



Full length article

## Smartphone application for unhealthy alcohol use: Pilot randomized controlled trial in the general population

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## ABSTRACT

**Background:** There is limited evidence of the efficacy of smartphone applications to reduce unhealthy alcohol use. We tested the efficacy of providing access to a smartphone-based brief intervention for unhealthy alcohol use.

**Methods:** We conducted a two parallel-group randomized controlled trial with follow-up at 6 months, among 977 individuals with an Alcohol Use Disorder Identification Test  $\geq 8$  and drinking 15 or more drinks/week. Participants were randomized to receive (or not) access to a smartphone application consisting of personalized feedback, risk assessment and self-monitoring. The primary outcome was the mean number of drinks/week. An intention to treat analysis (ITT) and a per protocol analysis (PP) were conducted.

**Results:** Mean age of participants was 34.2(9.8), 46% were female. The baseline mean number of drinks per week was 28.9(16.7). Results differed by type of analysis: ITT: all 977 participants were included in the analysis. Follow-up rate was 70.7% (n = 691). There was no significant intervention effect: the Incidence Rate Ratio (IRR) (95%CI) for number of drinks per week was 0.93(0.84; 1.03). PP: 702 participants were included in the analysis. Follow-up rate was 78.1% (n = 548). There was a significant intervention effect: the IRR for number of drinks per week was 0.88(0.78; 0.99).

**Conclusions:** Providing access to a smartphone-based brief intervention had no impact on drinking at 6 months and does not appear to be an effective intervention in reducing drinking. Those who downloaded the app appear to benefit from it, nevertheless downloads were limited and further development of similar apps should focus on increasing use.

### 1. Introduction

Unhealthy alcohol use is a leading cause of morbidity and mortality worldwide (Peacock et al., 2018).

Screening and brief intervention has demonstrated efficacy in primary care as an approach to non-treatment seeking individuals (Bertholet et al., 2005; Kaner et al., 2007, 2018), but implementation of face-to-face screening and brief intervention has been limited due to various constraints (e.g. time, competing priorities, clinician's training, fear of stigmatizing patients, availability of services) (Cohen et al., 2007). Information technology has the potential to overcome some of these barriers and allow access to screening and brief intervention to larger parts of the general population (Cunningham et al., 2014; Elliott et al., 2008). Compared to face-to-face interventions, interventions using information technology have a greater reach, may be more easily implemented and have a higher fidelity (i.e. because it is automated,

the intervention is delivered as intended and consistently for all participants) (Noell and Glasgow, 1999). Numerous electronic interventions using CD-ROM, computers or the internet have been developed and tested (Khadjesari et al., 2011; Riper et al., 2011), and electronic screening and brief intervention is considered an effective method for reducing unhealthy alcohol use (Kaner et al., 2017; Tansil et al., 2016).

In a context in which there is a demand for electronic interventions, the smartphone may be an adequate tool to disseminate interventions, (Vernon, 2010). Since smartphones are items people carry with them almost all the time, it may allow delivering interventions in context outside of reach of other computerized interventions. Some studies have highlighted the potential usefulness and the patient's interest in smartphone applications in the management of chronic conditions, physical activity, and mental health (Boulos et al., 2011; Rabin and Bock, 2011; Rizvi et al., 2011). In a review of available smartphone applications, Cohn et al. stressed the importance for the alcohol

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research field to remain up-to-date with interactive media to bring alcohol interventions to people who might otherwise not access care (Cohn et al., 2011). A recent study showed that a multifaceted smartphone application was beneficial to patients following an admission for alcohol inpatient treatment, (Gustafson et al., 2014) but similar applications have not been widely studied in less severe drinkers. A 2015 review of existing studies on smartphone applications to reduce alcohol use listed six applications (Meredith et al., 2015). Of these, two were associated with reductions in drinking (Gonzalez and Dulin, 2015), two were not associated with reductions (Gajecki et al., 2014) and two required further examination of possible effects.

