Descriptive research into large-scale user data from an established alcohol identification and brief advice (IBA) intervention website

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Abstract

Alcohol misuse causes significant health harms, including early mortality, increased healthcare and wider governmental costs. Identification and Brief Advice (IBA) interventions can reduce alcohol consumption, prevent alcohol misuse disorder progression, and are cheaper to deliver digitally than in-person. However, high-quality evidence is lacking for delivering IBA interventions, at scale, via publicly available websites. This study uses descriptive data from individuals in the United Kingdom (UK) and some from other countries over a six-year period from DrinkCoach, a website which delivers an IBA intervention developed in the UK delivering tailored interventions based on users' Alcohol Use Disorders Identification Test (AUDIT) scores. Researchers employed descriptive statistics, double-tailed Z tests and X^2 tests for relationships between variables. In 2018, 60,745 IBA interventions were completed, with 86% of these recording AUDIT scores > 7, indicating risky drinking. Significant positive relationships were identified between the AUDIT score and users' demographics such as gender and age-group which are well-established as well as new insights into relationships between AUDIT score and the time of the year or day the interventions were accessed and delivered, as well as the follow-up options selected by users. The website attracted a disproportionately higher proportion of risky drinkers completing IBA interventions compared with prevalence estimates or identified through in-person IBA approaches in the UK. The research indicates that websites delivering IBA interventions may support help-seeking behaviour for risky drinkers by providing anonymity and low interaction costs. The research results demonstrated a significant cost-benefit at scale when compared to in-person, particularly in specific local authorities who paid to access website data about their populations. This cost-benefit approach should inform alcohol health funding decisions and warrant further, higher-quality research into outcomes from websites delivering IBA interventions.

Key words

Alcohol misuse; Identification & Brief Advice; Digital Alcohol Intervention, Brief Intervention; Alcohol intervention website.

Introduction

Alcohol costs the NHS £3.5 billion p.a.[1] and the United Kingdom (UK) economy over £21 billion p.a.[2]. Alcohol contributes to health harms [3-10], and is a component in over 200 disease conditions[11]. In the UK, alcohol-specific mortality was estimated in 2021 at 14.8 deaths per 100,000 population[12] and has been the fifth-leading risk factor for mortality and morbidity[10].

Over five million litres of alcohol are sold in England per annum[13]; however, consumption is far from uniform in England, with 25% of the population consuming 78% of the alcohol sold[14]Higher alcohol consumption is correlated with higher health harms, hence the benefits of identifying those consuming higher amounts of alcohol and encountering alcohol-related harm[15].

Identification and Brief Advice (IBA) involves administering an alcohol screening questionnaire to an individual asking about their current drinking patterns, followed by personalised feedback on their screening result(s), advice and information about reducing alcohol consumption[5-9]. There are several recognised alcohol screening questionnaires; however, the Alcohol Use Disorders Identification Test (AUDIT) was created by the World Health Organization and is the recommended first-line, comprehensive alcohol identification tool[4], having high sensitivity and specificity for detecting alcohol misuse[16]. AUDIT is recognised as identifying a person's drinking risk category (DRC) group based as follows: low risk (scores: 0-7), increasing risk (8-15), higher risk (16-19) and potentially dependent (20-40)[3,4,16,17]. One method for brief advice to those scoring at increasing or higher risk (DRCs with AUDIT scores 8-19) that is recommended is called the FRAMES approach, which is a list of elements that can be considered to include in delivering an IBA intervention. FRAMES stands for Feedback, Responsibility, Advise, Menu for change, Empathy, and enhancing Self-efficacy. Feedback is on the AUDIT score and what the DRC is for that score; responsibility is that itis the individual's responsibility to address their own alcohol use; advise should mean advice which is tailored to DRC and addressing relative risk versus recommended low risk limits; menu should involve several options to alter alcohol use; empathy in the brief advice through reflective, warm and non-judgmental conveyance of information; self-efficacy means acknowledging the individual's agency in behaviour[18]. All scoring > 7 on the AUDIT, should be in receipt of brief advice including them being advised about the UK Government Chief Medical Officer's 2016 recommended weekly maximum limit of 14 UK alcohol units[21]. A Cochrane review of digital IBA interventions identified multiple potential behaviour change techniques to include when giving brief advice digitally, including via a website. The most effective techniques identified were: promoting behaviour substitution, engaging in problem-solving to reduce or prevent use, and the intervention being perceived as coming from a credible source[7].

IBA at a population level is a recommended, public health intervention which saves more public money over time than it costs to employ, which makes it cost-effective[9,15]. IBA can reduce consumption for increasing or higher risk drinkers, preventing alcohol disorder progression in those who in increasing risk or higher risk DRC groups as well as supporting separate, timely referral into treatment for the heaviest drinkers such as the possibly dependent DRC group[3-10, 15,20,21,22]. A specific benefit is that for every eight people drinking at increasing or higher risk who receive IBA, one will reduce to within the low risk limits[23]

There is recent high-quality evidence that IBA is effective at reducing consumption, particularly in increasing and higher risk DRCs in many settings[9,15] and is effective equally for both men and women[8]. However, poor practice is common[4], and results in low identification through healthcare staff not completing the full AUDIT when a positive screen occurs on the shorter AUDIT-C questionnaire and so no delivery occurs of indicated IBA interventions or referrals to alcohol services for possibly dependent drinkers who require it[24-28,]. In 2017, In-person IBA was estimated to cost £7.50 per intervention but bringing a benefit in the first year of £27 in reduced health and other costs, rising to £136 reduced cost return over five years[29]. These figures can be used now as a conservative estimate of cost-benefits of a website's IBA intervention as, the £7.50 cost is made up mainly of in-person labour and, due to inflation, the future cost savings of IBA interventions would have likely increased since that analysis by Public Health England. No more recent cost-benefit calculation for IBA has been published for the UK (personal communication in email from Colin Angus MSc (c.r.angus@sheffield.ac.uk), in 2022 August 9). It is important to note that in-person IBA, along with population alcohol surveys, have significant limitations as they result in participants either consciously or unconsciously under-reporting alcohol consumption[30,31]. Reasons for conscious minimisation of alcohol consumption include participants' perceptions that: a negative judgment about their alcohol consumption will be made and being stigmatised with an alcohol use disorder label[32,33]. That is why this paper focuses on the potential cost-benefits of a website's IBA intervention in comparison to in-person IBA, as estimates of in-person IBA interventions being cost neutral within five years when applied to patients newly registering with GPs[34], whereas it is easy to see an IBA programme which included a website's IBA intervention would achieve this cost-neutrality much sooner and could also reach a larger target population.

A website's IBA interventions provide anonymity, reduce barriers to help-seeking behaviour[35], and so overcome limitations to delivering IBA interventions, at scale, to primary care populations[17,36,37]. There is already evidence that Digital IBA interventions, which includes websites delivering IBA interventions, lower alcohol consumption at a comparable rate in a population to in-person IBA

approaches[7]. A website's IBA interventions have much greater reach and significantly lower costs when compared to in-person IBA; however, more research producing higher-quality evidence is recommended [7,35,44].

The DrinkCoach website (https://www.drinkcoach.org.uk), delivers an IBA intervention which is the focus of this research and will hereafter be called the "website's IBA intervention", is managed by the UK-based alcohol treatment provider Humankind, which provides alcohol health information and several alcohol interventions. Humankind have explained through the provision of a diagram (Figure 1) the user's journey through the website's IBA intervention, which demonstrates how the elements of this particular IBA intervention occur for a user. It also helps to shows how the DrinkCoach website captures user data used in this research as the website administers AUDIT; feeds back the total AUDIT score and DRC to the user; provides brief advice information; and a menu of follow-up options to choose from tailored to the user's DRC. The user journey described in Figure 1 still requires the user to click through each page or land on the page of the DrinkCoach website and some attrition of users is noted which is explained in the Results section.

The website's IBA intervention adheres to effective IBA elements such as using AUDIT as the alcohol questionnaire, tailoring feedback to the result(s) and employing brief advice based on the FRAMES approach5,8,18 and promotes behavioural change techniques deemed effective for digital IBA interventions7, such as behaviour substitution. The goal of the research was to interrogate quantitative data from the website's user sessions to give a sense of reach, potential benefits through IBA intervention delivery and provide insight into the relative value in the form of cost-benefit and effectiveness. In this paper we explore in discussion the comparison of this IBA intervention with separately published research on costs and benefits of traditional in-person IBA approaches thus expanding the boundaries of academic literature.

