



A quasi-experimental test of a virtual reality game prototype for adolescent E-Cigarette prevention

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HIGHLIGHTS

- *Invite Only VR* is a virtual reality e-cigarette prevention game for adolescents.
- Playing the game increased knowledge and perceptions of e-cigarette harm.
- Playing also decreased perceived likelihood of using e-cigarettes in the future.
- Participants stated that they enjoyed playing and would tell their friends to play.
- The game presents e-cigarette prevention material in a fun, effective format.

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ABSTRACT

Objective: To test the preliminary impact and participant experience/satisfaction of *Invite Only VR: A Vaping Prevention Game (Invite Only VR)*, an electronic cigarette (e-cigarette) prevention game prototype using virtual reality (VR) hardware.

Methods: Forty-seven adolescents (38 boys; mean age = 14.23 years, $SD = 0.914$) were enrolled to test the preliminary impact of *Invite Only VR* on knowledge, perceived likelihood of using e-cigarettes, perceptions of harm, attitudes, social norms, and self-efficacy to refuse e-cigarettes using a pre/post design. Experience/satisfaction was measured following gameplay. Paired-samples t -tests and associated effect sizes were used to assess changes in the dependent variables. Descriptive statistics were used to report on gameplay experience/satisfaction.

Results: From pre- to post-gameplay, players significantly increased in knowledge ($t(34) = -5.594, p < .001$, Cohen's $d = 0.946$) and perceptions of e-cigarette harm ($t(34) = -3.370, p = .002$, Cohen's $d = 0.530$) and decreased their perceived likelihood of using e-cigarettes in the future ($t(35) = 2.140, p = .039$, Cohen's $d = 1.274$). No significant change was found for attitudes towards e-cigarettes, social norm perceptions, nor refusal self-efficacy. Participants reported that they enjoyed playing the game ($M = 3.00, SD = 0.99$) and that they would tell their friends to play ($M = 3.08, SD = 0.91$).

Conclusions: *Invite Only VR* may help players develop knowledge and correct harm perceptions regarding e-cigarettes while reducing their perceived likelihood of using them in the future. Participant enjoyment also provides an initial indication that the intervention may be acceptable for use with adolescents.

1. Introduction

Electronic nicotine delivery systems (ENDS), specifically electronic cigarettes (e-cigarettes), are now the most commonly-used nicotine-containing products among U.S. middle- and high-school students

(National Institute on Drug Use, 2018). The precipitous rise in popularity of ENDS has caused increasing public health concerns about a new generation of nicotine-dependent youth. At the center of the adolescent e-cigarette vaping epidemic is the e-cigarette brand JUUL, which captured 72% of the e-cigarette market in 2017 (King et al.,

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2018), due to its targeted marketing of a product with a sleek, trendy design and kid-friendly flavors like “Fruit Medley” and “Creme Brule.” According to the National Youth Tobacco Survey, the percentage of high-school students who reported using e-cigarettes increased from 12% in 2017 to 28% in 2019 (Wang et al., 2019).

Nicotine exposure during adolescence has a demonstrated negative effect on attention and cognition, and exposure to nicotine through e-cigarettes can substantially increase adolescent’s susceptibility to future nicotine addiction (The US Department of Health and Human Services, 2016). E-cigarettes also can cause breathing difficulties, inflammatory reactions, and lung disease (Centers for Disease Control and Prevention, 2019; The U.S. Food and Drug Administration, 2019). Given these myriad adverse outcomes for adolescent e-cigarette use, it is imperative to develop evidence-based prevention programs that appeal to young people.

Previous research indicates that active intervention strategies are more effective than passive educational campaigns (Albarracín et al., 2005), and because interactive videogames provide “hands-on” experiences in which adolescents can acquire and rehearse skills that can transfer to real-life situations (Kato et al., 2008), they are well-suited for use in prevention programs. Moreover, 90% of American adolescents report they play videogames (Anderson & Jiang, 2018).

