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Worldwide application of prevention science in adolescent health

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Abstract

The burden of morbidity and mortality from non-communicable disease has risen worldwide and is accelerating in low-income and middle-income countries, whereas the burden from infectious diseases has declined. Since this transition, the prevention of non-communicable disease as well as communicable disease causes of adolescent mortality has risen in importance. Problem behaviours that increase the short-term or long-term likelihood of morbidity and mortality, including alcohol,

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Conflicts of interest
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tobacco, and other drug misuse, mental health problems, unsafe sex, risky and unsafe driving, and violence are largely preventable. In the past 30 years new discoveries have led to prevention science being established as a discipline designed to mitigate these problem behaviours. Longitudinal studies have provided an understanding of risk and protective factors across the life course for many of these problem behaviours. Risks cluster across development to produce early accumulation of risk in childhood and more pervasive risk in adolescence. This understanding has led to the construction of developmentally appropriate prevention policies and programmes that have shown short-term and long-term reductions in these adolescent problem behaviours. We describe the principles of prevention science, provide examples of efficacious preventive interventions, describe challenges and potential solutions to take efficacious prevention policies and programmes to scale, and conclude with recommendations to reduce the burden of adolescent mortality and morbidity worldwide through preventive intervention.

Introduction

Despite some regional differences and a concentration of deaths in low-income and middle-income countries, there is commonality in the causes of adolescent deaths worldwide.[1] The causes of adolescent death include communicable diseases (HIV/AIDS, tuberculosis, and lower respiratory-tract infection) and non-communicable diseases related to problem behaviours (motor vehicle fatalities, violence, self-harm, alcohol, tobacco, and other drugs, and risky sex leading to early or unintended pregnancy). Further, adolescence, partitioned into early (11–13 years), middle (14–18 years), and late (19–24 years) by the American Academy of Child and Adolescent Psychiatry,[2] is a common period for the onset of symptoms and behaviours that lead to disorders in adulthood. For some disorders (eg, alcohol misuse and dependence, antisocial personality disorder), greater than 50% of first diagnoses across the life course are by age 25 years.[3] Preventing adolescent problem behaviours might reduce the burden of morbidity in adolescence and adulthood.

Primary approaches to ameliorate these behaviour problems are health promotion, prevention, and treatment.[3] At the turn of the 20th century in high-income countries, adolescence became a distinct time of life because of industrialisation, advances in medicine, improved nutrition, and public health, which increased the need for an educated workforce and led to universal education through the second decade of life.[4] This extended period of dependence coincided with a rise in adolescent problem behaviours. Programmes designed to prevent these problem behaviours were first developed in the late 1960s in high-income countries, although few of these interventions were effective.[5–7] In response to the disappointing results, prevention programme developers aligned with the science of behaviour development that discovered predictors. A second generation of prevention efforts sought to use this information to design programmes to address these predictors of specific problem behaviours, which was more successful.[8,9] These prevention interventions focusing on single problems came under criticism, and there was a movement towards considering the co-occurrence of problem behaviours within the adolescent and understanding the overlap in predictors across many behaviours.[10] Others—ie, prevention practitioners, policy makers, and prevention scientists—advocated for more focus on factors that promote positive youth development, in addition to the focus on reducing factors that predict

problems.[11] They called for understanding the develop mental processes involved in these disorders, including structural, intermediate, and individual risk and protective factors. Such concerns helped expand the design of prevention programmes to include components aimed at health promotion.[3,12] Over the past 30 years, several controlled trials have shown that preventive and promotive policies and programmes (called preventive interventions hereafter) can be efficacious and cost effective at reducing adolescent problem behaviour and improving health.[13]

Prevention science has had a different history in low-income and middle-income countries. In these countries, economic conditions have somewhat delayed the recognition of adolescence as a distinct life stage, although as these countries develop economically, with population shifts to urban centres, there is a growing recognition of adolescence.[14] The research base that was developed in high-income countries has recently begun to be applied to low-income and middle-income countries through translation of existing approaches and developing and testing new preventive interventions in these lower-income contexts.

Treatment of adolescent behaviour problems remains the most common approach worldwide.[15] Ultimately, some combination of treatment and prevention pro grammes would be ideal, but how to achieve this vision is somewhat uncertain.[16] Investigators suggest that reducing a small amount of risk in the general (and proportionally larger) population might be epidemiologically more beneficial than reducing larger amounts of risk in the smaller, high-risk, segment of society.[17,18] Although evidence-based treatments are important, we advocate applying the growing research base for prevention science worldwide to substantially reduce morbidity and mortality.[19]

We provide an overview of the research base for prevention science and illustrative evidence of the efficacy of various preventive interventions. We surveyed broad outcomes, including obesity, violence, mental health, substance misuse, traffic crashes, pregnancy, and sexually transmitted infections, by assessing recent reviews and doing targeted searches of prevention controlled trials. We take a purposive approach, and have chosen to illustrate what works in prevention and health promotion, and refer to other more comprehensive and systematic reviews for other efficacious and non-efficacious interventions. In our opinion, the preventive interventions we have selected provide a broader over view of what is possible in preventing adolescent problems than comprehensive reviews of prevention programmes of a certain type or targeting a single problem behaviour.

We selected the programmes and policies identified in this report because they were tested in randomised or quasi-experimental trials, had a sustained and statistically significant effect on problem behaviours during adolescence at least 1 year after intervention, operate at different points in development during childhood and adolescence, and address accumulation of risk[20] as well as adolescent risk onset.[21] We chose these examples to provide some diversity in worldwide context, although most testing, particularly the long-term investigation of outcomes, has been done in high-income countries.

