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

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## Abstract

**Background:** Binge drinking (BD) among adolescents is a public health concern worldwide. This study assessed 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* program. The population consisted of adolescents 15 to 19 years of age. Data were recorded at baseline (January to February 2016) and after 4 months (May to June 2017) and were used to estimate costs and health outcomes, as measured by the number of BD occasions and quality-adjusted life years (QALYs). Incremental cost-effectiveness and cost-utility ratios were calculated from National Health Service (NHS) and societal perspectives and for a time horizon of 4 months. A multivariate deterministic sensitivity analysis of best/worst scenarios by subgroups was used to account for uncertainty.

**Results:** The cost of reducing BD occasions by one per month was €16.63 from the NHS perspective, which from the societal perspective resulted in savings of €7986.37. From the societal perspective, the intervention resulted in an incremental cost of €71.05 per QALY gained from the NHS perspective and this was dominant, resulting in savings of €34,126.64 per QALY gained in comparison with the control group. Subgroup analyses showed that the intervention was dominant for girls from both the perspectives and for individuals 17 years or older from the NHS perspective.

**Conclusions:** Computer-tailored feedback is a cost-effective way to reduce BD and increase QALYs among adolescents. However, long-term follow-up is needed to evaluate more fully changes in both BD and health-related quality of life.

**KEYWORDS**
adolescents, alcohol, binge drinking, cost-effectiveness, cost-utility, Spain

Trial registration number (ClinicalTrials.gov): NCT03288896

## INTRODUCTION

Globally, alcohol was responsible for 17.6% of all injury deaths and 7.2% of all premature mortality in 2016 (World Health Organization [WHO], 2018). Worldwide, this proportion was highest among people 20 to 39 years of age (13.5%) (WHO, 2018). Europe was the region with the highest proportions of deaths attributable to alcohol consumption in all age groups, with the highest percentage (27%) occurring among people 25 to 29 years of age and over 15% occurring among adolescents 15 to 19 years of age (WHO, 2018).

Moreover, young people tend to consume larger amounts of alcohol per occasion than adults (Substance Abuse and Mental Health Administration [SAMHSA], 2018). 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%, WHO, 2018). Despite reductions in HED among adolescents (15 to 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 (WHO, 2018).

"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 (National Institute on Alcohol Abuse and Alcoholism [NIAAA], 2019). 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 to 25) reaching almost 40% (Kuntsche & Gmel, 2013). Subsequently, prevalence rates decrease with age. Surveys on drug and alcohol use among adolescents in secondary education in Spain (ESTUDES, 2016 to 2017) have shown high prevalence of BD among adolescents aged 14 to 18 (31.7%) (Delegación del Gobierno para el Plan Nacional sobre Drogas [National Plan on Drugs], 2018).

In particular, literature on the economic consequences (healthcare and nonhealthcare costs) of BD is scarce. In the European Union, alcohol-attributable costs were estimated at €125 billion in 2003 (Anderson & Baumberg, 2006). We did not find any studies related specifically to costs associated with BD and underage drinking in Europe. However, previous work has shown that youth drinkers are at greater risk of involvement in violence, low educational attainment, and low college expectations, putting a financial burden on the criminal justice system and the education sector (Drost et al., 2016; Waterman et al., 2019). In addition to these consequences, Böckerman et al. (2017) discovered a negative association between BD and months of employment, and subsequently with long-term adverse labor market outcomes. The foregoing suggests a need to intervene to change young people's behavior in relation to BD. A variety of interventions have been developed to tackle this public health issue, but those aimed at preventing BD specifically are scarce (Anderson-Carpenter et al., 2016; Foxcroft & Tsertsvadze, 2011; Hanewinkel et al., 2017; MacArthur et al., 2015). Khadjesari et al. (2011), in a systematic review about the effects of computer-based interventions aimed at reducing alcohol consumption, concluded that these types of interventions are more effective than minimally active comparator groups (such as generic nontailored information or educational materials, assessment-only) not only at reducing alcohol consumption in both student and nonstudent adult populations but also at reducing the binge frequency in student populations. Among the advantages of this type of computer-based intervention that could be highlighted are the scalability of a public health intervention, the delivery of an individualized approach, increased access to the program, flexibility of use, and the low cost per additional user (Copeland & Martin, 2004; Linke et al., 2007; Murray, 2009). In addition, the other advantages of online intervention over face-to-face intervention for alcohol abuse described in the literature include convenience, easy access, anonymity (given the stigma surrounding alcohol abuse), and ongoing availability (Murray et al., 2013). Tait and Christensen (2010) found that web and brief face-to-face interventions aimed at alcohol-related problems had an almost equivalent effect, but web interventions offer the advantage that they can be applied to a much larger proportion of the target population.

Many international and national interventions have sought to prevent alcohol use among adolescents, but neither their cost-effectiveness has seldom been assessed, nor has the efficiency of the interventions been evaluated (Alayli-Goebbels et al., 2014; Drost et al., 2016; Sumnall et al., 2017). Among these studies, the study by Drost et al. (2016), which assesses the efficiency of the intervention (Jander et al., 2014) and on which our study is based in Dutch population, found that computer-tailored intervention could be a cost-effective measure to target alcohol consumption in adolescence. This intervention is based on the I-change model (de Vries, 2017; de Vries et al., 2005). In the context of budget constraints, it seems important to study the cost-effectiveness of interventions 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, WHO set as a priority goal to make efforts aimed at reducing BD in populations, particularly among young people (WHO, 2018).

The aim of the current study is to analyze the cost-effectiveness and utility of *Alerta Alcohol*, a web-based, computer-tailored intervention to prevent BD among adolescents 15 to 19 years of age in Andalusia, Spain. We compare the *Alerta Alcohol* program to the absence of any intervention. This program, adapted from previously described Dutch program known as *Alcohol Alert*, is a web-based, computer-tailored intervention that addresses the cognitive (e.g., knowledge and risk perception) and motivational factors (e.g., attitude, social influence, and self-efficacy) related to alcohol consumption and BD in adolescents. Furthermore, we provide plans to avoid these risky behaviors (for more information about the study design, *see* Lima-Serrano et al. (2018) and Tables S1 and S2).

## MATERIALS AND METHODS

The structure of this section has been developed following the ISPOR RCT-CEA Task Force Report (Ramsey et al., 2005) for economic evaluations based on a clinical trial. The study adhered to the Consolidated Health Economic Evaluation Reporting Standards (CHEERS) for economic evaluations.

