Global burden of disease in young people aged 10–24 years: a systematic analysis

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Summary

Background Young people aged 10–24 years represent 27% of the world's population. Although important health problems and risk factors for disease in later life emerge in these years, the contribution to the global burden of disease is unknown. We describe the global burden of disease arising in young people and the contribution of risk factors to that burden.

Methods We used data from WHO's 2004 Global Burden of Disease study. Cause-specific disability-adjusted life-years (DALYs) for young people aged 10–24 years were estimated by WHO region on the basis of available data for incidence, prevalence, severity, and mortality. WHO member states were classified into low-income, middle-income, and high-income countries, and into WHO regions. We estimated DALYs attributable to specific global health risk factors using the comparative risk assessment method. DALYs were divided into years of life lost because of premature mortality (YLLs) and years lost because of disability (YLDs), and are presented for regions by sex and by 5-year age groups.

Findings The total number of incident DALYs in those aged 10–24 years was about 236 million, representing 15·5% of total DALYs for all age groups. Africa had the highest rate of DALYs for this age group, which was 2·5 times greater than in high-income countries (208 *vs* 82 DALYs per 1000 population). Across regions, DALY rates were 12% higher in girls than in boys between 15 and 19 years (137 *vs* 153). Worldwide, the three main causes of YLDs for 10–24-year-olds were neuropsychiatric disorders (45%), unintentional injuries (12%), and infectious and parasitic diseases (10%). The main risk factors for incident DALYs in 10–24-year-olds were alcohol (7% of DALYs), unsafe sex (4%), iron deficiency (3%), lack of contraception (2%), and illicit drug use (2%).

Interpretation The health of young people has been largely neglected in global public health because this age group is perceived as healthy. However, opportunities for prevention of disease and injury in this age group are not fully exploited. The findings from this study suggest that adolescent health would benefit from increased public health attention.

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Introduction

In 2008, the worldwide population of young people aged between 10 and 24 years was more than 1·8 billion, the largest cohort ever, representing 27% of the population.[1] This number is projected to peak in 2032 at about 2 billion, with 90% of these people in this age group living in low-income and middle-income countries.[1] The size of this population makes their health status of interest, not only as a determinant of future population health, but also for social and economic development.[2,3] Adolescence is generally thought to be a time of good health, when disease burden is low.[4] Although risk factors and the lifestyles that young people adopt might not affect their health during this period, they can have a substantial effect in later life[5] and can potentially affect the health of future generations.[6] For example, high patterns of physical activity that are adopted during youth and sustained thereafter are thought to have protective effects against the onset of cardiovascular diseases and type 2 diabetes.[7]

A report[8] of the global and regional patterns of mortality for young people aged between 10 and 24 years recorded 2·6 million deaths in 2004 from a worldwide population of 1·8 billion in this age group. However, data for mortality only partly indicate disease burden because they do not show the conditions and behaviours that can lead to premature mortality and future disability—eg, the large burden that is associated with non-lethal mental disorders, which are common in adolescents and young adults.[6,9] Therefore, mortality data alone probably underestimate the potential importance of the contribution of adolescence to overall population health. An example is the onset of tobacco use and dependence, which typically occur during this period;[10,11] the prevention of even a small number of adolescents from smoking could substantially reduce the burden on future health and health systems.[12] Other important determinants of health risk emerging during adolescence relate to eating patterns, physical activity and weight, sexual behaviours, use of addictive substances, and the use of motorised transportation.[13,14]

This paper describes the global and regional burden of disease arising in young people aged 10–24 years, and the contribution of risk factors to that burden. It aims to provide policy makers with comparative data by cause, sex, and different age ranges from early adolescence to young adulthood. We have several specific aims: to describe all-cause and cause-specific disability-adjusted

life-years (DALYs) across global regions for people aged 10–24 years with breakdown by 5-year age bands (10–14, 15–19, and 20–24 years); to describe incident disability caused by years lost because of disability (YLDs) across regions for this age group with breakdown by 5-year age bands as above; and to describe the main global and regional risk factors that contribute to incident DALYs for 10–24-year-olds (10–14 and 15–24 years).

Methods

Data collection

The data used in this analysis were from WHO's 2004 Global Burden of Disease (GBD) study.[15] This study uses several data sources to quantify global and regional effects of disease, injuries, and risk factors on public health, and to provide a comprehensive and comparable assessment of worldwide mortality and loss of health attributable to these causes.[16–18] Population data for 2004 were from the UN population division.[1] Data were divided into three 5-year groups (10–14 years, 15–19 years, and 20–24 years) for the estimation of DALYs, and into two groups (10–14 years and 15–24 years) for the estimation of DALYs attributable to health risks. Changes in DALYs in early adolescence (10–14 years), late adolescence (15–19 years), and young adulthood (20–24 years) were investigated and analysed by sex and region. WHO member states were classified into several groups based on their income and region (webappendix pp 1–2). High-income countries were those in the Americas (n=3), the Mediterranean region (n=5), Europe (n=25), and the western Pacific (n=6). Low-income and middle-income countries were those from Africa (n=46); the Americas (n=31); the Mediterranean region (n=16), including Afghanistan, Iran, and Pakistan; Europe (n=27), including central Asia; southeast Asia (n=11); and the western Pacific (n=21) (webappendix p 1).

