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REVIEW

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Effectiveness of web-based personalised feedback interventions for reducing alcohol consumption among university students: A systematic review and meta-analysis

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Abstract

Issues: Meta-analysis was conducted to examine standalone web-based personalised feedback interventions (PFI) delivered in non-structured settings for reducing university students' alcohol consumption. Subgroup analyses by gender-focus, type-of-content and accessibility were conducted. Characteristics of the sample, the intervention and study quality were examined as moderators.

Approach: Ten databases were searched from 2000 to 2023. Eligible articles involved only randomised controlled trials. Random-effects meta-analysis was conducted to calculate the effect size on weekly alcohol consumption comparing web-PFIs and non-active controls. Meta-regressions were applied to explore effect moderators.

Key Findings: Thirty-one studies were included in the narrative synthesis, 25 of which were meta-analysed. Results found significant effect size differences on weekly alcohol consumption in favour of the intervention group in the short- (SMD = 0.11, 95% confidence interval [CI] 0.06, 0.15) and long-term period (SMD = 0.09, 95% CI 0.02, 0.15). Subgroup analyses identified that interventions which were gender-specific, multicomponent and had unlimited access had higher and significant effect sizes, although they were very similar with respect to comparative groups. Moderator analyses showed that times feedback was accessed significantly contributed to the effectiveness of the intervention. Effects diminished over time, although they remained significant.

Implications: The meta-analysis evidences the effectiveness of web-PFI for addressing university students' alcohol use, decreasing by 1.65 and 1.54 drinks consumed per week in the short- and long-term, respectively.

Conclusions: The results offer empirical evidence that supports the significant, although small, effect of web-PFI delivered remotely in universities. Future

research should focus on increasing their impact by introducing booster sessions and content components based on students' preferences.

KEYWORDS
alcohol drinking, alcohol drinking in college, feedback, internet-based intervention

1 | INTRODUCTION

Alcohol is one of the leading causes of death among individuals aged 15 to 24 years worldwide [1]. University students are a particularly high-risk group with high consumption levels and binge drinking rates (defined as consuming five or more beverages containing alcohol for males or four or more beverages containing alcohol for females on the same occasion [i.e., within a couple of hours] on at least 1 day in the past month); a significant public health issue today [2–4]. The National Survey on Drug Use and Health 2021 reported that 51.8% of American university students drank alcohol in the past month, and 28.7% engaged in risky (i.e., 'binge') drinking episodes [4]. The prevalence of this risky behaviour in university students remains similar across European countries: 40% of English students and 55% of Spanish students reported binge drinking in 2019 [5]. These patterns of drinking are associated with significant health and other risks in the short- (e.g., injuries, sexual assault, drunk driving, academic failure) and long-term (e.g., alcohol dependence in adulthood) [6], leading to lasting impacts [3].

The widespread consumption of alcohol among university students has prompted decades of research in identifying key cognitive, attitudinal, environmental, social and hereditary variables underlying alcohol use [2, 7]. The robust associations between these factors and university students' drinking have also prompted the development of a wide variety of intervention strategies targeting these variables [2]. Two main interventional approaches exist: environmental (e.g., alcohol free campuses and policies, and campus-wide social norms campaigns) and individual-level strategies (e.g., in-person/group brief motivational interventions, skills training and multicomponent education-focused programs) [8]. Among the latter, personalised feedback interventions (PFI) are one of the most promising approaches. Drawing on motivational and social psychology, PFIs aim to enhance the salience of normative and personal standards with the aim of encouraging careful reflection on future alcohol consumption [9]. PFIs vary in terms of their content, including personal patterns of quantity-frequency of drinking; blood alcohol concentration (BAC) level; practical costs (e.g., money spent on alcohol or caloric intake); associated health/social risks (e.g., tolerance level, family history of alcohol use disorders, age of onset, self-reported negative consequences); strategies to limit risks; available resources; and educational information about alcohol [10]. Normative comparison, which highlights disparities between one's perception of peer norms and the actual peer norms, contrasted with their self-reported consumption, is another crucial component of PFIs. The reference group may be general, known as gender-neutral, or matched on gender, known as gender-specific [3].

Research about personalised feedback programs identifies two main subtypes of interventions: multicomponent PFIs, which follow a multicomponent design covering various of the content components previously mentioned; and pure personalised normative feedback (PNF), which only include the normative comparison component, without additional issues [3, 10]. PNFs are increasing in the field of addiction [11], however, PFIs that include more topics are also effective [12] and usually cover contents that are of more interest to university students [13, 14]. Interventions for university students' drinking are increasingly incorporating a gender perspective, as gender-specific interventions are more effective [15, 16].

PFIs were originally part of face-to-face motivational enhancement programs and, in the last two decades, as part of computer-delivered interventions [17]. Computer-based interventions without professional guidance can be as effective as brief provider-guided programs [18], being more suitable for university students who prefer interventions without therapeutic involvement [19]. As research on computer-based interventions has continued to expand, PFIs have been examined as a standalone, self-guided intervention, with some studies suggesting they are an effective strategy for reducing alcohol use among university students [20–22].

Standalone PFIs have been implemented in both structured (at a designated location and often at a designated time, e.g., research laboratory) [23, 24] and non-structured settings (at a time and location chosen by the participant, e.g., self-directed remotely web-based completion) [25–27]. Evidence suggests that remote web-based PFIs, requiring no actual participant/practitioner contact, are an appealing option for university students due to their easier accessibility and dissemination, greater reach and lower cost [19]. Given its promising advantages to universities, it is paramount to thoroughly examine

the effectiveness of standalone PFIs delivered in this manner.

To date, several reviews and meta-analyses targeting university students' drinking have examined personalised feedback as a major component, either as a standalone [28–31] or as a part of a multifaceted intervention [29–31]; involving both a computer and web-based PFIs delivered in structured (e.g., research laboratory) and non-structured (e.g., remotely) settings [28–31]. Studies have involved active control conditions, which can diminish statistical power to detect intervention effects, and/or have non-randomised controlled trial (RCT) designs, which pose a higher risk of confounding and bias compared to RCTs [11]. The systematic review by Leeman et al. [19] focused on standalone web-based PFIs. However, they included active control conditions and did not conduct a meta-analysis to explore the effectiveness of PFIs on the type of content covered, or on a gender-specific approach when incorporating normative comparison. Dotson et al.'s [3] meta-analysis examined differences based on gender but only among pure PNF, covering both computer- and web-based PFIs. No systematic reviews and meta-analyses have focused solely on standalone web-based PFIs (both pure PNF and multicomponent PFIs), delivered in non-structured settings, including only non-active control conditions; examined the influence of gender perspective when including normative comparison; and compared the effect between pure normative feedback and multicomponent feedback.

As the number of RCTs focused on the effectiveness of standalone web-based PFIs delivered remotely for student alcohol use has increased in recent years, a new empirical review of these studies is timely. To this end, this systematic review aimed to consolidate existing research and conduct a meta-analysis of standalone web-PFIs for university student drinking in non-structured settings. The specific study aims were to: (i) contrast the effects of gender-neutral and gender-specific PFIs on university student drinking at short- and long-term, and compare effects based on the type of content covered (pure PNF vs. multicomponent PFI); and (ii) explore potential moderators of the effect magnitude regarding characteristics of the sample, the intervention and the study quality.

2 | METHODS

2.1 | Protocol and registration

This systematic review is reported in line with PRISMA (see PRISMA checklist in Table S1, Supporting Information) and was pre-registered on PROSPERO (CRD42023423805).

