

**Efficacy of a Group-Based Brief Tobacco Intervention Among Young Adults Between 18 and
20 Years**

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ABSTRACT

Introduction: “Tobacco 21” made it illegal for retailers in the U.S. to sell tobacco to those under 21. However, this policy does not help the large number of young adults 18 – 20 years who will need to successfully quit tobacco or obtain these products illegally but are less likely to successfully quit than other age groups. Additionally, there is limited research on cessation interventions among young adults under 21 years, as well as interventions targeting a wide range of products including electronic nicotine delivery systems (ENDS). Thus, this study tested the efficacy of a group-based Brief Tobacco Intervention (BTI) among a diverse sample of non-college attending young adults (18-20 years) who recently enlisted in the U.S. Air Force.

Methods: Participants were 2,999 US Air Force Technical Trainees at Joint Base San Antonio-Lackland Air Force Base in San Antonio, Texas from April 2017 through January 2018. Participants were group (cluster) randomized to three conditions: (1) BTI + *Airman’s Guide to Remaining Tobacco Free* (AG), (2) AG intervention alone, or (3) standard smoking cessation intervention (CTA). To assess the efficacy of the BTI+AG or AG interventions compared to CTA in preventing tobacco use at 3-months among specific baseline tobacco products use groups who were under 21 years of age, a domain analysis (Age<21 and ≥21) of a multinomial logistic regression model was used to test if there were significant interaction effects between the interventions and baseline tobacco product use as well as the interventions and baseline tobacco product use main effects.

Results: Among mono-tobacco users at baseline who were under 21 years of age, compared to CTA, those who received the BTI+AG intervention had higher odds of quitting tobacco use at 3 months (OR=2.13, 95% CI: 1.02 to 4.46, p=0.045). Among dual and poly-users at baseline who were under 21 years of age, compared to CTA, those who received the BTI+AG intervention had higher odds of reducing the number of tobacco products used (i.e., from dual/poly to mono-product use) at 3 months (OR=2.94, 95% CI: 1.03 to 8.37, p=0.044).

Conclusions: The BTI, which previously did not show intervention effects when tested with the entire sample of young adults, was found effective specifically for those between 18 and 20 years of age in reducing tobacco use at 3-month follow-up. The current study offers insight into components of cessation interventions that might be successful in helping this age group decrease tobacco use.

INTRODUCTION

Tobacco use is increasing among young people in the US, with 6.2 million middle (12.5%) and high school students (27.5%) reporting past 30-day use of a tobacco product in 2019.⁷ This is an increase of approximately 1.32 million youth from the previous year, largely driven by the rise in electronic nicotine delivery systems (ENDS).⁸ Young adults (aged 18-24) also report more than twice the national average of current ENDS use compared to adults in the US (7.6% vs 3.2%, respectively).⁹ Overall, 17.1% of 18-24 year olds report currently using a tobacco product, with 11.2% using a combustible product.⁹ Further, the use of multiple tobacco products is more prevalent among young adults than mono-use.¹⁰ Unfortunately, young people who use multiple products report higher nicotine dependence, greater difficulty quitting, and a greater likelihood of transitioning to other tobacco products.^{3,11,12}

Tobacco addiction is established early in life. Individuals who begin regular smoking between the ages of 18 to 20 years of age have lower odds of both intending and attempting to quit as well as higher

odds of nicotine dependence compared individuals who begin smoking after the age of 21.² Legislation increasing the minimum age to purchase tobacco is an important tobacco control strategy to prevent tobacco use among individuals under 21 years of age.