Virtual Reality (VR) is an emerging videogame technology that provides hands-on interaction and immerses the user’s senses. With the recent commercialization of VR hardware, the use of VR has emerged as an effective intervention and treatment approach for a range of health issues (Dascal et al., 2017), including phobias (Powers & Emmelkamp, 2008), social anxiety (Anderson et al., 2013), post-traumatic stress disorder (Motraghi et al., 2014), and pain management (Sharar et al., 2008; Chan et al., 2018). However, very little work has examined the possibility of using VR to prevent adverse outcomes, such as e-cigarette use initiation (for notable exception, see Ingram et al., 2019 for work on a bullying prevention intervention in VR). VR is unique in that it allows the simulation of real-life situations in a three-dimensional, computer-generated environment where the user can interact with the environment as if they were in the real world (Morina et al., 2014). For example, the Oculus Go VR headset is a standalone, all-in-one headset that is used while seated and stationary (Oculus, 2019). Across a wide range of VR headsets, there is evidence to suggest that individuals who acquire information, motivation, skills, and behaviors in a virtual environment, and subsequently practice those entities in a VR game, are more likely to act in accordance with the new skills in real life (Bainbridge, 2007; Hubal & Parsons, 2017; Didehbani et al., 2016).

Given the ubiquity of videogame play and their demonstrated impact on health promotion (e.g. Baranowski et al., 2008; Papastergiou, 2009, for reviews), our aim was to harness the potential for skill acquisition and practice in VR through the development of an engaging e-cigarette prevention VR videogame. To this end, we developed an evidence-based e-cigarette prevention game prototype called *Invite Only VR: A Vaping Prevention Game (Invite Only VR)* which provides the player with opportunities to practice navigating peer pressure situations involving e-cigarettes, including JUUL. This study was conducted to explore whether adolescents who played the *Invite Only VR* prototype would report increased knowledge about e-cigarettes, reduced perceptions of their likelihood of using e-cigarettes within one year, increased perceived harm of using e-cigarettes, change in attitudes and social norms, and increased self-efficacy to refuse e-cigarette use from pre- to post-gameplay. We also collected data on gameplay experience/satisfaction as an early indicator of the intervention’s acceptability.

2. Materials and methods

Approval for this feasibility study was obtained by the Yale University School of Medicine Human Investigation Committee.

2.1. *Invite Only VR: A vaping prevention game*

Invite Only VR is a VR story-based videogame intervention that teaches adolescents aged 13 to 16 years about the health risks of vaping e-cigarettes while providing a virtual environment for adolescents to practice refusing peer pressure to vape e-cigarettes. Using procedures established in our previous work (e.g., Duncan et al., 2014), we partnered with Preview Labs to develop the prototype game. Created with input from focus groups (Camenga et al., 2018), educators, and survey data from adolescents in our population, *Invite Only VR* was designed as a seated VR experience for the Oculus Go VR headset (Oculus, 2019).

The development of *Invite Only VR* was guided by constructs from well-established behavior change theories, including theory of planned behavior (Ajzen, 1991) and social cognitive theory (Bandura & Walters, 1977). The theory of planned behavior states that an individual must have both the motivation (intention) and ability (behavioral control) to successfully enact a particular behavior. To increase the development of healthy attitudes and intentions toward abstaining from vaping, the game provides opportunities for the player to evaluate behavioral outcomes and personal beliefs through narrative choices that affect both the player and other characters in the game. The game also includes the ability to practice essential skills related to increasing self-efficacy to refuse e-cigarettes and behavioral control, such as refusing peers in risky social situations that involve vaping. Given that learning occurs within a social context (Bandura & Walters, 1977), the game allows the player to observe and model behaviors of other characters while experiencing both positive and negative reinforcements from the virtual environment.