It is important to note that smartphone applications can also be developed for marketing purposes, to promote alcohol use. Indeed, most available alcohol-related applications on the major platforms (Google play, iTunes) are implicitly or explicitly encouraging the use of alcohol and only a minority are promoting health (Crane et al., 2015). In addition, of the current applications focusing on alcohol reduction, few contain evidence-based behavior change techniques (Crane et al., 2015) and even thoughtfully developed applications can be associated with unanticipated adverse effects (Gajecki et al., 2014).

The development of smartphone applications related to alcohol use has thus increased, but there is limited evidence of the efficacy of smartphone applications to reduce unhealthy alcohol use. The scarcity of evidence is particularly noticeable at a time when numerous applications are being developed and released. Evidence of the efficacy of computer based or web-based intervention cannot be extrapolated to smartphone applications: notably, computers and smartphones are used differently, which may change their impact, and content has to be adapted to the smartphone format. If proven effective, smartphone applications could contribute to bridge the gap between those in need of a brief intervention and those receiving it.

Therefore, we developed a smartphone application targeting unhealthy alcohol use, based on an existing website with web-based intervention with evidence of efficacy (Bertholet et al., 2015a, b). It consists of five modules: 1) personalized feedback on alcohol use (including normative feedback), 2) self-monitoring tool, 3) tool to choose a designated driver, 4) blood alcohol content (BAC) calculator, and 5) information on alcohol use and its consequences (i.e. “fact sheets”). Its theoretical rationale is based on social norms theory and risk perception. Therefore, this application includes a social norms intervention (Berkowitz, 2005; Perkins, 2002, 2007; Perkins et al., 2005). The application also provides personalized feedback on risk of harm. Personalized feedback is considered one of the possible mechanisms of brief interventions to reduce alcohol use (Carey et al., 2012; Crane et al., 2018; Gaume et al., 2014). In addition, the application is designed to encourage self-efficacy through autonomous goal setting. It also provides additional information and resources to users willing or needing more.

The acceptability of the developed app was evaluated in a pilot study (Bertholet et al., 2017). The app was generally acceptable to users, and, in this uncontrolled open study, app use was associated with reduced alcohol consumption. Decreases were observed over time on weekly drinking and on binge drinking prevalence (Bertholet et al., 2017). In order to further evaluate the app, we conducted a pilot randomized controlled trial in a general population sample in Canada and the US, a non-treatment seeking sample, using the app as it is available on iTunes and Google play, without any in app monitoring of which elements are used by users. The hypothesis was that participants randomized to receive access to the app would decrease their drinking more than those assigned to a no-intervention condition.

## 2. Methods

### 2.1. Trial design

We conducted a two parallel-group individually randomized

controlled trial with a 1:1 allocation ratio with follow-up at 6 months in a general population sample. The study was conducted electronically, and all assessments were completed online. The randomization was imbedded within the survey website. Participants were randomized immediately after they completed the baseline assessment. There was no involvement of the researchers in the randomization process and the concealment of allocation was total.

### 2.2. Participants

Participants were recruited via the Amazon Mechanical Turk online portal. Recruitment was conducted in January 2017. The study was presented on the MTurk portal as a survey on people’s drinking. People were paid 1.5 USD to complete a short survey designed to identify individuals with unhealthy alcohol use. Individuals reporting unhealthy alcohol use, defined as an Alcohol Use Disorder Identification Test (AUDIT) of 8 or more and drinking 15 or more drinks per week, were then invited to participate in the randomized trial. Inclusion criteria were: unhealthy alcohol use, being 18 or over, smartphone ownership and willingness to complete the 6 months follow-up. There were no exclusion criteria for the trial. Participants meeting inclusion criteria were invited to take part in the 6 months follow-up (paid 10 USD). After completing the MTurk survey, participants were offered to participate in a second survey, 6 months later, for which some of them would also be given access to a mobile app with some additional information about drinking. Participants were asked to check one of two boxes: one if they agreed to the 6 months survey, one if they did not want to be contacted again. Those willing to participate were randomized to be sent a request to download the smartphone app or not. Participants in the intervention group received an email thanking participants to agreeing to be contacted again six months later to fill out a new survey. They were encouraged to download the app with the following message “In the meantime, please have a look at an app that will let you see how your drinking compares with others. We will ask your impressions of this app on the next survey”. Participants in the control group received the same email but without the indication to download the app. As such, the tested intervention was the provision of access to a smartphone-based brief intervention for unhealthy alcohol use. Participants were blinded to the study hypotheses and outcomes. In the intervention group, participants received an incentive if they sent a picture of the app installed on their smartphone (considered a “proof” of download). In the control group a mimicking procedure was in place in the form of replying to a confirmatory email. Participants replying were paid an additional 5 USD. This incentive was presented after the participants were randomized as a “bonus 5 USD” that participants could receive if they sent a proof of download/confirmatory email. Total participation in the study added up to 16.50 USD (1.50 USD for the baseline survey, 10 USD for follow-up at 6-months and 5 USD if they downloaded the app or replied to the control email), however it was not presented to participants as a total amount (i.e. participants were not aware of the bonus 5 USD when they agreed to be randomized and to participate in the 6 months follow-up). Participants in the intervention and control groups received the same assessments. The difference between the two groups was the provision of a link to download the app.

