Drinks:Ration

The role of a smartphone application in reducing alcohol consumption in a veteran population seeking formal mental health support

Table of Contents

Tom McBarnet

Chief Executive (Acting)
Forces in Mind Trust

Forces in Mind Trust exists to support the successful and sustainable transition of ex-Service people to civilian life and our Health Programme sets a goal of all members of that community being able to access good quality health and social care services when and where needed. One strand of our strategy toward achieving that goal is to explore health interventions that could be effective in tackling known vulnerabilities associated with the veteran community. A key vulnerability is high alcohol intake, known to be above the average encountered in the wider UK population, and whilst no single intervention is likely to be able to provide a panacea as a solution, we are keen to offer our support to practical initiatives that can help.

Effective interventions are elusive: the veteran population often remains inaccessible behind a self-made shroud built upon culture, identity, Service experience and self-reliance. Help seeking behaviours are notoriously delinquent and so intervention strategies need to be relevant, suitable and simple if they are to achieve any traction. Digital technologies can offer both a pervasive and persuasive route into the veterans' 'bubble', their ubiquity in all aspects of modern life providing a normalising aspect to their use and an availability that suits the requirement of being able to provide support when and where needed. This study usefully lends support to the prospect of smartphone-based alcohol interventions becoming a feasible, acceptable and useable treatment option.

The growth in the availability and use of digital health tech heralds a vast array of opportunities for tackling previously hard to reach cohorts and conditions. Capable of significantly multiplying both evidential data capture and the reach of complementary therapies as part of a broader based approach to veteran mental health support, the *Drinks*:Ration smartphone application study provides a compelling argument for the wider use of digital technologies alongside treatment as usual. At FiMT, we are grateful to the research team for exploring this issue and strongly commend others to consider the implications of the report findings to inform further work toward practical implementation measures and how best these can contribute to real behavioural change.

Jeff Harrison

Chief Executive Officer
Combat Stress

Within the veteran population we treat at Combat Stress, there are many whose mental health problems are compounded by co-morbid alcohol difficulties. As such, we are pleased to support the *Drinks*:Ration project, which aims to help those former servicemen and women seeking support for alcohol misuse.

At Combat Stress, we have seen first-hand the benefits of digital technology, where it has increased veterans' access to the most appropriate services and improved the likelihood of them continuing to engage on their recovery journey. Through digital technology and behavioural change theory, the *Drinks*:Ration smartphone-based app is designed to reduce alcohol misuse by enabling veterans to access support whenever and wherever they want. They receive real time messages personalised around their own goals and lifestyle to help them change their drinking behaviour and monitor and manage their alcohol consumption. This means that together with *Drinks*:Ration, veterans can make the changes they want to their drinking.

The development of *Drinks*:Ration fitted closely with the principles underpinning the specialist mental health treatment offered by Combat Stress; namely, that veterans were central to developing the support provided by the app. For example, *Drinks*:Ration was co-produced by veterans and the research team to ensure it was easy to use and met the needs of these who were going to use it.

At Combat Stress we were pleased to see how effective *Drinks*:Ration was at helping veterans to reduce the amount they were drinking and we are proud to continue supporting this project as it further expands to bring the app to all veterans and make an even greater impact on the military community.

King's Centre for Military Health Research

Previously the Gulf War Illness Research Unit, the King's Centre for Military Health Research (KCMHR) was launched in 2004 as a joint initiative between the Institute of Psychiatry, Psychology and Neuroscience (IoPPN) and the Department of War Studies at King's College London. KCMHR draws upon the experience of a multi-disciplinary team and is led by **Professor Sir Simon Wessely** and **Professor Nicola T. Fear**. It undertakes research investigating military life using quantitative, qualitative, and digital methods. Its flagship study is a longitudinal investigation of the health and well-being of the United Kingdom's (UK) Armed Forces personnel. This study, funded by the UK Ministry of Defence, has been running since 2003 and completed its third phase of data collection in 2017.

Data from our studies have been used to analyse various military topics and papers have been published in peer reviewed, scientific journals. Our findings are regularly reported in the press and have also been used to inform policies that impact health and well-being of the Armed Forces Community.

Combat Stress

Combat Stress is a national charity in the UK that offers specialist mental health services to veterans. In particular, within the area of psychological trauma. Combat Stress was established in 1919 after the end of the second world war with the aim of supporting veterans with mental health difficulties.

The Combat Stress Research Department was established by **Professor Dominic Murphy** in 2014 as a joint initiative between Combat Stress and the KCMHR. It undertakes research to better understand the needs of the veteran community, research novel evidence-based interventions to support those in the veteran community and support the evaluation of Combat Stress's clinical services.

Lancaster University

Lancaster University is among the best in the UK. A top 15 university in the three major UK league tables, we are also highly ranked in international league tables such as the QS World Ranking. We also have a TEF Gold rating for teaching and we're highly ranked in international league tables such as the QS World Rankings.

The Division of Health Research at Lancaster University is a vibrant research community comprising over 100 staff from a range of academic and applied backgrounds: sociology, social policy, geography, public health, psychology, health economics and nursing. Along with the Medical School, the Division is based within the new Health Innovation One building on the Health Innovation Campus at Lancaster University, a new home for health and social care collaborations across the region.

Members of the Division of Health Research come from a wide range of academic disciplines and professional backgrounds. They have a well-established reputation for conducting excellent academic research that is both interdisciplinary and translational. The Division has good relations with NHS and social care partners, and the voluntary sector. They also host the regional and local centres for the NIHR Research Design Service for the North West and are part of the NIHR Applied Research Collaboration North West Coast.

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With thanks

Ethical approval

The research presented in this report was approved by the Local Ethics Committee of King's College London (registration number: HR-19/20-17438) and registered as a clinical trial (registration number: NCT04494594).

Appendix Material

The appendix material referenced in this report can be accessed using the following link:

www.doi.org/10.17605/OSF.IO/QHPBZ

Outputs arising from this project

Evaluating the Efficacy of a Mobile App (*Drinks*:Ration) and Personalised Text and Push Messaging to Reduce Alcohol Consumption in a Veteran Population: Protocol for a Randomized Controlled Trial.
Daniel Leightley, Roberto J. Rona, James Shearer, Charlotte Williamson, Cerisse Gunasinghe, Amos Simms, Nicola T. Fear, Laura Goodwin and Dominic Murphy. *JMIR Research Protocols*, 2020. DOI: 10.2196/19720.

Smartphone-Based Alcohol Interventions: A Systematic Review on the Role of Notifications in Changing Behaviours Towards Alcohol.
Charlotte Williamson, Katie White, Roberto J. Rona, Amos Simms, Nicola T. Fear, Laura Goodwin, Dominic Murphy and Daniel Leightley, *Journal of Substance Abuse*, 2022. DOI: 10.1080/08897077.2022.2074595

Recruiting Military Veterans into Alcohol Misuse Research: The Role of Social Media and Facebook Advertising.
Charlotte Williamson, Roberto J. Rona, Amos Simms, Nicola T. Fear, Laura Goodwin, Dominic Murphy and Daniel Leightley. *Telemedicine and eHealth*, 2022. DOI: 10.1089/tmj.2021.0587.

Evaluating the efficacy of a mobile app (Drinks:Ration) to reduce alcohol consumption in a help-seeking military veteran population: Randomised Controlled Trial.
Daniel Leightley, Charlotte Williamson, Roberto J. Rona, Ewan Carr, James Shearer, Jordan P. Davis, Amos Simms, Nicola T. Fear, Laura Goodwin and Dominic Murphy. *Journal of Internet Medical Research: mHealth & uHealth*, 2022. DOI: 10.2196/38991.

You can find more about the study on our project website:

https://www.drinksration.app

Abbreviations

AUDIT	Alcohol Use Disorders Identification Test
AUDIT-C	Alcohol Use Disorders Identification Test - Consumption
BCT	Behaviour Change Technique
CMDs	Common Mental Disorders
CONSORT	CONsorted Standards Of Reporting for Trials
DSM-5	Diagnostic and Statistical Manual for Mental Disorders (Fifth Edition)
GAD-2	Generalised Anxiety Disorder 2-item
InDEx	Information about Drinking for Ex-serving Personnel
IQR	Interquartile Range
ITQ-PTSD	International Trauma Questionnaire – Post-Traumatic Stress Disorder
MAUQ	mHealth App Usability Questionnaire
mHealth	Mobile Health
NHS	National Health Service
PHQ-2	Patient Health Questionnaire-2
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
PTSD	Post-Traumatic Stress Disorder
QR	Quick Response Code
RCT	Randomised Controlled Trial
SMS	Short Message Service
TIDieR	Template for Intervention Description and Replication
TLFB	Time-Line Follow back for Alcohol Consumption
UK	United Kingdom
WHOQoL-BREF	World Health Organisation Quality of Life-BREF

Glossary of terms

Alcohol misuse
Alcohol use causing harmful health consequences. In the UK, the Chief Medical Officer has stipulated that consuming more than 14 units of alcohol per week can be harmful to health.