2.2 | Search strategy and study selection

Studies were retrieved from the following databases for published papers: MEDLINE, PubMed, CINAHL, ERIC, PsycINFO, Scopus, Web of Science and the Cochrane Library. The combinations of free-text terms and medical subject heading terms used are shown in Table S2, Supporting Information. Unpublished papers were also included to avoid the file drawer effect [32]. They were searched for in DART-Europe and ProQuest. Finally, we also reviewed the reference lists to find relevant studies, as well as the references of empirical reviews retrieved from searches. The searches were limited to studies published in English, from January 2000 to May 2023. Only articles since 2000 were included as the internet offered limited features before 2000 [33].

Studies were included if: they were a RCT; they included a non-active control condition (assessment only, treatment as usual or attention condition: alternate personalised feedback concerning a topic other than alcohol); the intervention was a standalone personalised feedback delivered via the internet (web or email), in non-structured settings; participants were college/university students or from equivalent institutions (excluding college and high school seniors aged 16–18 years old) who drink alcohol; they reported outcomes for alcohol consumption; they were published in a peer reviewed journal (i.e., no conference abstracts) or thesis dissertations; and provided sufficient data for effect size (ES) calculation. When required, additional information necessary for inclusion was asked; if no response was received, the study was excluded. Thirteen authors were contacted, with a response rate of 61.5%. The screening process was conducted by two authors independently using Covidence systematic review management program. Discrepancies between authors were resolved by a third author. Intercoder reliability in the title and abstract, and full-text screening was high (Gwet's AC1 = 0.974 and 0.988, respectively).

2.3 | Coding and reliability

We created a coding template to systematically extract data at study level and ES level. Covidence was used for data extraction and management. Two authors independently coded study information (e.g., publication year), sample characteristics (e.g., gender, age), intervention details (e.g., type of content components, gender approach) and measurement specifics (e.g., recruitment method, outcomes, data for ES calculation). Discrepancies were resolved through discussion after a third

researcher searched for the data in the manuscript and compared decisions.

We assessed study quality using the Risk-of-Bias 2 tool [34]. It provides a framework for considering the risk of bias of intervention effects reported from randomised trials. The risk-of-bias in each study was classified as 'low', 'some concerns' or 'high' by judging five bias domains: randomisation process; deviations from intended interventions; missing outcome data; measurement of the outcome; and selection of the reported result. Within each domain, the assessment comprised: (i) a series of signalling questions; (ii) a judgement about risk of bias for the domain, facilitated by an algorithm; and (iii) free text boxes to justify responses to the signalling questions and judgements [34].

The risk-of-bias assessment was conducted by two authors independently. When any disagreement was reported, the manuscript was provided to a third author who assessed the study quality using the Risk-of-Bias 2 tool. Responses to signalling questions, judgements from algorithms, and text arguments were compared and discussed among the three evaluators, reaching a unanimous decision. Intercoder reliability was high (Gwet's AC1 = 0.829).

2.4 | Study outcomes

We examined alcohol consumption in terms of quantity consumed over time (e.g., drinks per week, month); quantity per drinking occasion (e.g., drinks consumed on a Friday night); maximum quantity consumed on one occasion; frequency of heavy episodic drinking; frequency of drinking days; typical or peak estimated BAC; and Alcohol Use Disorders Identification Test (AUDIT) scores. We obtained separate ES estimates for each alcohol consumption outcome. When multiple follow-ups were used, the immediate post-intervention and the last follow-up time-points were used in analyses. Post-intervention time-points ranged from 6 weeks to 11 months, and last follow-up time-points ranged from 5 to 24 months.

'Drinks per week' was reported consistently across the majority of the included studies, so was chosen as the outcome with which to conduct the meta-analysis. Additional meta-analyses were conducted with the secondary alcohol outcomes (drinks per occasion, drinking frequency, heavy episodic drinking and peak estimated BAC).

2.5 | Effect size derivation

We calculated the ES between-groups for each outcome variable regarding alcohol consumption at post-intervention and last follow-up. Between-group ESs were calculated as the standardised mean difference (SMD) in change scores between intervention and control group divided by the pooled standard deviation [35]. Their 95% confidence intervals (CI) were also estimated. When means and standard deviations were not reported, we calculated ESs from the available statistics. Intention-to-treat data was preferred over complete data. Positive ESs indicate a decrease in drinking among participants who received PFI in comparison to those in the control group. We applied the inverse variance approach which allocates ES weights based on standard errors, with larger studies receiving greater weights. This choice minimises the uncertainty of the pooled effect estimate [34]. A conventional ES of 0.2 was interpreted as small, 0.5 as medium, and 0.8 as large [36].

The assumption of independence, which precludes using a single analysis to compare multiple treatments to the same control condition, was followed [37]: when a study included multiple PFI arms, the version reported as having the strongest evidence for alcohol use outcomes was chosen. In addition, normative reference group arms based on gender (neutral or specific) were prioritised over other student referents, such as Greek status/fraternity membership or race. In studies with two control groups (e.g., full assessment or minimal assessment), or two intervention groups that only differ in the time point of implementation, the arm most similar to the comparison condition procedure was chosen. Table S3, Supporting Information, summarises all the decision rules.

2.6 | Statistical analyses

All analyses were conducted using Stata 17.0. We conducted a meta-analysis combining the outcomes from the individual trials related to 'drinks per week'. We used random-effect procedures to merge the results due to the range of different interventions used in the analysis. We estimated heterogeneity using the I^2 statistic and Q(chi^2) test. Heterogeneity was considered low when $I^2 = 0\%$–40% and the Q p-value was not significant, moderate if $I^2 = 41\%$–60% with a significant Q p-value, and high if $I^2 = 61\%$–100% [34].

We performed subgroup analyses to compare effects of gender-neutral and gender-specific PFIs on university student drinking, and to compare effects of the different PFI based on their type-of-content covered as established a priori. We also conducted subgroup analyses based on type of accessibility to the PFI based on the findings of the moderator analysis. Forest plots of post-intervention and last follow-up between-group ES were produced.

Moderator analyses were employed throughout meta-regressions to explore potential moderators of the

intervention effect. Characteristics of the sample, for example, type of drinkers (those drinking at hazardous levels, those drinking heavily, current drinkers and any university student), and characteristics of the intervention, for example, accessibility to the feedback (once vs. not limited in time), delivery modality (email vs. web), type of program (commercial vs. developed by authors), number of contents (pure PNF vs. multicomponent feedback) or gender approach (specific vs. neutral), as well as study quality (low, some concerns, high) were entered as predictors of the alcohol consumption variable.

Sensitivity analyses were also used to examine the influence of methodological characteristics of the studies, excluding those trials at high risk of bias, to determine the influence on PFI effectiveness. Finally, to explore publication bias, a funnel plot was created and Egger's regression-based test was estimated.

3 | RESULTS

Figure 1 illustrates the PRISMA flow-chart. The initial search yielded 3435 studies and 35 were identified through manual searching. Thirty-one of these met criteria for inclusion in the systematic review, 25 of which were included in the meta-analysis.

3.1 | Study characteristics

The characteristics of the studies included in the systematic review are presented in Table 1. Publication dates ranged from 2008 to 2023. Fifteen studies were conducted in United States, four in United Kingdom, four in Sweden, three in New Zealand, two in Germany, two in Canada and one in Brazil.

The alcohol consumption outcomes varied across the studies. Measures of overall drinking were predominantly reported: drinks per week being the most common ($n = 24$), followed by drinks per occasion ($n = 13$), frequency of drinking days ($n = 12$), frequency of heavy episodic drinking ($n = 7$), peak estimated BAC ($n = 8$) and AUDIT score ($n = 5$).