### 2.3. Measures

The primary outcome was number of drinks in a typical week, measured at 6 months. The number of drinks in a typical week was assessed with the following question: “what was your drinking like during a typical week in the past 6 months?” Participants were asked to report the number of drinks they usually drank on each day of the week. A drink was defined as 12 oz of beer, 5 oz of wine, 3 oz of fortified wine, or 1.5 oz of liquor. The number of drinks per week was the sum of the number of drinks reported for each day of the week. This measure is reliable and has been used in other studies using electronic assessments

**Table 1**  
Characteristics of study participants.

	Total (n = 977)	Full sample (n = 461)	Control (n = 516)	Total (n = 702)	Per protocol Intervention (n = 261)	Control (n = 441)
	Mean(SD)	Mean(SD)	Mean(SD)	Mean(SD)	Mean(SD)	Mean(SD)
	N(%)	N(%)	N(%)	N(%)	N(%)	N(%)
Age	34.2 (9.8)	34.2 (9.8)	34.3 (9.8)	33.6 (9.4)	32.4 (8.9)	34.3 (9.6)
Gender (female)	448 (45.9%)	205 (44.5%)	243 (47.1%)	327 (46.6%)	119 (45.6%)	208 (47.2%)
Ethnicity (white vs other)	785 (80.4%)	374 (81.1%)	411 (79.7%)	568 (80.9%)	211 (80.8%)	357 (81.0%)
Country (USA)	969 (99.2%)	457 (99.1%)	512 (99.2%)	695 (99.0%)	258 (98.9%)	437 (99.1%)
Post-Secondary Education	646 (66.1%)	308 (66.8%)	338 (65.5%)	467 (66.5%)	172 (65.9%)	295 (66.9%)
Married/stable relationship	441 (45.1%)	212 (46.0%)	229 (44.4)	316 (45.0%)	122 (46.7%)	194 (44.0%)
Income less than 20k	222 (22.7%)	98 (21.3%)	124 (24.0%)	146 (20.8%)	53 (20.3%)	93 (21.1%)
Employed full time	595 (60.9%)	286 (62.0%)	309 (59.9%)	443 (63.1%)	169 (64.8%)	274 (62.1%)
Daily internet use	848 (86.8%)	404 (87.6%)	444 (86.1%)	615 (87.6%)	235 (90.0%)	380 (86.2%)
AUDIT score	18.3 (7.1)	18.5 (7.2)	18.1 (6.9)	18.0 (7.0)	18.5 (7.4)	17.7 (6.7)
Number of drinks per week	28.9 (16.7)	28.9 (18.3)	28.9 (15.2)	28.9 (17.1)	29.2 (20.2)	28.8 (15.1)
Max drinks/occasion	11.4 (5.8)	11.3 (6.0)	11.5 (5.6)	11.4 (5.6)	11.6 (6.2)	11.3 (5.2)
Number of alcohol consequences reported (0-11)	3.9 (2.3)	4.0 (2.3)	3.9 (2.3)	3.8 (2.2)	3.9 (2.3)	3.8 (2.2)

(Kuhlhorn and Leifman, 1993; Neighbors et al., 2010; Romelsjo et al., 1995). Secondary outcomes were number of alcohol consequences reported (11 consequences were assessed: hangover, missing work or class, get behind in one's work, argue with friends, engage in unplanned sexual activity, not using protection while having sex, damaged property, got into trouble with the police, got hurt or injured or injured somebody else, required medical treatment for an alcohol overdose, drive under the influence of alcohol) and maximum number of drinks on one occasion, measured at 6 months.