### Trial-related issues

The sample was part of a two-arm cluster randomized controlled trial, with one intervention group and one waiting-list control group, which evaluated an intervention aimed at reducing BD among adolescents (15 to 19 years of age) in Andalusian secondary schools through a web-based computer-tailored program known as *Alerta Alcohol*. A total of 1247 adolescents from 15 public high schools were assessed at baseline (January to February 2017) and 612 adolescents at 4-month follow-up (May to June 2017). However, because the collection of cost data began later in time, complete data were only available on effectiveness and costs for 367 adolescents that were included in this economic evaluation analysis. A detailed description on the pattern of missing data and characteristics of the intervention and control group is provided in a previously published article (Vargas-Martínez et al., 2019).

Figure S1 shows a flowchart with the number of participants at baseline and follow-up according to Consolidated Standards of Reporting Trials (CONSORT).

*Alerta Alcohol* program 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 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, such as Ajzen's Theory of Planned Behaviour, Bandura's Social Cognitive Theory, and Prochaska's Transtheoretical Model, the Health Belief Model and Implementation and Goal setting theories, and assumes that behavior is the result of the individual's intentions, action plans, and abilities (de Vries, 2017; de Vries et al., 2005). This intervention comprised six sessions. In initial session or first session, participants completed a baseline questionnaire, which elicited information on demographics, alcohol use behaviors, mediator variables such as motivational determinants (attitude, social influences, and self-efficacy), and cost measures (healthcare and nonhealthcare costs) (more details in Section 2.2). This initial session was followed by the second and third sessions and a 1- to 2-week period between sessions, which comprise a short story in which the main character wakes up after an evening in which he/she consumed alcohol excessively and does not remember what happened. Those stories take place at home (Session 2), at celebrations (Session 2), and in public places (Session 3). Under these scenarios, questions and tailored messages are offered. In the fourth session, adolescents could accept the challenge of not consuming excessive alcohol at an upcoming event, and in the fifth session, the response to the challenge is evaluated. Finally, a sixth session, scheduled 4 months after the first session, was conducted to evaluate the intervention. The follow-up questionnaire included the same items as the baseline questionnaire, barring the demographic variables. The control group received only the baseline questionnaire and a follow-up questionnaire (Sessions 1 and 6) without receiving any active intervention in between.

### Data for the economic study

A cluster randomized controlled trial-based economic evaluation was carried out along the *Alerta Alcohol* study (Lima-Serrano et al., 2018). Both the baseline and follow-up questionnaires comprised several sections (demographics; alcohol use behaviors; motivational determinants such as attitude, social influences, and self-efficacy; and cost measures such as healthcare and nonhealthcare costs) as mentioned above, which were validated and cross-culturally adapted to Spanish prior to the development of this study (Jander et al., 2014; Lima-Serrano et al., 2017). In addition, these questionnaires include the EQ-5D-5L questionnaire validated in Spain by Garcia-Gordillo et al. (2016). The questionnaires were completed during class in computer classrooms through the intervention website (http://institucional.us.es/alertalcohol/), where each student created a user account. The students were advised by a research technician and under the supervision of a professor. Thus, the economic evaluation was performed with patient-level data extracted from the trial.

The two sets of estimates (from Spanish Health System and societal perspective) are presented separately and differentiated. Table 1 shows details of the data required for evaluating costs and health outcomes.

More details are given below of the data/variables and costs used in this study.

First, we used the reduction in the number of BD occasions over the last 30 days and gains in the number of quality-adjusted life years (QALYs) to assess the primary health outcome or effects of *Alerta Alcohol* program. The results of the primary analysis of the program's effects on the quality of life and alcohol consumption were published before the economic evaluation (Vargas-Martínez et al., 2019).

Independent variables related to alcohol use were collected, such as family (father, mother, and siblings) alcohol consumption, family BD, peer alcohol consumption, and peer BD frequencies. These as well as other variables related to risk perception and mediator variables, such as motivational determinants (attitude, social influences, and self-efficacy), are part of the five scales used to measure the determinants of BD in Spanish adolescents, which were validated by Lima-Serrano et al. (2017).

The QALYs gained were calculated according to the difference between the adolescent's answers to the EQ-5D-5L questionnaire at two different time points (baseline and 4-month follow-up) assuming a linear change in QALY. We considered the adult version of the EQ-5D-5L that assesses one's health-related quality of life (HRQoL),

**TABLE 1** Parameters for conducting the analysis (€2017); data are only for subjects included in the economic evaluation ($n = 367$)

| | Intervention group ($n = 210$) | | | | | | Control group ($n = 157$) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Preintervention | | | Postintervention | | | Preintervention | | | Postintervention | | |
| Type of cost | *n* | Mean (SD) (€2017) | Min to max | *n* | Mean (SD) (€2017) | Min to max | *n* | Mean (SD) (€2017) | Min to max | *n* | Mean (SD) (€2017) | Min to max |
| Outcome measures | | | | | | | | | | | | |
| Number of BD occasions | 210 | 1.08 (1.86) | 0 to 10 | 210 | 0.97 (1.81) | 0 to 10 | 157 | 1.17 (2.08) | 0 to 10 | 157 | 1.11 (2.24) | 0 to 10 |
| EQ utility index | 190 | 0.94 (0.10) | 0 to 1 | 175 | 0.96 (0.09) | 0 to 1 | 135 | 0.92 (0.15) | 0 to 1 | 144 | 0.94 (0.12) | 0 to 1 |
| Direct healthcare costs (DHC)[a] | | | | | | | | | | | | |
| Hospital stays due to binge drinking | | | | | | | | | | | | |
| Yes | | | | | | | 1 | 496 (.) | 496 to 496 | 1 | 496 (.) | 496 to 496 |
| No | 2 | 0 | 0 | 0 | | | 1 | 0 | 0 | 2 | 0 | 0 |
| Hospital stays due to an alcohol-induced coma | | | | | | | | | | | | |
| Yes | 0 | | | 0 | | | 0 | | | 1 | 1827.37 (.) | 1827.37 to 1827.37 |
| No | 2 | 0 | 0 | 0 | | | 2 | 0 | 0 | 1 | 0 | 0 |
| Emergency visits due to binge drinking (BD; hospital) | | | | | | | | | | | | |
| Yes | 0 | | | 0 | | | 1 | 285.66 (.) | 285.66 to 285.66 | 1 | 142.83 (.) | 142.83 to 142.83 |
| No | 0 | | | 0 | | | 0 | | | 1 | 0 | 0 |
| Emergency visits and observations due to an alcohol-induced coma (hospital) | | | | | | | | | | | | |
| Yes | 2 | 388.19 (0) | 388.19 to 388.19 | 0 | | | 2 | 388.19 (0) | 388.19 to 388.19 | 1 | 388.19 (0) | 388.19 to 388.19 |
| No | 0 | | | 0 | | | | | | 1 | 0 | 0 |
| Emergency visits due to BD (primary healthcare center) | | | | | | | | | | | | |
| Yes | 2 | 48.68 (0) | 48.68 to 48.68 | 1 | 48.68 (.) | 48.68 to 48.68 | 0 | | | 0 | | |
| No | 0 | | | 0 | | | 0 | | | 1 | 0 | 0 |
| Emergency visits and observations due to an alcohol-induced coma (primary healthcare center) | | | | | | | | | | | | |
| Yes | 2 | 109.41 (0) | 109.41 to 109.41 | 1 | 109.41 (0) | 109.41 to 109.41 | 0 | | | 0 | | |
| No | 0 | | | 0 | | | 1 | 0 | 0 | 1 | 0 | 0 |
| Emergency medical transports due to BD | | | | | | | | | | | | |
| Yes | 1 | 310.14 (0) | 310.14 to 310.14 | 1 | 310.14 (0) | 310.14 to 310.14 | 0 | | | 2 | 775.35 (657.91) | 310.14 to 1240.56 |
| No | 0 | | | 0 | | | 0 | | | 0 | | |

