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A meta-analysis of effectiveness of E-Interventions to reduce alcohol consumption in college and university students

Journal:	<i>Journal of American College Health</i>
Manuscript ID	JACH-2017-08-0285.R1
Manuscript Type:	Major Article
Keywords:	meta-analysis, electronic interventions, students, Alcohol
Abstract:	<p>Objective: To evaluate the effectiveness and moderators of E-Interventions versus assessment only (AO) controls in the reduction of alcoholic drinks per week (DPW) in university students.</p> <p>Study design and methods: Studies were included if they were: an RCT, assessed the effectiveness of E-Interventions at reducing DPW, and employed university/college students. 23 studies (N = 7,614) were included and quality was assessed using the JADAD scale.</p> <p>Results: Weighted mean effect sizes were calculated using random-effects models. These showed a small, significant effect of E-Interventions at reducing the number of alcoholic DPW. Moderator analysis found a significant advantage for web-based personalised feedback interventions compared to other E-Interventions.</p> <p>Conclusions: E-Interventions show a small, significant effect at reducing mean alcoholic DPW. Personalised feedback E-Interventions showed the strongest effect.</p>

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TITLE PAGE

In Review

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5 **A meta-analysis of effectiveness of E-interventions to reduce alcohol consumption in**
6 **college and university students.**
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10
11 **Abstract**

12 *Objective:* To evaluate the effectiveness and moderators of E-Interventions versus assessment
13 only (AO) controls in the reduction of alcoholic drinks per week (DWP) in university
14 students.
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20 *Study design and methods:* Cochrane library, CINAEL, ERIC, MEDLINE, PsycINFO,
21 PubMed, and Web of Science were searched up to June 2017. Studies were included if they
22 were: an RCT, assessed the effectiveness of E-Interventions at reducing DWP, and employed
23 university/college students. 23 studies ($N = 7,614$) were included and quality was assessed
24 using the JADAD scale.
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31 *Results:* Weighted mean effect sizes were calculated using random-effects models. These
32 showed a small, significant effect of E-Interventions at reducing the number of alcoholic
33 DWP. Moderator analysis found a significant advantage for web-based personalised feedback
34 interventions compared to other E-Interventions.
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41 *Conclusions:* E-Interventions show a small, significant effect at reducing mean alcoholic
42 DPW. Personalised feedback E-Interventions showed the strongest effect.
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46 *Keywords:* meta-analysis, electronic interventions, alcohol, students
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3 From neighbours sharing homebrewed cider to internationally recognisable events such as
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5 Oktoberfest¹ drinking is part of global social customs. However, with the consumption of
6
7 alcohol comes a risk of adverse health and social consequences². A period synonymous with
8
9 drinking is college/university years (students aged 18 and above)³, with alcohol use
10
11 increasing significantly following the transition from secondary school to college/university
12
13 in American and other nationalities of students^{4,5}. Furthermore, college/university students
14
15 misuse alcohol to a greater degree than their non-student peers, with approximately 45% of
16
17 students reporting a recent episode of heavy alcohol consumption on a monthly basis⁶; a
18
19 heavy drinking episode being classified as drinking five or more alcoholic drinks for men or
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21 four or more drinks for women in a two-hour period⁷.

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25 Both alcohol use in general, and heavy episodic drinking in particular, are associated
26
27 with significant health and other risks^{8,9}. For example, 47% of students who engaged in
28
29 heavy episodic drinking experienced five or more drink-related problems (e.g. injuries and
30
31 engagement in unplanned sexual activities⁹). However, heavy episodic drinking students
32
33 frequently do not see this behaviour as problematic, and rarely pursue help for an alcohol
34
35 problem⁹. Moreover, alcohol misuse in college/university student populations is an
36
37 international issue¹⁰. Therefore, there has been a drive for research to focus on developing
38
39 and improving a range of interventions that target problem drinking with students⁵, including,
40
41 in recent years, a substantial increase in interest in E-interventions¹¹.

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45 The term E-interventions refers to any intervention delivered, carried out or received
46
47 via electronic means, ranging for text messages to participants accessing a website with the
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49 intervention material on it. E-interventions can be advantageous as they tend to be a cheaper
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51 and less time consuming alternative to the traditional model of face-to-face support, and can
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53 be delivered across an array of personal devices, enabling students to approach the
54
55 intervention at their own pace, whilst sustaining privacy¹². Their accessibility, greater reach
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3 and low cost are appealing for student populations¹³, and they could be especially useful for
4 students on waiting lists for face-to-face support^{14,15}, since waiting lists are typically long¹⁶ as
5 resources are often limited¹⁷.
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10 However, E-Interventions may not be without their limitations. Some suggest that E-
11
12 30 Interventions prevent or restrict the development of the therapeutic alliance between therapist
13 and patient¹⁸, and as E-Interventions occur in private spaces, difficulties may also arise in
14 relation to motivation and compliance¹⁹, potentially leading to increasing attrition or non-
15 compliance¹⁹. In light of the potential advantages and limitations of E-interventions for
16 alcohol misuse, a number of meta-analyses have examined their effectiveness in student
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23 35 populations²⁰⁻²³.
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26 Nine meta-analyses have examined the efficacy of E-Interventions at reducing alcohol
27 consumption in the general population^{5,13,20,24-29}. In eight of the nine meta-analyses a small
28 significant effect was found in favour of E-interventions in the short-term (<4 months).
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32 However, no effect has been shown past 12 months, and it is unclear whether these results
33
34 40 generalize to a college/university population, who are potentially more 'at risk' through the
35 prevalence and acceptability of binge drinking within their cultural context.
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39 To date there have been six meta-analyses and narrative reviews that have examined
40 both face-to-face and E-Interventions that target hazardous drinking in the student population
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43 23,30-34. These have found strong support for brief motivational interventions combined with
44
45 45 personalised feedback, with intervention effects lasting up to 6 months. However, this raises
46 the question of whether these interventions are still effective with students who are not yet
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3 50 Three meta-analyses have examined E-Interventions on their own in student
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5 populations^{21,35,36}, including first year college students and mandated college students, in
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7 other words those who had broken campus policy on drinking. The most recent meta-analysis
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9 using a general student population undertaking an E-Intervention was published in
10
11 2012³⁶. Their results showed E-Interventions were effective at reducing drinking ($d_{+s}=0.07 -$
12
13 0.14). However, this meta-analysis only included studies publication up until 2011. Since
14
15 then there have been 13 additional RCTs evaluating the efficacy of E-Interventions at
16
17 reducing alcohol consumption in students. Some of these new studies have trialled new forms
18
19 of E-Interventions, thought to be better suited for this population³³. Furthermore, given the
20
21 rapid changes in technology that students have access to, there is now a wider variety of
22
23 means of offering E-interventions to students³⁷. Therefore, a new meta-analysis of the
24
25 60 efficacy of E-Interventions for student alcohol misuse is timely.
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29 To this end, the current meta-analysis aimed to: (i) provide an up to date assessment
30
31 of the extent to which E-Interventions reduce the number of alcoholic drinks a student
32
33 consumes per week relative to assessment only controls; and (ii) carry out a moderator
34
35 65 analyses examining whether their effectiveness has increased over time, whether E-
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37 Interventions are better suited for students who have already been classified as being 'at risk'
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39 drinkers, and whether web-based personalised feedback remains the most effective form of
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41 E-Intervention.
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48 70 **Method**