In the narrative of *Invite Only VR*, the player must secure an invitation to an exclusive party. In order to reach the party, the player encounters multiple scenarios where virtual peers pressure him or her to experiment with e-cigarettes. To overcome these instances of peer-pressure, the player uses four unique abilities: (1) The ability to observe the environment, (2) the ability to apply newly-gained knowledge about vaping in conversations with others, (3) the ability to decipher vaping colloquialisms, and (4) the ability to refuse peers in an effective way (see Fig. 1A for an example of the knowledge ability and Fig. 1B for an example of the refusal ability). Each of these skills reinforces the game’s learning goals, as depicted in the conceptual model of the game in Fig. 2. By incorporating voice recognition software in the game, the player can use his or her own voice to engage with virtual peers. In this manner, *Invite Only VR* facilitates a repetitive and meaningful practice of both refusing peers and applying knowledge of the dangers of e-cigarettes in conversations with peers.

2.2. *Participants and procedures*

In August/September of 2018, 47 adolescents (mean age 14.23 years; $SD = 0.914$) were recruited from a local high school after school sports program. Participants were recruited through posters advertising payment for participating in a research study about videogames. Each year the sports program enrolls approximately 85 students, and all individuals who returned informed consent paperwork signed by a parent or guardian were invited to join the study. Adolescents provided written assent prior to participating in the study. An a priori sample size calculation conducted using G*Power software indicated that for our planned statistical tests, with $\alpha = 0.05$ and $\text{power} = 0.90$, and assuming a moderate effect size on the primary dependent variable (knowledge), a sample size of 36 adolescents would be required. Participants were mostly boys (81%), and just over half self-identified as Latino (51%). Thirty-two percent of participants were Black, 19% identified as white, 19% identified as multi-racial, 2% identified as Hawaiian or Pacific Islander, 2% as Native, and the remaining 26% indicated “other” or left the question unanswered. The study was designed such that the players would play the 1.5–2-hour game over the course of 2 sessions separated by 1–5 days so that players

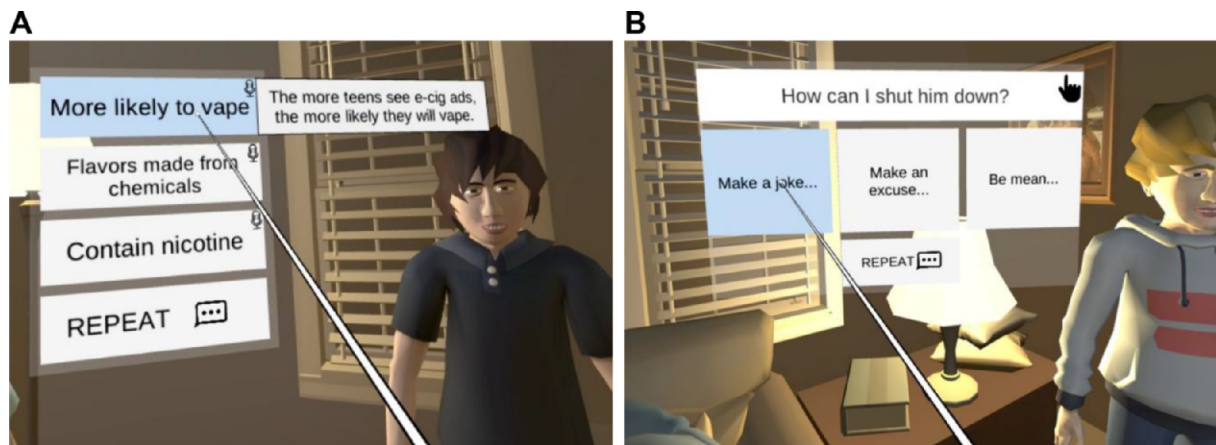


Fig. 1. Screenshots from *Invite Only VR*. A. The Ability to Apply Knowledge: The player corrects a character’s misinformation about e-cigarettes. The text shown to the right of the microphone must be read aloud by the player. Voice recognition software identifies correct statements and allows the player to proceed. B. The Ability to Refuse Peers: The player selects how to turn down a virtual character’s e-cigarette offer in the game. After selecting a refusal strategy, the game will provide an example that the player can read aloud to “shut down” the e-cigarette offer.

would not become overtired during a single extended play session. During each play session, participants were offered a 10-minute break after 30 min of gameplay. All participants who returned for a second play session completed the game. Participants were provided a \$30 gift card after completing both the pre- and post-gameplay surveys.

