Potentials of Smart Breathalyzer: Interventions for Excessive Drinking Among College Students

Aehong Min[(✉)] , Daehyoung Lee , and Patrick C. Shih

Indiana University Bloomington, Bloomington, IN 47405, USA
aemin@iu.edu, {lee2055,patshih}@indiana.edu

Abstract. Excessive drinking among college students is a significant public health issue. Electronic Screening Brief Intervention (e-SBI) has been shown to be an effective prevention tool, and it has been implemented on personal computers, web, mobile phones and social networking platforms. In this research, we asked college students to discuss about their perception of BACtrack Mobile Pro, the FDA-approved and consumer-oriented smart breathalyzer. We recruited 15 college students who have consumed alcohol regularly, asked them to use the smart breathalyzer for two weeks, and conducted pre- and post-study surveys and interviews. We identified five barriers with design opportunities for the smart breathalyzer: (1) Support from immediate family members or close friends, (2) Personalized results, (3) Intuitive status display, (4) Accessorizing the form factor, and (5) Quicker access. Future mobile and smart wearable e-SBI interventions targeted at college students should take these design considerations into account.

Keywords: Smart breathalyzer · Screening and brief intervention
e-SBI · Excessive drinking · Alcohol consumption
Persuasive technology

1 Introduction

Excessive drinking among college students is a serious public health issue. A national survey shows that roughly 60% of college students between 18-to-22 years of age have consumed alcohol excessively in the previous month [30]. According to the Centers for Disease Control and Prevention, excessive drinking includes heavy drinking, which is defined as drinking 15 drinks or more per week for men and eight for women, and binge drinking, which is defined as a pattern of drinking that causes the blood alcohol concentration (BAC) level to rise over 0.08% [7,26]. Excessive drinking could bring serious risks to students' health and safety that could result in car accidents, sexual assaults, bodily injuries, and long-term liver and kidney damage. About 1,800 students between 18 and 24 years old die annually from alcohol-related accidents [17]. Although problems

related to excessive drinking are well publicized, many college students perceive drinking as a part of their college life and subsequently establish drinking habits when they leave home to attend college after graduating from high school [27].

With recent advances in information and communication technologies (ICTs), electronic Screening Brief Intervention (e-SBI) has been found to have the potential of reducing the amount and frequency of drinking and is considered to be an effective prevention mechanism for young adults [21]. In spite of its importance and potential with current information technologies, little research has been conducted in the area of information science. In this paper, we first introduce existing literature on traditional and e-SBI studies. We then describe the results of our user study involving BACtrack Mobile Pro, which is a smart breathalyzer, as an intervention in a series of surveys and interviews with college students who consume alcohol regularly. We report five barriers and design opportunities related to current smart breathalyzers that have potential for providing a better user experience and more effective impacts on college students' perceptions on their drinking behavior.

2   Related Work

2.1   Screening and Brief Intervention

The screening and brief intervention (SBI) is a technique designed with the intent to assess a person's alcohol consumption behavior with a series of questions focusing on drinking patterns. Based on the SBI assessment score, feedback about various consequences of excessive alcohol consumption and suggestions of behavior change are then provided to raise awareness of the individual [8]. SBI has been conducted with various well-known, validated survey instruments, such as Alcohol Use Disorders Identification Test (AUDIT), Problem Oriented Screening Instrument for Teenagers substance use/abuse scale (POSIT), Cut, Annoyed, Guilty, Eye-opener (CAGE), Car, Relax, Alone, Forget, Friends, Trouble (CRAFFT), etc. [20]. Similarly, the brief interventions for excessive alcohol consumption could vary widely depending on the context of delivery (e.g., in the presence of a specialist, motivation of the targeted population, etc.) [15]. Although SBI researchers have focused on the research instruments and the context of delivery, there has yet to be a systematic review focusing on the form of delivery of technology-mediated SBI. Below, we provide a review of existing SBI methods and point to the potential of new forms of SBI using current technologies.