51 **Search strategy and study selection**

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53 Studies were retrieved from the following electronic databases from the inception of the
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55 database to June 2017: Cochrane library, CINAEL, ERIC, MEDLINE, PsycINFO, PubMed,
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3 and Web of Science. The search string was: (alcohol OR drink*) AND (college OR
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5 75 university OR undergraduate* OR student) AND (RCT OR "randomised controlled trial" OR
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7 "randomised controled trial" OR "randomized controlled trial" OR "randomized controlled
8
9 trial") AND (computer OR internet OR intranet OR DVD OR email OR text OR app* OR
10
11 *phone OR SMS OR telehealth OR tele-health OR eHealth OR e-health OR mhealth OR m-
12
13 health OR smart*). After the studies were retrieved, a screening process was conducted
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16 80 following the PRISMA protocol. The studies were included if: (i) they were a randomised
17
18 controlled trial (RCT); (ii) the intervention was an E-intervention, in that the intervention was
19
20 delivered via a technological device,; (iii) the participant group was solely composed of those
21
22 entering or current college/university students, this took into account that the term 'college'
23
24 in the UK is the equivalent to American senior high schools (students between 16-18) and
25
26 therefore studies looking at this age group were excluded; (iv) the study was published in
27
28 English in a peer reviewed journal, (v) the necessary data could be accessed from either the
29
30 paper or was provided by the authors, and (vi) the study investigated the effect of the chosen
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32 intervention on the number of drinks the student consumed in a week.
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37 To see if any further relevant studies could be found, the first author hand searched
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39 90 the reference sections of the selected papers. In addition, the last four years' worth of issues
40
41 of the four most frequent journals among the selected studies, namely *Addictive Behaviour*,
42
43 *Psychology of Addictive Behaviour*, *Journal of Consulting and Clinical Psychology* and *BMC*
44
45 *Public Health*, were hand searched for missing articles.
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47
48 Figure 1 illustrates the search and screening process in a PRISMA diagram. The
49
50 95 initial search produced 1,669 studies and 85 were identified by hand-searching. Twenty-three
51
52 of these met criteria for inclusion in the meta-analysis^{5,38-59}.
53

54 **Study quality**

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The quality of the studies was assessed using the JADAD scale, which produces a rating of zero to five, with five indicating the highest quality⁶⁰. All of the papers were rated independently by two raters. The ratings were identical for 18 out of the 23 papers. For five studies, the raters disagreed by one point and for one study by two points. After a discussion between the raters, an agreement was reached on the score for all papers (see Table 1).

Data analysis

The between group, post-intervention means, sample sizes and standard deviations for the measure of drinks per week were extracted and entered into Review Manager (Revman) version 5.3. The following formula was used by Revman to calculate post-intervention between group effect sizes:

$$SMD_i = \frac{m_{1i} - m_{2i}}{S_i} \left(1 - \frac{3}{4N_i - 9}\right)$$

Where,

$$S_i = \sqrt{\frac{(n_{1i} - 1)sd_{1i}^2 + (n_{2i} - 1)sd_{2i}^2}{N_i - 2}}$$

‘Drinks per weeks’⁶¹ was selected to provide a standardised measurement across all of the studies and as it can be regarded as a broad way of determining the effectiveness of an intervention. For all studies, the assessment only control condition was selected as the comparator, as every study included such a control group, but few included an active control condition. If the study included multiple intervention conditions, the condition that most closely fitted the description of an E-intervention was selected. If multiple versions of that intervention were being used (e.g. a basic format vs. more elaborate E-intervention), then the more sophisticated intervention was selected. Due to the range of different interventions used

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2
3 in the analysis, a random effects model was employed to account for differences between the
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5 interventions.
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8 A forest plot of post-interventions between-group effect sizes was produced using
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10 120 RevMan. Comprehensive meta-analysis (CMA) software (Professional version) was
11
12 employed to run a meta-regression between the quality ratings and effect sizes. To explore
13
14 publication bias, a funnel plot was produced using RevMan, and Rosenthal's failsafe N⁶² was
15
16 calculated using the Excel spread sheet produced by De Coster and Iselin (available from
17
18 <http://www.stathelp.com>).
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20 21 125 **Results**

22 23 **Study outcomes**

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26 While many of the studies tested a variety of factors, the primary outcome for our
27
28 analysis was drinks per week (DPW). Studies measured this in a variety of ways, including
29
30 asking participants to report their alcohol consumption over the course of a day, week or
31
32 130 month, which were all transformed by the studies to provide a weekly consumption. There
33
34 was also variation in how these data were captured. Some studies asked participants to upload
35
36 information each day on to an app or website, while others asked the participants to recall
37
38 their consumption at the end of the week or month. While research has shown this to be an
39
40 accurate method of collecting data when participants had consumed a low to moderate
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42 135 amount of alcohol, participants often under-estimate their consumption after a heavy drinking
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44 episode⁶³.
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46

47 48 **Study Characteristics**

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51 The characteristics of included studies are presented in Table 1. The study publication
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53 dates ranged across 13 years from 2004 to 2017. The number of participants included in the
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55 140 meta-analysis was N=7,614 (E-intervention n=3,617, assessment only n=3,997). The majority
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3 of studies came from the USA (k=16), with the second most common setting being the UK
4 (k=3). The four remaining papers came from Canada, Sweden and the Netherlands
5 respectively.
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10 The majority of participants were recruited by opportunistic sampling (k=18), using
11
12 145 either students who were about to start college/university or current college/university level
13 students. 1,011 of the 7,614 participants within the sample were college/university students
14 who had either been mandated by their college/university for breaking campus alcohol
15 policies or through the initial screen had been identified as at risk/heavy drinking students.
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23 24 150 **Interventions used**

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26 The most common E-intervention was Web-based personalised feedback (k=17), with
27 phone-based interventions being the second most common (k=2), and education-based
28 interventions and theory based interventions each being employed in only one study. These
29 interventions are now described in more detail.
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37 38 *Web-based personalised feedback*

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41 Web-based personalised feedback interventions seek to provide participants with
42 feedback on the amount of alcohol they have been drinking, their average blood alcohol
43 concentration (aBAC), the amount of calories consumed, and their level of consumption
44 compared to the recommended guidelines set by the country they are in. The feedback is
45 personalised by the participant submitting their own information to the intervention, which
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47 160 compared to the recommended guidelines set by the country they are in. The feedback is
48 personalised by the participant submitting their own information to the intervention, which
49 then provides the participant with feedback depending on their consumption.
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53 54 *Education based*

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3 Education based interventions seek to educate the participants about possible
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5 165 risks or harm they could face due to their drinking. This can range from the personal harm
6
7 they could experience, to the damage drinking related behaviour is having on the surrounding
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9 area they live in and the community. Personal harm could be in the form of the damage
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11 excessive alcohol can have on their body and the risks it can have on mental health.
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13 14 *Phone based*

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17 170 Phone based interventions refer to the means by which the intervention can be
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19 delivered, as personalised feedback, education based interventions and brief motivational
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21 interventions can be offered via phone. Most phone based interventions work by sending the
22
23 participant the outcome of their personalised feedback and/or by sending them motivational
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25 messages or facts about drinking, to help keep the participant on track with the intervention
26
27 or to help shift the participant's behaviour.
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33 **Study quality**

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35 The study quality scores are presented in Table 1. Half of the studies achieved a
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37 JADAD score of 3 out of 5, and the remainder had lower scores. One of the most common
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39 180 reason for dropping two points was the failure to double-blind, which can be challenging in
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41 the context of interventions of this nature. No significant association was found between the
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43 studies' effects size and the JADAD scores, ($Z=.37$, $p=.71$), suggesting that study quality did
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45 not affect the sizes of the outcomes obtained.
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49 **Publication bias**

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51 185 A funnel plot was created to test for publication bias (Figure 2). As this showed an
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53 asymmetry, there may be some publication bias in the literature. However, a Rosenthal's Fail
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Safe N showed that an additional 313 studies showing no intervention effect would be needed to reduce the overall effect size to non-significance, suggesting that the findings are robust.

