Cost-effectiveness and cost-utility analysis of a web-based computer-tailored intervention for prevention of binge drinking among Spanish adolescents

Ana Magdalena Vargas-Martínez
Universidad de Sevilla

Marta Lima-Serrano (mlima@us.es)
University of Seville https://orcid.org/0000-0003-3909-2718

Marta Trapero-Bertran
Universitat Internacional de Catalunya

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Abstract

Background

Worldwide, binge drinking (BD) today follows being a public health concern among adolescents. This study sought to assess the cost-effectiveness and cost-utility of a web-based computer-tailored intervention to prevent BD in adolescence.

Methods

The sample was drawn from a study evaluating the *Alerta Alcohol* programme. The population consisted of adolescents aged 15–19. Decision tree analysis was used to estimate costs and health outcomes, as measured by number of BD occasions and quality-adjusted life years (QALYs). Incremental Cost-Effectiveness and Cost-Utility Ratios were also calculated from National Health Service (NHS) and societal perspective and for a time horizon of four months. Multivariate deterministic sensitivity analysis of best/worst scenarios by subgroups was used to account for uncertainty.

Results

The intervention was dominant from the societal perspective resulting in savings of €7,986.37 by one BD occasion averted per month. With regard to Incremental Cost-Utility Ratios, the intervention resulted in an incremental cost of €71.05 per QALY gained from NHS perspective and this was dominant, from societal perspective, resulting in savings of €34,126.64 per QALY gained in comparison with the control group. Subgroup analyses showed that the intervention resulted dominant for girls from both perspectives, and for those who were older (17 years or more) from NHS perspective.

Conclusion

Computer-tailored feedback is a cost-effective way to reduce BD and to increase QALYs among adolescents. However, long-term follow-up would probably be needed to capture major changes both in reduction of BD and in increasing of health-related quality of life.

Trial registration

(ClinicalTrials.gov): NCT03288896. Registration date: September 20, 2017. “Retrospectively registered”.

Background

Globally, alcohol was responsible for 17.6% of all injury deaths and for 7.2% of all premature mortality in 2016 [1]. Worldwide, this proportion was highest among people aged 20 to 39 (13.5%) [1]. Europe was the region with the highest proportions of deaths attributable to alcohol consumption in all age groups, with the highest percentage (27%) occurring in the group aged 25 to 29 years and over 15% occurring among adolescents aged 15–19 [1].

Worldwide, more than a quarter of all adolescents aged 15 to 19 are current drinkers (26.5%) [1]. Although European adolescents drink less than the general population (43.8% are current drinkers, versus 59.9% of the general population), by the age of 20 to 24 years, drinking behaviour is close to that of the total population (58.4%) [1].

Moreover, young people tend to consume larger amounts of alcohol per occasion than adults [2]. Heavy episodic drinking (HED) (defined as drinking five or more drinks, 60 or more grams of pure alcohol, on at least one occasion at least once per month) among young people aged 15 to 19 years is particularly prevalent in Europe (24.1%) [1]. Despite reductions in HED among adolescents (15–19 years old) in Europe from 2000 (35.1%) to 2016 (24.1%), according to the WHO *Global Status Report on Alcohol and Health 2018*, levels of consumption remain dangerously high, and HED among adolescents continues to be a major public health concern [1].

“Binge drinking” (BD), another term for HED, has been defined as consuming five or more standard drinks per occasion for men and four or more drinks for women on the same occasion [3]. In the countries and regions of Europe and North America, prevalence of BD increases sharply in adolescence and peaks in early adulthood (around the age of 20–25) reaching almost 40% [4]. Subsequently, prevalence rates decrease with age. Surveys on drug and alcohol use among adolescents in secondary education in Spain (ESTUDES, 2016–2017) have shown high prevalence of BD among adolescents aged 14–18 (31.7%). [5]

A scarcity of literature in relation to the economic consequences (healthcare and non-healthcare costs) of BD in particular is found. In the European Union, alcohol-attributable costs in the general population were estimated at €125 billion in 2003 [6]. We did not find any studies related specifically to costs associated with BD and underage drinking in Europe. However, previous work has shown that youthful drinkers are at greater risk of involvement in youth violence, low educational attainment and low college expectations, putting a financial burden on the criminal justice system and the education sector [7–8]. In addition to these consequences, Böckerman et al [9] discovered a negative association between BD, in particular, and months of employment, and subsequently also with long-term adverse long-term labor market outcomes. The foregoing suggests a need to intervene to change young people’s behaviour in relation to BD. Nowadays, a variety of interventions have been developed to tackle this public health issue (adolescent substance use) but those aimed at preventing BD specifically are scarce [10–12]. Regard to alcohol use prevention in general, a meta-analysis carried out by MacArthur et al. (2015) to investigate and quantify the effect of peer-led interventions to prevent tobacco, alcohol and/or drug use among young people concluded that such interventions may be effective, although the evidence base is limited overall and is characterized by small studies of low quality [13]. A Cochrane systematic review carried out by Foxcroft and Tsertsvadze (2011) examined evidence on the effectiveness of universal school-based prevention programmes concluding that as small effects can provide important cost benefits for prevention programmes, studies should have sufficient statistical power to detect small effects [14].