TABLE 1 (Continued)

| | Intervention group ($n = 210$) | | | | | | Control group ($n = 157$) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Preintervention | | | Postintervention | | | Preintervention | | | Postintervention | | |
| Type of cost | *n* | Mean (SD) (€2017) | Min to max | *n* | Mean (SD) (€2017) | Min to max | *n* | Mean (SD) (€2017) | Min to max | *n* | Mean (SD) (€2017) | Min to max |
| Emergency medical transports due to an alcohol-induced coma | | | | | | | | | | | | |
| Yes | 2 | 361.49 (0) | 361.49 to 361.49 | 1 | 361.49 (0) | 361.49 to 361.49 | 1 | 361.49 (.) | 361.49 to 361.49 | 1 | 361.49 (.) | 361.49 to 361.49 |
| No | 0 | | | 0 | | | 0 | | | 0 | | |
| Total direct healthcare costs (NHS perspective) | | 1217.91 | | | 829,72 | | | 1531.34 | | | 3991.23 | |
| Direct nonhealthcare costs (DNHC) | | | | | | | | | | | | |
| Traffic accidents (injured but not hospitalized) | | | | | | | | | | | | |
| Yes | 5 | 13,724.08 (10,250.44) | 6238.22 to 24,952.88 | 5 | 8733.51 (3416.81) | 6238.22 to 12,476.44 | 6 | 12,476.44 (12,476.44) | 6238.22 to 37,429.32 | 4 | 23,393.33 (9357.33) | 18,714.66 to 37,429.32 |
| No | 189 | | | 175 | | | 125 | 0 | 0 | 141 | 0 | 0 |
| Average amount spent per day to arrest one person | 0 | | | 1 | 58.81 (0) | 58.81 to 58.81 | 0 | | | 5 | 164.67 (120.52) | 58.81 to 294.05 |
| Average cost per student per missed class | 2 | 97 (82.31) | 38.8 to 155.2 | 4 | 77.6 (31.68) | 38.8 to 116.4 | 4 | 116.4 (70.84) | 38.8 to 194 | 5 | 108.64 (57.55) | 38.8 to 194 |
| Direct costs to the subject (DCS) | | | | | | | | | | | | |
| Price of cigarettes per smoker | | | | | | | | | | | | |
| Yes | 41 | 51.98 (75.82) | 3.6 to 360 | 38 | 100.33 (126.74) | 3.6 to 504 | 18 | 70 (95.33) | 3.6 to 288 | 21 | 112.29 (95.48) | 7.2 to 360 |
| No | 149 | | | 145 | | | 109 | 0 | 0 | 124 | 0 | 0 |
| Price of shisha (tobacco) per smoker | | | | | | | | | | | | |
| Yes | 56 | 447.04 (558.64) | 146.4 to 3367.2 | 46 | 359.63 (282.38) | 146.4 to 1317.6 | 46 | 579.24 (674.75) | 146.4 to 3074.4 | 43 | 708.17 (994.44) | 146.4 to 5124 |
| No | 135 | | | 138 | | | 85 | 0 | 0 | 103 | 0 | 0 |
| Total direct nonhealthcare costs + direct costs to subject | | 14,320.1 | | | 9329.88 | | | 13,242.08 | | | 24,487.1 | |
| Societal perspective (DHC + DNHC + DCS) | | 15,538.01 | | | 10,159.6 | | | 14,773.42 | | | 28,478.33 | |

*Note*: The minimum and maximum values are referred to in the observed range.

[a]Questions about direct healthcare costs were answered only by adolescents who were engaged in BD during the last month. In addition, in relation to the questions about visits to the emergency room or hospital stays, adolescents were first asked if they had gone to a health center in general. If they answered "no," they were not asked the subsequent questions about emergency services, hospital stays, and emergency transport. Moreover, this occurred in the case of arrests and absenteeism or missed classes. Therefore, the sample size "*n*" for some cost units is very small (i.e., "0," "1," "2"...).

since it applies to subjects from the age of 15 (Rowen et al., 2020). In addition, there is no set value for EQ-5D-Y, and it interferes with the calculation of QALYs (de Vries et al., 2005). This index was calculated using the Spanish value set (Garcia-Gordillo et al., 2016; Hernandez et al., 2018; Martín-Fernández et al., 2018; Ramos-Goñi et al., 2018).

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

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. (2015).

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 to 10, €11 to 20, €21 to 30, and more than €30. Notwithstanding these amounts were recoded into three categories—0 €, 1 to 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. (2018). 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 a question with the following response categories: "No study," "Primary studies," "High school/professional training," and "University."

As regards to use of other substances (cocaine, nonprescribed tranquilizers, sedatives or sleeping pills and prescribed tranquilizers, sedatives, or sleeping pills), although its frequency of consumption was measured through a self-reported question based on the ESTUDES' questionnaire (Delegación del Gobierno para el Plan Nacional sobre Drogas [National Plan on Drug], 2018), only costs of cigarettes and shishas could be obtained from literature review. Additionally, the other substance use was minimal except for the consumption of cigarettes, shishas or hookahs, and cannabis.