2.2   Face-to-Face SBI

Traditional SBI is typically provided by health care professionals in a face-to-face setting with in-person feedback, which includes information about one's alcohol consumption pattern, its risks, benefits of lower alcohol consumption, and suggestions for adjusting drinking patterns. If appropriate, referral to treatment

could be included [6,8]. These traditional in-person and paper-based brief interventions have been found to be effective at reducing alcohol consumption and related problems in many studies. A meta-analysis study of 54 brief intervention trials shows positive evidence compared to the control group [25], and another meta-analysis study of 22 randomized control trials shows that after one year or longer, subjects who received brief interventions exhibited lower drinking levels compared to the control group [18].

Although research results focusing on SBI are generally positive, several studies have also pointed out limitations of utilizing it in the health care settings. A survey study of 282 general practitioners found that there is not adequate training and support for health care professionals to address alcohol-related issues [33]. Prior research has also found that the practitioners suffered from the lack of skills, knowledge, time, and resources for handling drinking problems [29]. Moreover, when it comes to the adoption of SBI among young people such as college students, research has shown that they are less receptive to being assessed by health care practitioners about drinking, and they tend to be more interested in receiving personalized feedback [21].

2.3 Electronic SBI

Unlike traditional SBI that typically accompanies face-to-face feedback, e-SBI could provide a personalized feedback about excessive drinking via digital medium such as web, text messages, mobile phone apps, and social network platforms. It could be fully automated and interactive [8], and it is possible to offer more anonymity and flexibility to the subjects. Instrumenting SBI using electronic medium is also relatively cheap to implement and deploy compared to paper-based and face-to-face mechanisms. In terms of reducing the time and cost, dissemination through digital medium has the potential of reaching more people who may benefit from SBI. Especially for young adults, e-SBI could mitigate concerns related to stigma in one's social circle [10]. Therefore, most health care professionals prefer e-SBI that offers anonymity. This anonymity can be provided by electronic alcohol risk assessment and feedback rather than face-to-face interaction [21,32].

Recent systematic reviews and meta-analysis studies show that e-SBI is effective for reducing alcohol consumption [12]. A systematic review of 31 e-SBI studies shows that a significant reduction in frequency and intensity of binge drinking were reported among participants who received e-SBI on regular intervals compared to the control group [32]. However, e-SBI studies have pointed out that the interventions may not be effective for long-term behavior changes beyond a period of three months [12,24].

Like traditional SBI that used various forms of interventions, e-SBI studies have experimented with various delivery platforms and feedback mechanisms. For example, computer-based interventions could involve a combination of web- and email-based interventions. Similarly, interventions on mobile platforms could involve text message prompts or native app notifications. We describe these electronic interventions in more detail below.

Computer-Based e-SBI. Research that analyzed 24 studies of online and in-person computer-based interventions found that the computer-based interventions are more effective at reducing the frequency drinking and binge drinking per week among college students compared to the control group [19]. Another computer-based intervention study shows a significant reduction in the students' drinking levels and drinking-related problems compared to the control group [16]. A review of 22 studies on social norm interventions that involve peer support, such as receiving notification messages from family and friends, showed that computer-based interventions are less costly, are more effective, and impacted across a broader set of outcomes for college students than mailed feedback, individual face-to-face feedback, and group face-to-face feedback for periods up to three months [24].

Although research shows that there are many positive potentials of e-SBI, some studies, particularly those that relied on personalized messages over emails, found that the interventions did not result in any significant effects to one's behavior. Several studies that utilized email interventions that contained personalized messages found that receiving those messages did not affect drinking patterns among college students [5,11,28]. Another email intervention study that provided personalized messages to college students found that only 8% of females and 3% of males believed that they would actually change their habits after receiving feedback [4].

Mobile Phone-Based e-SBI. Mobile phones are widely adopted in the young adult population. Mobile phones allow people to easily access text-messages, emails, and web contents. Research has found automated text messages to be an effective means for delivering alcohol-related interventions to college students [22,31]. Moreover, smartphones provide easier, wider, and faster access of the aforementioned services in addition to numerous other phone applications and connected devices. A current study in 2016 found 32 e-SBI apps on iTunes and Google Play that focused on drink monitoring [23].