On December 20, 2019 the federal minimum age for the sale of tobacco products was raised to 21 years. This legislation, known as “Tobacco 21”, instantly made it illegal for retailers in states without existing Tobacco 21 laws to sell tobacco to anyone under 21.¹ Evidence from local jurisdictions demonstrate that Tobacco 21 is an effective tobacco control strategy, {Kessel Schneider, 2016 #4491} {Zhang, 2018 #4492}, supported by the majority of U.S. adults. {King, 2015 #4493} However, this legislation does nothing to help the existing large number of 18-20 year olds with established nicotine dependence quit, particularly, given that they were previously allowed to legally purchase tobacco prior to Tobacco 21.⁶

While cessation at a younger age is associated with better health outcomes and less mortality,¹³ there is limited evidence for the long-term effectiveness of tobacco cessation programs for young adults.^{14,15} In a review of smoking cessation interventions for young adults by Villanti et al.,¹⁵ only two of 14 studies produced significant effects at a 4-6 month follow-up. While many young people who initiate tobacco use want to quit within a short time of commencing,¹⁶ evidence suggests that nicotine addiction occurs very quickly in this population, making the odds of a successful unaided quit attempt very difficult.¹⁷ Additionally, the majority of tobacco cessation programs focus on cigarettes, despite the growing popularity of non-cigarette tobacco products among young adults.¹⁵ Therefore, it is critical that effective tobacco cessation programs are developed addressing the wide range of currently available tobacco products and contemporary patterns of use. Further, this review¹⁵ included studies among young adults (18-24 years); thus, less information is known about effective interventions specifically among young adults between 18 and 20 years.

The current study sought to fill this gap by testing the efficacy of a group-based Brief Tobacco Intervention (BTI) as a tobacco cessation program among a diverse sample of non-college attending young adults who recently enlisted in the U.S. Air Force. We specifically examined whether the BTI,

which previously produced null findings when tested with a sample of young adults,¹⁸ was effective for 18-20 year olds specifically, who we know from the literature are less likely to quit,² and importantly, are now legally unable to purchase tobacco¹² making the need to quit even more salient in this population.

METHODS

Study Design

A description of the clinical trial and interventions can be found elsewhere.¹⁸ Briefly, this study was a three-group clustered randomized clinical trial. Participants were randomized by squadron (groups of about 50 Airmen who undergo all training and education together) to one of three conditions: (1) BTI + *Airman's Guide to Remaining Tobacco Free (AG)*, a relapse prevention pamphlet, (2) AG intervention alone, or (3) the National Cancer Institute's *Clearing the Air (CTA) pamphlet*, a standard smoking cessation intervention. The primary outcome was tobacco abstinence at 3-month follow-up.

Participants

Participants were US Air Force Airmen undergoing Technical Training at Joint Base San Antonio-Lackland Air Force Base in San Antonio, Texas from April 2017 through January 2018. Among the 3,347 participants that we approached, 2,999 consented to participate (89.6% consent rate). Eligibility criteria included being at least 18 years of age and understanding the consent process in English. Among those, 2,969 were eligible to participate in the study. We completed the 3-month follow-up with 2,611 Airmen (87.9% follow-up rate). The protocol was approved by the Institutional Review Board at the 59th Medical Wing of the US Air Force.

Procedure

Airmen were convened by squadrons in groups of approximately 50 Airmen per intervention. Upon arrival, the study and procedures were described, and Airmen were given an opportunity to ask questions. After obtaining informed consent, consented Airmen were administered a pretest assessment. All Airmen received one of the interventions (BTI+ AG, AG, or CTA), regardless of consent status since these interventions were considered part of Air Force training. Airmen assigned to receive the AG or CTA were provided with a 5-minute discussion of the key concepts in the booklets. The discussions were meant to

be interactive, utilizing the Socratic teaching style and eliciting participation through the principles of motivational interviewing. Airmen were encouraged to keep the booklets for the duration of Technical Training to use as a reference for themselves or a fellow Airmen. Airmen who were randomized to the treatment condition (i.e., BTI + AG) then received the BTI intervention components which included a series of open-ended questions through the principles of motivational interviewing.¹⁸ After the delivery of the interventions, all consented Airmen completed the post-test assessment. During the last week of Technical Training (3 months after receiving the intervention), consented Airmen were reconvened by team to complete the 3-month follow-up assessment in groups of approximately 50 Airmen.