Most of the PFI studies were web-based ($n = 27$), with only four email-based. The majority of the PFIs were developed by the authors, with six studies using a commercial program, such as e-CHECKUP TO GO or web-BASICS.

Regarding the intervention content components, eight studies examined the efficacy of PFI focused solely on normative comparisons: PNF. Twenty-six studies examined multicomponent conditions, including all of them the topic of normative comparison. Thirteen were gender-neutral PFI conditions and 20 gender-specific. Table 1 details the contents of the multicomponent PFIs. The most common issue was students' pattern of quantity-frequency ($n = 30$), followed by protective behavioural strategies ($n = 20$), educational information ($n = 20$), level of intoxication ($n = 19$), practical costs ($n = 16$), individual risk factors ($n = 16$) and resources ($n = 12$).

Regarding methodological characteristics, studies differed in terms of sample targeted: those drinking heavily ($n = 14$), people drinking at hazardous and/or harmful levels ($n = 7$), university students in general ($n = 6$) and drinkers at any level ($n = 4$). In relation to the comparison group, 23 studies involved an assessment-only control condition, and 8 an attention-matched control condition. Post-intervention time-points varied across studies, with the majority ($n = 23$) occurring in the first 3 months, while a few ($n = 8$) were conducted in the fourth to sixth month. Additionally, 16 studies included longer-term follow-ups, ranging from 4 to 12 months for 15 studies and at 24 months for one study.

Regarding accessibility, most of the studies ($n = 21$) let the participants access their feedback once, and the remainder ($n = 10$) had no restrictions or unlimited access until the follow-up measurement. Follow-up rates also differed across studies. At the post-intervention, several studies ($n = 16$) reported rates in the 70%-range or higher, while a few studies ($n = 3$) retained in the 50%-range or lower. Final follow-ups were lower, ranging from 32% to 90%. The total number of participants included in the meta-analysis was 14,756 (PFI $n = 7152$; assessment only control $n = 7174$).

3.2 | Risk of bias

Results of the risk of bias assessment are reported in Table 1. The majority of studies were assessed to have a low risk of bias ($n = 19$; 61%), with eight studies judged to have overall 'some concerns' and four studies rated as high risk of bias. Of the latter, three studies were judged as high risk in Domain 3 'Missing outcome data', and one study in Domain 2 'Deviations from intended interventions'. Domain 1 (randomisation process) and Domain 5 (selection of the reported results) were the most common areas where no concerns were raised. On the contrary, Domain 3 (missing outcome data) was the area that most raised some or high concern. Domain 4 (measurement of the outcome) was rated with low concern across all studies due to the difficulty to objectively assess the influence of participants' knowledge of the intervention assigned in the outcomes that were measured using self-report instruments.

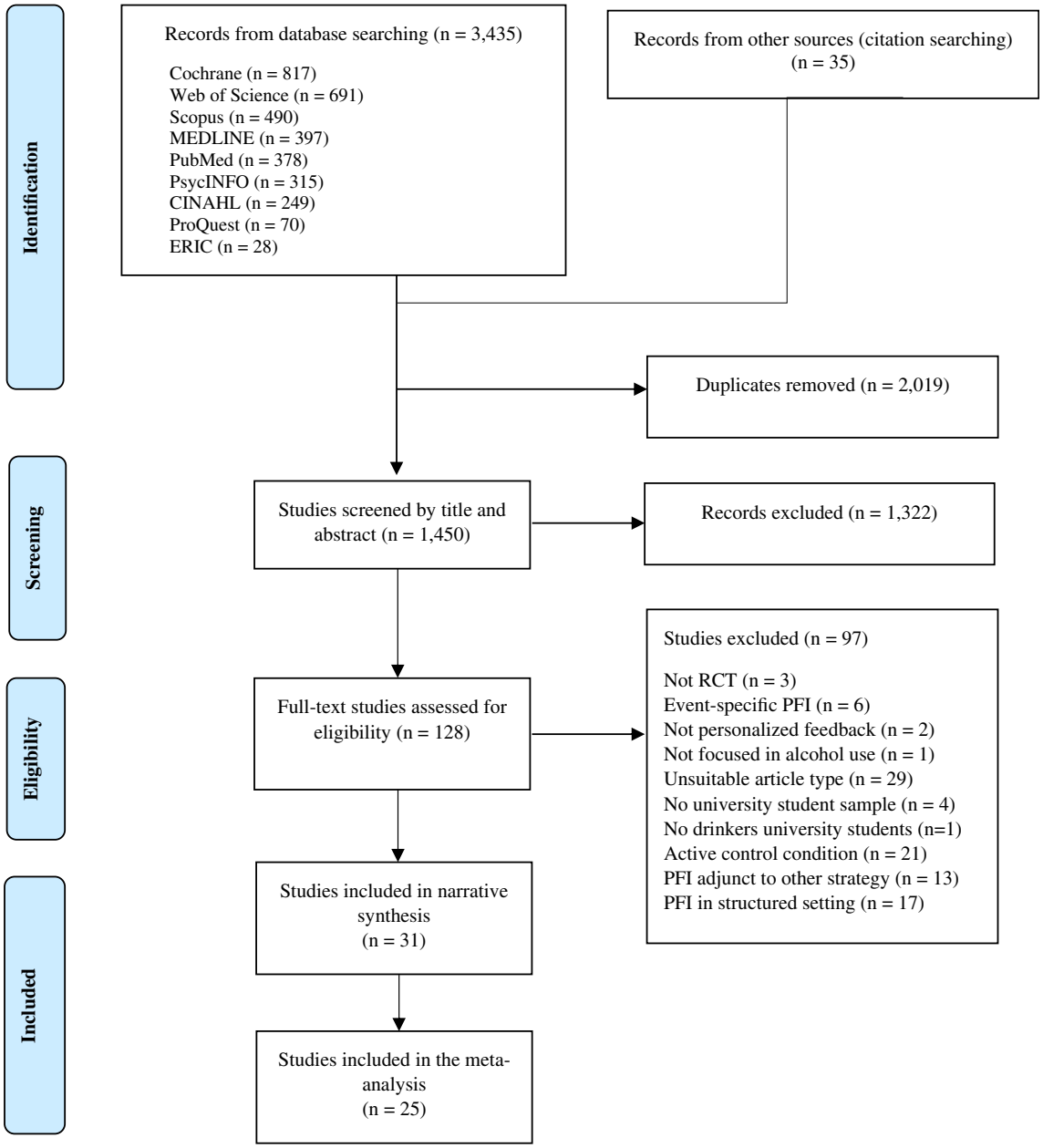

FIGURE 1 PRISMA flow diagram.

3.3 | Outcomes reported and ES estimates

The largest ESs were small-to-moderate in favour of the intervention group. Fourteen of the 31 included RCTs reported at least one ES of 0.20 or greater for an alcohol consumption reduction outcome; and 10 studies reported an ES in the range of 0.17–0.19; the remaining studies reported lower ESs. The outcome measures that were affected positively by the PFI conditions varied across studies, with 24 ESs of 0.20 or greater for quantity of alcohol consumption; along with 10 for BAC (typical or peak), 8 for frequency of drinking; and 1 for AUDIT-C score. Thirteen RCTs reported ESs in favour of the control group for at least one outcome. All had small ESs: 0.10 or lower in eight studies, ranging from 0.11 to 0.20 in the other five studies.

Both pure PNF and multicomponent PFIs, and both gender-neutral and gender-specific interventions, were empirically supported. Four of the eight PNF conditions reported several alcohol use outcomes with ESs of 0.20 or greater, whereas 12 out of the 26 PFI conditions reported ESs estimates of 0.20 or greater. Seven of the 13 gender-neutral conditions reported varied alcohol outcomes with ES of 0.20 or greater, whereas 7 out of the 20 gender-specific conditions reported estimates of 0.20 or greater.