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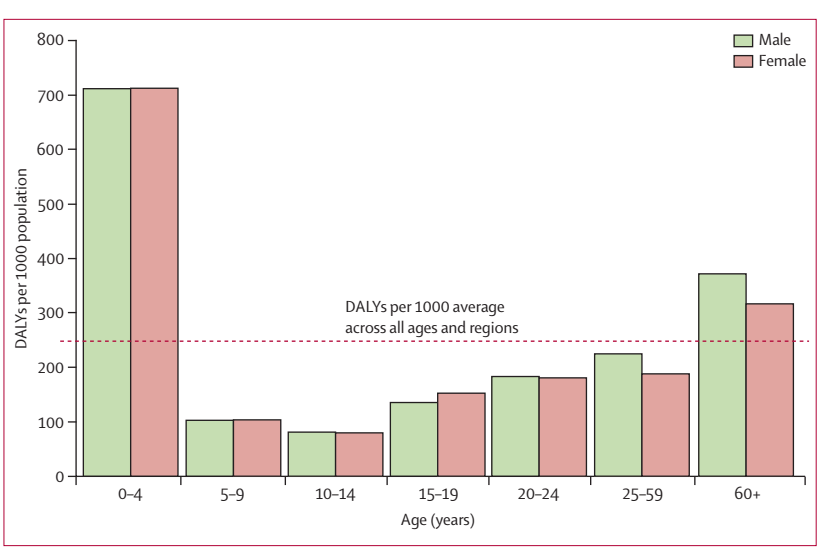

Figure 1: **DALYs per 1000 population by age groups**
Dotted line shows DALYs per 1000 average across all ages and regions. DALY=disability-adjusted life-year.

Estimates of DALYs and risk factors

The overall burden of disease was assessed with the DALY—a summary measure combining years of life lost because of premature mortality (YLLs) with YLDs for incident cases of the disease or injury.[16] One DALY represents the loss of the equivalent of 1 year of full health. YLLs were calculated from the number of deaths at each age and multiplied by a global standard life expectancy for each age. The standard DALYs reported in this analysis use 3% discounted and non-uniform age weights, and differ from the discounted but non age-weighted DALYs that are used in the Disease Control Priorities Project.[18] YLDs for a specific cause for 2004 were calculated by multiplication of the estimated number of incident cases in that period by the average duration of the disease, and then by a weight factor. The weight factor showed the disease severity on a scale ranging from 0 (optimum health status) to 1 (death).[15,16,18] The disability weights used for YLD calculations are mostly the same as those used in the 2000 and 2002 versions of the GBD studies.[17] Further details about data sources and cause-specific methods are available from previous studies.[15,18] Patton and colleagues' study[8] provides a summary of the data sources, coverage, compilation methods, and modelling for the estimates of all-cause mortality and cause-of-death estimates for the 2004 GBD dataset.

Although we calculated mortality and YLLs for 5-year age groups, WHO's 2004 GBD study calculated estimates of incidence, prevalence, and YLDs for broad age ranges—namely, 0–4 years, 5–14 years, 15–29 years, 30–44 years, 45–59 years, and older than 60 years. For causes in which the ratio of YLDs to YLLs was less than 5, we assumed that the incidence (and YLD rate) had the same age pattern as for the mortality rate. This assumption applies for maternal conditions, injuries, and other fatal causes. For the other non-fatal causes, we assumed that incidence and YLD rates per 1000 population were constant across the 5-year age groups within each global burden of disease age group.[15] Detailed information from UNAIDS about the age pattern for HIV incidence was used to calculate YLDs for HIV in 5-year age groups.

Information about the risk factors that cause or are associated with disease and injury is an important part of the GBD study. On the basis of the framework that was published in the comparative risk assessment, data and information for 24 global risk factors were obtained from WHO programmes and scientific studies of both for data exposure and for the causal associations of risk exposure to outcomes of disease and injury.[19,20] The most current risk analyses were applied to the latest regional estimates of mortality and disease burden for a comprehensive set of diseases and injuries for 2004.[15] Comparative risk assessment estimates of disease burden and injuries attributed to a risk factor or group of risk factors are based on a comparison with a counterfactual distribution of exposure that would result in the lowest population

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risk, irrespective of whether attainable in practice, which is referred to as the theoretical minimum-risk exposure distribution.[17] Furthermore, many diseases can be caused by more than one risk factor—the sum of the mortality or burden of disease attributable to each of the separate risk factors is often more than the combined mortality and burden of disease attributable to the groups of these risk factors.

