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The Changing Face of Tobacco Use Among United States Youth

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Abstract

Tobacco use, primarily in the form of cigarettes, is the leading cause of preventable morbidity and mortality in the United States (U.S.). The adverse effects of tobacco use began to be recognized in the 1940's and new hazards of active smoking and secondhand smoke (SHS) exposure from cigarettes continue to be identified to this day. This has led to a sustained and wide-ranging array of highly effective regulatory, public health, and clinical efforts that have been informed by extensive scientific data, resulting in marked decreases in the use of cigarettes. Unfortunately, the dramatic recent decline in cigarette use in the U.S., has been accompanied by an upsurge in adolescent and young adult use of new, non-cigarette tobacco and nicotine-delivery products, commonly referred to as alternative tobacco products (ATPs). Commonly used ATPs include hookah, cigars, smokeless tobacco, and electronic cigarettes. While there have been a number of review articles that focus on adult ATP use, the purpose of this review is to provide an overview of what is, and is not known about emerging ATP use among U.S. adolescents on a national scale; as well as to identify research gaps in knowledge, and discuss future health and policy needs for this growing public health concern. This paper is not meant to systemically review all published survey data, but to present clear depiction of selected ATP usage in youth populations using national survey data.

Keywords

Adolescents; alternative tobacco products; nicotine; tobacco; youth

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CONFLICT OF INTERESTS

The authors have no financial or other conflicts to declare.

1. INTRODUCTION

1.1. Alternative Tobacco Products and Adolescents in the U.S

Deleterious health consequences from the use of traditional cigarettes were first documented in the 1940's [1]. Despite the continued growth of data on the detrimental effects associated with first- and secondhand smoke (SHS) exposure, tobacco use has been documented as the leading cause of preventable morbidity and mortality in the U.S. [2]. The massive compilation of scientific data on traditional cigarettes has demonstrated that they are a causal factor in many disease states. Subsequently, exceedingly effective regulatory, public health, and clinical efforts have been developed and led to the attenuation in the U.S. of overall adult (18-years-old) consumption of cigarettes and all regulated combustible tobacco products in the past decade [3]. Regrettably, the marked decline in cigarette use has been accompanied by a relatively recent increase in adolescent (i.e., 11–18-years-old) and young adult (i.e., 18–25-years-of-age) use of new and emerging alternative tobacco products (ATPs) [4]. Many different types of ATPs exist, some of which are smoked (combustible tobacco), others that are smokeless, while still others reflect heat not burn products. Whereas the total consumption of cigarettes in the U.S. has decreased 33% between 2000 and 2011, the consumption of non-cigarette combustible tobacco products, overall has increased an alarming 123% over the same time period [3]. Use of many ATP types among adolescents is increasing due to a variety of influences, including: increased availability; widespread unsubstantiated perception of safety [4–5]; lack of or non-implemented regulations surrounding their use [6–7]; reduced cost and easy accessibility; and, attractive smell and taste [8].

Virtually all cigarette use in the U.S. begins during adolescence or young adulthood with experimentation frequently leading to dependence [9–10]. Of every three young cigarette smokers, one will quit, while one of the remaining smokers will die of a tobacco-related cause [9]. However, in contrast to our extensive knowledge regarding adolescent cigarette use, there is a marked paucity of research concerning the epidemiology and health effects of adolescent ATP usage. Such a gap hinders the development and implementation of generic- or product-specific policies, as well as intervention strategies that may or may not need to be implemented.

While existing review articles focus on adult ATP use [11–18], the intent of this paper is to provide a concise overview of what is, and is not known about current and emerging ATP use (i.e., hookahs (water pipes), cigarillos, little cigars, bidis, kreteks, smokeless tobacco, and electronic cigarettes) among U.S. adolescents based on national survey data from most prevalent (hookah) to least prevalent (bidis). This paper does not attempt to provide a comprehensive review of all available survey data, but rather to clearly frame the national prevalence of selected ATP usage, the concerns they pose for adolescents, and future public health directions. Below Table 1 provides the definitions of the products in this paper.

2. BACKGROUND

2.1. Hookah

Hookah (or waterpipe) shisha (tobacco or non-tobacco herbal, combustible materials used to smoke hookahs) use in the U.S. has increased dramatically over the past two decades [19], due, in part, to the increased immigration of Middle Eastern and South Asian populations, where hookah smoking originated [20–21]; presently, South Asians are the second largest and most rapidly growing Asian subgroup in the U.S. [20]. Middle Eastern immigrants, most of whom have retained their use of hookah as part of their cultural identity, also have grown dramatically in the past 50 years [21–23]. Although little is known about the diffusion of hookah use to other racial/ethnic groups in the U.S., its use nationwide is rapidly increasing (particularly, in urban areas), while regulations for use are limited [24–27]. The “head” of a hookah is filled with moistened shisha upon which a lit piece of charcoal is placed (separated from the shisha by punctured aluminum foil) [24]. The smoker inhales through a hose (plastic or leather) attached to the hookah side, and the charcoal heats the tobacco producing smoke that travels through the “body” of the hookah (which is filled with water), and then released through the hose mouthpiece [24, 28].

2.2. Electronic Cigarettes (E-Cigarettes)

Electronic cigarettes, known commonly as “e-cigs”, recently entered the U.S. market in a big way. While they are not a tobacco product they will be considered here as they represent a widely used alternative “smoking” product. Because they can be used in places where tobacco smoking is banned, e-cigarettes fit an important gap for smokers [9]. The FDA initially gained jurisdiction over e-cigarettes in 2010 as drug-delivery devices. However, after an e-cigarette manufacturer filed a lawsuit against the FDA, the U.S. Court of Appeals determined that e-cigarettes fell into this category only if they were marketed for therapeutic purposes, and could only be regulated under the 2009 Family Smoking Prevention and Tobacco Control Act (TCA), if they met the definition of a tobacco product [29]. Thus, e-cigarettes, not marketed for therapeutic purposes, are currently unregulated by the Food and Drug Administration (FDA), and as state regulations for e-cigarettes are uncommon, the product remains easily accessible to minors [30]. On April 24, 2014 the FDA proposed a new rule that would extend their authority to cover e-cigarettes under the TCA [31]. The proposal, if passed, would include banning the sale of e-cigarettes to minors and the distribution of free samples, as well as requiring manufacturers to register their products with the FDA. While health and incidence data on the use of these nicotine delivery devices is limited, available information indicates that usage is quickly increasing among adolescents in the U.S.