Behaviour change
A behavioural change can be a temporary or permanent effect that is considered a change in an individual's behaviour when compared to previous behaviour.

Civilian
A person who has not served in the Armed Forces.

Chi-squared test
A chi-squared test (often denoted as χ2) is used to determine whether there is a statistically significant difference between two groups.

***Drinks*:Ration**
A smartphone app designed to support and manage alcohol consumption in the Armed Forces Community.

Interquartile range
The range of values between the first and third quartiles of a distribution.

Median
The middle number of a sorted list of numbers.

Probable [diagnoses]
The term probable is used in the absence of a clinical diagnosis and is based on participants completing a self-report measure such as a questionnaire or taking part in an interview.

Push notification
A message sent by an application which pops up on the user's phone to gain their attention. This can be scheduled or triggered upon a specific event happening.

Statistical significance
Statistical hypothesis testing, using p values, is used to determine whether the relationship between variables is 'significant', i.e., unlikely to be due to chance alone. If the p value falls below 0.05, a statistically significant result has been found. If the p value exceeds 0.05, a non-statistically significant result has been found.

Standard deviation
Standard deviation is a number used to tell how measurements for a group are spread out from the average (mean). A low standard deviation means that most of the numbers are close to the average, while a high standard deviation means that the numbers are more spread out.

Unit of alcohol	One unit equals 10ml or 8g of pure alcohol, which is around the amount of alcohol the average adult can process in an hour.
Veteran	Anyone who has served for at least one day in Her Majesty's Armed Forces (Regular or Reserve) or Merchant Mariners who have seen duty on legally defined military operations.

Introduction

Alcohol misuse is higher in the UK Armed Forces than in the general population. Research has shown that this is also evident among those who have left service. It has been estimated that more than 50% of those who have left the Armed Forces meet the criteria for hazardous alcohol use - defined as drinking more than 14 units of alcohol per week - this compares with around 12% for the general population. Research from Combat Stress has suggested that personnel who have left service and who are seeking support for mental health problems often consume alcohol to cope. It is important to recognise that many do not seek help for their alcohol problems.

To support those drinking hazardously, we can harness the latest digital technologies to manage and reduce alcohol consumption. Smartphone-based interventions allow the user to monitor their drinking, allow for real-time messaging and targeted supportive messaging. To date, no smartphone app exists to support the UK Armed Forces community in reducing their alcohol intake.

Project objectives

In this project, we investigated the efficacy of *Drinks*:Ration, a 28-day brief alcohol intervention delivered via a smartphone app, in reducing self-reported alcohol consumption among UK veterans seeking help for mental health difficulties. We also conducted a systematic review of notification methodology to inform further refinement of *Drinks*:Ration.

Method

We performed a randomised controlled trial where we compared a smartphone app that included interactive features designed to reduce the amount of alcohol they consume (intervention arm) with a version that only provided standard UK guidance on alcohol consumption (control arm). We randomly assigned participants to either the intervention or control smartphone app. We asked all participants to use the app for a minimum of 28 days (the personalised messaging was switched off after 28 days), after which we compared the drinking behaviours in the two groups (intervention and control) at day 84.

Findings and interpretation

Between October 2020 and April 2021, we invited 2708 individuals to take part in this project, of whom 2531 did not respond, 54 were ineligible, 123 responded and they were randomly allocated. When we compared drinking behaviours between the two groups at day 84, we found that those in the intervention arm consumed 10.5 fewer units of alcohol compared with the control group. We also found a similar pattern for AUDIT score – a test designed and validated by the WHO to measure risky drinking – the intervention group had a score which was 3.9 points lower than the control group.

This is a significant reduction that could have a positive impact on clinical outcomes. Not only did we observe reductions in alcohol consumption, but we also found that quality of life in areas such as physical health, psychosocial and environment were improved in the intervention app compared with the control app.

Overall, our findings demonstrated that *Drinks*:Ration was efficacious in reducing alcohol consumption in help-seeking veterans. These effects were only observed in the short-term when participants were still actively using the app (at 28 days) and lasted until 84 days from baseline but were no longer present by day 168.

Key outcomes

Bringing together the findings of this project, engagement with stakeholders and study participants, we recommend the following:

- The use of digital technology in clinical settings to support the Armed Forces community.
- Future research focusing on the use of push notifications and how they influence positive changes in behaviour.
- Conducting further research to assess the generalisability and scalability of *Drinks*:Ration at a national level.
- *Drinks*:Ration is uniquely placed to support those who consume alcohol as a coping mechanism to manage other mental health problems.
- Finally, the delay between referral and treatment may be an opportunity to deploy the *Drinks*:Ration app to support help-seeking veterans while they wait for formal treatment.

Chapter 1
Alcohol misuse burden

Alcohol misuse is common in the United Kingdom (UK) Armed Forces, with the prevalence higher in the Armed Forces than the general population [1]–[4]. Research has shown that this trend continues after personnel leave service (F1) [1], [5]. It has been estimated that more than 50% of those who have left the Armed Forces meet the criteria for hazardous alcohol use, which is a score of eight or above on the Alcohol Use Disorders Identification Test (AUDIT; [6]), a commtool used in UK research to assess alcohol consumption [3].

Research has shown that civilians in the general population underestimate their drinking, and do not perceive it as problematic, even when they drink at potentially harmful levels (F2) [7]; young males are at particular risk of underestimating their drinking [7]. It is key to note that this pattern is similar among the UK Armed Forces personnel, with less than half of hazardous drinkers recognising that they have an alcohol problem [8], [9].

The culture of heavy alcohol use in the UK Armed Forces is well known, and encouraged by the social environment and often carries on in a social setting after personnel have left service [4], [10], [11]. Therefore, when they leave service, this could provide an opportunity to initiate behaviour change in settings with less peer pressure to conform to social norms and promote alcohol awareness.

A recent study of treatment-seeking UK service leavers identified 43% of respondents reported misusing alcohol, and that alcohol misuse was commonly comorbid with Post-Traumatic Stress Disorder (PTSD), and common mental disorders (CMDs) like anxiety and depression [12]. Alcohol misuse can also have a significant impact on treatment adherence. Research has shown that treatment-seeking veterans with alcohol misuse attend fewer mental health appointments and are more likely to have a negative perception of mental health treatment when alcohol misuse is comorbid with depression or PTSD [13]. It is therefore vital that we develop interventions that target drinking to cope motivations, as this may enhance engagement with mental health services and improve mental health outcomes.

The impact of alcohol misuse by Armed Forces personnel on wider society (e.g. healthcare utilisation, productivity and welfare) is unknown, yet is more likely to be higher compared to the general population. Previous research has indicated that heavy drinking in England, which is frequently co-morbid with mental health difficulties [14], is estimated to cost the National Health Service (NHS) of the UK £3.5bn per year (3.6% of its annual budget; [15]).

[F1] The term veteran or ex-serving are used interchangeably in the UK. In this report we use the term 'veteran'.
[F2] This is considered as consuming more than 14 units of alcohol in a week and has been defined by the UK Chief Medical Officer for both men and woman.

Brief interventions

There are a range of effective intervention options for management and treatment alcohol misuse categorised as: brief interventions, specialist treatment and less intensive treatments that span the two [16].

It is important to recognise that in the UK, personnel who have left service utilise the same healthcare system as the general population, and the same interventions are offered to both groups. This is different to other countries, such as the United States of America, where specific veteran services are offered via Department of Veterans Affairs.

Brief interventions for alcohol misuse are a popular treatment option used in the UK general population, often provided to individuals scoring 15 or below on the AUDIT (F3) [17]. A common theme amongst these interventions is the goal of improving recognition, targeting the individual's motivations to reduce their alcohol consumption, and developing coping strategies to control and reduce intake [16]–[18]. In some cases, brief intervention are delivered across more than one session and the content can include motivational interviewing, cognitive behavioural therapy, behaviour self-control training, behaviour change techniques (such as self-monitoring of behaviour and goal setting) and coping development, all of which are often tailored to the individual by a clinician [16].

