Introduction

The present generation of people aged 10–24 years is the largest in history—with a population of 1·8 billion,[1] they comprise a quarter of the world's population. Nearly 90% live in low-income and middle-income countries where they constitute a far greater proportion of the population than in high-income countries because of higher fertility rates (figure 1). The growth in adolescent populations coincides with a reduction in infectious disease, malnutrition, and mortality in infancy and early childhood, shifting attention to sexual and reproductive health, substance misuse, mental health, injury, obesity, and chronic physical illness, which become prominent during adolescence and need very different responses.[3,4]

Many countries have entered a demographic transition in which falling fertility and longer, healthier life expectancy increase the proportion of people able to work. A healthy, educated workforce has the potential to shape a country's economic prospects.[5] Conversely, poverty, inadequate education, mass unemployment, migration, natural disasters, and war result in social environments that can devastate the health of young people.[6–11]

Young people were at the forefront of the social unrest across north Africa and the Middle East that began in Tunisia in December, 2010. Although many succeeded in toppling the restrictive regimes that they fought against, they faced serious threats to their lives and health. Such engagement is a powerful reminder that, by stark contrast with younger children, adolescents have an increasing capacity to be active agents of change within their communities.[11,12] It raises concerns about the extent of young people's exposure to violence, exploitation, and abuse, and suggests the need for greater protection of human rights.[13]

Many of the economic, educational, and political issues that affect young people are interlinked. Investment in education of adolescents has clear benefits to individuals and their health, but is also a strategy for enhancing employment, human rights, social capital, and community wealth.[5] The adverse effects of child marriage and pregnancy at a young age (<18 years) on the health and human rights of girls is well appreciated, but just as potent is the dislocating effect of early pregnancy on girls' education, skill development, and social networks, which

Key messages

- At 1·8 billion, young people aged 10–24 years comprise more than a quarter of the world's population.
- The health of adolescents has improved far less than that of younger children over the past 50 years.
- The present generation of young people will take a different path through adolescence from previous generations and will face new challenges to their health and wellbeing. How they negotiate these years will have a powerful effect on their future health and their countries' economic and social prospects.
- Biological aspects of puberty mark the start of adolescence, and key social-role transitions have historically signalled the end, which is now less distinct than in the past. Neurocognitive development is another element of biological maturation with major effects on decision making, emotional wellbeing, and behaviour.
- A life-course perspective emphasises that the health of adolescents is affected by early childhood development and the biological and social-role changes that accompany puberty, shaped by social determinants of health that affect the uptake of health-related behaviours. The onset of these behaviours and states in adolescence affect the burden of disease in adults and the health and development of their children.
- Social determinants that negatively contribute to adolescent health are structural (such as poverty and sex inequality) and proximal (such as intrafamilial violence, parental mental disorder, and substance misuse). These determinants often cluster within individuals. Protective effects are important targets for preventive interventions.
- The ubiquitous nature of social media has changed the speed at which sociocultural norms are affected, with both risks and opportunities.
- Adolescents can be powerful agents of personal change and community development.
- Adolescents should be more prominent within future global public health policies and programming.

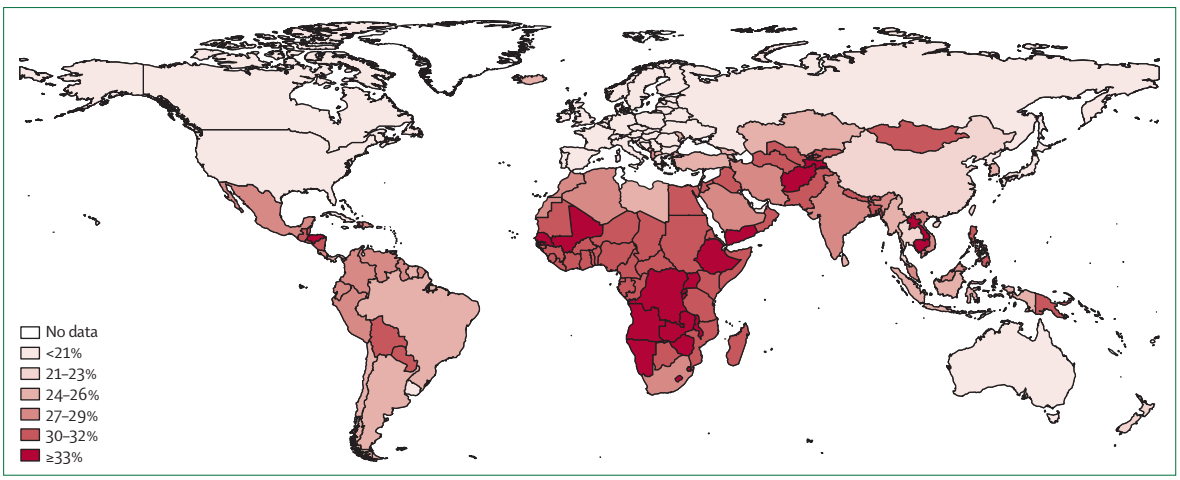

Figure 1: **Distribution of people aged 10–24 years as a proportion of the population by country**
Population estimates are for 2010 and were taken from the UN World Population Prospects report (2008 revision).[2]

all undermine their present and future health and wellbeing, the health of their children, and their nations' social and economic prospects.[14,15]