2.3. Cigars

The tobacco in a cigar is wrapped in leaf tobacco or any substance that contains tobacco (as opposed to a cigarette, which is defined as a roll of tobacco wrapped in paper or in a substance that does not contain tobacco) [32], and typically contains at least one-half ounce of aged, fermented tobacco (equivalent to a pack of cigarettes) and usually takes ~1–2 hours to smoke [33]. In contrast, little cigars (similar in size to a cigarette with a filter) and cigarillos (short [3–4 in] narrow cigars that typically contains ~3 g of tobacco without a

filter) [32] look similar to cigarettes and are even more appealing than cigars to adolescents and young adults [34], possibly because of the variety of flavors available. A recent report by the Centers for Disease Control and Prevention (CDC) indicated that overall use of loose tobacco (e.g., bagged tobacco for rolling your own cigarettes) and cigars have increased dramatically from 3% in 2000 to 10% in 2011 [3], creating great concern, as adolescents have higher rates of cigar use than adults [9]. Unfortunately, the current definition of cigars has allowed for gaps in regulation.

2.4. Smokeless Tobacco

An extremely large variety of commercially available smokeless tobacco products exist in the worldwide market. The term smokeless tobacco includes oral tobacco products that are sucked, chewed, or placed in the oral cavity, as well as powder tobacco mixtures that are inhaled and absorbed in the nose [35]. Dissolvable tobacco products are also included in this category. These latter products that are relatively new to the commercial market come in at least three forms often resembling candy: orbs (lozenges), strips, and sticks. As the TCA flavor ban in 2009 was limited to cigarette products, smokeless tobacco products continue to be available in an assortment of flavors including cinnamon, citrus, and mint [36]. As a result of the appealing nature of these products and limited regulation, smokeless tobacco products continue to be prevalent among youth populations, and may be increasing in use among some groups [37].

2.5. Kreteks

Kreteks originated from, and continue to be manufactured in Indonesia, where they are machine-manufactured in a manner similar to cigarettes [38]. About 90% of all smokers in Indonesia use kreteks. Substantial decreases in kretek use among U.S. adolescents have been observed likely due to the 2009 TCA, which banned kreteks due to their clove flavoring. However, kreteks (similar in appearance to the banned product) have been recently reintroduced into the U.S. market as little cigars (still allowed to be flavored) and are currently being used by adolescents [39].

2.6. Bidis

Bidis were first introduced into the U.S. in the 1970's and according to U.S. federal tobacco definitions are considered to be cigarettes [40], although they are often not perceived as such by the smoker. Bidis are most commonly smoked in India. Usage has been declining in the U.S. over time, although some national surveys demonstrate extensive 'ever' use among adolescents [38]. Like kreteks, reduced rates of bidi use in the U.S. are likely due to the TCA, in which the FDA banned all flavoring of any cigarette products, including bidis [41]. However, bidis still remain commercially available in U.S. stores and on the Internet [42].

3. SURVEY RESULTS

For this publication, data drawn only from U.S. national surveys will be reviewed so as to avoid drawing conclusions based on regional/local specific variations and convenience samples. Thus, data discussed herein was attained from four nationally representative surveys including the National Youth Tobacco Survey (NYTS), Monitoring the Future

(MTF) study, National Survey on Drug Use and Health (NSDUH), and the Youth Risk Behavioral Surveillance Survey (YRBSS). Sampling parameters for each of these surveys are shown in Table 2.

Data from these nationally representative samples indicate that overall use rates of certain ATPs are rising, as are the sources and opportunities to use them.

3.1. Hookah

a. NYTS—In 2011, the NYTS for the first time queried students about engaging in “smoking from a hookah or waterpipe” [43]. The CDC recently reported their analysis of the 2012 NYTS data [47] which found that from 2011–2012 current hookah use significantly increased among high school students overall (4.1% to 5.4%, respectively), and among non-Hispanic Whites (4.3% to 6.1%) [47]. The survey also revealed significant increases in current hookah use among Hispanic middle school students (1.3% to 2.7%) [47]. Analysis of the NYTS data by Amrock et al. (2013) revealed that of all adolescents surveyed 7.3% had ever tried hookah, and 2.6% were current hookah users (defined as use at least once in the past 30 days) [48]. Although males were more likely than females to have ever used hookah (3% vs. 2.3%), current hookah use was similar between genders [48]. Non-Hispanic Whites were the most likely to have ever used hookah (8.4%), while non-Hispanic Blacks were the least likely (2.3%). Adolescents that reported Other/Multiple for ethnicity were most likely to be current hookah users (3.9%), and non-Hispanic Blacks were least likely (1.3%) [48]. Ever and current hookah use increased with both age and grade; 1.7% of all adolescents (13-years-of-age and younger) surveyed were ever users, and 0.8% were current users. In contrast, 16.1% of adolescents 17 years-of-age and older were ever users, and 5.5% were current users. In addition, 2% of adolescents in or below grade 8 were ever users, and 1.0% were current users, whereas, 19.5% of 12th graders were ever users, and 6.7% were current users [48].

b. MTF—The MTF survey added questions concerning hookah use to their survey in 2010 for 12th graders (as well as followup survey questions for college students and young adults) [49]. The annual prevalence of hookah use for 12th graders was 17.1% in 2010, 18.5% in 2011, 18.3% in 2012, and 21.4% in 2013. Annual hookah use levels for college students and young adults were also very high— 27.9% in 2011, 25.7% in 2012, and 26.1% in 2013 for college students; and for young adults, 20.1% in 2011, 19.1% in 2012, and 20.4% in 2013 [49]. Prevalence among 12th grade students did not differ by sex, plans to go to college, or parental education. Hookah prevalence was positively correlated with population density, geographical region in the U.S. (use was higher in the West than other region), and was greater among Hispanic students than those of other ethnicities (i.e., 22.8% of Hispanic students, 20.2% of White students, and 8.6% of African American students) [49]. The MTF did not include questions on hookah use among 8th and 10th graders.

c. Summary—The results from the NYTS and MTF surveys demonstrate that hookah prevalence is high among adolescents overall, and especially for students 17 and older. Moreover, hookah use increases with age, and prevalence is highest among White students, although use does not appear to be correlated with sex. The other national surveys reviewed

(NSDUH and YRBSS) have not yet queried hookah use in their surveys. Figure 1 shows the temporal trends of current hookah use from the two most recent years that each survey was conducted, given that data on hookah use was available.

