Preliminary investigation of a videogame prototype for cigarette and marijuana prevention in adolescents

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Abstract

Background—Videogames are becoming increasingly popular to deliver health interventions; however, their role in the primary prevention of cigarette and marijuana use has not yet been evaluated. The purpose of this study was to conduct a preliminary test of the efficacy of a role-playing videogame prototype, ***smokeSCREEN***, aimed at developing knowledge and behavioral skills associated with primary prevention of cigarette and marijuana use. We also explored participants' gameplay experience.

Methods—This study employed a one-group pretest-posttest design with 25 adolescent boys and girls aged 11 to 14 years (M age = 11.56, SD = .77) who had never tried cigarettes or marijuana. Participants played four, one-hour gameplay sessions over a two-week period. Assessments of knowledge, self-efficacy, attitudes, perceived norms, and intentions related to cigarette and marijuana prevention were collected at baseline, two-week, and 12-week follow up. Ratings of gameplay experience were collected after the two weeks of gameplay. One-way repeated-measures ANOVAs were conducted.

Results—Improvements in knowledge for both cigarette (Wilks' Lambda = .62, $F(2, 23)$ = 7.21, p = .004) and marijuana (Wilks' Lambda = .67, F (2, 23) = 5.75, p = .009) use from pre- to post-gameplay that were characterized by large effects. Non-significant trends in the expected direction

emerged for changes in self-efficacy and perceived norms related to both cigarettes and marijuana that were characterized by medium-large effects. Overall, the players provided positive reports of their experience with the ***smokeSCREEN*** videogame prototype.

Conclusions—These findings provide preliminary evidence that a videogame has the potential to influence key cognitive and motivational variables and can be an engaging means to deliver a cigarette and marijuana prevention intervention.

Keywords

Cigarettes; marijuana; adolescents; videogame; prevention

Introduction

Cigarette and marijuana use among young teens has many negative consequences. Consistent cigarette use dramatically increases the risk for numerous chronic diseases including cardiovascular disease and cancer.[1] Marijuana use can lead to memory loss, hindered brain development, and mental illness, among other consequences,[2] and can serve as a gateway to the use of even more harmful substances.[3] Using these substances before the age of 18 years increases the risk of long-term cigarette and marijuana use in adulthood.[1,4] Recent data indicate that 32% of 14 year olds have tried cigarettes and 30% have tried marijuana and that use of these substances increases during the transition from middle school to high school and continues to increase throughout high school.[5] Taken together, these data suggest that middle school may be the optimal time to intervene to prevent these behaviors and avert the associated health consequences.

State-wide policies, mass media campaigns, and comprehensive programs in schools and communities have targeted smoking prevention among adolescents. [1] Although these initiatives have been effective, individual behavioral decisions to abstain from cigarette and marijuana use also depend on cognitive-behavioral factors such as the ability and self-efficacy to refuse peer offers of these substances. Regardless of the intervention approach, prevention efforts are often limited by a lack of sustained funding for effective programs.[1] Thus, programs that address cognitive and motivational factors and are effective and inexpensive to implement and maintain, are needed.

Videogames could be effective for engaging adolescents in primary cigarette and marijuana prevention and addressing challenges related to program costs. Up to 72% of boys and girls aged 12-17 years regularly play videogames.[6] Research shows that young adolescents are attracted to learning through videogame play[7] and evidence is emerging that games can be effective for changing attitudes, behaviors, and health outcomes across a range of health contexts.8,9[1]

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[1]Although a considerable body of research demonstrates the potential of videogames to be used for good, some researchers have also raised concern that videogame play can be problematic or compulsive for some adolescents. At this stage; however, problematic gaming, is not considered a diagnostic condition within the *Diagnostic Statistical Manual of Mental Disorders* (DSM; American Psychiatric Association, 2013).

Researchers have begun to evaluate the potential of videogames to assist in the development of healthy thoughts and behaviors related to smoking. [11,12] A recent content analysis of commercially available smoking prevention and cessation games concluded that many games lack critical elements for behavior change (i.e., a theoretical foundation) and effective game development (e.g., a narrative), thus limiting their potential to affect change.[13] In addition, most studies have focused on older teens and adults and have targeted cessation rather than prevention.