Study Measures

Tobacco use was assessed at baseline and follow-up. Participants were asked how often they used the following products: cigarettes/roll your own cigarettes, smokeless tobacco/snus, cigars, cigarillos/little cigars, pipe, ENDS and hookah. Response categories ranged from “Never,” “Quit,” “Less than monthly,” “Monthly,” “Weekly,” to “Daily.” Due to the fact that all Airmen are required to be tobacco free during Basic Military Training, at baseline, the questionnaire assessed tobacco use prior to Basic Military Training. For the primary outcome, tobacco use included the use of any tobacco product at the 3-month follow-up. Tobacco product use at baseline and the 3-month follow-up was defined as: regular mono use of any product, regular dual or poly use of any products (use of two or more products), seldom use of any product(s), and no use of any products. Regular use refers to at least monthly use and the seldom use refers to less than monthly use.⁹

Statistical Analyses

Primary analysis. To assess the efficacy of the BTI+AG or AG compared to CTA in preventing tobacco use, a multinomial logistic regression model was used to test both the intervention arms and baseline tobacco use status main effects as well as interaction effects between the intervention arms and baseline tobacco use status. The model was also adjusted for participant demographics (e.g., gender, race, education, and marital status), as well as correlations between Airmen from the same squadron due to the group-based (cluster samples) randomization using Taylor series variance estimation method. Because we

were primarily interested in the subsample of Airmen who were under 21 years of age, a domain analysis of the multinomial logistic regression model was employed to incorporate the variability of the formation of different domains of age groups into the variance estimation (SAS Proc Surveylogistic). The overall ability of the multinomial logistic regression model to discriminate between the 4 tobacco use categories was quantified by estimating nonparametric polytomous discrimination index, bootstrapped 95% confidence intervals^{19,20}, and pairwise C-statistics²¹ between categories to determine which categories can be well discriminated. The significance level was specified at $\alpha = 0.05$. All analyses were performed in SASv9.4 (Cary, NC, USA) and R3.6.0 (The R Foundation for Statistical Computing).

Secondary analysis. Since ENDS use among young adults has been increased dramatically in recent years,⁹ we conducted a secondary analysis to determine whether the intervention produced cessation or harm reduction effects among ENDS users specifically at baseline (i.e., regular mono users of ENDS, and dual or poly users of ENDS and other products). A similar analytic approach as described for the primary analysis was used.

RESULTS

The majority of participants were white males, and roughly 20% of participants were Hispanic (Table 1). Among participants who were less than 21, regular mono tobacco use at baseline ranged from 11.6% to 13.2% by intervention arms, regular mono use of ENDS at baseline specifically ranged from 5.2% to 7.0%. Among participants ≥ 21 , regular mono tobacco use at baseline ranged from 9.7% to 14.2%; regular mono ENDS use at baseline ranged from 2.5% to 3.9% by intervention arms. At the 3-month follow-up, among participants who were less than 21, regular mono tobacco use ranged from 8.6% to 9.0% by intervention arms, regular mono use of ENDS specifically ranged from 4.6% to 5.3%. Among participants ≥ 21 , regular mono tobacco use at the 3-month follow-up ranged from 5.1% to 7.9%; regular mono ENDS use at baseline ranged from 1.4% to 3.1% by intervention arm.

Primary analysis. Overall, there were significant interaction effects between the interventions and baseline tobacco use ($p < 0.0001$) and baseline tobacco use main effects ($p < 0.0001$), although the main effect of the interventions was not significant ($p = 0.794$). Compared to CTA, BTI+AG intervention

demonstrated significant efficacy in helping younger Airmen (age<21) who were regular mono-users at baseline to quit at 3-month follow-up (OR=2.13, 95% CI: 1.02 to 4.46, p=0.045, see Table 2). Regular dual/poly-users at baseline who received the BTI+AG compared to CTA were less likely to quit at follow-up compared to reporting mono-use (OR=0.36, 95% CI: 0.15 to 0.91, p=0.030), in other words, the BTI+AG intervention were more likely to help dual/poly-users at baseline to reduce the number of tobacco products used to mono-product use at follow-up. Comparing the BTI+AG with CTA, regular dual/poly users at baseline were less likely to report regular dual/poly use at 3-month follow-up compared to mono-use (OR=0.34, 95% CI: 0.12 to 0.97, p=0.044; see Table 2), in other words, the BTI+AG helped dual/poly-users at baseline to become mono-users at follow-up (OR=2.94, 95% CI: 1.03 to 8.37). The AG alone did not show any significant intervention effects compared to CTA (p>0.05). There were no significant differences between the intervention groups in the over 21-year-old group (see Supplemental Table 1).

