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Original Article

Evaluation of a Cognitive-Behavioral Game Design-Based Mobile Game on Alcohol Use for Adolescents

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Abstract

Objective: Determine the effectiveness of a cognitive behavioral game design (CBGD) based mobile game as an alcohol use intervention.
Materials and Methods: Experimental design with 140 participants randomly assigned to either play a mobile game ($n=69$) or watch a video documentary ($n=71$).
Results: Both groups displayed a decrease in intent to use and an increase in knowledge. The video intervention was superior in affecting actual use.
Conclusion: Mobile game affects intent to use and is superior to the video in affecting knowledge.

Keywords: Alcohol use, Treatment, Mobile games

Introduction

Teenage alcohol drinking is a rampant worldwide issue. Despite the multiple efforts of the World Health Organization (WHO) to decrease adolescent alcohol use, 155 million adolescents worldwide drink alcohol.[1] Thus, countries around the world, as well as the WHO, have been proposing and taking steps to decrease underage drinking.

Interventions for alcohol use take many forms. Individual-level interventions aim at changing skills, intention, knowledge, attitudes, and motivations of people to use alcohol. Family-based intervention programs intend to change the behavior of parents and children by increasing skills and knowledge regarding alcohol use. School-based interventions focus on implementing policies that discourage drinking while increasing motivations and skills to curb drinking. Lastly, environment-based interventions target reducing alcohol availability, alcohol use penalties, and changing community drinking norms.[2]

Beyond personal or institutional interventions, media and technology have increasingly been used to influence attitudes and actual use. A study showed that reducing alcohol advertisements can significantly decrease adolescent alcohol use and binge drinking.[3] The use of media, primarily television and radio, can also lead to positive changes in knowledge, beliefs, and attitudes on alcohol consumption.[4] Recent years have also seen the emergence of games to shape substance use. A study of the game *Pure rush* reported that playing their game showed a significant gain in knowledge about drugs.[5] Another study reported that most computerized serious educational games with a social influence approach showed positive outcomes, such as reduced drug and alcohol use.[6]

Interest in use of mobile games outside of education purposes has also led to theories explaining psychological mechanisms in a mobile game that can enable change. The Cognitive Behavioral Game Design (CBGD) theory,[7] suggests that Bandura's Social Cognitive Theory and Gardner's Multiple Intelligences theory can be integrated in the design of games. The CBGD theory states five social cognitive elements that help facilitate health behavior change: knowledge, goals, outcome expectations, encouragement, and barriers. These elements are delivered through multiple intelligence mechanisms: graphics, music/sound, physical movement, humor, space, narrative, logic, nature, relationships, numbers, words, and personal reflection. The integration of social cognitive elements and multiple intelligences is expected to facilitate the enjoyment process: engagement, challenge, flow, persistence, and mastery.[7]

A study using Cognitive Behavioral Game Therapy highlighted a possibility of improved social skills in children with mental retardation.[8] However, there has been no study thus far testing the use of CBGD. This study seeks to address the dearth by testing the effectiveness of a CBGD-based mobile game as an alcohol use intervention. Specifically it asks: How effective can the CBGD-based mobile game be in

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increasing adolescents' knowledge on alcohol use and protective behavioral techniques while reducing intent to use and actual use?

Methods

Methodology

This study, and its use of human subjects, was approved by the Ateneo de Manila University Research Ethics Office. It used a between-within experimental design. Participants were tasked to secure a timeslot through Google Sheets. Afterward, Google Forms were used for the participants to provide consent. Upon providing full consent to participate, they were able to proceed with the study.

Participants were randomly assigned to participate in either a mobile game or treatment as usual (video) intervention. Both interventions were run simultaneously in separate private rooms, with five participants each. The video intervention was presented on a laptop with speakers. On the other hand, the game was played on five Android mobile phones with five sets of earphones, both of which were provided by the researchers. Tests measuring the study variable were administered before the intervention and a week later. All participants were given the right to withdraw from the study at any point. Moreover, to reduce physical discomfort, they were given freedom to move around due to the duration of the experiment. On the other hand, participants were to be referred to the institution's guidance and counseling center if they experienced psychological distress.