Brief interventions aim to raise awareness of the risks associated with hazardous drinking and to help individuals reduce the amount they drink. Often brief interventions are delivered to individuals who are not seeking help for alcohol misuse from a specialist alcohol service and are delivered in the general community setting (e.g. general practitioner, hospital doctor, nurse).

There is a body of research confirming the efficacy of brief interventions in reducing alcohol consumption and alcohol-related harm for those drinking at a hazardous level in the general population [19]–[21]. Yet, little is known with regards to their efficacy in the Armed Forces context [20]. Given the shared culture in the military in which alcohol plays a meaningful role, it is vital to evaluate the efficacy of brief interventions in this type of population.

[F3] A score of 15 or less on the AUDIT represents that a person is consuming alcohol at a harmful to hazardous level. This means it can have significant impacts on their health.

Smartphone-based brief interventions for alcohol misuse

Over the last two decades we have seen the proliferation of the use of digital technologies to support brief intervention management and treatment of alcohol misuse in the general public, yet little attention has focused towards the Armed Forces community [22]–[25]. This gap needs to be addressed.

In the late 1990's interventions were commonly delivered via a computer using CD-ROM-based programmes. With the advent of the World Wide Web many new opportunities arose to harness increase reach, provide real-time monitoring, and offer personalised treatment [26]–[32]. This includes the use of Short Message Service (SMS) which have been shown to be effective in encouraging people to change their behaviour [33]–[35].

Over the last five years, the mode of intervention delivery has shifted from web- to smartphone-based [36]. Smartphone interventions for alcohol misuse, such as DrinkLess [25] and Drinkaware [37], which are recommended for use by the NHS, and have several advantages over web-based delivery. These include having a low cost per use, allow for rapid changes and iterative development, can avoid the stigma associated with receiving help in person and are highly convenient because they can be used as and when the individual wants (discretely or openly).

The interventions mentioned previously are focused towards the general population and do not target individual beliefs, prevailing social context, and perceptions of consumption which are experienced by the Armed Forces community [10], [38]. Smartphone-based interventions allow the user to revisit information about their drinking as often as they need to, so have the potential to promote positive changes in behaviour [19], [39]. Further, there are indications of the potential of smartphone-based interventions being cost effective if found to be efficacious [26], [29], [30].

Most existing alcohol apps targeted at the general public include self-monitoring (e.g. DrinkLess [25], Drinkaware [37], One You Drinks Tracker [40]), whereby users are encouraged to regularly record and monitor (via visual graphics) their alcohol consumption within an app [25], [41]. Self-monitoring (or self-recording) has been found to be associated with improved outcomes and an effective behaviour change technique (BCT) for reducing alcohol use; a BCT is defined as a specific component of an intervention designed to change behaviour and a putative active ingredient in an intervention [22].

A recent review of personalised digital interventions for reducing hazardous and harmful alcohol consumption found that the provision of behaviour substitution, problem solving and providing a credible source were associated with better outcomes including reductions in alcohol consumption [42]. There are benefits to the use of digital technology for the UK Armed Forces community. Yet, to date, there is no research that seeks to test a brief intervention alcohol reduction app which is personalised to individual users and targeted to support military veterans of the UK.

Project objectives

The main objectives of this project were:

- To undertake a systematic review exploring the role of smartphone notifications in digital interventions focused on alcohol reduction.
- To undertake a randomised controlled trial (RCT) of the smartphone app *Drinks*:Ration to assess the efficacy of reducing self-reported weekly alcohol consumption among a veterans who drink at a hazardous or harmful level and have sought help for mental health symptoms in a clinical setting.

Chapter 2
Smartphone-based notifications to improve communication

Smartphone-based interventions often use notifications to help increase user engagement. There is strong evidence that SMS text message based interventions can help individuals modify health behaviours positively [43], [44]. Other notification types are becoming increasingly popular, potentially because users may be more accepting of notifications as they can better control notification settings.

Notifications (*e.g.* push notifications, alerts, nudges or prompts) (F4) are effective at maintaining app engagement [45]. A push notification is an automated message sent by an application which pops up on the user's phone to gain their attention. Various authors have suggested that future mobile health apps should implement regular push notifications to encourage active engagement of users [46], [47].

Although it has been suggested that notifications help to improve engagement, literature on the use of notifications in smartphone-based interventions aiming to reduce alcohol consumption remains limited. There is some literature exploring the effectiveness of using text messages in healthcare apps more generally [33], [34]. Importantly, there is a lack of research in relation to the role of notifications within smartphone-based alcohol interventions. To address this, as part of this report, we conducted a systematic review of the available literature exploring this topic (F5).

The primary aim of this review was to explore the use of notifications in smartphone-based interventions designed to support, manage, or reduce alcohol consumption and to describe development approaches used to inform future intervention development. The secondary aims were to explore the protocols in which notifications are used, including time and frequency, and to consider how personalised notifications impact on alcohol reduction.

Characteristics of identified publications

A total (F6) of 14 studies, describing 10 interventions, were identified as eligible for inclusion into our review . The earliest study was published in 2012, with most studies published between 2017 and 2021. Six papers (43%) were based on United States of America data [48]–[53], five (36%) on UK data [54]–[58] and three (21%) on Australian data [59]–[61].

[F4] These are notifications which appear in the notification centre in modern smartphones.
[F5] See **Appendix 1 – Systematic review methodology** for a detailed explanation of the search strategy.
[F6] Detailed information about the included publications can be found in **Appendix 2 – Identified publications**.

Gustafson et al. [49], and McTavish et al. [50] reported on the same dataset, as did both papers by Poulton et al. [59], [60], but each were included as they reported different outcome measures of interest. The interventions used were Drinkaware [58], LBMI-A [48], [52], DrinkLess [56], [57], A-CHESS [49], [50], BRANCH[54], CASA-CHESS [51], CNLab-A [59], [60], AlcoRisk [61], Step Away [53], and one un-named app developed for research [55].

Of the 14 studies identified, two [49], [50] (reporting on one intervention) were RCTs and the remainder were non-randomised studies, where available comparator/control groups were reported. Of the non-randomised studies, four involved qualitative interviewing to collect at least some of the data [54], [56], [58], [61]. Measures of alcohol consumption varied across studies, including Alcohol Use Disorder Identification Test-Consumption (AUDIT-C; [62]) [53], AUDIT-10 [55]–[57], [59], [60] and clinician applied Diagnostic and Statistical Manual for Mental Disorders, Fifth Edition (DSM-5) criteria [49], [50].

Not all studies reported on the duration of the study and/or intervention [55], [56]. Across those that did, the majority measured short-term outcomes (less than three months), one measured medium-term outcomes (three to six months) and five measured long-term outcomes (six months or longer). The shortest was a two-week feasibility trial [61] and the longest length of follow-up was 12 months [49], [50].

A variety of different outcome measures were used to assess changes in alcohol consumption. Two studies reported their main outcome measures related to a reduction in alcohol consumption as measured by number of units or drinks [52], [58]. Two studies monitored drinking behaviours post-discharge from residential treatment for alcoholism [49], [50]. Three studies explored prospective versus retrospective reporting of alcohol behaviours [48], [55], [59]. Three reported on app development [56], [60], [61]. Three reported on app usage and engagement [51], [54], [57] and how it related to changes in alcohol consumption. The final study's main outcome related to the usability of the app, however, they also reported on change in alcohol consumption [53]. All interventions used notifications to some extent (F7).

Populations studied

Approximately half of the studies reported a sample of 100 participants or less. The smallest sample was 19 participants [61]. The largest sample, reported by Attwood et al. was over 100,000 participants [58]. All studies used mixed-gender samples, however, these were not always evenly distributed. In total, six studies were conducted using samples from the general population [55]–[61], seven used clinical populations [48]–[53] for example participants that met DSM-5 criteria for alcohol use disorder, and one study did not report on the population type [54].

[F7] Additional information about the included studies can be found in **Appendix 3 – Additional information** about identified publications.

Development

Only three studies focussed on development [56], [60], [61]. Poulton *et al.* concluded that the development of CNLab-A followed an appropriate methodology for measuring alcohol consumption over time [60]. Smith *et al.* feasibility trial supported the efficacy of the AlcoRisk app's software development process and offered an evidence-based approach to integrating relevant behavioural and technical areas [61]. Both publications used an iterative development process with three stages: (1) requirements analysis, (2) feature and interface design, and (3) app implementation.