Secondary analysis. There were significant interaction effects between the interventions and baseline ENDS use (p<0.0001) and baseline ENDS use main effects (p<0.0001), although again the main effect of the intervention was not significant (p=0.851). Among regular ENDS mono-users at baseline, younger Airmen (age <21) in the BTI+AG intervention were more likely to report abstinence at the follow-up compared to Airmen receiving CTA (OR=2.95, 95% CI: 1.16 to 7.53, p=0.024; see Table 3). Regular concurrent ENDS and other tobacco product users who received the BTI+AG compared to CTA at baseline were less likely to quit at follow-up compared to reporting mono-use (OR=0.19, 95% CI: 0.05 to 0.69, p=0.011), in other words, were more likely to become mono-users at follow-up. The same was true for participants who received the AG (OR=0.18, 95% CI: 0.04 to 0.79, p=0.023). . There were no significant differences between the intervention groups in the over 21-year-old group. (see Supplemental Table 2). Because our primary outcome has 4 categories, the null polytomous discrimination index (PDI) of the overall model is $\frac{1}{4}=0.25$ (viz., random guess). The estimated PDI of 0.43 (bootstrapped 95% confidence interval: 0.40 to 0.45) from the primary analysis model is about 1.7 times of the lower bound which corresponds to no discriminative ability, indicating the model has fairly good predictive

discriminative ability. The pairwise C-statistics of 0.76 for the comparison of “regular mono use of any product” and “no use” categories at 3-month follow-up and of 0.84 for the comparison of “regular dual or poly of any products” and “no use” categories indicated that the model has good to excellent discriminative ability for the comparisons of the primary interests.

DISCUSSION

This study found that a brief 45-minute tobacco intervention was effective in reducing tobacco use among a large military sample of racially diverse young adults. Specifically, the BTI + AG intervention demonstrated significant efficacy in helping younger participants (< age 21) who were mono-tobacco users at baseline (i.e., cigarettes/roll your own cigarettes, smokeless tobacco/snus, cigars, cigarillos/little cigars, pipe, ENDS or hookah) to quit at 3-month follow-up, as well as dual and poly tobacco users reduce the number of tobacco products they used to mono-product use. Additionally, among exclusively mono ENDS users at baseline, these individuals were more likely to be quit from ENDS at follow-up if they received the BTI + AG intervention. These results are promising because despite tobacco use being on the rise among young adults⁷⁻⁹ There has been limited evidence for the long-term effectiveness of tobacco cessation programs for this age group^{14,15}. Recent T21 laws will help prevent the uptake of tobacco among individuals under the age of 21 years, yet this policy does not address cessation efforts among youth who have already developed nicotine dependence to these products⁶. Therefore, the efficacy of this BTI + AG intervention has implications for cessation efforts for youth using tobacco, including those exclusively using ENDS.

Although ENDS are the most common tobacco product used among young adults⁹, few youth-focused cessation programs have focused specifically on helping ENDS users quit these products²². ENDS deliver nicotine at higher or comparable levels to cigarettes, are capable of introducing nicotine dependence to otherwise tobacco naïve individuals, and have negative cardiovascular health effects (e.g., elevating heart rate and diastolic blood pressure)^{23 24,25}. A recent qualitative exploration identified key differences in ENDS cessation compared to other tobacco products among young adults, including increased social acceptability of vaping, more uncertainty in regard to the health effects of vaping, and

behavioral differences in vaping delivery²⁶. Thus, it is likely important to differentially target specific tobacco products within cessation interventions for young adults, as well as for studies to examine the effects of the intervention across products.