Main analysis

190 The test for heterogeneity in effect-sizes was not statistically significant ($\chi^2(22)=$
29.25, $p = 0.14$, $I^2 = 25\%$). This supports the inclusion of this group of studies in a meta-
analysis, and the combining of their findings into one pooled effect-size. The test for the
overall effect found a small, but highly significant, effect ($Z = 4.80$, $p < 0.00001$, $SMD = -$
0.15, $CI\ 95\% [-0.21, -0.09]$). Thus, E-Interventions are effective at reducing the number of
195 alcoholic drinks students consume per week compared to assessment only controls.

Moderator analysis

Three moderator analyses were conducted.

At risk vs. any drinkers

Studies were included in the 'at risk' category if they had given their participants a pre-
200 intervention test to assess their drinking behaviour and had found the drinking to be at
harmful levels. The test for the overall effect for the 'at risk' students was not significant ($Z =$
1.88, $p=0.06$, $SMD = -0.20$, $CI\ 95\% [-0.40, 0.01]$). The test for the overall effect of the 'any
drinkers' showed a significant, small effect ($Z = 5.29$, $p < .00001$, $SMD = -0.13$, $CI\ 95\% [-$
0.18, -0.08]). However, the test for sub-group differences was not significant, ($\chi^2(1) = 0.35$, p
205 $= 0.55$).

Publication date

A comparison was run between studies that were published before 2012 and those that
were published subsequently. This date was selected as the most recent meta-analysis in this
area had included studies up to 2011. For the earlier studies, there was a significant effect in
210 the small to medium range ($Z = 3.13$, $p=0.002$.0001, $SMD = -0.24$, $CI\ 95\% [-0.39, -0.09]$),

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3 and for the later studies, there was also a significant, small effect ($Z = 3.67$, $p=0.0002$, SMD
4 $= -0.1$, $CI\ 95\% [-0.16, -0.05]$). The difference between these sub-groups was marginally
5 significant, but did not reach full significance ($\chi^2(1) = 2.77$, $p = 0.1$). Thus there was tentative
6 evidence that more recent studies may have smaller effect sizes than pre-2012 ones.
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11 215 However, when year of publication was used as a continuous predictor in a meta-regression it
12 was non-significant $Z=.94$, $p= .35$.
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16 *Web-based personalised feedback vs. other interventions*

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19 A comparison was run between studies that were conducted using a web-based
20 personalised feedback and those that used other types of interventions. The studies were
21 selected for the web-based personalised feedback group if the intervention had been
22 220 selected for the web-based personalised feedback group if the intervention had been
23 described using the term ‘personalised feedback’ and had been delivered using email, website
24 or web-based technology. For the web-based personalised feedback interventions, there was a
25 significant effect in the small to medium range ($Z = 4.69$, $p<0.00001$, $SMD = -0.19$, $CI95\% [-$
26 $0.27, -0.11]$). For the other interventions, there was no significant effect ($Z = 1.84$, $p=0.07$,
27 $SMD = -0.07$, $CI95\% [-0.14, 0.00]$). Overall, there was a significant difference found in the
28 225 effect size between these two sub groups, ($\chi^2(1) = 5.30$, $p = 0.02$). The forest plot associated
29 with this moderation analysis is shown in Figure 3.
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41 *Follow up*

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44 Some studies collected additional outcome data at follow-up time point(s), after the
45 230 post-intervention time-point. Therefore, an analysis was conducted, comparing drink per
46 week for E-Interventions with assessment only controls at follow-up. In cases where a study
47 had more the one follow-up time point, the longest follow-up for which data were available
48 was included. This resulted in six studies being included, with their included follow-ups
49 ranging from 6 to 12 months’ post-intervention. The forest plot can be seen in Figure 4. No
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3 235 significant difference between the groups was found ($Z = 1.31$, $p=0.19$, $SMD = -0.05$, CI
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5 95% [-0.12, 0.02]).
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8 **Discussion**

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10 This meta-analysis examined the effectiveness of E-Interventions compared to
11 assessment only controls at reducing the number of alcoholic drinks college/university
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13
14 240 students drank per week. 56.52% (i.e. $k = 13$) of the included studies were published since the
15
16 last meta-analysis that specifically examined such E-Interventions in students, confirming the
17
18 need for a new meta-analysis. Furthermore, the low level of heterogeneity between the
19
20 included studies makes it credible to argue that they were testing similar enough interventions
21
22 to be combined in a meta-analysis.
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26 245 The results showed a small, significant reduction in drink per week following E-
27
28 Interventions relative to assessment only controls. This overall finding is consistent with
29
30 previous meta-analyses^{21,23,33,34}, and adds to the growing pool of evidence that E-
31
32 Interventions can support students in reducing their daily drinking. In addition, web-based
33
34 personalised feedback was found to be the most effective of the E-Interventions, while there
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37 250 was not good evidence of a difference in efficacy of E-Interventions between ‘at risk’ and
38
39 ‘any drinkers’.
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42 However, the beneficial effects of E-Interventions disappeared after 6 to 12 months,
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44 since the intervention and control conditions no longer significantly differed in the analysis of
45
46 the follow-up data. Therefore, future research could helpfully focus on maintaining treatment
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48 255 effects over a longer time period. In addition, the most surprising finding was the tentative
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50 evidence towards more recent studies showing smaller effects compared to pre-2012 trials.
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52 This result does not appear to be driven by any changes in study quality that may have
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54 occurred over time, since the latter was not associated with effect size. However, the apparent
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3 decline in effect size over time should be treated with some caution, given that it was only
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5 260 marginally significant. If this trend is found to be robust in future meta-analyses conducted
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7 after further RCT have been completed, then it would be a cause for concern. By way of
8
9 comparison, it is interesting to note that a decrease in the efficacy of interventions over time
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11 has been found in a meta-regression of interventions for depression⁶⁴.
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16 17 265 **Implications and limitations**

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19 Based on the current findings, the use of E-Interventions, and in particular web-based
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21 personalised feedback, appears warranted for both ‘at risk and ‘any’ student drinkers.
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23 However, these interventions may need to be repeated 6 to 12 months after the first ‘course’
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25 of the intervention has been completed, since their treatment effects do not appear to be
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27 maintained at 6 to 12 month follow-up.
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31 The main limitations of this meta-analysis are that: (i) a small number of studies
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33 examined interventions other than web-based personalised feedback, limiting the extent to
34
35 which the efficacy of different types of interventions could be compared; (ii) there was some
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37 suggestion of publication bias, which may have led to an over-estimation of the effects of the
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39 275 interventions; (iii) there were too few trials with active control groups to conduct a meta-
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41 analysis of E-Interventions versus such controls, which would have been a more stringent test
42
43 of their efficacy; and (iv) generally participants’ self-reported alcohol consumption was relied
44
45 upon to measure outcomes, the limitations of which have already been described.
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49 A technological advance that appears to have the potential to address this latter
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51 280 limitation is the recent development of wearable technology that can measure blood alcohol
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53 levels⁶⁵. Assuming that such technology can demonstrate satisfactory reliability and validity
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55 of measurement at an affordable cost-base, it could be used in trials to generate outcome
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3 measurements that would likely have greater validity than self-report. In addition, it would
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5 also appear to have the potential to support more efficacious personalised-feedback E-
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7 285 Interventions, since the feedback would be based on a more accurate measurement of
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9 participants' alcohol consumption than in the current interventions, which rely on self-report.
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11 Therefore, feasibility RCTs evaluating such an approach would seem a helpful next step for
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13 the field.
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In Review

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In Review

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Table 1 Characteristics of the studies included in the meta-analysis

Footnote. (Target group) UStd = University students, MUsd = Mandated university students, HdUStd = Heavy drinking university students. (Nature of Intervention) Wb-PF = Web-based personalised feedback, Wb-PF+SN = Web-based personalised feedback with social norms, Phd-BMI = Phone-delivered brief motivational intervention, Tb-HBI = theory-based online health behaviour intervention, Phd-BI = Phone delivered brief intervention. Wb-PF+BI = Web-based personalised feedback and brief intervention, Wb-PF+Edu = Web-based personalised feedback and education intervention. FB+ST = Feedback and skills training. PBS = Protective behavioural strategies

In Review

Figure 1: Flow of information from collection to inclusion of studies.