TABLE 1 Characteristics of studies included in the systematic review.

Article	Country	Target group	Total sample size	% female	Intervention	Components	Gender focus	Access type	% rates[a]	Effect size estimates	Risk of bias
Andersson [20]	Sweden	Heavy drinkers	231	62.0%	Web alcohol-only PFI (developed by authors)	P F N S	GS	Not limited in time	3 months (93%) 6 months (81%)	Drinks per week: 0.29 (3 month), 0.11 (6 month) Drinks per occasion: 0.15 (3 month), 0.04 (6 month) Frequency of drinking days: 0.26 (3 month), 0.11 (6 month)	Low
Andersson [38]	Sweden	Hazardous drinkers	1015	41.0%	Two arms: • Web single PFI • Web repeated PFI (developed by authors)	P L F N S I	GN	Access until follow-up	6 weeks (84%)	Drinks per week: 0.11 (single), 0.01 (repeat) Frequency of drinking days: 0.08 (single), 0.16 (repeat) BAC typical: 0.22 (single), −0.03 (repeat) BAC peak: 0.26 (single), 0.12(repeat) AUDIT: 0.16 (single), 0.16 (repeat)	Low
Bedendo et al. [39]	Brazil	Current drinkers	4460	52.4%	Web PFI (developed by authors)	P L C F N S I	GS	Access until follow-ups	1 month (83%) 6 months (32%)	Drinks per occasion: 0.11 (1 month), 0.10 (6 month) AUDIT: 0.04 (1 month), 0.02 (6 month)	High
Bendtsen et al. [40]	Sweden	Hazardous and harmful drinkers	1605	49.1%	Web PFI (developed by authors)	P L N I	GS	Once	2 months (58%)	Drinks per week: 0.09 Drinks per occasion: 0.08 Frequency of drinking days: 0.03 BAC peak: 0.14 Frequency of HED: 0.10	Low
Bewick et al. [41]	United Kingdom	Any university student	506	69.0%	Web PFI (developed by authors)	P N S R I	GN	Not limited in time	12 weeks (63%)	Drinks per week: 0.17	Some concerns

(Continues)

TABLE 1 (Continued)

Article	Country	Target group	Total sample size	% female	Intervention	Components	Gender focus	Access type	% rates[a]	Effect size estimates	Risk of bias
										Drinks per occasion: 0.20	
Bewick et al. [42]	United Kingdom	Current drinkers	688	73%	Immediate web PFI (developed by authors)	P N S R I	GN	Access until first follow-up	8 weeks (67%) 24 weeks (39%)	Drinks per week: −0.05 (2 month), 0.05 (6 month) Drinks per occasion: 0.04 (2 month), 0.03 (6 month)	Low
Bewick et al. [43]	United Kingdom	Current drinkers	1478	70.1%	Web PFI (developed by authors)	P N S R I	GN	Access until first follow-up	16 weeks (48%) 34 weeks (41%)	Drinks per week: 0.16 (4 month), 0.04 (9 month) Drinks per occasion: 0.36 (4 month), 0.20 (9 month)	High
Collins et al. [44]	United States	Heavy drinkers	473	56%	Web PFI (developed by authors)	P L C N	GS	Once	1 month (90%) 12 months (75%)	Frequency of drinking days: 0.13 (1 month), −0.01 (12 month) Drinks per week: −0.06 (1 month), −0.17 (12 month)	Low
Cunningham et al. [45]	Canada	Hazardous drinkers	425	47.5%	Web PFI (commercial program)	P C N	GS	Once	6 weeks (68%)	AUDIT-C: 0.17	Low
Ganz et al. [46]	Germany	Hazardous drinkers	981	56.1%	Web PFI (commercial program)	P L C F N S	GN	Once	3 months (43%) 6 months (35%)	Drinks per week: 0.17 (3 month), 0.21 (6 month) Frequency of HED: −0.06 (3 month), −0.01 (6 month) BAC peak: 0.08 (3 month), 0.18 (6 month)	Low
Gilmore et al. [47]	United States	Heavy drinkers	107	100%		P L F N S I	GS	Once	3 months (79%)	Frequency of HED: 0.29	Some concerns

TABLE 1 (Continued)

Article	Country	Target group	Total sample size	% female	Intervention	Components	Gender focus	Access type	% rates[a]	Effect size estimates	Risk of bias
					Web alcohol-only PFI (developed by authors)						
Hustad et al. 2010 [48]	United States	Any university student	56	51.0%	Web PFI (commercial program)	P L C F N S R I	GS	Once	1 month (96%)	Drinks per week: 0.55 Drinks per occasion: 0.35 Peak drinks per occasion: 0.50 Frequency of HED: 0.49 BAC typical: 0.43 BAC peak: 0.60	Low
Juárez et al. [49]	United States	Heavy drinkers	122	52.5%	Mailed PFI only (developed by authors)	P L F N I	GS	Once	2 months (73%)	Drinks per occasion: 0.11 BAC peak: −0.08	High
Kypri et al. [50]	New Zealand	Heavy drinkers	2435	45.3%	Web PFI (developed by authors)	E P L C F N S R I	GS	Access until follow-up	1 month (78%) 6 months (65%)	Drinks per occasion: 0.14 (1 month), 0.05 (6 month) Frequency of drinking days: 0.17 (1 month), 0.16 (6 month) Drinks per week: 0.21 (1 month), 0.17 (6 month)	Low
Kypri et al. [51]	New Zealand	Hazardous or harmful drinkers	1789	65.5%	Web PFI (developed by authors)	P L C F N S R I	GS	Once	5 months (79%)	Drinks per occasion: 0.10 Frequency of drinking days: 0.13 'Drinks per week': 0.17	Low
Kypri et al. [52]	New Zealand	Hazardous or harmful drinkers	3422	57.5%	Web PFI (developed by authors)	P L C F N S R I	GS	Once	5 months (83%)	Drinks per occasion: 0.04 Frequency of drinking days: 0.01 'Drinks per week': 0.01	Low
Labrie et al. 2013 [53]	United States	Heavy drinkers	738	56.7%	Three arms: • Typical sex PNF • Typical student PNF	PNF: P N BASICS PFI:	GS GN	Once	1 month (81%) 12 months (41%)	Drinks PER week:	Low

(Continues)

TABLE 1 (Continued)

Article	Country	Target group	Total sample size	% female	Intervention	Components	Gender focus	Access type	% rates[a]	Effect size estimates	Risk of bias
					• Web-BASICS PFI (developed by authors, and commercial program)	P L C F N S R I				Typical Norms: 0.20 (1 month), 0.14 (12 month) Sex norms: 0.07 (1 month), −0.10 (12 month) BASICS: 0.09 (1 month), 0.06 (12 month) Peak drinks per occasion: Typical norms: 0.18 (1 month), 0.15 (12 month) Sex norms: −0.09 (1 month), −0.10 (12 month) BASICS: 0.05 (1 month), 0.03 (12 month) Frequency of drinking days: Typical norms: 0.20 (1 month), 0.08 (12 month) Sex norms: 0.13 (1 month), 0.09 (12 month) BASICS: 0.04 (1 month), 0.04 (12 month)	
Larimer et al. [21]	United States	Heavy drinkers	1137	63.2%	Four arms: • Descriptive PNF • Injunctive PNF • Combined PNF • Multi-component PFI (developed by authors)	PNF: P N Multi-component PFI: P L C F N S R I	GN	Not limited in time during 4 weeks	3 months (93%) 12 months (89%)	Drinks per week: Descriptive: 0.23 (3 month),0.25 (12 month) Injuctive: 0.27 (3 month), 0.24 (12 month) Combined: 0.25 (3 month), 0.26 (12 month)	Low