Participants

The researchers garnered data from 140 participants who completed the experiment. Participants were purposively sampled from a university in Metro Manila. Criteria for sampling were as follows: from 18 to 21 years old and has drunk alcohol at least once in their lifetime. The participants' ages ranged from 18 to 21 (mean [M] = 18.66; standard deviation [SD] = 0.7). Among 140 participants, 59 (42.1%) were aged 18, 69 (49.3%) were aged 19, 9 (6.4%) were aged 20, and 3 (2.1%) were aged 21. Participants underwent random sampling to determine their treatment conditions. Sixty-nine (49.3%) were subjected to the mobile game, and 71 (50.7%) were subjected to the video documentary. A summary of the participants and interventions is presented in Figure 1.

Measures

The study measured four dependent variables: knowledge on effects of alcohol use, knowledge on protective behavioral strategies, alcohol use intent, and alcohol knowledge.

Alcohol use pertains to participants' alcoholic beverage intake. It was measured by using a modified version of the Alcohol Use Disorders Identification Test (AUDIT).[9] The reliability coefficient (Cronbach's alpha) ranged from 0.74 to 0.76.

Intent to use alcohol pertained to the participants' intentions to drink, as well as their attitudes toward alcohol use. This was measured by using the Scale to Assess Attitudes toward Drinking and Alcoholism (SAADA) test.[10] It tests participants' attitudes toward drinking by using four factors: Acceptance, Rejection, Avoidance, and Social Dimension. It

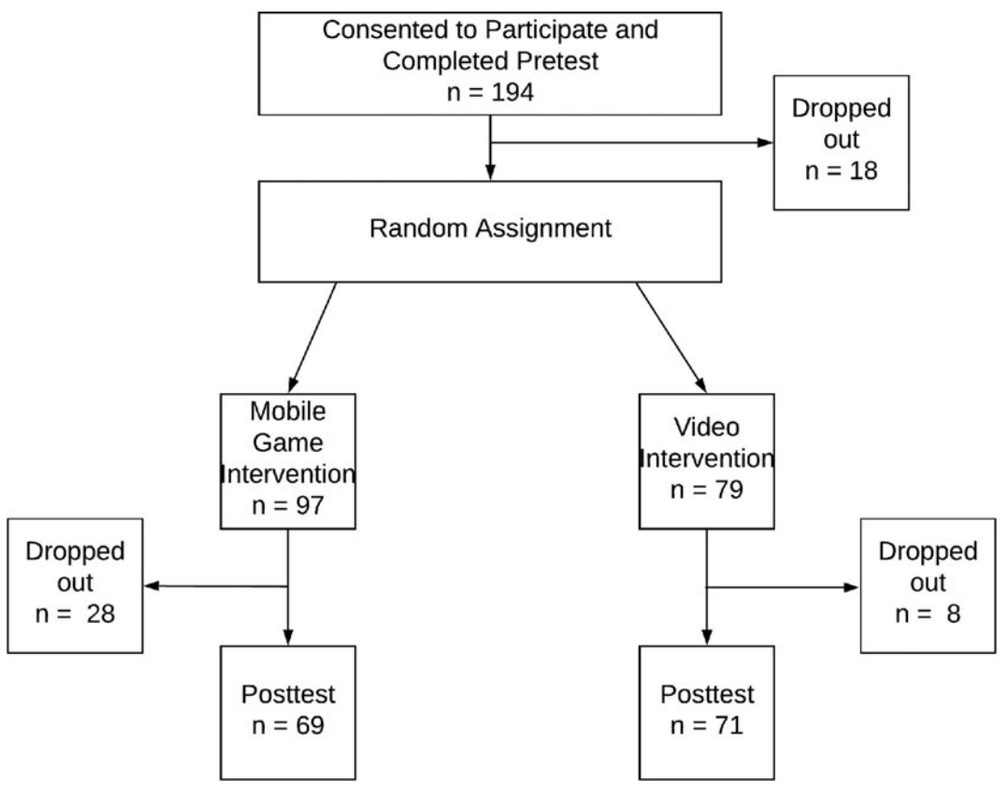

FIG. 1. Flow diagram of participants and interventions.

was modified to remove items that pertained to certain cultures and races. Reliability analysis yielded Cronbach's alpha values of 0.82 to 0.89.