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Figure 2: A funnel plot of post-intervention effect sizes by standard error.

In Review

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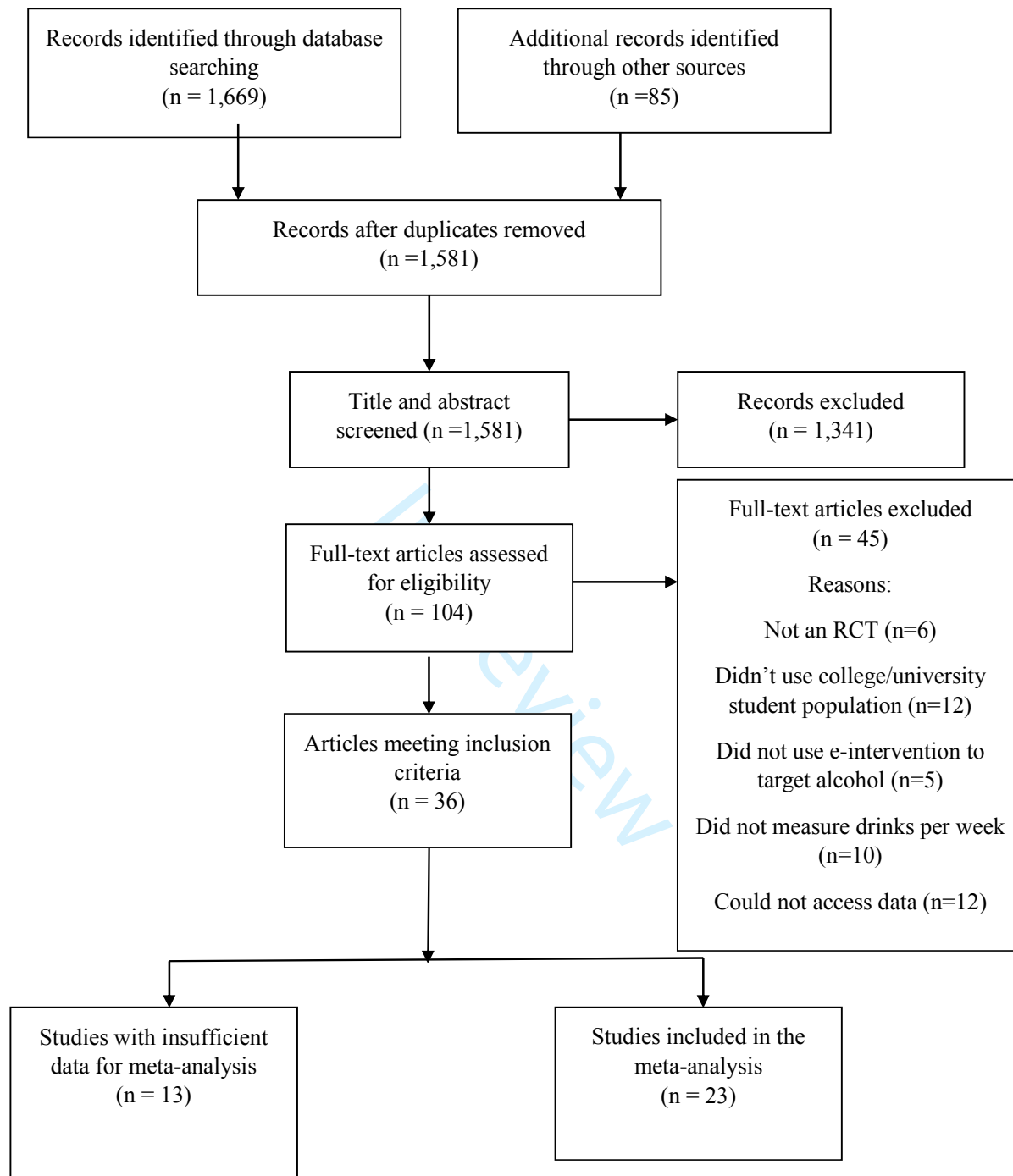
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Figure 4. Forest plot for post intervention overall effect for the available follow up results.

In Review

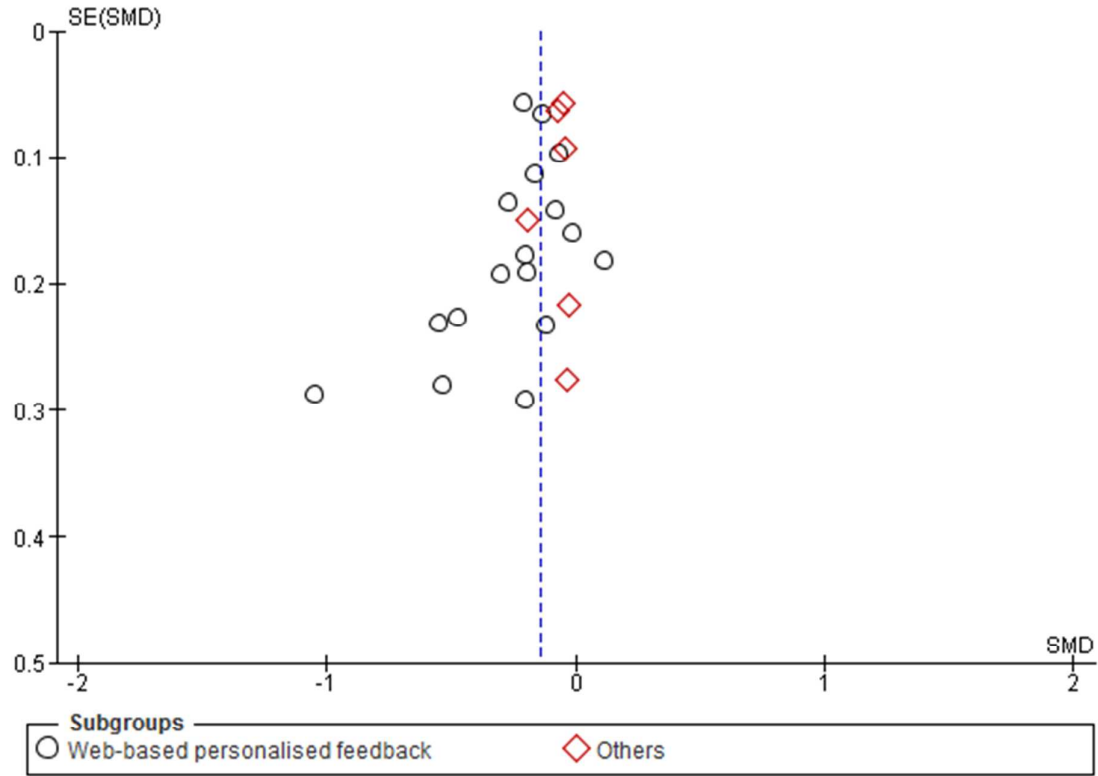
Figure 1: Flow of information from collection to inclusion of studies.



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In Review

Figure 2: A funnel plot of post-intervention effect sizes by standard error.



view

Figure 3. Forest plot for post-intervention between-group effect sizes for the web-based personalised feedback vs. other interventions.