Many international and national interventions have sought to prevent alcohol use among adolescents, but their cost-effectiveness has seldom been assessed, nor has the efficiency of the interventions been evaluated [7, 15, 16]. In a context of budget constraints, it seems important to study the cost-effectiveness of interventions in order to better inform health decision-making. In particular, there is a need to evaluate the cost-effectiveness of different interventions that are being, or could be, implemented to tackle the problem of BD among adolescents. In addition, World Health Organization (WHO) (2018) stablished as a priority goal to make efforts aimed at reducing “binge drinking” in populations, particularly among young people [1].

The aim of this current study was to analyse the cost-effectiveness and cost-utility of *Alerta Alcohol*, a web-based computer-tailored intervention for the prevention of binge drinking among adolescents aged 15 to 19 in Andalusia, Spain.

Methods

Design, population and sample

The sample was part of a two-arm cluster randomized controlled trial that evaluated an intervention aimed at reducing binge drinking among adolescents (aged 15–19) in Andalusian secondary schools through a web-based computer-tailored programme known as *Alerta Alcohol* (more information about the design of the study may be found in Lima-Serrano et al. (2018) [17]). A total of 1,247 adolescents from 15 public high schools were assessed at baseline (January-February, 2017) and 612 adolescents at 4-month follow up (May-June, 2017). However, because the collection of cost data began later in time, we only had complete data on effectiveness and costs for 367 adolescents that were included in this economic evaluation analysis.

Figure A1 (*see* Additional file 1) shows a flowchart with the number of participants at baseline and follow-up according to Consolidated Standards of Reporting Trials (CONSORT).

Intervention and comparator

Alerta Alcohol programme provided feedback through preventive messages and personalized information about the benefits of not consuming alcohol, with the aim of reducing positive attitudes about and excessive consumption of alcohol, while also assessing social influences and self-efficacy. The tailored messages were based on the I-change model, which integrates elements of various models of social cognition and self-regulation, and assumes that behaviour is the result of the individual’s intentions, action plans and abilities [18–20]. This intervention comprised six sessions. In initial session or first session, participants completed a baseline questionnaire which elicited information on demographics, alcohol use behaviours, mediator variables such as motivational determinants (attitude, social influences, self-efficacy) and cost measures (healthcare and non-healthcare costs). The EQ-5D-5L questionnaire was used to measure health-related quality of life (HRQOL). This initial session was followed by presentation of three different scenarios (sessions 2–3) existing a 1–2-week period between sessions, a fourth session in which adolescents could accept the challenge of not consuming excessive alcohol at an upcoming event, a fifth session to evaluate the response to the challenge and a sixth session, scheduled four months after the first session, to evaluate the intervention. The follow-up questionnaire included the same items that the baseline questionnaire except for the demographic variables. The control group received only the baseline questionnaire and a follow-up questionnaire (sessions 1 and 6) not receiving any active intervention in between.

Model

A cost-effectiveness (CEA) and a cost-utility analysis (CUA) were carried out in order to evaluate the efficiency of the *Alerta Alcohol* programme compared with not engaging in any active intervention. A decision tree was developed consisted of three situations: the adolescent reduces, maintains or increases the number of BD occasions in the last 30 days (Fig. 1). Each arm of the decision tree resulted in health outcomes and costs. The health outcomes were, for the CEA, the mean of the difference between the number of BD occasions in the last 30 days in the post-intervention and pre-intervention periods, and for the CUA, the mean of the difference in QALYs obtained through the EQ utility index.

A time horizon of four months was evaluated, so no discount rate was applied because of the short time horizon. Subgroup analysis was carried out by age, gender and availability of pocket money. All estimates were calculated from the Spanish National Health Service (NHS) perspective as well as from the societal perspective. The two sets of estimates are presented separately and differentiated. Table 1 shows details of the data required to populate the model for costs and health outcomes. The analysis was conducted using Stata version 14.0 (StataCorp, College Station, TX, USA) and Microsoft Excel version 16.16.5.

Table 1
Parameters for populating the model (€2017), data are only for subjects included in economic evaluation (n = 367)

Type of costs		Intervention group (n = 210)						Control group (n = 157)				
		Pre-intervention			Post-intervention			Pre-intervention			Post-interventio	
		n	Mean (SD) (€2017)	Min-max	n	Mean (SD) (€2017)	Min-max	n	Mean (SD) (€2017)	Min-max	n	Mean (SD) (€2017)
Outcome measures												
Number of BD occasions		210	1.08 (1.86)	0–10	210	0.97 (1.81)	0–10	157	1.17 (2.08)	0–10	157	1.11 (2.24)
EQ utility index		190	0.94 (0.10)	0–1	175	0.96 (0.09)	0–1	135	0.92 (0.15)	0–1	144	0.94 (0.12)
Direct healthcare costs (DHC)												
Hospital stay due to binge drinking	Yes							1	496 (.)	496–496	1	496 (.)
	No	2	0	0	0			1	0	0	2	0
Hospital stay due to alcohol-induced coma	Yes										1	1827.37 (.)
	No	2	0	0	0			2	0	0	1	0
Emergency visit due to binge drinking (hospital)	Yes	0			0			1	285.66 (.)	285.66-285.66	1	142.83 (.
	No	0			0						1	0
Emergency visit and observation due to alcohol-induced coma (hospital)	Yes	2	388.19 (0)	388.19-388.19	0			2	388.19(0)	388.19-388.19	1	388.19(0
	No										1	0
Emergency visit due to BD (primary healthcare centre)	Yes	2	48.68 (0)	48.68–48.68	1	48.68 (.)	48.68–48.68					
	No										1	0
Emergency visit and observation due to alcohol-induced coma (primary healthcare centre)	Yes	2	109.41 (0)	109.41-109.41	1	109.41 (0)	109.41-109.41					
	No							1	0	0	1	0
Emergency medical transport due to BD	Yes	1	310.14 (0)	310.14-310.14	1	310.14 (0)	310.14-310.14				2	775.35 (657.91)
	No											
Emergency medical transport due to alcohol-induced coma	Yes	2	361.49 (0)	361.49-361.49	1	361.49 (0)	361.49-361.49	1	361.49 (.)	361.49-361.49	1	361.49 (.
	No											
Total direct healthcare costs (NHS perspective)			**1,217.91**			**829,72**			**1,531.34**			**3,991.23**

