



Review article

Implications of Science for Illicit Drug Use Policies for Adolescents in Low- and Middle-Income Countries

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 A B S T R A C T

Advances in neuroscience have improved our knowledge of the impact of illicit drug use on the adolescent brain. Translating this new knowledge into improved policies and programs requires the participation of public health and social sciences. This article discusses the implications of the recent advances of neurobiology for policies especially as they pertain to adolescents in low- and middle-income countries. It includes an overview of adolescent use of illicit drugs in low- and middle-income countries and calls for a move toward a transdisciplinary approach. It presents some of the challenges for research aimed at increasing our understanding of the issue and for policy.

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Addiction to illicit drugs is a substance use disorder that often takes root during the adolescent years and affects individuals in high-income countries as well as those in low- and middle-income countries (LMICs). A consistent pattern in the age of onset of substance use disorders has been documented, with a rapid increase in onset during late adolescence and early adulthood [9]. The developmental processes as well as the events and environments of adolescence likely shape later risk of developing such problems. There is evidence that early initiation increases the risk of dependence [4].

Recent advances in the neurobiology of addiction have expanded our understanding of the effects of illicit drugs on the human brain and in particular on the adolescent brain. Furthermore, research on the interplay between mental health disorders and substance use disorders has indicated opportunities for intervention. Although this new knowledge has the potential to improve prevention and treatment, translating these scientific advances into better policies requires collaboration and dialogue between the social sciences and the biological sciences.

This article discusses the implications of the recent advances in the neurobiology of addiction for policies relating to

adolescent addiction especially as they pertain to LMICs. It is introduced by a brief overview of the adolescent use of illicit drugs in LMICs followed by a discussion of how advances in both neurobiology and mental health research pertain to adolescents in low-resource settings.

Illicit Drugs and Adolescents in Low- and Middle-Income Countries

Despite global variations in rates of illicit substance use, the World Mental Health Survey Initiative indicates that substance dependence and abuse are problems in both high- and low-income countries. Although the highest rates are found in high-income countries such as the United States and New Zealand [11,16], relatively high rates are also found in selected middle-income countries in various geographic regions. In South Africa, the rate of substance abuse is 3.9% and the rate of substance dependence is 0.6% [8]. Substance abuse is less prevalent in Mexico at 2.7%, but the rate of dependence is 0.8% [13].

Although LMICs have lower rates of illicit drug use, individuals with substance abuse problems experience higher mortality and are less likely to receive treatment than their counterparts in high-income countries. A review of mortality rates of opioid users found that individuals in lower income countries had higher crude mortality rates than those in higher income

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countries, although few studies in LMICs were identified [5]. According to the World Mental Health Survey in the United States, more than half of individuals with substance dependence received treatment [11], whereas in Mexico only 17% received treatment [15]. Furthermore, during the first year of onset of substance abuse disorders, only 2.8% received treatment in Nigeria and China and only 0.9% in Mexico [22].

High rates of illicit drug use among adolescents in LMICs have been documented, with estimates ranging from 5.2% of 12 to 17 year olds in Mexico City [3] to 10.5% of 13- to 15-year-old students in sub-Saharan Africa [18]. Although the methods and definitions used in deriving such estimates vary, the magnitude of such figures is cause for concern. Illicit drug use among adolescents contributes to serious health consequences. Among individuals ages 15 to 24, 2% of the global disability-adjusted life-years (DALYs) are attributable to illicit drug use. The only risk factors that are responsible for a greater share of DALYs are alcohol use, which accounts for 8% of DALYs, and unsafe sex, which accounts for 5% of DALYs [7].

Among adolescents in developing countries illicit drug use is associated with numerous other risk behaviors and risk factors, which may either contribute to or be the result of the drug use. A study of adolescents in three Central American countries found that problems with drugs were associated with risk factors including family drug use, school disengagement, peer deviance, and exposure to violence [12]. Adolescents who use illicit drugs have been shown in a variety of LMICs to be at increased risk of tobacco and alcohol use [6,18]. Understanding the association between these risk factors and illicit drug use can be challenging because many data sets are cross-sectional and cannot establish temporality between risk factors and the onset of substance use. In Mexico, the median age of onset for drug use disorders is 17 years, whereas the age of onset for alcohol and nicotine dependence is 25 years [14], suggesting in conjunction with studies that show clustering of illicit drug use with alcohol and tobacco use that early initiation of illicit drug use may lead to subsequent alcohol and tobacco problems. An increased understanding of the neurobiology of addiction in adolescents may contribute to further untangling the mechanisms of risk and protective factors and identifying effective points of intervention.