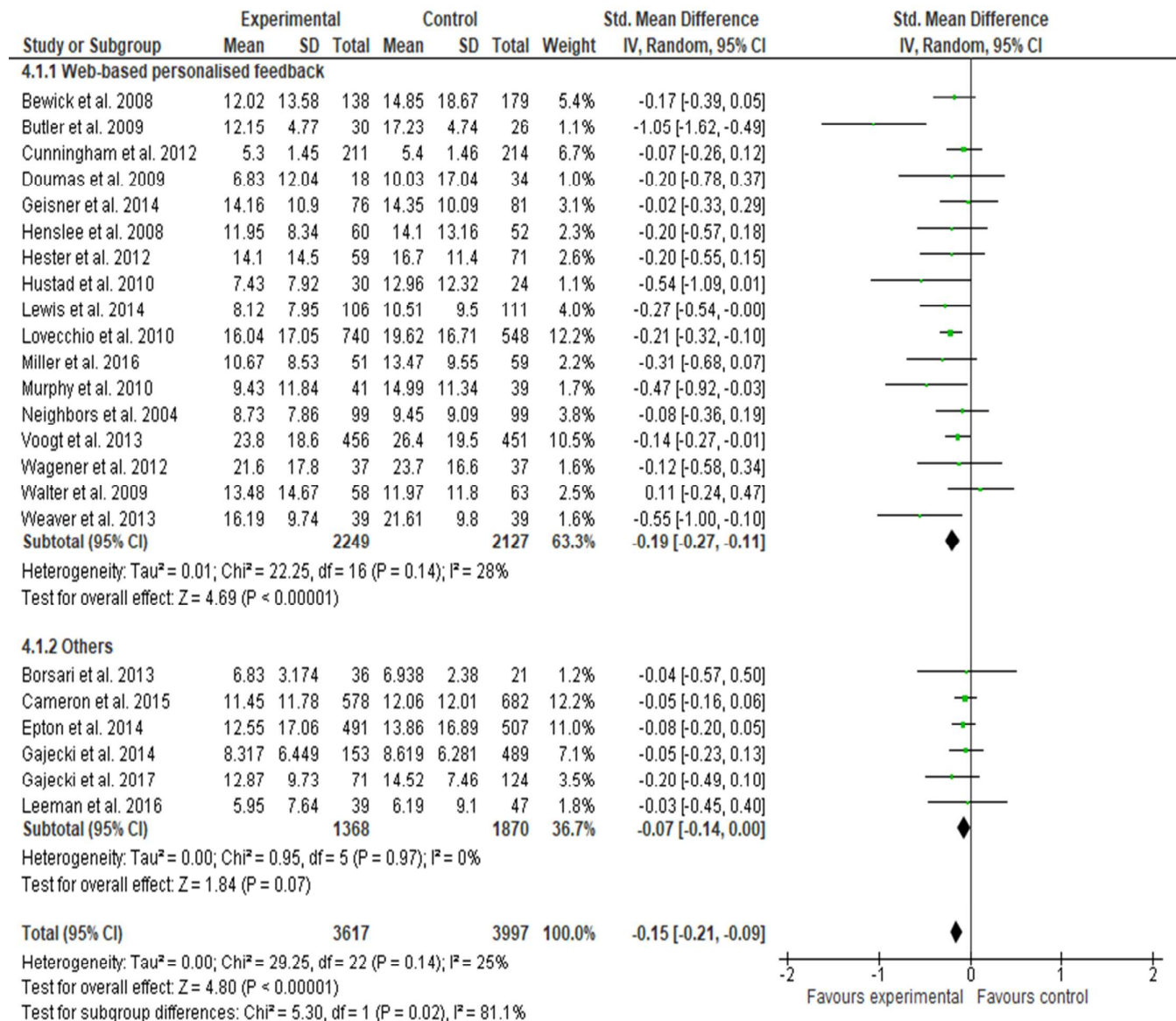
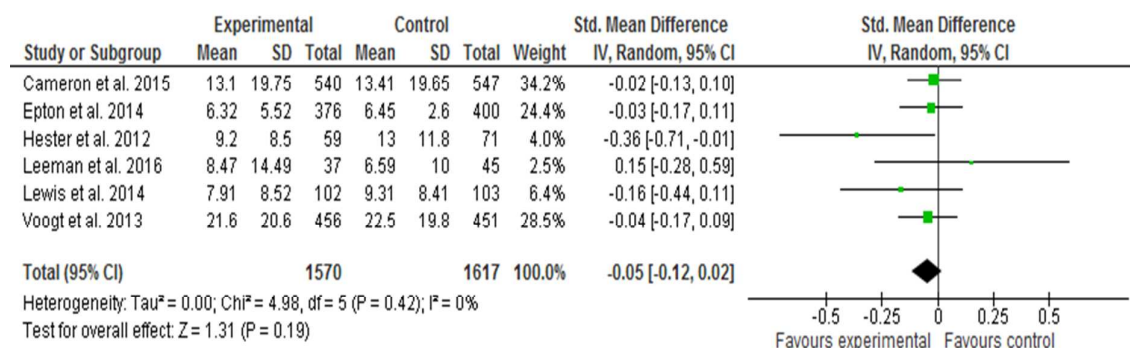


Figure 4. Forest plot for post intervention overall effect for the available follow up results.



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2 Table 1
3 Characteristics of the studies included in the meta-analysis

Study (year)	Location	% (Female)	Measurement time-points (months after baseline)	Sample size		Target group	JADAD score (out of 5)	Nature of Intervention
				Intervention (n =)	Control (n=)			
<i>Web-based personalised feedback</i>								
Bewick et al. (2008)	UK	69	3	138	179	UStd	2	Wb-PF+SN
Butler et al. (2009)	USA	63	1	30	26	HdUStd	3	Wb-PF
Cunningham et al. (2012)	Canada	47.5	1.5	211	214	HdUStd	2	Wb-PF
Dousmas et al. (2009)	USA	41	3	18	34	UStd	2	Wb-PF
Geisner et al. (2014)	USA	62.4	1	76	81	UStd	1	Wb-PF+BI
Henslee et al. (2012)	USA	63.4	1.25	60	52	UStd	2	Wb-PF
Hester et al. (2012)	USA	45	1 & 12	59	71	UStd	2	Wb-PF
Hustad et al. (2010)	USA	51	1	30	24	UStd	3	Wb-PF
Lewis et al. (2014)	USA	49.8	3 & 6	106	111	UStd	3	Wb-PF
Lovecchio et al. (2010)	USA	54.3	1	740	548	UStd	2	Wb-PF+Edu
Miller et al. (2016)	USA	59	1	51	59	UStd	3	Wb-PF
Murphy et al. (2010)	USA	51	1	41	39	HdUStd	1	Wb-PF
Neighbours et al. (2004)	USA	58.7	3 & 6	99	99	HdUStd	2	Wb-PF
Voogt et al. (2013)	Netherlands	39.7	0.25, 0.5, 1.75 & 4	456	451	UStd	3	Wb-PF+BI
Wagener et al. (2012)	USA	45.4	2.5	37	37	HdUStd	3	Wb-PF
Walter et al. (2009)	USA	64.2	6	58	63	UStd	2	Wb-PF
Weaver et al. (2013)	USA	49.4	1	39	39	UStd	2	Wb-PF
<i>Other</i>								
Borsari et al. (2013)	USA	38.9	3, 6 & 9	36	21	MUStd	1	PhD-BMI
Cameron et al. (2015)	UK	54.9	1 & 6	578	682	UStd	3	Tb-HBI
Epton et al. (2014)	UK	55.2	1 & 6	491	507	UStd	3	Tb-HBI
Gajecki et al. (2014)	Sweden	51.7	1.75	153	489	UStd	3	PhD-BI
Gajecki et al. (2017)	Sweden	68.4	1.5 & 3	71	124	HdUStd	3	FB+ST
Leeman et al. (2016)	USA	62.5	1 & 6	39	47	UStd	2	PBS