Statistical analysis

Data sources and uncertainty of estimates have been previously discussed for estimates of deaths and YLLs.[8] A previous analysis of 95% uncertainty ranges for regional estimates of cause-specific mortality from the GBD study ranged from 1% for high-income countries to 15–20% for sub-Saharan Africa, which shows differential availability of data.[21] Uncertainty ranges were generally larger for deaths from specific diseases. For example, the relative uncertainty for deaths from road-traffic accidents ranged from 3% for high-income countries to 25% for sub-Saharan Africa, and from 10% for high-income countries to 30% for sub-Saharan Africa for stroke.[8] For the analyses reported here, which are restricted to the adolescent and young adult age ranges, uncertainty ranges are almost certainly larger than the ranges quoted above for all ages combined.

The YLD estimates from WHO's GBD study are based on systematic assessments of the available data for incidence, prevalence, duration, and severity of several disorders.[15] However, these assessments are often based on inconsistent, fragmented, and partial data from different studies; therefore, substantial data gaps and uncertainties remain.[15,22] Uncertainties in YLD estimates are determined mainly by the uncertainty in epidemiological estimates for the prevalence and incidence of specific diseases and injuries, and in the distribution of disability severity that is associated with these factors.[15,22] Previous assessments of YLD uncertainty for specific causes have accounted not only for typical values of measurement error in the input datasets, but also for expert judgment about the degree of uncertainty arising from the scarcity of available data for each region.[15,22] The ranges for YLD uncertainty will generally be larger than those for mortality uncertainty, particularly with the additional assumptions that are used to impute estimates for adolescent age groups from the GBD analyses. However, for some causes there are specific and complete sources of information.

Although 2004 GBD estimates have similarly large ranges of uncertainty for some causes and regions, they provide useful information about broad relativities of disease burden, the importance of mortality and disability, and regional patterns of disease burden.[15] Previous analyses of the levels of uncertainty in the GBD estimates reinforce the need for caution when global comparative epidemiological assessments are interpreted for adolescents. Although our results provide useful information about the relativities and inequalities in the burden of disease and risk factors in adolescents, care should be taken to not overinterpret small differences.

	10–24 years			25 years and older		
	Male	Female	Both	Male	Female	Both
High-income countries	85	78	82	159	135	147
Low-income and middle-income countries						
Africa	184	232	208	458	460	459
Americas	143	109	126	228	176	201
Eastern Mediterranean	147	144	145	274	232	253
Europe	130	93	112	328	207	263
Southeast Asia	140	170	154	290	275	283
Western Pacific	103	85	95	196	160	178

DALY=disability-adjusted life-year.

Table 1: **Estimated total number of DALYs per 1000 population for those aged between 10 and 24 years, and 25 years and older**

Role of the funding source

There was no funding source for this study. FMG, VJ, and CDM had full access to the all the data in the study, and FMG had final responsibility for the decision to submit for publication.

Results

The overall burden for both sexes was much higher for children younger than 5 years (700 DALYs per 1000 population) than for other age groups (figure 1). We noted a substantial decrease in the burden for children aged 5–9 years. The burden slightly fell in those aged 10–14 years when compared with those aged 5–9 years, before increasing steadily from late adolescence to early adulthood and later life (figure 1). Overall, DALY rates were equal between sexes until adulthood, except for the 15–19-year-olds for whom rates were higher in young women than in young men (152 DALYs per 1000 *vs* 136 DALYs per 1000). For those aged 25 years and older, rates were noticeably higher for men than for women and remained so into old age (figure 1).

The high rate of DALYs for girls and young women aged 10–24 years in Africa and southeast Asia, compared with boys and young men in these regions (table 1), is attributable to a female excess burden in 15–19-year-olds (figure 1). In Africa, the difference between males and females was only small in those aged 25 years and older (458 DALYs per 1000 *vs* 460 DALYs per 1000) when regarded across the lifespan. Worldwide, DALYs tended to be higher in males than in females (table 1). DALYs were lower in 10–24-year-olds than in those aged 25 years and older (134 DALYs per 1000 *vs* 232 DALYS per 1000) (table 1). Total DALYs for young people aged 10–24 years were about 236 million, representing 15·5% of the total DALY burden for all age groups. Of these DALYs, 93·4% were in low-income and middle-income countries, and more than half of these were in Africa (21·5%) and southeast Asia (31·9%) (webappendix p 3). The 10–24-year-olds are the only age

Figure 2: **Major causes of disease burden in DALYs in adolescents per 1000 population**
(A) 10–24-year-olds. (B) 10–14-year olds. (C) 15–19 year-olds. (D) 20–24 year-olds. DALYs=disability-adjusted life years. TB=tuberculosis.

group for whom worldwide DALYs were higher in women than in men in some regions. This difference is driven by higher female rates in Africa because of maternal mortality and disability, and, similarly, in southeast Asia (table 1).