#### 2.4. Content of the application

As reported in the introduction, the app consisted of five modules. The personalized feedback module comprised normative feedback in addition to an indication of the risk related to alcohol use (weekly risky drinking or risky single occasion drinking or both) with examples matched for the drinking profile and gender (i.e. impact on health conditions such as liver disease, cancer, high blood pressure or accidents) and an indication of the amount of calories corresponding to the reported alcohol consumption. Normative feedback is presented as the percentage of people of the same age drinking as much as the participant and less than the participant (for weekly drinking and heavy drinking frequency). The self-monitoring tool allows participants to set drinking limits for the next 1, 2 or 7 days. Participants are then invited to complete a drinking diary and can receive a badge when they drink at or below the decided drinking limits. The designated driver tool allows users to randomly select the designated driver for the night among a group of up to 6 people. The blood alcohol content (BAC) module computes BAC for the reported consumption and provides an estimate as to when BAC will be back to zero. The fact sheets include general information on alcohol and health. The app does not send push notifications and its use is unsolicited once downloaded.

#### 2.5. Analyses

Intervention effect was assessed using negative binomial regression models using multiple imputation to handle missing values. These models were selected because they best fitted the data. Two analyses were conducted: 1.) an intention to treat analysis, where all participants were included in the analyses, and 2.) a per protocol analysis in which only those who confirmed the download of the app or the confirmatory email were included. Regression models were adjusted for outcome baseline values. Two sensitivity analyses were conducted: one with complete cases, the other with the baseline observation carried forward.

In addition, we assessed potential differences between participants

who downloaded the app/replied to the confirmatory email or not. The trial (including the primary hypothesis and primary outcome) has been registered (ClinicalTrials.gov, NCT03008928) and approved by the IRB at the Centre for Addiction and Mental Health, Toronto, Canada. Analyses were conducted using SAS 9.4.

#### 2.6. Sample size

Based on our previous evaluation of the app and similar web-based brief alcohol interventions, we expected effects on drinking to be in the small range (e.g., Cohen, 1992;  $d = .20$ ). Given maximum expected attrition, a sample size of 788 will provide .80 power to detect effects sizes of  $d = .20$ . Based on our previous work, we expected a retention rate of 80% at 6-month follow-up. Thus, we aimed to recruit an initial sample of 986 participants.

### 3. Results

Recruitment was completed in 9 days. 3456 people completed the baseline survey, and 996 fulfilled the inclusion criteria (Cunningham et al., 2017). Nine participants were excluded because they did not submit contact information and could not be contacted for follow-up, and an additional 10 participants were excluded because they declared inaccurate data reporting at follow-up (i.e. when asked, they stated that they had not provided accurate follow-up data). This left a study sample of 977 (intervention group,  $n = 461$ ; control group,  $n = 516$ ). Of the 461 in the intervention group, 261 (56.6%) sent a confirmation of app download. Of the 516 in the control group, 441 (85.5%) replied to the confirmatory email. Characteristics of participants are presented in Table 1.

#### 3.1. Intention to treat analysis

977 participants were included in the analysis. Of them 691 (70.7%) completed the 6 months follow-up. At follow-up, the mean (SD) number of drinks per week was 18.9 (15.0) in the intervention group and 21.4 (18.0) in the control group. There was no significant intervention effect on the primary outcome. The incidence rate ratio (95%CI) for number of drinks in a typical week was 0.93 (0.84; 1.03). There was no intervention effect on secondary outcomes. Details are presented in Table 2. Sensitivity analyses with complete cases and with baseline values carried forward yielded similar results.