2.3. Measures

Demographic characteristics (e.g., age, grade, gender, ethnicity and

race) were collected in the pre-gameplay survey. Questions about whether participants had heard of e-cigarettes prior to participating in the study, whether friends or family members used ENDS, and whether they themselves had ever tried e-cigarettes in the past were included in the pre-gameplay survey. JUUL, Blu, Vuse, NJOY, and Flavor Vapes were presented as examples. Aside from the gameplay experience/satisfaction questions included in the post-gameplay survey, the remainder of the pre-gameplay and post-gameplay questionnaires were identical and consisted of questions from the Youth Risk Behavior

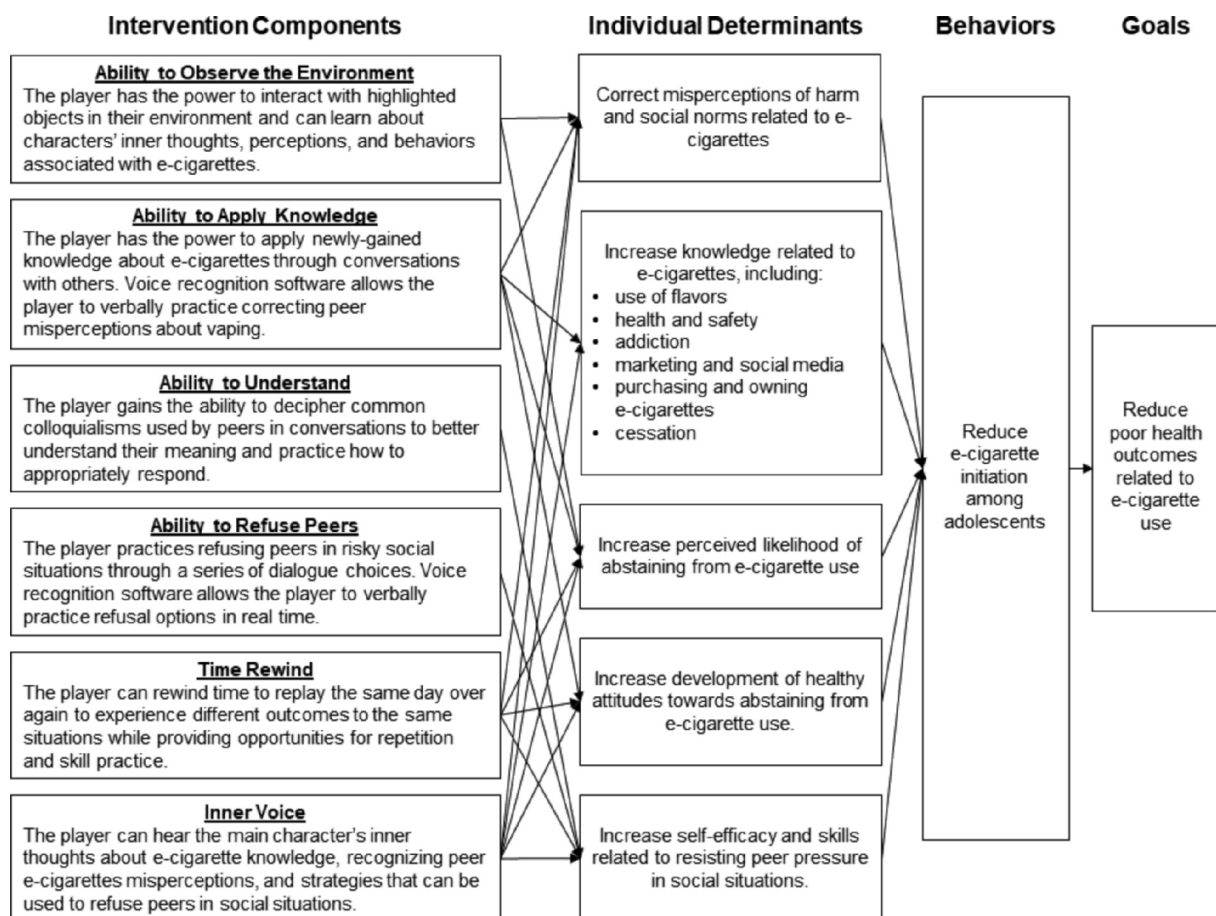


Fig. 2. The conceptual model of the game outlines how the abilities in the game contribute to meeting the intervention goal.

Table 1
Impact of gameplay on primary outcomes.

	Pretest M (SD)	Posttest M (SD)	Effect size (Cohen's d)
Knowledge	4.09 (2.92)	7.46 (2.45)	0.946
Likelihood of Use	1.53 (0.86)	1.33 (0.68)	0.257
Perceived Harm	2.84 (0.76)	3.25 (0.74)	0.530
Attitudes			
It is easy to quit vaping/JUULing after you start	2.89 (0.83)	3.03 (0.79)	0.128
It is safe to JUUL/vape for a year as long as you quit after that	1.65 (0.89)	1.53 (0.71)	0.118
It is hard to get addicted to vaping/JUULing	1.11 (1.36)	1.82 (1.34)	0.453
I think I might enjoy vaping/JUULing	1.63 (0.84)	1.58 (0.73)	0.056
Self-efficacy	3.46 (0.92)	3.57 (0.69)	0.135; NS

Effect sizes are Cohen's d and were interpreted using the following guidelines: 0.2 = small; 0.5 = medium; 0.8 = large. Composite knowledge scores ranged from 0 to 10, whereas composite self-efficacy and perceived harm scores ranged from 0 to 5 (higher numbers represent greater self-efficacy to refuse and greater perceived harm of e-cigarettes). Attitude scores ranged from 0 to 4 (higher numbers represent greater agreement with the statement).

Survey (Kann et al., 2018) that was adapted to include additional questions about vaping norms and attitudes for the specific context of this research.