Garnett *et al.* systematically developed the DrinkLess app based on scientific literature and theory [56]. Their approach involved two phases: (1) selection of intervention components, and (2) design and translation into app. Given the small number of included studies that report on the development process, it is difficult to draw conclusions that may help to inform future development of smartphone-based alcohol interventions.

Of the studies that reported on intervention development, none explicitly reported using co-production in app development. Co-production involves the active participation of relevant stakeholders during pre-development and development. It is imperative that end-users are involved in the development process to get a representation of how the app may be used in practice and the relevance and importance of particular outcomes for service users [63], [64]. The three studies that reported on development did use a small group for usability testing [56], [60], [61].

It remains unclear whether these testing groups led to improvements in engagement. Drinkaware [58], CNLab-A [59], [60] and AlcoRisk [61] were developed for use on both iOS and Android systems. Others were available on only Android devices including CASA-CHESS [51], or only iOS devices including Step Away [53] and DrinkLess [56], [57].

Implementation

The most common mode of delivery of notifications reported in the included studies were reminders, prompts or alerts to log drinking behaviours [48], [53]–[57], [59]–[61]. For instance, as set by the app developers, DrinkLess users were sent daily push notifications at 11am asking to "*Please complete your drink diaries*" to encourage self-monitoring of drinking behaviour [57]. Another common notification type was GPS initiated-alerts which were activated when in a 'high-risk' drinking location as specified by the user [49], [50], [52], [58]. For example, the Drinkaware app sent alerts to users stating "*You are near one of your designated weak spots. Remember, drinking less has many feel-good benefits*" [58].

Notification frequency varied, some publications limited the number that could be sent, for example, the CNLab-A app sent a maximum of 42 notifications across the 21-day intervention, asking users to record drinking information [59], [60]. Critically, not all interventions worked this way. Some interventions sent notifications any time GPS located the user in a 'weak spot' or 'high-risk' location (*e.g.* A-CHESS [49], [50]). Only one study, reporting on the DrinkLess app, discussed participant engagement with notifications by reporting on log-in sessions and frequency of log-in session, drinking diary entry and disengagement rates [57].

Only two of the included studies reported on the use of personalisation. BRANCH app users received tailored notifications, personalised feedback and tailored information [54]. This included in-app reminders based on goals, motivational messaging (including positive reinforcement and praise), and tailored feedback and information based on their motivations to reduce drinking. Additionally, users of Step Away, could personalise the app through reminders including high-risk times as specified by the user, reasons for change and scheduled activities [53].

It is unclear if this included personalised notifications. All other included studies either did not use [61] or did not report on [48], [49], [60], [50]–[52], [55]–[59] the use of personalised notifications. The AlcoRisk app was reported as having low utility because it did not include personalised feedback relating to alcohol consumption [61].

User response and engagement

Some studies drew conclusions regarding notification impact. Drinkaware users highlighted in interviews a need for personalisation and tailoring of content to promote long-term app engagement [58]. LMBI-A users reported that receiving notifications in a high-risk location was an potentially useful feature of the app, however, it was not considered to be useful in the study because location accuracy was unreliable [52].

Only one study reported on the relationship between notifications and engagement. Bell et al. reported a strong association between the delivery of a notification and the user opening the Drink Less app within the following hour [57]. During the first month following download, the likelihood of using the app within an hour of receiving a notification was around four times higher than the probability of using the app the hour before the notification was sent [57]. Bell et al. did not report the number of participants who cleared the notification without using the app, only that this action was not recorded as use. Therefore, the proportion of users who did not want to engage with notifications remains unknown.

Outcome of included publications

Some studies reported on behaviour change outcomes. For instance, Gustafson *et al.* concluded that the intervention group who received treatment as usual plus A-CHESS reported a lower number of drinking days and a higher likelihood of continued abstinence when compared to the control group who received treatment as usual only [49]. Additionally, Dulin *et al.* pilot study reported significant reductions in the number of days of hazardous alcohol use while using LBMI-A; 56% of days at baseline versus 25% of days while using the app [52].

Only one study reported on the use of notifications and how they influenced behaviour change. Bell *et al.* reported that notifications encouraged users to record drink-free days more than drinks consumed, and that the median time per session reduced for the rest of the day following a notification [57]. None of the other included studies reported on the role of notifications in changing behaviour towards alcohol.

Quality assessment of included studies

The overall mean Newcastle-Ottowa Scale score was 5/8, and only two studies met less than half of the assessed quality criteria. Due to study design, some of the quality assessment measures were not applicable to all studies and therefore led to an unclear assessment of quality. The quality assessment for each study is summarised in **Appendix 4 – Quality assessment scores for included publications**.

Summarising the current evidence

The role of notifications in changing behaviour towards alcohol of the reviewed interventions was inconclusive. Many of the included studies did not report on the specifics of notifications, such as content, development, triggers, and personalisation. Overall, there was a lack of literature exploring the role of notifications used in smartphone-based interventions which aim to change behaviours towards alcohol. This review found tentative evidence regarding the benefits of using notifications in smartphone-based interventions for alcohol misuse.

The most common mode of delivery of notifications reported in the included studies were reminders, prompts or alerts to log drinking behaviours [48], [53]–[57], [59]–[61]. Previous literature highlights the promotion of self-monitoring of behaviour in brief interventions, within smartphone-based alcohol interventions for example, is associated with improved outcomes [22]. Self-monitoring allows the user to monitor and record their behaviour. In an alcohol intervention, this includes recording consumption in a drink's diary. However, smartphone-based alcohol interventions often have a high rate of attrition and struggle to maintain engagement [65]. For example, on up to 95% of apps, the majority of users disengage after one month [66].

In this review, only one publication drew distinct conclusions about the use of notifications and engagement, and the relationship between notifications and behaviour change [57]. Previous literature highlights that notifications are one of the most useful features of smartphone-based alcohol interventions [67], [68]. For example, one qualitative analysis revealed that participants ranked personalised features, including notifications, the most highly for promoting app engagement [69].

Thirteen studies did not draw distinct conclusions regarding notifications, with authors failing to report why they did not assess the impact of notifications on the outcome. One possible explanation is that permission is required to send notifications to users. This is a potential barrier as none of the studies reported on how many users gave permission for notifications. Further, the primary aims of many studies focussed on the impacts of the app as a whole and not specifically on the additional impact of notifications, particularly because this is a relatively novel field of research.

Future research should take the above into account and consider reporting on different elements of smartphone-based interventions that may be used to promote engagement, including personalised notifications. Future research should seek to isolate each intervention component to determine which features bring about behaviour change.

In this review, several studies used a GPS location tool to notify the user when in a high-risk drinking location, but this was not reported as useful by participants [52], [58]. In some instances participants recognised the potential usefulness of receiving alerts but felt that the GPS system was unreliable due to poor location accuracy [52].

In another study, the concept of notifying an individual of a physical environment trigger was also not viewed as useful and was poorly understood by participants [58]. This aligns with previous literature including one study that found lower user ratings for smartphone-based alcohol reduction apps using these types of features [70].

It is important to consider that although smartphone-based interventions are a useful way to deliver interventions, there can be potential negative consequences, including stress associated with technical difficulties. Although, as none of the included studies reported any negative consequences, it is not clear whether they were not present or just not reported.

Additionally, digital technology is advancing at a faster pace than interventions are typically developed [71]. Therefore, some interventions risk becoming obsolete before the end of the development process.

Due to the aims of the review, our search criteria were narrow leading to a small number of relevant papers being included in the review. A broader review with wider search criteria may have included a larger number of relevant papers such as that by Blonigen *et al*. [72], and Giroux *et al*. [73].

Limitations we identified

In this review we provided an overview of the current evidence around smartphone-based alcohol interventions which use notifications. There were concerns about the duration of interventions, inadequate follow-up periods and the use of self-report measures. We identified 14 published, peer-reviewed publications, reporting on 10 interventions which used notifications, therefore when interpreting the results, it is important to take this low number into consideration.

Further, the literature lacks RCTs assessing the role of notifications in managing alcohol misuse. Potentially this could be explained by the novelty of this research field. Additionally, to gather as much available evidence as possible, the included studies vary as to whether the study was carried out in a general population or clinical sample and what sort of control/comparator groups were used, if any. These variations limit the ability to make comparisons between studies.