Type of costs		Intervention group (n = 210)						Control group (n = 157)				
Direct non-healthcare costs (DNHC)												
Traffic accident (injured not hospitalized	Yes	5	13724.08(10250.44)	6238.22-24952.88	5	8733.51 (3416.81)	6238.22-12476.44	6	12476.44 (12476.44)	6238.22-37429.32	4	23393.33 (9357.33
	No	189			175			125	0	0	141	0
Average amount spent per day for the arrest of one person		0			1	58.81 (0)	58.81–58.81				5	164.67 (120.52)
Average cost per student per missed class		2	97 (82.31)	38.8-155.2	4	77.6 (31.68)	38.8-116.4	4	116.4 (70.84)	38.8–194	5	108.64 (57.55)
Direct costs to subject (DCS)												
Price of cigarettes per smoker	Yes	41	51.98(75.82)	3.6–360	38	100.33 (126.74)	3.6–504	18	70 (95.33)	3.6–288	21	112.29 (95.48)
	No	149			145			109	0	0	124	0
Price of shisha (tobacco) per smoker	Yes	56	447.04(558.64)	146.4-3367.2	46	359.63(282.38)	146.4-1317.6	46	579.24 (674.75)	146.4-3074.4	43	708.17 (994.44)
	No	135			138			85	0	0	103	0
Total direct non-healthcare costs + direct costs to subject			**14,320.1**			**9,329.88**			**13,242.08**			**24,487.1**
Societal perspective (DHC + DNHC + DCS)			**15,538.01**			**10,159.6**			**14,773.42**			**28,478.3**
Note: The minimun and maximun values are refered to the observed range.												

Variables

Information on demographics (gender, age, economic situation at home, weekly pocket money, parents´ educational level), alcohol use behaviours, other substances use, and mediator variables such as motivational determinants (attitude, social influences, self-efficacy) were collected through the clinical trial using a questionnaire with the purpose of comparable working the two groups (intervention and control group).

Within demographics variables, the economic situation at home was obtained using the question “Of the following situations, which one would you identify with the most?”. The response options were converted into a dummy variable, which indicated a value of 1 “good economic situation at home” and a value of 0 “other economic situation”. This question was developed ad hoc and used in another study carried out by Lima-Serrano et al. [21].

The weekly pocket money availability was asked by means of the question “How many Euros do you have per week to spend on yourself?” with five response options: 0 €, 1–10€, 11–20€, 21–30€, more than 30 €. Notwithstanding these amounts were recoded into three categories: 0 €, 1–20€ and more than 20 €; due to proportions of each response category. Similar recode was used in the study carried out by Díaz-Geada et al. [22]. Later, for analyses, this variable was converted to a numerical variable using the mean of each response option.

The parents´ educational level was calculated according to the number of schooling years after answering to a question with the following response categories: "No study", "Primary studies", "Baccalaurate/professional training", "University".

In relation to alcohol use, data about the number of BD occasions in the last 30 days, the alcohol use in the last week, family (father, mother and siblings) alcohol consumption frequency, family binge drinking frequency, peer alcohol consumption frequency and peer binge drinking frequency were asked. These questions as well as other variables related to risk perception and mediator variables such as motivational determinants (attitude, social influences, self-efficacy) are part of five scales to measure determinants of BD in Spanish adolescents validated by Lima-Serrano et al. [23].

As regards to other substances use although its frequency of consumption was measured through a self-reported question based on the ESTUDES' questionnaire [5], only costs of cigarettes and shishas were able to obtained from literature review.

Costs

The following direct healthcare and non-healthcare costs related to the *Alerta Alcohol* programme and BD behaviour were identified and measured: (1) intervention costs, (2) direct healthcare costs (i.e., costs for services within the healthcare sector), (3) direct non-healthcare costs (i.e., costs for services outside the healthcare sector), and (4) direct costs to the subject (e.g., costs associated with use of tobacco or other substances) (*see* Additional file 2 - Table A1 for more details).

To aid the comparative quantitative analysis, the mean unit and annual costs were converted to €2017 using country-specific or country-group-specific inflation on average consumer prices. Literature reviews were carried out between 2016 and 2019 and, where necessary, international (Eurostat, DARE, HTA, NHS EED, Pubmed) and national (Official Journal [*Boletín Oficial del Estado*], Health Council of Andalusia) databases were used to acquire data for the model inputs.

