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## Commentary

## Adolescent Risk-Taking, Cancer Risk, and Life Course Approaches to Prevention

 John S. Santelli, M.D., M.P.H.<sup>a,\*</sup>, Kavita Sivaramakrishnan, Ph.D.<sup>a</sup>, Zoe R. Edelstein, Ph.D.<sup>a,b</sup>,  
 and Linda P. Fried, M.D., M.P.H.<sup>a</sup>
<sup>a</sup> Mailman School of Public Health, Columbia University, New York, New York<sup>b</sup> HIV Center for Clinical and Behavioral Studies, Columbia University, New York, New York
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## A B S T R A C T

Adolescent risk-taking may have long-term consequences for adult cancer risk. Behaviors such as smoking and sexual activity, commonly initiated during adolescence, may result—decades later—in cancer. Life course epidemiology focuses on unique vulnerabilities at specific development periods and their importance to later development of disease. A life course epidemiological perspective that integrates social and biological risk processes can help frame our understanding how specific adult cancers develop. Moreover, life course perspectives augment traditional public health approaches to prevention by emphasizing the importance of unique windows of opportunity for prevention.

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Adolescence is characterized by exploration, experimentation, and—from the viewpoint of adults—risk-taking. When manifest as health-risk behaviors, such risk-taking can have serious short- and long-term adverse health consequences. Health-risk behaviors, which include smoking, substance abuse, aggression, and early sexual activity, also show significant clustering and covariation [1,2]. Involvement in behaviors such as smoking and sexual activity rises rapidly in early adolescence beginning about age 12 [3,4]. For example, 80% of adult smokers initiate smoking before age 18 and virtually none after age 25 [4]; similarly, 58% of young people initiate sex before 18, 77% before age 20, and more than 90% before age 25 [3]. Importantly, smoking and risky sexual behaviors such as having multiple partners frequently persist into adulthood. This adolescent period of behavior initiation is relatively universal across nations and cultural groups, even if cultural values and pressures shift the average age of initiation by a year or two [5].

Adolescent risk behaviors are the result of a complex combination of social, genetic, and developmental factors [2,6], characterized by an underlying propensity for risk taking that involves high sensation seeking and immature self-regulation [7]. Given the covariation in adolescent risk-taking, comprehensive interventions for young people are recommended. These interventions target multiple risk behaviors by enhancing resiliency, life circumstances, and life skills rather than through programs that target risk behaviors one at a time [8,9]. It is important to note that, although health professionals often focus on the negative consequences of adolescent risk-taking, being a risk taker may also have positive consequences, particularly from the viewpoint of evolutionary survival [10]. Witness Bill Gates and Steve Jobs who, from adolescence onward challenged the status quo.

From a life course epidemiologic perspective, adolescence is a critical period in the development of health and disease processes. Life course epidemiology—still a relatively young field—is concerned with earlier precursors (risk factors) for later adverse health outcomes, outcomes whose precursors are often poorly understood initially because they occurred many years earlier [11,12]. Key concepts in life course epidemiology include critical periods of vulnerability, latency between exposure and outcome, and resiliency in the face of adverse exposures. Life course epidemiology also considers accumulation of risk

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\* Address correspondence to: John S. Santelli, M.D., M.P.H., Harriet and Robert H. Heilbrunn Professor, Chair, Heilbrunn Department of Population and Family Health, Mailman School of Public Health, Columbia University, 60 Haven Avenue, B2, New York, NY 10032.

E-mail address: [js2637@columbia.edu](mailto:js2637@columbia.edu) (J.S. Santelli).

exposures over time, dose-response, clustering of exposures, and the potential for chains of risk [11].

Figure 1 places adolescence and risk of cancer within the life course epidemiological perspective of periods of exposure, latency, and disease outcomes. As the figure shows, often considerable time elapses between a carcinogenic exposure and clinical disease. For example, the latency periods between starting to smoke and lung cancer or between acquiring an oncogenic strain of human papillomavirus (HPV) infection and cancer are measured in years and decades. Exposures may also have a complex relationship with time (e.g., cumulative or progressive). They may also be multifactorial, such as the impact of smoking and socioeconomic status on adult cardiovascular disease outcomes. Furthermore, although this special issue of the *Journal of Adolescent Health* focuses on adolescent behaviors that increase risk for cancer in adulthood, from a life course perspective, adolescence is both a period of exposure to health risk factors for cancer and a period in which health outcomes from prenatal or early life exposures can manifest as cancer (e.g., the impact of in utero exposure to diethylstilbestrol on adenocarcinoma of the vagina) [13].

