



A synthesis of the literature to inform vaping cessation interventions for young adults

Carla J. Berg^{a,b,*}, Nandita Krishnan^a, Amanda L. Graham^{c,d}, Lorien C. Abroms^{a,b}

^a Department of Prevention and Community Health, Milken Institute School of Public Health, George Washington University, Washington, DC, United States

^b George Washington University Cancer Center, George Washington University, Washington, DC, United States

^c Innovations Center, Truth Initiative, Washington, DC, United States

^d Department of Medicine, Mayo Clinic College of Medicine and Science, Rochester, MN, United States

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ABSTRACT

There is an urgent need to address young adult (YA) vaping. However, there is limited vaping cessation intervention research, particularly studies tested via experimental designs. This manuscript focuses on YA vaping and critical needs for research to advance vaping cessation interventions for YAs. The smoking cessation literature, especially regarding YA smoking, provides evidence and theory from which to draw. However, the extent to which this literature has utility for vaping cessation warrants investigation. Research to inform the development and optimization of effective vaping cessation interventions for YAs requires attention to both potential targets for behavioral intervention (e.g., conceptual framework) and how to best reach YAs (i.e., delivery modality). Regarding the former, such interventions must consider the complexity of YA vaping (e.g., complex social influences, limited negative outcome expectancies, quit intentions). One particularly challenging aspect of YA cessation is co-use of other tobacco products and marijuana and ensuring that those who quit vaping do not continue or increase other product use. With regard to intervention modality, technology-based interventions (e.g., text messaging, apps) may prove promising, and individualized intervention (e.g., one-on-one counseling) may be needed to carefully intervene on the complexity of substance use, particularly cigarette and marijuana use, within this population.

1. Introduction

In the past decade, e-cigarettes have become a prominent public health controversy (Kennedy et al., 2017) that have disproportionately impacted young adults (YAs) (Academies, 2018; Vallone et al., 2019). E-cigarette use (i.e., vaping nicotine) in YAs (18–24 years old) increased from 5.2% in 2014 to 9.3% in 2019 (Cornelius et al., 2020; Centers for Disease Control and Prevention. National Health Interview Survey, 2018) and is associated with other tobacco use (Primack et al., 2015; Unger et al., 2016), as well as use of other substances, particularly marijuana (Cohn et al., 2015; Lanza et al., 2020). Despite increasing vaping prevalence (Cornelius et al., 2020; Centers for Disease Control and Prevention, 2018), strong demand for vaping cessation interventions among YAs (Graham et al., 2020a, 2020b), and a call for research to develop effective vaping cessation interventions in the 2020 Surgeon General's Report on Smoking Cessation (Centers for Disease

Control and Prevention, 2021), there is limited vaping cessation intervention research (Graham et al., 2020a, 2020b; Hadland and Chadi, 2020; O'Connor et al., 2019; Silver et al., 2016; Sahr et al., 2020; Amato et al., 2021) and no published randomized trials. Nonetheless, state and local health departments, non-profit organizations, quitline providers, educational institutions, and others are working quickly to develop and implement programs to address this critical need. Thus, research is urgently needed to rapidly inform ongoing and future vaping cessation programs and to enhance the evidence base.

This manuscript focuses on YA nicotine vaping and critical research needs to advance cessation interventions for this population. We acknowledge the need to address vaping among adolescents. However, differences between YAs and adolescents with regard to socio-contextual determinants of vaping (e.g., home/school environments, access, other substance use), use levels/profiles, and potential delivery channels (e.g., school curricula) warrant separate discussion. Below, we highlight: 1)

* Corresponding author at: Department of Prevention and Community Health, Milken Institute School of Public Health; George Washington Cancer Center, George Washington University, 800 22nd Street NW, #7000C, Washington, DC 20052, United States.

E-mail address: carlaberg@gwu.edu (C.J. Berg).

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the evidence base for smoking cessation treatment and considerations in adapting cessation interventions for vaping, 2) promising intervention modalities and delivery channels, 3) a vaping cessation intervention currently being disseminated and studied, and 4) directions for future work.