As a result of the initial/background research the following objectives were established:

- Understand website and IBA intervention access, user journey, and behaviour
- Explore profile and numbers of IBA intervention recipients
- Explore relationships between user DRCs and other variables
- Apply a cost-benefit analysis comparing IBA approaches

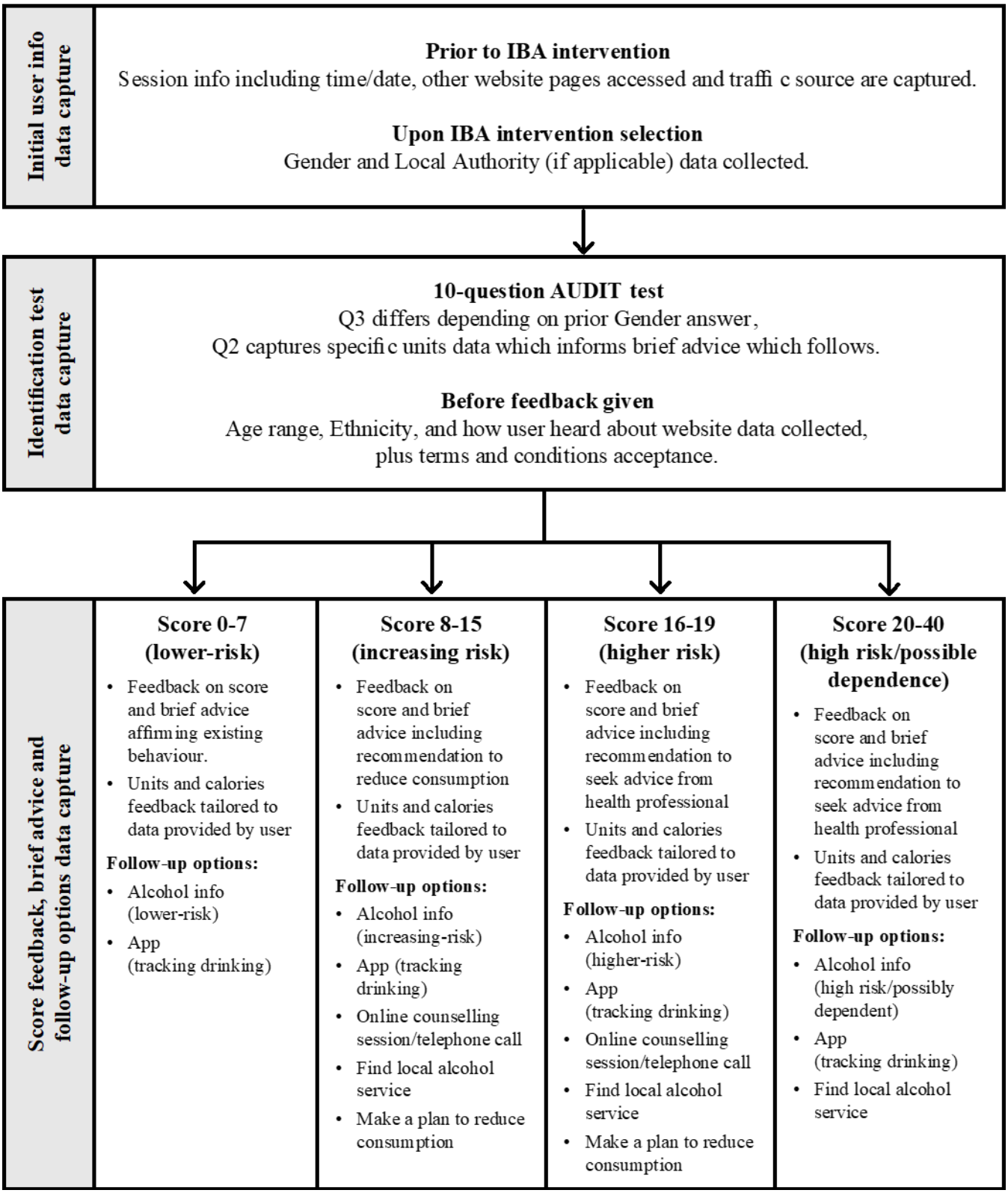

Figure 1 – DrinkCoach website IBA intervention pathway

Method

In January 2020, the researcher and supervisor submitted a brief research proposal to Humankind, as data-owner, requesting all data from the website that relates to user journeys engaging in IBA interventions. Humankind's own research committee considered and approved the proposal. The University of Hertfordshire, as the project sponsor, considered ethical issues relating to the potential data available prior to the proposal being submitted, and following receipt of the data from Humankind.

Access to data for the researcher and supervisor began in February 2020 allowing a review of all data items potentially accessed by users visiting the website and engaging in IBA interventions. Humankind sent reports to the researchers from the Google Analytics platform used, and also provided separate csv spreadsheet files covering individual website elements, both including the 2013-2019 time-period. A different csv file showing disaggregated data from each user session was sent, which covered a 15-month period from October 2017 to December 2018 inclusive due to web development work during that period. Both researcher and supervisor reviewed the total data items available and selected datasets focusing on the disaggregated user session IBA intervention data for greater attention – thus reducing the risk of selection bias. It should be noted that researchers did not have access or time to look into to every version of the DrinkCoach website, and the website's iterative changes. It is known that, over time, some elements of the website's IBA intervention were altered, for example in 2016 after new low risk limits were introduced meaning copy within the brief advice text provided to users was changed. Also, some follow-up option data items changed or differed depending on their local authority selection at times, so all content available to users was not identical over the lifetime of this data source. However, Humankind have confirmed the structure and content for the website's IBA intervention as shown on Figure 1 has otherwise remained the same throughout the timeframe covered by this research and the researchers concluded those changes would neither affect the ability and value of analysing the data available over the periods of time chosen, nor their validity.

When considering the research value of the data available the researcher was guided by the lack of high-quality evidence for digital IBA interventions, including websites delivering IBA interventions[7,35,38]. This website has been continuously operational since 2012 as an English-language website delivering IBA interventions, providing a significant store of data from 868,104 user sessions to researchers over the period July 2013 to December 2019. When a user accesses the website this starts a 'user session', the data in each user session are captured and will include the users' time of visit, whether they leave after the first website page (bounce) and what data they

provide in response to the IBA intervention questions including the AUDIT questions, related demographic characteristics, as well as follow-up options selected as part of receiving brief advice. The data were collected from each user session using JavaScript (or tracking code) and then sent to a Google data collection server where sessions are aggregated and then made accessible via the Analytics console online. A disaggregated, anonymised dataset from October 2017 to 2018 year-end was available as part of backing-up data whilst website re-development was undertaken. To look at time and seasonality a decision was taken to look at just one calendar year to avoid skewing any findings as the 15 months available included two alcohol awareness weeks when higher website usage and IBA interventions occurred, so the disaggregated data from the full 2018 year were requested and provided as a .csv file via secure file transfer to the researchers. These data, hereafter called “2018 data”, allowed visibility of each data item for each user session and so analysis of relationships between variables for 232,302 user sessions including 60,745 completed IBA interventions could be undertaken. Both datasets available were quantitative, historic, anonymised, and provided by users without any means for further contact nor consent to conduct experimental research. The dataset includes 55 potential items the website collects from a user session which can be passively provided as they click through each page or actively provided, including questions users respond to including: demographics: ethnicity, age-range, gender, and Local Authority (LA). For some analysis a user’s selection of a UK-based local authority area or areas were used as a means for separate analysis of that population from all users, for example in the case of looking at the time (in Greenwich Mean Time) the user session on the website occurred, or where a specific local authority’s population using the website was compared to prevalence data for alcohol use. Through passively provided user data, this dataset also captures user behaviour including: bounce rates (users who leave immediately rather than continue to further pages of the website), the time spent on the website during a session of use, user’s AUDIT score if completed, IBA intervention activity and completion rates, and follow-up options selected by users as part of receiving an IBA intervention. The data are predominantly ordinal and nominal, with pre-set answers for users to select from, so the most useful research methodology is descriptive quantitative research. A descriptive research study was pursued as such a significant amount of data meant that much more data analysis could have been conducted looking at the relationships between multiple data items, however due to resources and time meant the researchers had to restrict the focus within the possible options available. The data analysis was focused to give us more detail to inform us about what reach a website’s IBA intervention can have, who the users are completing the website’s IBA intervention, the DRC of users, significant relationships between different variables of users completing the website’s IBA interventions and how they behave during the IBA intervention on the website.

Excel was the main tool used to conduct descriptive statistical analysis. Where possible, DRC proportions of in the adult population taken from Local Alcohol Profiles England (LAPE) data estimates[39] were applied to adult (16+) population figures taken from ONS data[40]. This allowed for a measurement of the website's IBA intervention penetration in 2018 by taking that year's DRC results and comparing this with the DRC estimates against adult population numbers, but only where users indicated they were from an LA listed on the website. This particular part of the analysis could only be applied to LA areas who commissioned the IBA website during 2018 and so could be selected by users that year.

This study has delivered a quantitative analysis of selected, relevant nominal and ordinal data of significant size from the website, particularly focused on those users completing IBA interventions. The design is a cross-sectional study as the individual users' own online-generated activity is not able to be repeatedly analysed over time and also because links between any additional, secondary visits are not captured in the data. Furthermore, the users are self-selecting individuals, presumed interested in feedback on their alcohol-use behaviour; presenting a sampling bias which is explored in the Discussion.

Results

The results draw upon 2013-2019 data, unless otherwise specified.

Website usage: sessions, length, and device

A session is a single period of user access to the website. In total there were 868,104 sessions by 772,664 unique devices. This could be interpreted as 89.0% of sessions were undertaken by unique individual users; however, multiple different users could also share a single device, or a single user could use multiple devices. The average bounce rate was 40.0%, so in 60.0% of sessions the user progressed beyond the website's first page. Average session length was 141 seconds including those who only visited the website's first page. Since 2013 devices used to access the website have changed with increasing mobile and decreasing desktop access (Figure 2).