Implications for future researchers

We would recommend that future research should seek to explore the role of notifications more thoroughly on smartphone-based interventions aiming to support, manage or reduce alcohol consumption. This should include exploring whether notifications can be used to improve engagement and adherence to digital interventions and remote measurement technology. New research should seek to report on the relationship between the use of notifications in smartphone-based alcohol interventions and behaviour change related to alcohol consumption. Using notifications in smartphone-based alcohol interventions should report the protocols used for implementing notifications, the engagement rates with notifications, and the acceptability of using notifications (for instance how many users provided permission for notifications and how many notifications failed to send).

Research should highlight whether notifications were generic or personalised, if they were clinician activated or automated, and should report on notification development. It is important to identify the effective components of smartphone-based alcohol interventions and which combination of components is optimal. This will help inform the future development of smartphone-based alcohol interventions. New research should consider using a factorial design to explicitly evaluate the role of notifications. The development of an effective alcohol intervention would have significant implications for public health.
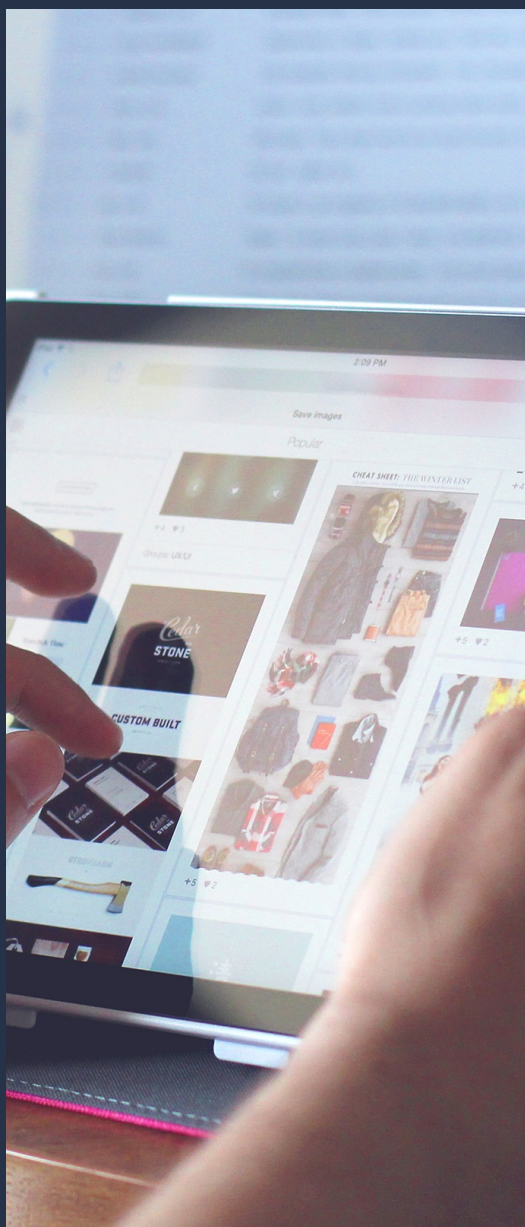
Additionally, this review finds some evidence regarding the benefits of using smartphone-based interventions for alcohol misuse. In the UK, the National Institute for Health and Care Excellence recognise that the evidence base is growing but currently remains limited. These guidelines recommend mobile health interventions for alcohol misuse as an adjunct to existing services.

Alongside existing literature [42], [74]–[76], this review supports the idea that smartphone-based alcohol interventions may become a feasible, acceptable and useable treatment option. Future research should seek to compare the efficacy of stand-alone smartphone-based alcohol interventions versus using smartphone-based interventions alongside treatment as usual. New studies should use adequately statistically powered samples and an adequate length of follow-up to ensure that results of behaviour change are meaningful.

Concluding remarks

Overall, evidence for the role of notifications in changing behaviour towards alcohol of the reviewed interventions was disappointingly inconclusive. While several studies highlighted that smartphone-based alcohol interventions are an important tool for monitoring alcohol consumption and that many incorporate notifications, future research should focus on providing stronger evaluations relating to the role of notifications within smartphone-based interventions for alcohol reduction. We have taken these findings forward to help develop our messaging as part of the *Drinks*:Ration platform.

Summary

- **14 studies** were identified, reporting on **10 interventions**.

- The strength of the evidence regarding the role and utility of notifications in changing behaviour towards alcohol of the reviewed interventions was **inconclusive**.

- Only one study drew distinct conclusions about the **relationships between notifications and app engagement**, and notifications and behaviour change.

- Several studies highlighted that smartphone-based alcohol interventions **are an important tool** for monitoring alcohol consumption and that many incorporate notifications.

- This review highlights a **lack of evidence** to support the use of notifications (such as push notifications, alerts, prompts, and nudges) used within smartphone interventions for alcohol management aiming to promote positive behaviour change.

- **Future research** should focus on providing stronger evaluations relating to the role of notifications within smartphone-based interventions for alcohol reduction.

Chapter 3
About Drinks:Ration - an Android and iOS app for Armed Forces personnel

Drinks:Ration (**www.drinksration.app**; formerly called *InDEx*; [77]–[79]) was developed following the Medical Research Council Complex Intervention Guidelines and using co-design methodology (F8). It was developed by the King's Centre for Military Health Research (at King's College London) and the University of Liverpool, supported by experts in smartphone app development, epidemiology, addiction psychiatry, and military mental health. Example screenshots of the app can be seen in **Figure 1**.
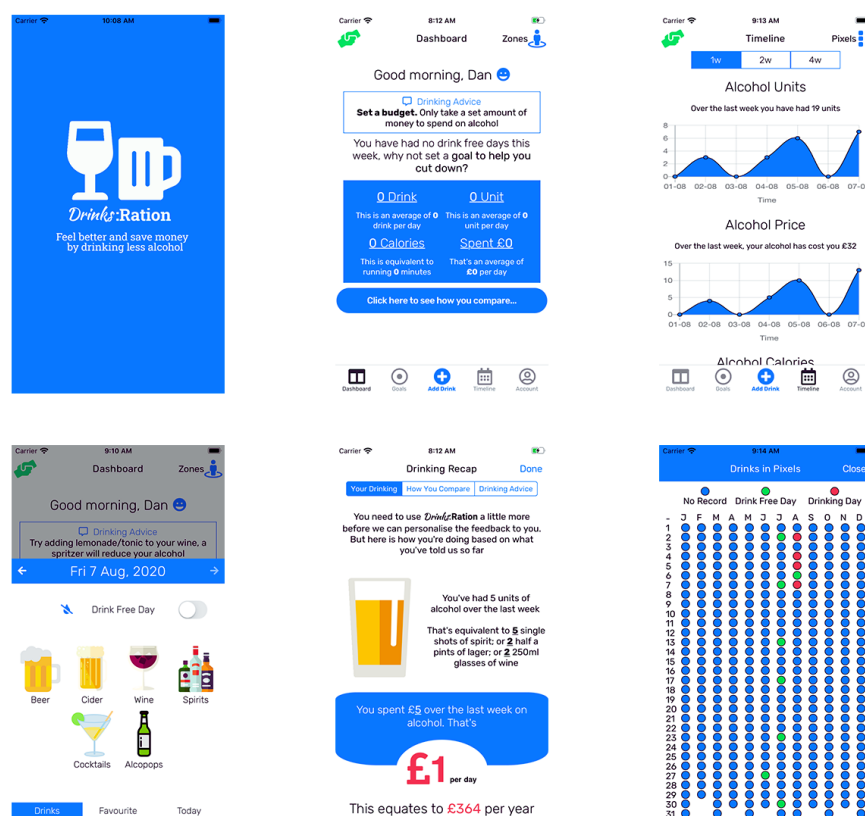

Figure 1: Example images extracted from the *Drinks*:Ration app.

The app was designed to support veterans drinking at a hazardous or harmful level by providing bespoke advice and support over a 28-day period. The app was designed to enhance user motivation and self-efficacy in modifying their alcohol consumption by means of BCT in the content displayed (F9), and the messaging sent to the user. The iterative development process, theoretical framework and feasibility trial were previously published in peer reviewed academic journals [77]–[79].

[F8] This means that we engaged end-users across all stages of the development process.
[F9] Following the principles of the Behaviour Change Technique taxonomy, we developed the *Drinks*:Ration app to be supportive in making positive changes in a person's behaviours. See **Appendix 5 – Behaviour Change Technique assignment to each Drinks:Ration component** for more information.