Compared with the disease burden in those aged 15–19 years and 20–24 years, the burden in young people aged 10–14 years was low for both sexes across regions (figure 2). Africa had the highest all-cause rate of DALYs of all the regions, except for boys aged 15–19 years in the Americas who have a similar number of DALYs (figure 2). Males in this age group also had the smallest difference between regions (120 DALYs per 1000 in the western

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	Males		Females		Total	
	Cause	Total DALYs (x1000) (%)	Cause	Total DALYs (x1000) (%)	Cause	Total DALYs (x1000) (%)
10–24 years						
1	Road traffic accidents	93 (7·8%)	Unipolar depressive disorders	115 (9·8%)	Unipolar depressive disorders	193 (8·2%)
2	Unipolar depressive disorders	78 (6·6%)	Schizophrenia	46 (4·0%)	Road traffic accidents	127 (5·4%)
3	Violence	69 (5·8%)	Bipolar disorder	44 (3·7%)	Schizophrenia	96 (4·1%)
4	Alcohol use	62 (5·3%)	Abortion	43 (3·7%)	Bipolar disorder	88 (3·8%)
5	Schizophrenia	50 (4·2%)	HIV/AIDS	38 (3·2%)	Violence	81 (3·5%)
6	Bipolar disorder	45 (3·8%)	Road traffic accidents	34 (2·9%)	Alcohol use	71 (3·0%)
7	Self-inflicted injuries	35 (3·0%)	Self-inflicted injuries	32 (2·7%)	HIV/AIDS	70 (3·0%)
8	HIV/AIDS	32 (2·7%)	Maternal sepsis	32 (2·7%)	Self-inflicted injuries	67 (2·8%)
9	Tuberculosis	32 (2·7%)	Lower respiratory infections	30 (2·6%)	Tuberculosis	60 (2·6%)
10	Asthma	32 (2·7%)	Panic disorder	30 (2·6%)	Lower respiratory infections	60 (2·6%)
10–14 years						
1	Road traffic accidents	15 (6·0%)	Lower respiratory infections	15 (6·3%)	Unipolar depressive disorders	28 (5·7%)
2	Unipolar depressive disorders	14 (5·4%)	Unipolar depressive disorders	14 (6·1%)	Lower respiratory infections	28 (5·6%)
3	Lower respiratory infections	13 (4·9%)	Asthma	12 (5·1%)	Road traffic accidents	26 (5·2%)
4	Asthma	10 (4·1%)	Migraine	11 (4·8%)	Asthma	23 (4·6%)
5	Drownings	10 (3·8%)	Road traffic accidents	10 (4·2%)	Refractive errors	19 (3·8%)
6	Refractive errors	10 (3·7%)	Refractive errors	9 (3·8%)	Iron-deficiency anaemia	17 (3·4%)
7	Falls	9 (3·4%)	Iron-deficiency anaemia	8 (3·5%)	Falls	16 (3·2%)
8	Iron-deficiency anaemia	9 (3·4%)	Falls	7 (2·9%)	Migraine	16 (3·2%)
9	Schizophrenia	6 (2·5%)	Diarrhoeal diseases	6 (2·7%)	Drownings	14 (2·9%)
10	Lymphatic filariasis	6 (2·5%)	Fires	6 (2·5%)	Diarrhoeal diseases	12 (2·4%)
15–19 years						
1	Unipolar depressive disorders	34 (8·0%)	Unipolar depressive disorders	53 (11·7%)	Unipolar depressive disorders	86 (9·9%)
2	Road traffic accidents	33 (7·8%)	Schizophrenia	23 (5·2%)	Schizophrenia	46 (5·3%)
3	Alcohol use	30 (7·2%)	Bipolar disorder	22 (4·9%)	Road traffic accidents	46 (5·3%)
4	Schizophrenia	23 (5·4%)	Abortion	17 (3·8%)	Bipolar disorder	44 (5·1%)
5	Bipolar disorder	23 (5·3%)	Panic disorder	16 (3·5%)	Alcohol use	34 (4·0%)
6	Violence	21 (5·1%)	Maternal sepsis	14 (3·1%)	Violence	26 (3·0%)
7	Drug misuse	11 (2·7%)	Self-inflicted injuries	13 (3·0%)	Self-inflicted injuries	24 (2·8%)
8	Asthma	11 (2·6%)	Road traffic accidents	13 (2·9%)	Panic disorder	23 (2·7%)
9	Self-inflicted injuries	11 (2·6%)	Chlamydia	10 (2·3%)	Asthma	18 (2·0%)
10	Drownings	10 (2·5%)	Iron-deficiency anaemia	9 (2·1%)	HIV/AIDS	17 (2·0%)
20–24 years						
1	Road traffic accidents	44 (8·7%)	Unipolar depressive disorders	48 (9·9%)	Unipolar depressive disorders	79 (7·9%)
2	Violence	41 (8·1%)	HIV/AIDS	24 (5·0%)	Road traffic accidents	56 (5·6%)
3	Unipolar depressive	31 (6·0%)	Abortion	24 (4·9%)	Violence	47 (4·7%)
4	Alcohol use	28 (5·6%)	Schizophrenia	21 (4·4%)	HIV/AIDS	44 (4·4%)
5	Self-inflicted injuries	21 (4·0%)	Bipolar disorder	20 (4·1%)	Schizophrenia	42 (4·2%)
6	Schizophrenia	21 (4·0%)	Maternal sepsis	18 (3·7%)	Bipolar disorder	40 (4·1%)
7	Bipolar disorder	20 (4·0%)	Tuberculosis	15 (3·2%)	Tuberculosis	35 (3·5%)
8	HIV/AIDS	20 (3·9%)	Self-inflicted injuries	14 (2·9%)	Self-inflicted injuries	35 (3·5%)
9	Tuberculosis	20 (3·9%)	Panic disorder	14 (2·9%)	Alcohol use	32 (3·2%)
10	War	14 (2·7%)	Road traffic accidents	11 (2·3%)	Abortion	24 (2·4%)