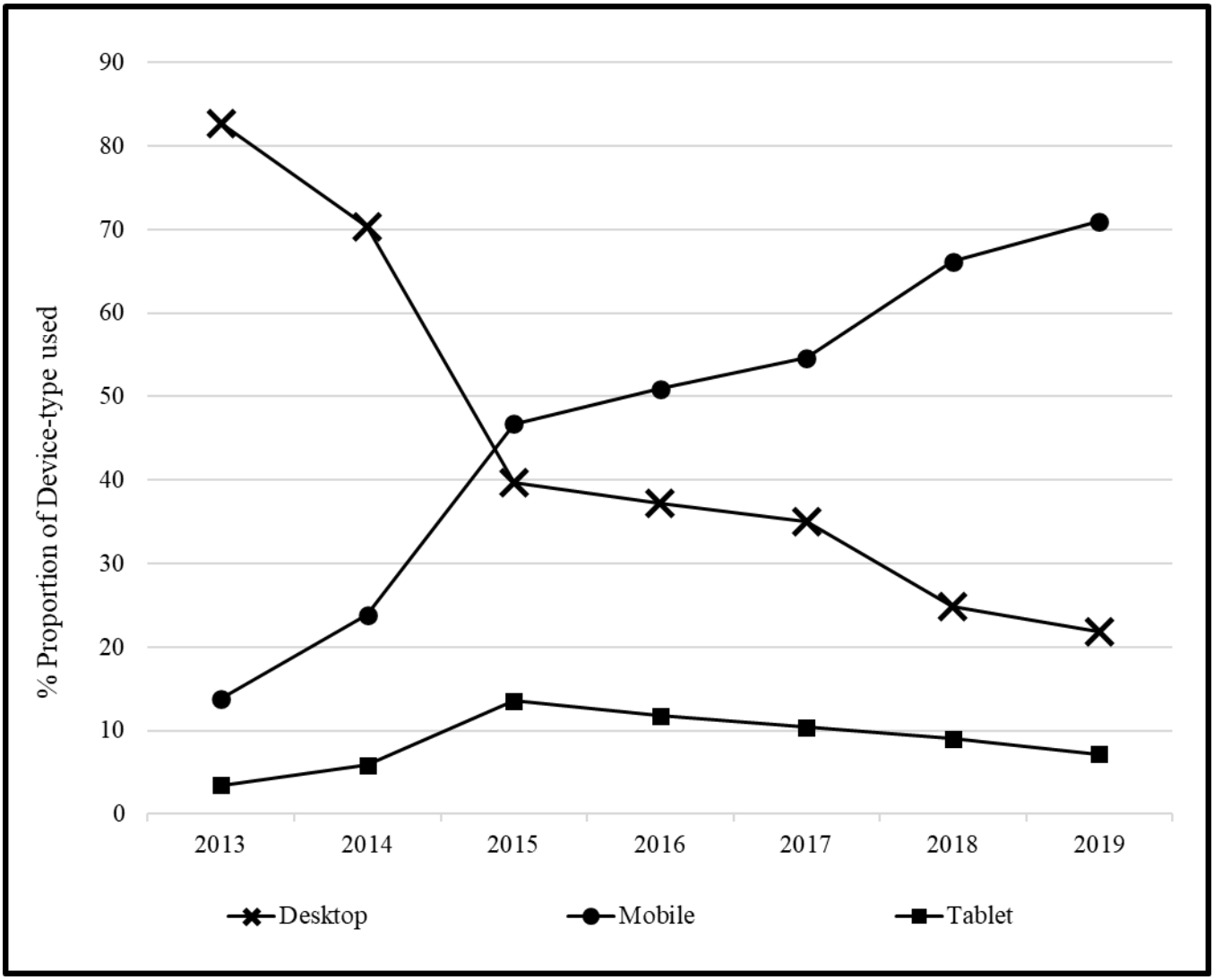

Figure 2 – Device used to access DrinkCoach website 2013-2019

Digital behaviour and seasonality

Figure 3 shows a higher proportion of sessions between August and January compared to the rest of the year. January and November, in particular, were months with highest use. April showed the lowest use figures. These session spikes are correlated with established alcohol public health campaigns in the United Kingdom such as “Alcohol Awareness Week” which occurs in the third week of November, or those related to abstaining from alcohol including “Go Sober for October” or “Dry January”. Higher sessions in August correspond with summer school holidays.

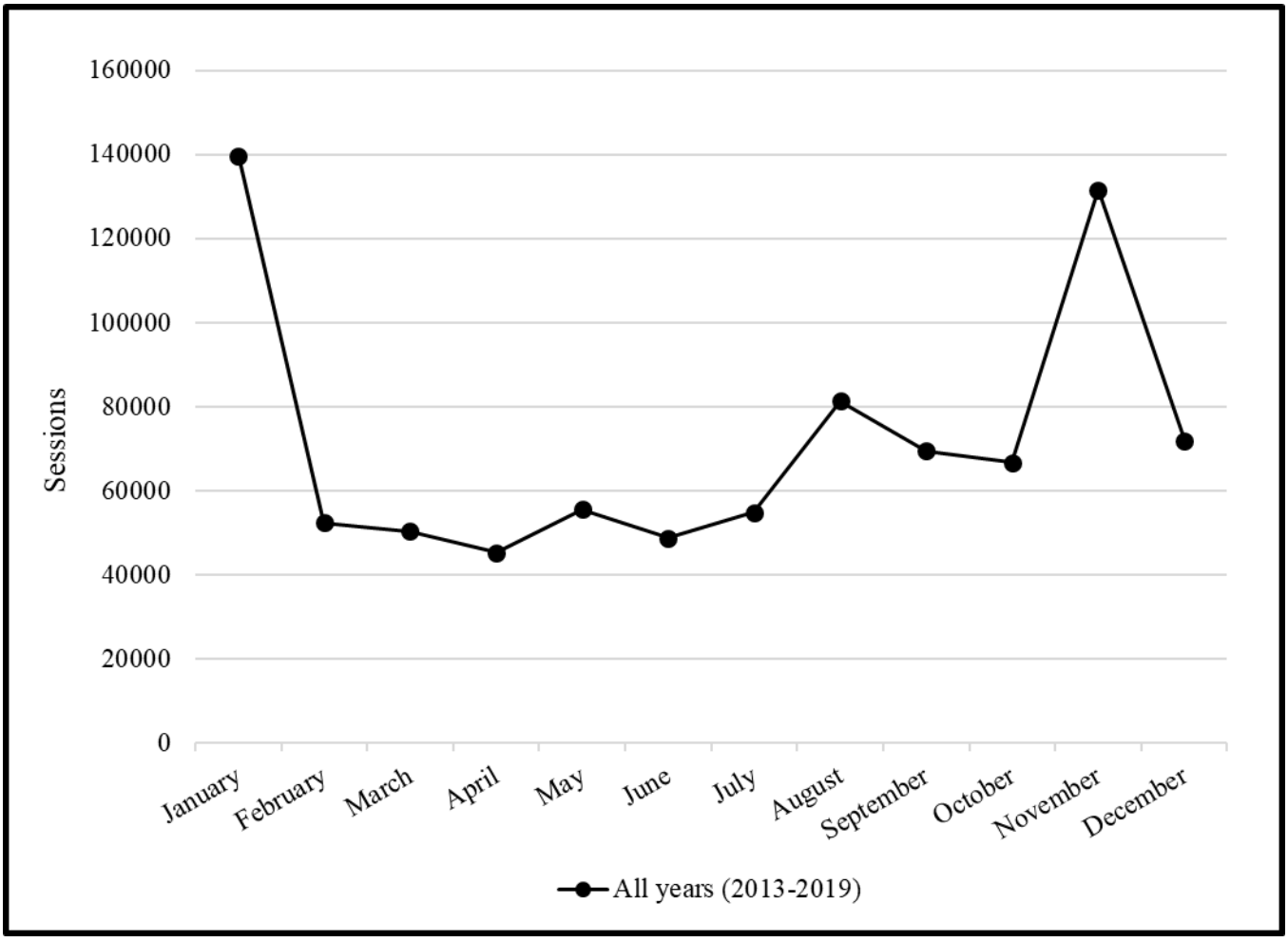

Figure 3 – DrinkCoach website session count by month using 2013-2019 data

A search engine site was employed in 47.4% of all sessions and social media used in 17.7% of all preceded users visiting the website. Figure 4 shows responses from IBA completing users (n= 247,998), to the question “how did you hear about [the website]?”.

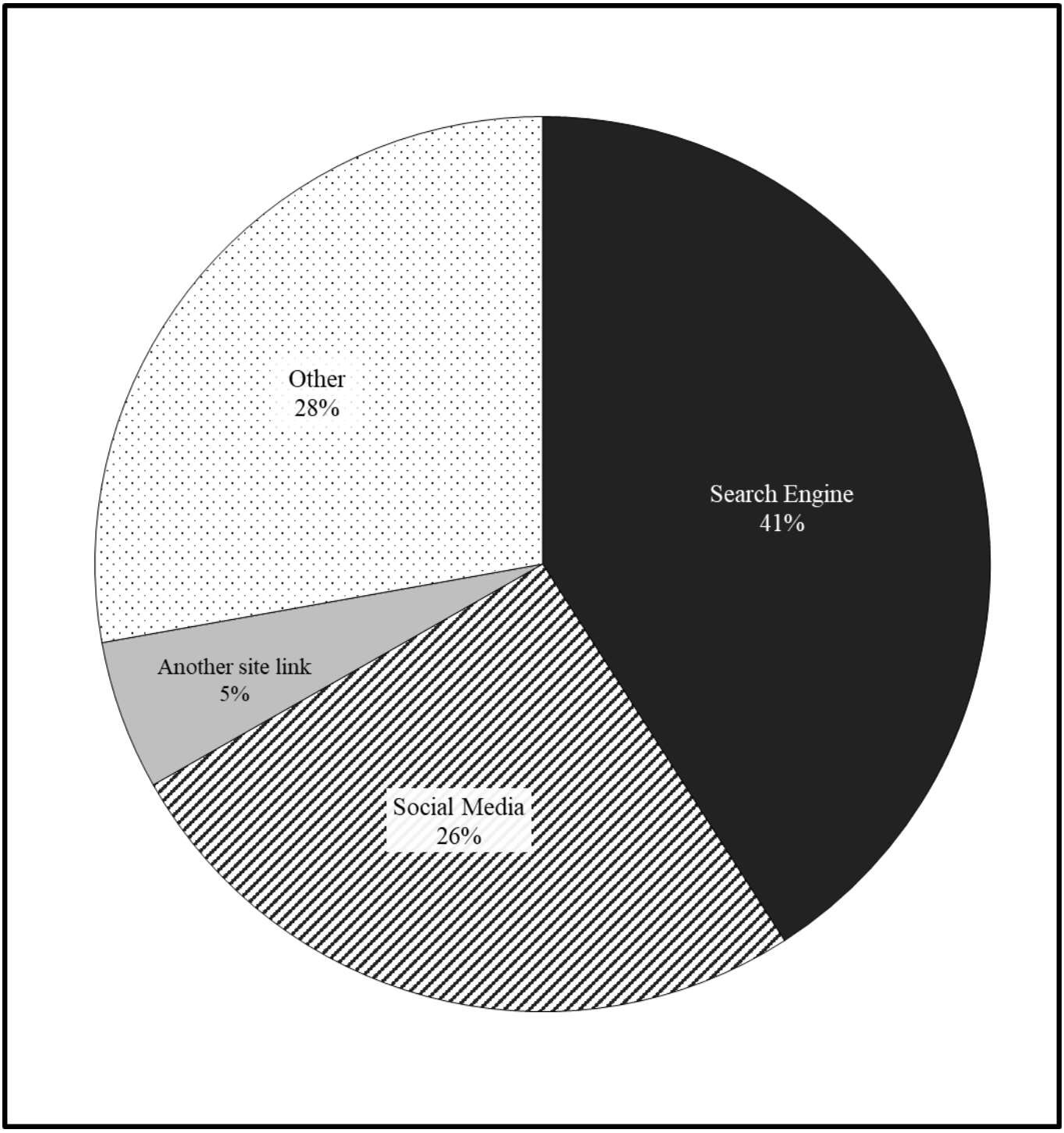

Figure 4 – DrinkCoach IBA intervention users' responses to "how did you hear about [DrinkCoach]?"