2. Behavioral intervention content and considerations

The US Public Health Service Clinical Practice Guidelines state that effective smoking cessation treatments should offer problem-solving and coping skills training, social support, and pharmacotherapy (except when contraindicated) (Fiore et al., 2008). The Guidelines state that improved abstinence rates result from behavioral interventions that are: 1) more intensive (e.g., multi-session) and 2) delivered via multiple modes (e.g., counseling, self-help manuals) (Fiore et al., 2008). However, these guidelines are based on the general adult-smoker population and include caveats or limitations with respect to younger populations (Fiore et al., 2008). Relevance of these guidelines to vaping cessation warrants empirical investigation (Sanchez et al., 2021).

Such efforts must account for nuances of YA vaping that may make vaping cessation particularly challenging. Important considerations are: varying use patterns/profiles (Buu et al., 2020), co-use with other tobacco products (particularly cigarettes) and marijuana (Buu et al., 2020; Bluestein et al., 2019), varying readiness to quit vaping or prior experience with such attempts (Buu et al., 2020), distinct and broad-ranging vaping motives (Buu et al., 2020; Berg, 2016), and distinct motives for abstinence/cessation (Berg, 2016; Amato et al., 2020; Perks et al., 2019), among others, briefly summarized below. Subsequently, we provide an overview of how these considerations might inform conceptual frameworks for YA vaping cessation interventions.

2.1. Diverse E-cigarette use levels and patterns

The literature suggests that nicotine content in e-cigarettes with the greatest market share increased over time (Romberg et al., 2019), nicotine consumption and exposure via e-cigarettes can be extremely high among YAs (Buu et al., 2020; Berg, 2016; Windle et al., 2017), and vaping on a daily basis is associated with lower odds of vaping cessation (Coleman et al., 2019). However, other data also suggest potentially low levels of nicotine exposure among YAs who vape. For example, an analysis of data from the Population Assessment of Tobacco and Health (PATH) (Buu et al., 2020) indicated that e-cigarette users use an average of 10 days of the past 30, and ~15% used e-liquids not containing nicotine. Moreover, ~33% of users say they are “not at all addicted” to nicotine, despite most indicating at least one symptom of addiction (Buu et al., 2020). The smoking literature indicates that YA nondaily smokers are unlikely to perceive themselves as addicted or identify as “smokers”, which is associated with lower likelihood of attempting to quit smoking (Berg et al., 2009). Thus, both high and low levels of e-cigarette use may pose unique challenges for promoting cessation.

2.2. Co-use with other tobacco products and marijuana

One PATH analysis indicated that ~80% of YA e-cigarette users use cigarettes, 53% marijuana, and 82% alcohol (vs. 40% cigarettes, 39% marijuana, and 77% alcohol in nonusers) (Buu et al., 2020; Bluestein et al., 2019). In another study, 65% of YA e-cigarette users used other tobacco products and 60% marijuana; only 17% used e-cigarettes but no other tobacco product or marijuana (Berg et al., in press). Moreover, being a former smoker (vs. never smoker) and use of other combustible tobacco products are associated with lower odds of vaping cessation (Coleman et al., 2019). These data on poly-use highlight several major intervention considerations: 1) the risks of nicotine addiction, chronic use, and chronic relapse given the potentially high nicotine exposure among dual or polytobacco users (Wagner, 1998); 2) the complexities of how vaping initiation and cessation impact exposure to and cessation of

cigarettes (Wei et al., 2020); 3) the impact of polysubstance use, including vaping marijuana, on motivation and ability to quit; and 4) the need for interventions that simultaneously target multiple substances vaped (i.e., nicotine, marijuana) and/or multiple modes of nicotine consumption (i.e., vaping, cigarette smoking).

2.3. Various experiences with quitting and levels of readiness to quit

Per PATH data, only 13% of YA current e-cigarette users tried to quit completely, and only 7% had tried to reduce (Buu et al., 2020). In another PATH analysis, 62.4% of current adult e-cigarette users – the majority of whom were YAs (ages 18–34 years) – planned to quit vaping for good (28.7% within the next six months), and 25% reported a past-year quit attempt (Rosen and Steinberg, 2020). Similarly, a 2020 study found that 20.8% of YA e-cigarette users reported being ready to quit e-cigarettes in the next 6 months and 32.3% reported past-year quit attempts (Berg et al., 2020).