#### 3.2. Per protocol analysis

702 participants were included in the analysis. Of them 548 (78.1%)

**Table 2**

Intention to treat and per protocol analyses of number of drinks per week, maximum number of drinks on one occasion and number of alcohol related consequences.

	Intention to treat			Per protocol		
	IRR	95% CI	P	IRR	95% CI	P
<b>Primary outcome</b>	<b>Drinks per week at 6 months</b>			<b>Drinks per week at 6 months</b>		
Intervention	0.93	0.84; 1.03	0.17	0.88	0.78; 0.99	0.04
Drinks per week, baseline	1.02	1.02; 1.03	< 0.0001	1.02	1.02; 1.03	< 0.0001
<b>Secondary outcome (1)</b>	<b>Maximum number of drinks on one occasion at 6 months</b>			<b>Maximum number of drinks on one occasion at 6 months</b>		
Intervention	0.99	0.93; 1.06	0.81	0.95	0.88; 1.03	0.20
Maximum number of drinks on one occasion, baseline	1.06	1.05; 1.06	< 0.0001	1.06	1.05; 1.06	< 0.0001
<b>Secondary outcome (2)</b>	<b>Number of consequences at 6 months</b>			<b>Number of consequences at 6 months</b>		
Intervention	1.00	0.91; 1.10	0.99	0.94	0.84; 1.06	0.31
Number of consequences, baseline	1.18	1.16; 1.20	< 0.0001	1.18	1.15; 1.21	< 0.0001

Negative binomial regression.

IRR = incidence rate ratio; CI = confidence interval.

completed the 6 months follow-up. At follow-up, the mean number of drinks per week was 18.5 (14.8) in the intervention group and 21.1 (17.4) in the control group. There was a significant intervention effect on the primary outcome. The incidence rate ratio for number of drinks per week was 0.88 (0.78; 0.99). There was no effect on secondary outcomes. Details are presented in Table 2. Sensitivity analyses yielded similar results. Specifically, the intervention effect on the number of drinks per week remained significant (complete cases: incidence rate ratio 0.87 [0.77; 0.99], baseline value carried forward: incidence rate ratio 0.90 [0.82; 0.99]).

### 3.3. Comparison of participants who downloaded the app/replied to a confirmatory email and those who did not

There were no significant differences on baseline characteristics between participants who completed the protocol and those who did not, except for age, employment status and income. Per protocol participants were significantly younger (33.6 vs 35.8,  $p = 0.003$ ), more likely to be full time employed (63% vs 55%,  $p = 0.03$ ), and less likely to have an income of less than 20 K per year (21% vs 28%,  $p = 0.03$ ).

## 4. Discussion

In this randomized trial, we did not find an effect of giving access to a smartphone app on drinking at 6 months. There was no effect on the primary and secondary outcomes of receiving access to a smartphone app compared to a no-intervention control condition. Therefore, providing access to a smartphone app is not an effective intervention in reducing drinking.

When the sample was restricted to participants who downloaded the app or completed a matching procedure in the control group (i.e. per protocol analysis), we found a significant effect of the intervention on the volume of drinking at 6 months. Those who downloaded the app reported 12% less drinks per week at 6 months compared to the no-intervention control condition. Nevertheless, the proportion of participants who downloaded the app remained low (57%) which limits the potential benefits of this mode of intervention delivery. Compared to internet interventions that do not require extensive manipulations, downloading an app may prevent some participants from participating further. Even if efforts necessary to download an app are limited, it may be enough to stop some participants. Specifically, in the present study, participants had to send a proof of download (picture of the app installed on their smartphone), which may have been perceived as too burdensome and time consuming (also, since some participants needed further instructions to do this, it is possible some participants did not know how to do this and gave up). It should be noted that the

participants received an incentive after downloading the app and that the design did not allow to test the effect of this incentive on app download. Given the recruitment method used in the present study, which relies on individuals who are making some income out of participating in surveys, the saliency of the study subject may have prevented people from downloading the app (even though an incentive was attached to it). On the other hand, the sample was very used to new information technology tools and may be considered with a higher technology literacy than other members of the general population. One area of improvement for electronic interventions is therefore to increase actual participation when access to an intervention is provided. The study was conducted in a non-treatment seeking, non-clinical sample. This approach is different from what could be done in a clinical setting with a proactive and systematic screening, where the burden would be put on the clinical team to provide adequate screening and interventions. Here, the burden was on the participants who were responsible to actively download and use the app. This allowed to obtain information on how an alcohol brief intervention app would be downloaded in a non-treatment seeking population.