In both the pre- and post-gameplay survey, knowledge about e-cigarettes was evaluated with 10 true/false statements such as “the vapor from e-cigarettes is just water, which is safe to inhale” or “e-cigarettes rarely contain nicotine,” and recoded as correct/incorrect. A cumulative knowledge score was then created for each participant, with a maximum score of 10. Likelihood of self-reported e-cigarette use in the coming year was measured with the question “How likely is it that you will be vaping/JUULing one year from now,” to which participants could respond 1 (not at all likely) to 5 (very likely). Perceived harms of e-cigarettes were assessed with 3 items (e.g., “How much do you think people harm themselves when they breathe in other people's e-cigarette or JUUL vapor?”), measured on a 4-point Likert scale ranging from 1 (no harm) to 4 (a lot of harm), with the option to select 5 (I don't know). These items were then combined into a composite scale (cronbach's alpha at pre = 0.625; cronbach's alpha at post = 0.651). Attitudes about e-cigarettes were assessed with 4 statements like “It is easy to quit vaping/JUULing after you start” or “It is hard to get addicted to vaping/JUULing,” to which participants could respond with answers ranging from 1 (strongly disagree) to 4 (strongly agree).

Social norms and social expectations surrounding vaping/JUUL were assessed with 3 items (e.g., “people who vape/JUUL have *more/less/the same number of friends* as people who don't vape/JUUL”). Self-efficacy for refusing e-cigarettes was measured using 8 items with response options ranging from 1 (very sure) to 5 (not at all sure) the respondent was that he or she could refuse peers in situations involving e-cigarettes. The following is an example self-efficacy question: “how sure are you that you can refuse if a friend offers you a hit off a JUUL?” These items were combined into a composite scale (cronbach's alpha at pre = 0.977; cronbach's alpha at post = 0.914). In the post-gameplay survey only, gameplay experience/satisfaction was assessed with 10 questions with 5-point Likert-type responses ranging from 1 (Strongly Disagree) to 4 (Strongly Agree), with the option to select 5 (I don't know) (Fiellin, et al., 2016, 2017; Duncan et al., 2018; Hieftje, Duncan, & et al., 2019). Example questions include “I enjoyed playing the game” and “I would make decisions in life like I made them in the game.”