2.4. Outcome expectancies and motives for use, co-use, and discontinued use

E-cigarette use. Interventions to promote vaping cessation should address outcome expectancies of vaping and/or reasons or motives for vaping. Motives for YA vaping include beliefs that e-cigarettes are less harmful to self and others, can be used where smoking is not allowed, have appealing flavors, are more acceptable to nonsmokers, facilitate socializing, support smoking cessation or reduction, or as an alternative to quitting smoking cigarettes (Amato et al., 2021; Buu et al., 2020; Berg, 2016; Biener et al., 2015; Kinouani et al., 2020). These often differ among cigarette use subgroups. For example, never or non-smokers most commonly cite curiosity and socialization as reasons for vaping (Berg, 2016; Biener et al., 2015); former smokers commonly vape to quit using cigarettes or other tobacco products (Berg, 2016; Biener et al., 2015; Boyle et al., 2019; Yong et al., 2019); and users of both e-cigarettes and cigarettes commonly vape because they perceive e-cigarettes as less harmful than cigarettes or to help cut down on or quit cigarette smoking (Berg, 2016; Biener et al., 2015; Boyle et al., 2019; Yong et al., 2019).

Co-use with other tobacco and/or marijuana. Measures have been developed to examine motives for polytobacco use (Berg et al., 2016) and motives for nicotine and marijuana co-use (Berg et al., 2018) that identified four factors: instrumentality (synergistic effects of products), social context (use in different settings/social situations), displacement (using one product to reduce/quit the other), and experimentation. Interventions attending to such polyuse motives should be investigated to determine the extent to which co-use motives may have implications for behavior change outcomes across different products (e.g., e-cigarettes, cigarettes, marijuana).

Discontinued use. The literature has identified several key motives for quitting vaping including: social influences discouraging use, concerns about academic/athletic/career prospects/performance, mental and physical health concerns (including addiction), lack of satisfaction with taste or to deal with cravings (particularly in smokers substituting with e-cigarettes), or because they only experimented with e-cigarettes (Windle et al., 2017; Biener et al., 2015; Yong et al., 2019; Berg, 2016; Amato et al., 2020; Perks et al., 2019; Weaver et al., 2020; Simonavicius et al., 2017; Pepper et al., 2014; Kong et al., 2015; Biener and Hargraves, 2015). Moreover, smoking history has implications for vaping cessation motives (Berg, 2016; Biener et al., 2015; Boyle et al., 2019; Yong et al., 2019; Kong et al., 2015). Across never, current, and former cigarette smokers, reasons for quitting vaping include: health concerns and cost among never or non-smokers (Berg, 2016; Biener et al., 2015); health concerns and not needing e-cigarettes to stay quit among former smokers (Berg, 2016; Biener et al., 2015; Boyle et al., 2019; Yong et al., 2019); and finding e-cigarettes less satisfying than cigarettes among users of both e-cigarettes and cigarettes (Berg, 2016; Biener et al., 2015; Boyle et al., 2019; Yong et al., 2019). In addition, one study found that

those who vape for non-goal-oriented reasons (e.g., curiosity) were more likely to quit than those who vaped for goal-oriented reasons (e.g., quitting smoking) (Pepper et al., 2014).

2.5. Integrating considerations to inform conceptual frameworks for vaping cessation

Research is needed to test whether and/or how the effectiveness of vaping cessation interventions can be enhanced by addressing the various use levels and complex user profiles, other tobacco/substance use, varying interest in or experience with quitting, and the diversity of motives for use and potential cessation (Coleman et al., 2019). Social Cognitive Theory (SCT) (Bandura, 1998, 2004) may provide an effective conceptual framework for addressing YA vaping cessation. SCT posits that social support, outcomes expectations (e.g. benefits and barriers from quitting), behavioral capability, and self-efficacy affect readiness to quit (i.e., behavioral intention) and ultimately cessation.