Outcome measures

For the CEA, the outcome unit measured was measured in terms of reducing the number of BD occasions in the last 30 days by gender, age and available pocket money. Data was provided by the clinical trial. It was analysed using a two-part model (Table 2).

Table 2
Impact of the *Alerta Alcohol* programme intervention on BD through two-part model (marginal effects), by subgroup

Number of BD occasions	Gender		Age		Pocket money		
	FEMALE	MALE	< 17 years	≥ 17 years	€0	€1–20	>€20
Intervention							
Period[a]	0.190 (0.25)	0.380 (0.26)	0.188 (0.15)	0.649 (0.37)*	0.599 (0.44)	0.153 (0.19)	0.142 (0.56)
Treated[b]	0.234 (0.18)	0.199 (0.16)	0.126 (0.14)	0.322 (0.21)	0.195 (0.27)	0.276 (0.14)*	-0.303 (0.45)
Intervention impact[c]	-0.190 (0.28)	-0.542 (0.29)*	-0.129 (0.20)	-1.076 (0.46)**	-0.583 (0.46)	-0.341 (0.23)	0.041 (0.76)
Adherence to intervention[d]	-0.138 (0.07)**	-0.055 (0.06)	-0.063 (0.06)	-0.134 (0.09)	-0.109 (0.12)	-0.126 (0.05)**	0.066 (0.20)
Socioeconomic							
Age	0.242 (0.06)***	0.277 (0.07)***	0.410 (0.08)***	0.134 (0.11)	0.068 (0.10)	0.314 (0.05)***	0.251 (0.13)*
Female[c]	0.376 (0.37)	0.060 (0.54)	0.045 (0.10)	0.182 (0.22)	0.173 (0.17)	-0.038 (0.11)	0.636 (0.45)
Spanish[f]	-0.014 (0.12)	-0.223 (0.10)**	0.074 (0.33)	0.535 (0.39)	-0.375 (0.56)	0.847 (0.37)**	-0.692 (0.56)
Nuclear family composition[g]	-0.001 (0.00)	-0.004 (0.00)**	-0.089 (0.11)	-0.125 (0.13)	-0.031 (0.16)	-0.143 (0.08)*	-0.002 (0.25)
Mother's schooling years	0.052 (0.10)	0.003 (0.11)	-0.003 (0.00)**	-0.000 (0.00)	0.003 (0.00)**	-0.004 (0.00)***	0.005 (0.01)
Good economic situation at home[h]	0.030 (0.01)***	0.011 (0.01)*	-0.010 (0.09)	0.049 (0.19)	-0.113 (0.21)	-0.011 (0.11)	0.245 (0.36)
Pocket money (weekly)	-0.522 (0.14)***	-0.073 (0.13)	0.013 (0.01)**	0.039 (0.01)***	-0.321 (0.22)	-0.299 (0.13)**	-0.022 (0.40)
Completed questionnaire more days after last weekend[i]	0.005 (0.01)	-0.008 (0.01)	-0.341 (0.10)***	-0.358 (0.21)*	0.001 (0.01)	-0.003 (0.01)	-0.001 (0.02)
Completed questionnaire near to local events			-0.010 (0.00)	-0.000 (0.01)			
Family model							
Family alcohol consumption[j]	0.525 (0.09)***	0.455 (0.10)***	0.405 (0.09)***	0.697 (0.10)***	0.236 (0.23)	0.458 (0.06)***	0.816 (0.26)***
N	1,322	1,172	1,552	942	288	1,764	344
Wald χ^2	182.72	182.72	182.72	182.72	182.72	182.72	182.72
Log likelihood	-1432.04	-1432.04	-1432.04	-1432.04	-1432.04	-1432.04	-1432.04

Note: Average values and standard deviations shown in brackets. ***, ** and * represent the significance level at 1%, 5% and 10%, respectively; 1,000 replications were used for bootstrapping and standard errors were clustered at classroom level.

[a] 1 = post-intervention period 1; 0 = pre-intervention period.

[b] 1 = intervention group; 0 = control group.

[c] The product of the number of subjects who participated in the programme and the difference in the number of BD occasions between the post- and pre-intervention periods.

[d] Adherence to the intervention based on the number of sessions completed.

[e] 1 = female; 0 = male.

[f] 1 = Spanish; 0 = other nationality.

[g] 1 = nuclear family (father, mother and/or brother(s) and sister(s)); 0 = other.

[h] 1 = Good economic situation at home; 0 = other.

[i] Completed questionnaire more days after last weekend: 1 = Completed questionnaire on Wednesday, Thursday or Friday; 0 = Completed questionnaire on Monday or Tuesday.

Number of BD occasions	Gender		Age		Pocket money		
	FEMALE	MALE	< 17 years	≥ 17 years	€0	€1–20	>€20

[j] Family alcohol consumption: 0 = Mother, father and siblings do not binge drink; 1 = Mother or father or siblings binge drink occasionally or more frequently; 2 = Two members of the family (mother, father or siblings) binge drink occasionally or more frequently; 3 = Mother, father and siblings binge drink occasionally or more frequently

For the CUA, the outcome measure was quality-adjusted life years (QALYs), calculated by means of the EQ utility index on the basis of the answers given by the adolescents to the EQ-5D-5L questionnaire. We considered the EQ-5D-5L (adult version) as the appropriate questionnaire version, being this indicated from the age of 15 [24]. In addition, there is no a value set for EQ-5D-Y and then, it interferes with the calculation of QALYs [20]. This index was calculated by using the Spanish value set [25–28].

