Original Investigation

Web-Based Alcohol Screening and Brief Intervention for University Students
A Randomized Trial

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IMPORTANCE Unhealthy alcohol use is a leading contributor to the global burden of disease, particularly among young people. Systematic reviews suggest efficacy of web-based alcohol screening and brief intervention and call for effectiveness trials in settings where it could be sustainably delivered.

OBJECTIVE To evaluate a national web-based alcohol screening and brief intervention program.

DESIGN, SETTING, AND PARTICIPANTS A multisite, double-blind, parallel-group, individually randomized trial was conducted at 7 New Zealand universities. In April and May of 2010, invitations containing hyperlinks to the Alcohol Use Disorders Identification Test-Consumption (AUDIT-C) screening test were e-mailed to 14 991 students aged 17 to 24 years.

INTERVENTIONS Participants who screened positive (AUDIT-C score ≥4) were randomized to undergo screening alone or to 10 minutes of assessment and feedback (including comparisons with medical guidelines and peer norms) on alcohol expenditure, peak blood alcohol concentration, alcohol dependence, and access to help and information.

MAIN OUTCOMES AND MEASURES A fully automated 5-month follow-up assessment was conducted that measured 6 primary outcomes: consumption per typical occasion, drinking frequency, volume of alcohol consumed, an academic problems score, and whether participants exceeded medical guidelines for acute harm (binge drinking) and chronic harm (heavy drinking). A Bonferroni-corrected significance threshold of .0083 was used to account for the 6 comparisons and a sensitivity analysis was used to assess possible attrition bias.

RESULTS Of 5135 students screened, 3422 scored 4 or greater and were randomized, and 83% were followed up. There was a significant effect on 1 of the 6 prespecified outcomes. Relative to control participants, those who received intervention consumed less alcohol per typical drinking occasion (median 4 drinks [interquartile range {IQR}, 2-8] vs 5 drinks [IQR 2-8]; rate ratio [RR], 0.93 [99.17% CI, 0.86-1.00]; $P = .005$) but not less often (RR, 0.95 [99.17% CI, 0.88-1.03]; $P = .08$) or less overall (RR, 0.95 [99.17% CI, 0.81-1.10]; $P = .33$). Academic problem scores were not lower (RR, 0.91 [99.17% CI, 0.76-1.08]; $P = .14$) and effects on the risks of binge drinking (odds ratio [OR], 0.84 [99.17% CI, 0.67-1.05]; $P = .04$) and heavy drinking (OR, 0.77 [99.17% CI, 0.56-1.05]; $P = .03$) were not statistically significant. In a sensitivity analysis accounting for attrition, the effect on alcohol per typical drinking occasion was no longer statistically significant.

CONCLUSIONS AND RELEVANCE A national web-based alcohol screening and brief intervention program produced no significant reductions in the frequency or overall volume of drinking or academic problems. There remains a possibility of a small reduction in the amount of alcohol consumed per typical drinking occasion.

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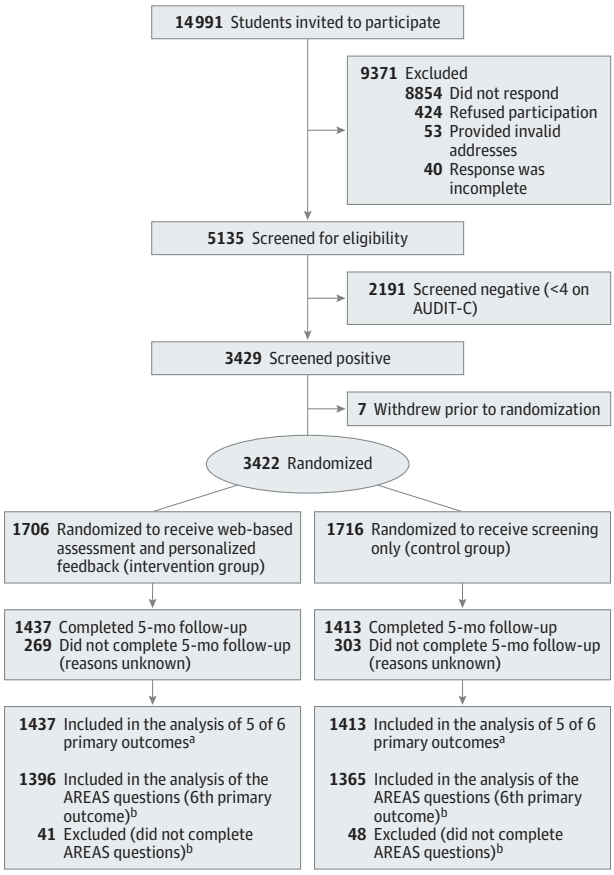
Unhealthy alcohol use is highly prevalent among young people and university students in particular.[1,2] Among the widely disseminable strategies shown to be effective in reducing this behavior is screening and brief intervention,[3] but this approach is not implemented routinely for young people in any country.