Societies typically define adolescence in terms of age and social roles with little consistency between countries. We focus on adolescents and young adults aged 10–24 years (referred to as young people and youth and hereafter referred to as adolescents) because this age-group encompasses most individuals who are going through the biological changes and social-role transitions that historically defined adolescence (panel). Although the biological sequences of puberty are highly consistent (table 1), changes in the timing of puberty, the nature of social-role changes, and the hopes and aspirations of adolescents across the world are widely affected by economic and sociocultural factors.

We assess the role of adolescence as a foundation for future health, emphasising the changing context of health and social development from late childhood to early adulthood and the place of adolescents within global public health. Our report is arranged around a conceptual framework that we have developed to describe the many factors affecting adolescent health and to put into context the subsequent reports in this Series (figure 2).

Adolescence within the life course

Social disadvantage and negative experiences in infancy and early childhood interfere with the achievement of normal developmental milestones in later childhood, such as healthy peer relationships and literacy.[21] This can lead to peer rejection, school disengagement, academic failure, and early uptake of risky behaviours in adolescence.[21–23] Adoption of a life-course perspective promotes the understanding that factors affecting preconception and early childhood can cumulatively affect adolescents. Thus, programmes intended to enhance maternal, infant, and child health will also positively affect the health of adolescents.[24] However, although aspects of adolescent health are known to be related to earlier determinants, less emphasis has been placed on how adolescent health is also the product of the biological and social experiences that are specific to this phase of life (figure 2).

Similarly, policy makers have responded inadequately to the knowledge that health-related behaviours (ie, behaviours that positively or negatively affect health) and health outcomes in adolescence have a sustained effect on the future health of these young people. The life-course approach promotes a different temporal understanding of prevention because many opportunities for prevention of non-communicable diseases, mental disorders, and injuries in adults arise from a focus on risk processes that begin in or before adolescence.[3,5,15,25] Many health-related behaviours that usually start in adolescence (tobacco and alcohol use, obesity, and physical inactivity) contribute to the epidemic of non-communicable diseases in adults[26,27]—eg, in people older than 60 years, high blood pressure and elevated cholesterol and glucose account for 29% of disability-adjusted life-years (DALYs); tobacco use accounts for 10%; physical inactivity for 7%; and being overweight or obese for 7%.[17]

The health of pregnant adolescents in particular contributes to the health of the next generation by affecting developing fetuses. Viral infections such as rubella and HIV, maternal malnutrition and micronutrient deficiency,[28] obesity and gestational diabetes,[29–31] and health-related behaviours such as the consumption of alcohol, tobacco, and psychotropic drugs will affect the health of offspring.[32,33] Impaired fetal growth is more common in pregnancy in girls younger than 18 years and is a potent precursor of adult diabetes.[34] Specific transgenerational effects will be particularly severe in countries where, in terms of nutrition for example, both adolescent malnutrition and micronutrient deficiency are high and teenage pregnancy is common. For example, in India, about half of girls aged 15–19 years are underweight and anaemic, and a similar

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proportion are married before age 19 years.[14] Other countries, such as South Africa, are grappling with the double burden of both underweight and overweight adolescents.[35] Although it has not yet been described, health-related behaviours of boys probably also have an effect on the health outcomes of the next generation.

Panel: Definitions of adolescence and young adulthood

Child
Defined by the Convention on the Rights of the Child (1989) as a person younger than 18 years, unless majority (ie, the legal threshold of adulthood) is attained at a younger age in a particular country.[13]

Adolescence
Historically defined by WHO as the period between ages 10 and 19 years.[16] It is derived from the Latin *adolescere*—the present participle *adolescens* means growing up, whereas the past participle *adultus* means grown up.

Youth
The UN defines youth as people aged between 15 years and 24 years, a definition made in the lead up to the International Youth Year of 1985.

Teenager
Refers to people aged 13–19 years. The term was first used in the USA in the 1920s, and became widely used within popular culture after World War 2.

Young people
A less formally defined term that generally refers to people aged 10–24 years, as does the composite term adolescents and young adults.[16]

When data are reported, the 10–24 year age range is increasingly being divided into three categories: 10–14 years (early adolescence); 15–19 years (late adolescence); and 20–24 years (young adulthood) to appropriately examine the extent of changes in health that take place during these years.[17–19]

Adulthood
The age that children and adolescents gain legal rights and accountabilities varies. 18 years is the legal age of majority in many countries, although not universally. Even in law, no unified definition of adulthood exists—instead, laws define adulthood at different ages depending on the activity in question.