The science of prevention

In the past three decades, prevention science has emerged as a discipline built on the integration of life-course development research, community epidemiology, and preventive intervention trials.[22] Prevention science is based on a framework that identifies empirically verifiable precursors that affect the likelihood of undesired health outcomes. Precursors include structural, intermediate (family, school, peer), and individual risk factors that predict an increased likelihood of problems, and protective factors that mediate or moderate exposure to risk or directly decrease the likelihood of problems.[3,23,24] Risk and protective factors emerge at particular periods of development. Some factors are problem specific and some are more general, predicting multiple outcomes, including alcohol, tobacco, and other drug misuse, adolescent pregnancy, violence, delinquency, school dropout, and mental health dis-orders.[3,25] The commonality in risk factors across problem behaviours means that interventions that address a risk factor will probably affect many problems.[25] This commonality also suggests that preventive interventions that address precursors of multiple problems are an efficient approach. Further, exposure to several risk factors, and lack of exposure to protective factors, strengthens the likelihood of problem outcomes, but preventive interventions that effectively reduce risk and enhance protective factors can have the reverse effect and make healthy development more probable (appendix).[10,26]

Although several typologies for targeting preventive interventions have been described,[3] we use the categories of universal, selective, and indicated preventive interventions (appendix). The intended application of universal preventive interventions is across a population irrespective of risk. Policies that address structural determinants are often applied universally, as are programmes that encourage all young people to adopt skills to refuse offers of alcohol, tobacco, and other drugs. Selective preventive interventions are applied to groups with raised risk for poor outcomes—eg, pro grammes targeted at low-income neighbourhoods or families. Indicated preventive interventions are applied to individuals who are already showing symptoms of a disorder or problem behaviour—eg, working with young people after their first contact with the justice system to prevent further penetration into the system. The policies and programmes we include provide examples of all three prevention approaches.

Risks tend to cluster in two patterns across childhood and adolescence, a so-called early accumulated risk cluster and a so-called adolescent-onset risk cluster. Risks accumulate early in the life course when develop mental challenges are not met and problems begin to cascade, so that having one risk makes it more probable that the individual will develop another.[20] For example, early family adversity and risks, such as low income and poor family management including abuse and neglect, make it harder for children to be ready for school, hindering their academic achievement. These children might best be helped by selective interventions implemented in the early years to counteract family risk and avoid school-related problems. If early developmental challenges are not met, risk can continue to accumulate in adolescence, with low school achievement leading to rejection by prosocial peers, increased interaction with deviant peers, and the start of problem behaviours.[27] These adolescents might best be helped by indicated preventive intervention provided to those showing signs and symptoms of problems.[3] The adolescent-onset pattern[21] of risk arises in

early to late adolescence. In the absence of protective influences, post-pubertal normative increases in problem behaviours can be exacerbated through negative peer influences. This pattern can affect all adolescents, even those without accumulated early risk, and might be targeted through preventive universal interventions with parents, schools, or communities that seek to reduce favourable attitudes towards problem behaviours and increase protection.[28]

Several preventive interventions have been tested in controlled trials and shown to be efficacious.[3,29–32]

Evidence of efficacy

Table 1 and the appendix show how the efficacious interventions target structural, intermediate, and individual risk, divided into childhood, early adolescence, and late adolescence. We summarise the types of prevention interventions that address structural risk through policy changes and those that address intermediate risks in the family, school, peer, and individual. Table 2 details these programmes and policies, where and how they have been assessed, and the effect size, odds ratio, or change in prevalence; we also show the risk cluster addressed (early accumulated or adolescent-onset risk) and the intervention target (universal, selective, and indicated).

Prevention policies that address structural risk factors have the potential to affect whole populations and can be implemented broadly, from local administrative districts to entire nations. Policies in table 2 were tested in Australia, Canada, the UK, and the USA. The example efficacious policies include providing minors (ie, those younger than 18 years) with free or easier access to contraception, raising taxes on alcohol, increasing the minimum legal drinking age, and having graduated licensing policies for adolescent drivers (eg, restrictions on when and under what conditions they are allowed to drive). Assessments of these types of policies have shown reductions in unintended adolescent pregnancy and risky sexual behaviour, harmful drinking, traffic crashes, and crime.

Preventive programmes that address family and individual risk factors have shown effects across development in trials done in the USA. For example, the Nurse-Family Partnership[46] provided services to low-income, first-time mothers to improve their health and behaviours while pregnant and strengthen parenting skills when children were infants. All other interventions targeted both parents and children to simultaneously enhance protection and reduce family and individual risks. Examples include enhanced education services for primarily low-income, very young children to improve their cognitive, language, and social-cognitive skills;[48–50] and interventions that strengthen parenting skills, parent–child communication, and affective relationships. These include universal (eg, the Strengthening Families Program for Parents and Youth 10–14[28,72,73] and the Computer-Based Intervention[54,55]), selective (eg, the New Beginnings Program[56]), and indicated programmes (eg, Functional Family Therapy[74]). Across programmes, significant effects were identified in early childhood to late adolescence and include reduced child abuse and neglect, alcohol and other drug misuse, risky sexual activity, depression, and delinquency and crime, and greater educational attainment.