3.2. E-cigarettes

a. NYTS—In 2011, the NYTS began to query e-cigarette use in their survey [43]. Large increases in the prevalence of e-cigarette use were seen from 2011–2012 among all students (6–12th grade; i.e., 3.3% to 6.8%) [30]. Among middle school students, ever e-cigarette use increased from 1.4% to 2.7% and current use increased from 0.6% to 1.1%. Concurrent use of e-cigarettes and conventional cigarettes also increased from 0.3% to 0.7%; and, 20.3% of e-cigarette middle school users in 2012 reported never having used conventional cigarettes [30]. Greater use of e-cigarettes was observed among older students. Ever e-cigarette use by high school students more than doubled (i.e., 4.7% to 10%) and current use increased from 1.5% to 2.8%. Concurrent use of both e-cigarettes and conventional cigarettes increased from 1.2% to 2.2%; in 2012, 7.2% of all e-cigarette users in high school reported never having used conventional cigarettes [30, 47]. A 2013 report from the CDC estimated that ~160,000 students that had ever used e-cigarettes had never used conventional cigarettes [30].

b. MTF—The MTF survey added questions concerning e-cigarette use to their survey in 2014, thus 2013 data is not available [49].

c. Summary—The prevalence of e-cigarette use among adolescents has risen dramatically from 2011–2012 and will likely continue to increase. Because national survey data are limited (only NYTS queried e-cigarettes), determining prevalence of e-cigarette use and user characteristics is difficult. Figure 2 shows the temporal trends of current e-cigarette use from the two most recent years that each survey was conducted, given that data on e-cigarette use was available.

3.3. Cigars

a. NYTS—Based on the 2012 NYTS, current cigar use, which includes cigarillos, and little cigars, was ~3% among middle school students and ~13% among high school students [47], similar to those rates reported for cigar use in 2009 and 2011 [4]. Results showed that high school males were more likely to be current cigar users (~16%) than high school females (~8%); in contrast, prevalence of current cigar use among middle school students was similar for both sexes. Non-Hispanic Blacks had the highest current use among high school students, and both non-Hispanic Blacks and Hispanics had the highest current use among middle school students. The CDC recently reported their analysis of the 2012 NYTS data, which found that from 2011–2012 current use of cigars significantly increased among non-Hispanic Black high school students (11.7% to 16.7%) [47]. Unfortunately, the NYTS did not distinguish between little cigars, cigarillos, and regular cigars in their questionnaires.

b. MTF—The MTF added questions concerning cigar use (exclusively small cigars) to their survey in 2010 for 12th graders (as well as follow-up survey questions for college students and young adults) [49]. The annual percentages for use within the past year of cigar use for

12th graders were 23.1% in 2010, 19.5% in 2011, 19.9% in 2012, and 20.4% in 2013. College students and young adults also demonstrated high annual prevalence for cigars—23.6% in 2011, 20.3% in 2012, and 19% in 2013 for college students; and, 19.2% in 2011, 18.0% in 2012, and 18.4% in 2013 for young adults [49]. In addition, annual prevalence among 12th grade students was higher for males (26.5%) than females (14.8%). Annual prevalence of small cigar use is higher in the Midwest than in other U.S. geographical regions. Use of small cigars was slightly higher for those without college plans, and higher among White students than those of other ethnicities (i.e., 23.9% of White students, 16.0% of Hispanic students, and 9.1% of African American students). Cigar use among 12th grade students did not differ by population density or parental education [49]. However, the MTF failed to: measure regular cigar use; lifetime or current prevalence of small cigars; differentiate between little cigars and cigarillos; and, include questions on small cigar use for 8th and 10th graders.

c. NSDUH—From 2011–2012 the NSDUH demonstrated decreases in cigar use among 12–17-year-old adolescents for use over a lifetime (10.7% to 9.6%), past year use (7.8% to 6.8%), and past month use (3.4% to 2.6%) [45]. From 2002 to 2012 past month prevalence among the same age bracket (12–17-years-old) exhibited a significant decrease from (4.5% to 2.6%) [45]. The 2012 NSDUH analysis of this age bracket revealed that White (but not Hispanic) males were most likely to have used cigars, while those of Asian origin were least likely to use cigars and, 17-year-old adolescents had the highest lifetime (21.0%), past year (14.9%), and past month use (6.1%). Cigar use among 18–25-year-olds changed very little between 2011–2012, but, was much higher than that observed for those aged 12–17 (i.e., 39%, 21.7%, and 10.7% for lifetime, past year, and past month use, respectively) [45]. Prevalence of cigar use was greatest among males compared to females, and among those who reported being Native Hawaiian or Other Pacific Islander, two or More Races, White, and Not Hispanic or Latino. Lifetime, past year, and past month use was highest for 24 year-olds (43.6%), 20 year-olds (24.8%), and 18 year-olds (12.2%), respectively. Lifetime cigar use was positively correlated with education level (college graduates having the highest lifetime prevalence, 45.9%), and current employment (those employed full-time had highest lifetime prevalence, 43.7%) [45]. The NSDUH did not distinguish between little cigars, cigarillos, and regular cigars.

d. YRBSS—The 2013 YRBSS showed that overall current (i.e., at least one day in the past 30 days) cigar use for 9th–12th grade students was 12.6% [46]. While the YRBSS measured significant declines in cigar use from 1997 to 2005 (22.0% to 14.0%), measured levels since 2005 (i.e., 2009, 2011, 2013) showed little change [46]. The 2013 survey found that: prevalence was greater for males (16.5%) than females (8.7%). In addition, White males had a greater prevalence (18.1%) than Hispanic males (14.7%), and Black males (14.0%), while Black females had greater cigar usage (9.4%) than Hispanic females (9.2%) and White females (8.0%). Students in the 12th grade had a greater prevalence (16.7%) than those in the 11th grade (14.7%), 10th grade (10.8%), or 9th grade (9.0%). Unfortunately, the YRBSS did not distinguish between little cigars, cigarillos, and regular cigars, and did not include measurements for lifetime use.

e. Summary—The results from these four national surveys show that prevalence of cigar use among adolescents, while high, appears to have leveled off over the last few years. Additionally results show that cigar use: (1) appears to increase with age; (2) is greater among males than females; (3) does not appear to be correlated with race or ethnicity; and, (4) adolescent use of different cigar types has yet to be quantified on a national scale. Figure 3 shows the temporal trends of current cigar use from the two most recent years that each survey was conducted, given that data on cigar use was available.