Puberty and social-role transitions

The onset of puberty has long been accepted as the starting point of adolescence, and key social-role transitions such as completion of education, employment, marriage, and childrearing historically signalled the end. Until the industrial revolution in the 1800s, the achievement of physical maturity generally paralleled social-role maturity.[36] Even until the early 20th century, the delay between physical and social-role maturity was very short.

The decreasing age of onset of puberty that took place throughout the 20th century seemed to be related to improvements in childhood hygiene, nutrition, and health. This trend had largely ceased by the 1960s in high-income countries when the mean age of menarche stabilised at about 12–13 years.[37] In these countries, the increase in the age at which adult social roles and responsibilities were adopted began at about the same time, which has made it less clear when adolescence now ends. Not only do young people now spend longer in education and marry and have children later[22,38] but also contemporary social-role transitions, such as completion of education, employment, marriage, and childrearing, are increasingly less defined and linear than they were historically.[38] Despite its widespread legal significance, the age of 18 years clearly no longer signifies adulthood in many parts of the world (panel).

The combination of children beginning puberty earlier and taking on characteristically adult roles at an older age than they did historically has increased the length and indeed changed the shape of adolescence. These secular trends, evident in all but the poorest of countries,[39,40] are further affected by regional social determinants (economic, cultural, and political) and by risk and protective factors. For example, in the Arabic-speaking countries of north

	Physical development	Cognitive development	Social and emotional development
Early adolescence (~age 10–14 years)	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)	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	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
Late adolescence (~15–19 years)	Physical growth slows for girls but continues for boys	Continued growth in capacity for abstract thought; increased capacity for setting goals; interest in moral reasoning; think about the meaning of life	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
Young adulthood (~20–24 years)	Young women are typically fully developed physically; young men continue to gain height, weight, muscle mass, and body hair	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	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

Adapted from a US Office of Population Affairs table,[20] 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**

Africa and west Asia, high costs of marriage and secure housing have contributed to an increase in the age at which people are getting married.[41] Additionally, increasing industrialisation, globalisation, urbanisation, and access to digital media are reducing the influence that families and communities traditionally had on the transition to adulthood by decreasing parental control, social support for families, and social cohesion. At the very least, there seems to be less agreement between generations and within different communities across the world about the accepted timing and pathways to adult roles.

The biology of adolescent development

Like early childhood, adolescence is a sensitive period in which both normative and maladaptive patterns shape future trajectories. Part of this sensitivity relates to the social embedding of health risks and the biological changes before, during, and beyond adolescence.

100 years ago, puberty was widely thought merely a process of physical maturation that propelled individuals into different social contexts that affected their health.[42] We now appreciate that puberty is a highly programmed and biologically driven process that affects behaviour, emotional wellbeing, and health in complex ways. For example, the timing of puberty rather than chronological age is most associated with the increase in health-related behaviours and mental health states during adolescence.[43] These changes in behaviour and mental health might be partly related to changes, started at puberty, in the regulation of oxytocin in girls and vasopressin in boys, which have been linked to social attachment, pair-bonding, and parenting behaviour across species.[44] Although the processes have not yet been elucidated, family and social factors such as parental health and marital tension and the presence of a stepfather also affect pubertal timing.[45–47]

There is growing interest in understanding how puberty affects the developing brain. Animal data show that hormonal events during puberty exert major effects on brain maturation and behaviour that alter the perceptions, motivations, and behavioural repertoire of these animals and enable reproductive behaviour and independence.[48] Although little is known about the relation between puberty and neural development in people, investigators have tentatively suggested that pubertal hormones might also affect the structure and function of the developing human brain.[48]

Advances in MRI have enabled the identification of changes in the cortical grey matter of the brain that take place in a region-specific and non-linear manner throughout adolescence and into early adulthood.[49,50] Across the frontal, temporal, and parietal cortices, transformations of grey matter conform to an inverted-U-shaped developmental trajectory, with increases in volume during childhood reaching a peak in early adolescence with a subsequent decrease in volume in early adulthood.[49,51] This trajectory is thought to arise from dendritic outgrowth and synaptogenesis (corresponding to increased grey matter volume in MRI) with subsequent synaptic pruning (decreased grey matter volume).[52] This fine tuning of synaptic connections provides an opportunity for brain remodelling in response to social, emotional, and behavioural exposures, such as substance misuse. MRI studies show an overall increase in white matter from childhood to adolescence, which then slows and stabilises in early to mid-adulthood depending on the brain region in question. This increase is attributable to progressive age-related axonal myelination or increasing axonal calibre, both of which enhance the speed of neuronal transmission.[53]