Presentation of results

The main model outputs used in this analysis were the incremental cost-effectiveness ratio (ICER) and the incremental cost-utility ratio (ICUR). We used the cost-utility threshold for Spain of €21,000 to €24,000 per QALY [29].

Subgroup and sensitivity analysis

Cost-effectiveness and cost-utility analyses were carried out for three subgroups (defined by gender (female/male), age (< 17 years old/≥17 years old) and weekly pocket money (€0/€1 20/>€20)) due to differences found in the literature in these subgroups [7,30–32]. Uncertainty was studied through multivariate deterministic sensitivity analysis of best/worst scenarios by the same subgroups mentioned above.

Results

Sample Characteristics

In relation to socioeconomic characteristics, age at beginning of intervention by group (intervention and control group) was statistically significant, as well as current job situation of the adolescent´s father. In baseline period, there were statistically significant differences in relation to number of glasses of alcohol consumed in outdoor public places and siblings´ BD frequency. In post intervention period, there were statistically significant differences in relation to siblings´ alcohol use frequency, adolescent´s father BD frequency and adolescent´s shishas or hookahs use (see Table 3).

Table 3
Characteristics of the sample in the pre and post intervention period by intervention or control group (n = 367)

	Pre-intervention		Post-intervention	
	Intervention n = 210	Control n = 157	Intervention n = 210	Control n = 157
Socioeconomic				
Age at beginning of programme	16.78 (0.96)	16.36 (0.84)***	0.96 (0.09)	0.94 (0.12)
Being female	0.57 (0.50)	0.49 (0.50)		
Being Spanish	0.97 (0.18)	0.93 (0.26)		
Being Catholic	0.63 (0.48)	0.68 (0.47)		
No religion	0.32 (0.47)	0.26 (0.44)		
Type of family composition: nuclear	0.75 (0.43)	0.73 (0.44)		
Family functionality: APGAR	1.69 (0.57)	1.70 (0.56)		
Years of schooling of the mother	11.32 (3.39)	11.73 (3.00)		
Years of schooling of the father	11.41 (3.15)	11.09 (3.26)		
Current job situation of the mother	0.66 (0.48)	0.76 (0.43)*		
Current job situation of the father	0.83 (0.38)	0.70 (0.46)***		
Good economic situation at home	0.44 (0.50)	0.47 (0.50)		
Economic difficulties at home	0.40 (0.49)	0.30 (0.46)*		
Pocket money (weekly)	10.12 (8.82)	11.66 (9.76)		
Completing questionnaire later in week	0.70 (0.46)	0.64 (0.48)		
		0.91 (0.17)*		
Quality of life (EQ index value)	0.94 (0.10)			
Alcohol consumption				

Note: We show the average values and standard deviations in brackets. ***, ** and * represents statistically significant differences at 1%, 5% and 10% between values of variables in intervention group and control group in pre and post-intervention period (2nd and 3rd columns, 4th and 5th columns, respectively).

	Pre-intervention		Post-intervention	
Number of BD occasions	0.94 (1.67)	1.02 (1.93)	1.05 (2.25)	1.20 (2.78)
Alcohol use over last weekend	0.21 (0.41)	0.20 (0.40)	0.27 (0.45)	0.22 (0.41)
Frequency of alcohol use in public outdoor places	1.42 (2.60)	0.98 (2.22)*	1.07 (2.30)	0.71 (1.81)
"…" at parties or celebrations	1.46 (2.54)	1.77 (2.78)	1.27 (2.42)	1.37 (2.49)
"…" at home or someone else´s home	0.98 (2.25)	1.23 (2.52)	0.63 (1.37)	0.85 (1.94)
Glasses of alcohol consumed in outdoor public places	1.86 (2.24)	1.07 (1.79)***	1.51 (2.27)	1.14 (2.35)
"…" at parties or celebrations	2.56 (2.75)	2.68 (2.76)	2.22 (2.37)	2.34 (2.98)
"…" at home or someone else´s home	1.33 (2.23)	1.56 (2.19)	1.10 (2.01)	1.35 (2.22)
Mother consumes alcohol occasionally/more frequently	0.21 (0.40)	0.24 (0.43)	0.24 (0.43)	0.19 (0.39)
Father "…"	0.42 (0.50)	0.38 (0.49)	0.37 (0.48)	0.35 (0.48)
Siblings "…"	0.19 (0.39)	0.24 (0.43)	0.16 (0.37)	0.25 (0.43)**
Partner "…"	0.17 (0.38)	0.16 (0.37)	0.15 (0.36)	0.13 (0.34)
Friends "…"	0.86 (0.35)	0.82 (0.39)	0.75 (0.43)	0.75 (0.43)
Best friend "…"	0.65 (0.48)	0.57 (0.50)*	0.59 (0.49)	0.50 (0.50)
Mother binge drinks more frequently	0.03 (0.18)	0.06 (0.23)	0.05 (0.21)	0.05 (0.22)
Father "…"	0.15 (0.36)	0.16 (0.37)	0.16 (0.37)	0.09 (0.29)**
Siblings "…"	0.09 (0.29)		0.11 (0.31)	
Partner "…"	0.12 (0.33)		0.10 (0.30)	
Friends "…"	0.72 (0.45)		0.64 (0.48)	
Best friend "…"	0.48 (0.50)		0.49 (0.50)	
		0.16 (0.37)**		0.10 (0.30)
		0.10 (0.30)		0.11 (0.31)
		0.65 (0.48)		0.61 (0.49)
		0.38 (0.49)*		0.40 (0.49)*
Consumption of other substances				
Being smoker or tobacco user (cigarettes or shishas/hookahs)	0.41 (0.49)	0.36 (0.48)	0.36 (0.48)	0.39 (0.49)
Number of cigarettes a week	3.12 (11.37)	2.76 (11.87)	5.79 (19.51)	4.52 (14.8)
Number of shishas or hookahs a week	0.90 (2.48)	1.39 (3.31)	0.61 (1.43)	1.43 (4.27)**
Being cannabis user	0.10 (0.29)	0.12 (0.32)	0.13 (0.34)	0.16 (0.37)
Prescribed tranquilizers, sedatives or sleeping pills	0.02 (0.15)	0.04 (0.19)	0.05 (0.21)	0.06 (0.23)
Not prescribed tranquilizers, sedatives or sleeping pills	0.02 (0.15)	0.02 (0.15)	0.03 (0.17)	0.05 (0.22)