3.4. Smokeless Tobacco

a. NYTS—In 2011, the NYTS began to incorporate questions on dissolvable tobacco (e.g., Ariva, Stonewall, Camel orbs, Camel sticks, or Camel strips) and snus (e.g., Camel or Marlboro Snus) apart from the smokeless tobacco category, which only included chewing tobacco, snuff, or dip (e.g., Redman, Levi Garrett, Beechnut, Skoal, Skoal Bandits, and Copenhagen) [43]. From 2011–2012 the prevalence and use of smokeless tobacco and snus changed very little among middle and high school students [47]. The 2012 smokeless tobacco prevalence rates were 1.7% for middle school students and 6.4% for high school students, while prevalence rates for snus were 0.8% for middle school students and 2.5% for high school students [47]. From 2011–2012 the current prevalence of dissolvable tobacco significantly increased from 0.3% to 0.5% for middle school students and doubled (i.e., 0.4% to 0.8%) for high school students [47]. High school males had greater current prevalence rates for smokeless tobacco and snus than high school females. Among middle school students, Hispanic students had the highest current prevalence rates for smokeless tobacco (2.4%), snus (1.1%), and dissolvable tobacco (1.0%) compared to students of other races/ethnicities. Among high school students, White students had the highest current prevalence rates for smokeless tobacco (8.1%), and snus (3.3%), while Hispanic students had the highest current prevalence rates for dissolvable tobacco (1.4%).

b. MTF—The overall (i.e., 8th, 10th and 12th grade combined) 30-day prevalence of smokeless tobacco use in the 2013 MTF was 5.7%, which was comparable to levels measured in previous years (5.8% in 2000) [49]. Similarly, the overall (8th, 10th and 12th grade combined) daily prevalence of smokeless tobacco use was 1.7% (1.9% in 2000) [49]. The 12th graders surveyed had higher lifetime, 30-day, and daily usage of smokeless tobacco than 10th and 8th graders. Lifetime prevalence use for 12th, 10th, and 8th graders was 17.2%, 14.0%, and 7.9%, respectively, while 30-day prevalence use was 8.1%, 6.4%, and 2.8%, respectively, while daily prevalence yielded the lowest frequencies (i.e., 3.0%, 1.9%, and 0.5%, respectively). For both lifetime and 30-day measures, males had higher prevalence rates of smokeless tobacco use than females, and White students had higher prevalence rates of smokeless tobacco use than Hispanic and African American students in all grades. Students that selected “none or under 4 years” when asked about college plans, and those who lived in low population density areas had higher prevalence rates of smokeless tobacco use. Use of smokeless tobacco did not appear to correlate with the U.S. region of residence, or level of parental education [49]. Follow-up MTF surveys for college students and young adults failed to query smokeless tobacco use.

In 2011 the MTF began monitoring snus and dissolvable tobacco in addition to smokeless tobacco in 12th graders (as well as follow-up survey questions for college students and young adults) [49]. In 2012, these two products were also added to the 8th and 10th grade questionnaires [49]. Annual prevalence rates of snus use in the 2013 MTF survey were 7.7% for 12th graders (7.9% in 2012), 5.2% for 10th graders (6.9% in 2012), and 2.0% for 8th graders (2.4% in 2012) [49]. Annual prevalence of snus use was the same in both young adults and college students (i.e., 4.8%) [49]. Prevalence of snus use was higher in males than females, and in White students (in all grades). Likewise to smokeless tobacco, prevalence rates of snus use were higher for students that selected “none or under 4 years” when asked about college plans, and lived in low population density areas. Use of snus use was also not correlated with U.S. region of residence, level of parental education, or ethnicity [49].

Annual prevalence rates of dissolvable tobacco use in the 2013 MTF survey were 1.9% for 12th graders (1.6% in 2012), 1.2% for 10th graders (1.6% in 2012), and 1.1% for 8th graders (1.0% in 2012) [49]. Annual prevalence rates of dissolvable tobacco were 0.3% for young adults, and 0.2% for college students. Annual use of dissolvable tobacco was higher in males than females in all grades. Prevalence rates of dissolvable tobacco use were higher for students that selected “none or under 4 years” for college plans, and lived in low population density areas. Dissolvable tobacco use was not correlated with the students’ level of parental education, region of residence, or ethnicity [49]. The MTF survey did not report lifetime, 30-day, or daily prevalence for snus or dissolvable tobacco.

c. NSDUH—The 2012 NSDUH found that among 12–17-year-olds, lifetime use of smokeless tobacco was 6.4%, while a prevalence of 3.9% was noted for past year use, and 2.1% for past month use [45]. These values were comparable to those reported in the 2011 survey [45]. Males had higher levels than females for lifetime, past year, and past month smokeless tobacco use. Analysis of NSDUH data based on Hispanic Origin and Race found that those who selected “American Indian or Alaska Native” for their race had the highest lifetime (15.0%), past year (10.1%), and past month (5.4%) prevalence of smokeless tobacco use. Analysis of the data based on combined Gender/Race/Hispanic Origin revealed that those who selected “Male, White, Not Hispanic” had the highest lifetime (15.4%), past year (9.4%), and past month (5.8%) prevalence of smokeless tobacco use [45]. Examination by individual ages demonstrated that 17-year-olds had the highest lifetime (12.1%), past year (7.6%), and past month use (4.3%) of smokeless tobacco [45].

Use of smokeless tobacco among 18–25-year-olds in 2012 changed little from the 2011 survey; 2012 NSDUH prevalence levels for this age category were 19.9% for lifetime, 9.0% for past year, and 5.0% for past month use [45]. Lifetime and past year use by 18–25-year-old young adults was higher than that seen for adolescents (i.e., 12–17-year-olds), but both age categories had similar past month prevalence of use. Males had higher levels than females for lifetime, past year and past month smokeless tobacco consumption. NSDUH data, analyzed based on Hispanic Origin and Race, demonstrated that those who selected “American Indian or Alaska Native” had the highest lifetime (37.1%), past year (18%), and past month (10%) prevalence of smokeless tobacco use [45]. Examination by individual ages in 18–25-year-olds demonstrated that lifetime use was greatest among 25-year-olds (22.8%), while past year use by 19-year-olds was highest (10.5%), and past month use

greatest for 22-year-olds (6.2%). Prevalence of use was greatest for those who graduated high school and were currently employed full-time [45]. The NSDUH did not query separate categories for different types of smokeless tobacco.

d. YRBSS—The 2013 YRBSS demonstrated that overall current smokeless tobacco use for 9th-12th grade students was 8.8% [46]. While the YRBSS measured significant declines in smokeless tobacco use from 1995 to 2003 (i.e., 11.4% to 6.7%), levels since 2003 remained relatively constant [46]. The 2013 survey found that White males had a greater prevalence of use (20.6%) than Hispanic males (7.7%), followed by Black males (4.4%), Hispanic females (3.5%), White females (3.1%), and Black females (1.0%). Overall: (1) prevalence of current smokeless tobacco use was highest for White students compared to Hispanics and Blacks; (2) use was greater for males (14.7%) than females (2.9%); and, (3) 11th grade students had a higher prevalence of use (10.5%) than 12th graders (9.4%), 10th graders (8.1%), and 9th graders (7.1%) [46]. The YRBSS did not distinguish between different types of smokeless tobacco products, and did not measure lifetime use.

e. Summary—The national survey data on smokeless tobacco demonstrates that prevalence of use among adolescent populations remains high, but appears to have stabilized over the last few years. In addition, smokeless tobacco use while not correlated with race or ethnicity, does increase with increasing age. In contrast to smokeless tobacco, dissolvable tobacco use appears to be increasing over time. Figures 4, 5 and 6 show the temporal trends of current smokeless tobacco, snus, and dissolvable tobacco use from the two most recent years that each survey was conducted, respectively; given that data on use of each of these ATPs was available.