Alcohol knowledge pertained to the participants' knowledge on protective behavioral techniques and the harmful effects of alcohol use. Protective Behavioral Strategies referred to harm reduction strategies that may be used to mitigate the use of alcohol by drinking responsibly. A test consisting of 30 items was created. Twenty multiple-choice questions were about alcohol use facts, alcohol use disorder symptoms, as well as the negative physical and cognitive effects of excessive alcohol use. Ten true or false questions were asked regarding protective behavioral techniques. Examples of these questions were: Eating salty food reduces the negative effects of alcohol use and avoiding friends who drink excessively decreases the negative effects of alcohol use. Reliability analysis yielded Cronbach's alpha values ranging from 0.67 to 0.71.

Mobile game intervention design

A mobile game named Drug Defense was a tower defense game designed by using the CBGD theory.[7] Players were tasked to prevent alcohol from damaging the liver by placing turrets, which shot enzymes. Players took on the role of a medical apprentice, reading through the character's journal entries. The character was depicted as a college student who relocated to the city and experienced various challenges that students may face, such as loneliness, heartbreak, and academic failures. The main character, Miguel, escalated into excessive alcohol use until friends and family helped him.

The various elements of CBGD were incorporated in various ways. Knowledge was embedded in the journal entries that present alcohol use facts and protective behavioral strategies. The goal was preventing alcohol from damaging the liver. Encouragement was embedded through affirmation of correctly answered items. Barriers were the quantity and speed of alcohol bottles. Outcome expectation was embedded in the use of game stages. Multiple intelligences were used in terms of the narrative and character, color, placement, music, etc. A summary of game elements vis-à-vis CBGD components is depicted in Table 1.

Treatment as usual (video) intervention

The treatment as usual intervention was a video documentary about the life of Ryan, a diagnosed alcoholic. It portrayed his alcohol abuse, along with attempts to seek treatment and rehabilitation and his eventual death (https://bit.ly/2CuDYAe).

Procedure

Ethics approval was obtained from the Ateneo de Manila University Research Ethics Office before the study. Participants were recruited from a freshman course, briefed on the study, and asked for informed consent. Those who consented were asked to fill out a pretest battery and were randomly assigned to treatment groups by using the fishbowl method. The mobile game lasted from 20 to 40 minutes, whereas the video documentary lasted for 45 minutes. The time of game playthrough was dependent on each participant's pace since they were made to repeat stages that they failed to complete. Post-tests were sent to participants 1 week after their experiment was run. Privacy and confidentiality were ensured in collection, encoding, and storage of data by using code numbers and password protection. To reduce physical discomfort, participants were encouraged to move around if they felt physically uncomfortable while playing the game or watching the video. Moreover, participants who had test scores that indicated a high possibility of alcohol use were to be referred to the institution's guidance and counseling center.

Data analysis

The researchers conducted reliability analyses of the measures used to confirm their effectiveness. Independent-samples *t*-test was used to ensure that pretest conditions in the two experimental groups did not have any significant differences. Dependent-samples *t*-test was then used to test for each intervention's effectiveness among the three dependent variables. A mixed analysis of variance (ANOVA) statistical analysis method was used to compare the between-within effects between those two interventions. Cohen's d was also computed to indicate effect size.

Table 1. Cognitive Behavioral Game Design Elements in Game

Theoretical	*Element*	*Application*
Social cognitive	Knowledge	Knowledge was conveyed through the journal entries.
	Goals	The goal of the game was to prevent any organ damage.
	Outcome Expectation	Players expected to clear every stage and the game
	Encouragement	Other characters encouraged the main character
	Barriers	Alcohol bottles and money hindered players.
Multiple intelligences	Graphics	Damage to the organ was shown through color change.
	Space/positioning	The game encouraged proper installation of turrets.
	Relationships	The characters interacted in complex social situations.
	Music/sound	The music was meant to facilitate flow.
	Narrative	The narrative portrayed the consequences of alcohol use.
	Math/numbers	Players calculated the price of the turrets.
	Logic/patterns	The players had to optimize position and price of turrets.
Enjoyment process	Engagement	Engagement was facilitated through music and graphics.
	Challenge	The game's stages increased with an increase in difficulty.
	Flow	The game's structure was cyclical.
	Persistence	Players had to adapt to finish the game.