Note: We show the average values and standard deviations in brackets. ***, ** and * represents statistically significant differences at 1%, 5% and 10% between values of variables in intervention group and control group in pre and post-intervention period (2nd and 3rd columns, 4th and 5th columns, respectively).

Table 1 also shows that mean healthcare costs were lower in the intervention group (€829.72) than in the control group (€3,991.23) at the 4-month follow-up point. This difference can be explained largely by the difference in costs of reported hospital stays. Mean direct non-healthcare costs were also lower in the intervention group (€9,329.88) than in the control group (€24,487.1). This difference was mainly related to traffic accidents. Additionally, the number of BD occasions decreased and HRQoL increased in both groups, but the effect was greater in the intervention group than in the control group.

The programme showed a statistically significant reduction in number of BD ocassions in the older group (≥ 17 years). Females and those who had available pocket money of between €1 and €20 showed greater adherence to the intervention and a reduction in number of BD occasions.

Incremental cost-effectiveness and cost-utility ratios (ICERs and ICURs)

ICERs differed from both perspectives. Cost of reducing BD occasions by one per month was €16.63 from the NHS perspective. Notwithstanding, the intervention was dominant from the societal perspective resulting in savings of €7,986.37 by one BD occasion averted per month.

With regard to QALYs gained, the intervention was more expensive but also more effective, resulting in an incremental cost of €71.05 per QALY gained from NHS perspective in comparison with the control condition. From societal perspective, this intervention was dominant resulting in savings of €34,126.64 per QALY gained (see Table 4).

Table 4
ICERs and ICURs and multivariate deterministic sensitivity analysis of best/worst scenarios using the base data for NHS (financier) and societal perspective, w
BD occasions in the last 30 days as the outcome variable (discount rate 0%)