3.5. Kreteks

a. NYTS—The NYTS demonstrated significant decreases from 2011 to 2012 for both sexes in current kretek use among U.S. middle school (1.1% to 0.5%) and high school students (1.7% to 1.0%) [47]. Hispanic students had the greatest prevalence of current use in middle school (1.0%), while White students had the greatest prevalence of current use in high school (1.1%) [47].

b. MTF—The MTF began monitoring kretek use in their 2001 questionnaire, but dropped it from 8th and 10th grade surveys in 2006 due to very low prevalence rates; kretek use continues to be monitored in the survey for 12th graders [49]. Annual prevalence rates for these combustible tobacco products were 2.6% for 8th graders, 6.0% for 10th graders, and 10.1% for 12th graders in 2001. Four years later (2005), the last year that questionnaires included kreteks use by 8th and 10th graders, the survey demonstrated an annual prevalence rate of 1.4% and 2.8%, respectively. From 2012–2013 the annual prevalence rate of kretek use for 12th graders decreased from 3.0% to 1.6% [49].

c. Summary—The results from these two national surveys (i.e., NYTS and MTF) reveal that prevalence of kretek use among adolescents has significantly decreased over time and appears to have or be leveling off. The two other national surveys discussed in this review article (i.e., NSDUH and YRBSS) have not included kreteks in their questionnaires. Figure 7

shows the temporal trends of current kretek use from the two most recent years that each survey was conducted, given that data on kretek use was available.

3.6. Bidis

a. NYTS—The NYTS found significant decreases in current bidi use from 2011 to 2012 among middle school (1.7% to 0.6%) and high school students (2.0% to 0.9%) for both sexes [47]. Of the different ethnicities surveyed, Hispanic students had the greatest prevalence of current use in both middle (1.2%) and high school (1.4%) [47].

b. MTF—The MTF found that annual prevalence of bidi use by 8th graders was 3.9%, 6.4% for 10th graders, and 9.2% for 12th graders in 2000. The MTF dropped bidi use questions from its 8th and 10th grade questionnaires in 2006, and from 12th grade questionnaires in 2011 due to very low usage rates [49]. In 2005, the last year that questionnaires included bidi use by 8th and 10th graders, the annual prevalence rates for both grades were 1.6%. In 2010, the last questionnaire including bidi use by 12th graders, the annual prevalence rate was 1.4% [49].

c. Summary—Results from the aforementioned two national surveys reveal overall use of bidis by adolescents is low and significantly decreasing with time. The NSDUH and YRBSS surveys have never queried bidis in their survey questionnaires. Figure 8 shows the temporal trends of current bidi use from the two most recent years that each survey was conducted, given that data on bidi use was available.

3.7. Overall Survey Results

Overall survey results show that rates of use of some ATPs by adolescents and young adults is either rising or leveling off over time, with the exception of bidis and kreteks, whose usage has decreased significantly over the past decade. Use of cigars and smokeless tobacco has remained relatively constant over recent years. However, as both of these tobacco product categories encompass a large diversity of products (e.g. cigars include little cigars and cigarillos), which were not individually identified in the surveys, pinpointing use patterns for each product is currently impossible. Although only limited surveys currently quantify use of these products, prevalence trends of current and emerging tobacco products (i.e. hookah, dissolvable tobacco, and e-cigarettes) are rising, and in some cases dramatically. Taken together, these data suggest that current policies and regulations for most ATPs may be ineffective for tobacco cessation.

4. HEALTH IMPACTS

Most, if not all tobacco combustion products are complex mixtures that contain numerous toxic agents, many of which have been directly linked to adverse health outcomes [50–51]. Evidence demonstrates that smoked ATPs often deliver more tar, nicotine, and carbon monoxide to the smoker than cigarettes [52], and could have adverse health effects similar to, or possibly more severe than, those caused by conventional cigarettes. In addition, ATPs are likely to be highly addictive and may be more frequently used than cigarettes because of the false perception of safety [52].

4.1. Hookah

There is a common misperception among users that hookah/shisha use is less harmful and less addictive than cigarette smoking [6, 24, 53–55]. Even *Youtube* videos, whose audiences are mostly adolescents and young adults, fail to provide information on harmful consequences and/or to provide explicit anti-smoking messages [56]. Recent investigations have attempted to characterize the chemical composition/combustion products of hookah smoke, as well as to compare its health impact to that of cigarette smoke [57–60]. However, no consensus of safety has been reached in this regard. Schubert et al. (2011) showed lower concentrations of primary aromatic amines in waterpipe smoke compared to cigarette smoke, while Sepetdjian et al. (2008) demonstrated that total levels of polycyclic aromatic hydrocarbons (PAHs) were about 20 times higher in hookah smoke compared to cigarette smoke. Studies by Daher et al. (2010) revealed that hookah smoke contains significantly larger amounts of PAHs, ultrafine particles, aldehydes, and carbon monoxide compared to cigarette smoke. Thus, hookah smoke emerges as a potentially serious public health hazard [57–60]. The method of waterpipe smoking also adds to public health risk. Since a typical 45-minute waterpipe smoking session generates 40 times more smoke volume than a single cigarette, (based on a human clinical study that examined 31 participants), the smoker is exposed to 1.7 times more nicotine content, comparatively [61]. Nicotine exposure from daily water pipe usage is equivalent to smoking ~10 cigarettes per day [53]. In addition, hookah users have reported known features of dependence including drug-seeking behavior, use escalation over time, and inability to quit [53]. While some data concerning health impacts exist, many knowledge gaps in hookah science remain, including (but not limited to): smoke constituents and concentrations of specific tobacco and non-tobacco based shisha; human health effects of shisha; and, mechanistic *in vivo* and *in vitro* studies associated with direct and second hand hookah smoke exposure (as many urban hookah establishments also contain restaurants and bars).