Briefly, *Drinks*:Ration was developed and tested with five core modules, these are:

- **Account management:** Users can modify personal information (*e.g.* first name and mobile number) and app parameters (*e.g.* automatic log-out, clear local storage, data sharing permission and leaving the study).
- **Questionnaire and individualised normative feedback:** Captures the user responses to a set of questions and aggregates responses to produce an individualised infographic representing the user's alcohol consumption in comparison to the general population, the Armed Forces community and other participants of *Drinks*:Ration.
- **Self-monitoring and feedback:** Records alcohol consumption by users and provides a range of visual illustrations (*e.g.* charts, figures, and text) to allow for monitoring of consumption. Further, users can select visual metrics relevant to their interest (*e.g.* calories, cost, exercise required).
- **Goals (setting and review):** Users can set goal(s) based on the implementation intentions (if and then) [80] methodology; visual feedback provides feedback on progress toward achieving goal(s) set.
- **Personalised messaging:** Users are sent tailored messages via push notification or SMS messaging that provides prompts to use the drinks diary, suggests alternative behaviours, and provides feedback on goals.

The *Drinks*:Ration app is compatible with all modern iOS and Android supported devices and no clinical involvement is required to operate. Data is collected, managed and processed using Google Firebase server infrastructure located in the UK (London, UK) which means that if a user has a smartphone, and access to the internet, they will be able to us the *Drinks*:Ration app. This also means the app can scale and meet demand as required.

Drinks:Ration user centred privacy

Informed consent is sought from users via the *Drinks*:Ration app prior to the collection of any personal data and they could withdraw at any time. Individual optional consent (example screenshots presented in **Figure 2**) was sought for access to GPS location, sending of push notifications (F10) or SMS messaging. Participants could change optional consents at any time via the 'settings' page of the app.

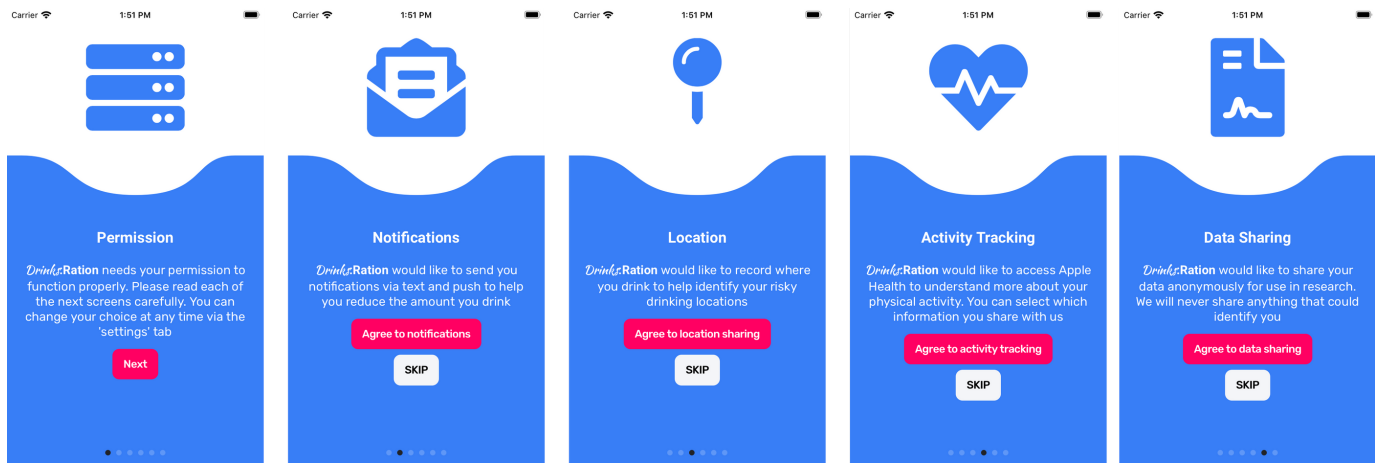[F10] *Drinks*:Ration notifications are managed by a central server.

Figure 2: Consent flow screenshot examples presented to all participants of the study.

Users could withdraw at any time via the *Drinks*:Ration app (see **Figure 3** for example). Users could choose to withdraw from the app, but allow the research team to use the data, or delete their account by contacting the research team. The reasons for withdrawal fell within:

- **Users choosing to no longer take part in the study:** participants were informed via the *Drinks*:Ration app that use is voluntary and that they could withdraw at any point without providing a reason.
- **Adverse event:** the user was withdrawn by the research team in the event of an adverse event, protocol violation, technical, administrative, or other reason(s).

In the event of a user choosing to withdraw from the app, we prompted for a reason as to why they were withdrawing; but this was optional.
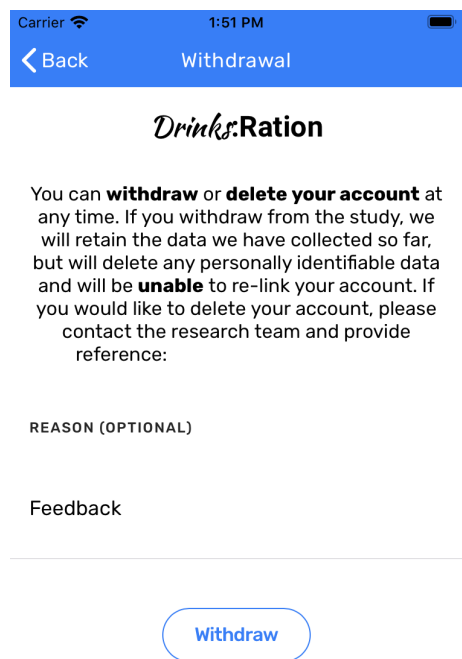

Figure 3:Participant withdrawal screen with includes the ability to delete account or withdraw from the study.

Chapter 4
Piloting Drinks:Ration in a veteran population

It is important to develop effective interventions to reduce alcohol use for military populations. Prior to conducting the RCT, we undertook a mixed-methods pilot study to explore the usability of *Drinks*:Ration, using a validated usability measure and qualitative interviewing in both veterans and expert users. The objective was to obtain final feedback prior to commencement of the RCT, and ensure changes made to the app are usable and functional.

By including expert users, as well as veteran users, the pilot study considered the views of a population that we have not yet explored. Expert users working in the field of military mental health have experience and expert knowledge of what works in practice with military personnel and veteran patients.

Pilot study objective

The aim of the pilot study was to assess the usability of *Drinks*:Ration based on expert and veteran user assessments of *Drinks*:Ration over a 14-day testing period using a mixed-methods design. Any feedback obtained was used to improve the *Drinks*:Ration app.

Pilot study sample

16 participants were recruited for the pilot study. The sample was made up of 8 'expert users', individuals who provide healthcare services to the Armed Forces community, and 8 'veteran users', individuals who have previously served in the UK Armed Forces. Most veteran users were recruited through Combat Stress, a UK veterans mental health charity. The two participant groups were chosen because their knowledge in military mental health means they understand what is required to successfully engage veterans in an alcohol intervention and promote positive changes in behaviour.

Procedure

Eligible participants who had read the information sheet and provided informed consent to participate in the study were invited to download the *Drinks*:Ration app onto their smartphones and to test the app for 14-days. Upon successful registration, participants completed a baseline questionnaire to assess mental health (e.g. anxiety, depression, and PTSD), readiness to change, self-efficacy, and socio-demographics (e.g. age, gender and serving status).

If the participant consented to notifications, they received a maximum of ten notifications over the 14-day testing period. The notifications sent included prompts to encourage the user to record their drinks (and drink-free days), complete app questionnaires used to personalise the experience, suggest alternative behaviours, provide feedback on goals, and promote a healthy lifestyle.

After 14-days, all participants were asked to complete the mHealth App Usability Questionnaire (MAUQ; [81]) and were invited to undertake a semi-structured telephone interview to further discuss their experiences of using the app. Participants were reminded of their right to withdraw at any time. They were also reminded that any data from the app would be deleted and only data from the interview and questionnaire would be analysed. Interview topics included what worked well on the app, which features would be most useful to veterans, any issues that arose and suggestions to improve the usability (F11).