The following direct healthcare and nonhealthcare costs related to the *Alerta Alcohol* program and BD behavior were identified and measured: (1) intervention costs (i.e., initial start-up costs for setting up and installing a database and making it available-TailorBuilder, license fee per project-TailorBuilder, hosting costs for *Alerta Alcohol* project November 2016 to July 2017, research technician for 6 days), (2) direct healthcare costs (i.e., costs for services within the healthcare sector), (3) direct nonhealthcare 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* Table 2 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, Database of Abstracts of Reviews of Effects [DARE], Health Technology Assessment [HTA], National Institute for Health Research Economic Evaluation Database [NHS EED], PubMed) and national (Official Journal [*Boletín Oficial del Estado*], Health Council of Andalusia) databases were used to acquire data for the analysis.

## Methods of analysis

Cluster randomization was used to select the sample, but not to conduct the analyses. This type of randomization is often used among health service researchers, particularly in health promotion trials among children where these are conducted within a school setting by randomizing whole schools and/or full classes to include a new health promotion intervention (Puffer et al., 2005). In addition, cluster randomization is useful to avoid "contamination" between students who receive the program and those who did not, understood as the fact that the intervention group shares information with the control group within the same school, thus resulting in a probable dilution bias (Puffer et al., 2005).

A descriptive analysis of the characteristics of the sample was carried out, and a Wilcoxon–Mann–Whitney test was used to compare the means of the scores between values of variables in the intervention group and control group in the pre- and postintervention period, and Pearson chi-squared test to compare the frequencies. The preintervention period is defined as the baseline period prior to the delivery of the program, and the postintervention period is considered the one after the development of the program; it means 4 months after the start of the intervention.

A cost-effectiveness analysis (CEA) and cost-utility analysis (CUA) were carried out to evaluate the efficiency of the *Alerta Alcohol* program compared with not engaging in any active intervention. The health outcomes were, for the CEA, the difference in mean number of BD occasions in the last 30 days in the postintervention (4 months after baseline) and preintervention (baseline) periods obtained through the aforementioned questionnaire and for the CUA, the difference in mean group QALYs obtained through the EQ utility index. In both analyses, CEA and CUA, the difference in costs between the intervention and control groups was divided by the difference in health outcomes between both groups, resulting in the incremental cost-effectiveness and cost-utility ratio (ICER and ICUR, respectively).

In more details, the outcome unit used for the CEA was measured in terms of reducing the number of BD occasions in the last 30 days by subgroups (gender, age, and available pocket money). Data referring to each subject's BD occasions, as well as the costs and all the measures used in the analyses of this study, were obtained from the main clinical trial. The impact of *Alerta Alcohol* program intervention on BD by those subgroups (gender, age, and pocket money) was analyzed using a two-part model using backward stepwise selection method to

**TABLE 2** Use of resources and direct healthcare and nonhealthcare costs and direct costs to subject

| | | Perspective-type of cost | Unit of measurement | Unit cost (€2017) | Source |
|---|---|---|---|---|---|
| **Societal perspective** | **NHS perspective** | **Intervention costs** | | | |
| | | Initial start-up costs for setting up and installing a database and making it available (TailorBuilder) | | 785.00 | |
| | | License fee per project (TailorBuilder) | | 2350.00 | |
| | | Hosting costs for the *Alerta Alcohol* project November 2016 to July 2017 (35 weeks) | Cost per week | 10.00 | |
| | | Research technician (for 6 days) | Salary | 225.50 | |
| | | **Direct healthcare costs** | | | |
| | | Hospital stay due to BD | Average price per hospitalization/subject | 490.73 | Servicio Andaluz de Salud (2005) |
| | | Hospital stay due to an alcohol-induced coma | Average price per hospitalization/subject | 1827.37 | |
| | | Emergency hospital visit due to BD | Per consultation | 142.83 | |
| | | Emergency hospital visit due to an alcohol-induced coma | Per consultation | 388.19 | |
| | | Emergency primary healthcare center visit due to BD | Per consultation | 48.68 | |
| | | Emergency primary healthcare center visit due to alcohol-induced coma | Per consultation | 109.41 | |
| | | Emergency medical transport due to BD | Per trip or service | 310.14 | |
| | | Emergency medical transport due to alcohol-induced coma | Per trip or service | 361.49 | |
| | **Direct nonhealthcare costs** | | | | |
| | | Traffic accident (injured but not hospitalized) | Per accident | 6238.22 | Dirección General de Tráfico (2016) |
| | | Arrest of one person | Average amount spent per day | 58.81 | Aebi et al. (2016) |
| | | Missed classes at school | Average cost per student per missed class | 38.80 | European Commission (n.d.) |
| | **Direct costs to subject** | | | | |
| | | Tobacco use (cigarettes) | Per pack of cigarettes | 4.5 | Agencia Estatal Boletín Oficial del Estado (2017b) |
| | | Tobacco use (shisha) | Per unit | 9.15 | Agencia Estatal Boletín Oficial del Estado (2017a) |

**TABLE 3** Impact of the *Alerta alcohol* program intervention on BD through two-part model (marginal effects), by subgroup

| | Gender | | Age | | Pocket money | | |
|---|---|---|---|---|---|---|---|
| Number of BD occasions | Female | Male | <17 years | ≥17 years | €0 | €1 to 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[e] | | | 0.045 (0.10) | 0.182 (0.22) | 0.173 (0.17) | −0.038 (0.11) | 0.636 (0.45) |
| Spanish[f] | 0.376 (0.37) | 0.060 (0.54) | 0.074 (0.33) | 0.535 (0.39) | −0.375 (0.56) | 0.847 (0.37)** | −0.692 (0.56) |
| Nuclear family composition[g] | −0.014 (0.12) | −0.223 (0.10)** | −0.089 (0.11) | −0.125 (0.13) | −0.031 (0.16) | −0.143 (0.08)* | −0.002 (0.25) |
| Mother's schooling years | −0.001 (0.00) | −0.004 (0.00)** | −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] | 0.052 (0.10) | 0.003 (0.11) | −0.010 (0.09) | 0.049 (0.19) | −0.113 (0.21) | −0.011 (0.11) | 0.245 (0.36) |
| Pocket money (weekly) | 0.030 (0.01)*** | 0.011 (0.01)* | 0.013 (0.01)** | 0.039 (0.01)*** | | | |
| Weekly day when the questionnaire was completed[i] | −0.522 (0.14)*** | −0.073 (0.13) | −0.341 (0.10)*** | −0.358 (0.21)* | −0.321 (0.22) | −0.299 (0.13)** | −0.022 (0.40) |
| Completed questionnaire close to local events | 0.005 (0.01) | −0.008 (0.01) | −0.010 (0.00) | −0.000 (0.01) | 0.001 (0.01) | −0.003 (0.01) | −0.001 (0.02) |
| 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* | 1322 | 1172 | 1552 | 942 | 288 | 1764 | 344 |
| Wald $\chi^2$ | 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 are shown in brackets. ***, ** and * represent a significance level of 1%, 5% and 10%, respectively; 1000 replications were used for bootstrapping analysis, and standard errors were clustered at classroom level.