TABLE 1 (Continued)

Article	Country	Target group	Total sample size	% female	Intervention	Components	Gender focus	Access type	% rates[a]	Effect size estimates	Risk of bias
										Multicomponent: 0.23 (3 month), 0.27 (12 month) BAC peak: Descriptive: 0.19 (3 month), 0.21 (12 month) Injuctive: 0.14 (3 month), 0.15 (12 month) Combined: 0.14 (3 month), 0.15 (12 month) Multicomponent: 0.16 (3 month), 0.21 (12 month)	
Leavens et al. [54]	United States	Heavy drinkers	268	61%	Two arms: • Mailed typical strategies feedback • Mailed norm strategies feedback (developed by authors)	Typical PFI: S Norm PFI: N S	GN	Once	1 month (58%)	Drinks per week: −0.06 (typical), −0.05 (norm) Peak drinks per occasion: −0.05 (typical), −0.12 (norm)	Some concerns
Lewis et al. [55]	United States	Heavy drinkers	340	57.6%	Web alcohol-only PNF arm (developed by authors)	P N	GS	Not limited in time	3 months (64%) 6 months (60%)	Drinks per week: 0.27 (3 month), 0.17 (6 month) Drinks per occasion: 0.23 (3 month), 0.14 (6 month) Frequency of drinking days: 0.33 (3 month), 0.15 (6 month)	Low
Miller [56]	United States	Heavy drinkers	191	51%	Three arms: • Mailed norms only PNF • Mailed enhanced PFI	Normative PFI: P N Enhance PFI: P C N S	GS	Once	1 month (57%)	Drinks per week: 0.39 (norms only), −0.02 (enhanced), 0.41 (choice)	High

(Continues)

TABLE 1 (Continued)

Article	Country	Target group	Total sample size	% female	Intervention	Components	Gender focus	Access type	% rates[a]	Effect size estimates	Risk of bias
					• Mailed choice PFI (developed by authors)	Choice PFI: P N + two choice				Drinks per occasion: 0.11 (norms only), −0.16 (enhanced), −0.04 (choice) Frequency of HED: 0.50 (norms only), 0.17 (enhanced), 0.29 (choice) Frequency of drinking days: 0.70 (norms only), 0.37 (enhanced), 0.63 (choice) BAC peak: 0.62 (norms only), 0.26 (enhanced), 0.48 (choice)	
Moreira et al. [57]	United Kingdom	Any university student	1751	61%	Mailed PFI (developed by authors)	P L C F N I	GN	Once	6 months (50%) 12 months (41%)	Proportion of weekly drinking: 0.08 (6 month), 0.11 (12 month) Drinks per week: 0.05 (6 month), 0.08 (12 month) Drinks per occasion: 0.02 (6 month), 0.07 (12 month) Drinking days per month: 0.05 (6 month), 0.11 (12 month) AUDIT: −0.01 (6 month), 0.08 (12 month)	Low
Neighbors et al. [58]	United States	Heavy drinkers	818	57.6%	Four arms: • Single neutral PNF • Repeated neutral PNF	P N	GN GS	At each follow-up	6 months (92%) 24 months (81%)	Drinks per week: Single neutral PNF: −0.19 (6 month), −0.20 (24 month)	Low

TABLE 1 (Continued)

Article	Country	Target group	Total sample size	% female	Intervention	Components	Gender focus	Access type	% rates[a]	Effect size estimates	Risk of bias
					• Single specific PNF • Repeated specific PNF (developed by authors)					Repeated neutral PNF: 0.03 (6 month), −0.02 (24 month) Single specific PNF: −0.03 (6 month), −0.01 (24 month) Repeated specific PNF: −0.13 (6 month), 0.07 (24 month) Frequency of HED: Single neutral PNF:-0.11 (6 month), −0.17 (24 month) Repeated neutral PNF: 0 (6 month), −0.10 (24 month) Single specific PNF: −0.07 (6 month), 0 (24 month) Repeated specific PNF: −0.09 (6 month), 0.08 (24 month)	
Palfai et al. [59]	United States	Any university student	1336	70.9%	Web PFI (developed by authors)	P L C N S R I	GS	Once	5 months (53%)	Drinks per week: 0.01 Frequency of HED: 0.04	Some concerns
Paulus et al. [60]	United States	Hazardous drinkers	125	76.8%	Web PFI (developed by authors)	P N S I	GS	Once	1 week (84%) 1 month (70%) 3 months (67%)	AUDIT-C score: 0.02 (1 week), 0.15 (1 month), 0.30 (3 month)	Low
Pischke et al. [26]	Germany	Any university student	4463	59.0%	Web PNF (developed by authors)	P N	GS	Once	5 months (28%)	Estimation of drinks per week: 0.17	Some concerns
Riordan et al. [27]	New Zealand	Any university student	524	68.1%	Web PFI (developed by authors)	P L C F N S I	GS	Once	4 months (92%) 8 months (90%)	Drinks per week: 0.01 (4 month), −0.04 (8 month)	Low
Scharer [61]	United States	Heavy drinkers	225	47.7%	Web standard PFI (commercial program)	P L C F N S R I	GN	Once	1 month (62%)	Drinks per week: 0.27 Peak drinks per occasion: 0.26	Some concerns

(Continues)

TABLE 1 (Continued)

Article	Country	Target group	Total sample size	% female	Intervention	Components	Gender focus	Access type	% rates[a]	Effect size estimates	Risk of bias
Thompson et al. [62]	Canada	Current drinkers	245	66%	Web PFI (commercial program)	P L C F N	GN	Once	3 months (61%) 5 months (58%)	'Drinks per week': −0.02 (3 month), 0.11 (5 month) Frequency of drinking (no. weeks): 0 (3 month), 0.13 (5 month)	Some concerns
Walters et al. [63]	United States	Heavy drinkers	136	64.2%	Web PFI (developed by authors)	P L C N S R I	GN	Once	3 months (90%) 6 months (85%)	Drinks per week: −0.11 (3 month), 0.06 (6 month) BAC peak: 0.05 (3 month), 0.19 (6 month)	Low
Young et al. [22]	United States	Heavy drinkers	124	70.4%	Web PNF only (developed by authors)	P N	GS	Once	1 month (68%)	Drinks per week: 0.13 Peak drinks per occasion: 0.08	Some concerns

Note: Target group definitions: *heavy drinkers*: students that consume at least four drinks (for women) or five drinks (for men) on one occasion; *hazardous/harmful drinkers*: students that score on the Alcohol Use Disorders Identification Test (AUDIT) ≥6 for women/≥8 for men; *current drinkers*: students that report any alcohol use; *any university student*: both drinkers and non-drinkers.

Abbreviations: AO, assessment only; AM, attention-matched; AUDIT, Alcohol Use Disorders Identification Test; BAC, blood alcohol concentration; C, practical costs; F, risk factors; GN, gender-neutral; GS, gender-specific; HED, heavy episodic drinking; I, educational information L, level of intoxication; N, normative comparisons; P, patterns of alcohol use; PFI, personalised feedback interventions; PNF, personalised normative feedback; R, available resources; S, protective behavioural strategies.

[a]% rates at post-intervention and last follow-up time-points.