Since this study was a pilot trial, there was no extensive data collection. Specifically, we used the app as it is available on iTunes or Google Play and no information was collected on which modules were used and how often. Additional limitations include use of self-report and the recruitment method. Because participants were recruited via MTurk, the sample consists of individuals who may be considered as professional survey takers, which may limit generalizability. In addition, the retention rate was smaller than expected and therefore analyses may have been slightly underpowered.

The present study has notable strength. First, it is one of the first randomized trials of a smartphone app for unhealthy alcohol use conducted in a large sample. With the study design, it was possible to assess how people reacted when they are offered access to an alcohol intervention delivered through a smartphone. In addition, we were able to compare intervention effects in the full sample vs. among those who downloaded the app. Limitations include the use of a recruitment method likely to select a very specific population, which limits generalizability. Similar to samples recruited through ads, the current study population is likely not fully representative of the general population and results should be interpreted with caution.

## 5. Conclusions

We did not find an effect of providing access to a smartphone application on drinking outcomes. Providing access to a smartphone application does not appear to be an effective intervention in reducing drinking. Nevertheless, those who accessed the intervention appear to

benefit from it when compared to a no-intervention control. It should be noted that differences were observed between those who accessed the app or not and that these differences suggest that younger individuals and individuals from higher socio-economic strata are more likely to access the intervention. The possible difference in socio-economic status is potentially problematic when considering that individuals from lower socio-economic strata are suffering from alcohol consequences and therefore should not be left out. Smartphone apps represent an opportunity to deliver interventions for unhealthy alcohol use, nevertheless, as of today, evidence of efficacy is scarce and providing access to the intervention is likely insufficient to lead to significant changes in drinking among people with unhealthy alcohol use. In an area that is facing important development, we think our results are important and indicate that additional measures are necessary to encourage participants to access the intervention and use it repeatedly, a necessary step to expect some intervention effects.

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### Contributors

Conceived and designed the experiment: NB AG JAC. Performed the experiments: AG JAC. Analyzed the data: NB AG JAC. Wrote the paper: first draft: NB, final version: NB AG JAC. Secured funding: JAC.

The submitted manuscript has been read and approved by all contributing authors, all authors acknowledge they have exercised due care in ensuring the integrity of the work.

### Conflict of interest

No conflict declared.

### Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:<https://doi.org/10.1016/j.drugalcdep.2018.12.002>.