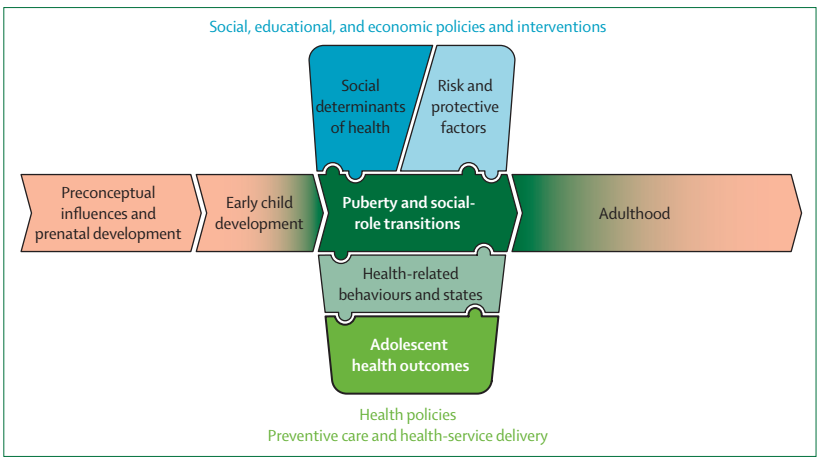

Figure 2: **Conceptual framework for adolescent health**
The framework emphasises the crucial importance of a life-course perspective in the understanding of adolescent health and development (represented by the horizontal flow of the framework) and the importance of social determinants of health (vertical flow). The axes intersect around the unique characteristics of adolescence (the complex interactions between puberty, neurocognitive maturity, and social-role transitions) to emphasise how these factors affect adolescent health and development. The text outside the boxes refers to settings and scope of policies, preventive interventions, and services that affect adolescent health.

The prefrontal cortex—the site of executive control functions, including planning, emotional regulation, decision making, multitasking, and self-awareness—is one of the brain regions that undergoes the most protracted development in human beings. The prefrontal cortex starts to develop very early in life and continues after adolescence until the individual is well into their 20s.[49,54] This brain development might explain the steady improvement in self-control from childhood to adulthood. By contrast, the limbic system, which governs reward processing, appetite, and pleasure seeking, develops earlier in adolescence than does the prefrontal cortex.[55] The greatest disparity in maturation between the limbic system and prefrontal cortex is during early to mid-adolescence. Heightened risk-taking at this time could be explained by a developmental imbalance that favours behaviours driven by emotion and rewards over more rational decision making.[48,55]

The reason why adolescents can be poor decision makers was thought to be because they were less intellectually mature; however, data suggest that adolescents can make surprising decisions despite knowledge of risks. Adolescents seem to be more affected than adults

by exciting or stressful situations when making decisions—so-called hot cognitions—especially in the presence of peers.[56] Increased activity in the nucleus accumbens—a region associated with reward, pleasure, and other emotional responses—seems linked to these behaviours.[57] This is consistent with the notion of sensation seeking—the willingness to take risks to attain new, varied, and stimulating experiences—an important mediator for risky behaviour and which increases between age 10 and 15 years, suggesting this behaviour is affected by puberty.[56,58] Such knowledge reinforces policies supporting graded exposure to risk, such as a limit to the number of passengers allowed in a car with a young driver.[59] The wider implications of the nature and timing of adolescent neurocognitive maturation on policies and programming are only starting to be explored.[60]

The effects of social context on health

Both structural determinants of health (eg, national wealth and income inequality, access to education and health-care services, employment opportunities, and sex inequality) and proximal or intermediate determinants of health (eg, connectedness of adolescents to family and school) affect health-related behaviours and states in adolescence.[61] Whereas many social determinants contribute to an individual's health across their lifetime, some have particular salience during adolescence. Social determinants of health that specifically affect adolescents consist of policies and environments that support access to education, provide relevant resources for health (eg, contraception), and create opportunities to enhance young people's autonomy, decision-making capacities, employment, and human rights.

Similar to proximal determinants of health is the notion of risk and protective factors. However, these operate within the individual and their family, peers, school, and community. By interacting with structural determinants of health, risk and protective factors across these domains affect adolescents' engagement in health-related behaviours—both positively and negatively.[24,62,63] For example, risk factors within the individual domain that relate to intelligence, sexual orientation, or personality can result in negative peer relationships, such as bullying, which increase the likelihood of various health-related behaviours, including substance misuse, unsafe sex, depression, antisocial and illegal activities, and dangerous driving.[64,65] Thus, beyond academic achievement, schools are an important social environment for adolescents that promote peer connections, emotional control, and health. School-based interventions that create strong engagement between students and teachers and a feeling of emotional safety result in reduced substance misuse, violence, and other antisocial behaviours in adolescents.[66] This finding is consistent with the positive youth development approach, which focuses on adolescents' assets and developmental strengths, whether internal to the individual (eg, intelligence), or external (eg, peers and school).[67,68]