To address the need for an engaging, effective, and cost-effective intervention for adolescents we created *smokeSCREEN*, a prototype of a videogame aimed at the primary prevention of cigarette and marijuana use. The purpose of this study was to determine the preliminary efficacy of *smokeSCREEN* by exploring changes in knowledge, self-efficacy, attitudes, perceived norms, and intentions related to the use of cigarettes and marijuana as well as to evaluate the overall experience of participants' gameplay.

Methods

The Game

In *smokeSCREEN* players try to succeed academically and socially throughout 30 days of high school. Players begin by selecting an avatar from three male and three female options representing varying races and physical features. They then use this avatar to make decisions to earn good grades and social points, while navigating social situations that involve cigarettes and marijuana and thus threaten their success in both domains. The game was developed using procedures we have used in our previous work.[14,15] Through an extensive literature review we identified important cognitive and motivational variables associated with the primary prevention of cigarette and marijuana use and created a logic model to serve as the theoretical foundation for the development of the videogame prototype.

Participants

Eligible participants were English-speaking boys and girls between the ages of 11 and 14 years who had never tried smoking cigarettes or marijuana. Twenty five participants were recruited from two classes at one elementary/middle school. The teacher assisted in screening for eligibility and obtaining written assent (adolescents) and consent (parents). Though the sample size is small it was determined to be sufficient for providing preliminary data given our priority on allocating funds primarily to the development of the videogame prototype to ensure it addressed the shortcomings of existing games.

Measures

The participants provided standard demographic information. At baseline they also indicated (yes/no) whether they had ever used cigarettes and marijuana and if "yes", how old they were the first time they tried it and how much they used it during the past 30 days.

The dependent variables were assessed using self-report scales adapted from our previous research and the smoking prevention literature.[15] Cronbach's alphas for the scales ranged from .71 - .95. Knowledge was assessed with 18 items (9 each for cigarettes and marijuana;

e.g., "Marijuana can cause anxiety, panic attacks, and depression") to which participants responded true, false, or not sure. The responses were re-coded to 1 (*correct*) or 0 (*incorrect/not sure*) and a sum was calculated for each substance. Self-efficacy to refuse offers of cigarettes and marijuana was assessed with two items per substance rated on a scale from 1 (*not sure at all*) to 4 (*definitely sure*). A mean self-efficacy score was calculated for each substance with higher scores indicating higher levels of self-efficacy. Attitudes toward cigarettes and marijuana use were assessed with five bipolar adjectival scales (e.g., harmful – beneficial) for each substance. A mean of the five items was calculated with lower scores reflecting more negative (i.e., healthier) attitudes. Perceived norms were assessed with six items per substance rated from 1 (*strongly disagree*) to 4 (*strongly agree*). A mean of the six items was calculated with lower scores representing healthier perceived norms. Intentions to use cigarettes and marijuana in the future were assessed with three items per substance rated from 1 (*not at all likely*) to 5 (*definitely likely*). Mean intentions scores were calculated for each substance with higher scores indicating greater intentions. To report on their gameplay experience, players responded from 1 (*strongly disagree*) to 4 (*strongly agree*) to 10 items.

Procedures

The [Institution Removed for Blinding] Human Investigation Committee approved the research. After consent was obtained, demographic information and baseline measures of knowledge, self-efficacy, attitudes, perceived norms, and intentions were collected in a one-on-one interview with the adolescent and a research staff member. Participants then played *smokeSCREEN* on an iPad for one hour, twice per week for two weeks to accumulate four hours of gameplay. This total duration and number of sessions is consistent with those found in effective smoking prevention interventions[16] and with the amount of time adolescents play videogames.[17] Assessments of knowledge, self-efficacy, attitudes, perceived norms, intentions were taken at post gameplay (two weeks) and follow-up (12 weeks). Given the preliminary nature of this study and the short intervention period, cigarette and marijuana use were not assessed at two or 12 weeks. Gameplay experience was measured at post gameplay. All protocols were reviewed by a data and safety monitoring board (DSMB).

Design and Analysis

The study involved a one-group pretest-posttest design with data collected before gameplay, after gameplay (two weeks), and at a 12-week follow-up. The data were screened to detect missing values and outliers and to test for conformity with the assumptions of the statistical tests. One-way repeated-measures ANOVAs were conducted to examine changes in knowledge, self-efficacy, attitudes, perceived norms, and intentions across the three assessment points. Partial eta squared values were used to determine effect sizes and were interpreted using common guidelines (.01 = small; .06 = moderate; .14 = large effect). Bonferroni tests were conducted for pairwise comparisons in cases where the multivariate tests were significant.