Preventive programmes that address school and individual risk factors include many primary and secondary school programmes. The examples in table 2 were assessed in Australia, Kenya, Malawi, and the USA. Two of these programmes (the Seattle Social Development Project[31,58–60] and the Gatehouse Project[61,62]) include classroom-based curricula taught by teachers to improve student cognitive, social, and emotional competencies and seek to alter school factors by enhancing teacher instructional and student classroom management skills or changing school and classroom norms for behaviour. Another efficacious prevention programme provides cash incentives for students to remain in school.[63,64] Together, these school-based prevention pro grammes have shown effects in reducing aggression, crime, alcohol and tobacco use, unwanted pregnancies, sexually transmitted diseases, and mental health symptoms and disorders, and have shown increases in secondary school completion, educational attainment, and income. Positive outcomes have been shown across adolescence, with enduring effects 1–15 years after intervention.

The last set of efficacious prevention programmes shown in table 2 addresses peer and individual risk factors and seek to change many outcomes, including drug use (Unplugged[65] and Life Skills Training[66,67]), positive development (Positive Adolescent Training Through Holistic Social Programs[68,69]), and risky sexual behaviours (Stepping Stones[70,75] and Sistering, Informing, Healing, Loving and Empowering[71]). These prevention pro grammes have been assessed in several European countries, Hong Kong, South Africa, and the USA; they provide services directly to young people and target adolescent-onset risk factors. Sessions seek to promote positive peer relationships, interpersonal skills, and skills to counteract negative peer influences. Effective interventions also simultaneously promote the development of individual skills and competencies via group-based sessions in school classrooms or community settings. Across interventions, positive effects have included reduced alcohol and other substance misuse, delinquency, risky sexual activity, sexually transmitted disease (herpes simplex virus), unwanted pregnancy, and academic failure, and increased psychosocial competencies.

The programmes and policies described are examples of prevention interventions that have shown significant reductions in problem behaviours in children and adolescents by targeting relevant risk and protective factors from infancy to adolescence. These illustrative interventions have worked in many contexts, from policy to the individual. Furthermore, they have used many formats, including laws, in-person delivery, and electronic media. Although there is variation in their effect sizes and ability to produce desired changes in the long term, these strategies affect various problem behaviours associated with adolescent morbidity and mortality. Our approach is illustrative, and there are many more prevention interventions that are efficacious. Employing a combination of programmes and policies that engage schools, families, and communities will probably yield long-term beneficial effects.[76,77] Early intervention might be best to forestall the accumulation of risk, but investments are also needed during adolescence to offset the pattern of adolescent-onset risk and to work with those whose accumulated risk now needs indicated prevention.

The efficacy of many preventive interventions has been established and provides a strong foundation for action. However, several key gaps in our knowledge remain. Most preventive interventions have been assessed in high-income countries, and less prevention research has

been done in low-income and middle-income countries. Across nations, there has been a lack of controlled trials that assess long-term outcomes or study the comparative efficacy of prevention strategies. Further, although many prevention programmes have been efficacious, few replications have been undertaken, and effectiveness trials are uncommon. Funding for prevention trials has favoured innovation and efficacy rather than replication. To ensure that the discipline develops robust interventions, advocacy for research funding targeting replication, generalisation, and effectiveness trials is needed.

In the USA, the Washington State Institute for Public Policy has advanced preventive science by estimating the cost-effectiveness of diverse prevention programmes with scientifically rigorous standards applied consistently across programmes. Six of the interventions we include have been assessed by the Institute, and all have shown economic benefits. Benefit-per-dollar cost ratios range from US$2·11 to $42·13, and savings per participant range from $1348 to $31 036.[13] However, cost–benefit estimates of interventions are scarce, due to challenges in calculating accurate intervention effect sizes; the failure of many programme developers to fully document and make available intervention costs; complexities in doing economic analyses (eg, establishing appropriate discount rates, making assumptions regarding future events, and lifetime benefits etc); and few incentives for researchers to undertake such work. Existing cost–benefit studies differ in their methods.[3] Reaching consensus on standards for undertaking cost–benefit analyses and making this a routine part of programme assessment can help policy makers choose models that not only improve adolescent health, but also ensure that investments return downstream benefits.[3,78,79]

Although gaps remain in the development and assessment of preventive interventions and policies, existing models offer promise for reducing the substantial public health burden. Widespread dissemination would provide opportunity to undertake replication, generalisation, and effectiveness trials to ensure that we fill knowledge gaps.

Translation of efficacious interventions

A key challenge for prevention science is translating scientific advances into practice, with the goal of supporting the dissemination and sustainability of evidence-based interventions at scale within and across nations.[80] Improved translation of efficacious prevention programmes to standard practice is needed not only in low-income and middle-income countries, but also in high-income countries. For example, a national study of public secondary schools in the USA[81] showed that only about 43% of schools implement efficacious drug-prevention curricula. Substantial barriers that hinder the widespread dissemination of prevention interventions in countries of all incomes include restricted government financing of preventive interventions, lack of prevention training in professional communities, and restricted knowledge of, or support for, prevention in the general public.[15,82]

Many government officials lack training in public health[83] and often focus policies and funding on remedial rather than preventive efforts. Further, there is unbalanced attention focused on physical health problems and medical treatment at the expense of mental health

problems and psychosocial intervention.[15,69] The consequence is that financial resources spent on prevention are usually inadequate, and prevention programming is done in an unsystematic and piecemeal manner.[82] Improving the technical capacity of government, fostering trust between government and researchers, and establishing the standard of using scientific evidence to inform decisions are crucial directions for the future.[15,83,84]

Professionals working with young people in countries of all incomes usually lack training in prevention and evidence-based practice, resulting in diminished appreciation for prevention and outcome assessement.[82,85] Poor communication and dissemination of research findings[83] about prevention research and health-policy analysis[86] hinder the use of research findings in prevention practice. Overcoming these barriers might be helped by user-friendly packaging of research findings; increased dialogue between policy makers, researchers, and professionals and practitioners;[87] and the provision of incentives for researchers to work towards these goals and incentives for practitioners to use the results in their programming.[83]

Similarly, the general public does not advocate for the use of effective prevention strategies. Although the public often has knowledge of and a high expectation for the efficacy of preventive medical interventions such as vaccines, they have little knowledge of the efficacy of psychosocial preventive initiatives. To overcome this lack of awareness, there is a need for broad dissemination of information on prevention, its efficacy, and the ability of preventive interventions to save money as well as lives.