Demographics

The users commencing AUDIT (n=328,549) were 51% male and 49% female. After the AUDIT, users are asked to enter their demographic information including their age-group and ethnicity. Of the age-group data (Figure 5) 35-44 years' old (n=57,256) was most common. Under 16s using the website could not select their age group so may have selected another age-group which could undermine data validity. Ethnicity was broadly representative of the general population in England. Uncommon UK ethnicities including: “American” or “Hispanic” were identified in a small proportion of cases in some years when free text was able to be added to core ethnicity and could indicate users outside the UK. 2018 data showed 48.2% (n=29,471) of IBA intervention recipients were from the 12 commissioning LAs, with the remainder selecting “other”.

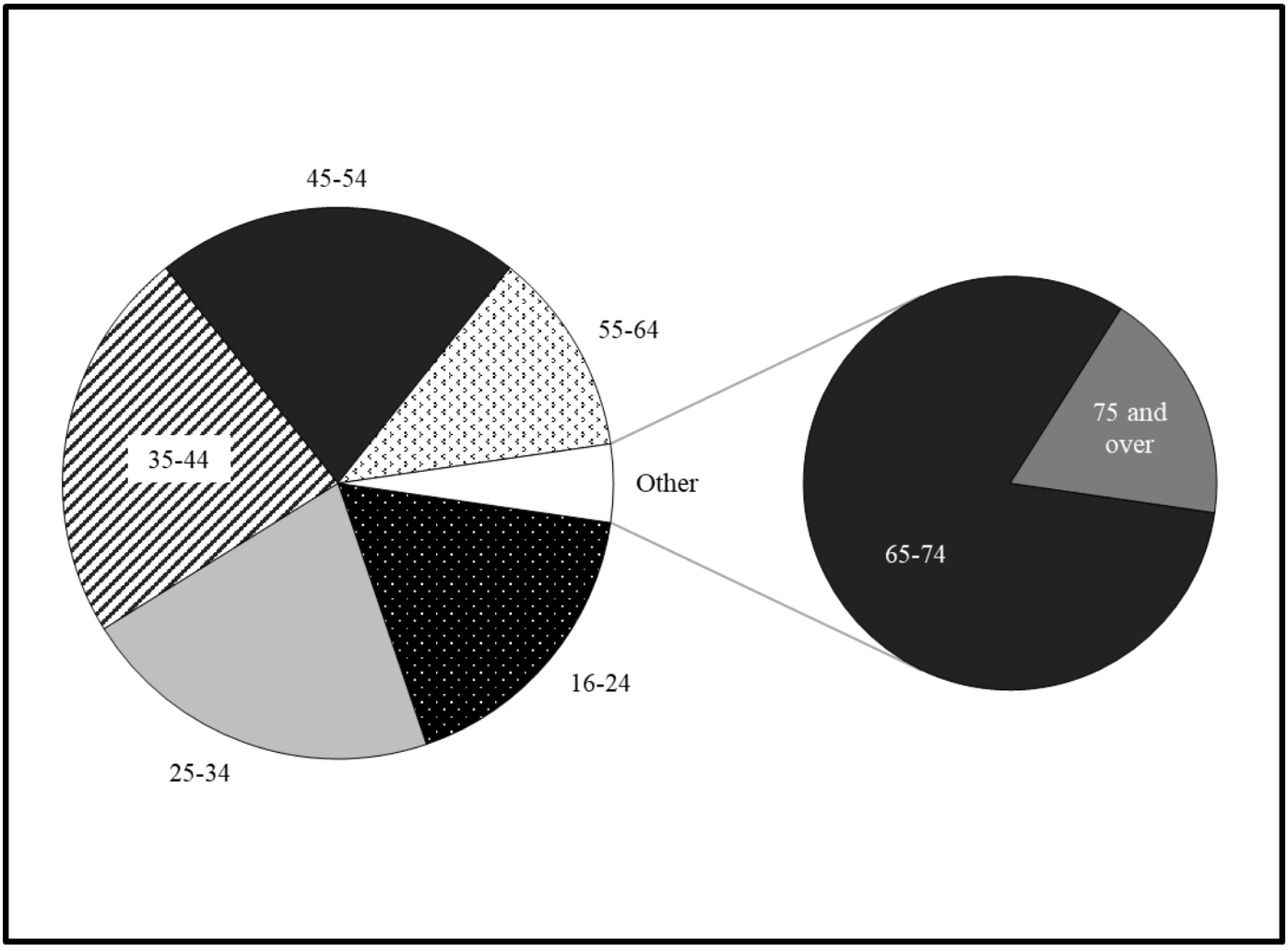

Figure 5 – DrinkCoach IBA intervention users’ age groups

IBA intervention results

37.8% of all sessions (n=328,549) saw the AUDIT commenced. 28.6% of all sessions (n=247,998) saw IBA intervention completion which comprised: demographic/user information capture, AUDIT, feedback on score and DRC, Brief Advice and any follow-up actions chosen.

328,549 AUDITs were commenced with 79.9% (n=262,446) completing AUDIT. About three-quarters of AUDITs commenced resulted in IBA intervention delivery (75.5%; n=247,998); however, the 2013-2019 data DRC counts were only available at the AUDIT completion stage and not IBA completion stage. Of AUDIT completers: 86.4% (n=226,657) were risky drinkers (AUDIT >7) as shown in Figure 6.

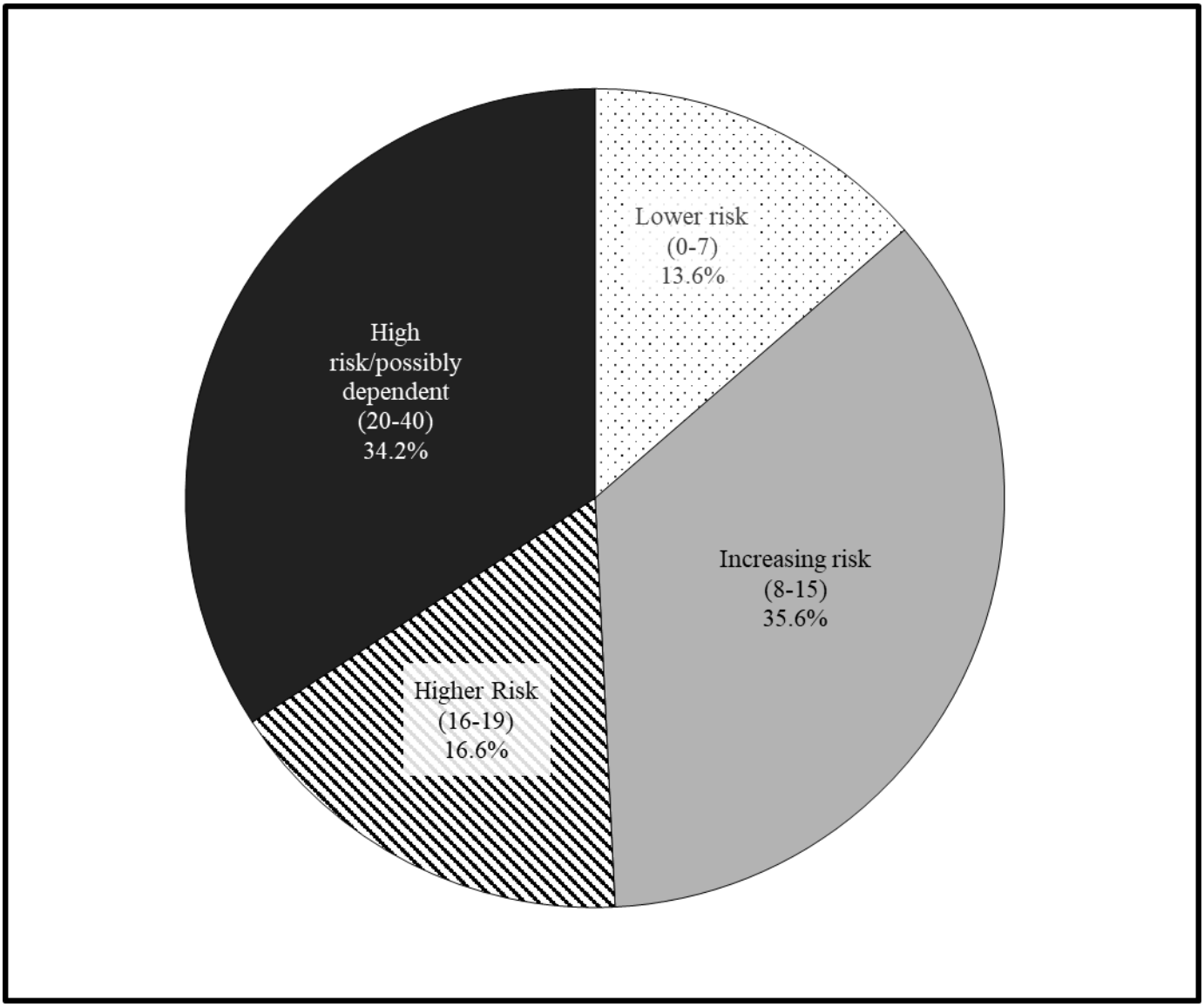

Figure 6 – AUDIT score drinking risk categorisation of AUDIT-completing DrinkCoach users (2013-2019)

2018 data from completed IBA interventions (n=60745) allowed disaggregation of AUDIT scores from DRCs and so analysis of score distribution as shown in Figure 7. The Kolmogorov-Smirnov test was applied, and the Maximum result was 0.0760, higher than the Critical Distribution figure for 0.0066 (1.62762/square root of n). So, the data are not normally distributed ($p<0.01$). The descriptive statistics were: $\mu = 16.12$; M = 15; and Mo = 11.