37 *Note.* (Target group) UStd = University students, MUStd = Mandated university students, HdUStd = Heavy drinking university students. (Nature of Intervention) Wb-PF =
38 Web-based personalised feedback, Wb-PF+SN = Web-based personalised feedback with social norms, PhD-BMI = Phone-delivered brief motivational intervention, Tb-HBI =
39 theory-based online health behaviour intervention, PhD-BI = Phone delivered brief intervention. Wb-PF+BI = Web-based personalised feedback and brief intervention, Wb-
40 PF+Edu = Web-based personalised feedback and education intervention. FB+ST = Feedback and skills training. PBS = Protective behavioural strategies

In Review

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3 **A meta-analysis of effectiveness of E-interventions to reduce alcohol consumption in**
4 **college and university students.**

5
6 **Journal of American College Health**

7
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In Review

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5 **A meta-analysis of effectiveness of E-interventions to reduce alcohol consumption in**
6 **college and university students.**
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10
11 **Abstract**

12 *Objective:* To evaluate the effectiveness and moderators of E-Interventions versus assessment
13 only (AO) controls in the reduction of alcoholic drinks per week (DWP) in university
14 students.
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20 *Study design and methods:* Cochrane library, CINAEL, ERIC, MEDLINE, PsycINFO,
21 PubMed, and Web of Science were searched up to June 2017. Studies were included if they
22 were: an RCT, assessed the effectiveness of E-Interventions at reducing DWP, and employed
23 university/college students. 23 studies ($N = 7,614$) were included and quality was assessed
24 using the JADAD scale.
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31 *Results:* Weighted mean effect sizes were calculated using random-effects models. These
32 showed a small, significant effect of E-Interventions at reducing the number of alcoholic
33 DWP. Moderator analysis found a significant advantage for web-based personalised feedback
34 interventions compared to other E-Interventions.
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41 *Conclusions:* E-Interventions show a small, significant effect at reducing mean alcoholic
42 DPW. Personalised feedback E-Interventions showed the strongest effect.
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46 *Keywords:* meta-analysis, electronic interventions, alcohol, students
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3 From neighbours sharing homebrewed cider to internationally recognisable events such as
4 Oktoberfest¹ drinking is part of global social customs. However, with the consumption of
5 alcohol comes a risk of adverse health and social consequences². A period synonymous with
6 drinking is college/university years (students aged 18 and above)³, with alcohol use
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11 5 increasing significantly following the transition from secondary school to college/university
12 in American and other nationalities of students^{4,5}. Furthermore, college/university students
13 misuse alcohol to a greater degree than their non-student peers, with approximately 45% of
14 students reporting a recent episode of heavy alcohol consumption on a monthly basis⁶; a
15 heavy drinking episode being classified as drinking five or more alcoholic drinks for men or
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22 10 four or more drinks for women in a two-hour period⁷.

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25 Both alcohol use in general, and heavy episodic drinking in particular, are associated
26 with significant health and other risks^{8,9}. For example, 47% of students who engaged in
27 heavy episodic drinking experienced five or more drink-related problems (e.g. injuries and
28 engagement in unplanned sexual activities⁹). However, heavy episodic drinking students
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33 15 frequently do not see this behaviour as problematic, and rarely pursue help for an alcohol
34 problem⁹. Moreover, alcohol misuse in college/university student populations is an
35 international issue¹⁰. Therefore, there has been a drive for research to focus on developing
36 and improving a range of interventions that target problem drinking with students⁵, including,
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44 in recent years, a substantial increase in interest in E-interventions¹¹.

45 20 The term E-interventions refers to any intervention delivered, carried out or received
46 via electronic means, ranging for text messages to participants accessing a website with the
47 intervention material on it. E-interventions can be advantageous as they tend to be a cheaper
48 and less time consuming alternative to the traditional model of face-to-face support, and can
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56 25 intervention at their own pace, whilst sustaining privacy¹². Their accessibility, greater reach

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3 and low cost are appealing for student populations¹³, and they could be especially useful for
4 students on waiting lists for face-to-face support^{14,15}, since waiting lists are typically long¹⁶ as
5 resources are often limited¹⁷.
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10 However, E-Interventions may not be without their limitations. Some suggest that E-
11
12 30 Interventions prevent or restrict the development of the therapeutic alliance between therapist
13 and patient¹⁸, and as E-Interventions occur in private spaces, difficulties may also arise in
14 relation to motivation and compliance¹⁹, potentially leading to increasing attrition or non-
15 compliance¹⁹. In light of the potential advantages and limitations of E-interventions for
16 alcohol misuse, a number of meta-analyses have examined their effectiveness in student
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23 35 populations²⁰⁻²³.
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26 Nine meta-analyses have examined the efficacy of E-Interventions at reducing alcohol
27 consumption in the general population^{5,13,20,24-29}. In eight of the nine meta-analyses a small
28 significant effect was found in favour of E-interventions in the short-term (<4 months).
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31 However, no effect has been shown past 12 months, and it is unclear whether these results
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34 40 generalize to a college/university population, who are potentially more 'at risk' through the
35 prevalence and acceptability of binge drinking within their cultural context.
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39 To date there have been six meta-analyses and narrative reviews that have examined
40 both face-to-face and E-Interventions that target hazardous drinking in the student population
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43 23,30-34. These have found strong support for brief motivational interventions combined with
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45 45 personalised feedback, with intervention effects lasting up to 6 months. However, this raises
46 the question of whether these interventions are still effective with students who are not yet
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3 50 Three meta-analyses have examined E-Interventions on their own in student
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5 populations^{21,35,36}, including first year college students and mandated college students, in
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7 other words those who had broken campus policy on drinking. The most recent meta-analysis
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9 using a general student population undertaking an E-Intervention was published in
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11 2012³⁶. Their results showed E-Interventions were effective at reducing drinking ($d_{+s}=0.07 -$
12
13 0.14). However, this meta-analysis only included studies publication up until 2011. Since
14
15 then there have been 13 additional RCTs evaluating the efficacy of E-Interventions at
16
17 reducing alcohol consumption in students. Some of these new studies have trialled new forms
18
19 of E-Interventions, thought to be better suited for this population³³. Furthermore, given the
20
21 rapid changes in technology that students have access to, there is now a wider variety of
22
23 means of offering E-interventions to students³⁷. Therefore, a new meta-analysis of the
24
25 60 efficacy of E-Interventions for student alcohol misuse is timely.
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30 To this end, the current meta-analysis aimed to: (i) provide an up to date assessment
31
32 of the extent to which E-Interventions reduce the number of alcoholic drinks a student
33
34 consumes per week relative to assessment only controls; and (ii) carry out a moderator
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36 65 analyses examining whether their effectiveness has increased over time, whether E-
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38 Interventions are better suited for students who have already been classified as being 'at risk'
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40 drinkers, and whether web-based personalised feedback remains the most effective form of
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42 E-Intervention.
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48 70 **Method**