Together with differential protection of human rights, the complex interaction of social determinants of health and risk and protective factors with the biological and social-role transitions of adolescence explains the growing disparities between the health of adolescents in different regions and countries. These same factors also affect the experience of growing up within the same country, where adolescents can have highly heterogeneous life experiences and diverse health outcomes. In Australia, for example, adolescents with an indigenous ethnic origin, from a refugee background, or who are incarcerated or homeless have worse health outcomes than do their mainstream peers.[69–72]

Changes in the adolescent burden of disease

Changes in the biological and social transitions that define adolescence have important links to health (figure 2), although the processes by which this happens are complex and still not wholly understood. For example, the timing of puberty is linked to the onset of sexual activity and the risks of teenage pregnancy and sexually transmitted infections.[73] That adult roles and responsibilities are now achieved at an older age in many high-income countries also has implications for sexual health, but for different reasons. In these countries, where the age of first sexual intercourse is about 16 years, the period of vulnerability to sexually transmitted infections caused by premarital sexual intercourse has extended from only a few years to more than a decade. The heightened sensitivity to peers during adolescence affects adolescents' experimentation with health-related behaviours, such as substance misuse.[74,75] The timing of puberty also affects substance misuse—eg, young people who begin drinking in early adolesence are more likely to become alcohol dependent within 10 years and to have lifetime alcohol dependence than those who begin drinking at an older age.[76] The increase in the length of adolescence has also changed the importance of these behaviours. For example, because marriage and child-rearing contribute to the reduction in many risk behaviours,[77] the trend for people to marry and have children at an older age is especially potent when combined with the early onset and heavy consumption of alcohol, which is increasingly seen in girls as well as boys.[78,79] Additionally, youth unemployment, which is at very high levels in several countries, increases the risks for substance misuse and mental disorders in adolescence. The subsequent effects on social confidence, skills, and financial resources will probably have far-reaching results well into adulthood.

Overall, the health of adolescents has improved to a lesser extent than that of younger children.[80] In a longitudinal study of 50 countries, childhood mortality was reported to have declined by more than 80% in the past 50 years.[18] By contrast, adolescent mortality has only marginally improved. A notable example is in Brazil, where more adolescents die from violence than do children younger than 5 years from infectious diseases.[14]

Although engagement in some risky behaviours might be thought a normal aspect of adolescent development, some have immediate negative effects and many are preventable.[24] The leading risk factors for incident DALYS in young people aged 10–24 years are alcohol (7% of DALYs), unsafe sex (4%), iron deficiency (3%), lack of contraception (2%), and illicit drug misuse (2%).[17] At least 15% of the worldwide disease burden is accounted for by DALYs in 10–24 year olds, which challenges the widespread belief that adolescence is a healthy time of life.

An analysis of worldwide patterns of mortality reported that 2·6 million young people aged 10–24 years died in 2004, with mortality increasing from early to mid-adolescence and into young adulthood.[19] The rate and causes of death differed substantially by age, sex, and region, with mortality rates almost four times higher in low-income and middle-income countries than in high-income countries. The leading causes of death were injuries (both unintentional, such as road traffic accidents, and self-inflicted, such as suicide); maternal causes; communicable, nutritional, and perinatal diseases (eg, tuberculosis, meningitis, and HIV/AIDS); and non-communicable diseases (such as diabetes and cancer). Irrespective of region, most adolescent deaths are preventable and thus strongly justify worldwide action to enhance adolescent health. Incident disability also increases with age throughout adolescence.[17] The contribution of mental disorders to the non-fatal burden of disease rises sharply throughout adolescence and is the largest contributor to the burden of disease in young people aged 10–24 years (45%), ahead of unintentional injuries (12%) and infectious and parasitic diseases (10%).[17]

Emerging drivers of adolescent health

In addition to the well established influences of parents and peers during adolescence, various new drivers are emerging. Marketing of unhealthy products and lifestyles (eg, tobacco, alcohol, and foods high in fat, sugar, and salt) clearly targets young people. Analogous to an infectious disease epidemic, mass media can be viewed as a vector that carries attitudes and products to an increasing number of hosts, resulting in outbreaks of previously uncommon behaviours. The extent of such epidemics results from the relation between economic, sociocultural, and public-policy environments.[81] For example, tobacco marketing to men, and then increasingly to young women, largely brought about the rise in smoking that peaked around the mid-1960s in men in high-income countries, and about a decade later in women.[82] As a result of ever-tightening policy environments, the tobacco epidemic is now well past its peak in countries such as Australia, Canada, the UK, and the USA, with substantial declines in adolescent smoking seen over the past 15 years in these regions.