In terms of the effectiveness of smartphone e-SBI, a randomized clinical trial study of 349 patients who suffered from alcoholism found that patients who used the e-SBI smartphone app reported significantly fewer risky drinking days than those in the control group [14]. However, for smartphone apps that calculate blood alcohol concentration (BAC), research found that using these apps tended to increase drinking frequency and BAC level among participants. Researchers attributed the increase to the fact that more male participants were represented in the study, and that they were more likely to treat the BAC level as a competitive social game [13].

Personal Smart Breathalyzer as New e-SBI. In general, although there are many studies that point to the positive impact of e-SBI for reducing alcohol consumption among young adults due to its ease of access and anonymity, there is very little research that involved the use of smartphone and wearable devices in both health- and information science-related areas. Also, little research

has focused on the use of breathalyzer for e-SBI. One randomized clinical trial study focused on the effectiveness of a contingency management treatment on the mobile phone platform. The study used a breathalyzer to monitor breath alcohol concentration level (BrAC), but the study's primary focus was on the effectiveness of the contingency management treatment as opposed to using the breathalyzer as an intervention tool for drinking [1]. To our knowledge, there has been no prior reporting of consumer-oriented breathalyzer device usage. In this paper, we describe an exploratory study that involves the use of a personal smart breathalyzer device that can be paired to one's smartphone.

3   BACtrack Mobile Pro

Figure 1 shows BACtrack Mobile Pro with three mouthpieces and a pouch that was given to the participant for the research.

Fig. 1. BACtrack Mobile Pro

BACtrack Mobile Pro is a consumer breathalyzer. We selected this device as a tool to use for our research since BACtrack is the first, and currently the only, company to obtain FDA approval to manufacture and market breathalyzers for consumer use. Moreover, consumer reviews on Amazon.com also show higher user satisfaction than other competing products [2,3]. Therefore, we concluded that it is reliable to use for the study.

This breathalyzer is developed to monitor and manage one's BAC and drinking habits by linking to a smartphone or a smart watch. The device can connect to BACtrack app for a smartphone via Bluetooth. Through an attached mouthpiece of the device, a user could blow and check her/his BAC on the app. The app can record the BAC levels and GPS-based location with an additional comment area that allows the user to take notes. The user can retrieve and compare the information over time. Depending on the BAC level, the app also displays appropriate suggestions along with the BAC reading. In addition, the app provides the user an estimated time when her/his BAC level is expected to drop to 0. The app also contains convenience features such as calling Uber [3]. Figure 2 shows screenshots of the smartphone app.
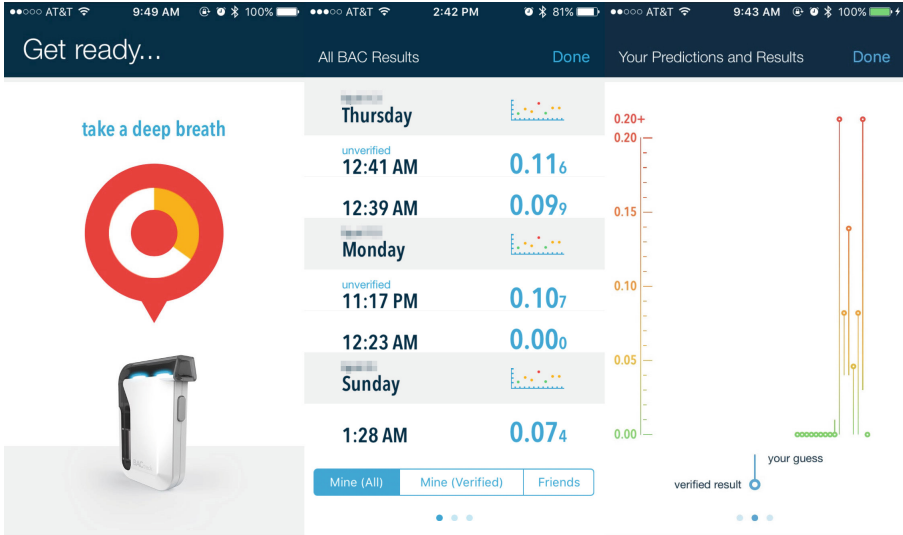
Fig. 2. Screenshots of BACtrack application

4   Methods

The goal of this research is to understand how the smart breathalyzer could influence college students' perceptions and behaviors on drinking, and how the design of the device and application could be potentially improved to prevent college students from excessive drinking.