2.4. Statistical analysis

Paired-samples t-tests were conducted to explore changes on the continuous dependent variables (i.e., knowledge, perceived likelihood of using e-cigarettes, perceptions of harm, attitudes, and self-efficacy) from pre- to post-gameplay. Effect sizes associated with the associated with changes from baseline to post-gameplay were interpreted using traditional guidelines (0.2 = small; 0.5 = medium; 0.8 = large effect) (Cohen, 1969). Descriptive statistics were used to evaluate the gameplay experience/satisfaction items.

3. Results

Of the 47 adolescents, 8 participants (17%) had not heard of either JUUL or e-cigarettes prior to participating in the study. Four of the 47 participants (9%) said that they had JUULed or used e-cigarettes in the past. Furthermore, 23 participants (49%) said at least one of their friends JUULed or used e-cigarettes, and 7 participants (15%) reported that a member of their household JUULed or used e-cigarettes. Participants played *Invite Only VR* 1–2 times over the course of 1–2 weeks and accumulated an average of 93 min ($SD = 26$ min) of total play time.

Because we were working with an after-school high school sports team, 11 participants were unable to attend the second gameplay session due to having to attend an away game and therefore did not complete the post-gameplay survey. The following data are analyzed from the 36 participants (77%) who completed the pre-gameplay assessment, two gameplay sessions, and the post-gameplay assessment. Seven participants (19%) from this final sample were among the subset of participants who reported that they had not heard of either e-cigarettes or JUUL prior to the start of the study.

3.1. Impact of *Invite Only VR*

The means and standard deviations for the composite measures at baseline and post-gameplay are presented in Table 1. Paired samples t-test showed a significant improvement in knowledge from baseline assessment to post-game play: $t(34) = -5.594, p < .001$, Cohen's $d = 0.946$. A paired samples t-test also revealed a significant reduction in the self-reported likelihood that a participant would experiment with e-cigarettes in the coming year: $t(35) = 2.140, p = .039$, Cohen's $d = 1.274$. Paired samples t-test detected a significant increase in perceived harm of e-cigarettes from baseline to post-gameplay $t(34) = -3.370, p = .002$, Cohen's $d = 0.530$. Paired sample t-tests examining changes from baseline to post-gameplay assessment items regarding attitudes towards e-cigarettes revealed no significant changes. Visual inspection of the means for attitudes towards e-cigarettes shows nonsignificant changes that suggest increased wariness surrounding e-cigarettes regarding their addictiveness. Participant endorsement of items assessing perceived social norms of e-cigarettes also did not change significantly following exposure to *Invite Only VR*. It is worth noting that the number of participants who believed that “teens who JUUL have more friends than teens who don't JUUL” decreased from 10 participants (27.8% of respondents) to 1 participant (2.8%) following gameplay. Finally, paired samples t-tests revealed no significant improvement in self-efficacy to refuse.

3.2. Sensitivity analysis

We conducted a sensitivity analysis to examine whether the inclusion of the 8 participants who had not heard of either JUUL or e-

Table 2
Descriptive statistics for gameplay experience/satisfaction.