Web-based alcohol screening and brief intervention has been suggested as a means of reaching large numbers of young people and systematic reviews suggest possible benefits.[4-6] All the reviews identified weaknesses in study design and analysis and call for robust trials conducted in settings in which the intervention could be sustainably implemented.

There have been several trials conducted among university students; however, most occurred in conditions that generalize poorly to practice (eg, in psychology classes rather than as part of a systematic university-wide prevention program) and there have been no large multisite trials.[4-6] Trialling the intervention at a variety of sites permits testing the robustness of effects across student drinking cultures, which national surveys have shown to vary in levels of consumption,[7,8] exposure to alcohol outlets,[9,10] and alcohol promotion.[11,12]

Here we describe findings of the web-based alcohol screening and brief intervention project in New Zealand, which includes 2 large randomized controlled trials (RCTs) delivered at New Zealand universities—one in Māori (ie, indigenous) students and the other in non-Māori students. The Māori people experience a disproportionate burden of alcohol-related harm[13] and are often poorly served by health research because of inadequate sample sizes. These trials were planned to be run simultaneously but to be analyzed and reported separately to permit adequate attention to the Māori data.[14] In the RCT among Māori students (a group who constitute 10% of the national university population), those receiving intervention were found to drink 22% (95% CI, 11%-31%) less alcohol and to experience 19% (95% CI, 5%-31%) fewer alcohol-related academic problems at 5-month follow-up,[15] results that are of considerable public health significance given that it was a full-scale effectiveness trial. The aim of this trial was to estimate the effectiveness of a web-based alcohol screening and brief intervention program in reducing unhealthy alcohol use in the general population of university students in New Zealand.

Figure. Study Participant Flow and Follow-up Rates



AREAS indicates Academic Role Expectations and Alcohol Scale.

[a] Five of the 6 planned coprimary outcome measures were: frequency of drinking (range, 0-28 days), number of standard drinks (10 g ethanol) per typical occasion, average weekly volume of drinks ([28-day frequency × typical quantity]/4), whether the participant was drinking above recommended limits for acute risk (>40 g [for women] or >60 g [for men]) of ethanol on 1 occasion in the preceding 4 weeks), and whether the participant exceeded guidelines for chronic risk (>140 g [for women] or >210 g [for men] of ethanol/week in the preceding 4 weeks).[16]

[b] The score range for the Academic Role Expectations and Alcohol Scale (AREAS) is 0 to 15; completion of the AREAS questions is the 6th outcome measure in this analysis.

Methods

Trial Design

The design was a multisite, double-blind, parallel-group RCT with a 1:1 allocation ratio (**Figure**).[14]

Participants

Participants were students aged 17 to 24 years who did not select Māori in response to the ethnicity question on the university enrollment form (ie, no Māori students were included in this trial). In 2010, 90% of university students indicated their ethnicity as other than Māori. All data were collected via the Internet such that participants could answer screening questions, participate in the intervention, and complete follow-up assessments whenever and wherever they chose.

Sample Size

The estimate of required sample size was based on the 6-month outcomes in the THRIVE study, a trial of web-based alcohol screening and brief intervention at an Australian university.[8] Assuming a 5% level of significance, 80% power, a dispersion factor of 0.92 (for skew in the distribution), and attrition of 30%, 547 participants per group were required at follow-up to detect a 25 g ethanol difference (161 g vs 136 g) in weekly alcohol consumption.[14] Assuming that 40% would agree to screening (based on the THRIVE trial[8]) and 50% would screen positive (based on surveys of this population group[17]), the goal was to invite 7812 students aged 17 to 24 years (1116 in each of 7 universities [547 × 2 × {1−0.30}/0.40/0.50/7]).