The tobacco industry is now vigorously investing in advertising campaigns in middle-income and low-income countries that historically had very low rates of smoking, especially in women.[83,84] Not surprisingly, these countries are undergoing an increase in male smoking,[85] with substantial yearly increases in cigarette smoking per person in countries such as China (8·0%), Indonesia (6·8%), and Syria (5·5%).[83] Tobacco in other forms, such as smokeless (chewing) tobacco and waterpipe smoking, is also marketed to young people[86]—nearly one in five of the world's adolescents aged 13–15 years use tobacco, and more than one in ten use tobacco in a form other than cigarettes.[87] A major concern is the rapid rise in female smoking as marketing and globalisation lead to a decrease in traditional cultural prohibitions against this practice.[82,85] Men are four times more likely than women to smoke,[88] whereas boys aged 13–15 years are now only 2·3 times more likely to smoke than girls their age,[87] and in many countries sex differences in adolescent smoking rates no longer exist.[89]

Young people are the earliest adopters of information and communication technology such as mobile phones, the internet, instant messaging, and social networking sites including Facebook and Twitter, both in low-income and middle-income countries as well as high-income regions.[5,14] The expanded social environment provided by new forms of social media has both real and perceived risks and benefits. New social media provide a powerful voice for young people to actively engage with one another or to circumvent more traditional and controlled forms of media and communication. The extent to which various governments have attempted to restrict access to new media—such as internet censorship and restrictions to social networking sites imposed in China,[90] Libya, and Iran—reinforces the perceived power of such communication. Arguably, young people's engagement with new social media has enabled adults to appreciate the capacity of the young to be active catalysts for community change, a part they have long played. However, young people are susceptible to the physical effects of intense engagement with media (eg, decreased physical activity and sleep disturbance), to new variations of old difficulties (eg, cyberbullying and pornography) and to previously unknown behaviours, such as sexting (the act of sending sexually explicit messages or photographs by mobile phone).

Adolescence is a sensitive time for social learning through imitation of behaviours, especially by peers. The ubiquitous nature of new media has arguably changed the very notion of the peer group. Certainly, it has changed the speed at which sociocultural norms are affected[91] and has contributed to the rise of what were previously less common attitudes, aspirations, and behaviours.[92] Social contagion received attention more than 200 years ago as a result of a cluster of suicides after publication of a popular novel in which a young man committed suicide.[93] Copycat suicides are even more probable now, in view of the power of new media to emotively and graphically publicise suicides.[94] Social contagion has been invoked as contributing to behaviours that range from the very uncommon (eg, school shootings[95]) to the more widespread (eg, deliberate self harm[96]). The extent of publicity around such behaviours further contributes to new norms.

The rising influence of social media has resulted in great interest in how it can be used to promote the health of adolescents, and a growing number of trials suggest positive effects of interventions that make use of information and communication technology.[97] Population-focused social marketing approaches seem to have particular salience in changing community values and attitudes in the young. For example, the South African multimedia so-called edutainment programme *Soul City* has helped change social norms about HIV/AIDS and domestic violence, contributed to increases in individuals' knowledge about condom use and domestic violence, and widely contributed to the empowerment of local communities.[98] For such interventions to be effective, knowledge of prevention science will no longer be sufficient; new skills and alliances will be needed to exploit opportunities for health, such as social marketing, information technology, and creative design. One such alliance, the television network MTV's Staying Alive Ignite campaign, aims to prevent the spread of HIV by changing attitudes, behaviours, and national norms. Based on a confronting television drama, the accompanying multimedia campaign challenges young people in Kenya, Trinidad and Tobago, and Ukraine to ignite a wide social movement to stop the spread of HIV.

For more on the **MTV Staying Alive Ignite campaign** see http://igniteblog.staying-alive.org/about-ignite/

Adolescents and global health agendas

The Millennium Development Goals have driven global health policy for the past decade. Adolescence has become an important focus because improvement of adolescent health is central to the achievement of worldwide targets associated with maternal health, child mortality, and HIV/AIDS. The Millennium Development Goals continue to provide a very important opportunity to focus on sexual and reproductive health, which are fundamental to improvement of young people's health—maternal mortality is one of the leading causes of death in adolescent girls and young women in Africa and southeast Asia;[19] more than a third of girls still undergo child marriages;[15] and adolescents are at the heart of the HIV/AIDS epidemic (table 2).[103]

However, adolescents are central to the success of many other emerging health agendas. The growing worldwide focus on mental health is an important opportunity to target adolescent health, because adolescence is when many psychiatric disorders begin,[118] and neuropsychiatric disorders, including substance misuse, contribute to nearly half of non-fatal DALYs in people aged 10–24 years.[17] Undoubtedly, there can be no improvement in mental health without a focus on adolescent health.