There are multiple components of the current BTI + AG intervention that likely facilitated reducing tobacco use in this population. For example, the BTI intervention focused on restructuring cognitive misperceptions related to tobacco use (e.g., normative beliefs and perceptions of harm) and decreasing hyperbolic discounting (i.e., consider long-term goals in the context of current behavior²⁷). Clear communication addressing misperceptions about tobacco harms might have been particularly useful for those using ENDS, given that young people have reported fatigue and confusion in regard to conflicting information about the risk of ENDS²⁶. Further, having these young adults identify the ways in which tobacco use might impact their long-term goals might have helped facilitate quitting similarly to other substance use interventions²⁷. Additionally, the BTI intervention was interactive and group-based, with approximately 50 participants per group. A Cochrane review among young adults found that group-based tobacco interventions had the most promising results for reducing tobacco use rates¹⁴. Thus, current findings are consistent with the civilian literature in suggesting that youth are more likely to quit when hearing supportive responses and feedback from their peers during the intervention^{14,22}. Further, interventionists in this study had a military career background. Thus, it is likely that an intervention facilitated by someone trusted and respected by these young adults was more impactful to them. Although there were likely multiple components of this intervention that helped reduce tobacco use, it is unclear which specific components were more effective than others. It will be important for future studies to continue examining specific strategies that help individuals under the age of 21 years quit tobacco products.

Neither the BTI + AG nor the AG interventions prevented participants switching from regular mono ENDS use at baseline to the use of other tobacco products at the 3-month follow-up. A recent meta-analysis of nine studies comprising 17,389 youth and young adults, found that ever ENDS users were 3.5 times more likely to initiate cigarettes at follow-up compared to never users.²⁸ Therefore, cessation

interventions among young adults should provide education about this common harm escalation of ENDS to dual or poly tobacco use in order to mitigate this outcome. However, it is important to note that in the current study, the BTI + AG intervention helped dual/poly tobacco users (of any products) reduce to mono-tobacco use at the 3-month follow-up. Young adults (aged 18-34 years) have been found to use multiple tobacco products more commonly than using only one product¹⁰. Given rising rates of ENDS⁹, a product which also increases the likelihood of concurrently initiating other tobacco products²⁸, it might be beneficial for cessation interventions to at least initially support dual and poly tobacco users reduce to single use, and then subsequently build on this initial success in order to promote complete tobacco abstinence long term.

There are some limitations that are important to consider. This cessation intervention was delivered during an enforced military tobacco ban, which has been found to produce long-term cessation rates from 15 to 20% in military populations^{29,30}. However, this condition would be uniform across all three randomized arms, and intervention effects were only seen in the BTI intervention arm. Further, even though an 8 ½ week enforced tobacco ban is unique to the military, tobacco bans are not unlike smoke-free policies and tobacco restrictions on college campuses and dorms which have also been shown to reduce tobacco prevalence rates³¹. Because baseline tobacco rates relied on self-report of tobacco use prior to the tobacco ban, there may be some social desirability bias, but this was unlikely to differ by intervention arm and therefore would not be anticipated to have a differential effect on our outcomes of interest. Finally, this population included Air Force personnel and thus results might not be generalizable to other military branches despite similar tobacco bans across all military training.

The current study identified the efficacy of a group-based brief tobacco intervention in reducing tobacco rates at the 3-month follow-up among a sample of young adults (18 – 20 years old) recently enlisted in the U.S. Air Force. Although the intervention was implemented within a military sample, there are important implications for both civilian and military young adults. First, this population offered a unique opportunity to examine a cessation intervention within a large, racially diverse, non-college sample of young adults. Secondly, despite rising tobacco rates in young adulthood⁷⁻⁹, there have been few

randomized-controlled trials of tobacco cessation interventions in this age group^{14,15}. Finally, cessation trials have typically focused on cigarettes and fewer have observed outcomes among young adults using only ENDS. Therefore, the current cessation trial expands upon the prevention efforts of Tobacco 21 laws, by offering effective strategies for young adults (18-20 years) who are already established tobacco users (including ENDS only users), to reduce their use of these products.

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DECLARATION OF INTERESTS

None declared.