		NHS perspective						Societal perspective				
Subgroups of the sample	Scena-rio	Incre-mental cost (€2017)	Incre-mental effect (number of BD occasions less)	ICER (€2017)	Incre-mental cost (€2017)	Incre-mental effect (QALYs)	ICUR (€2017)	Incre-mental cost (€2017)	Incre-mental effect (number of BD occasions less)	ICER (€2017)	Incre-mental cost (€2017)	Incre-mental effect (QALYs)
Total sample	Best	0.58	0.2656	**2.18**	0.58	0.0336	**17.21**	-903.13	0.2656	**D**	-903.13	0.0336
	Base data	0.58	0.0348	**16.63**	0.579	0.0081	**71.05**	-278.12	0.0348	**D**	-278.12	0.0081
	Worst	0.58	-0.1959	**d**	0.58	-0.0173	**-33.39**	346.89	-0.1959	**d**	346.89	-0.0173
Female	Best	-23.25	0.5013	**D**	-23.26	0.0484	**D**	-964.49	0.3564	**D**	-964.49	0.0358
	Base data	-23.25	0.1685	**D**	-23.25	0.0108	**D**	-379.75	0.1685	**D**	-379.75	0.0108
	Worst	-23.25	-0.1641	**141.69**	-23.25	-0.0269	**-865.88**	298.63	-0.1323	**d**	298.63	-0.0161
Male	Best	11.52	0.2079	**55.37**	11.52	0.0384	**300.23**	-392.05	0.2079	**D**	-392.05	0.0384
	Base data	11.52	-0.1293	**d**	11.52	0.0043	**2,710.92**	-166.88	-0.1293	**1,290.19**	-166.88	0.0043
	Worst	11.52	-0.4666	**d**	11.52	-0.0297	**d**	58.28	-0.4666	**d**	58.28	-0.0297
< 17 years old	Best	3.54	0.1714	**20.68**	3.54	0.0454	**78.15**	-888.46	0.1714	**D**	-888.46	0.0454
	Base data	3.54	-0.0482	**d**	3.54	0.0166	**213.64**	-423.01	-0.0482	**8,777.39**	-423.01	0.0166
	Worst	3.54	-0.2678	**d**	3.54	-0.0122	**d**	42.45	-0.2678	**d**	42.45	-0.0122
≥ 17 years old	Best	-10.40	0.8649	**D**	-10.40	0.0248	**D**	-1,078.73	0.8649	**D**	-1,078.73	0.0248
	Base data	-10.40	0.3030	**D**	-10.40	-0.0244	**426.21**	549.80	0.3030	**1,814.53**	549.80	-0.0244
	Worst	-10.40	-0.2589	**40.18**	-10.40	-0.0736	**141.26**	2,178.33	-0.2589	**d**	2,178.33	-0.0736
Pocket money= €0	Best	5	1.1463	**4.36**	5	0.1344	**37.19**	-437.27	1.1463	**D**	-437.27	0.1344
	Base data	5	0.4650	**10.75**	5	0.0298	**167.53**	33.67	0.4650	**72.42**	33.67	0.0298
	Worst	5	-0.1921	**d**	5	-0.0747	**d**	504.61	-0.1921	**d**	504.61	-0.0747
Pocket money= €1–20	Best	9.86	0.3627	**27.18**	9.86	0.0212	**464.12**	-1,186.30	0.3627	**D**	-1,186.30	0.0212
	Base data	9.86	0.1024	**96.26**	9.86	-0.0074	**d**	-339.42	0.1024	**D**	-339.42	-0.0074
	Worst	9.86	-0.1591	**d**	9.86	-0.0360	**d**	507.46	-0.1591	**d**	507.46	-0.0360
Pocket money= >€20	Best	-40.24	0.8732	**D**	-40.24	0.1352	**D**	-1,199.01	0.8732	**D**	-1,199.01	0.1352
	Base data	-40.24	-0.4454	**90.37**	-40.24	0.0571	**D**	-270.34	-0.4454	**607.02**	-270.34	0.0571
	Worst	-40.24	-1.7639	**22.82**	-40.24	-0.0210	**1,919.20**	658.34	-1.7639	**d**	658.34	-0.0210

Note: "D"=Dominant; "d"=dominated

The positive values for "incremental effect" in relation to number of BD occasions averted refer to reduction of the number of BD occasions in the interventio regards control group, meanwhile the negative values refer to increasing of the number of BD occasions. The positive values for "incremental effect" in relati are refer to increasing of quality of life, meanwhile the negative values refer to decreasing of quality of life.

Subgroup and sensitivity analyses

An analysis by gender was carried out from both perspectives, but the results did not change at decision level from societal perspective when the effect measure used was QALY finding that the intervention was dominant for girls and boys, resulting in savings of €35,332.38 and €39,289.26 per QALY gained, respectively. A difference was noted from NHS perspective, finding that the intervention was dominant only for girls resulting in savings of €2,163.6 per QALY gained, meanwhile for boys, the intervention was cost-effective with an incremental cost of €2,710.92 per QALY gained. For reduction in the number of BD occasions per month, the intervention was dominant for girls resulting in savings for both perspectives. Nonetheless, the intervention did not result effective for boys.

By age, the intervention was dominant from NHS perspective for older adolescents (≥ 17 years), resulting in savings of €34.33 per BD occasion averted, and it could be cost-effective from societal perspective. A difference was noted when the outcome measure used was QALY gained, finding that the intervention was dominant from societal perspective for younger adolescents (< 17 years) with savings of €25,499.25 per QALY gained. In addition, it was cost-effective from NHS perspective with an incremental cost of €213.64 per QALY gained.

In relation to pocket money, the intervention proved more cost-effective for those who had no pocket money using both outcome measures, number of BD occasions averted and QALYs gained. However, some differences were found in those who had a pocket money available between €1 and €20, and those who had more than €20.

The best scenario showed that the intervention could be cost-effective in reducing the number of BD occasions from NHS perspective and dominant from societal perspective. As regards QALYs gained, the best scenario showed its cost-effectiveness from NHS perspective and its dominance from societal perspective (*see* Table 3 and Additional file 3 - Figure A2).

Discussion

To our knowledge, this study is one of the first studies to examine the cost-effectiveness and cost-utility of a web-based intervention carried out among adolescents with the aim of preventing binge drinking in Spain. The intervention showed cost-effectiveness and cost-utility from both NHS and societal perspective, based on the BD occasions outcome measure and QALYs in comparison with no active intervention.

The inferiority of the intervention for certain subgroups could be explained in part by the finding that baseline consumption for these subgroups was relatively low compared with that of their counterparts. For instance, the number of BD occasions in the baseline period for the female subgroup and for the older subgroup (17 and older) was markedly higher than for the male subgroup and for the younger subgroup (under 17 years). The major incremental effect obtained by subgroups in terms of number of BD occasions averted per month was for adolescents who had not weekly pocket money available reaching an incremental effect of 0.465. This fact was also found in the study of Crocamo et al. [30] in which a high pocket money availability was a risk factor for young people in relation to the number of BD episodes. On the other hand, the major incremental effect obtained in relation to QALYs gained was for those had a weekly pocket money of more than €20. In relation this finding, Nur et al. [31] found that young people who received an adequate amount of pocket money (understanding “adequate” similar to high) had a higher score in quality of life, specifically in mental health. Hence, this could explain a better general HRQoL. In addition, the small incremental effect in QALYs could be explained due to heterogeneity found in another studies among binge drinker young people [33–35].