The global health agenda on injury prevention could be used to achieve major health benefits for adolescents because this age-group disproportionately contributes to all-age injuries.[111] Road traffic accidents, suicide and homicide, violence and war, drownings, and fire-related incidents account for about 40% of all youth mortality, by contrast with people older than 25 years for whom these injuries account for only 10% of deaths.[19]

The substantial rise in tobacco use in adolescents will result in devastating effects on adult health in low-income

	Reasons for being a global health goal	Reasons to focus on adolescents
Improve maternal health (MDG 5)	Only 23 countries are on track to achieve a 75% reduction in maternal mortality by 2015;[99] satisfying unmet need for contraception would cut maternal deaths by a third;[100] nearly 21 million (50%) induced abortions per year are unsafe;[101] complications from induced abortions account for 13% of maternal deaths[100]	About one in eight births in developing countries are to girls aged 15–19 years;[2] 44% of married girls aged 15–19 years in developing countries want to avoid pregnancy, but less than one in three of them use effective contraception;[100] in sub-Saharan Africa, girls aged 15–19 years account for 25% of all unsafe abortions[102]
Reduce the spread of HIV (MDG 6)	33·3 million people were living with HIV at the end of 2009;[103] more than 50% live in sub-Saharan Africa, and about 20% live in the Asia-Pacific region[103]	More than 1 million people aged 15–24 years become infected with HIV every year, accounting for 41% of new infections in those older than 15 years;[103] HIV/AIDS is the sixth leading cause of death in people aged 10–24 years and the second leading cause of death in people aged 20–24 years;[19] early marriage is a risk factor for HIV/AIDS in sub-Saharan Africa[104]
Respond to the burden of mental disorders	About 50% of the worldwide population meets the criteria for one or more mental disorders in their lifetime[105]	75% of mental disorders present before age 24 years and 50% before 14 years;[106] the median age-group of onset of anxiety and impulse control disorders is those aged 11–15 years, ahead of substance-misuse disorders (19–21 years) and mood disorders (24–30 years);[106-108] neuropsychiatric disorders are the leading cause of disability in 10–24 year olds;[17] self-inflicted injury is the second leading cause of death in people aged 10–24 years[19]
Respond to the burden of intentional and unintentional injuries	In addition to 1·27 million deaths per year from road traffic accidents there are 20–50 million non-fatal injuries;[109] people from poor economic settings are disproportionately affected by road traffic accidents, even in high-income countries;[110] the cost to governments of road traffic injuries is more than is received as financial aid to promote development[110]	Road traffic accidents are the leading cause of death in people aged 10–24 years;[19] road traffic accidents, suicide and homicide, violence and war, drownings, and fire-related incidents account for about 40% of all deaths of people aged 10–24 years, by contrast with people older than 24 years for whom injuries account for only 10%;[19] road traffic accidents are the second leading cause of DALYs in 10–24 year olds[17]
Control tobacco use	Tobacco is the second leading cause of death worldwide;[111,112] it is expected to cause at least 10 million deaths in 2020 (twice that of 2005);[111] 70% of tobacco-related deaths are in developing countries[113]	17% of children aged 13–15 years use tobacco; 11% use tobacco other than cigarettes;[87] 90% of adult smokers are estimated to have started smoking before age 20 years
Respond to the burden of NCDs	Two of three deaths every year are attributable to NCDs;[109] age-specific NCD death rates are nearly two times higher in low-income and middle-income countries than in high-income countries;[114] tobacco use accounts for one in six of all deaths from NCDs[27]	Many risk factors for NCDs start in adolescence[115]—eg, obesity in adolescence confers very high risks for obesity in adults;[116] 70% of overweight adolescents have one or more risk factor for cardiovascular disease; 23% had three or more risk factors[117]

MDG=Millennium Development Goal. DALY=disability-adjusted life-year. NCD=non-communicable disease.

Table 2: **Examples of global public health goals and the contribution of adolescence**

and middle-income countries for many decades.[85] The success of tobacco control policies that focused on access (eg, pricing and taxation) emphasises that many interventions promoting adolescent health are the result of population-targeted campaigns.[24] Urgent implementation of the Global Framework Convention on Tobacco Control[119]—a treaty to reduce the availability of, and interest in, tobacco for young people—is necessary.

The rising burden of non-communicable diseases has resulted in an increased worldwide focus on tobacco control and other risk factors for adult disease, such as obesity, low levels of physical activity, and alcohol consumption.[26,27] Policy resonance is being driven mainly by arguments about the worldwide burden of non-communicable diseases, which now account for two in every three deaths, including in low-income and middle-income countries,[120] and about the efficiencies that could be achieved by clinically oriented secondary prevention interventions targeting common risk factors in adults. Despite the estimation that 70% of premature deaths in adults are largely caused by behaviours started in adolescence that share common risk factors,[1] little articulation has taken place within the non-communicable disease agenda about the importance of adolescents as a target for universal prevention.