Implications for future researchers

We would recommend that future research should seek to explore the role of notifications more thoroughly on smartphone-based interventions aiming to support, manage or reduce alcohol consumption. This should include exploring whether notifications can be used to improve engagement and adherence to digital interventions and remote measurement technology. New research should seek to report on the relationship between the use of notifications in smartphone-based alcohol interventions and behaviour change related to alcohol consumption. Using notifications in smartphone-based alcohol interventions should report the protocols used for implementing notifications, the engagement rates with notifications, and the acceptability of using notifications (for instance how many users provided permission for notifications and how many notifications failed to send).

Research should highlight whether notifications were generic or personalised, if they were clinician activated or automated, and should report on notification development. It is important to identify the effective components of smartphone-based alcohol interventions and which combination of components is optimal. This will help inform the future development of smartphone-based alcohol interventions. New research should consider using a factorial design to explicitly evaluate the role of notifications. The development of an effective alcohol intervention would have significant implications for public health.

[F11] A copy of the interview scheme can be found in **Appendix 6 – Pilot study interview schedule**.

Analysis

Statistical analyses were performed after completing pilot study data collection. Descriptive statistics were calculated to summarise the data. Following the recommended analysis guidelines for the MAUQ [81], questionnaire responses were analysed based on participant type (if they were expert or veteran) to generate average usability scores, and reported as mean and standard deviation. The time gap between completing the 14-day testing period and being interviewed was also calculated and reported as median and interquartile range.

Interviews were audio recorded, transcribed verbatim and analysed using thematic analysis [82]. Thematic analysis is frequently used in the analysis of other usability studies involving alcohol interventions delivered via smartphone apps (e.g. [70], [78], [83]). Thematic analysis was chosen for this pilot study to allow for the identification of common themes across participant responses [82].

This involved:

- Familiarising with the data.
- Generating initial codes.
- Searching for themes.
- Reviewing themes.
- Defining and naming themes.

Advantages of thematic analysis include its flexibility and accessibility, meaning that it can be modified to meet the needs of many studies [82]. Thematic analysis provides a rich and detailed account of data, and is regarded as a useful method for exploring the perspectives of each participant [82], [84].

An inductive approach was chosen to allow for the identification of patterns within the data from the 'ground-up'. This has benefits over a 'top-down' approach as it enhances fidelity to the data because themes are directly developed based on participants' responses [85]. Interview data was supplemented with the free-text comments from the end of the online questionnaire. All qualitative data was divided into responses by participant type (expert or veteran) and datasets were initially analysed separately, to consider potential differences, and finally combined during the creation of themes. NVivo 12 was used to facilitate the coding process.

Results of the pilot study

Overall, 16 participants were recruited to download and test the Drinks:Ration app (**Table 1**). Of the 16 participants, 8 were expert users (2 male and 6 female) and 8 were veteran users (all male). 14 participants (88%) completed the online usability questionnaire, of whom 7 (50%) were expert users and 7 (50%) were veteran users. Of the 14 participants who completed the questionnaire, 9 (64%) completed the free-text comments, of whom 4 (44%) were expert users and 5 (56%) were veteran users. 12 participants (75%) went on to be interviewed - 7 (58%) were expert users and 5 (42%) were veteran users.

Table 1: Participant demographics at each stage of the pilot study.

Participant Details	Downloaded App (n=16)	Completed Questionnaire (n=14)	Completed Interview (n=12)
Expert - Primary Clinical Care	5 (31%)	4 (29%)	4 (33%)
Expert - Charitable Sector	3 (19%)	3 (21%)	3 (25%)
Veteran	8 (50%)	7 (50%)	5 (42%)

Quantitative results

Overall, participant ratings suggest that Drinks:Ration had high ease of use and satisfaction, as well as an interface that was highly appealing. Veteran users were more critical than expert users about the usefulness of the app. **Table 2** shows the results from the MAUQ. The mean score for expert users (mean=6.37; SD=1.00) and veteran users (mean=5.66; SD=1.50) differed slightly. The overall mean score on the MAUQ was 6.09 (SD=1.37) indicating good usability. The range of individual scores from participants varied from 1 (disagree) to 7 (agree).

The Drinks:Ration app was rated as being easy to learn and use by expert users (mean=6.43; SD=1.13 and mean=6.14; SD=1.07, respectively) and veteran users (mean=6.43; SD=1.51 and mean=6.00; SD=1.41, respectively). Both expert (mean=6.57; SD=0.53) and veteran (mean=6.29; SD=1.25) users felt that the app adequately acknowledged and provided information that informed them of their progress.

Table 2: Descriptive statistics of mHealth Acceptability and Usability Questionnaire (*n*=14).

No.	Item	Expert (*n*=7)		Veteran (*n*=7)	
		Mean (SD)	Median (IQR)	Mean (SD)	Median (IQR)
-	**Ease of use**	**6.45 (0.94)**	**7 (6-7)**	**6.31 (1.28)**	**7 (6-7)**
Q1	The app was easy to use.	6.14 (1.07)	6 (6-7)	6.00 (1.41)	7 (5-7)
Q2	It was easy for me to learn to use the app.	6.43 (1.13)	7 (6.5-7)	6.43 (1.51)	7 (7-7)
Q3	The navigation was consistent when moving between screens.	6.57 (0.53)	7 (6-7)	6.57 (0.79	7 (6.5-7)
Q4	The interface of the app allowed me to use all functions (such as entering information, responding to reminders, viewing information) offered by the app.	6.71 (0.76)	7 (7-7)	6.86 (0.38)	7 (7-7)
Q5	Whenever I made a mistake using the app, I could recover easily and quickly.	6.40 (1.34)	7 (7-7)	5.25 (2.06)	5.5 (3.75-7)
-	**Interface and Satisfaction**	**6.34 (0.84)**	**7 (6-7)**	**5.98 (1.55)**	**7 (4.5-7)**
Q6	I like the interface of the app.	6.29 (1.11)	7 (6-7)	5.29 (1.89)	6 (3.5-7)
Q7	The information in the app was well organised, so I could easily find the information I needed.	6.00 (1.15)	6 (5.5-7)	5.86 (1.95)	7 (5-7)
Q8	The app adequately acknowledged and provided information to let me know the progress of my action.	6.57 (0.53)	7 (6-7)	6.29 (1.25)	7 (6-7)
Q9	I feel comfortable using this app in social settings.	6.00 (0.89)	6 (5.25-7)	6.50 (1.22)	7 (7-7)
Q10	The amount of time involved in using this app has been fitting for me.	6.57 (0.53)	7 (6-7)	6.86 (0.38)	7 (7-7)
Q11	I would use this app again.	6.50 (0.84)	7 (6.25-7)	5.00 (2.00)	5 (4-6.75)
Q12	Overall, I am satisfied with this app.	6.43 (0.79)	7 (6-7)	6.00 (1.41)	7 (5-7)
-	**Usefulness**	**6.32 (1.44)**	**6 (6.75-7)**	**4.88 (1.73)**	**4 (4-7)**
Q13	This mHealth app provides an acceptable way to receive healthcare services.	6.71 (0.49)	7 (6.5-7)	5.60 (1.52)	6 (4-7)
Q14	The app helped me manage my health effectively.	6.14 (1.46)	7 (5.5-7)	4.33 (1.37)	4 (4-4)
Q15	This app has all the functions and capabilities I expected it to have.	6.00 (2.24)	7 (6.5-7)	5.57 (1.81)	7 (4-7)
Q16	The app would be useful for my health and wellbeing.	6.43 (1.13)	7 (6.5-7)	4.00 (1.90)	4 (3.25-5.5

SD: standard deviation; IQR: interquartile range.

Expert users felt that the interface of the app allowed them to use all the functions (mean=6.71; SD=0.76) and they thought that the *Drinks*:Ration app provided an acceptable way to receive healthcare services (mean=6.71; SD=0.49). Veteran users felt the amount of time it took to use the app was fitting (mean=6.86; SD=0.38) and thought that the navigation was consistent when moving between screens (mean=6.57; SD=0.79).

Veteran users did not agree that the app was helpful for their health and wellbeing (mean=4.00; SD=1.90) or that it helped them manage their health effectively (mean=4.33; SD=1.37). Generally, veteran users did not score *Drinks*:Ration highly for usefulness. Overall, participants were satisfied with the app (experts mean=6.43; SD=0.79 and veterans mean=6.00; SD=1.41).