Statement	N	Min.	Max.	M	SD
I enjoyed playing the game	36	1.00	4.00	3.00	0.99
I would play the game again	36	1.00	4.00	2.75	1.02
I would tell my friends to play	36	1.00	4.00	3.08	0.91
I felt connected to my character	36	1.00	4.00	2.75	0.97
I felt connected to the other characters	36	1.00	4.00	2.58	1.05
I liked the look of the game	36	1.00	4.00	2.81	0.86
I felt responsible for my decisions in the game	36	1.00	4.00	3.08	0.84
The game was challenging	36	1.00	4.00	2.17	0.77
I would make decisions in life like I made them in the game	36	1.00	4.00	3.00	0.93
The game was frustrating	36	1.00	4.00	2.06	0.86
Valid N (listwise)	36				

All statements are presented such that higher numbers represent greater agreement. In this analysis, 5 (I don't know) was treated as 1 (strongly disagree), except for the question about frustration, for which it was treated as 4 (strongly agree).

cigarettes influenced the main findings regarding the impact of Invite Only VR. After re-analyzing the data with these participants removed, the pattern of results was unchanged, with the exception of the findings related to self-reported likelihood that a participant would experiment with e-cigarettes in the coming year. This outcome variable no longer demonstrated a significant change from pre- to post-gameplay: $t(28) = 1.535, p = .136$. However, the mean likelihood scores at pre and post gameplay were largely the same as the means for the whole sample (Pre: $M = 1.55, SD = 0.78$; Post: $M = 1.34, SD = 0.72$) with most participants responding that they were either "not at all likely" or "not very likely" to experiment with e-cigarettes in the coming year" both before and after gameplay.

3.3. Gameplay satisfaction

Overall, participants' experience/satisfaction with the intervention and gameplay experience was moderately high (Table 2).

4. Discussion

Although e-cigarettes are the most prevalent nicotine-containing products used by adolescents in the U.S. (Wang et al., 2019), a recent review documented that most e-cigarette interventions were adaptations of preexisting tobacco control programs, rather than e-cigarette specific interventions (O'Connor et al., 2019). Therefore, the creation of novel e-cigarette prevention programs is vital to combat the public health concerns of rising nicotine dependence among adolescents (National Academies of Sciences, Engineering, and Medicine, 2018; Case et al., 2018).

To our knowledge, *Invite Only VR* is the first e-cigarette prevention game to be developed for a VR platform, making it unique among the limited pool of e-cigarette intervention videogames designed for adolescents (Hieftje, Fernandes, & et al., 2019; Pentz et al., 2019 for examples of other smoking and vaping prevention videogames). For this initial investigation of intervention impact, we created an interactive VR game with a compelling narrative about characters faced with peer-pressure scenarios surrounding vaping. The majority of our participants (88%) agreed or strongly agreed that they enjoyed playing the game. An enjoyable intervention is likely more impactful because participants will be motivated to play to completion (Dishman, et al., 2005; Ryan, Rigby, & Przybylski, 2006). Moreover, 78% of players stated that they would tell their friends to play *Invite Only VR*, which likely signifies that they saw value in their gameplay experience and the content of the intervention.

Playing *Invite Only VR* significantly increased key psychosocial determinants of e-cigarette use: knowledge, perceptions of harm of e-

cigarettes, and likelihood of trying e-cigarettes in the coming year. This finding is promising, as a review of videogame health improvement interventions noted the importance of using games to convey health-related information (Rahmani, & Boren, 2012). Increasing knowledge about e-cigarettes, such as the fact that they contain nicotine and can lead to addiction, can help individuals arrive at a decision to avoid e-cigarette initiation. Likewise, acknowledging the potential for harm can also influence health behaviors. Both of these factors provide the motivation to avoid e-cigarette use. The final component needed according to the theory of planned behavior (Ajzen, 1991) is the ability (behavior control) to avoid e-cigarette use. Given that the game is designed to encourage meaningful practice combating peer pressure to engage in e-cigarette use, there is ample opportunity to hone this ability.