We recruited undergraduate students by advertising the research through social media and snowball sampling. Our target population was college students who have consumed alcohol at least once a week. Participants were informed about the research process and signed an informed consent form approved by Institutional Review Board (IRB) at Indiana University. The participants were asked to fill out a basic demographics questionnaire. We then conducted an in-depth, one-hour interview asking about their current alcohol consumption perceptions, behaviors, and cultures. The participants were provided a short tutorial to learn how to use the breathalyzer device and the smartphone app. They then were given the breathalyzer with three mouthpieces, a pouch, and a charger for two weeks. At the end of each week, we sent short online surveys to query their usage experience in the previous week. At the end of the two-week period, the participants were required to fill out a post-study questionnaire about their overall user experiences. Finally, we conducted a follow-up interview to explore how the device had influenced the participant's alcohol consumption, perception, and behavior, and to uncover barriers related to device usage. All surveys were conducted via Qualtrics, and the interviews were audio-recorded and transcribed. We analyzed data by conducting open coding and iteratively refined the emerged themes [9].

5   Results

We recruited nine female and six male college students (mean age: 21.8 years old). They used the device between 2-to-7 times during the two-week period. From the follow-up surveys and interviews, we identified five main barriers with opportunities to improve the smart breathalyzer as a form of electronic intervention on drinking: *(1) Support from immediate family members or close friends, (2) Personalized results, (3) Intuitive status display, (4) Accessorizing the form factor, and (5) Quicker access.*

5.1   Support from Immediate Family Members or Close Friends

The functions of BACtrack Mobile Pro include not only BAC level calculation, but also calling Uber and simple sharing the BAC level online anonymously. At the beginning of the study, we expected that they might not want to share any alcohol-related information (e.g., BAC, status, or location) with other people they know. However, the college students said they want to share their drinking-related information with their immediate family members and close friends, mostly for safety. For instance, if a user registers their family members or friends on the app, the family or friends will receive notifications if the app detects an abnormally high BAC level. The family or friends could then provide any help to the user. Also, the participants wanted to help their family and friends if they become overly impaired.

P-02: "If I see one of my friends has a high BAC level, I will call and check on them to make sure they are ok."
P-11: "If I show my BAC level and status when I feel drunk, I can show it to my friends and let them know I should stop drinking. Then, they might not give me more shots."

A user can receive support by fending off peer pressure when the user shares BAC reading.

P-15: "I can share my BAC level with my friends when we drink together. Sometimes I may look fine to my friends, but I was actually drunk. So this BAC level would help me prove that I am drunk and that I won't be pressured into drinking more."

Our findings suggest that a closed peer support network system could be designed for those who want to share their states to get support from family members and friends.

5.2   Personalized Results

Participants also mentioned that they needed more meaningful representation of their BAC level; some of them have trouble understanding the meaning and

difference between readings such as 0.08 and 0.12. A more meaningful visual representation is needed to help those participants understand their alcohol consumption habits.

Since each person is different and could react to alcohol differently, the BAC level, which is shown on the app, might not exactly indicate the precise risk level for each person. Although the color and value of BAC level could indicate the risk level to a certain degree, many of our participants reported that they did not feel drunk when their BAC level exceeded the legal threshold of 0.08. On the other hand, some participants reported feeling drunk despite the BAC level being far below the 0.08 threshold while the app shows a green color.

P-07 "I am a light weight compare to other people. When I began to feel a headache from drinking too much and blew the breathalyzer, the color of BAC level was green. The device stated that my status is OK, but I wasn't. So I felt this is not helpful for me."
P-10 "It would be good if the device knows my state and gives some alerts to prevent me from having bad symptoms."
P-11 "It should provide personalized information about my drinking in detail. You know, degree of excessive drinking might be different, so if I just get BAC level without any detailed information, it does not have enough value."

Future design could allow participants to annotate their BAC levels to indicate their personal comfort level, and that could be used to personalize the individual's status display. For example, the app could display a red color if a user sets the threshold to 0.05 as opposed to the normative 0.08. This feature could provide more effective personalized feedback as intervention.