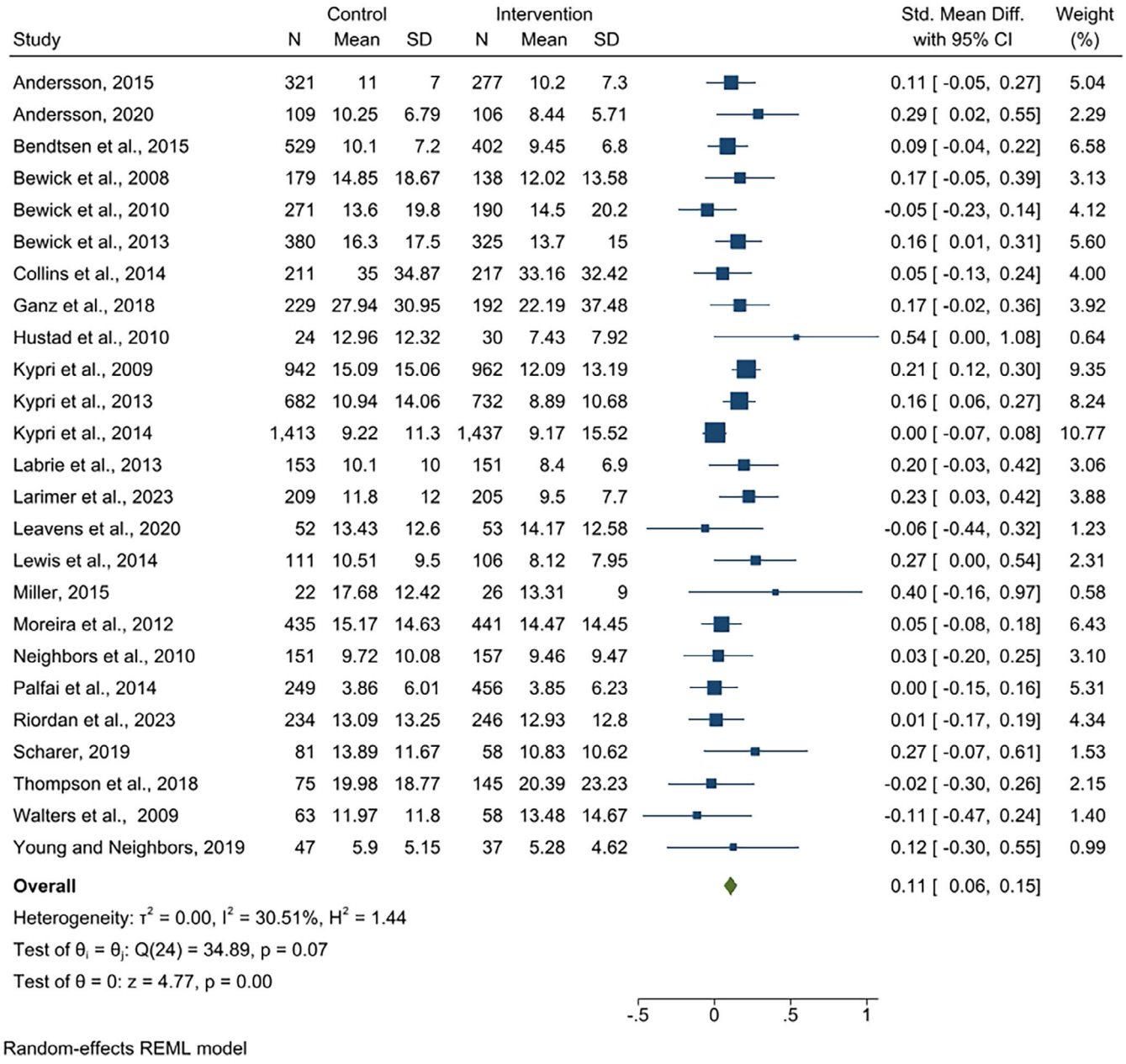

FIGURE 2 Effectiveness of web PFI on drinks per week at post-intervention between-groups.

3.4 | Meta-analysis

The results of the meta-analysis are presented as forest plots (Figures 2 and 3). These graphs include the SMDs and 95% CIs for each study and the pooled effects and heterogeneity estimates. At post-intervention time-point, as shown in Figure 2, the pooled SMD showed a small but significant reduction of drinks per week in the PFI group compared to the control groups (SMD = 0.11, 95% CI 0.06, 0.15), with low heterogeneity ($I^2 = 30.51\%$, $p = 0.07$). At the last follow-up period, 14 studies were meta-analysed, showing again smaller but significant effect in favour of the PFI group (SMD = 0.09, 95% CI 0.02, 0.15). Heterogeneity was also low ($I^2 = 26.79\%$, $p = 0.24$).

Figure S1 displays the meta-analysis forest plots of secondary alcohol outcomes.

3.5 | Subgroup analysis

Figure S2 presents all the forest plot graphics of the subgroup meta-analysis.

3.5.1 | By gender focus

Studies were categorised as 'gender-specific' if the normative reference group was matched by gender, and

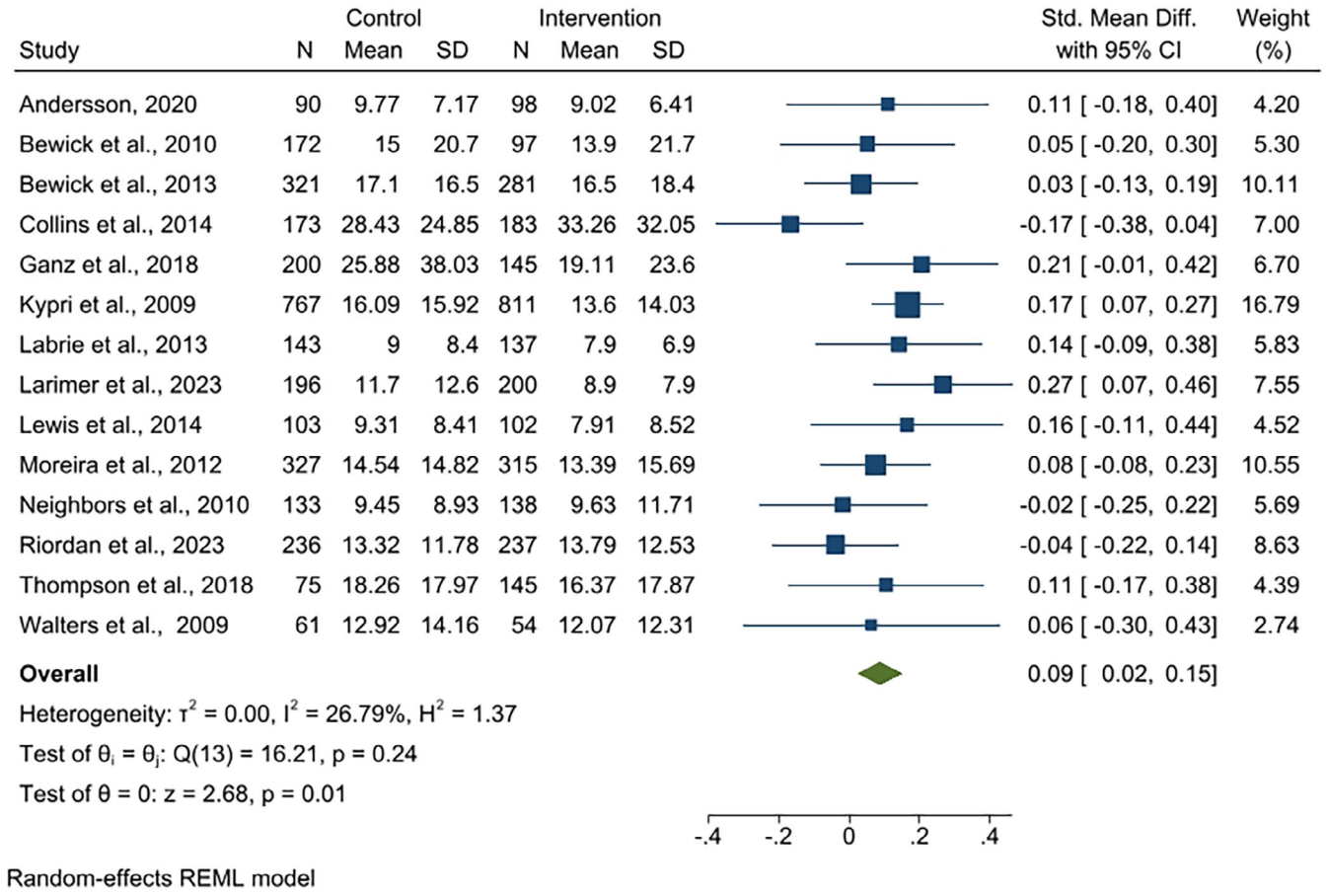

FIGURE 3 Effectiveness of web PFI on drinks per week at last follow-up between-groups.