Some barriers to the dissemination of evidence-based prevention interventions are more prevalent in low-income and middle-income countries than high-income countries. In low-income and middle-income countries, adolescence might not be fully acknowledged as an important life stage, and thus, interventions that focus on adolescents might receive little support. Further, there might be perceptions that efficacious preventive interventions developed in high-income countries might not be acceptable or applicable in lower income settings, in view of the important differences in the epidemiologic patterns, social norms and traditional practices, and levels of poverty in these countries.[88]

There is a need to expand research on adolescent preventive interventions in low-income and middle-income countries so that context-specific issues can be addressed. However, a growing body of research shows that some interventions created in high-income countries can be translated to and be effective in low-income and middle-income countries. For example, a review of 83 sex education programmes based on western theories of behaviour change showed that two-thirds were effective at reducing adolescent sexual risk behaviour in several countries, cultures, and groups of young people.[75] The studies included nine from high-income countries other than the USA and 18 from low-income and middle-income countries.

Although these examples show that effective interventions can be successfully replicated in different contexts, there is substantial debate on how to transfer programmes to new settings, both within and across nations.[89] Advocates of strict implementation fidelity highlight evidence that participant outcomes are stronger and sometimes only achieved when

interventions are replicated as closely as possible to their original protocol.[90,91] Others contend that adaptations are needed to ensure that an intervention's content, language, examples, and methods of delivery are culturally appropriate and relevant to the new population.[92] This view anticipates that modifications will increase participant responsiveness, programme effectiveness, and sustainability.

The goal is to have enough effective interventions available worldwide so that adopters can select those that closely match their own population, needs, and resources, then faithfully replicate them. Until that is possible, dissemination efforts can be fostered by better identification of the core elements of efficacious interventions— the content, activities, and modes of delivery that best represent their underlying logic and causal mechanisms.[91,93] Adopters must be aware of these principles and ensure their full implementation.[94] When planned adaptations of programme features substantially revise the intervention, rigorous assessment, perhaps comparing the unaltered intervention to the adaptation, should be done to ensure that the new version is effective.[92,94] Innovative and cost-effective methods for designing and assessing programme adaptations are emerging in prevention science to guide this process.[95]

Building capacity

Dissemination of efficacious prevention interventions across diverse nations and communities begins with efforts to identify the most salient needs. Although there are similarities across nations in the leading causes of adolescent mortality, there are also differences.[1] Such differences also exist within nations, at the community level.[96,97] Selecting the right intervention for the right population requires the identification and prioritisation of community need. Community monitoring systems that assess behaviour problems, as well as risk and protective factors, can help communities target prevention strategies. The Communities That Care (CTC) Youth Survey is one example of a valid, reliable, and efficient school survey method that can be used to identify local levels of risk and protective factors as well as alcohol, tobacco, and other drug misuse, delinquency, violence,[98,99] and depression.[100] This survey has been used in Australia, India, Netherlands, the UK, and the USA.[101–103] The survey assesses community need for prevention by providing information on risk, protection, and youth outcomes that are most elevated, and thus most appropriate for prevention efforts. When surveys are repeated over time, communities can monitor the effects of prevention policies and programmes.[97]

Other assessment methods include the Monitoring the Future survey[104] in the USA and The European School Survey Project on Alcohol and Other Drugs,[105] which focus on assessing adolescent drug misuse. The school-based Global Student Health Survey assesses nine problem behaviours and some predictors in young people aged 13–15 years.[106] The Early Development Index, administered widely in Australia, Canada, and other countries, monitors physical health and wellbeing of young children entering school, and measures some risk and protective factors (including social competence, emotional maturity, language and cognitive development, and communication skills).[107] Despite these worthy examples, additional surveys are needed that can measure risk and protective factors and problem behaviours comprehensively at a local level. Greater infrastructure development to support

use of monitoring systems is also needed in all countries, but promising developments have been made towards this goal by WHO (eg, Child and Adolescent Health Survey), the World Bank (eg, Living Standards Measurement Study), European School Survey Project on Alcohol and Other Drugs, and others.[105,106] The development of a database of these instruments, which lists constructs measured and scales, would allow adoption of measures for community monitoring systems.