[a]1 = Postintervention period 1; 0 = Preintervention period.

[b]1 = Intervention group; 0 = Control group.

[c]The product of the number of subjects who participated in the program and the difference in the number of BD occasions between the post- and preintervention 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]Weekly day when the questionnaire was completed (closeness to the last weekend): 1 = Completed the questionnaire on Wednesday, Thursday or Friday; 0 = Completed the questionnaire on Monday or Tuesday.

[j]Family alcohol consumption: 0 = Mother, father, and siblings do not binge drink; 1 = Mother, 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.

incorporate the covariates (Table 3). Specifically, the first part of the two-part model is estimated using a logit regression model, and the second part is specified as a generalized linear model panel regression. This model was used because of the presence of a large proportion of zero count observations (Mora et al., 2015), and it was carried out with the initial sample ($n = 1247$). Owing to the high desertion rate in the postintervention period, for the majority of variables in the follow-up questionnaire, we decided not to use multiple imputation and instead conducted the analysis with pairwise deletion. Despite the fact that the postintervention dropout rate was more than 50%, the use of multiple imputation methods was ruled out. As Rubin (1987) states, although this type of analysis generates good results even when desertion reaches 50%, others (Medina & Galván, 2007) do not recommend imputing data in which the desertion in one or more variables is greater than 20%, especially when the results support the design of public policies. An alternative to data imputation that mitigates data loss is the pairwise elimination technique, which uses all available cases in the data analysis procedure.

The covariates were selected after conducting correlation analyses. In addition, the backward stepwise selection method was used to obtain the most parsimonious model.

Cost-effectiveness and cost-utility analyses were carried out for three subgroups (defined by gender (female/male), age (<17 years of age/≥17 years of age), and weekly pocket money (€0/€1 20/>€20)) due to differences found in the literature in these subgroups (Crocamo et al., 2018; Drost et al., 2016; Jönsson, 2009; Nur et al., 2017). Uncertainty was studied through multivariate deterministic sensitivity analysis of best/worst scenarios by the same subgroups mentioned above. In this type of analysis, several parameters are modified and values that combine the parameters producing the best and worst cost-effectiveness ratios and the most optimistic and pessimistic scenarios are chosen to examine if the intervention is cost-effective in an extreme scenario. These values were chosen through the 95% confidence interval for the effectiveness measures used in the analyses (i.e., the number of BD occasions avoided over the last month and the number of QALYs gained) by each subgroup. The minimum value of the 95% confidence interval for both measures would constitute the worst scenario and the maximum the best.

The main outputs used in this analysis were the ICER and ICUR. We used the cost-utility threshold for Spain of €21,000 to €24,000 per QALY (Vallejo-Torres et al., 2016).

A time horizon of 4 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 analysis was conducted using Stata version 14.0 (StataCorp) and Microsoft Excel version 16.16.5.

## Ethics approval

The study received approval from the Bioethics Committee of Andalusia (registration number: PI-0031-2014, 04 August 2015). 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.

# RESULTS

## Sample characteristics

In relation to socioeconomic characteristics, age at the beginning of intervention by group (intervention and control groups) and current job situation of the adolescent's father were statistically significant. In the baseline period, there were statistically significant differences in relation to the number of glasses of alcohol consumed in outdoor public places and siblings' BD frequency. In the postintervention 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 4).

Table 1 also shows that total direct healthcare costs were lower in the intervention group (€829.72) than in the control group (€3991.23) at the 4-month follow-up point. This difference can be explained largely by the difference in cost of a reported hospital stay. While no hospital stay was reported by the intervention group before taking the *Alerta Alcohol* program (baseline period) or at a 4-month follow-up session, in the control group, a hospital stay owing to BD was reported in the baseline period, and two hospitals stays were reported at the 4-month follow-up session. Total direct nonhealthcare costs were also lower in the intervention group (€9329.88) 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 mean intervention cost calculated for all adolescents who received the program in the trial on which this study is based ($n = 712$) was of €5.26 per adolescent. An increase in number of adolescents receiving the program does not increase the intervention cost.

As shown in Table 3 through the variable "intervention impact," the program showed a statistically significant reduction in number of BD occasions of 1.076 between the baseline period and the follow-up period in the older group (≥17 years). Similarly, 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 of 0.138 and 0.126, respectively.

## 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 €7986.37 by one BD occasion averted per month. This cost savings is obtained by dividing the difference in total costs (−€278.12) by the difference in the

**TABLE 4** Characteristics of the sample in the pre- and postintervention period by intervention or control group ($n = 367$)

| | Preintervention | | Postintervention | |
|---|---|---|---|---|
| | Intervention ($n = 210$) | Control ($n = 157$) | Intervention ($n = 210$) | Control ($n = 157$) |
| Numerical variables | | | | |
| Socioeconomic | | | | |
| Age at the beginning of the program | 16.78 (0.96) | 16.36 (0.84)*** | | |
| 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) | | |
| Pocket money (weekly) | 10.12 (8.82) | 11.66 (9.76) | | |
| HRQoL (EQ index value) | 0.94 (0.10) | 0.91 (0.17)* | 0.96 (0.09) | 0.94 (0.12) |
| Alcohol consumption | | | | |
| Number of BD occasions | 0.94 (1.67) | 1.02 (1.93) | 1.05 (2.25) | 1.20 (2.78) |
| Frequency of alcohol use in public outdoor places (number of times a month) | 1.42 (2.60) | 0.98 (2.22)* | 1.07 (2.30) | 0.71 (1.81) |
| "…" at parties or celebrations (times a month) | 1.46 (2.54) | 1.77 (2.78) | 1.27 (2.42) | 1.37 (2.49) |
| "…" at home or at someone else's home (times a month) | 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 at someone else's home | 1.33 (2.23) | 1.56 (2.19) | 1.10 (2.01) | 1.35 (2.22) |
| Consumption of other substances | | | | |
| 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)** |
| Categorical variables | | | | |
| Socioeconomic | | | | |
| Being female (vs. male) | 119 (56.67) | 77 (49.05) | | |
| Being Spanish (vs. no Spanish) | 203 (96.67) | 144 (92.90) | | |
| Being Catholic (vs. another religion) | 132 (62.86) | 106 (67.52) | | |
| No religion (vs. religion) | 68 (32.38) | 40 (25.48) | | |
| Family composition: Nuclear | 158 (75.24) | 115 (73.25) | | |
| Current job situation of the mother (yes) | 129 (65.48) | 91 (75.83)* | | |
| Current job situation of the father (yes) | 147 (83.05) | 77 (70.0)*** | | |
| Good economic situation at home | 92 (43.81) | 74 (47.13) | | |
| Economic difficulties at home | 83 (39.52) | 47 (29.94)* | | |
| Completing the questionnaire later in the week | 146 (69.52) | 101 (64.33) | | |
| Alcohol consumption | | | | |
| Alcohol use over the last weekend [yes] | 45 (21.43) | 32 (20.38) | 57 (27.14) | 34 (21.66) |
| Mother consumes alcohol occasionally/more frequently | 43 (20.48) | 38 (24.20) | 50 (23.81) | 30 (19.11) |
| Father "…" | 89 (42.38) | 59 (37.58) | 77 (36.67) | 55 (35.03) |
| Siblings "…" | 40 (19.05) | 37 (23.57) | 34 (16.19) | 39 (24.84)** |
| Partner "…" | 36 (17.14) | 25 (15.92) | 32 (15.24) | 21 (13.38) |
| Friends "…" | 180 (85.71) | 128 (81.53) | 158 (75.24) | 118 (75.16) |
| Best friend "…" | 137 (65.24) | 89 (56.69)* | 123 (58.57) | 79 (50.32) |
| Mother binge drinks more frequently | 7 (3.33) | 9 (5.73) | 10 (4.76) | 8 (5.10) |
| Father "…" | 32 (15.24) | 25 (15.92) | 34 (16.19) | 14 (8.92)** |
| Siblings "…" | 19 (9.05) | 25 (15.92)** | 22 (10.48) | 16 (10.19) |