4.2. E-cigarettes

E-cigarettes are alternative-smoking products whose potential health effects are poorly defined. A self-reported study of e-cigarette users showed that >3% of all users reported blood pressure changes, and experienced both ‘positive’ and ‘negative’ effects in the upper and lower respiratory system [62]. Many of the noted ‘negative’ symptoms involved the neurological and sensory systems, likely due to nicotine overdose or withdrawal [62]. Contrary to that observed in the aforementioned online forum study, another study (that examined 32 participants who consumed one e-cigarette cartridge/day for 4 weeks) found no abnormal changes in blood pressure [63]. While puffing characteristics vary between conventional and e-cigarettes [64], byproducts produced in e-cigarette vapor results in very small exposures, and thus potential reduction in risk [65]. However, the high level of nicotine present in e-cigarettes brings about the potential for addiction and increase in usage [66]. While the health effects of e-cigarette use are currently unclear, there remains a large concern for adolescents and young adults of reproductive age using these products since nicotine may have potential negative impacts on the developing brain [30, 67].

4.3. Cigars

Use of conventional cigars has been associated with adverse health effects including cancers of the mouth, lung, esophagus, and larynx, as well as increased risk of chronic obstructive pulmonary disease [68–70]. Due to different cigar products and varied smoking behaviors associated with each, laboratory studies are difficult to perform [71]. Little cigars are smoked in a different manner than large cigars, with little cigars being smoked more like cigarettes and thus inhaled more deeply [52, 72]. Several studies indicate that cigar smokers misperceive little cigars and cigarillos as more “natural” alternatives and as less harmful compared to conventional cigarettes [73–75]. However, in reality few studies have examined potential health effects of these tobacco products beyond that of cancer, and of those results are often contradictory [76]. Preliminary studies have indicated that a popular cigarillo brand (i.e., Black & Milds) deliver high doses of carbon monoxide and nicotine, and increases heart rate immediately after smoking [76], while another study found that Black & Mild cigarillos deliver significantly less nicotine, but significantly more carbon monoxide than conventional cigarettes [71]. As cigars deliver nicotine through both smoke and direct oral contact with tobacco paper (when used), the addictive nature of cigars could be even greater than conventional cigarettes [77].

4.4. Smokeless Tobacco

In general, smokeless tobacco products contain >3000 constituents that ultimately contribute to the taste and aroma of the tobacco [78–81]. There are 28 known carcinogens that have been identified in smokeless tobacco with the most abundant group of carcinogens being non-volatile alkaloid-derived tobacco-specific *N*-nitrosamines and *N*-nitrosoamino acids [78–82]. The Massachusetts Department of Public Health (MDPH) conducted a study comparing the moisture, nicotine content, and pH in chewing tobacco, moist snuff, and dry snuff. Results showed that (on average) moist snuff had the highest pH, level of moisture, and nicotine content [83]. Data also revealed that pH and unprotonated nicotine content are brand- and company-specific, making it difficult to compare even those smokeless tobacco products that are similar in appearance [83]. These complex and varying characteristics of smokeless tobacco products make hazard evaluation very problematic. In a study that examined 54 male snuff users consuming about 2.8 tins/week, results demonstrated that men on average excreted 20.1 nmol cotinine/mg creatinine (or 3.3 nmol cotinine per dip) in the urine compared with 27 nmol cotinine/mg creatinine (1.07 nmol creatinine per cigarette) excreted by cigarette smokers who consumed ~28 cigarettes/day [84–85]. Very few data on the health risks associated with dissolvable tobacco products are available.

In addition to smokeless tobacco products typically consumed in the U.S., there exist a number of ethnically linked smokeless tobacco types that contain areca nut, a Group 1 carcinogen [86]. Use of areca nut-containing smokeless tobacco is known to cause oral cancer, yet despite this, prevalence is increasing in the Western Pacific [86].

4.5. Kreteks

Kreteks deliver higher amounts of tar, nicotine, and carbon monoxide than conventional cigarettes, [87] and can serve as an alternative nicotine delivery system that can result in addiction in its adolescent users [88]. Similar to that observed by conventional cigarette

users kreteks/clove “cigarette” users demonstrate significantly increased heart rate, systolic blood pressure, plasma levels of nicotine, and exhaled carbon monoxide [89]. Eugenol, the active ingredient of clove oil, that appears to act similarly to menthol to reduce smoke harshness, is used as an additive in kreteks [38]. By itself, Eugenol has been associated with increased fluid and blood in the lungs, bronchospasm, increased respiratory tract infections, and other severe lung injuries [87, 90–93]. Clove “cigarettes” have been referred to as “trainer cigarettes”, suggesting that their use could initiate conventional cigarette smoking [87, 94].

4.6. Bidis

Smoke from bidis contains phenol, hydrogen cyanide, benzo(a)pyrene, carcinogenic tobacco-specific nitrosamines, and delivers considerable amounts of carbon monoxide to the smoker [42]. In addition, bidis are puffed more frequently than cigarettes in order to keep the product lit, thus resulting in the inhalation of 2–3 times more nicotine and tar than a conventional cigarette [42, 95–98]. In a study in which nicotine content of 12 popular bidi brands was compared to cigarettes, bidis had a much higher concentration of nicotine [42]. This could suggest that bidi users have a greater potential for addiction than regular cigarette smokers, and possibly an increased risk of cancers of the throat, oral cavity, pharynx, larynx, lungs, esophagus, stomach and liver above cigarette smokers due to increase exposure to bidi-associated carcinogens [99–100].

5. DISCUSSION

Substantial literature exists regarding trends in adolescent cigarette smoking, characteristics of such youth, and the influence of parents [101–103], and friends on usage [103–105]. However, similar information concerning adolescent ATP use is sparse, making these parameters important new areas of research. These are especially imperative for ATPs with rising prevalence rates. Currently, standardized national U.S. youth tobacco surveys have been successful in quantifying certain types of ATP use, an imperative first step leading to use reduction. However, separating cigarillo and little cigar use from large cigars, and employing individual classifications for categorizing different types of smokeless tobacco products could enhance usefulness of current surveys for capturing ATP data. Moreover, inclusion of emerging smoking and smokeless products like e-cigarettes, hookah, and dissolvable tobacco is critical as prevalence rates among adolescents are quickly climbing. As adolescents have a reduced harm perception of most alternative products, there is an urgent need for clinical and toxicological research that can lead to a better understanding of the adverse health effects from mainstream and secondhand exposure from these agents.