DALY=disability-adjusted life-year.

Table 2: **Main causes of DALYs for 10–24-year-olds and for 5-year age groups[14]**

Pacific and 160 per 1000 in Africa) compared with, for example, women aged 20–24 years in whom the DALYs ranged from 110 per 1000 in the western Pacific, to almost 350 per 1000 in Africa (figure 2, webappendix p 3). The disease burden more than doubled across regions in groups aged 10–14 years and 20–24 years, with a clear

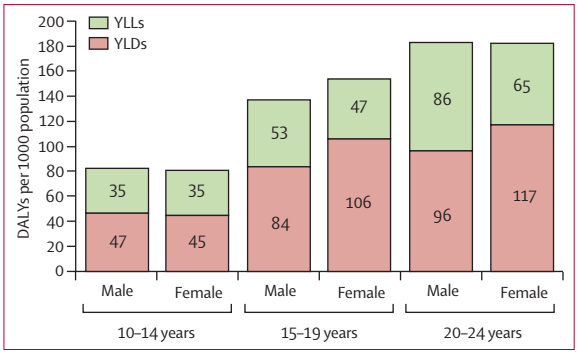

Figure 3: **DALY breakdown by YLLs and YLDs**
DALY breakdown is per 1000 population for males and females for the age groups 10–14 years, 15–19 years, and 20–24 years. YLLs=years of life lost due to premature mortality. YLDs=years lost due to disability. DALY=disability-adjusted life-year.

increase in disease burden from injuries in men aged 20–24 years (figure 2). In this age group, the disease burden in women is increased by maternal conditions particularly in Africa, southeast Asia, and the eastern Mediterranean, and by communicable disease in Africa (figure 2). With more than 200 DALYs per 1000 population, Africa is the region with the highest rate of DALYs in 10–24-year-olds. The lowest rates were in high-income countries, with only 82 DALYs, followed by the western Pacific with 95 DALYs (table 1, webappendix pp 1–2).

Figure 2 provides an overall picture of the distribution of major causes of DALYs by disease group in 10–24-year-olds across region and by sex. Further division of age groups showed an increasing burden of disease and disability for those aged 10–14 years, 15–19 years, and 20–24 years (figure 2). In the 10–24-year age group, injuries affected males more than females and were high across all regions (table 2, figure 2). Overall, neuropsychiatric disorders were the main cause of burden in high-income countries, especially in those aged 15–24 years (50 DALYs per 1000 males and 52 DALYs per 1000 females) (webappendix pp 4–5). The burden of disease from these disorders was also high in low-income and middle-income countries (figure 2). In southeast Asia and the eastern Mediterranean regions, injuries were as important as neuropsychiatric disorders (figure 2).

Disaggregation of DALYs into YLLs and YLDs showed that more all-cause DALYs in late adolescence and early adulthood were caused by incident disability rather than by mortality for those aged 10–24 years (figure 3). YLD rates doubled for males between 10–14 years and 20–24 years, and increased more than 2·5 times for females. YLD rates for females aged 15–19 years were more than double those for girls aged 10–14 years (figure 3). YLD rates for young people varied less between regions than did YLL rates (figure 4). YLLs ranged from 22 to 99 per 1000 males across the different regions (figure 4), and from 9 to 117 per 1000 females. YLDs ranged from 63 to 88 YLDs per 1000 males and from 67 to 115 YLDs per 1000 females (figure 4).

The overall burden of disabling disorders was dominated by causes that contributed more than 80% of the burden of YLDs. The six main causes of worldwide disability in both sexes were neuropsychiatric disorders (including substance misuse), unintentional injuries, infectious and parasitic diseases, maternal conditions, diseases of the sense organs, and respiratory disease (webappendix pp 4–5). Neuropsychiatric disorders were the main cause of YLDs in all regions (webappendix pp 4–5). These disorders ranged from mostly unipolar major depression (20%) and alcohol use (11%) in high-income countries, to unipolar major depression (12%) and schizophrenia (7%) in the eastern Mediterranean region, and unipolar major depression (7%) and bipolar disorder (5%) in Africa. Unintentional injuries—from mainly road-traffic accidents—are the second leading cause of YLDs worldwide and range from 6% of total YLDs in high-income countries to 16% in both southeast Asia and the eastern Mediterranean. Intentional injuries, which are mostly from self-inflicted injuries and violence, are the second leading cause of disability in the Americas with 8% of total YLDs and 5% of total YLDs in the eastern Mediterranean (webappendix pp 4–5). Infectious and parasitic disorders were a leading cause of YLDs in all regions except for in high-income countries. Worldwide, these disorders represented 10% of total disabilities and were the cause of more than a fifth of all disabilities in Africa (22% of total YLDs) (webappendix pp 4–5). Maternal conditions ranked fourth worldwide and within the top