Once local levels of risk, protection, and behavioural outcomes are identified and prioritised, the most efficacious prevention approaches that meet these needs can be chosen and implemented. A challenge at this stage is for communities to ensure that the programme elements crucial to success have been well implemented,[89] because careful implementation of programmes' core components has been associated with stronger effects on targeted outcomes.[90] There will be challenges to implementation, and communities will need technical assistance to help them monitor the quality of implementation. Communities must ensure that they use methods and delivery systems that reach targeted participants in sufficient numbers to achieve population-level outcomes. Some trials have shown that reaching 40–60% of targeted participants might be sufficient to produce community-level effects.[76,108]

Methods for increasing the capacity of local communities to undertake successful prevention efforts are only beginning to emerge.[109] Five core components for capacity building have been identified;[84] these include improvement of data collection, defining the epidemiology of the health problem, estimation of the societal cost of the problem, understanding public perceptions of problem causation, and engaging policy makers to improve prevention and control. Strong collaborations between researchers and practitioners are essential to build this capacity. Such partnerships have been the focus of community-based prevention trials in the USA, such as the CTC or the Promoting School Community University Partnerships to Enhance Resilience prevention models.[52,110] In the CTC model, broad-based community coalitions that include representatives of government, non-governmental organisations, service sectors, and key community leaders receive structured training workshops and proactive technical assistance for assessing their prevention needs, targeting these needs with tested and efficacious prevention strategies, and ensuring that these new strategies are well implemented and integrated with existing prevention efforts.[111] A randomised, controlled assessment has shown that CTC substantially increased the number and scope of prevention services in intervention compared with control communities, and produced community-wide reductions in alcohol and tobacco use and delinquent behaviour that were sustained 2 years later.[76,110]

As efficacious programmes become more widely adopted across communities and nations, the need for strategies to enhance long-term sustainability are crucial. Research on the conditions that facilitate or undermine the maintenance of new initiatives is beginning to emerge. An assessment of the CTC prevention system in 110 US communities in Pennsylvania[112] estimated a survival rate of CTC coalitions of about 60% over 6 years after withdrawal of state funding, with the primary factors leading to sustainability including local funding and planning for sustainability and fidelity to the CTC model. Other research has suggested that long-term sustainability is associated with strong support for the programme

among staff and leaders; widespread belief in the benefits of the innovation; and a strong integration between the new innovation and the agency's mission statement, schedule of services, and staffing profile.[113]

Conclusions

Although there are many significant challenges to going to scale with efficacious prevention interventions, advances have been made. For continued progress, a change in attitude is needed to position the importance of preventive programmes in the minds of parents, communities, professionals, and policy makers. Specific actions might help support widespread adoption of preventive interventions. First, government officials must appreciate the importance of tested, efficacious prevention programmes and policies that have the potential to reduce health spending and other social costs (table 3), and support the development of a widespread prevention delivery system for adolescents. Few examples of such prevention delivery systems exist at present. Prevention funding needs to move from short-term discretionary grants to stable funding streams. Second, professional training in prevention science is needed. Prevention science and evidence-based practice should be included in the basic and continuing professional education programmes for professionals working with young people.[114] Third, an increase in local community capacity to assess needs is needed to identify priority problems. This increase in capacity should include the development and use of monitoring systems that identify community levels of risk, protection, and behaviour problems in children and adolescents, and improved collaboration between the science and practice community. Constructing a database of community monitoring methods will also help. Fourth, research on adaptation, going to scale, and sustainability of efficacious prevention programmes and policies across countries of all incomes needs to be done. Adaptation research will help ensure that evidence-based prevention interventions can be tailored to other contexts. Since many preventive interventions have been tested in high-income countries, a concerted effort is needed to address barriers to widespread adoption in low-income and middle-income countries. Translational research should be promoted through increased funding, training of translational investigators, removal of barriers blocking collaboration between scientists and practitioners, and development of administrative facilitation for translational research.[115] Fifth, there is a need to create a credible database documenting exemplary and promising prevention interventions across behaviour problems, including, at a minimum, substance misuse, violence, crime, early school leaving, obesity, mental health, unsafe sex, unintended pregnancy, and risky and unsafe driving. Although some databases have programmes that address many outcomes, none covers this breadth of outcomes. Sixth, research is needed to establish whether there are unique risk and protective factors in the low-income and middle-income countries that might provide the basis for additional targets for preventive interventions. Reducing the emergence of problems during adolescence should have a substantial effect on reducing the burden of health problems well into adulthood.

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Key messages

- Behaviour problems are important causes of adolescent morbidity and mortality
- There is sufficient evidence from controlled trials that carefully designed preventive interventions can improve adolescent health
- Effective adolescent health programmes should include a combination of preventive policies and programmes before and during the second decade of life
- A programme of public education is needed to ensure that policy makers, practitioners, scientists, and the general public are made aware of the health and social benefits and cost savings from evidence-based preventive interventions
- Research is needed on how to most effectively take such evidence-based prevention interventions to scale, including research on how to build community capacity, identify local need, match need to efficacious prevention interventions, support and sustain these interventions, and learn what adaptations might be needed for programmes designed in high-income countries to be effective in low-income and middle-income countres
- An international agency such as WHO, UNICEF, or The World Bank should be encouraged to convene a guideline development group to identify broad behavioural health risks confronting adolescents, recommend preventive policies and programmes that have evidence of reducing these risks and promoting adolescent health, and advise on actions that countries should institute to take up and sustain a national programme to promote adolescent health
- Databases should be developed, including a database of community surveys that comprehensively measure structural and intermediate determinants and health and behaviour problems, and a database of efficacious preventive policies and programmes across behaviour problems and health outcomes, the structural and intermediate determinants they address, and their target populations

Table 1

Relevant risks and developmental period for illustrative preventive interventions by age group

	Pre-adolescence	Early adolescence (11–13 years)	Late adolescence (14–18 and 19–24 years)
Prevention policies			
Address structural risks	..	Access to contraceptives and increased tax on alcohol	Graduated driving and legal drinking age 21 years
Prevention programmes			
Address intermediate and individual risks			
Family and individual	Nurse Family Partnership (0–2 years), early childhood education (3–5 years), New Beginnings (9–12 years)	Functional Family Therapy, Strengthening Families Program (10–14 years)	Functional Family Therapy, Nurse Family Partnership (adolescent mother impact)
School and individual	Seattle Social Development Project (6–11 years)	Gatehouse Project	Conditional cash-transfer programmes
Peer and individual	Computer-based intervention (10–12 years)	Unplugged, Life Skills Training, Positive Training Through Holistic Social Programmes	Stepping Stones and Sistering, Informing, Healing, Loving and Empowering