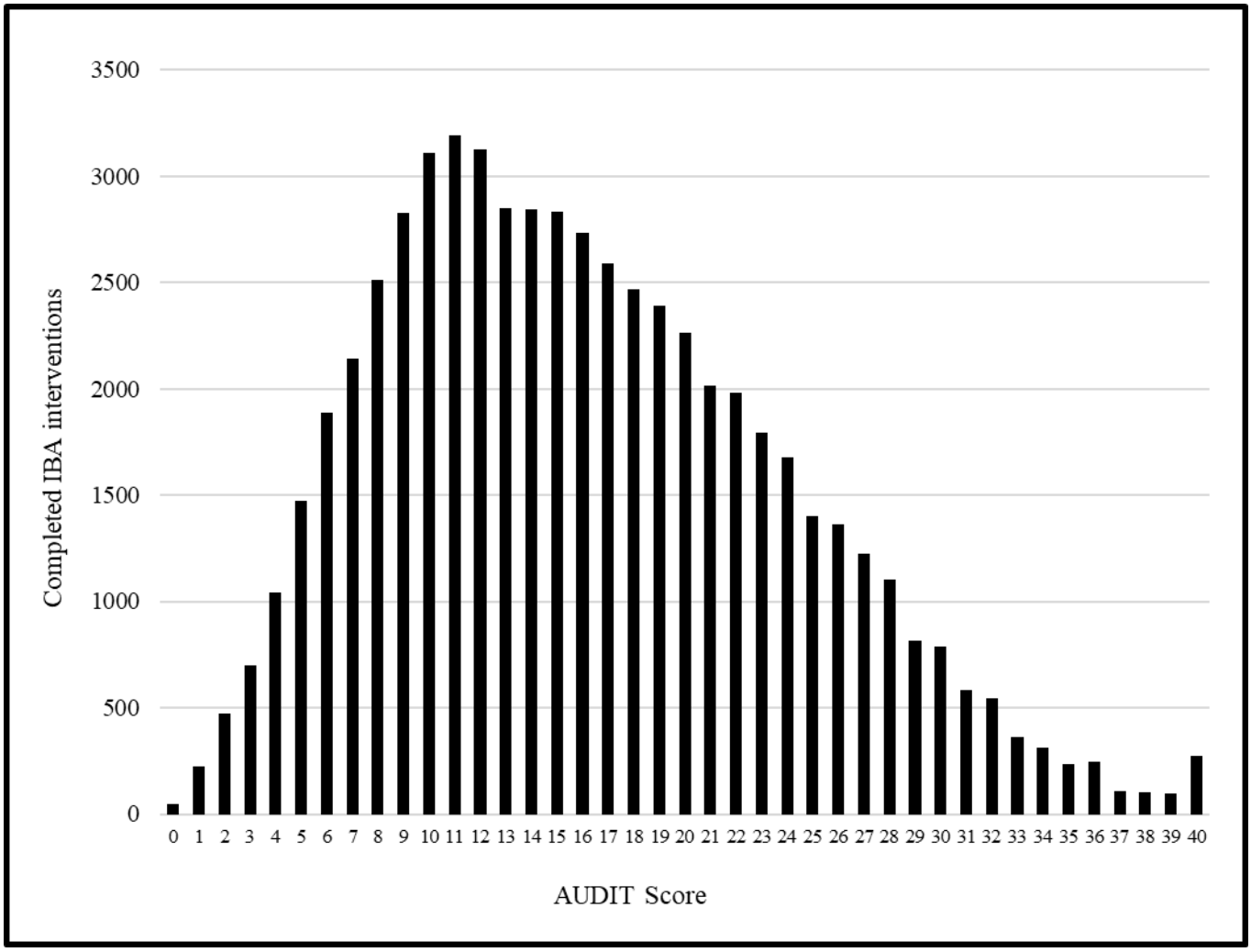

Figure 7 – Distribution of DrinkCoach AUDIT completers AUDIT scores (2018 data)

Follow-up option selection

At least one follow-up option was selected in only 9% (n=22,563) of sessions with selections shown in Figure 8. Three-fifths (59%) of users selecting a follow-up option sought information about or support from an alcohol service (postcodes, online appointments, requesting calls/emails). The postcode follow-up option, when selected, was for postcodes (n=11,398) within a commissioned LA area 80.45% (n=9,170) of the time. This shows a significant proportion of users from LAs who commissioned the service of the DrinkCoach website from Humankind.

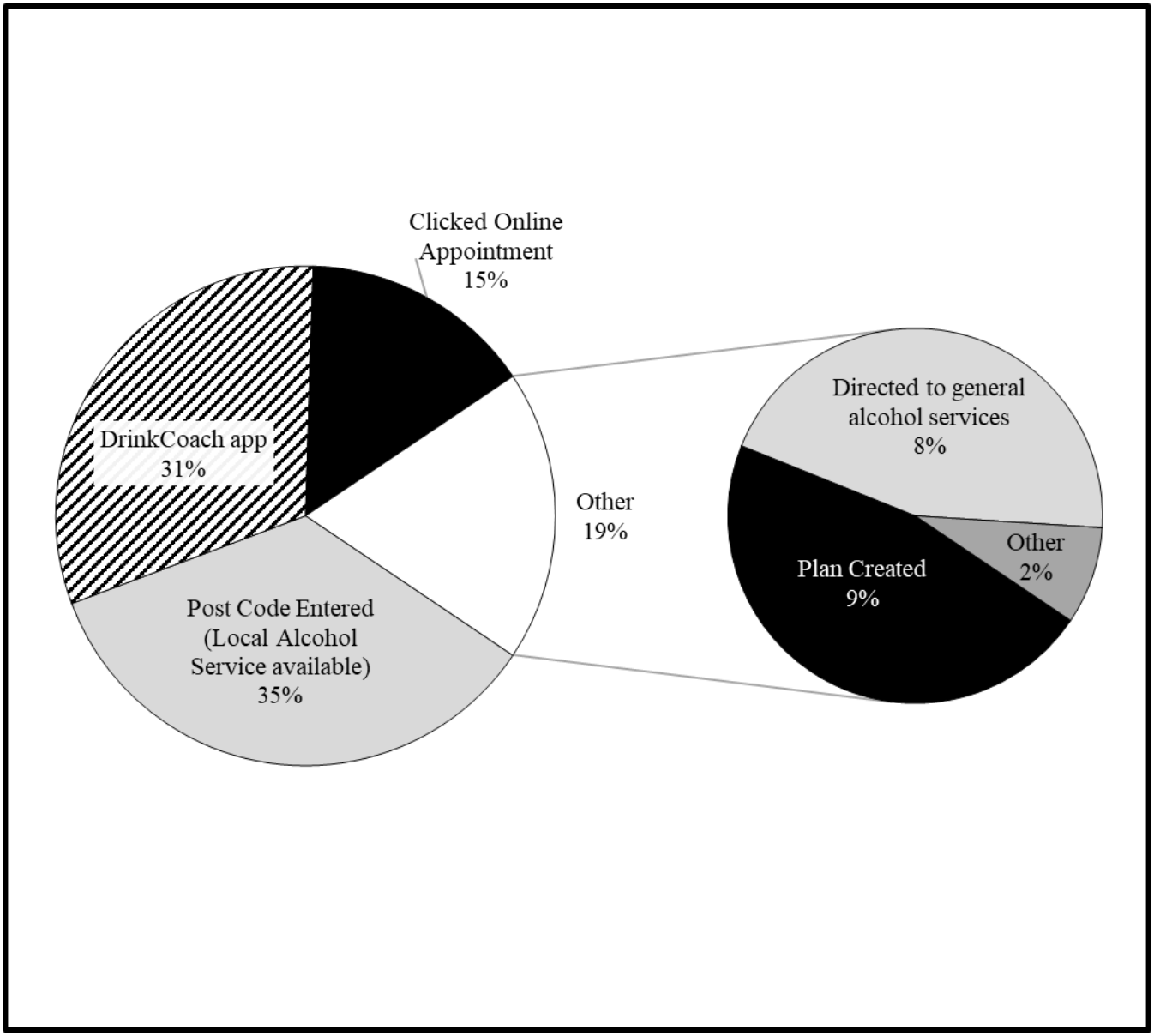

Figure 8 – Post-IBA follow-up selectors chosen options (excludes non-selectors)

Cost-Effectiveness and Cost-Benefit

In Table 1, the value in projected cost savings to health services and future alcohol-related health harms based on Public Health England calculations[29] were applied to the website's IBA intervention data from 2018. This includes comparison with in-person IBA costs and accepts the benefits[29], which are explained in the Methods section of this paper. Furthermore, comparing in-person IBA approaches, such as NHS health checks which apply universal IBA interventions to whole populations with a website's IBA intervention which attracts more drinkers who would benefit from IBA receipt we can realise further cost-benefits. By using psychiatric household survey prevalence estimates of 19.7% for excessive alcohol use[17] and considering how many more IBA interventions in-person would be required to identify the same number of individuals drinking excessively (considering the research's finding of 86.4% of users demonstrating excessive alcohol use) we can calculate how many more are needed to be treated with an IBA to deliver the same scale of alcohol consumption reduction.