5.1. The Influence of Immigration, Race/Ethnicity Pattern, and ATP Adolescent Usage

It is important to consider how changing immigration and race/ethnicity patterns in the U.S. have contributed to increased rates of adolescent use of some ATPs. Over the past two decades, U.S. immigrant population has increased steadily at a rate of ~ 1 million per year [106], which is closely aligned with a dramatic shift in the national origin of immigrants. Currently, immigrants comprise 12 – 13% of U.S. population; 20% of the nation’s children have immigrant parents, a statistic projected to rise to 33% by 2040 [107–108]. Between

1980 and 2000, 50% of all U.S. immigrants were from Latin America and 34% were of Asian origin. This shift has continued, evidenced by the numbers of people gaining legal permanent status, i.e., in 2010 ~39% were from Asia and 41% from Latin America [106]. Thus, Latin American and Asian born immigrants are adding substantially to the increasing proportion of the U.S. “minority” racial/ethnic population and specifically changing the composition of the minority population [109]. These shifts in ethnicities and cultures appear to have repercussions for adolescent ATP use in the U.S. with widespread adoption by non-immigrant adolescents.

Despite the “changing face” of tobacco use, national surveys lack detailed information about adolescent and family immigration status, region of emigration, race and ethnicity, family economic status, and educational attainment. In addition, national surveys include few or no questions on the use of ethnically linked tobacco products. One popular group of ethnically linked tobacco products is chewing tobacco products containing areca nut (e.g. gutkha and paan), prevalent among U.S. South Asian communities. As numbers of South Asians continue to grow in the U.S., the use of smokeless tobacco products containing areca nut has grown in accordance [110]. Many South Asian immigrants have deep cultural and traditional roots to these products, and consider them safe. In fact, some users believe these products to have medicinal properties that are associated with positive health effects [111].

Scientific studies are needed to understand the availability and sales patterns of ATPs in immigrant communities, their diffusion into other communities, as well as sociodemographic and cultural dimensions of tobacco risk behaviors. These data are critical for developing effective regulatory policy and risk messaging/communication. Without prompt intervention, it is likely that adolescent use of existing ATPs will dramatically increase, and new ATPs could begin to surface. One such emerging product is called “dohka”, also known as “medwek”/“medwik”, which is a mixture of Iranian tobacco with high concentrations of nicotine that contains aromatic leaf and bark herbs, and is smoked in a small pipe called “midwakh” [112]. Dokha smoking is prevalent among adolescents and young adults in the United Arab Emirates with >10% of medical and allied health students there reporting use [112]. Improving the health of vulnerable populations whose global view and life circumstances may not be amendable to traditional methods requires not only an understanding of cultural and social factors related to individual-level health behavior changes, but also use of innovative and effective mechanisms to address their specific needs [113].

5.2. Relationship Between Conventional Cigarettes and ATPs

Current anti-cigarette smoking policies at the individual, community, and federal level have led to great reductions in adolescent cigarette use. The absence of accurate information on health risks associated with ATP use combined with inadequate regulatory policies could unintentionally reinforce the idea that these products are less harmful than conventional cigarettes [72]. Despite increased use and sale of many ATPs in the U.S., they are not generally subject to strict regulation, and/or enforcement. For example, a powerful intervention strategy to diminish adolescent cigarette use is the raise in price of tobacco and its products [6]. Adolescents and young adults are 2–3 times more price-sensitive than

adults, yet the current federal tax on pipe tobacco is \$2.83/pound, which is almost \$22/pound less than that on cigarettes [6]. New Jersey's 2001 and 2002 Adult Tobacco Survey found that after a cigarette excise tax increase, a proportion of recently quit cigarette smokers tried cigars, substituted cigars for cigarettes, or remained tobacco users in the form of cigars [114]. These data suggest that cigarette taxation strategies may be translatable to cigar, little cigar, and cigarillo regulation and cessation of use, while lack of regulation could lead to sustained use or initiation of use. Similarly, some ATPs (i.e. hookah, cigars, smokeless tobacco, and e-cigarettes) are flavored, a practice banned by the FDA for cigarettes [115], and what evidence exists suggests that adding flavor to tobacco products enhances both adolescent and adult usage [34, 116]. Efficacies of flavor bans are seen by the substantial declines in adolescent use of bidis and kreteks after the TCA banned their flavoring in 2009. Additionally, federal law requires health-warning labels on cigarettes and smokeless tobacco, but not on pipe tobacco. Such labels are needed on tobacco products of all types to inform users of the associated adverse health outcomes. In particular, graphic pictorial warnings appear very effective in this regard [6]. Health warnings and bans on advertisements and deceptive descriptions also need to accommodate the multi-component nature of ATPs [50].

5.3. Current Gaps in Federal Policy

Recent declines in cigarette use is attributed (at least partly) to the 2009 TCA, which led, in turn, to creation of the Center for Tobacco Products (CTP) within the framework of the FDA [7]. The FDA CTP now has the ability to regulate the manufacture, distribution, and marketing of "tobacco products" under the Federal Food, Drug and Cosmetic Act (FDCA). In addition, section 901 of the FDCA permits the FDA to issue regulations deeming other tobacco products subject to the FDCA [117]. The TCA provides the FDA the authority to regulate cigarettes, cigarette tobacco, roll-your-own tobacco, and smokeless tobacco. Successes of the TCA include the banning of flavored cigarette products other than menthol (including bidis and kreteks), restriction on the use of misleading terms such as 'light' and 'mild,' and creation of a registration/reporting system for manufacturers [38].

TCA "boundaries" for hookah, large and little cigars, cigarillos, dissolvable tobacco and e-cigarettes are less clear or remain undefined. The FDA's CTP research priorities are outlined in 7 categories and 56 research questions. Among these categories is "Understanding the diversity of tobacco products" which includes questions relevant to ATPs (e.g. "what are the constituents, components, and design features of new and emerging tobacco products [e.g., dissolvable tobacco products, e-cigarettes, hookah tobacco], and how do these features differ within the same class of products?") [29]. For example one question that could be addressed is: why cigarillos and little cigars, which contain many of the same toxic compounds found in conventional cigarettes making their chemical features similar [118], are subject to less regulation and are taxed at lower rates [116].

Gaps within the TCA can be seen clearly using three products as examples: kreteks, smokeless lozenges, and e-cigarettes. Kreteks, being banned as cigarettes in 2009 because of clove flavoring, were reintroduced into the market as little cigars [38, 119]. In addition, two smokeless lozenges (Ariva BDL and Stonewall BDL) will remain unregulated as they were

declared by the FDA not to be “tobacco products” due to the manufacturing process [38, 120]. One of the most obvious examples of gaps in the TCA is the lack of e-cigarette regulation. E-cigarettes have remained virtually unregulated by the federal government after the pivotal 2010 court decision (*Sottera v. FDA*), which declared e-cigarettes to be tobacco products rather than drugs or medical devices [29, 38].