Table 1. Screening Participation Rates, Age, and Drinking Data by University

University	No. of Students Sampled	No. (%)		Mean (SD)	
		Screened	Women	Age, y	AUDIT-C Score
Otago	2232	978 (44)	638 (65)	20.0 (1.6)	5.7 (3.0)
Lincoln	1707	641 (38)	358 (56)	20.1 (1.8)	6.1 (2.9)
Auckland	2232	815 (37)	488(60)	20.5 (1.9)	3.9 (2.7)
Canterbury	2232	833 (37)	448 (54)	20.2 (1.8)	5.0 (3.0)
Waikato	2229	746 (34)	477 (64)	20.6 (2.0)	5.0 (2.8)
Massey	2127	593 (28)	392 (66)	20.5 (2.0)	4.7 (2.9)
Victoria	2232	529 (24)	350 (66)	20.1 (1.6)	5.0 (2.8)
Total	**14 991**	**5135 (34)**	**3151 (61)[a]**	**20.3 (1.8)**	**5.1 (2.9)**

Abbreviation: AUDIT-C, Alcohol Use Disorders Identification Test-Consumption.

[a] Women comprised 61% of the university student population as old as 24 years in 2010.[18]

Recruitment and Screening

After 2 weeks of recruitment, the rate of uptake was lower than expected so further random samples of 1116 eligible students were selected from universities in which numbers permitted (Otago, Auckland, Canterbury, and Victoria) and of all eligible students at the other universities (Lincoln, Massey, and Waikato). A second wave of invitations was issued, bringing the total number of students invited to 14 991 (**Table 1**). The 2 recruitment waves occurred on April 19, 2010, and May 3, 2010, using procedures described elsewhere.[15] As many as 3 reminder e-mails were sent in the following weeks. Students were offered the opportunity to win a $500 supermarket voucher (New Zealand dollars [NZD]) or an iPad by participating. Respondents visited a 3-page web questionnaire that covered sex, age, and living arrangements; drinking in the last 12 months (yes/no); and the Alcohol Use Disorders Identification Test-Consumption (AUDIT-C), a validated 3-item screen for hazardous and harmful drinking.[19] Screening was limited to 3 questions because there is review-level evidence that asking about alcohol consumption can itself reduce self-reported drinking.[20] This evidence base is stronger among university students than in other populations and suggests the possibility of reactivity to the research conditions causing bias toward the null.[20,21]

Randomization and Blinding

Students were sent an e-mail containing a hyperlink to a web questionnaire and were informed that "the main focus of this study is student alcohol use over time and its consequences." Response to the survey was taken as consent to participate. Respondents who scored 4 or greater were randomly assigned by the web server to the control (screening only) or intervention group. This procedure was used to ensure that participants were blind to the true nature of the study, which was presented as 2 surveys to minimize the potential for research participataion effects.[21] Researchers were blind to allocation as randomization and all other study procedures were fully automated and thus could not be subverted. Blinding was considered ethically acceptable,[22] given the low risk to participants and benefits in terms of reducing bias.[21] Ethical approval for the study was granted by New Zealand's Multi-region Ethics Committee (MEC/10/01/009).

Intervention

The AUDIT-C comprises the 3 consumption questions of the 10-item World Health Organization Alcohol Use Disorder Identification Test (AUDIT).[23] Participants in the intervention group were then presented with AUDIT items 4 to 10, which cover alcohol problems and additional questions regarding the largest number of drinks consumed on a single occasion in the preceding 4 weeks, the duration of the drinking episode in hours, and the participant's body weight (for the purpose of estimating their peak blood alcohol concentration). Participants then completed the 10-item Leeds Dependence Questionnaire (LDQ).[24] Questions were presented in a seamless series of web pages immediately after screening and randomization. The psychometric performance online of the AUDIT and the LDQ has been confirmed in a previous study with university students.[25]

The intervention group received personalized feedback consisting of their AUDIT and LDQ scores with explanation of the associated health risk and information about how to reduce that risk; an estimated blood alcohol concentration for their heaviest episode in the previous 4 weeks with information on the behavioral and physiological sequelae of various blood alcohol concentration levels and the risk of having a motor vehicle traffic crash; estimates of monthly expenditure; bar graphs comparing reported episodic and weekly consumption with that of other students and the general population of the same age and sex; and hyperlinks for help with drinking problems. Additional web pages were presented as options offering facts about alcohol, tips for reducing the risk of harm, and informing of where medical help and counseling could be found. The instrument can be viewed online.[26]