Results

Data were subject to paired-samples *t*-test to see the effectiveness of the game compared with the Treatment As Usual (TAU) intervention. Those who participated in the game showed significant increase in knowledge scores and a decrease in intent to use, but not in actual use. In the case of the video intervention, participants reported a significant increase in knowledge, and decrease in both knowledge and intent.

Cohen's d showed that the effect size of change in knowledge across pretests and post-tests was significantly higher in the game ($d = 2.54$) than the video ($d = 0.89$). Although scores for actual use were only significantly different in the video treatment, the effect sizes in both video and game were the same ($d = 0.11$).

Mixed ANOVA was used to compare differences in between-within effects of the mobile game and video interventions. No significant difference was observed for intent ($P = 0.15$) and use scores ($P = 0.61$). However, knowledge scores showed a significant difference between the two intervention groups, at $P = 0.00$. This significant difference shows that the mobile game was more effective in teaching knowledge than the video documentary.

Discussion

Findings showed a significant difference in alcohol knowledge for both game and video settings, with the game having a larger effect size than the video. This may be attributed to the use of in-game quizzes to increase player's references. This supports the claim that repetition helps facilitate stimulus into long-term memory.[11] The game's narrative and interactional elements may have engaged the players more, explaining the higher scores compared with the TAU. The participants assigned to the mobile game could make decisions that affect their individual intervention outcomes, without affecting the overall narrative. On the other hand, those watching the video intervention were a uniform story and outcome. This supports that interaction with characters enables more effective message delivery.[12] As such, games are more effective in facilitating learning compared with traditional methods.[13]

The study found that the video had a significant effect on alcohol use, whereas the game did not. The game portrayed experiences of heartbreak and loneliness in the social and academic aspects of the character's life. Although it may have been relatable, the depth of emotion was far greater in the video, which portrayed the actual struggles and everyday life of an alcoholic and his loved ones as well as the death of its main character. This is supported by a study exhibiting the importance of emotions in enabling changes in attitudes and behaviors.[14] Moreover, the video intervention alluded to avoiding alcohol use whereas the game aimed at simultaneously reducing alcohol consumption and promoting protective behavioral techniques in drinking alcohol. The video had the aim of cessation, whereas the game had a goal of reduction.

Both types of interventions showed significant decreases on intent to use, although through different pathways. In the case of the video, the change in attitude was through the pathway of emotion. This is supported by literature saying when people are conditioned with fear of a negative outcome, they tend to act in a manner that prevents them from experiencing such effects.[15] The game took the pathway of relatability. Despite the absence of deep emotions, the fact that the game also enabled a decrease in intent to use also supported their value in engaging players through relatable interventions.[16] As mentioned, the main character of the game was made more relatable to adolescents through experiences of social challenges and academic difficulties. This may have made it easier to understand not just the negative outcomes that sprout from alcohol use but also the factors that enticed the game's main character to dwell into alcohol use, as well.

Limitations and recommendations

A limitation of the study was that video content was not exactly parallel to that of the mobile game. For one, the video had an adult main character whereas the game's main character was an adolescent. In addition, the video ended with a strong negative emotion, whereas the game ended with a positive emotion. Future studies may test a game that has parallel emotional narratives or test the impact of using both a game and a video to bring about behavior change. It may also venture into how effective a game intervention would be across various age groups.

Another limitation was whether those exposed to the game may have gained an in-game goal of completing all of its stages. There was no such goal for those exposed to the video intervention.

The researchers recommend to determine the longitudinal outcome on alcohol use, intent, and knowledge since post-tests were conducted only a week after the intervention. For example, the significant differences in knowledge of protective behavioral strategies are noteworthy and a longitudinal study may determine whether these will lead to better harm reduction outcomes.

Another recommendation would be to decrease the number of participants per run due to the number of devices needed. The set-up of the video intervention was much simpler than the mobile game set-up since it only required one laptop, one speaker, and one laptop charger. On the other hand, testing the game in a group setting was hectic since five Android mobile phones had to be readily available by the hour. Logistical concerns in the use of mobile phones involve battery, erasing the app data at the end of each experiment run as to remove the previous participants' data, and having five earphones to eliminate the in-game sounds of one participant to affect the others.

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