51 **Search strategy and study selection**

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53 Studies were retrieved from the following electronic databases from the inception of the
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55 database to June 2017: Cochrane library, CINAEL, ERIC, MEDLINE, PsycINFO, PubMed,
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3 and Web of Science. The search string was: (alcohol OR drink*) AND (college OR
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5 75 university OR undergraduate* OR student) AND (RCT OR "randomised controlled trial" OR
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7 "randomised controled trial" OR "randomized controlled trial" OR "randomized controlled
8
9 trial") AND (computer OR internet OR intranet OR DVD OR email OR text OR app* OR
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11 *phone OR SMS OR telehealth OR tele-health OR eHealth OR e-health OR mhealth OR m-
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13 health OR smart*). After the studies were retrieved, a screening process was conducted
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16 80 following the PRISMA protocol. The studies were included if: (i) they were a randomised
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18 controlled trial (RCT); (ii) the intervention was an E-intervention, in that the intervention was
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20 delivered via a technological device,; (iii) the participant group was solely composed of those
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22 entering or current college/university students, this took into account that the term 'college'
23
24 in the UK is the equivalent to American senior high schools (students between 16-18) and
25
26 therefore studies looking at this age group were excluded; (iv) the study was published in
27
28 English in a peer reviewed journal, (v) the necessary data could be accessed from either the
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30 paper or was provided by the authors, and (vi) the study investigated the effect of the chosen
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32 intervention on the number of drinks the student consumed in a week.
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38 90 To see if any further relevant studies could be found, the first author hand searched
39
40 the reference sections of the selected papers. In addition, the last four years' worth of issues
41
42 of the four most frequent journals among the selected studies, namely *Addictive Behaviour*,
43
44 *Psychology of Addictive Behaviour*, *Journal of Consulting and Clinical Psychology* and *BMC*
45
46 *Public Health*, were hand searched for missing articles.
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50 95 Figure 1 illustrates the search and screening process in a PRISMA diagram. The
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52 initial search produced 1,669 studies and 85 were identified by hand-searching. Twenty-three
53
54 of these met criteria for inclusion in the meta-analysis^{5,38-59}.
55

56 57 58 59 60 **Study quality**

The quality of the studies was assessed using the JADAD scale, which produces a rating of zero to five, with five indicating the highest quality⁶⁰. All of the papers were rated independently by two raters. The ratings were identical for 18 out of the 23 papers. For five studies, the raters disagreed by one point and for one study by two points. After a discussion between the raters, an agreement was reached on the score for all papers (see Table 1).

Data analysis

The between group, post-intervention means, sample sizes and standard deviations for the measure of drinks per week were extracted and entered into Review Manager (Revman) version 5.3. The following formula was used by Revman to calculate post-intervention between group effect sizes:

$$SMD_i = \frac{m_{1i} - m_{2i}}{S_i} \left(1 - \frac{3}{4N_i - 9} \right)$$

Where,

$$S_i = \sqrt{\frac{(n_{1i} - 1)sd_{1i}^2 + (n_{2i} - 1)sd_{2i}^2}{N_i - 2}}$$

‘Drinks per weeks’⁶¹ was selected to provide a standardised measurement across all of the studies and as it can be regarded as a broad way of determining the effectiveness of an intervention. For all studies, the assessment only control condition was selected as the comparator, as every study included such a control group, but few included an active control condition. If the study included multiple intervention conditions, the condition that most closely fitted the description of an E-intervention was selected. If multiple versions of that intervention were being used (e.g. a basic format vs. more elaborate E-intervention), then the more sophisticated intervention was selected. Due to the range of different interventions used

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2
3 in the analysis, a random effects model was employed to account for differences between the
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5 interventions.
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8 A forest plot of post-interventions between-group effect sizes was produced using
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10 120 RevMan. Comprehensive meta-analysis (CMA) software (Professional version) was
11
12 employed to run a meta-regression between the quality ratings and effect sizes. To explore
13
14 publication bias, a funnel plot was produced using RevMan, and Rosenthal's failsafe N⁶² was
15
16 calculated using the Excel spread sheet produced by De Coster and Iselin (available from
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18 <http://www.stathelp.com>).
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20 21 125 **Results**

22 23 **Study outcomes**

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26 While many of the studies tested a variety of factors, the primary outcome for our
27
28 analysis was drinks per week (DPW). Studies measured this in a variety of ways, including
29
30 asking participants to report their alcohol consumption over the course of a day, week or
31
32 130 month, which were all transformed by the studies to provide a weekly consumption. There
33
34 was also variation in how these data were captured. Some studies asked participants to upload
35
36 information each day on to an app or website, while others asked the participants to recall
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38 their consumption at the end of the week or month. While research has shown this to be an
39
40 accurate method of collecting data when participants had consumed a low to moderate
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42 135 amount of alcohol, participants often under-estimate their consumption after a heavy drinking
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44 episode⁶³.
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47 48 **Study Characteristics**

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51 The characteristics of included studies are presented in Table 1. The study publication
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53 dates ranged across 13 years from 2004 to 2017. The number of participants included in the
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55 140 meta-analysis was N=7,614 (E-intervention n=3,617, assessment only n=3,997). The majority
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3 of studies came from the USA (k=16), with the second most common setting being the UK
4 (k=3). The four remaining papers came from Canada, Sweden and the Netherlands
5 respectively.
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10 The majority of participants were recruited by opportunistic sampling (k=18), using
11
12 145 either students who were about to start college/university or current college/university level
13 students. 1,011 of the 7,614 participants within the sample were college/university students
14 who had either been mandated by their college/university for breaking campus alcohol
15 policies or through the initial screen had been identified as at risk/heavy drinking students.
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23 24 150 **Interventions used**

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26 The most common E-intervention was Web-based personalised feedback (k=17), with
27 phone-based interventions being the second most common (k=2), and education-based
28 interventions and theory based interventions each being employed in only one study. These
29 interventions are now described in more detail.
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37 38 *Web-based personalised feedback*

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41 Web-based personalised feedback interventions seek to provide participants with
42 feedback on the amount of alcohol they have been drinking, their average blood alcohol
43 concentration (aBAC), the amount of calories consumed, and their level of consumption
44 compared to the recommended guidelines set by the country they are in. The feedback is
45 personalised by the participant submitting their own information to the intervention, which
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47 160 compared to the recommended guidelines set by the country they are in. The feedback is
48 personalised by the participant submitting their own information to the intervention, which
49 then provides the participant with feedback depending on their consumption.
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54 55 *Education based*

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3 Education based interventions seek to educate the participants about possible
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5 165 risks or harm they could face due to their drinking. This can range from the personal harm
6
7 they could experience, to the damage drinking related behaviour is having on the surrounding
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9 area they live in and the community. Personal harm could be in the form of the damage
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11 excessive alcohol can have on their body and the risks it can have on mental health.
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14 *Phone based*

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17 170 Phone based interventions refer to the means by which the intervention can be
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19 delivered, as personalised feedback, education based interventions and brief motivational
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21 interventions can be offered via phone. Most phone based interventions work by sending the
22
23 participant the outcome of their personalised feedback and/or by sending them motivational
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25 messages or facts about drinking, to help keep the participant on track with the intervention
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27 or to help shift the participant's behaviour.
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33 **Study quality**

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35 The study quality scores are presented in Table 1. Half of the studies achieved a
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37 JADAD score of 3 out of 5, and the remainder had lower scores. One of the most common
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39 180 reason for dropping two points was the failure to double-blind, which can be challenging in
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41 the context of interventions of this nature. No significant association was found between the
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43 studies' effects size and the JADAD scores, ($Z=.37$, $p=.71$), suggesting that study quality did
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45 not affect the sizes of the outcomes obtained.
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49 **Publication bias**

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51 185 A funnel plot was created to test for publication bias (Figure 2). As this showed an
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53 asymmetry, there may be some publication bias in the literature. However, a Rosenthal's Fail
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Safe N showed that an additional 313 studies showing no intervention effect would be needed to reduce the overall effect size to non-significance, suggesting that the findings are robust.

Main analysis

190 The test for heterogeneity in effect-sizes was not statistically significant ($\chi^2(22)=$
29.25, $p = 0.14$, $I^2 = 25\%$). This supports the inclusion of this group of studies in a meta-
analysis, and the combining of their findings into one pooled effect-size. The test for the
overall effect found a small, but highly significant, effect ($Z = 4.80$, $p < 0.00001$, $SMD = -$
0.15, $CI\ 95\% [-0.21, -0.09]$). Thus, E-Interventions are effective at reducing the number of
195 alcoholic drinks students consume per week compared to assessment only controls.

Moderator analysis

Three moderator analyses were conducted.