Neurobiology of Addiction and Mental Health in Adolescents

Understanding the neurobiological mechanisms of addiction in adolescents can strengthen our understanding of why they are particularly susceptible to addiction and indicate how to intervene. Early initiation of use of substances, such as tobacco, has been shown to increase the probability of reinitiating use later on in adulthood in both animal models [1] and in studies with humans [14]. The same pattern is likely applicable to use of illicit substances, indicating the importance of addressing substance use during the adolescent years to reduce the risk of later addictions.

Potenza [19] gives an overview of the current research on the neurobiological mechanisms of addiction, which are important in explaining adolescent vulnerability to addiction. One mechanism of addiction that Potenza describes is the process of deciding between immediate rewards and long-term goals, such as the completion of education, which occurs in the prefrontal cortical brain regions. This is particularly relevant for adolescents as development of this region of the brain continues into the teen

years and explains in part why they may be more likely than older adults to choose the short-term rewards, such as a drug-induced high, over long-term goals. Furthermore, the cycle of increased impulsivity following initial exposure to substances can lead to increased chances of developing an addiction, further emphasizing the importance of delaying initial exposure to addictive substances.

Comorbidity between substance abuse disorders and other mental health disorders further complicates prevention and treatment approaches [17]. The increased risk of developing drug dependence when mental health disorders pre-exist suggests that treating mental disorders at an early age may be an important prevention strategy. Kessler et al. [10] estimated the effects of mental disorders in predicting the subsequent first onset of drug use problems and dependence and found that the odds ratios for effects on dependence ranged from 3.3 and 14 for anxiety disorders and between 4.4 and 18.6 for mood disorders. The ages of onset for primary mental disorder and subsequent drug dependence show a window of opportunity for preventive interventions. A period of between 5 and 8 years after the onset of the primary mental disorder and the onset of the secondary drug use disorder was observed for most mental disorders. Mental disorders were associated with half of all drug dependence (54% among men and 48% among women).

Improvements in our understanding of the neurobiology of addiction as well as an increased awareness of the connections between mental health disorders and substance use problems are highly relevant for adolescents. The window of opportunity between the onset of mental health disorders and substance use problems will occur during adolescents for many individuals. To effectively reach all adolescents including high-risk individuals with mental health disorders, interventions that take into account what is known about the neurobiology of addiction are needed.

Recommendations for Policies and Programs

An increased understanding of how illicit substance use affects the adolescent brain should inform policies in LMICs. Addressing addiction in the adolescent years involves not only treatment, but also a large focus on prevention, both of which can be informed by advances in research. Neglecting to acknowledge the neurobiological realities may result in scarce resources wasted on failed treatment and prevention programs.

Patterns of illicit drug use vary widely among countries and are important in determining how to design effective responses to the problem. For example, in Africa the majority of treatment demand is accounted for by cannabis, whereas in Asia opioids dominate treatment demand and in South America cocaine is most prominent [21]. Despite variation in specific responses, correlates of illicit substance use in LMICs indicate that effective programs should focus on multiple contexts, including individual, family, school, and community [3,12,18]. Although studies from the social sciences have indicated *where* to intervene, research in the biomedical sciences can help identify *how* to intervene.

Although a review conducted by Barbor et al. [2] suggests that some drug prevention programs work, there is strong evidence that many programs have not been effective, and in particular many non-science-based programs have failed to achieve their desired results. The improved understanding of the underlying mechanisms in the brain that explain the development of dependence brings the possibility of developing efficient drug therapies that could prevent addictive substances from reaching

the brain and producing their effects. Although animal models have been more successful than clinical studies with humans, this is an important area for future research. While the neurobiology of addiction is directly applicable to the development of effective pharmacotherapeutic treatments, this approach to treating addiction is not always easily implemented in low-resource settings. However, the neurobiological mechanisms can also inform behavioral interventions. Romer and Hennessy [20] recommend physical exercise interventions as a way to delay or prevent initiation of substance use. Physical exercise may provide an outlet for the sensation seeking impulses that are not yet fully tempered by the less developed prefrontal cortex of adolescents.

Beyond the design of effective interventions, having a strong understanding of the neurobiological mechanisms can help justify the importance of targeting prevention efforts in adolescent years. Showing that interventions are well-informed and based on knowledge of these neurobiological pathways may further encourage policy makers that the proposed solutions will reduce the burden of adolescent use of illicit substances.

The review of neurobiological mechanisms of addiction [19] as well as the article on the comorbidities of mental health disorders and drug use [17] in this volume highlight the recent scientific advances in the field of addiction. Although the manifestation of problems associated with illicit drug use varies across countries and within different subpopulations, certain lessons can be learned from these advances and applied to the prevention and treatment of addiction for adolescents in LMICs. Major factors relating to the risk of developing substance use disorders are sociocultural and include exposure to violence, social tolerance of drugs, and drug availability. These advances in neurobiology and mental health point to the importance of integrating social sciences and biological sciences while moving from a multidisciplinary approach to a transdisciplinary approach in order to most effectively improve health outcomes for adolescents.

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