From a life course perspective, there are unique vulnerabilities at specific developmental periods that have dramatic importance for later health outcomes [11,12]. Vulnerability is defined by sensitive periods in which the effect of an exposure is greatly magnified. Therefore, if life course and developmental perspectives are combined, adolescence can be seen as a period of high vulnerability with multiple transformations occurring simultaneously: biological growth, development in multiple organ systems (including the brain and reproductive organs), increased receptivity to social influences beyond the family, and initiation of multiple health risk behaviors. Perhaps the most obvious vulnerability—and the one most amenable to public health interventions—is the initiation of health risk behaviors. Notably, adolescents who initiate sexual intercourse and smoking earlier than their peers also report increased involvement in risk behaviors as young adults [14,15]. Adult women reporting early initiation of smoking (earlier than their peers)

also report greater sexual risk-taking and more adverse reproductive health outcomes [15]. Initiation of tobacco use, because of its addictive qualities, often results in persistent use throughout adulthood. Moreover, use of certain gateway drugs (tobacco and alcohol) during adolescence may lead to use of other drugs such as cocaine or opiates [16]. Recent research shed light on one potential mechanism that leads adolescents from smoking to other drug use: nicotine may prime the developing adolescent brain to later use of cocaine, providing a molecular basis for the gateway hypothesis and reinforcing the importance of early adolescent vulnerability [17].

Life course perspectives on health are supported by cohort and case-control studies that are increasingly specific about period of exposure and that connect distant exposures with contemporary disease outcomes. Distal social factors, for instance, have complex and multiple implications that emerge through multiple pathways. Furthermore, life course cohorts are also affected by historical context and risk factors may operate differently over time and across societies and social groups, given differing social values and practices and changing exposures to technology. Therefore, the interaction between the period and cohort effects may have important implications for secular growth trends such as the changing age of girls at menarche. Given this complexity, when an exposure and vulnerable period are identified, further investigations of the risk factors for the exposure and strategies to prevent exposure within a critical period are often warranted.

From a public health perspective, periods of exposure and vulnerability are critical because they are windows of opportunity to prevent disease. However, our review of the life course epidemiology literature suggested that the vulnerability of adolescents in utero and during early childhood. We have perhaps only scratched the surface in identifying exposures during adolescence that are important to cancer and other health outcomes.

This special issue of the *Journal of Adolescent Health* on opportunities for cancer prevention during pre-adolescence and adolescence reviews research on health-risk behaviors (e.g.,

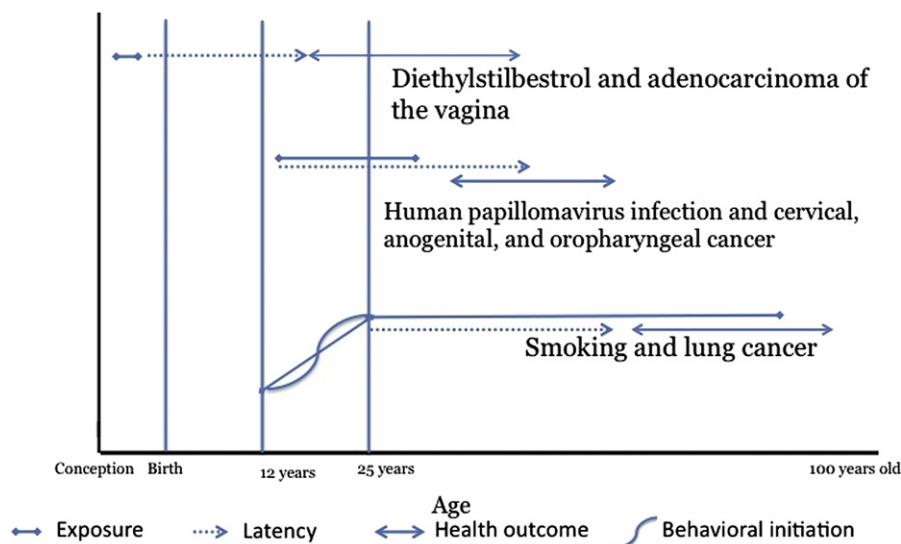


Figure 1. Adolescence and cancer risk from a life course perspective.

smoking, indoor tanning, sexual activity) that are commonly initiated during the teenage years and that have importance for adult risk for cancers (e.g., lung, skin, reproductive, oropharyngeal). From a life course epidemiology perspective, these articles examine exposures during critical, and potentially vulnerable, periods and offer insights for primary prevention.

Dube and colleagues [18] explore the susceptibility of U.S. middle and high school students to tobacco advertising in various media. Advertising was associated with young people's susceptibility to smoking, even after controlling for two other well-known influences on tobacco use: peer and parental smoking. Regulation of such advertising is an obvious public health response.