### References

- Berkowitz, A.D., 2005. An overview of the social norms approach. In: Lederman, L., Stewart, L. (Eds.), *Changing the Culture of College Drinking: A Socially Situated Health Communication Campaign*. Hampton Press, Cresskill, NJ.
- Bertholet, N., Daepfen, J.B., Wietlisbach, V., Fleming, M., Burnand, B., 2005. Reduction of alcohol consumption by brief alcohol intervention in primary care: systematic review and meta-analysis. *Arch. Intern. Med.* 165, 986–995.
- Bertholet, N., Cunningham, J.A., Faouzi, M., Gaume, J., Gmel, G., Burnand, B., Daepfen, J.B., 2015a. Internet-based brief intervention for young men with unhealthy alcohol use: a randomized controlled trial in a general population sample. *Addiction* 110, 1735–1743.
- Bertholet, N., Cunningham, J.A., Faouzi, M., Gaume, J., Gmel, G., Burnand, B., Daepfen, J.B., 2015b. Internet-based brief intervention to prevent unhealthy alcohol use among young men: a randomized controlled trial. *PLoS One* 10, e0144146.
- Bertholet, N., Daepfen, J.B., McNeely, J., Kushnir, V., Cunningham, J.A., 2017. Smartphone application for unhealthy alcohol use: a pilot study. *Subst. Abuse* 38, 285–291.
- Boulos, M.N., Wheeler, S., Tavares, C., Jones, R., 2011. How smartphones are changing the face of mobile and participatory healthcare: an overview, with example from eCAALYX. *Biomed. Eng. Online* 10, 24.
- Carey, K.B., Scott-Sheldon, L.A., Elliott, J.C., Garey, L., Carey, M.P., 2012. Face-to-face versus computer-delivered alcohol interventions for college drinkers: a meta-analytic review, 1998 to 2010. *Clin. Psychol. Rev.* 32, 690–703.
- Cohen, E., Feinn, R., Arias, A., Kranzler, H.R., 2007. Alcohol treatment utilization: findings from the National Epidemiologic Survey on alcohol and related conditions. *Drug Alcohol Depend.* 86, 214–221.
- Cohn, A.M., Hunter-Reel, D., Hagman, B.T., Mitchell, J., 2011. Promoting behavior change from alcohol use through mobile technology: the future of ecological momentary assessment. *Alcohol. Clin. Exp. Res.* 35, 2209–2215.
- Crane, D., Garnett, C., Brown, J., West, R., Michie, S., 2015. Behavior change techniques in popular alcohol reduction apps: content analysis. *J. Med. Internet Res.* 17, e118.
- Crane, D., Garnett, C., Michie, S., West, R., Brown, J., 2018. A smartphone app to reduce excessive alcohol consumption: identifying the effectiveness of intervention components in a factorial randomised control trial. *Sci. Rep.* 8, 4384.
- Cunningham, J.A., Gulliver, A., Farrer, L., Bennett, K., Carron-Arthur, B., 2014. Internet interventions for mental health and addictions: current findings and future directions. *Curr. Psychiatry Rep.* 16, 521.
- Cunningham, J.A., Godinho, A., Kushnir, V., 2017. Using Mechanical Turk to recruit participants for internet intervention research: experience from recruitment for four trials targeting hazardous alcohol consumption. *BMC Med. Res. Methodol.* 17, 156.
- Elliott, J.C., Carey, K.B., Bolles, J.R., 2008. Computer-based interventions for college drinking: a qualitative review. *Addict. Behav.* 33, 994–1005.
- Gajecski, M., Berman, A.H., Sinadinovic, K., Rosendahl, I., Andersson, C., 2014. Mobile phone brief intervention applications for risky alcohol use among university students: a randomized controlled study. *Addict. Sci. Clin. Pract.* 9, 11.
- Gaume, J., McCambridge, J., Bertholet, N., Daepfen, J.B., 2014. Mechanisms of action of brief alcohol interventions remain largely unknown – a narrative review. *Front. Psychiatry* 5, 108.
- Gonzalez, V.M., Dulin, P.L., 2015. Comparison of a smartphone app for alcohol use disorders with an Internet-based intervention plus bibliotherapy: a pilot study. *J. Consult. Clin. Psychol.* 83, 335–345.
- Gustafson, D.H., McTavish, F.M., Chih, M.Y., Atwood, A.K., Johnson, R.A., Boyle, M.G., Levy, M.S., Driscoll, H., Chisholm, S.M., Dillenburg, L., Isham, A., Shah, D., 2014. A smartphone application to support recovery from alcoholism: a randomized clinical trial. *JAMA Psychiatry* 71, 566–572.