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Table 1: Participant Characteristics by Interventions and Age Groups

	Age <21 (n=2117)			Age ≥21 (n=852)		
	BTI+AG (n=1034)	AG (n=566)	CTA (n=517)	BTI+AG (n=404)	AG (n=205)	CTA (n=243)
Age^a	18.8 (18,19,19)	18.8 (18, 19, 19)	18.8 (18,19,19)	23.4 (21, 22, 24)	23.6 (21, 23, 24)	23.4 (21, 22, 25)
Male	728 (70.4)	369 (65.2)	385 (74.5)	271 (67.1)	149 (72.7)	173 (71.2)
Race						
Black	202 (19.5)	110 (19.4)	94 (18.2)	87 (21.5)	30 (14.6)	58 (23.9)
White	652 (63.1)	348 (61.5)	339 (65.6)	237 (58.7)	126 (61.5)	133 (54.7)
Multiple	106 (10.3)	64 (11.3)	53 (10.3)	40 (9.9)	22 (10.7)	24 (9.9)
Other	74 (7.2)	44 (7.8)	31 (6.0)	40 (9.9)	27 (13.2)	28 (11.5)
Hispanic	220 (21.3)	106 (18.7)	103 (19.9)	94 (23.3)	50 (24.4)	57 (23.5)
Married	49 (4.7)	23 (4.1)	21 (4.1)	92 (22.8)	41 (20.0)	45 (18.5)
Education						
High school diploma/GED	795 (76.9)	418 (73.9)	407 (78.7)	107 (26.5)	71 (34.6)	75 (30.9)
Vocational training	11 (1.1)	1 (0.2)	1 (0.2)	0 (0.0)	6 (2.9)	3 (1.25)
Some college/Associates	226 (21.9)	134 (23.7)	105 (20.3)	219 (54.2)	101 (49.3)	121 (49.8)
Bachelor's degree or higher	2 (0.2)	13 (2.3)	4 (0.8)	78 (19.3)	27 (13.2)	44 (18.1)
Military Rank						
Active Duty	940 (91.3)	503 (89.8)	456 (88.4)	322 (80.1)	167 (82.7)	189 (78.8)
Guard	67 (6.5)	43 (7.7)	44 (9.5)	54 (13.4)	23 (11.4)	28 (11.7)
Reserve	23 (2.2)	14 (2.5)	11 (2.1)	26 (20.5)	12 (5.9)	23 (9.6)
Prior Tobacco Use						
Regular mono-use	136 (13.2)	69 (12.2)	60 (11.6)	39 (9.7)	29 (14.2)	32 (13.2)
Regular dual/poly-use	121 (11.7)	69 (12.2)	73 (14.2)	41 (10.2)	15 (7.4)	24 (9.9)
Seldom use	102 (9.9)	59 (10.4)	43 (8.3)	50 (12.4)	17 (8.3)	24 (9.9)
No-use	673 (65.2)	368 (65.1)	340 (65.9)	274 (67.8)	143 (70.1)	163 (67.1)
Prior ENDS/ENDS Use						
Regular ENDS/ENDS mono-use	69 (7.0)	36 (6.4)	27 (5.2)	10 (2.5)	8 (3.9)	8 (3.3)
Regular concurrent use of ENDS/ENDS and other products	75 (7.3)	50 (8.9)	56 (10.9)	23 (5.7)	7 (3.4)	15 (6.2)
Regular other products use	113 (11.0)	52 (9.2)	50 (9.7)	47 (11.6)	29 (14.2)	33 (13.6)
Seldom use	102 (9.9)	59 (10.4)	43 (8.3)	50 (12.4)	17 (8.3)	24 (9.9)
No use	673 (65.2)	368 (65.1)	340 (65.9)	274 (67.8)	143 (70.1)	163 (67.1)
Tobacco Use at 3-Months						
Regular mono-use	80 (8.6)	43 (8.9)	41 (9.0)	28 (7.9)	9 (5.1)	12 (5.6)
Regular dual/poly-use	78 (8.4)	34 (7.0)	43 (9.5)	16 (4.5)	7 (4.0)	12 (5.6)
Seldom use	58 (6.3)	30 (6.2)	23 (5.1)	27 (7.6)	12 (6.9)	15 (7.0)
No use	711 (76.7)	377 (77.9)	348 (76.5)	285 (80.1)	147 (84.0)	175 (81.8)
ENDS Use at 3-Months						
Regular ENDS mono-use	49 (5.3)	26 (5.4)	21 (4.6)	11 (3.1)	4 (2.3)	3 (1.4)