Results

Participant Characteristics

Sixteen of the 25 participants (64%) were boys with a mean age of 11.56 ($SD = .77$). Eighteen (72%) were African-American, three (12%) American Indian/Native American, three (12%) Hispanic, and one identified as "other." Twenty-four participants confirmed they had never tried cigarettes or marijuana prior to study enrollment. One participant had tried cigarettes and marijuana but had not used either substance in the past 30 days. To avoid identifying and/or highlighting this behavior this participant was retained for the study.

Impact of smokeSCREEN on Knowledge, Self-efficacy, and Perceived Norms

Descriptive statistics for each of the outcomes at baseline, two weeks, and 12 weeks are presented in Table 1. A check for skewness and kurtosis in the dependent variables revealed non-normal distributions for the attitudes and intentions variables at multiple time points. We attempted logarithmic transformation to normalize the attitude and perceived norm variables, however, the resultant variables were still substantially skewed thus the planned parametric statistical tests were deemed inappropriate. We also considered conducting non-parametric tests; however, the distribution of scores on these variables still left some cells with insufficient data for analysis.

Knowledge—For cigarettes, Wilks' Lambda = .62, $F(2, 23) = 7.21$, $p = .004$, multivariate partial eta squared = .39. For marijuana, Wilks' Lambda = .67, F (2, 23) = 5.75, $p = .009$, multivariate partial eta squared = .33. These findings indicate a significant main effect for time and improvements in knowledge characterized by large effects for both substances. Pairwise comparisons for each substance indicated significant increases in knowledge between baseline and post-play with no significant differences in scores at any other assessment points.

Self-efficacy—For cigarettes, Wilks' Lambda = .81, $F(2, 23) = 2.54$, $p = .10$, multivariate partial eta squared = .18. Despite not reaching traditional levels of significance, the improvement in cigarette-related self-efficacy scores showed a trend in the expected direction and was characterized by large effects. For marijuana the findings were not significant; however, the improvement in scores showed a moderate effect size (multivariate partial eta squared = .08).

Perceived norms—No significant changes in perceived social norms were observed. The means and standard deviations, however, indicate a trend toward reduced perceptions of norms related to smoking cigarettes and marijuana from baseline to post gameplay that are maintained to the 12-week follow up. The effect sizes characterizing the change in perceived norms over time are large (multivariate partial eta squared = .15 for cigarettes and .18 for marijuana).

Gameplay Experience

Descriptive statistics related to gameplay experience are reported in Table 2. Overall, the players' experience with *smokeSCREEN* was positive.

Discussion

The purpose of this study was to explore the changes in knowledge, self-efficacy, attitudes, perceived norms, and intentions related to cigarette and marijuana use among adolescents who played the *smokeSCREEN* prototype. The findings show that *smokeSCREEN* may have the potential to influence cognitive and motivational factors related to cigarette and marijuana use among adolescents who have never tried using these substances. It appears that the most active component of *smokeSCREEN* may be the mechanism by which knowledge about cigarettes and marijuana are taught to and reinforced in the players. This finding is encouraging as a review of videogame interventions noted the importance of conveying information through the gameplay.[18] Although this is a promising finding, our logic model which was based on an extensive literature review indicated that knowledge of the consequences of substance use is not enough to protect against its adoption.[19] The findings also show encouraging improvements in other key variables from our logic model including players' self-efficacy for refusing offers of cigarettes and marijuana as well as perceived norms. These improvements were non-significant; however, the effect sizes suggest that *smokeSCREEN* may include effective mechanisms for fostering healthier thoughts and motivation. Testing *smokeSCREEN* in a larger sample of adolescents could provide sufficient power to demonstrate significant results.