- Kaner, E.F., Beyer, F., Dickinson, H.O., Pienaar, E., Campbell, F., Schlesinger, C., Heather, N., Saunders, J., Burnand, B., 2007. Effectiveness of brief alcohol interventions in primary care populations. *Cochrane Database Syst. Rev.* 2, CD004148.
- Kaner, E.F.S., Beyer, F.R., Garnett, C., Crane, D., Brown, J., Muirhead, C., Redmore, J., O'Donnell, A., Newham, J.J., de Vocht, F., Hickman, M., Brown, H., Maniopoulos, G., Michie, S., 2017. Personalised digital interventions for reducing hazardous and harmful alcohol consumption in community-dwelling populations. *Cochrane Database Syst. Rev.* 9, CD011479.
- Kaner, E.F.S., Beyer, F.R., Muirhead, C., Campbell, F., Pienaar, E.D., Bertholet, N., Daepfen, J.B., Saunders, J.B., Burnand, B., 2018. Effectiveness of brief alcohol interventions in primary care populations. *Cochrane Database Syst. Rev.* 2, CD004148.
- Khadjesari, Z., Murray, E., Hewitt, C., Hartley, S., Godfrey, C., 2011. Can stand-alone computer-based interventions reduce alcohol consumption? A systematic review. *Addiction* 106, 267–282.
- Kuhlhorn, E., Leifman, H., 1993. Alcohol surveys with high and low coverage rate: a comparative analysis of survey strategies in the alcohol field. *J. Stud. Alcohol* 54, 542–554.
- Meredith, S.E., Alessi, S.M., Petry, N.M., 2015. Smartphone applications to reduce alcohol consumption and help patients with alcohol use disorder: a state-of-the-art review. *Adv. Health Care Technol.* 1, 47–54.
- Neighbors, C., Lewis, M.A., Atkins, D.C., Jensen, M.M., Walter, T., Fossos, N., Lee, C.M., Larimer, M.E., 2010. Efficacy of web-based personalized normative feedback: a two-year randomized controlled trial. *J. Consult. Clin. Psychol.* 78, 898–911.
- Noell, J., Glasgow, R.E., 1999. Interactive technology applications for behavioral counseling: issues and opportunities for health care settings. *Am. J. Prev. Med.* 17, 269–274.
- Peacock, A., Leung, J., Larney, S., Colledge, S., Hickman, M., Rehm, J., Giovino, G.A., West, R., Hall, W., Griffiths, P., Ali, R., Gowing, L., Marsden, J., Ferrari, A.J., Grebely, J., Farrell, M., Degenhardt, L., 2018. Global statistics on alcohol, tobacco and illicit drug use: 2017 status report. *Addiction* 113, 1905–1926.
- Perkins, H.W., 2002. Surveying the damage: a review of research on consequences of alcohol misuse in college populations. *J. Stud. Alcohol Suppl.* 91–100.
- Perkins, H.W., 2007. Misperception of peer drinking norms in Canada: another look at the "reign of error" and its consequences among college students. *Addict. Behav.* 32, 2645–2656.
- Perkins, H.W., Haines, M.P., Rice, R., 2005. Misperceiving the college drinking norm and related problems: a nationwide study of exposure to prevention information, perceived norms and student alcohol misuse. *J. Stud. Alcohol* 66, 470–478.
- Rabin, C., Bock, B., 2011. Desired features of smartphone applications promoting physical activity. *Telemed. J. E. Health* 17, 801–803.
- Riper, H., Spek, V., Boon, B., Conijn, B., Kramer, J., Martin-Abello, K., Smit, F., 2011. Effectiveness of E-self-help interventions for curbing adult problem drinking: a meta-analysis. *J. Med. Internet Res.* 13, e42.
- Rizvi, S.L., Dimeff, L.A., Skutch, J., Carroll, D., Linehan, M.M., 2011. A pilot study of the DBT coach: an interactive mobile phone application for individuals with borderline personality disorder and substance use disorder. *Behav. Ther.* 42, 589–600.
- Romelsjo, A., Leifman, H., Nystrom, S., 1995. A comparative study of two methods for the measurement of alcohol consumption in the general population. *Int. J. Epidemiol.* 24, 929–936.
- Tansil, K.A., Esser, M.B., Sandhu, P., Reynolds, J.A., Elder, R.W., Williamson, R.S., Chattopadhyay, S.K., Bohm, M.K., Brewer, R.D., McKnight-Eily, L.R., Hungerford, D.W., Toomey, T.L., Hingson, R.W., Fielding, J.E., Community Preventive Services Task, F., 2016. Alcohol electronic screening and brief intervention: a community guide systematic review. *Am. J. Prev. Med.* 51, 801–811.
- Vernon, M.L., 2010. A review of computer-based alcohol problem services designed for the general public. *J. Subst. Abuse Treat.* 38, 203–211.