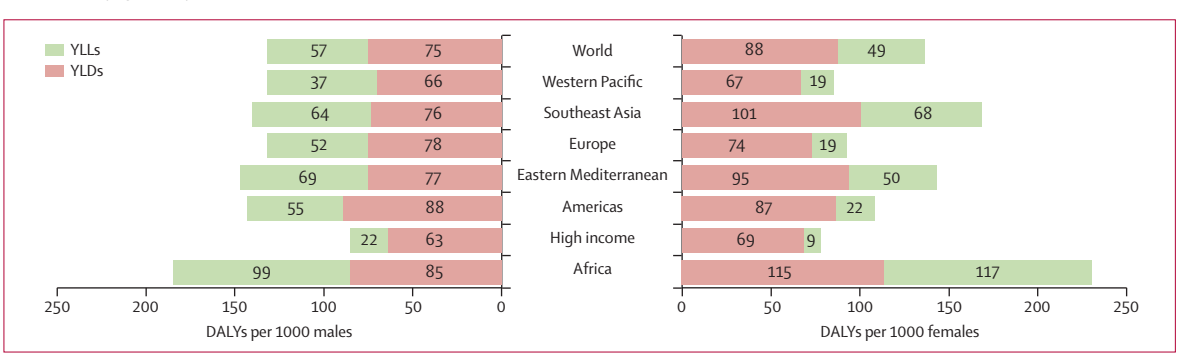

Figure 4: **DALY breakdown by YLDs and YLLs by region and sex in those aged 10–24 years**
DALY=disability-adjusted life-year. YLDs=years lost due to disability. YLLs=years of life lost due to premature mortality.

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	10–14 years	15–24 years	25–59 years	60 years and over
Alcohol use	2%	8%	8%	3%
Unsafe sex	2%	5%	8%	1%
Lack of contraception	0	2%	1%	0
Iron deficiency	3%	2%	2%	0
Illicit drug use	0	2%	2%	0
Unsafe water, sanitation, and hygiene	2%	1%	1%	0
High blood pressure, cholesterol, and glucose	0	0	11%	29%
Physical inactivity	0	0	3%	7%
Tobacco use	0	0	6%	10%
Overweight and obesity	0	0	4%	7%

Figure 5: **Global DALYs (%) attributable to leading risk factors for males and females within the age bands of 10–14 years, 15–24 years, 25–59 years, and 60 years and older**

Risk factors above the dashed line start contributing to the DALYs in late childhood or early adolescence (from ages 10–14 years or 15–24 years). Those below the dashed line generally start contributing only from ages 25 and older. For example, tobacco use is often started in youth, but the effects become apparent only in later life. DALY=disability-adjusted life-year.

six main causes of disability in each region. The percentage of total YLDs in females ranged from 2% of total YLDs in high-income countries to 16% in Africa (webappendix pp 4–5). Disorders of sense organs ranked fifth worldwide, contributing 5% of total YLDs. More than two-thirds of the YLDs were caused by refractive errors that can be corrected with the provision of glasses or other visual correction. Respiratory disorders were the sixth main cause of disability worldwide. Most of these YLDs were caused by asthma. The burden was highest in high-income countries where these disorders contributed to 7% of total YLDs (webappendix pp 4–5).

We calculated results of risk factors contributing to DALYs for 10–14-year-olds and 15–24-year-olds only. More detailed age distributions of exposure were not available. We selected the risk factors on the basis that they have a global spread, that data were available to estimate population exposures or distributions, and that known means exist to reduce them.[5] The main risk factors for all ages (0–80 years and older) worldwide are underweight, unsafe sex, alcohol use, and unsafe water, sanitation, and hygiene.[5] By contrast, the main risk factors contributing to DALYs in 10–24-year-olds were alcohol use, unsafe sex (increasing risk of disease transmission), iron deficiency,