The findings of this study are similar to those of the *Alcohol Alert* study carried out by Drost et al. (2016), in which, from both perspectives, and particularly, the intervention was more cost-effective in reducing the number of BD occasions per month for older adolescents (aged 17–19 years) than for those who were younger than 17 years old [7].

Given the scarcity of literature related to economic evaluations of behaviour change interventions, one of the main strengths of this study is the cost-effectiveness and cost-utility assessment including both the NHS and the societal perspective [36]. It is known that the societal perspective is dominant over other perspectives [32, 37–38]. Nevertheless, both the choice of this perspective and the way in which it was implemented in the design of the study can be considered important strengths. Another strength of our study is the separate reporting of data for subgroups, since the impact of behaviour change interventions might vary according to contextual factors, as noted by Das et al. (2016) [39].

Notwithstanding these strengths, it is necessary to contextualize the results of this study by taking into account the limitations encountered, the first being the low response rate in the follow-up period and, in relation to the cost questionnaire, the failure to include questions related to costs from the beginning of the study. The main cause of missing data for the follow-up questionnaire was early completion of classes by vocational training students (whose classes ended before those of the other participants). Moreover, the date for administering the post-intervention questionnaire fell close to the final examination period in the schools involved, which made it difficult to ensure that all participants completed the questionnaire. It is known that high attrition rates are common in eHealth interventions [40, 41].

A second limitation was that the data collected in the study came from self-reported questionnaires completed by the adolescents and may therefore have been affected by subjectivity. However, previous studies have found that self-reporting of risk behaviours among adolescents and young adults shows good reliability and validity [42–44].

Finally, another important limitation was that short-term behaviour change assessments capture little benefit, so we would need to monitor the effect of this intervention in the long term. However, according to a review of economic evaluations of behaviour change interventions [15], only six studies had longer follow-up periods (up to 5 years).

Conclusions

To conclude, computer-tailored feedback is a cost-effective way to prevent binge drinking in terms of reducing the number of BD occasions and of increasing QALYs among adolescents and especially for specific subgroups of this population. However, in order to capture major changes both in reduction of number of BD occasions and in quality of life and savings in healthcare costs due to a behavioural change intervention, long-term follow-up of the intervention would probably be required. Countries should consider this type of programme to inform the design of public health policies targeting alcohol use among adolescents.

Abbreviations

BD: binge drinking; CONSORT:Consolidated Standards of Reporting Trials; CEA:Cost-Effectiveness Analysis; CUA:Cost-Utility Analysis; HED:Heavy episodic drinking; HRQOL:Health-related Quality of Life; ICER:Incremental Cost-Effectiveness Ratio; ICUR:Incremental Cost-Utility Ratio; NHS:National Health Service; QALY:Quality-adjusted Life Year; WHO:World Health Organization

Declarations

Ethics approval and consent to participate

The study received approval from the Bioethics Committee of Andalusia from the Ministry of Health and Families of Andalusia (Consejería de Salud y Familias de la Junta de Andalucía), contract PI-0031-2014.Written informed consent was obtained from parents and students prior to participation in the study. The questionnaires were self-completed by the adolescents and confidentiality was ensured.

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors’ contributions

MLS, MTB and AMVM made substantial contributions to the conceptualization and design of the study. AMVM contributed to formal analysis and prepared the original draft of the work. MTB and MLS supervised the work. All authors have read and approved the final version of the manuscript.

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Figures

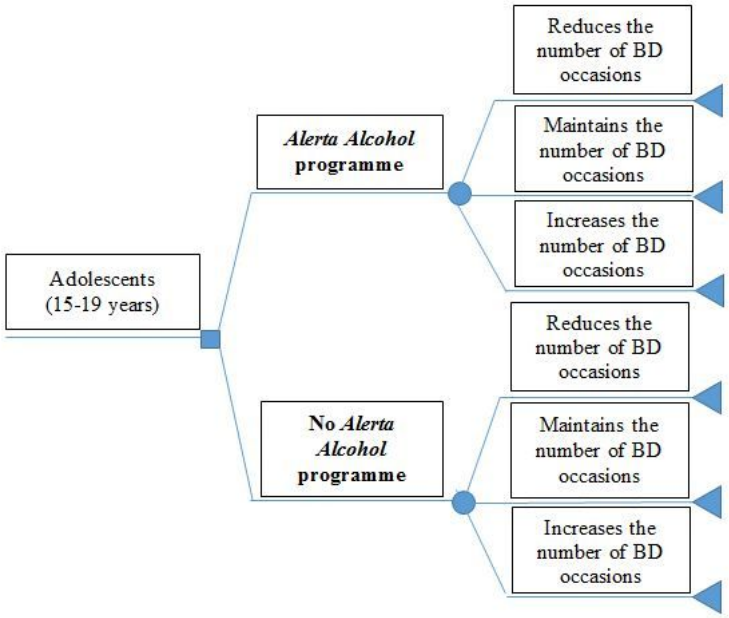

Figure 1

Decision model using the outcome variable "number of BD occasions in the last 30 days"

Supplementary Files

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