Noting the nuances of YA vaping behavior, SCT may be particularly appropriate, as several facets of vaping align with SCT constructs. The social aspect of YA vaping is multifaceted: YAs may be introduced to vaping by friends/peers, may vape to socialize, and/or integrate vaping into substance use common in YA socialization; however, others may also discourage vaping and/or provide support to quit. YAs also indicate a broad range of outcome expectancies – both positive (e.g., enjoying flavors or “buzz”, help with nicotine cravings, discreetness of vaping behavior) (Sanchez et al., 2021; Buu et al., 2020; Berg, 2016; Windle et al., 2017; Biener et al., 2015; Boyle et al., 2019; Yong et al., 2019) and negative (e.g., not enjoying taste/smell, insufficient help with cravings, academic/athletic performance impacted negatively) (Windle et al., 2017; Biener et al., 2015; Boyle et al., 2019; Yong et al., 2019; Berg, 2016; Amato et al., 2020; Perks et al., 2019; Weaver et al., 2020; Simonavicius et al., 2017; Pepper et al., 2014; Kong et al., 2015; Biener and Hargraves, 2015). Particularly relevant negative outcome expectancies are perceived risks – with regard to several dimensions including health risks, risk of addiction, and risks in the context of co-use with other tobacco products and/or marijuana (Windle et al., 2017; Biener et al., 2015; Boyle et al., 2019; Yong et al., 2019; Berg, 2016; Amato et al., 2020; Perks et al., 2019; Weaver et al., 2020; Simonavicius et al., 2017; Pepper et al., 2014; Kong et al., 2015; Biener and Hargraves, 2015). Additionally, limited attempts to quit may underscore challenges in developing skills to apply to the process of vaping cessation (i.e., behavioral capability) and in developing self-efficacy to achieve cessation.

Regarding behavioral intention, YA vaping cessation interventions are also challenged to engage those who are not ready to quit, use infrequently, may not believe they are addicted, and/or perceive few negative implications of vaping (or co-use with other tobacco/marijuana). At the same time, these interventions must also be appropriate for those with high levels of use and addiction, for example, by providing more intensive and ongoing behavioral intervention support and considering the need for pharmacotherapy and nicotine replacement to address withdrawal.

Particularly critical, vaping cessation interventions must also ensure that those who quit vaping do not continue or increase use of other tobacco products (particularly cigarettes) or marijuana. Unfortunately, a major gap in the research is messaging strategies and interventions to effectively promote positive behavior change among polytobacco or polysubstance users; particularly relevant to this manuscript, greater research must examine how to address co-use of e-cigarettes, cigarettes, and/or marijuana. Relatedly, because the harms – particularly long-term – associated with vaping remain uncertain, developing compelling, evidence-based messages to promote cessation poses a challenge.

3. Intervention modality and delivery

Although there are various modalities and delivery channels to

consider, such as in-person counseling, group-based counseling, and others, identifying the most appropriate strategies for young people is critical in developing vaping cessation interventions. Unfortunately, one of the most universally available cessation resources – quitlines – have shown very low uptake among YAs (Campbell et al., 2014; Rudie and Bailey, 2019). However, other remote, phone-based modalities hold promise. Three Cochrane Reviews (Whittaker et al., 2016, 2019, 2012) and a review by the Guide to Community Preventive Services (Centers for Disease Control and Prevention, 2012) indicate that mobile-phone based behavioral interventions are effective for long-term smoking cessation (Whittaker et al., 2016, 2019, 2012; Centers for Disease Control and Prevention, 2012) and are effective among YAs (Whittaker et al., 2019; Villanti et al., 2010, 2020; Hoepfner et al., 2017). Notably, 99% of YAs own mobile phones; 95% own smartphones (Pew Research Center, 2019). Text messaging is an easy-to-use, discreet, and preferred communication modality among YAs, with high readership rates (Rideout and Robb, 2018; Heron et al., 2019; Tseng et al., 2017), underscoring its utility to reach and engage this population in vaping cessation. Moreover, text messaging programs that make use of multimedia (visual formats, video) may be more effective at engaging YAs than stand-alone text messages (Abrams et al., 2015). While text messaging programs have a solid evidence base for smoking cessation, they are typically technologically basic (e.g., black/white text, emojis, 160 characters/message) and have not integrated multimedia formats available on smartphones.

Vaping cessation intervention research is needed to examine the utility of novel technology-based intervention strategies – for example, programs that expand on text messaging programs, designed as smartphone apps, chatbots, and/or integrated with social media (e.g., Snapchat, TikTok) (Massey et al., 2021). Indeed, a cursory search for apps in the iTunes and Google Play stores reveal the availability of a handful of apps aimed at vaping cessation, though their efficacy is unknown. Research is also warranted regarding whether interventions that take advantage of a range of smartphone capabilities (e.g., videos, games, memes) may effectively engage YAs and promote vaping cessation. For example, gamification can emphasize specific types of information and promote skill development (Abrams et al., 2015a, 2015b). Such features are likely to increase engagement, a critical factor in a program's success (Abrams et al., 2015). In short, intervention research should examine whether specific technology-based approaches and different features may be effective in engaging YAs who vape and promoting behavior change.