Table 2

Prevention programmes with evidence of efficacy

	Programme	Target population (country)	Risk cluster	Study design	Number at baseline	Significant effects on outcomes
Policies that address structural risks						
Guldi 2008[33]	Access to contraception: legal access to oral contraception without parental involvement	Universal (USA); unmarried, white first-birth adolescents	Adolescent-onset risk	Quasi-experimental design	50 states	Access to oral contraception was associated with an 8·5% decrease in birth rates
Zavodny 2004[34]	Access to contraception: law requiring parental consent before contraceptives are provided to adolescents	Universal (USA)	Adolescent-onset risk	Quasi-experimental design	Four counties	Teen births rose 0·52 percentage points in the county requiring parental consent *vs* declines of 0·16 percentage points in comparison counties
Kearney and Levine 2009[35]	Access to contraception: financial aid expanding contraceptive access to low-income adolescents	Selective (USA); low-income adolescents	Adolescent-onset risk	Quasi-experimental design	50 states	Reduced birth rates in adolescents aged 15–19 years by 4·2%
Yang and Gaydos 2010[36]	Access to contraception: financial aid expanding contraceptive access to low-income adolescents	Selective (USA); low-income adolescents	Adolescent-onset risk	Quasi-experimental design	50 states	Reduced adolescent birth rate of 2·1 per 1000 female adolescents
Zabin et al 1986[37]	Access to contraception: school-based contraceptive services, counselling, and sexuality education	Selective (USA); low-income African-American students	Adolescent-onset risk	Randomised controlled trial	3646 young people	At the 28 month follow-up, the pregnancy rate in intervention schools declined by 30·1% *vs* an increase of 57·6% in control schools
Purshouse et al 2010,[38] Wagenaar et al 2009,[39] Elder et al 2010[40]	Increased taxes on alcohol	Universal (USA and UK)	..	Systematic reviews of multiple studies	Varies	Most studies identified that increased taxes were significantly associated with reduced consumption and alcohol-related harms
Wagenaar and Toomey 2002[41]	Minimum legal drinking age	Universal (Australia, Canada, and USA)	Adolescent-onset risk	Systematic reviews of multiple studies	Varies	11 of 33 studies found higher minimum legal drinking age was related to less drinking—one identified the opposite; 46 of 79 studies identified higher minimum legal drinking age was related to fewer traffic crashes—none found the opposite
Shope 2007,[42] Russell et al 2011[43]	Graduated licensing for teenage drivers: restrictions on the number of hours of driving before licensing, peer passengers, and driving at night	Universal (Canada and USA)	Adolescent-onset risk	Systematic review of 21 studies	Varies	Reduced car crashes in 16-year-olds by 5–73% (most by 19–39%)
Programmes that address family and individual risk						

	Programme	Target population (country)	Risk cluster	Study design	Number at baseline	Significant effects on outcomes
Olds et al 1988,[44] 1998,[45] and 2004[46]	Nurse-Family Partnership: a home visiting programme for first-time, low-income mothers and their children; trained nurses make regular home visits with structured content until children are age 2 years	Selective (USA); low-income first-time mothers	Early accumulated risk	Randomised controlled trial	Study 1=354 Study 2=1139	Study 1: women had 43% fewer subsequent pregnancies, delayed a subsequent pregnancy 12 months longer, less welfare use, fewer self-reported arrests (0.18 *vs* 0·58), and less smoking during pregnancy (25% fewer cigarettes); at age 15 years, children had fewer arrests (0·20 *vs* 0.45), convictions (0·09 *vs* 0·47), days drinking in past 6 months (1·09 *vs* 2.49), and lifetime sexual partners (0·92 *vs* 2.48) Study 2: mothers had fewer pregnancies and longer intervals between births; at age 6 years, children had improved cognitive development (ES=0·18) and fewer serious behaviour problems (OR=0·32)
Campbell et al 2002[47]	Abecedarian Project: full-day, year-round child care given 5 days a week for 5 years (from age 0–5 years with a structured curriculum)	Selective (USA); mixed sex, 98% African American, low-income	Early accumulated risk	Randomised controlled trial	111 young people	Intervention young people less likely to be a parents before age 20 years (26% *vs* 45%), more years of education by age 21 years (12·2 *vs* 11·6 years), more likely to be enrolled in a 4 year college (35·9% *vs* 13·7%), more likely to be in school at age 21 years (42% *vs* 20%), more likely to hold a better job (47% *vs* 27%), and less likely to report past-month marijuana (18% *vs* 39%)
Schweinhart et al 1993[48]	High/Scope Perry Preschool Program: social and cognitive development preschool programme lasting 1–2 years, 2·5 h daily from October to May; includes weekly home visits by teachers, monthly small group meetings of parents	Selective (USA); African American children aged 3–4 years from families living in poverty	Early accumulated risk	Randomised controlled trial	123 young people	Intervention young people had significantly better intelligence quotient scores at ages 5–7 years; better academic achievement at age 14 years; by age 19 years, higher high school grade point average (2·09 *vs* 1·68), fewer arrests (1·3 *vs* 2·3), fewer felony arrests (0·7 *vs* 2·0), and more employment (50% *vs* 32%); by age 27 years, less likely to have an adolescent pregnancy (68% *vs* 117%); higher high school graduation (71% *vs* 54%), higher earnings (29% *vs* 7%), less welfare use (15% *vs* 32%), fewer out-of-wedlock births (57% *vs* 83%), and fewer arrests (1·8 *vs* 4·0)
Reynolds et al 2001,[49] 2007,[50] and 2011[51]	Chicago Child–Parent Center program: early childhood programme including half-day preschool for children aged 3–4 years, half or full-day kindergarten, and full-day services for children aged 6–9 years	Selective (USA); aged 3–4 years, minority ethnic origin from low-income neighbourhoods	Early accumulated risk	Quasi-experimental design	1539 young people	At age 20 years, participants had better high school completion (49.7% *vs* 38·5%), more years education (10·6 *vs* 10·2), and fewer arrests (16·9% *vs* 25·1%), violent arrests (9·0% *vs* 15·3%), and school dropout rates (46.7% *vs* 55·0%); at age 24 years, greater school completion (71·4% *vs* 63.7%), attendance in 4 year colleges (14.7% *vs* 10·0%), years of education (11.7 *vs* 11.4), fewer felony arrests (16·5% *vs* 21·1%), felony convictions (15·8% *vs* 19·9%), and incarceration rates (20·6% *vs* 25·6%); at age 28 years, higher income (US$11 582 *vs* $10 796), occupational prestige (28·2% *vs* 21.4%), and less substance abuse (13.7% *vs* 18·9%), drug and alcohol abuse (16·5% *vs* 23·0%), arrests (47·9% *vs* 54·3%), felony arrests (19·3% *vs* 24·6%), and incarceration rates (15·2% *vs* 21·2%)