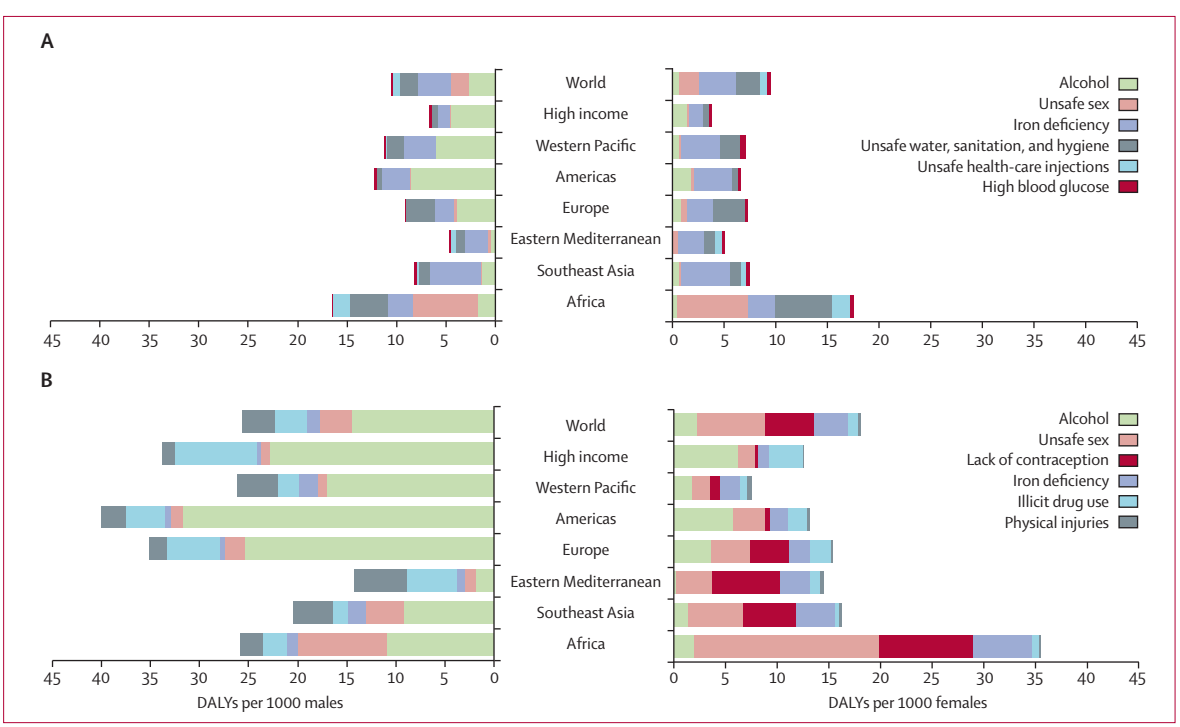

Figure 6: **Percentage of DALYs attributable to the most important risks factors by region and sex in 2004**

(A) 10–14-year-olds. (B) 15–24-year-olds. DALY=disability-adjusted life-year. Physical injuries refer to unintentional injuries resulting from occupational risks.

Panel: **Research in context**

Systematic analysis

This paper presents information for a specific population (young people aged 10–24 years) on the basis of WHO's 2004 Global Burden of Disease (GBD) study. No previous published studies were available that provided a comprehensive picture of the global burden of disease among young people. Murray and Lopez[16] describe the GBD approach as a metasynthesis—ie, a construction of a comprehensive and comparable view of health problems using all available sources of information. Available data have many gaps and uncertainties because they are from regions with limited, incomplete, and poor quality data.

Interpretation

This is the first systematic description of global disease burden arising during adolescence and young adulthood. One important aspect of the Article is the consideration of the contributions of mortality and morbidity to disease burden with use of disability-adjusted life-years (DALYs) as a measure. It provides the most complete overview until now of disease burden for this age group and is seen as complementary to Patton and colleagues' 2009 paper,[8] which provided an overview of global mortality patterns. Although mortality improves with economic development, the disease burden from disability is relatively high in all regions; therefore, non-fatal disease burden should be a main determinant of policy in young people. This finding in turn has implications for the types of data and health information systems that countries should use when informing youth health policies.

and lack of contraception (leading to pregnancy); (figure 5). Other important risk factors were illicit drug use, physical injuries (occupational risk factors for injuries), and unsafe health-care injections (figure 5).[5]

The total burden of disease attributable to specific risk factors increased substantially with age. The increase was greatest for males in whom an increase of 2·5 times occurred from 10–14 years to 15–24 years (10 DALYs per 1000 males for 10–14-year-olds, to 26 DALYs per 1000 males for 15–24-year-olds). This increase was nearly four times higher in the Americas than elsewhere (9 DALYs per 1000 males for 10–14-year-olds, to 35 DALYs per 1000 males for 15–24-year-olds). In high-income countries there was an almost five-fold increase in the DALYs attributed to risk factors, from 7 DALYs per 1000 males for 10–14-year-olds to 34 per 1000 for 15–24-year-olds (figure 6). The main risk factors changed in their contribution to DALYs between early adolescence and young adulthood. Although iron deficiency was most prominent in 10–14-year-olds, it continued to have a role in females aged 15–24 years (figure 6) but not in males. In adolescents aged 15–24 years, alcohol use, unsafe sex, lack of contraception, and iron deficiency were important contributions to DALYs, and, by contrast, unsafe water, sanitation, and hygiene were less important (figure 5, figure 6). Other risk factors that did not contribute to DALYs in young people but that become major public health threats in later life were high blood pressure, cholesterol and glucose, tobacco use, physical inactivity, and overweight and obesity (figure 5).