Outcomes and Follow-up

Five months after randomization in September 2010, all participants were mailed a prenotice letter and sent an e-mail 2 days later with a hyperlink to a follow-up questionnaire. Questions concerned the frequency of drinking and amount consumed per typical drinking occasion, each with a reference period of the last 4 weeks. These frequency/quantity measures have been extensively validated[27] and used with this population group.[28] In addition, participants were presented with the 5-item Academic Role Expectations and Alcohol Scale (AREAS),[29] an alcohol problems measure also validated online with university students.[25]

There were 6 planned coprimary outcome measures: frequency of drinking (range, 0-28 days), number of standard drinks (10 g ethanol) per typical occasion, average weekly volume of drinks ([28-day frequency × typical quantity]/4), the AREAS score (range, 0-15), whether the participant was drink-

ing above recommended limits for acute risk (>40 g [for women] or >60 g [for men]) of ethanol on 1 occasion in the preceding 4 weeks), and whether the participant exceeded guidelines for chronic risk (>140 g [for women] or >210 g [for men] of ethanol/week in the preceding 4 weeks).[16]

Statistical Analysis

The outcomes were analyzed using negative binomial regression with empirical variance using Stata statistical software, version 12.1. For the proportions exceeding medical guidelines, logistic regression was used. Results are presented as rate ratios (RRs) and odds ratios (ORs). A Bonferroni adjustment was made to account for having 6 outcomes such that the *P* value for statistical significance is .0083 (= .05/6) and 99.17% CIs are presented around the effect estimates to reflect the adjusted α level (ie, 1−.0083 = .9917).

Participants were analyzed in the groups to which they were randomized (intention to treat [ITT]). Patterns of missing values and comparisons of those observed vs missing in terms of baseline characteristics are described. Additional comparisons include baseline AUDIT-C scores, age, and sex of participants lost to follow-up vs those followed up to assess whether attrition varied by randomization group.

Two types of models were fit for the ITT analysis using pattern mixture models to assess sensitivity to missing at random, as part of a sensitivity analysis.[30] The first model yielded unbiased estimates under the assumption that values were missing at random.[31] In the second model, we used *rctmiss* in Stata to conduct a missing not at random sensitivity analysis with the *typical occasion quantity* variable. We fit a sensitivity analysis with a parameter δ allowing for a difference between unobserved and observed in the group with the larger fraction of missing information. This model allowed a difference between observed and unobserved participants in the intervention group and assumed that observed and unobserved participants in the control group were identical (ie, conditions that would produce attrition bias). The value δ is the multiplicative factor that controls this missing not-at-random mechanism: the unobserved drink exp (δ) × that of those observed in the intervention group (δ = 0 being equivalent to a missing-at-random assumption).

Four posthoc subgroup analyses were conducted that examined whether sex, age, AUDIT-C score, and university modified the effect of the intervention. Each variable was included in the regression models using the *testparm* command in Stata, which produces a χ^2 statistic for nonlinear models.

Results

Screening and Randomization

Participant flow, follow-up rates, and the numbers analyzed are presented in the Figure. Of 14 991 students who were sent an e-mail invitation, 5135 (34%) completed screening (Table 1). Of these, 3429 (67%) screened positive for hazardous or harmful drinking and 3422 were randomized to the control (n = 1716) or intervention (n = 1706) group. The median completion time for the baseline questionnaire was 1.2 minutes (interquartile range [IQR], 0.9-1.7) and the intervention took an additional 4.3 minutes (IQR, 3.3-5.5) plus reading time, which could not be measured but is expected to have been less than 5 minutes. Web server logs show that more than 99% of intervention group participants opened the feedback page in which intervention elements were presented. **Table 2** presents summary statistics for the study groups at baseline.

Table 2. Baseline Demographic and Drinking Characteristics

	Intervention (n = 1706)	Control (n = 1716)
Women, No. (%)	989 (58)	978 (57)
Age, mean (SD), y	20.2 (1.8)	20.1 (1.7)
AUDIT-C, mean (SD), score[a]	6.8 (2.0)	6.6 (2.1)
Drinking summary data[b]		
Alcoholic drinks ≥2×/wk, %	35	33
Standard drinks per typical drinking occasion, mean (SD)	7.5 (4.7)	7.5 (5.0)

Abbreviation: AUDIT-C, Alcohol Use Disorders Identification Test-Consumption.

[a] The possible range of the AUDIT-C is 0 to 12, with higher scores indicating more hazardous and harmful drinking.

[b] Adapted from items 1 and 2 of the AUDIT-C.