At risk vs. any drinkers

Studies were included in the 'at risk' category if they had given their participants a pre-
200 intervention test to assess their drinking behaviour and had found the drinking to be at
harmful levels. The test for the overall effect for the 'at risk' students was not significant ($Z =$
1.88, $p=0.06$, $SMD = -0.20$, $CI\ 95\% [-0.40, 0.01]$). The test for the overall effect of the 'any
drinkers' showed a significant, small effect ($Z = 5.29$, $p < .00001$, $SMD = -0.13$, $CI\ 95\% [-$
0.18, -0.08]). However, the test for sub-group differences was not significant, ($\chi^2(1) = 0.35$, p
205 $= 0.55$).

Publication date

A comparison was run between studies that were published before 2012 and those that
were published subsequently. This date was selected as the most recent meta-analysis in this
area had included studies up to 2011. For the earlier studies, there was a significant effect in
210 the small to medium range ($Z = 3.13$, $p=0.002$.0001, $SMD = -0.24$, $CI\ 95\% [-0.39, -0.09]$),

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3 and for the later studies, there was also a significant, small effect ($Z = 3.67$, $p=0.0002$, SMD
4 $= -0.1$, $CI\ 95\% [-0.16, -0.05]$). The difference between these sub-groups was marginally
5 significant, but did not reach full significance ($\chi^2(1) = 2.77$, $p = 0.1$). Thus there was tentative
6 evidence that more recent studies may have smaller effect sizes than pre-2012 ones.
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11 215 However, when year of publication was used as a continuous predictor in a meta-regression it
12 was non-significant $Z=.94$, $p= .35$.
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16 *Web-based personalised feedback vs. other interventions*

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19 A comparison was run between studies that were conducted using a web-based
20 personalised feedback and those that used other types of interventions. The studies were
21 selected for the web-based personalised feedback group if the intervention had been
22 220 selected for the web-based personalised feedback group if the intervention had been
23 described using the term ‘personalised feedback’ and had been delivered using email, website
24 or web-based technology. For the web-based personalised feedback interventions, there was a
25 significant effect in the small to medium range ($Z = 4.69$, $p<0.00001$, $SMD = -0.19$, $CI95\% [-$
26 $0.27, -0.11]$). For the other interventions, there was no significant effect ($Z = 1.84$, $p=0.07$,
27 $SMD = -0.07$, $CI95\% [-0.14, 0.00]$). Overall, there was a significant difference found in the
28 225 effect size between these two sub groups, ($\chi^2(1) = 5.30$, $p = 0.02$). The forest plot associated
29 with this moderation analysis is shown in Figure 3.
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41 *Follow up*

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44 Some studies collected additional outcome data at follow-up time point(s), after the
45 230 post-intervention time-point. Therefore, an analysis was conducted, comparing drink per
46 week for E-Interventions with assessment only controls at follow-up. In cases where a study
47 had more the one follow-up time point, the longest follow-up for which data were available
48 was included. This resulted in six studies being included, with their included follow-ups
49 ranging from 6 to 12 months’ post-intervention. The forest plot can be seen in Figure 4. No
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3 235 significant difference between the groups was found ($Z = 1.31$, $p=0.19$, $SMD = -0.05$, CI
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5 95% [-0.12, 0.02]).
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7 8 **Discussion**

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10 This meta-analysis examined the effectiveness of E-Interventions compared to
11 assessment only controls at reducing the number of alcoholic drinks college/university
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13 240 students drank per week. 56.52% (i.e. $k = 13$) of the included studies were published since the
14 last meta-analysis that specifically examined such E-Interventions in students, confirming the
15 need for a new meta-analysis. Furthermore, the low level of heterogeneity between the
16 included studies makes it credible to argue that they were testing similar enough interventions
17 to be combined in a meta-analysis.
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26 245 The results showed a small, significant reduction in drink per week following E-
27 Interventions relative to assessment only controls. This overall finding is consistent with
28 previous meta-analyses^{21,23,33,34}, and adds to the growing pool of evidence that E-
29 Interventions can support students in reducing their daily drinking. In addition, web-based
30 personalised feedback was found to be the most effective of the E-Interventions, while there
31 was not good evidence of a difference in efficacy of E-Interventions between 'at risk' and
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36 250 'any drinkers'.
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41 However, the beneficial effects of E-Interventions disappeared after 6 to 12 months,
42 since the intervention and control conditions no longer significantly differed in the analysis of
43 the follow-up data. Therefore, future research could helpfully focus on maintaining treatment
44 effects over a longer time period. In addition, the most surprising finding was the tentative
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47 255 evidence towards more recent studies showing smaller effects compared to pre-2012 trials.
48 This result does not appear to be driven by any changes in study quality that may have
49 occurred over time, since the latter was not associated with effect size. However, the apparent
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3 decline in effect size over time should be treated with some caution, given that it was only
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5 260 marginally significant. If this trend is found to be robust in future meta-analyses conducted
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7 after further RCT have been completed, then it would be a cause for concern. By way of
8
9 comparison, it is interesting to note that a decrease in the efficacy of interventions over time
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11 has been found in a meta-regression of interventions for depression⁶⁴.
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17 265 **Implications and limitations**

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19 Based on the current findings, the use of E-Interventions, and in particular web-based
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21 personalised feedback, appears warranted for both ‘at risk and ‘any’ student drinkers.
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23 However, these interventions may need to be repeated 6 to 12 months after the first ‘course’
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25 of the intervention has been completed, since their treatment effects do not appear to be
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27 maintained at 6 to 12 month follow-up.
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31 The main limitations of this meta-analysis are that: (i) a small number of studies
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33 examined interventions other than web-based personalised feedback, limiting the extent to
34
35 which the efficacy of different types of interventions could be compared; (ii) there was some
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37 suggestion of publication bias, which may have led to an over-estimation of the effects of the
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39 275 interventions; (iii) there were too few trials with active control groups to conduct a meta-
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41 analysis of E-Interventions versus such controls, which would have been a more stringent test
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43 of their efficacy; and (iv) generally participants’ self-reported alcohol consumption was relied
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45 upon to measure outcomes, the limitations of which have already been described.
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49 A technological advance that appears to have the potential to address this latter
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51 280 limitation is the recent development of wearable technology that can measure blood alcohol
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53 levels⁶⁵. Assuming that such technology can demonstrate satisfactory reliability and validity
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55 of measurement at an affordable cost-base, it could be used in trials to generate outcome
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3 measurements that would likely have greater validity than self-report. In addition, it would
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5 also appear to have the potential to support more efficacious personalised-feedback E-
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7 285 Interventions, since the feedback would be based on a more accurate measurement of
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9 participants' alcohol consumption than in the current interventions, which rely on self-report.
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11 Therefore, feasibility RCTs evaluating such an approach would seem a helpful next step for
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13 the field.
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In Review

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In Review

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Table 1
Characteristics of the studies included in the meta-analysis

Footnote: (Target group) UStd = University students, MUsd = Mandated university students, HdUStd = Heavy drinking university students. (Nature of Intervention) Wb-PF = Web-based personalised feedback, Wb-PF+SN = Web-based personalised feedback with social norms, Phd-BMI = Phone-delivered brief motivational intervention, Tb-HBI = theory-based online health behaviour intervention, Phd-BI = Phone delivered brief intervention. Wb-PF+BI = Web-based personalised feedback and brief intervention, Wb-PF+Edu = Web-based personalised feedback and education intervention. FB+ST = Feedback and skills training. PBS = Protective behavioural strategies

In Review

Figure 1: Flow of information from collection to inclusion of studies.

In Review

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Figure 2: A funnel plot of post-intervention effect sizes by standard error.

In Review

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Figure 4. Forest plot for post intervention overall effect for the available follow up results.

In Review