TABLE 4 (Continued)

| | Preintervention | | Postintervention | |
|---|---|---|---|---|
| | Intervention ($n = 210$) | Control ($n = 157$) | Intervention ($n = 210$) | Control ($n = 157$) |
| Partner "…" | 25 (11.90) | 16 (10.19) | 21 (10.0) | 17 (10.83) |
| Friends "…" | 151 (71.90) | 102 (64.97) | 134 (63.81) | 95 (60.51) |
| Best friend "…" | 100 (47.62) | 60 (38.22)* | 103 (49.05) | 63 (40.13)* |
| Consumption of other substances | | | | |
| Being a smoker or a tobacco user (cigarettes or shishas/hookahs) | 85 (40.48) | 57 (36.31) | 76 (36.19) | 61 (38.85) |
| Being a cannabis user | 20 (9.52) | 18 (11.46) | 27 (12.86) | 24 (15.92) |
| Prescribed tranquilizers, sedatives, or sleeping pills (yes) | 5 (2.38) | 6 (3.82) | 10 (4.76) | 9 (5.73) |
| Not prescribed tranquilizers, sedatives, or sleeping pills (yes) | 5 (2.38) | 6 (3.82) | 6 (2.86) | 8 (5.10) |

*Note*: We show the average values and standard deviations in brackets for the numerical variables and frequencies and percentages in brackets for the categorical variables. ***, **, and * represent statistical significance at a 1%, 5%, and 10% level between the values of variables in the intervention and control groups in the pre- and postintervention periods (second and third columns, fourth and fifth columns, respectively).

effectiveness measure (0.0348), for the intervention group versus control group (*see* Table 5). Because there was a cost reduction in the intervention group at the 4-month follow-up, which did not occur in the control group, the difference yields a negative result, which generates monetary savings. Conversely, regarding the measure of effectiveness, there was a greater reduction in the monthly number of BD occasions in the intervention group than in the control group.

With regard to QALYs gained, the intervention was more expensive but also more effective (a difference of 0.0081 QALYs gained between intervention and control conditions), resulting in an incremental cost of €71.05 per QALY gained from the NHS perspective in comparison with the control condition. From the societal perspective, this intervention was dominant resulting in savings of €34,126.64 per QALY gained (*see* Table 5).

## Subgroup and sensitivity analyses

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 was not effective for boys. From the NHS perspective, the intervention was dominant only for girls that resulted in savings of €2163.6 per QALY gained; meanwhile, for boys, the intervention was cost-effective with an incremental cost of €2710.92 per QALY gained. An analysis by gender was carried out from both the perspectives, but the results did not change at decision level from the 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.

By age, the intervention was dominant from the NHS perspective for older adolescents (≥17 years of age), resulting in savings of €34.33 per BD occasion averted, and it could be cost-effective from the societal perspective. A difference was noted when the outcome measure used was QALY gained, finding that the intervention was cost-effective from NHS perspective with an incremental cost of €213.64 per QALY gained and dominant from the societal perspective for younger adolescents (<17 years) with savings of €25,499.25 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 *Alerta Alcohol* program was not cost-effective from both perspectives for QALYs for those who had a pocket money between €1 and €20 and for reducing the number of BD occasions for those who had a pocket money 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 the societal perspective. Regarding QALYs gained, the best scenario showed its cost-effectiveness from NHS perspective and its dominance from the societal perspective (*see* Table 5 and Figure S2).

# DISCUSSION

To our knowledge, this study is the first to examine the cost-effectiveness and cost-utility of a web-based intervention carried out among adolescents with the aim of preventing BD 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.

Regarding the type of intervention, in addition to studies that are already cited, the results of Donoghue et al.'s (2014) systematic review and meta-analysis indicate that an intervention based on electronic screening and brief intervention (eSBI) not only results in a significant reduction in weekly alcohol consumption during the intervention and control conditions in different follow-up periods, but it also has a lower implementation cost and wider accessibility

**TABLE 5** ICERs and ICURs and multivariate deterministic sensitivity analysis of best/worst scenarios using the base data for the NHS (financier) and societal perspectives, with number of BD occasions in the last 30 days as the outcome variable (discount rate 0%)