Follow-up Assessment

Follow-up data were obtained from 1413 participants in the control group (83%) and 1437 in the intervention group (84%). The median time from sending e-mail invitations to completion of follow-up was 2 days (IQR, 1-8 days) in each group.

Loss to follow-up did not differ by group and covariates were equivalent. Among those unobserved at follow-up, women comprised 46% of the control and 51% of the intervention group (*P* = .20). In the control and intervention groups, the mean ages of those unobserved were 20.2 and 20.3 years (*P* = .51), and mean AUDIT-C scores were 6.9 and 6.8 (*P* = .37).

Outcome data (**Table 3**) show that 44% of the sample exceeded thresholds for acute harm (binge drinking) but participants drank infrequently (slightly more than 1×/wk on average), thus fewer than 1 in 6 exceed guidelines for chronic harm.

Outcomes

Table 3 also presents results for the 6 outcomes with 99.17% CIs to reflect the α adjustment for multiple tests. Although all of the point estimates were in the hypothesized direction, only the effect on typical occasion quantity was statistically significant (*P* < .008) after Bonferroni adjustment.

Sensitivity Analysis

As per the ITT analysis, missing-not-at-random assumptions were made to assess how sensitive the analysis was to differential attrition with δ of 0.05, 0.10, and 0.30. Assuming that unobserved intervention participants were consuming 11% more drinks than observed intervention participants, while there was no difference between unobserved vs observed control participants (δ = *ln* 1.11 = 0.10) the model yielded a *P* value (*P* = .01) larger than our adjusted α level. The effect estimate was robust to a 5% (δ = 0.05; *P* = .002) but not to a 35% (δ = 0.30) differential loss to follow-up (*P* = .27).

Table 3. Outcome Data and Intervention Effect Estimates[a]

Outcome	Median (25th-75th Percentiles)		Effect Estimate	
	Intervention (n = 1437)	Control (n = 1413)	Intervention vs Control (99.17% CI)	*P* Value
Drinking duration, days	5 (2-8)	5 (3-8)	RR = 0.95 (0.88-1.03)[b]	.08
No. of drinks per typical drinking occasion	4 (2-8)	5 (2-8)	RR = 0.93 (0.86-1.00)	.005[c]
Volume consumed (No. of drinks per wk)	5 (2-10)	6 (3-11)	RR = 0.95 (0.81-1.10)	.33
Consequences related to academic role expectations (AREAS score)[d]	0 (0-2)	1 (0-2)	RR = 0.91 (0.76-1.08)	.14
Exceeded guidelines for binge drinking (risk of acute harm), No. (%)[e]	620 (43)	621 (44)	OR = 0.84 (0.67-1.05)[f]	.04
Exceeded guidelines for heavy drinking (risk of chronic harm), No. (%)[g]	199 (14)	208 (15)	OR = 0.77 (0.56-1.05)	.03

Abbreviations: AREAS, Academic Role Expectations and Alcohol Scale; AUDIT-C, Alcohol Use Disorders Identification Test-Consumption; OR, odds ratio; RR, rate ratio.

[a] All measures use the preceding 4 weeks as the reference period.

[b] Adjusted for baseline AUDIT-C score with 99.17% CI from negative binomial regression model.

[c] Statistically significant after Bonferonni adjustment (0.05/6 = 0.008).

[d] The possible range of AREAS scores is 0 to 15 with higher scores indicating more problems. For this category, there were 1396 in the intervention group and 1365 in the control group.

[e] Alcohol Advisory Council (New Zealand): 4 or fewer drinks (40 g ethanol) in any one occasion for women, and 6 or fewer drinks (60 g ethanol) in any one occasion for men.

[f] Adjusted for baseline AUDIT-C score with 99.17% CI from logistic regression model.

[g] Guidelines indicate 14 or fewer drinks (140 g ethanol) per week for women, and 21 or fewer drinks (210 g ethanol) per week for men.

Subgroup Analyses

There was no significant variation in the effects of the intervention by age, sex, or drinking level on the primary outcomes. There was a difference in the intervention effect by university on the typical occasion quantity ($\chi^2 = 13.2$; $df = 6$; $P = .04$), and volume of alcohol consumed ($\chi^2 = 13.5$; $df = 6$; $P = .04$); however, these results are not statistically significant considering the multiple tests performed.