'gender-neutral' when it was not matched by gender. At post-intervention, the overall effect of 'gender-neutral' PFIs ($n = 13$) showed a significant, small reduction in drinks per week, favouring the intervention group (SMD = 0.10, 95% CI 0.04, 0.16). The overall effect for 'gender-specific' PFIs ($n = 12$) was also significant and slightly higher (SMD = 0.12, 95% CI 0.05, 0.18). However, the test for subgroup differences was not significant ($chi^2 = 0.12$, $p = 0.73$).

Subgroup analyses for the last follow-up time-point also showed significant effect for gender-neutral PFIs ($n = 9$; SMD = 0.10, 95% CI 0.03, 0.17) but not for gender-specific PFIs ($n = 5$; SMD = 0.05, 95% CI −0.09, 0.18). Similarly, there were no significant differences between groups ($chi^2 = 0.50$, $p = 0.48$).

3.5.2 | By intervention content-type

Studies were categorised based on the components covered: 'pure PNF' refers to those PFIs including only normative comparison, whereas 'multicomponent PFI' refers to studies that include more elements. At post-intervention, for 'pure PNF' ($n = 4$), there was no significant overall effect (SMD = 0.13, 95% CI 0.00, 0.26), whereas for multicomponent PFIs ($n = 21$) there was a significant small effect (SMD = 0.10, 95% CI 0.06, 0.15). The test for subgroup differences was not significant ($chi^2 = 0.11$, $p = 0.74$). Subgroup analyses for the last follow-up showed, similarly, no significant effect for 'pure PNF' ($n = 3$; SMD = 0.09, 95% CI −0.05, 0.23). For multicomponent PFIs there was a significant small effect ($n = 11$; SMD = 0.08, 95% CI 0.01, 0.16). However, the test for subgroup differences was not significant ($chi^2 = 0.01$, $p = 0.93$).

3.5.3 | By type of accessibility

Studies were compared based on the students' ability to access and receive the personalised feedback; the category 'once' was used for studies where students had one-off access, whereas 'not limited in time' for those where participants had more opportunities. At post-intervention, the overall effect of 'once' PFIs ($n = 16$) showed a significant, small reduction in drinks per week in favour of the

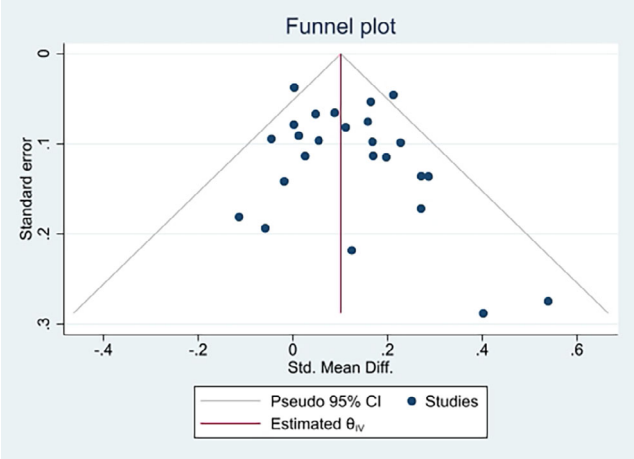

FIGURE 4 Funnel plot at post-intervention effect sizes.

intervention group (SMD = 0.07, 95% CI 0.02, 0.12). The overall effect for 'not limited in time' PFIs ($n = 9$) was in the small to medium range (SMD = 0.16, 95% CI 0.09, 0.22). Overall, there was a significant difference found in the ES between these two subgroups ($chi^2 = 4.10$, $p = 0.04$). Subgroup analyses for the last follow-up time-point showed, in this case, no effect for 'once' PFIs ($n = 7$; SMD = 0.05, 95% CI −0.05, 0.15). For those PFIs with no limitations in time, there was a small but significant overall effect ($n = 7$; SMD = 0.13, 95% CI 0.05, 0.20). Contrary, the test for subgroup differences was not significant ($chi^2 = 1.63$, $p = 0.20$).

3.6 | Moderator analyses

We conducted meta-regressions to explore the relationship between the magnitudes of the study ESs and the variables identified a priori. At post-intervention, these moderator analyses were non-significant for all variables studied, except for accessibility (coefficient = 0.084; $p = 0.043$), which showed a statistically significant positive relationship. At the last follow-up time-point, none of the potential moderators were statistically significantly associated with study-specific ESs (see Table S4).

3.7 | Sensitivity analyses

In sensitivity analyses, in which we excluded the two studies deemed to have 'high' risk of bias at post-intervention, the SMD remained significant, suggesting a small difference in drinks per week, favouring the intervention group (SMD = 0.10, 95% CI 0.06, 0.15). Heterogeneity was unchanged ($I^2 = 33.45\%$; $chi^2 = 33.16$, $p = 0.06$). Sensitivity analyses at the last follow-up time-point showed, after excluding one study with 'high' risk of bias, that the pooled ES remained similar (SMD = 0.09, 95% CI 0.02, 0.06).

3.8 | Publication bias

A funnel plot was developed to test for publication bias. Figure 4 shows symmetry at post-intervention, which was confirmed by Egger's regression-based test for small-study effects at both post-intervention and last-follow-up time-points ($p = 0.304$ and $p = 0.711$, respectively). These results confirm the absence of publication bias in the literature, suggesting robustness of the findings.

4 | DISCUSSION

This systematic review and meta-analysis contribute to and expand current international knowledge on the effectiveness of web-based standalone PFI, specifically delivered in non-structured settings and compared to non-active controls, at decreasing alcohol use among university students. Quality assessment indicated low risk of bias for most of the included studies, which enhance the strength and trustworthiness of the evidence generated.

Overall, this review provides evidence that supports the effectiveness of PFI in the reduction of university students' alcohol use across a range of measured outcomes, such as quantity and frequency of drinking, although ESs tended to be smaller than 0.20 compared to controls. Reductions across all reported variables were observed at post-intervention and last follow-up, with the effect magnitude diminishing over longer assessment intervals. Previous reviews [19, 64] have found similar ESs for PFIs targeted at college students.