Discussion

Worldwide, young people bear a substantial burden of DALYs, both for YLLs and for YLDs, representing 15·5% of the total DALY burden for all age groups versus 18·5% in children younger than 5 years. This age group is the only one for whom DALYs were higher in women than men, notably in Africa and in southeast Asia. Africa had the highest regional rate of DALYs for those aged 10–24 years—2·5 times greater than in high-income countries. Differences in the causes of disease burden between high-income, middle-income, and low-income countries were substantial with very low rates of contribution from communicable diseases and maternal conditions in high-income regions. The contribution of YLLs and YLDs to overall disease burden also changed across country grouping. Improvements in levels of health (ie, low DALY rates) decreased the proportion of YLLs to overall DALYs to less than 25% but was close to 50% in the worst affected regions. This finding suggests that to improve health, policy makers should increasingly base decisions about young people's health on the disability-related proportion of DALYs because they represent the highest burden for the health system throughout the life-course.

The previous study of patterns of global mortality in young people[8] concluded that investment in injury prevention—the main cause of death in this age group—had fallen behind investments in areas such as reproductive health and HIV/AIDS, a finding that is also supported in this analysis. DALYs for road-traffic accidents ranked second and violence was the fifth leading cause (table 2, webappendix pp 4–5). Importantly our analysis emphasises the causes of disease burden that rarely lead to death. Neuropsychiatric disorders, which have largely been overlooked in public health, are the leading cause of disability in young people in each region. However, this area tends to be poorly measured,[23] making it a challenge to obtain a realistic estimate for the extent of the problem, especially in low-income and middle-income countries where communicable disease is often the research priority. Mental health is a mostly overlooked area in public health programmes of low-income and middle-income countries for all ages, but especially so in young people.[9] Poor mental health in adolescence is associated with a high prevalence of adult emotional, behavioural, and severe psychiatric problems,[9] and a large proportion of all adult mental health disorders start in adolescence.[23]

The disease burden arising in early adolescence from major risk factors is low. However, rates rise sharply in late adolescence and early adulthood for both alcohol use and unsafe sex. For other risk factors that commonly start in adolescence such as tobacco use, low physical activity, high blood pressure, and overweight and obesity,[23] their contribution to disease becomes apparent only in mid-to-late adulthood. The rising burden of non-communicable diseases is an increasing focus of global public health.[16,24] Our risk factor data suggest that preventive strategies should adopt a life-course approach whereby the focus on the adolescent and young-adult years is prominent.[6,25]

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The epidemiological transition occurring with economic development has profoundly affected patterns of health but, until now, has not been substantially explored in adolescence and young adulthood.[6] Our findings suggest that one consequence of this transition is the need to increase focus on non-communicable and non-fatal causes of disease burden both in adolescence and in later adult life. In turn, this focus is likely to shift attention to lifestyle risk factors and their social and environmental determinants.[26–29] This shift will present challenges in the political willingness among key stakeholders to invest in programmes that take many years to show their full effects. For example, the extent to which comprehensive tobacco-control programmes can prevent young people from becoming persistent smokers will affect mortality rates in the middle or second half of the 21st century.[29] The introduction of vaccination of adolescent girls for human papillomavirus for the prevention of cervical cancers in high-income, low-income, and middle-income countries might indicate that willingness is growing to invest in prevention when new technologies and strong evidence for effectiveness of interventions become available.[30]

Although methodological and data developments in the past decade have improved the empirical base for assessment of disease burden, substantial data gaps and uncertainties still remain, particularly for causes of death and levels of adolescent and adult mortality in Africa and parts of Asia. Improvements in population-level information about causes of death and the incidence, prevalence, and health states that are associated with causes of major disease and injury are still a main priority for national and international health and statistical agencies. Better information for young people than is currently available will need improved health-information systems, notably in efforts towards improving death-registration data and data obtained through household surveys and research studies. Such data systems and surveys should report results for more detailed age categories that are relevant to young people, rather than only for broad age ranges, as is often the case.[5]

Until improved data become available, systematic assessments and syntheses of the available evidence will continue to provide important inputs for global health planning. Several areas still need further research development to address these data gaps, such as innovative methods involving sample registration and the use of verbal autopsy questionnaires in surveys. Research of strategies to improve comparability of cause-of-death certification and coding practices across countries is also a high priority. Nonetheless, for the first time, a systematic analysis of the global disease burden for young people aged 10–24 years is now available (panel).

Contributors

PJNB, BJF, FMG, and GCP conceived the idea for the study. FMG, CDM, GCP, SMS, and CC compiled, analysed, and summarised the study estimates. Tables, graphs, and figures were prepared by FMG and VJ, with input from all other authors. FMG led the writing of the paper with contributions from all other authors.

Conflicts of interest

We declare that we have no conflicts of interest.

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