Although players did not show changes in their self-efficacy to refuse e-cigarettes, the adolescents in our sample scored high in self-efficacy at baseline. The participants' high levels of perceived self-efficacy at pre-test is consistent with longitudinal examinations of self-efficacy to refuse, which find that most adolescents have high levels of self-efficacy to refuse tobacco products in early adolescence, but that over the course of adolescence and as they encounter more situations in which people use tobacco products, their self-efficacy decreases (Otten et al., 2009). Many adolescents in our sample were unfamiliar with e-cigarettes, and such have likely not been faced with a situation in which they would need to refuse. As such, the value of *Invite Only VR* is that it serves as a safe environment in which players can practice refusing e-cigarette products even before they have encountered them in the real world. Moreover, *Invite Only VR* is structured such that players learn very quickly that JUUL is a type of e-cigarette. Since many adolescents reported that they had heard of JUUL but did not know that it was a type of e-cigarette, our game takes an important step towards bridging that knowledge gap.

Although the findings of this pilot study are based on a small sample, we present the preliminary evidence to demonstrate that playing the game is related to changes in the target outcomes. We also present the effect sizes which we used to determine the appropriate sample size for our current non-randomized cluster trial (NCT) testing the effects of the final version of the *Invite Only VR*.

4.1. Limitations

There were several limitations to this study. The *Invite Only VR* prototype game was developed for the Oculus Go headset, which was released in May 2018, just months before data collection for this study began. There were some technical challenges with the headsets that prevented some gameplay sessions from running as smoothly as we intended. Oculus has since corrected these technical problems such that implementing a similar gameplay protocol in a larger study would be possible without issue. Despite the technical challenges, participants still enjoyed the game and learned from the experience, a testament to the engaging power of VR and the compelling design of the game prototype.

An additional limitation is 23% of participants were lost to follow up due to schedule restrictions at our data collection site. We did not include a control group in our study; therefore, we cannot rule out other extenuating factors that may have contributed to the observed changes in knowledge, harm perception and intentions surrounding e-cigarette experimentation in the coming year. This study design also did not employ any long-term follow-up assessments and so we were unable to examine whether the intervention influenced behavior related to e-cigarette use.

4.2. Conclusions

The preliminary findings from this pilot study are promising. Even in its prototype form, *Invite Only VR* is an intervention that participants enjoyed playing. There was a statistically significant improvement in

knowledge about and harm perception of e-cigarettes, as well as a reduced self-reported likelihood of e-cigarette use in the year following gameplay. Although no changes to self-efficacy to refuse, attitudes or social norms regarding e-cigarettes were detected, these results provided a clear path for the future development of a polished game with more robust interventions. Now that the limitations of the Oculus Go technology are well-understood, improvements made to the *Invite Only VR* software architecture have greatly reduced the technical difficulties experienced with the prototype and new features added to the game have expanded its potential for changing attitudes and social norm perceptions of e-cigarettes. This pilot investigation demonstrated that even in a prototype form, *Invite Only VR* is an enjoyable intervention approach that has the potential to reach many adolescent players and can help them to develop knowledge about and motivations to avoid the use of e-cigarettes. The prototype game also provides an example for teams creating VR-based health intervention games and sets the stage for the next iteration of *Invite Only VR* that is currently undergoing evaluation in a NCT.

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Funding for this study was provided by Oculus. Oculus had no role in the study design, collection, analysis or interpretation of the data, writing the manuscript, or the decision to submit the paper for publication.

CRedit authorship contribution statement

Veronica U. Weser: Writing - original draft, Visualization. **Lindsay R. Duncan:** Formal analysis, Writing - review & editing. **Tyra M. Pendergrass:** Investigation, Supervision, Project administration. **Claudia-Santi Fernandes:** Conceptualization, Investigation, Supervision. **Lynn E. Fiellin:** Conceptualization, Methodology. **Kimberly D. Hieftje:** Conceptualization, Methodology, Investigation, Writing - review & editing, Funding acquisition.

Declaration of Competing Interest

Dr. Kimberly Hieftje is the Principal Investigator for this study and has a significant relationship with the videogame prototype company, PreviewLabs, Inc. that developed the videogame intervention as part of this research study. All other authors declare that they have no conflicts of interest.

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