Holman and Watson [19] examine the correlates of intentional tanning among adolescents and preadolescents aged 8–18 years in the United States, given the importance of this behavior for skin cancer risk. Intentional tanning is correlated with individual factors (female sex, older age), participation in other health risk behaviors, social factors (parental and peer tanning and parental permission to tan), and environmental factors such as proximity to tanning facilities. This research suggests the vulnerability of young people to social and environmental influences. On the basis of their review, the authors suggest regulatory and environmental approaches that may be effective in preventing skin cancer risk.

The articles by Thomas et al. [20] and Morales-Campos et al. [21] address barriers to HPV vaccination in populations where uptake is low and HPV-related cancer rates are more common.

In 2006, to prevent cervical cancer, the Food and Drug Administration approved the quadrivalent HPV vaccine for adolescent and young adult women, and the Advisory Committee on Immunization Practices (ACIP) recommended that the three-dose series be routinely administered to 11- to 12-year-old girls with catch-up for young women up to 26 years old. In 2008, the quadrivalent vaccine was also approved for protection against vulvar and vaginal cancer, and in 2010 it was approved for protection against male and female anal cancer. In 2009, the bivalent vaccine was approved for prevention of cervical cancer.

Vaccination against HPV during adolescence prevents cancer; it is safe and efficacious, and as such, changes the natural history of HPV-related cancers. However, national surveys suggest that less than a quarter of female adolescent and young women are following the ACIP's recommendations [22–24]. The National Immunization Survey-Teen estimated that in 2011 53% of females aged 13 to 17 had one dose of the HPV vaccine and 35% had the recommended three doses. Only 9% of adolescent males had initiated the vaccine series in 2011, following the ACIP guidance in 2009 that males 9 to 26 years of age could be vaccinated.

Unfortunately, there continue to be significant barriers to HPV vaccine uptake. In fact, because HPV is an STI, as Morales-Campos et al. found, some parents feel that vaccination against HPV will alter their child's life course negatively by condoning sexual risk-taking. The Thomas et al. and Morales-Campos et al. articles suggest that it is important for health care providers and health *promotoras* to give parents medical information that might surmount barriers to vaccination. Such information should include emphasizing the benefits of the HPV vaccine for cancer prevention, assuring them of the vaccination's safety, and noting that there is no evidence of an association between HPV vaccination and risky sexual behavior [25].

Why are life course perspectives on cancer risk important for adolescents? From a public health viewpoint, focusing on

precursors is essential for primary prevention. From a scientific viewpoint, it is critical to base primary prevention practices on a specific understanding of disease processes and vulnerable periods, particularly when risk factors and outcomes are separated widely in time. Finally, in an increasingly antiscience political sphere, it becomes important to communicate scientific information to the public in simple and understandable terms. Cancer prevention faces significant challenges in translating scientific information for the public and disseminating it to the public. Public health scientists need to build scientific communication expertise and to understand the popular norms and values that challenge the uptake of research findings.

Approaches to prevention for cancer that originate during adolescence should be based on prevention science. The National Prevention Strategy, whose development was led by the U.S. Surgeon General, focuses on healthy and safe community environments; clinical and community preventive services, including vaccination; empowering people; and eliminating health disparities. Two safe and highly effective vaccines are available to prevent primary infection with HPV, which can lead to cancer; these vaccines cover the oncogenic HPV strains that result in most HPV-related cancers of the cervix, penis, anus, and oropharynx [26]. Thus, efforts to prevent HPV-related cancer in today's adolescents have shifted toward addressing parental and provider acceptance of the HPV vaccine. In addition to parental and provider education, use of new technologies such as text messaging may be an important method to increase adherence to the multiple-dose vaccination schedules.

To reduce tobacco-related cancers and skin cancer, we need a combination of strategies to empower young people to adopt healthful behaviors. Individual behavior change for primary prevention remains a major challenge to reducing adolescents' health-risk behaviors, although the complexity of behavior change is better understood today than 25+ years ago as a result of efforts to prevent HIV infection. Risk reduction approaches, including increased awareness, health education, and specific risk reduction programs show promise, as do programs to promote young people's resiliency [27].

However, focusing on changing individual behavior is generally less successful than focusing on structural change within community environments. For example, school mandates are among the most effective approaches to increasing vaccine uptake. Structural changes that reduce financial and health system barriers to vaccination are also essential. Effective structural approaches to reduce smoking among young people include taxing tobacco products, regulating tobacco sales and advertising, and countering tobacco company advertising. Although many approaches to cancer prevention during adolescence are likely to be effective, no single strategy will be sufficient.

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