	Programme	Target population (country)	Risk cluster	Study design	Number at baseline	Significant effects on outcomes
Spoth et al 2001,[28] 2004,[52] and 2009[53]	Strengthening Families Program: 10–14 years, parent training programme for parents and adolescents including seven weekly 2 h sessions	Universal (USA); white young people aged 10–14 years from rural regions	Adolescent-onset risk	Randomised controlled trial	667 youth	At 4 years after intervention young people reported less initiation of alcohol use (24% reduction) and having been drunk (40·1% reduction); at 6 years after intervention young people had lower lifetime alcohol use, drunkenness, and less illicit drug misuse (OR=2·34)
Schinke et al 2004[54] and Schwinn and Schinke 2010[55]	Computer-based intervention: ten-session social-cognitive programme delivered via CD-ROM; a parent programme includes a video, two newsletters, a 2 h in-person workshop, and a self-administered CD-ROM	Universal (USA); young people aged 10–12 years, 54% African American, 30% Hispanic, 11% white	Adolescent-onset risk	Randomised controlled trial with three conditions: CD-ROM self-instruction, CD-ROM and parent training, and a control condition	514 young people and their parents	At 6 year follow-up[55] (age 17 years), young people in both intervention groups had less past-month smoking (ES=0·23), drinking (ES=0·29), and heavy drinking (ES=0·19); young people in the CD-ROM plus parent group had less smoking *vs* the CD-ROM-only group (ES=0·40)
Wolchik et al 2002[56]	New Beginnings: mothers receive 11 group and two individual sessions to improve mother–child relationships, effective discipline, and interparental conflict; children receive 11 group sessions to decrease negative thoughts, improve mother–child relationships, and increase coping skills	Selective (USA); recently divorced families with children aged 9–12 years, 89% white	Adolescent-accumulated risk	Randomised controlled trial	83	At 6 years after, intervention youth reported fewer externalizing problems (−0·11 *vs* 0·08) and fewer sexual partners (0·65 *vs* 1·68); control group young people had had 2·83-times higher odds of being diagnosed with any mental health or substance-misuse disorder
Klein et al 1977[57]	Functional Family Therapy: intensive family therapy for high-risk young people; 8–12 sessions on parenting skills, family bonding, and accessing resources	Indicated and selective (USA)	Adolescent-accumulated risk	Randomised controlled trial	46 siblings of young people convicted of minor offenses	At 2·5–3–5 year follow-up, 20% of the siblings of intervention young people were involved with the juvenile justice system *vs* 40–63% of the siblings of comparison young people
Programmes that address school and individual risks*						
Hawkins et al 1999,[31] 2005,[58] and 2008,[59] and Lonczak et al 2002[60]	Seattle Social Development Project: school and family programme for grades 1–6; includes teacher training in proactive classroom management, interactive teaching and cooperative learning; cognitive and social skills curriculum for students; and parent training in child management, academic development, and drug prevention strategies	Selective (USA); students in high-crime neighbourhoods of an urban city 44% white, 26% African American, 22% Asian American, 5% Native American	Early accumulated risk	Quasi-experimental design with three conditions: full—intervention in grades 1–6; late—intervention in grades 5–6 only, and no intervention	643 young people	At age 18 years, full group had less violence (48·3% *vs* 59.7%) and heavy drinking (15.4% *vs* 25·0%), higher grade point average (2.42 *vs* 2·18), less likely to repeat a grade (14·10% *vs* 22·80%), to engage in intercourse (83·0% *vs* 71·2%), and to be pregnant or cause a pregnancy (26.4% *vs* 17·1%); at age 21 years, full group more likely to have delayed age at first intercourse (16·3 *vs* 15·8 years) and to use condoms (60% *vs* 44%), fewer sex partners (3·6 *vs* 4·1), less likely to have a court charge (42% *vs* 53%), less likely to have sold drugs (4% *vs* 13%), and more likely to graduate from