Discussion

Overall, the intervention produced a modest reduction in the amount consumed per typical drinking occasion but not in the frequency of drinking, overall volume consumed, or in related academic problems. The effect estimate for the amount consumed per typical occasion (RR, 0.93; $P = .005$), when analyzed with a pattern mixture model, shows that it could be vulnerable to attrition bias. All of the point estimates were in the expected direction but were smaller than those found in a previous efficacy trial of a similar intervention at a single Australian university (5% difference in this study compared with 11% difference in overall volume of alcohol consumed).[8] In the companion trial of the same intervention run contemporaneously at the same universities using identical study procedures for Māori students, there was a 22% difference in overall volume of alcohol consumed, although the impact on amount consumed per typical occasion was similar (RR, 0.93 and 0.92, respectively).[15]

A limitation of the study is the prespecification in the trial protocol of 6 coprimary outcomes, which necessitated a conservative approach to statistical significance. The literature does not offer a clear basis for choosing one alcohol consumption paramater over another and our own trials show different effects on different estimates.[8,15] In retrospect, a joint model encompassing all 6 outcomes (which are correlated) producing a single *P* value might have been preferable as the analytic strategy.[32] All of the outcomes are in the hypothesized direction but the sensitivity analysis. The sensitivity analysis, which shows that modest differential attrition could account for some or all of the observed difference, tempers confidence that there was an effect.

Strengths of the study include the participation of 7 of New Zealand's 8 universities, encompassing diversity in student population characterististics, drinking cultures,[8] and alcohol availability,[10] and thereby subjecting the intervention to a robust test. The effect modification data are interesting for hypothesis generation in this regard; it may be that universities shape the potential effect of these kinds of brief alcohol interventions.

The participation rate of one-third shows that it is possible to screen a large number of students at very low cost (ie, staff time to send e-mail invitations, bandwidth for e-mail and web traffic, and routine server support) that could be expected to be absorbed as part of usual service delivery. There is evidence that as much as two-thirds of the student population will complete screening if more active strategies, including a pre-notice letter, are used, and more than 80% can be reached with the addition of follow-up phonecalls.[28] These procedures were judged to be beyond the means of routine screening programs and were therefore not used in this pragmatic trial to better maximize the external validity of the findings. The possible cost effectiveness of these additional strategies offers another target for future study.[33]

Given that the outcome data are self-reported, it is possible that the intervention group misreported its consump-

tion and alcohol-related problems to a greater extent than the control group, thus biasing the effect estimates away from the null. There is no practical alternative to self-report in a web-based trial given that obtaining biological samples is infeasible. Differential error in misreporting cannot be ruled out but the trial was conducted in conditions conducive to accurate reporting, using a computerized questionnaire completed in the absence of the researchers,[34] with assurances of confidentiality, nonjudgemental language, and on a subject that New Zealand students do not find stigmatizing.[35]

The point estimates from this large, multicenter pragmatic trial are smaller (ie, RRs closer to 1) than those typically seen in efficacy trials conducted at single institutions,[4-6] which is not surprising in the context of what is known about how estimates from efficacy trials often do not generalize to the conditions of clinical practice.[36] The findings are comparable with those of a recent effectiveness trial of a similar intervention for university students in Sweden, showing a 3.7% reduction in the proportion of risky drinkers and a 0.16-point reduction in AUDIT-C scores.[37]

There are large differences in effects between non-Māori students in this trial and those estimated for Māori students in the companion trial for outcomes other than amount consumed per typical occasion and exceeding guidelines.[15] Extensive consultation with Māori researchers and student welfare staff suggests the possibility that Māori students would be more heavily influenced by social norm feedback than non-Māori students. Māori students may have a stronger group identity, enhanced by being a small minority in the university setting, a view consistent with social identity theory.[38,39] The difference could also be due to chance, underscoring the need to undertake replication and further studies evaluating web-based alcohol screening and brief intervention in full-scale effectiveness trials.

Conclusions

Among university students in New Zealand, a web-based alcohol screening and brief intervention program resulted in, at best, a small reduction in the amount consumed in a typical drinking occasion but not in other alcohol consumption and problem measures. The findings underline the importance of pragmatic trials to inform preventive medicine.[40] They indicate that web-based alcohol screening and brief intervention should not be relied upon alone to address unhealthy alcohol use in this population[41] and should be used in conjunction with effective environmental interventions such as restriction in the physical availability and promotion of alcohol.[42]

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Correction: This article was corrected on April 8, 2014, to fix an author affiliation and typographical errors in the Results section of the Abstract and also in the last paragraph of the Discussion section.

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