Findings from our meta-analysis largely show a small but significant effect in the number of drinks consumed by university students per week, equivalent to a decrease of 1.65 drinks. This indicates that web PFI delivered in non-structured settings is an effective standalone approach for decreasing university students' drinking relative to controls in the short-term. These overall results are in line with previous meta-analyses [31, 64–66], adding to the growing pool of evidence that standalone web PFI can help students decrease their alcohol consumption. In addition, our findings are consistent with other meta-analyses targeting young adults where web PFI are completed in different sites, such as emergency room, or primary health care [67], which include computerised PFI compared with active controls in the university context [3, 68]. Moreover, the modest significant ESs we identified seem to be aligned with other brief interventions which are more

intensive or face-to-face, such as phone-delivered brief motivational intervention (ES = 0.04) [31] or cognitive behavioural therapy (ES = 0.13) [67]. This review highlights the advantages of interventions delivered remotely, being a feasible option due to easier dissemination, greater reach and lower cost [19]. This is also supported by Dotson et al. [3] whose meta-analysis concluded that there is a similar impact between structured and unstructured PNFs. Nevertheless, it is important to consider the risks of non-structured interventions as students can be distracted when completing them, highlighting the need of designing interventions that garner engagement.

Regarding subgroup analyses, this study yielded results suggesting that web-based PFI with a gender-specific approach, including multiple content components, and with unlimited access for participants, are more effective in addressing alcohol use in the short-term, although ESs were very similar among comparative groups. Discussing the gender focus, our findings are coherent with several social-norms approach theories (Social Comparison Theory or Social Impact Theory) which suggest that information pertaining to more socially proximal referents should have greater influence on one's behaviour compared with more socially distal referents [69]. Nevertheless, it is important to point out that there were no significant differences compared to gender-neutral PFIs, in line with the findings of Dotson et al. [3]. Further qualitative research would help to clarify this issue. Our results are also in line with a meta-analysis by Saxton et al. [11], who concluded that pure PNF and mixed PFI had similar ESs, but reporting significant findings for multicomponent feedback interventions for the medium-term follow-up period (4–11 months). On the contrary, Larimer et al. [21] did not find significant differences at any follow-up, although multicomponent PFIs were associated with students' lower perceived social norms than pure PNF. Nevertheless, our results should be interpreted with caution as there were fewer pure PNF studies than multicomponent PFI studies, and it is not possible to draw firm conclusions.

Our meta-analysis showed that the overall effect of PFI decreases at the last follow-up, although ESs still remain significant in favour of the intervention group. Specifically, the ES was equivalent to a reduction of 1.54 drinks consumed per week. After stratifying by subgroups, unlimited access PFIs seem to have slightly longer lasting effects, favouring significantly the intervention groups, but the small beneficial effect of gender-specific PFI disappeared. In terms of type of content, effect magnitude from both pure PNF and multicomponent PFIs also decreased, still remaining the absence of significant differences when comparing each other. The overall reduction in effects that we observed aligns with the findings from other meta-analyses [11, 65, 67]. Weakening effects are expected due to the brief nature of PFI, yet they highlight the potential advantages of recurrent interventions for maintaining long-term behaviour change [11]. This is confirmed by our results when analysed by type of access by participants to the feedback: unlimited access PFI had a more significant and enduring effect, showing a significant difference relative to those studies in which participants accessed feedback once. This finding could be explained due to the increasing opportunities to delve deeper into the content [70]. Students may need multiple sessions to view feedback in its entirety, and to return to the feedback for a more detailed and careful review because of the distractions when viewing online interventions. Therefore, web-based PFIs should allow long-term and sustained access so that participants can return when needed [70]. In addition, future research should analyse the impact of booster sessions and other strategies to maintain treatment effects over longer-time periods. In this regard, including components such as students' alcohol consumption, consequences, or strategies to moderate their drinking [71], and those of more interest to students [13, 70], can enhance the effectiveness in the long-term.

Finally, it is important to note that although our meta-analysis was based on drinks per week, which was the common metric across studies, it may not be the best measure of drinking outcomes among university students, which typically consist of binge drinking episodes. Reporting the actual number of drinks per binge drinking episode would be more appropriate [3, 72]. In addition, this meta-analysis has been conducted following a series of decisions (such as excluding articles when authors did not respond to requests for estimates for ES calculation; prioritising PFIs with the strongest evidence when multiple PFI arms were examined; or giving preference to normative reference group arms based on gender over those focused on other students referents), which affects the representativeness of the included investigations compared to the population of studies in the PFI field. This needs to be taken into account when interpreting the results.

4.1 | Implications for practice and policy

PFIs have potential benefits at both policy and practice levels, and are clinically relevant when examined from a public health perspective. Despite being associated with small ESs, PFIs are potentially worthwhile interventions for implementation in university settings given their brevity and low cost [67]. In this regard, brief interventions are not typically intended as full treatments

expected to produce sustainable change, but as a precursor to further intensive interventions aimed to prompt motivation and engagement, providing individuals with resources to manage their behaviours [11, 67]. Thus, stand-alone PFIs might be more suitable in raising awareness and providing initial, low-threshold advice for students, but are less appropriate to 'treat' students with heavy drinking patterns or with alcohol use disorders. These would need more intensive programs, such as peer-motivational interviewing that have demonstrated to be effective for reducing alcohol use and related consequences among university students who engage in binge drinking [73].

Additionally, the recent cost-effectiveness study by Vargas-Martinez et al. [74], which focused on web-based computer-tailored intervention for prevention of binge drinking among Spanish high-school students, provides useful insight to the true value of implementing this type of intervention. They estimated the cost per month at €16.63 from the National Health System perspective, which from the societal perspective resulted in savings of €7986.37. Considering the higher accessibility, dissemination and greater reach of PFIs, there are clear benefits for public health.

The evidence is clear about the time-limited effect of PFI. In addition to the briefness of this type of intervention, one reason could be the low level of perceived importance among university students' to change their consumption, which is considered a predictor of change [75, 76]. Future studies which include related content components are needed to explore the potential enhancement of long-term effects. Conversely, our results show that the frequency of accessing the feedback is a factor influencing the success of the PFI in the long term. This is in line with the increasing research about booster interventions [77, 78] which could be a viable option for PFI as they are not time consuming.

4.2 | Limitations

This systematic review and meta-analysis had some limitations. Firstly, despite 25 studies being included in the meta-analysis, subgroup analyses included a small sample of studies, limiting the extent to which the effect of different PFI could be compared. Secondly, last follow-up time-points varied notably across studies, making comparison challenging and results must be interpreted accordingly. Thirdly, our review was limited to English language articles, which could lead to missing key studies. Fourthly, participants' alcohol use was self-reported. The recent development of valid and reliable wearable technology may be an affordable option for measuring blood alcohol levels [79], enhancing the efficacy of PFI as it would be based on a more accurate measurement. Finally, this work has been conducted using aggregate data of a count variable, which may be over-dispersed and zero-inflated, potentially leading to biased conclusions [80]. Future meta-analyses in the field of PFIs should incorporate more advanced analytical methods, such as the two-step meta-analysis of individual participant data. It would permit checking and ensuring data accuracy, and examining the robustness of intervention effects across different participants and settings, making the estimates more precise and reliable [81].

5 | CONCLUSION

In conclusion, the review offers an empirical summary of web-based standalone PFIs for university students' drinking delivered in non-structured settings, and provides a foundation for future research. The findings support the effectiveness of PFIs for addressing alcohol in the short-term, and to a lesser extent in the long-term. Findings of the meta-analysis suggest that specific-gender, multicomponent PFI, and with unlimited access are slightly more enduring than gender-neutral PFI, pure PNF studies, with one-off access, though effect sizes were very similar, and only a few studies were meta-analysed. While all the significant ES were modest, they were in line with those of more costly face-to-face interventions. Thus, web-based standalone PFIs are worth pursuing given their brevity, easy dissemination, lower cost and time-consuming, and university students' preference for this type of intervention.

AUTHOR CONTRIBUTIONS

Each author certifies that their contribution to this work meets the standards of the International Committee of Medical Journal Editors.

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CONFLICT OF INTEREST STATEMENT

No conflict of interest has been declared by the authors.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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