Regular concurrent use of ENDS and other products	59 (6.4)	24 (5.0)	27 (5.9)	7 (2.0)	5 (2.3)	9 (4.2)
Regular other products use	50 (5.4)	27 (5.6)	36 (7.9)	26 (7.3)	7 (4.0)	12 (5.6)
Seldom use	58 (6.3)	30 (6.2)	23 (5.1)	27 (7.6)	12 (6.9)	15 (7.0)
No use	711 (76.7)	377 (77.9)	348 (76.5)	285 (80.1)	147 (84.0)	175 (81.8)

Note. N (%) unless otherwise noted; ^aMean (1st quartile, median, 3rd quartile); BTI = Brief Tobacco Intervention, CTA = National Cancer Institute's Clearing the Air intervention, AG = Airman's Guide intervention; GED = General Educational Development.

Table 2: Primary analysis of interventions effects in predicting of tobacco products use at follow-up (among participants <21 years of age)

Tobacco Product Use at Baseline	Intervention arm	Tobacco Product Use at 3-month (reference category: Regular Mono Use) OR (95% CI)	
		No use	Regular dual or poly use
Any regular tobacco mono use	BTI+AG vs. CTA	2.13 (1.02, 4.46)	1.63 (0.54, 4.89)
	AG vs. CTA	2.07 (0.81, 5.26)	1.54 (0.54, 4.40)
Regular dual or poly tobacco use	BTI+AG vs. CTA	0.36 (0.15, 0.91)	0.34 (0.12, 0.97)
	AG vs. CTA	0.46 (0.15, 1.40)	0.37 (0.12, 1.09)

Bold indicates statistical significance at $p < 0.05$.

Table 3: Secondary analysis of interventions effects in predicting tobacco products use at follow-up among ENDS users at baseline (among participants < 21 years of age)

Any ENDS Use at Baseline	Intervention arm	Tobacco Product Use at 3-month (reference category: Regular Mono Use) OR (95% CI)	
		No use	Regular dual or poly use
Regular mono use of ENDS	BTI+AG vs. CTA	2.95 (1.16, 7.53)	1.67 (0.37, 7.53)
	AG vs. CTA	2.53 (0.81, 7.91)	1.27 (0.25, 6.55)
Regular concurrent use of ENDS and other products	BTI+AG vs. CTA	0.19 (0.05, 0.69)	0.28 (0.08, 1.00)
	AG vs. CTA	0.18 (0.04, 0.79)	0.26 (0.07, 1.03)

Bold indicates statistical significance at $p < 0.05$.

Supplemental Table 1. Interventions effects in predicting of tobacco products use at follow-up (among participants ≥ 21 years of age)

Tobacco Product Use at Baseline	Intervention arm	Tobacco Product Use at 3-month (reference category: Regular Mono Use) OR (95% CI)	
		No use	Regular dual or poly use
Any regular tobacco mono use	BTI+AG vs. CTA	1.48 (0.32, 6.74)	0.66 (0.06, 7.44)
	AG vs. CTA	3.20 (0.51, 19.97)	2.74 (0.38, 19.50)

Regular dual or poly tobacco use	BTI+AG vs. CAT	0.88 (0.22, 3.56)	0.37 (0.11, 1.21)
	AG vs. CTA	1.12 (0.20, 6.38)	0.26 (0.05, 1.30)

Supplemental Table 2: Interventions effects in predicting tobacco products use at follow-up among ENDS users at baseline (among participants ≥ 21 years of age)

Any ENDS Use at Baseline	Intervention arm	Tobacco Product Use at 3-month (reference category: Regular Mono Use) OR (95% CI)	
		No use	Regular dual or poly use
Regular mono use of ENDS	BTI+AG vs. CTA	0.51 (0.03, 8.22)	0.25 (0.01, 8.00)
	AG vs. CTA	?NA	NA
Regular concurrent use of ENDS and other products	BTI+AG vs. CTA	1.02 (0.20, 5.29)	0.42 (0.06, 3.11)
	AG vs. CTA	0.87 (0.09, 8.01)	NA

NA: not sufficient information for estimation.

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