5.3   Intuitive Status Display

The device shows BAC level, texts, and graph on the app. However, many participants stated that they were confused when they saw the results. For instance, they did not know the BAC level at which it becomes dangerous for operating a motor vehicle. Also, although the app displays what a BAC level means to a user's possible status and suggestions with texts, they said the messages were too small and lengthy to read and understand, especially when they were drinking or were already intoxicated. Thus, they suggested that if the results show visual images that correspond to someone's physical conditions, such as passing out or in a form of emoticon, it would help them understand the status much more intuitively.

P-02 "If the device shows pictures of someone who is passed out or police officer who hands out ticket, it would encourage me to stop drinking. If you are drunk, you might not be able to read the words, but you can see the pictures."
P-13 "I wanna see what each BAC status means. When I used the device and saw the value, I thought 'Is this BAC level enough for my body? Is this dangerous to drive?' I don't understand intuitively."

Thus, future design should consider a participant's cognition and their physical conditions while drinking. This could be understandable even for users who are already drunk. The addition of audio or haptic effects could provide a more noticeable and effective intervention for users.

5.4 Accessorizing the Form Factor

The size of BACtrack Mobile Pro is small enough to be held in one hand. It is convenient to carry in one's purse or bag, but almost every participant mentioned that they were worried about losing the device because of its size, especially when they were less cognizant of their surroundings when drinking. Also, some participants suggested different shapes of devices such as a watch, a neckless, or a bracelet that could better fit their lifestyle and aesthetic preferences.

P-01 *"I had it in my purse, but I don't think it would be easy to carry for male students. It would be better if it could be attached to my cellphone."*
P-05 *"I don't wanna lose it, so I didn't bring it sometimes."*
P-13 *"At first time, I brought and used it. But the next day I was drunk, I almost could not find the device. Then I became really worried if I really lost it so I always leave the device at home."*

Therefore, future designs that investigate different ways of accessorizing the appearance of the breathalyzer and how it can be worn or carried conveniently could significantly affect the wider adoption of the device.

5.5 Quicker Access

To retrieve the BAC level, the user must turn on Bluetooth, open the app, and click on the device to pair the app. When a connection is established, the user needs to wait for the device to 'warm up' before she or he can blow into it to get the BAC reading. The device needs to capture a large enough amount of air that contains alcohol before a reading can be registered. This process could take up to one minute. Some participants expressed that the process took too long and was inconvenient and burdensome to use.

P-09 *"It was not easy to check my BAC because I was drunk. Why can't they monitor automatically?"*
P-12 *"I usually forgot to use it while I was drinking. It took quite a long time for me to set it up and check my BAC."*
P-15 *"You know, my device was really slow to turn on the app and Bluetooth. I was trying to check my level in the middle of drinking with my friends, but it took a long time. It was obvious that it disrupted our conversation."*

Today's smartphone is capable of location detection. It may be possible to program the breathalyzer and the app to enter into a 'hibernation' mode so that it could be accessed quicker. For example, if the app detects that a user is located

in the vicinity of a bar or any preset place where the user usually drinks, the app is automatically turned on in the hibernation mode. If automatic detection is not possible, it may be possible to create a manual mode that allows the user to set the connection state manually if they know when and where they plan to drink that evening.

6   Conclusion

This ongoing research has explored current college students' perceptions, behaviors, and cultures regarding drinking, and the issues of using a smart breathalyzer as a potential e-SBI device to prevent excessive drinking among college students. We have identified five current barriers and future design opportunities to improve the app interface and device form factor. Those promising features have potential for attracting college students and providing a better user experience to them for reducing risky drinking. Even though some limitations of the study include the short usage time (two weeks) and a relatively small number of users (15 college students), this study contributes to exploring potential of future e-SBI tools as an extension of previous SBI studies where few studies have focused on using up-to-date technology such as a smart breathalyzer. Also, we contribute to introducing a new, important role of information technology in the field of information science where little research has conducted for this significant role considering public health. Current information technology can be a more effective way of motivating and helping college students with preventing from drinking issues, which is a big problem that needs to be solved.

Future research should specifically consider how to design effective interventions for college students. We plan to design and implement a different smartphone app that integrates with the smart breathalyzer, and to conduct a longer-term deployment study to understand the potential impact on college students' perceptions and behaviors of alcohol consumption.

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