The website's IBA intervention is currently free to users; costs to administer IBA interventions via this website are absorbed by Humankind. . However, if a LA wishes to incorporate their own LA into the website, add local service information, offer bespoke follow-up options post IBA and receive their LA data then there is an initial cost in year one of £6,500, and £4,500 in subsequent years. Using a £7.50 IBA intervention unit cost[29], we can calculate that 867 is the number of IBA interventions required for the commissioning of the website's IBA intervention to be cost-neutral in year one through future cost savings from IBA, with 600 IBA interventions per annum in following years to achieve cost neutrality from future cost savings from IBA.

The two strongest examples of IBA intervention penetration and cost-effectiveness were from two commissioning LAs: Essex and Hampshire. Both of these LAs would have each achieved over £100,000 of future cost savings in the next year when we apply the £27, per annum, per IBA, future health and other costs savings figure to every increasing and higher risk drinker from those LAs completing IBA interventions in 2018 via the website's IBA intervention[29]. Hampshire showed the strongest case for spending on a website delivering IBA interventions, with a £17 return for every £1 spent on (£4,500 p.a. cost).

Table 1 – DrinkCoach IBA interventions future health services' cost savings

IBA outputs	2018 data Number & (Percentage)	2013-2019* Number & (Percentage)
Low Risk (AUDIT score 0-7)	7,987 (13.1%)	33,827 (13.6%)
Increasing Risk (AUDIT score 8-15)	23,286 (38.3%)	88,238 (35.6%)
Higher Risk (AUDIT score 16-19)	10,179 (16.8%)	41,068 (16.6%)
Potentially Dependent (AUDIT score 20 or above)	19,293 (31.8%)	84,865 (34.2%)
All excessive drinker groups (increasing, higher, high risk/possibly dependent)	52,758 (86.9%)	214,171 (86.4%)
Total IBAs completed	**60,745**	**247,998**
Number of IBAs where £27 per annum IBA future cost saving benefit[29] achieved (increasing and higher risk drinkers only)	33,465 (55.1%)	129,306 (52.1%)
Estimated Cost saving based on £27 per annum, per IBA future cost saving benefit for each increasing/higher risk drinker[29]	**£903,555**	**£3,491,262**
Estimated Cost saving based on £136 per IBA future cost saving benefit over five years for each increasing/higher risk drinker[29].	**£4,517,775**	**£17,456,310**
Number of adults you would need to deliver universal in-person IBA interventions to in order to equivalent numbers scoring 8+ on AUDIT based on 19.7% of England Adults prevalence[17]compared to website's IBA intervention prevalence of those scoring on 8+ AUDIT being 86.4%.	267,807	1,087,162
Ratio of universal in-person IBA interventions required to deliver same number of IBA interventions as website's IBA intervention to those scoring 8+ on AUDIT based on 19.7% of England Adults prevalence[17] and the website's intervention prevalence of those scoring 8+ on AUDIT being 86.4%.	**4.41:1**	**4.38:1**
Equivalent costs for universal in-person IBA intervention approach in primary care cost at £7.50 per IBA[29]required to match same IBA intervention delivery to 8+ AUDIT scorers taking in account prevalence difference to website's IBA intervention data.	**£2,008,553**	**£8,153,715**

*Estimated based on AUDIT scores DRC % against IBA completions (n=247,998) as IBA completions DRC % not available in data.

When we look at penetration rates into the DRC groups in Essex, in 2018, the website's IBA intervention was completed by 2,385 individuals drinking at increasing and higher risk (AUDIT score 8-19). Using ONS adult (aged 16+) population data for Essex[40], and applying the prevalence proportions of increasing and higher risk drinkers in Essex[39] to that population we can estimate that 330,747 adults in Essex are increasing or higher risk drinkers and conclude that the website's IBA intervention reached 0.72% of that population. For the 12,205 potentially dependent drinker (AUDIT score 20+) population in Essex[39], the website's IBA intervention's penetration rate was higher still at 10%, with 1,221 of that population receiving an IBA intervention and, through tailored brief advice and follow-up options, information about and direction to local alcohol treatment services.

When we look at penetration rates into the DRC groups in Hampshire, in 2018, the website's IBA intervention was completed by 2,869 drinking at increasing and higher risk (AUDIT score 8-19). Using ONS adult (aged 16+) population data for Hampshire[40], and applying the prevalence proportions of increasing and higher risk drinkers estimated in Hampshire[39] to that population, we can estimate that 388,679 adults in Hampshire are increasing or higher risk drinkers and conclude that the website's IBA intervention reached 0.74% of that population. For the 9,980 potentially dependent drinker (AUDIT score 20+) population in Hampshire[39], the website's IBA intervention's penetration rate was higher still at 14.43%, with 1,440 of that population receiving an IBA intervention and, through tailored brief advice and follow-up options, information about and direction to local alcohol treatment services.

Relationships between variables and Drinking Risk Categories (DRC)

A series of relationships between different variables and DRC were identified. The relationships were quantified by count and proportion, then subjected to a X^2 test to measure correlation between datasets ($p<0.01$) and double-tailed Z tests to measure whether the difference in proportion was statistically significant ($p<0.01$). The analysis of relationships between specific variables and DRC is covered in Tables 2 and 3.

The relationship between seasonality and DRC is shown in Figure 9.

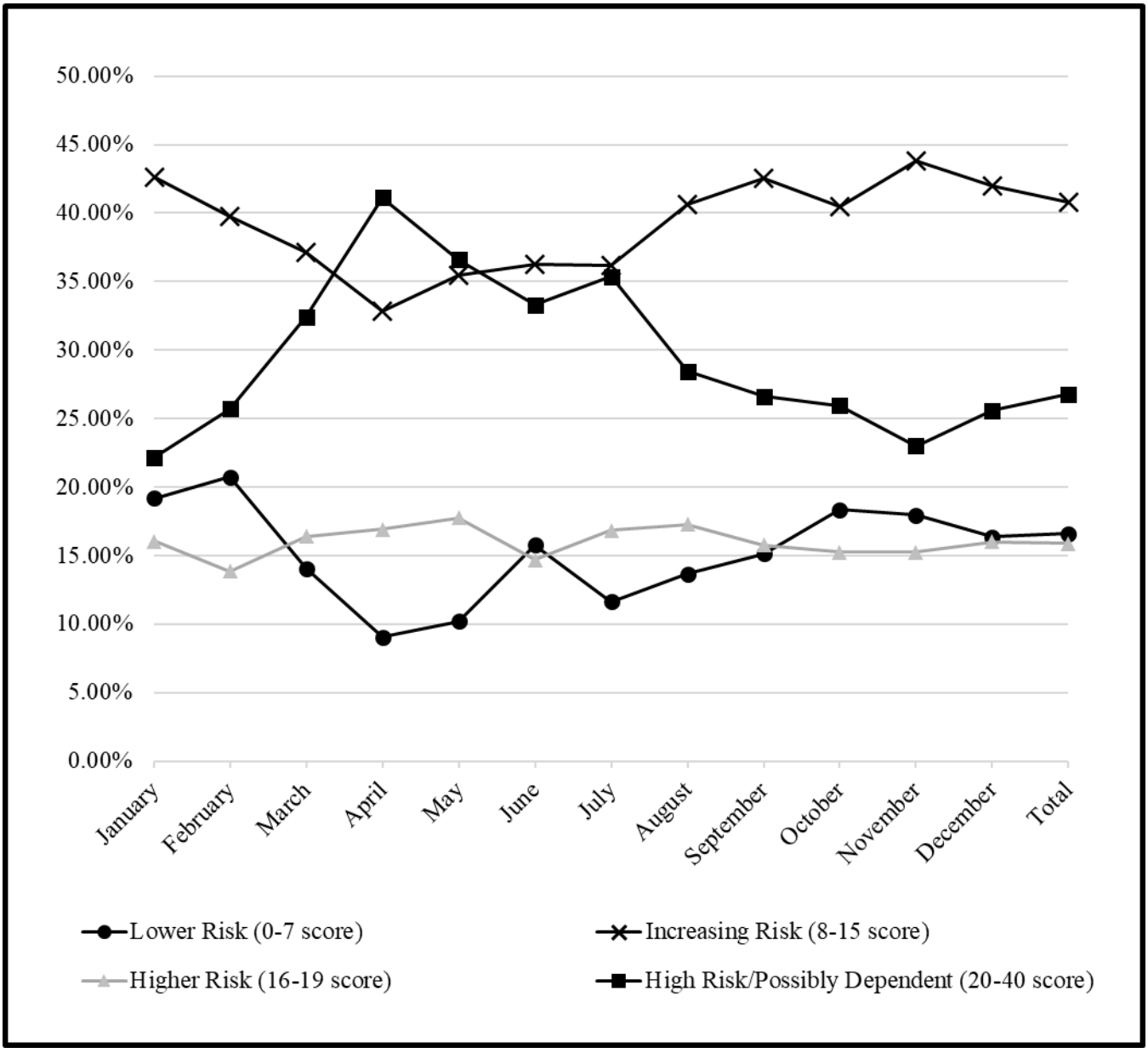

Figure 9 – Relationship between drinking risk category and month of DrinkCoach IBA intervention (2018 data)

This shows a seasonal effect on the observation of DRC recorded during IBA interventions. In particular, the months around campaigns, with greater IBA completion rates, are correlated with greater proportions of low risk drinkers being identified in January (the highest month for IBA completions) and February (the month following the “Dry January” public health campaign). In lower-IBA completion months such as April, greater proportions of potentially dependent drinkers were identified.