	Programme	Target population (country)	Risk cluster	Study design	Number at baseline	Significant effects on outcomes
						high school (91% *vs* 81%); at age 27 years, the full group had better educational and economic attainment (ES=0·28), less likely diagnosed with a mental disorder (15% *vs* 26%) or sexually transmitted disease (23% *vs* 35%)
Patton et al 2006[61] and Bond et al 2004[62]	Gatehouse Project: 2 year, 8 week school curriculum to build social, problem-solving, and coping skills; school-level and classroom-level changes to promote inclusion; and community-school links	Universal (Australia); students in grade 8, 87% born in Australia	Adolescent-onset risk	Cluster-randomised trial: 25 schools	2545 young people	At 4 years after, intervention students were less likely to report initiation of sexual intercourse (OR=0·55), initiation of risky behaviours (OR=0·71), and regular smoking (OR=0·66)
Baird et al 2010[63]	Zomba Cash Transfer Program: payment of school fees and cash transfers (average of US$10 per month) conditional on regular school attendance	Universal (Malawi); girls and women aged 13–23 years in school or recent dropouts	Adolescent-onset risk	Randomised controlled trial	3805 young people	At 1 year follow-up, recent dropouts were more likely to return to school (61·4% *vs* 17·2%) and have better school retention (93% *vs* 89%); of those out of school at baseline, the rates of getting married and becoming pregnant were lower (41% and 31%)
Duflo et al 2006[64]	Conditional cash transfer: free school uniforms (value US$6) given to students	Universal (Kenya); students in grade 6, age 14 years	Adolescent-onset risk	Randomised controlled trial: 328 primary schools	about 74 000 young people	At the 3 year follow-up, intervention girls 13% less likely to have ever had sexual intercourse and 15% less likely to have dropped out of school; intervention boys were 15% less likely to have dropped out of school and 40% less likely to be married
Programmes that address peer and individual risk						
Faggiano et al 2010[65]	Unplugged: 12 h school curriculum on improving students' goal-setting, decision-making, and drug refusal skills	Universal (seven European countries); students in grades 7–9	Adolescent-onset risk	Randomised controlled trial	170 schools, 7079 students	At 15 month follow-up, effects on any drunkenness (prevalence OR=0·80), frequent drunkenness (prevalence OR=0·62), and frequent past-month cannabis use (prevalence OR=0·74)
Botvin et al 2006[66] and Griffin et al 2004[67]	Life Skills Training: 3 year school curriculum on decision making, goal setting, anger management, communication, stress reduction, pressure to misuse drugs, and drug misuse consequences	Universal (USA); urban and suburban students; multiple ethnic origin	Adolescent-onset risk	Randomised controlled trial	Study 1: 5954 grade 6 students Study 2: 758 grade 6 students	Study 1: At 6 years after, reduced pack-a-day smoking (by 25%), binge drinking (by 50%), and illicit drugs (up to 50%) Study 2: At 1 year after, high-risk participants reported less drinking (ES=0·22), smoking (ES=0·22), and polydrug use (ES=0·21)
Shek and Ma 2011[68] and Shek and Yu 2011[69]	Positive Adolescent Training through Holistic Social Programs: school curriculum on emotional literacy, self-control, social competence, peer relations, and problem-solving skills	Universal (Hong Kong); students in grade 7–9	Adolescent-onset risk	Randomised controlled trial	7846 students in grades 7–9	At 3 years after, participants had better positive development (eg, psychosocial competencies and positive self-identity; ES=0·1) and lower levels of risk behaviour (eg, substance misuse and delinquency; ES=0·35–0·96)
Jewkes et al 2008[70]	Stepping Stones: 13 3-h single-sex group meetings,	Universal (South Africa); aged	Adolescent-onset risk	Cluster-randomised trial	2776 young people	At 2 year follow-up, there were significant intervention effects

	Programme	Target population (country)	Risk cluster	Study design	Number at baseline	Significant effects on outcomes
	three 3 h mixed-sex group meetings, and 1 community meeting to reduce risky sex	15–26 years				for incidence of herpes simplex virus 2 (relative risk=0·67) and past-year physical or sexual intimate partner violence for males (adjusted OR=0·62)
DiClemente et al 2005[71]	Sistering, Informing, Healing, Loving and Empowering: 16 h groups on pride of ethnic origin and sex, HIV risk reduction, and healthy relationships	Selective (USA); sexually experienced African American girls 14–18 years	Adolescent-onset risk	Randomised controlled trial	522	At 12 months after, more consistent use of condoms in the past 6 months (OR=2·30), more condom use during last sex (OR=3·94), fewer new vaginal partners in the previous month (OR=0·40), and fewer chlamydia infections (OR=0·17)

The full version of this table is in the appendix. ES=effect size. OR=odds ratio. K=kindergarten, generally before year 1.

* Grade refers to year in school.

Table 3

Cost–benefit of selected programmes

	Benefits	Cost*	Benefit minus cost	Benefit per dollar cost
Nurse–Family Partnership	$30 325	$9421	$20 905	$3·23
Chicago Child-Parent Centers	$39 160	$8124	$31 036	$4·82
Strengthening Families Program for Parents and Youth 10–14 (SFP 10–14)	$6656	$851	$5805	$7·82
Functional Family Therapy	$37 739	$3190	$34 549	$11·86
Seattle Social Development Project	$6237	$2959	$3279	$2·11
Life Skills Training	$1415	$34	$1382	$42·13

* Cost estimates are per participant, based on 2003 US$ for SFP 10–14; 2007 $ for the Chicago Child–Parent Centers; and 2010 US$ for all other interventions.[13]