In addition, Clinical Practice Guidelines indicate that providing multiple modes of delivery is likely to boost quit rates (Fiore et al., 2008). Particularly relevant to YA vaping, per the most recent Cochrane review on mHealth (Whittaker et al., 2019), human-delivered counseling (including via text messaging (White et al., 2019)) has been shown to boost quit rates over automated text-messaging programs alone. Vaping is a highly complex behavior, and cessation may impact other behaviors, particularly combusted tobacco use. Individualized counseling to address various dimensions of cessation may be needed given rates of tobacco, nicotine, and marijuana polyuse (Buu et al., 2020; Bluestein et al., 2019; Coleman et al., 2019; Wagner, 1998; Wei et al., 2020).

4. Case example

Ongoing work is striving to address the gaps in existing research and practice. Here we highlight one example of a vaping cessation intervention currently being disseminated and studied. In 2019, Truth Initiative launched *This is Quitting*, a nationally-available text messaging vaping cessation program for youth (13–17 years old) and YAs (18–24 years old) (Graham et al., 2020) *This is Quitting* has enrolled more than 232,000 young people (93,000 teens, 139,000 YAs) as of December 2020, demonstrating significant demand among young people. The program is grounded in the evidence for smoking cessation treatment

among young people and behavior change theory (Fiore et al., 2008; Fanshawe et al., 2017; Mayo Clinic, 2019). The messages are tailored to users' age, their enrollment or quit date, and the vape product they use, and differ for those not ready to quit (i.e., focused on building skills and confidence). An initial observational evaluation of *This is Quitting* (Graham et al., 2020) indicated that, in YAs, the majority set a quit date (74%) and 38.4% used interactive key words. At 14 days (response rate 37%), 61% indicated reduction (47%) or stopping (16%); at 90 days (response rate 21%), 7-day and 30-day point-prevalence abstinence were 26% and 15.0%, respectively (Graham et al., 2020). This program is being disseminated through the national truth® campaign and partnerships with youth-serving organizations (e.g., state/local governments, health plans, school systems). A two-arm RCT (Graham et al., 2020) (vs. control) among 2,600 YAs recruited via web ads was completed in December 2020 (under review). This example shows that theory-driven, technology-based approaches drawing from the smoking cessation treatment evidence base are feasible, acceptable, and promising among YAs.

5. Summary and conclusions

Given the urgency of addressing YA vaping, tobacco control stakeholders have developed and implemented programs to address this critical need. Intervention development has outpaced vaping cessation intervention research, particularly tested via experimental designs. The smoking cessation literature, especially regarding YA smoking, provides evidence and theory from which to draw. However, the extent to which this literature has utility for vaping cessation efforts warrants investigation. Research is needed to inform the development and optimization of effective vaping cessation interventions for YAs. This requires attention to how such interventions address the complexity of YA vaping (e.g., complex social influences, limited negative outcome expectancies, quit intentions). One particularly challenging aspect of YA cessation is addressing polytobacco use and co-use with marijuana – particularly ensuring that those who quit vaping do not continue or increase their cigarette smoking. Intervention modality is also a critical consideration. Technology-based interventions (e.g., text messaging) are promising, and individualized intervention (e.g., one-on-one counseling) may be needed to carefully intervene on the complexity of substance use, particularly cigarette smoking, within this population. There is a critical need to catalyze research to inform ongoing and future vaping cessation programs and advance the science.

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CRedit authorship contribution statement

Carla J. Berg: Conceptualization, Writing - review & editing, Data curation, Formal analysis, Investigation, Methodology, Writing - original draft. **Nandita Krishnan:** Conceptualization, Writing - review & editing, Data curation, Formal analysis, Investigation, Methodology. **Amanda L. Graham:** Conceptualization, Writing - review & editing.

Lorien C. Abroms: Conceptualization, Writing - review & editing, Data curation, Formal analysis, Investigation, Methodology.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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