| | | NHS perspective | | | | | | Societal perspective | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Subgroups of the sample | Scenario | Incremental cost (€2017) | Incremental effect (number of BD occasions less) | ICER (€2017) | Incremental cost (€2017) | Incremental effect (QALYs) | ICUR (€2017) | Incremental cost (€2017) | Incremental effect (number of BD occasions less) | ICER (€2017) | Incremental cost (€2017) | Incremental effect (QALYs) | ICUR (€2017) |
| Total sample | Best | 0.58 | 0.2656 | **2.18** | 0.58 | 0.0336 | **17.21** | −903.13 | 0.2656 | **D** | −903.13 | 0.0336 | **D** |
| | Base data | 0.58 | 0.0348 | **16.63** | 0.579 | 0.0081 | **71.05** | −278.12 | 0.0348 | **D** | −278.12 | 0.0081 | **D** |
| | Worst | 0.58 | −0.1959 | **d** | 0.58 | −0.0173 | **−33.39** | 346.89 | −0.1959 | **d** | 346.89 | −0.0173 | **d** |
| Female | Best | −23.25 | 0.5013 | **D** | −23.26 | 0.0484 | **D** | −964.49 | 0.3564 | **D** | −964.49 | 0.0358 | **D** |
| | Base data | −23.25 | 0.1685 | **D** | −23.25 | 0.0108 | **D** | −379.75 | 0.1685 | **D** | −379.75 | 0.0108 | **D** |
| | Worst | −23.25 | −0.1641 | **141.69** | −23.25 | −0.0269 | **−865.88** | 298.63 | −0.1323 | **d** | 298.63 | −0.0161 | **d** |
| Male | Best | 11.52 | 0.2079 | **55.37** | 11.52 | 0.0384 | **300.23** | −392.05 | 0.2079 | **D** | −392.05 | 0.0384 | **D** |
| | Base data | 11.52 | −0.1293 | **d** | 11.52 | 0.0043 | **2710.92** | −166.88 | −0.1293 | **1290.19** | −166.88 | 0.0043 | **D** |
| | Worst | 11.52 | −0.4666 | **d** | 11.52 | −0.0297 | **d** | 58.28 | −0.4666 | **d** | 58.28 | −0.0297 | **d** |
| <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 | **D** |
| | Base data | 3.54 | −0.0482 | **d** | 3.54 | 0.0166 | **213.64** | −423.01 | −0.0482 | **8777.39** | −423.01 | 0.0166 | **D** |
| | Worst | 3.54 | −0.2678 | **d** | 3.54 | −0.0122 | **d** | 42.45 | −0.2678 | **d** | 42.45 | −0.0122 | **d** |
| ≥17 years old | Best | −10.40 | 0.8649 | **D** | −10.40 | 0.0248 | **D** | −1078.73 | 0.8649 | **D** | −1078.73 | 0.0248 | **D** |
| | Base data | −10.40 | 0.3030 | **D** | −10.40 | −0.0244 | **426.21** | 549.80 | 0.3030 | **1814.53** | 549.80 | −0.0244 | **d** |
| | Worst | −10.40 | −0.2589 | **40.18** | −10.40 | −0.0736 | **141.26** | 2178.33 | −0.2589 | **d** | 2178.33 | −0.0736 | **d** |
| Pocket money = €0 | Best | 5 | 1.1463 | **4.36** | 5 | 0.1344 | **37.19** | −437.27 | 1.1463 | **D** | −437.27 | 0.1344 | **D** |
| | Base data | 5 | 0.4650 | **10.75** | 5 | 0.0298 | **167.53** | 33.67 | 0.4650 | **72.42** | 33.67 | 0.0298 | **1128.25** |
| | Worst | 5 | −0.1921 | **d** | 5 | −0.0747 | **d** | 504.61 | −0.1921 | **d** | 504.61 | −0.0747 | **d** |
| Pocket money = €1 to 20 | Best | 9.86 | 0.3627 | **27.18** | 9.86 | 0.0212 | **464.12** | −1186.30 | 0.3627 | **D** | −1186.30 | 0.0212 | **D** |
| | Base data | 9.86 | 0.1024 | **96.26** | 9.86 | −0.0074 | **d** | −339.42 | 0.1024 | **D** | −339.42 | −0.0074 | **45,915.77** |
| | Worst | 9.86 | −0.1591 | **d** | 9.86 | −0.0360 | **d** | 507.46 | −0.1591 | **d** | 507.46 | −0.0360 | **d** |
| Pocket money = >€20 | Best | −40.24 | 0.8732 | **D** | −40.24 | 0.1352 | **D** | −1199.01 | 0.8732 | **D** | −1199.01 | 0.1352 | **D** |
| | Base data | −40.24 | −0.4454 | **90.37** | −40.24 | 0.0571 | **D** | −270.34 | −0.4454 | **607.02** | −270.34 | 0.0571 | **D** |
| | Worst | −40.24 | −1.7639 | **22.82** | −40.24 | −0.0210 | **1919.20** | 658.34 | −1.7639 | **d** | 658.34 | −0.0210 | **d** |

*Note*: "D" = Dominant; "d" = dominated. An intervention or program is considered "Dominant" when it is superior in effectiveness and its adoption involves fewer resources than its comparator. The opposite case would be one in which the new intervention or program to be evaluated is more expensive (i.e., it involves a greater sacrifice of resources) and less effective than its comparator; therefore, it would be an intervention "dominated" by the intervention with which it is being compared. "Base data" = mean the values observed in the sample; "Best scenario" = maximum value of 95% IC for effectiveness measures; "Worst scenario" = minimum value of 95% IC for effectiveness measures. The positive values for the "incremental effect" in relation to the number of BD occasions averted refer to a reduction in the number of BD occasions in the intervention group as regards control group; meanwhile, the negative values refer to an increase in the number of BD occasions. The positive values for the "incremental effect" in relation to QALYs refer to an increasing quality of life, while the negative values refer to a decreasing quality of life.

than conventional face-to-face SBI. The current widespread use of mobile and electronic technologies may increase the population with access to SBI, and the potential cost of delivery may be reduced because the main cost is incurred during the development of the intervention with limited additional costs being associated with its delivery (Linke et al., 2007). However, there is limited evidence about the cost-effectiveness of this type of Internet-based intervention (Ingels et al., 2013; Nelson, 2015; Suijkerbuijk et al., 2014). Future studies on the cost-effectiveness of health promotion and prevention for adolescents that include long-term assessments are recommended since the effect on behavior change is higher at long time, which could increase the savings of the accumulated costs of these interventions (Ahmad, 2005). 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 older subgroup (17 years of age and older) was markedly higher than that for the male subgroup and younger subgroup (under 17 years of age). This fact is also discussed by Drost et al. (2016). The major incremental effect obtained by subgroups in terms of the number of BD occasions averted per month was for adolescents who had no weekly pocket money available, with a difference of 0.465 BD occasions averted per month more in the group that received the *Alerta Alcohol* program compared to adolescents who received no active intervention. This finding is consistent with the study of Crocamo et al. (2018) in which a high pocket money availability was a risk factor for young people in relation to the number of BD episodes. However, the major incremental effect obtained in relation to QALYs gained was for those who had a weekly pocket money of more than €20. In relation to this finding, Nur et al. (2017) 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 by the heterogeneity found in other studies among binge drinker young people (Bourdieu, 1979; Luquiens et al., 2018; Scott et al., 2017).

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 to 19 years of age) than for those who were younger than 17 years old.