In addition to previous examples demonstrating TCA weakness, the CTP has no authority to regulate tobacco farming, change taxes on tobacco, implement tobacco-free and clean indoor air policies, or develop therapeutics for tobacco cessation [29].

6. CONCLUSION

In summary, there is a clear need to develop regulatory policies and increase educational campaigns that can effectively convey information regarding risks associated with ATP use to adolescents, as well as to health care clinicians, public health leaders, and policy makers. While ATPs differ from conventional cigarettes, their similar nature and potential adverse health effects suggest expansion of many of the same policies used for cigarette control could have a major impact on decreasing youth ATP use. Success of this strategy has already been witnessed by incorporation of bidis and kreteks in the flavor ban for cigarettes in 2009. As youth are large users of social media/social networks, such mechanisms can be used to campaign against ATP use and increase awareness [38]. Increased research and communication venues will also help to inform FDA efforts to develop innovative and effective regulatory policy, as well as to reduce the tobacco-related public health toll in the U.S. [121–123]. While policies, regulation, and research will be a great advancement in ATP use prevention and cessation, they are not enough; public enforcement and awareness are also urgently needed.

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List of Abbreviations

U.S	United States
ATPs	alternative tobacco products
SHS	Second Hand Smoke
e-cigarettes	electronic cigarettes
TCA	Family Smoking Prevention and Tobacco Control Act
FDA	United States Food and Drug Administration
CDC	Centers for Disease Control and Prevention
NYTS	National Youth Tobacco Survey
MTF	Monitoring the Future study

NSDUH	National Survey on Drug Use and Health
YRBSS	Youth Risk Behavioral Surveillance Survey
PAHs	polycyclic aromatic hydrocarbons
MDPH	Massachusetts Department of Public Health
CTP	Center for Tobacco Products
FDCA	Federal Food, Drug and Cosmetic Act

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Figure 1. Temporal Hookah Trends Over the Past 2 Years Available by Survey

Note: Values from NYTS reflect current prevalence, while MTF values reflect annual prevalence, as current prevalence values were not available.

Figure 2.
Temporal E-cigarette Trends Over the Past 2 Years Available by Survey

Figure 3. Temporal Cigar Trends Over the Past 2 Years Available by Survey

Note: Values from NYTS, NSDUH and YRBSS reflect current prevalence, while MTF values reflect annual prevalence, as current prevalence values were not available.

Figure 4.
Temporal Smokeless Tobacco Trends Over the Past 2 Years Available by Survey

Figure 5. Temporal Snus Trends Over the Past 2 Years Available by Survey

Note: Values from NYTS, NSDUH and YRBSS reflect current prevalence, while MTF values reflect annual prevalence, as current prevalence values were not available.

Figure 6. Temporal Dissolvable Tobacco Trends Over the Past 2 Years Available by Survey
Note: Values from NYTS, NSDUH and YRBSS reflect current prevalence, while MTF values reflect annual prevalence, as current prevalence values were not available.

Figure 7. Temporal Kretek Trends Over the Past 2 Years Available by Survey

Note: Values from NYTS reflect current prevalence, while MTF values reflect annual prevalence, as current prevalence values were not available.

Figure 8.
Temporal Bidi Trends Over the Past 2 Years Available by Survey

Table 1

Definitions of Commonly Used ATPs ranging from Most Prevalent to Least Prevalent Use in the U.S.

Hookah	Sometimes called water pipes; devices that use charcoal to heat and smoke a tobacco, called shisha, which is specifically made for hookah and available in a variety of flavors. ^a
Electronic Cigarettes	Battery-powered devices that vaporize liquid containing nicotine, flavoring, and other chemicals (such as propylene glycol), but do not contain tobacco- often referred to as “nicotine delivery systems”. The vapor produced by the device is inhaled like a cigarette. ^b
Cigar	A roll of tobacco usually wrapped in leaf tobacco. ^c
Cigarillo	A short, narrow cigar that typically contains ~3 grams of tobacco and usually has no filter. ^c
Smokeless Tobacco	Tobacco that is consumed without burning or heating the product. These products can be used orally or nasally. ^d
Kreteks	Also referred to as “clove cigarettes” imported to the U.S. imported from Indonesia. They consist of tobacco, cloves, and other additives. ^e
Bidis	Small, thin hand-rolled cigarettes imported to the U.S. primarily from India and other countries in the South Asian region. They consist of tobacco wrapped in a tendu or temburni leaf, and can be flavored or unflavored. ^e

References for Table 1:

^aCenters for Disease Control and Prevention. Smoking Tobacco and Use Fact Sheets- Hookahs. (2013). Available from: http://www.cdc.gov/tobacco/data_statistics/fact_sheets/tobacco_industry/hookahs/index.htm

^bCobb, N, Byron, M, Abrams, D, & Shields, P. Novel nicotine delivery systems and public health: The rise of the “E-cigarette”. Am J Public Health 2010; 100(12): 2340–2342.

^cRefer to reference [32]

^dRefer to reference [35]

^eCenters for Disease Control and Prevention. Smoking Tobacco and Use Fact Sheets- Bidis and Kreteks. (2013). Available from: http://www.cdc.gov/tobacco/data_statistics/fact_sheets/tobacco_industry/bidis_kreteks/

Table 2

Included Survey Parameters

Sample and Population Parameters	National Youth Tobacco Survey (NYTS)	Monitoring the Future (MTF)	National Survey on Drug Use and Health (NSDUH)	Youth Risk Behavioral Surveillance Survey (YRBSS)
Sample Size (18 years old)	~19,000	~50,000	~20,000	~15,000
Population (18 years old)	☐ Students enrolled in grades 6–12 ☐ 244 public, Catholic, and other private schools	☐ Enrolled 8 th , 10 th and 12 th graders ☐ ~420 public and private secondary schools	☐ Residents of households and persons in noninstitutional group quarters (e.g., shelters, rooming/boarder houses, college dormitories) ☐ In 2012 those aged 12–17 were sampled at a rate of 87.3% on average	☐ Enrolled 9 th –12 th graders ☐ ~158 public and private high schools
Sample Size for young adults	N/A ^a	☐ ~1000 college students ☐ ~5000 young adults (defined as those aged 19–28)	☐ ~20,000/survey (defined as those aged 18–25)	N/A ^a
Population surveyed for young adult population	N/A ^a	☐ subsample of each 12th-grade class sample is taken ☐ ~2,400 participants from each class selected for follow-up.	☐ 18–25-year-olds sampled at a rate of 69.8% on average when present in sampled households or group quarters	N/A ^a

Adapted from methodology sections of each individual survey [43–46].

^aThese surveys did not conduct any studies on this particular age group.