Both relationships are shown in Table 2 as statistically significant ($p<0.01$). There is also a significant relationship between users accessing the website’s IBA intervention, the hour of day, and their

resulting DRC as shown in Figure 10. Higher use in the evenings between 7pm and 11pm Greenwich Mean Time (GMT) is a notable finding.

The relationships between follow-up choices, gender, ethnicity, and age-group of significance are shown in Table 3.

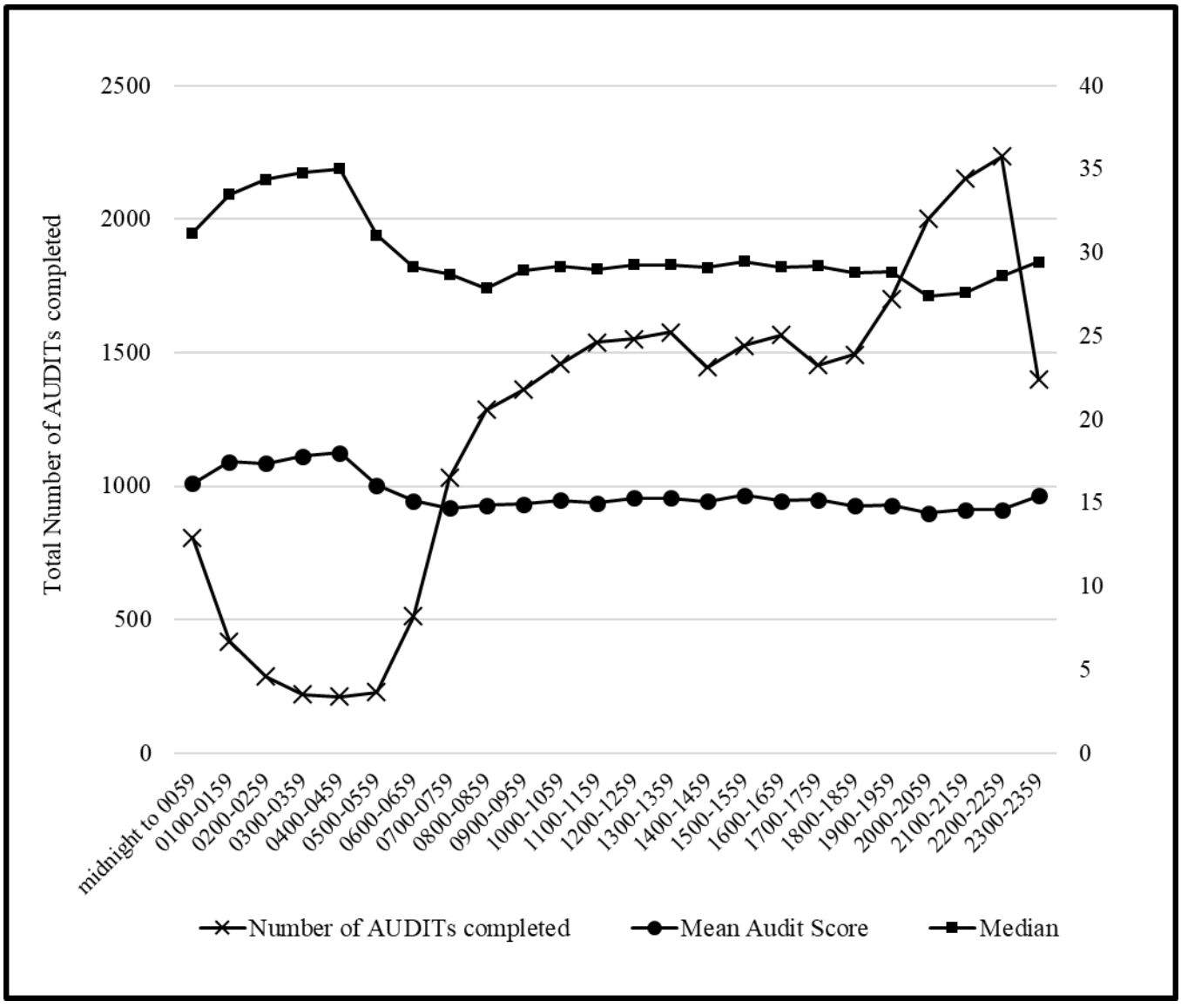

Figure 10 – Relationship between AUDIT score averages and GMT hour of day (2018 data UK-only local authority-based users only)

Table 2 – Relationships between drinking risk categorisation and time elements of DrinkCoach IBA intervention

Variable (sample number)	DRC comparison tested	Number & (Proportion)		X^2 test result	Two-tailed Z test result
January *highest use* (6685)	LR vs RD	LR 1283 (19.19%)	RD 5402 (80.81%)	61.79 1 DOF p<0.01	**Z 7.8608. significant result (p <0 .01)**
April *lowest use* (1016)		LR 92 (9.06%)	RD 924 (90.94%)		
January *highest use* (6685)	HRPD vs LR, IR and HR	HRPD 1481 (22.15%)	LR, IR, & HR 5204 (77.85%)	171.15 1 DOF p<0.01	**Z -13.0825. significant result (p <0 .01)**
April *lowest use* (1016)		HRPD 418 (41.14%)	LR, IR, & HR 598 (58.86%)		
Using just UK LA user data (as time data aligned with GMT)					
Variable (sample number)	**DRC comparison tested**	**Number & (Proportion)**		**X^2 test result**	**Two-tailed Z test result**
Weekdays (21319)	LR vs RD	LR 3490 (16.36%)	RD 17829 (83.63%)	2.43 1 DOF p<0.01	Z -1.5575. p is .11876. not significant result
Weekends & Holidays (8152)		LR 1396 (17.12%)	RD 6756 (82.88%)		
0000-0559 (2177)	LR vs RD	LR 267 (12.26%)	RD 1910 (87.74%)	31.64 1 DOF p<0.01	**Z -5.6247. significant result (p <0 .01)**
0600-2359 (27294)		LR 4619 (16.92%)	RD 22675 (83.08%)		

Legend
LR: Low Risk drinker (scoring 7 or less on AUDIT)
RD: Risky drinker (scoring 8 or more on AUDIT)
DOF: Degrees of Freedom

Table 3 - Relationships between drinking risk categorisation and DrinkCoach user behaviour, user demographics

Variable (sample number)	DRC comparison tested	Number & (Proportion)		X^2 test results	Two-tailed Z test result
Selected Follow-up (3712)	LR vs PD (excluding IR & HR)	LR 118/7987 (1.48%)	PD 1906/19293 (9.88%)	580.50 1 DOF p<0.01	**Z -24.0935. significant result (p<0.01)**
Did not Select Follow-up (57033)		LR 7869/7987 (98.52%)	PD 17387/19293 (90.12%)		
Female (29778)	LR vs RD	LR 4767 (16.01%)	RD 25011 (83.99%)	464.40 1 DOF p<0.01	**Z 21.55. significant result (p<0.01)**
Male (30460)		LR 3076 (10.10%)	RD 27384 (89.90%)		
Age groups 16-54 (45258)	LR vs RD	LR 4940 (10.24%)	RD 40318 (89.76%)	614.76 1 DOF p<0.01	**Z 24.7944. significant result (p<0.01)**
Age groups 55 & over (9828)		LR 1971 (16.02%)	RD 7857 (83.98%)		
White British (45905)	PD vs LR & IR & HR	PD 14825 (32.29%)	LR, IR & HR 31080 (67.71%)	11.18 1 DOF p<0.01	**Z 3.3438. significant result (p<0.01)**
White Irish (2157)	PD vs LR & IR & HR	PD 771 (35.74%)	LR, IR & HR 1386 (64.26%)		

Legend
LR: Low risk drinker (scoring 7 or less on AUDIT)
IR: Increasing risk drinker (scoring 8-15 on AUDIT)
HR: Higher risk drinker (scoring 16-19 on AUDIT)
PD: Potentially dependent (scoring 20+ on AUDIT)
RD: Risky drinker (scoring 8 or more on AUDIT)
DOF: Degrees of Freedom

Discussion

This website, and the IBA intervention it delivers, provided vast amounts of data so only the most salient findings were included in this paper.

Engaging Risky Drinkers and delivering IBA

A review of literature did not identify any source of evidence for equivalent productivity of IBA intervention delivery in public settings by which to compare this website's IBA intervention with in-person approaches. No studies were identified for publicly accessible websites online to compare the IBA intervention completion rate of users of this website, where 28.6% visited completed IBA interventions between 2013-2019, nor compare the 86.4% proportion of users scoring 8 or above on AUDIT, indicating risky drinking. This may mean the results of this research into this website's IBA intervention are not generalisable to all websites and their IBA interventions. The results could be generalisable to any other websites' IBA interventions which are: accessible on the internet, adhere to IBA intervention requirements,[18] and use AUDIT as the alcohol questionnaire. Other UK websites vary in their components and may not be considered an IBA intervention as described in this paper. NHS's "drink less" is not led by a website IBA intervention but is a campaign aimed at healthier alcohol use. In the UK, Drinkaware and WDP operate AUDIT-led IBA interventions on websites, which closely match the DrinkCoach website's IBA intervention and so the results could be seen as generalisable to those in particular. The proportion of risky drinkers receiving IBA was disproportionately higher than the 19.7% of adults indicated by the most recent survey in the UK[17]. This disparity between website data and the survey sample of the general UK population could be due to a number of factors including the website being actively sought by those who have concerns about their alcohol use and possibly a confirmation of under-reporting masking the true extent of the risky drinking in the UK[30,31]. This disparity may also be due to website's IBA intervention having the benefit of anonymity to users[34].