Recognition of adolescent health

Within child health, decades of clinical experience have stimulated research that has in turn affected national and global public policy, public health, and models of clinical practice within key domains of interest (eg, infant mortality and pneumonia). These efforts have contributed to the growth and integration of child public health. Collaborations, networks, advocacy, and funding organisations that stretch beyond health have resulted in national and worldwide investment and initiatives that have led to substantial improvements in child health.

Adolescent health is a much younger discipline by comparison. Although the International Pediatric Association was established in 1910, the International Association of Adolescent Health was not established until 1987. In many low-income countries, the life stage of adolescence is only just being recognised.[39,121] In the USA, adolescent medicine emerged as a distinct medical specialty about 50 years ago and has contributed to improvements in clinical practice, public health, and prevention science.[122] Other high-income countries have only very recently adopted adolescent medicine as a specialty, which explains why many health professionals have insufficient training and skills to work effectively with adolescents.[123,124] The training needs of clinicians and public health practitioners in low-income and middle-income countries are only starting to be appreciated.[121,125]

The current generation will take a different path through their adolescent years from previous generations and will face new challenges to their health along the way. How they negotiate these years will have a powerful effect on their future health and their countries' economic and social prospects. We make the following recommendations to promote the health of adolescents and to ensure that adolescence is indeed a strong foundation for future health.

Recommendations

Embrace adolescence within the life course

What happens during adolescence is central to many emerging global health agendas. In view of this prominence, these agendas are unlikely to be successful without a greater focus on adolescence. Even when the contribution of adolescents to the wider agenda is indisputable, such as in international HIV/AIDS initiatives, it is often overlooked in terms of policy and programming. To rectify this omission, much greater appreciation of the importance of adolescence within a life-course perspective is needed.

Develop a cross-cutting agenda

Social determinants of health that are distinctly influential during adolescence combined with common risk and protective factors suggest that efforts to improve health issues will probably be effective if they are part of a cross-cutting agenda focused on adolescent health as a whole, rather than in terms of different diseases. An international agenda on adolescent health would place the developmental phase of adolescence centre stage rather than any one health issue, but would build on and contribute to the interventions taking place within distinct disease entities (so-called vertical silos). This agenda would focus attention on the common determinants of health that promote both risk and protective factors in young people's lives. It would also promote the implementation of adolescent-friendly health systems and services that are able to effectively respond to the specific needs of young people.[4,126] Importantly, it would support investments in preventive interventions that extend well beyond the health sector[24,127] through alignment with education, employment, sex equality, and human rights initiatives.

Make adolescents and their health visible

Good information systems are an important step towards making adolescents and their health more visible to policy makers, researchers, donors, and development partners. The insufficient prominence of adolescent health could be a result of inadequate information systems,[128,129] which shows inadequate acknowledgment of adolescence as a developmental stage and a failure to appreciate the dynamic nature of health across adolescence. No doubt, this is compounded by inconsistent age definitions—eg, age categories that view young people aged 15–19 years as adults (eg, 0–14 years, 15–64 years) effectively render adolescence invisible, and are usually inconsistent with the age criteria of relevant services such as health and education.[130] The value of reporting data for three categories across adolescence (10–14 years, 15–19 years,

and 20–24 years) is clear from publications that have raised awareness of the greatly changing health profile across this developmental period.[17–19]

Give adolescents a stronger voice

Greater engagement of young people, whether as consumers of health services or recipients of preventive intervention programmes, will help to ensure the relevance of interventions that set out to target this diverse population. If adolescents are given a voice by being involved in the identification of their health issues and development of appropriate solutions, they will also be more visible to their communities, stakeholders, and decision makers.

Increase the capacity of the specialty

Despite growing worldwide interest in adolescent health and medicine,[4,5,14,15,25] local, national, and global capacity is insufficient to shape the necessary attitudes and skills of the next generation of public health practitioners, prevention scientists, policy makers, and clinicians. Functional capacity will be provided by greater investments in people and organisations.

Funding to support the development of academic centres of excellence in adolescent health, such as the Leadership in Adolescent Health programme in the USA,[25] is necessary to develop sufficient public health, prevention science, advocacy, and policy skills within adolescent health. This development would foster proficiency within the major categories of adolescent public health (eg, sexual health, tobacco use, substance misuse, mental health, and injuries). A strong focus on adolescent health within undergraduate and postgraduate health programmes is urgently needed, as is reorientation of existing professionals to the specialty.

Achievement of the necessary worldwide investments in adolescent health would be greatly aided by more visible advocacy efforts, especially in relation to governments, donors, and development partners. In the short term, reorientating child-health advocacy groups to be more inclusive of adolescents would be helpful, but in the medium term, more focused initiatives on adolescents are needed.

Contributors

SMS conceived the paper as part of the planning of the Series on adolescent health, and led the writing of the paper, which all other authors contributed to. SMS and GCP led the development of the conceptual framework.

Conflicts of interest

We declare that we have no conflicts of interest.

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