A review of the literature indicates that within the realm of smoking prevention, very few interventions use electronic media and to date, no studies describing the development and testing of a videogame intervention are reported.[20] Games for health represent a promising approach to adolescent-focused health education because they capitalize on adolescents' preference for experiential learning.[7] Given the high rates of videogame play among adolescents, a videogame intervention may reach them in a context in which they are already engaged, increasing the opportunity to provide an optimal intervention dose. Indeed, the findings from this test of *smokeSCREEN* indicate that players had a positive experience with the game and agreed that they would play it again. Future versions of *smokeSCREEN* might benefit from adding features /to increase players' feelings of connectedness within the game. In developing *smokeSCREEN* we addressed a shortcoming of existing smoking cessation/prevention games by including a narrative component.[13] The prototypic nature of the game, however, limited the extent to which immersion in a narrative was possible and future versions of the game may increase player engagement if the narrative is expanded.[21]

Our findings are limited by the one-group pretest-posttest design. The absence of a comparison group limits our ability to confirm that improvements in the dependent variables can specifically be attributed to playing *smokeSCREEN* Data cleaning procedures revealed substantial problems (floor effects) with the assessments of intentions and attitudes that precluded our planned analyses. These problems point to the need for more valid measures of these variables in future research. It should be noted that this study represents an evaluation of a prototype rather than that of a completed game and data reported here suggest some areas for redesign in subsequent versions. Additionally, the *smokeSCREEN* prot*otype* does not include all the components of interventions that have previously been found to be effective. For example, the 2012 Surgeon General's report highlighted the

influence of media depictions of smoking initiation among young people;[1] thus, a future version of *smokeSCREEN* may benefit from the addition of a media literacy component.

Conclusion

These findings are promising despite their preliminary nature and *smokeSCREEN* being in a prototype form. Although the data show only modest changes in some of the variables associated with cigarette and marijuana use, they provide a clear direction for further development of *smokeSCREEN* Further, these findings contribute to the growing literature on games for health, providing some preliminary evidence that a videogame based on key cognitive and motivational variables may be an effective and engaging means to deliver a cigarette and marijuana prevention intervention.

Acknowledgments

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Table 1

The Impact of smokeSCREEN on Knowledge, Self-efficacy, and Perceived Norms.

Variable	Baseline M (SD)	Post Gameplay 2 weeks M (SD)	Follow-Up 12 weeks M (SD)
Cigarette Knowledge	4.16 (2.53)	5.48 (2.40)	4.88 (2.09)
Marijuana Knowledge	4.12 (2.40)	5.48 (2.38)	5.16 (2.30)
Cigarette Self-Efficacy	2.98 (1.18)	3.40 (.87)	3.44 (.96)
Marijuana Self-Efficacy	3.22 (1.08)	3.58 (.67)	3.44 (.95)
Cigarette Intentions	1.51 (1.21)	1.07 (.15)	1.10 (.24)
Marijuana Intentions	1.75 (1.45)	1.12 (.29)	1.05 (.14)
Cigarette Attitudes	1.36 (.59)	1.37 (.47)	1.38 (.68)
Marijuana Attitudes	1.42 (.77)	1.24 (.37)	1.33 (.54)
Cigarette Perceived Norms	1.81 (.69)	1.70 (.63)	1.67 (.67)
Marijuana Perceived Norms	1.50 (.56)	1.59 (.67)	1.50 (.56)

Note. Knowledge items represent a sum of correct responses in which the maximum value is 9.0. Self-efficacy scores represent a mean of 2 items with values ranging from 1 to 4 and higher values indicating higher levels of self-efficacy. Intention scores represent a mean of 3 items with values ranging from 1 to 5 and higher values indicating greater intentions to use the substance (i.e., lower values represent healthier intentions). Attitude scores represent a mean of 5 items with scores ranging from 1 to 5 and lower scores representing healthier attitudes. Perceived norms scores represent a mean of six items with values ranging from 1 to 4 and lower scores representing healthier perceived norms.

Table 2

Descriptive statistics for gameplay experience

Item	M (SD)
I enjoyed playing the game	3.36 (.57)
I would play this game again	3.20 (.71)
I felt responsible for the choices I made in the game	3.12 (.78)
I felt connected to my character in the game	2.96 (.84)
I would make decisions in my life like I made them in the game	2.96 (.93)
I would tell my friends to play this game again	2.96 (.98)
I like the way the game looks	2.92 (.57)
The game was challenging	2.68 (.94)
I felt connected to other characters in the game	2.40 (1.00)
I was frustrated with this game	2.20 (1.04)

Note. Each item was rated on a scale ranging from 1 (*strongly disagree*) to 4 (*strongly agree*).