There are likely multiple factors influencing this disproportionate identification of risky drinkers by the website's IBA intervention l. The website's digital strategy is attracting users via keyword searches on search engines, hence 41% arrive by search engine, whilst 26% of users arrive via social media. Furthermore, the website retains 60% of users beyond the first page, converting 28.6% of all users into IBA intervention completions. The lower the interaction cost for users in each of the website's steps, and the fewer collective steps, the less attrition occurs and the greater the success in users' completing desired actions[41,42]. This is despite this website's IBA intervention using the longer 10-question AUDIT, which delivers higher sensitivity (92%) and specificity (94%)[16] than the

shorter AUDIT-C, which at 3 questions would deliver less interaction cost and so, presumably higher completion rates of IBA interventions. Similarly, users appear to want little more beyond the initial results and brief advice page with only 9% of all DRC users selecting any further follow-up options. There may be many reasons for a lack of selection of the follow-up options: it could be users were not satisfied with the follow-up options offered; or disagreed with the feedback or brief advice; were just curious to find out their score but were not ready or motivated to make any changes to their alcohol use behaviour; finally some users may have been curious just to see what would happen if they reported the highest alcohol consumption and provided answers gaining the highest score on AUDIT rather than answering honestly, which may explain the particular skewed distribution of AUDIT scores in the 2018 data including the higher number of scoring 40 compared with those scoring 39, as shown in Figure 7.

These concepts of digital strategy to draw in the target risky drinker users, website design minimising interaction costs and delivering lower attrition rates and higher IBA intervention completions are factors receiving scant mention in recent systematic reviews[7,35]. The scale of effective delivery and penetration by websites' IBA interventions to risky drinkers is important when considering what public health approaches work and could be a more important focus for research to maximise the collective population-level effects of IBA interventions. If a digital IBA intervention delivers significant reductions in alcohol consumption but is not evaluated for its reach and appeal beyond the trial setting, then it will be an ineffective public health intervention for investment compared with a widely accessed and used website IBA interventions that may deliver more modest alcohol consumption reductions.

Reach and Public Health promotion

Aside from the disproportionate use by risky drinkers, 49% of the website's IBA intervention users identified as female, greater than the 40% of females in alcohol treatment in England[10]. Females are accessing the website nearly as often as males by proportion of the England population, in contrast to their accessing alcohol treatment services in England. This is a useful insight into who is attracted to this website and completing its IBA intervention, and potentially engaging in the follow-up options presented at the end of the IBA intervention. This finding should inform design of website IBA interventions when considering groups with protected characteristics. This relative parity of access for females could be because of the non-judgmental nature of a website, or the apparent safety in accessing alcohol information and support through a computer as opposed to in person in an environment where male service users are predominant and are perceived to pose a risk. The website's IBA intervention was used by some aged 75 and over but this was significantly less than

younger age groups, with 35-44 being the age-group that completed IBA interventions the most. It is important to note that, in a time of COVID-restrictions and guidance to engage alcohol and substance misusers remotely[43], this website was established as a means to do so, and data over the period of the COVID pandemic for website's delivering IBA interventions may well prove the utility of this reach during this time.

Analysis comparing time windows showed AUDIT tests were most often completed between 7pm and 11pm GMT. A statistically significant proportion of higher risk and potentially dependent drinkers engaged with the site between midnight and 6 am. These insights should inform marketing and public health engagement activities such as media campaigns trying to address such problematic drinking behaviour. For example, media promoting a website delivering IBA interventions might use a call to action such as – "take two minutes to do the test tonight" rather than trying to get users to do it during the day. Similarly, different communications aimed at potentially dependent drinkers on media between midnight and 6am might also be undertaken to allow access to or direct towards treatment. Also, service providers should consider the availability of support for alcohol misuse during these time windows through the provision of online sessions, initial treatment assessments, counselling, or live-chat functions to best engage the more problematic drinking population, women, and the population as a whole when it appears they might be more receptive.

Cost, effectiveness and comparative benefit

Websites delivering IBA interventions cost significantly less and deliver effective IBA at the time it is needed by users[7,35,36]. Given the website's IBA intervention studied is free to access online for users, the benefit to them could be argued to be infinite. However, the Cost-Benefit of the website's IBA intervention was assessed by using: commissioning LA costs and data; population data[40]; relevant PHE prevalence data[39]; and the website's 2018 data on IBA interventions. In the case of the Hampshire LA: £17 in future health savings (per annum for up to five years) would have been realised for every £1 invested in the website delivering IBA interventions, drawing upon future health cost savings' estimates[29] when applied to increasing and higher risk drinkers alone. Furthermore, commissioning LAs would have benefited from an effective integrated digital pathway for those users requiring more than IBA interventions, including the follow-up options, especially those who are potentially dependent drinkers.

Using the prevalence estimate for the adult population in England of 19.7% scoring 8 or above on AUDIT[17], we can calculate that 4.41 in-person IBA interventions would be required to identify

equivalent proportions of those scoring above this threshold for every single IBA intervention that the website delivered to this target 'risky drinking' population.

No standardised, national data monitoring in England on IBA intervention delivery to increasing and higher risk drinkers are available to confirm a low proportion of those populations are receiving them. However, a review of GPs being paid incentives to deliver IBA interventions to primary care populations did describe flawed identification from misusing screening tools, a lack of delivery of brief advice to those identified to require it and inaccurate reporting of DRCs and patient referral on or follow-up[28]. This is not surprising as those working in primary care are commonly not aware of the low risk limits[44] and poor IBA practice continues to be the common practice in UK primary care by GPs and other healthcare workers[26-28]. When financial incentives in primary care were put in place for GPs no significant change identification of alcohol use practice was noted[28], and when incentives were withdrawn, identification practice reduced further[45]. Alcohol misusers may not attend commissioned treatment services as they may not wish to associate themselves with those who do attend those services as they may stigmatise other alcohol misusers as not being like them or drug-users as part of the alcohol and drug double-standard[46]. With in-person IBA and treatment approaches only, this affects referral pathways for those in need of specialist treatment (scoring 16-40 on the AUDIT), as evidenced by only 14% of individuals in specialist alcohol treatment being referred by their GP[10]. Based on the analysis in this paper, digital IBA interventions, including those delivered by websites, should be recommended as a relatively cheap, cost-effective public health intervention that can complement in-person IBA, thus increasing IBA delivery to risky drinkers and improve referral rates into specialist treatment.

Study strengths and limitations

This research fills some of the identified gap[7] in evidence for digital alcohol IBA interventions and indicates where further, significant research into websites delivering IBA interventions. This is because such websites can produce high volumes of data for analysis and recruit into studies to confirm alcohol behaviour change by re-measuring AUDIT scores at later stages as part of study follow-up, and confirming consumption or wider behaviour change with alcohol, particularly in a UK cultural context. The large dataset has been built up due to the longevity and online use of the website which has maintained a structure that adheres to the central elements of an IBA intervention and uses the highly sensitivity and specific AUDIT tool. This large dataset and the structure of the IBA intervention offered mean the results could be generalisable to other websites' IBA interventions, particularly those in English and in a UK context. The large dataset meant the analysis has established, with confidence, significant relationships between the DRCs and other user

variables can be drawn to influence our understanding of how IBA is accessed and delivered online, by who and in what context. The research makes a strong case for websites delivering IBA interventions being helpful public health interventions in the real, digital world. There are limitations to the research in that it is cross-sectional and so does not relate each user's journey over time, which would indicate further experimental research in this area is needed to draw firmer conclusions of IBA websites benefits being realised. The content of the website has changed due to the then new guidelines on low risk limits in 2016, as well as follow-up options varying depending on the local authority the user identified during the IBA intervention. The researchers were not able to look at the differences in the website's IBA intervention content over the time period of 2013-2019 within which the data subjected to analysis was collected – however Humankind, the website owner, have provided assurance that the IBA intervention structure has been maintained during that period and content changes have been carried out to maintain fidelity to IBA tenets (e.g. FRAMES). To address the limitation of researcher bias through selection of data, the supervisor was given equal access to scrutinise the data available.

Conclusions

This website's IBA intervention is an example of effectively reaching large numbers of adults, who are disproportionately risky drinkers, and who will benefit from reduced alcohol consumption. This website's IBA intervention would appear to be an effective return on investment in the case of the highlighted LAs who commissioned it. The profile of users showed greater proportions of women than found in treatment services and those who need IBA and specialist alcohol treatment household surveys or primary care in-person approaches. The value of a website delivering IBA interventions is that it is open 24 hours a day, 7 days a week and this has implications for service provision, as well as for public health intervention marketing.

This research will benefit public health commissioners with limited budgets with the described value of websites delivering IBA interventions through their effectiveness and benefits from predicted future health savings serves as a useful comparison to other in-person approaches and their costs. Furthermore, academics and clinicians will benefit from the research highlighting the prevalence of excessive drinking (as measured by the AUDIT score) indicated by the users of a website delivering IBA interventions. This will help in considering future research activities, including the potential of a website to address the stigma of alcohol consumption rather than in-person or via survey, and how alcohol treatment pathways should include a website delivering IBA interventions as a first contact point. Finally, the online behaviour preceding and following a website-delivered IBA intervention will

assist service providers, commissioners, and academics in considering the design and delivery of alcohol-related, and other, public health interventions.

Authors' contributions

The original concept was that of the first author (DAK) and was developed under the supervision of the second author (JMC) as part of a programme of study for the award of MSc (Studies in Health) by the University of Hertfordshire in October 2020.

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Declarations of interest

The first author states that his spouse controls, through shares, an organisation which provides digital design services to the organisation which owns the digital asset and so has a by-proxy financial interest. His spouse's company (Orbis Media Limited) may be affected by the research or opinions being reported in the current submission secondary to the organisation (Humankind) which owns the digital asset.

The second author declares no conflicts of interest.

The views and opinions expressed here are those of the two authors and do not necessarily represent those of their current or former employers.

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