Given the scarcity of literature related to economic evaluations of behavior change interventions, one of the main strengths of this study is the cost-effectiveness and cost-utility assessment, including both the NHS and societal perspectives (Onrust et al., 2016). It is known that the societal perspective is dominant over other perspectives (Byford & Raftery, 1998; Jönsson, 2009). Jönsson (2009) provided 10 arguments for taking a broad societal perspective in conducting HTA studies. Since regulatory decisions about the market authorization of new medical technologies are based on an assessment of the societal benefits and risks, HTA studies should take the same perspective. Another argument is that adopting a payer perspective instead of a societal perspective may create a bias against investments aimed at improving health through healthcare spending. Since it is widely accepted that economic evaluations should include all potential health effects, the costs should also be considered from a societal perspective. Another argument is that specific payer perspectives should be assessed within the societal perspective because it may thereby be possible to identify the most relevant perspective depending on the policy issue to be addressed. Furthermore, Jönsson (2009) proposed that a societal perspective promotes an informed public discussion and democratic decisions since it is the public that pays for and receives the benefits of new technologies and healthcare interventions. In addition, previous studies on the economic evaluation of similar programs, such as Drost et al. (2016), Ingels et al. (2013), and Sumnall et al. (2017), also chose the societal perspective. 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 behavior change interventions might vary according to contextual factors, as noted by Das et al. (2016).

Notwithstanding these strengths, it is necessary to contextualize the results of this study by taking into account the study's limitations, 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 postintervention 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 (de Vries et al., 2012; Kohl et al., 2013). Another possible reason for this attrition could be the design of the intervention for the target population. The feedback to the adolescent in this program is provided through text messages that come from an avatar that each adolescent chooses when registering on the program's website, and this avatar accompanies them during all sessions. A review of the literature on computer-based interventions and prevention programs to reduce alcohol use among young people notes that few programs exploit the potential of technologies using elements of gamification, smartphones apps, or social media to complement the design of interventions such as the *Alerta Alcohol* program, which are based on a program personalized for the youth's individual demographic characteristics, risk factors, and vulnerabilities (Schinke & Schwinn, 2017). This fact indicates that the program design should be improved in future research. A possible explanation for the difference in the number of adolescents that comprise the intervention and control groups could be because of the fact that although 16 schools initially accepted the invitation to participate and were randomly assigned to either the intervention or control group, a school

in the control group did not start the baseline assessment and withdrew owing to logistical problems. Therefore, the study started with an inferior sample in this comparator group from the beginning.

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 behaviors among adolescents and young adults shows good reliability and validity (Brener et al., 2003; Harrison et al., 2007). In this line, a 4-month recall period after the start of program to assess the alcohol use could increase the recall bias as suggested by Cherpitel et al. (2018) in their study.

Another important limitation was that short-term behavior 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 behavior change interventions (Alayli-Goebbels et al., 2014), only six studies had longer follow-up periods (up to 5 years). There are still very few studies regarding the long-term effectiveness of eHealth interventions in schools that are aimed at preventing unhealthy behaviors in general. Champion et al. (2019) highlighted the need for longer-term follow-up and future lines of research on the effects of these interventions during adolescence, especially for substance use. It is expected that a natural increase in its use will be found. Several scholars (Cremers et al., 2012; Schneider et al., 2013) have identified aspects of the content and design of web-based interventions that may improve their effects, for instance, using booster sessions to remind the core concepts emphasizing reminders for the sessions. After assessing the effectiveness of the Alcohol Alert program, improvements in the design related to gamification were proposed as well as the inclusion of booster sessions (Martinez-Montilla et al., 2020).

A limitation related to the number of participants who reported being admitted to a hospital is important due to the few events that occurred in this regard in the sample. A low number for the results of a variable could affect the accuracy of the outcomes. However, the data reported by the Hospital Emergency Indicators in Andalusia (Andalusian Plan on Drugs and Addictions, 2018) for 2017 (i.e., the year of data collection) indicated that 1277 people had a hospital emergency due to alcohol consumption; 11.7% of them, or 149 people, were between 15 and 19 years of age. In addition, of the total number of emergencies due to psychoactive substance use, 8% were admitted to a hospital, and of these emergencies, 2.8% were due to the exclusive consumption of alcohol. Therefore, the data regarding hospital stays in the sample population are similar to what was found in our study. This possible standard error associated with low outcome counts could be solved by considering the average number of days of a hospital stay, but such data were not available owing to a lack of responses.

Finally, in relation to known limitations related to economic evaluations based on clinical trials, using economic evaluation as a basis for decision making about the national reimbursement of health care technologies demands some specific analytical methods. For instance, this article has incorporated two perspectives, NHS and societal, to consider a consistent perspective among what would be appropriate and the actual focus of decision makers. Although the time horizon considered in this analysis has been shorter than the appropriate 4 months, there is no robust evidence that this type of interventions has a direct impact on mortality. In addition, trial-based economic evaluations exhibit a difference between costs and benefits, which can be estimated in the trial, and those which are needed for decision making. It is true that the main problem is that economic evaluation based on single trials will invariably fail to reflect all the available evidence related to a particular decision problem. However, they have the advantage of reflecting an unbiased estimate of the relative treatment effect, reducing the risk of selection bias. In any case, trial-based economic evaluation is an important source of evidence, though future work should address this by using a decision-analytic model to meet full requirements for decision making (Petrou, 2012; Sculpher et al., 2006).

To conclude, computer-tailored feedback could be a cost-effective way to prevent BD in terms of reducing the number of BD occasions and increasing QALYs among adolescents. This intervention could be implemented at schools to all students to prevent alcohol consumption and especially BD, although it would be interesting to tailor the program to specific subgroups of this population that are at greater risk of being involved in BD. However, to capture major changes both in the reduction of number of BD occasions and in HRQoL and savings in healthcare costs due to a behavioral change intervention, long-term follow-up of the intervention would probably be required. Other countries could evaluate this type of program to design the public health policies targeting alcohol use among adolescents.

## AUTHOR CONTRIBUTIONS

Conceptualization: Marta Lima-Serrano, Marta Trapero-Bertran and Ana Magdalena Vargas-Martínez. Formal Analysis: Ana Magdalena Vargas-Martínez and Marta Trapero-Bertran. Methodology: Marta Lima-Serrano, Marta Trapero-Bertran and Ana Magdalena Vargas-Martínez. Supervision: Marta Trapero-Bertran and Marta Lima-Serrano. Writing—Original Draft Preparation: Ana Magdalena Vargas-Martínez. Writing—Review & Editing: Marta Trapero-Bertran, Marta Lima-Serrano and Ana Magdalena Vargas-Martínez.

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## CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

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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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