Qualitative results

Overall, positive participant feedback suggested that the *Drinks*:Ration app had high usability for the target population of help-seeking veterans. Participants also provided several recommendations to further improve the usability of the app. Although the most used feature of the app was the drinks diary, participants also reported the goal setting and drinking recap to be important and beneficial for the target population. Initially, the two participant groups were analysed separately but are reported together due to the converging of themes across the groups. A total of three overarching themes were developed: **Simplicity; Appropriateness for Veteran**s; and **Engagement (see Figure 4)**.
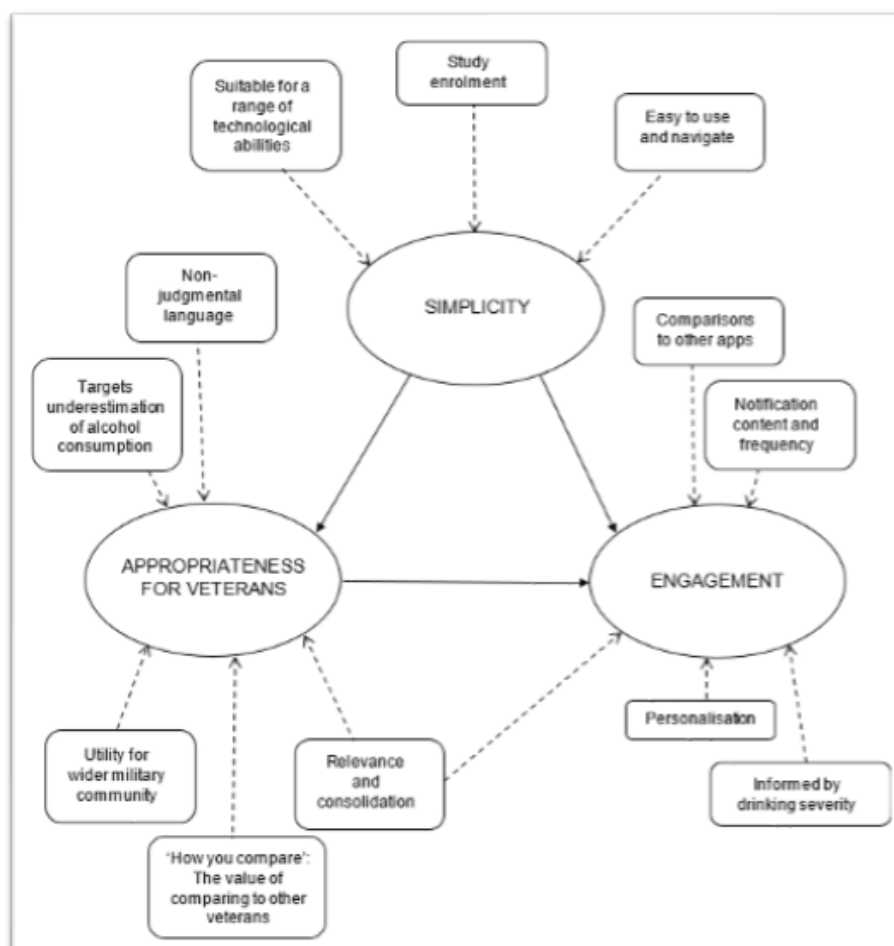

Figure 4: Thematic map: overview of themes and subthemes.

Theme 1 – Simplicity

The *Drinks*:Ration app was generally described as a simple and easy to use app, yet simplicity sometimes prevented nuance. The theme of simplicity was made up of three subthemes: (1) study enrolment, (2) suitable for a range of technological abilities and (3) easy to use and navigate. Most participants described *Drinks*:Ration as an intuitive and easy to use app which could be learned quickly. The theme of simplicity can be linked to both Theme 2: Appropriateness for Veterans and Theme 3: Engagement. Simplicity enhanced the accessibility of the app for the veteran population who have diverse and unique needs, and requiring minimal effort appeared to determine subsequent engagement.

Study enrolment: Most participants found installing the app and the study enrolment process easy: "*It installed perfectly well onto my phone*" [P1, expert, male] and "*the registration was very straightforward*" [P12, expert, female]. One participant highlighted one difficulty when setting up their account: "*The initial set-up age slider was difficult to set to the right age*" [P10, veteran, male].

Easy to use and navigate: Navigation was supported by the easy-to-use tabs at the bottom of the app, which signposted participants to different components, including the dashboard, goals, timeline and drinks diary: "*[it] makes it really easy to use as an app*" [P5, expert, female]. Although, for some, this compromised simplicity: "*I could do with fewer tabs*" [P4, veteran, male] when discussing the drinks diary specifically.

Generally, participants found it easy to add drinks to the drink's diary. However, some examples of difficulties included correcting a mistake: "*When I mistakenly added a drink to the app I was unable to undo the input*" [P7, veteran, male]. This differed to results from the quantitative data where participants generally agreed that they could recover quickly and easily when they made a mistake.

Aesthetically, the app was described as well laid out and drinking habits were displayed clearly. This withstanding, one participant highlighted how the volume and presentation of text could be improved: "*Maybe increase the font size slightly, and remove some of the text in favour of more pictures so it's easy to navigate without having to read a lot*" [P1, expert, male].

Suitable for a range of technological abilities: *Drinks*:Ration was deemed easy to use for those less familiar with using technology: "*I'm not a … not really a 'techy type person' but I found that easy to navigate, so there wasn't too much I had to try and find*" [P1, expert, male]. This subtheme can be linked to Theme 2: Appropriateness for Veterans as expert users explained "*our veteran group…might be struggling more with technology*" [P13, expert, female].

Theme 2 – Appropriateness for Veterans

Participants generally thought *Drinks*:Ration was an acceptable app for the target population of help-seeking veterans drinking at hazardous or harmful levels. This theme consists of five subthemes: (1) targets underestimation of alcohol consumption, (2) relevance and consolidation, (3) utility for wider military community, (4) non-judgemental language and (5) 'how you compare': the value of comparing to other veterans. All subthemes can be linked to Theme 3: Engagement because meeting veterans' unique needs subsequently appeared to increase engagement with the app.

Targets underestimation of alcohol consumption: Most participants did not view their current drinking habits as hazardous or harmful. Drawing on their professional experiences, expert users suggested that veterans are not always aware of how the amount of alcohol they consume relates to recommended drinking guidelines.

Features, such as the comparison page, comparing users' drinking to both the general population and other veteran users of the *Drinks*:Ration app, were regarded as useful for encouraging more accurate perceptions of users' drinking. This applied to both veteran users, "*it just did surprise me that I drank a little bit more than I thought I did*" [P7, veteran, male] and expert users, "*it shocks you a little bit when you see that you're drinking more than the rest of the country*" [P3, expert, female]. This subtheme therefore clearly links to the subtheme of 'How You Compare': The Value of Comparing to Other Veterans.

Via the drinks diary, participants were able to record what they drink which also raised awareness of their alcohol consumption, including the calories consumed and money spent on alcohol: "*So being able to write down exactly how much they drink over a month, I think visually, just seeing that, is sometimes a good scare tactic*" [P13, expert, female], and "*…they don't necessarily see it as a problem until they see it written down, exactly what they are consuming. So that's really important*" [P5, expert, female]. One participant raised concerns over the honesty of veterans when recording their drinking: "*they need to be honest about how much they're drinking because it'll be easy to sort of down on the size of your drinks or your quantities*" [P14, veteran, male].

Relevance and consolidation: Participant opinions suggested that *Drinks*:Ration was suitable for veterans by meeting a range of different needs: "*You've hit on the main things that an ex-military person, that would help them, the kind of things they would see as being important*" [P1, expert, male]. The fact that the app consolidated a range of resources in one place was particularly popular, for example:

"*I think that would be beneficial for kind of veterans, especially those with mental health problems and drinking issues. I think because it's all in one place, so they don't have to kind of you know, go to lots of different sites or lots of different apps, it's all in one, so I think that's why it would be useful*" [P3, expert, female].

Utility for wider military community: Some participants were concerned about veteran engagement if the app was expanded for use by non-military populations:

"*I do think they would actively engage with it, as long as, something I see from veterans is that they are very much closed off to the civilian life and see themselves as within a syndicate. So, I think as long as it was made purely for veterans and civilians couldn't go on it*" [P11, veteran, male].

Though some participants recommended the app could be expanded to the wider military community, including "*for those serving*" [P4, veteran, male] and also family members of military personnel: "*I mean there's the possibility as well that it's not just the veterans but also their family members*" [P5, expert, female].

Non-judgemental language: Participants shared the opinion that the language used in *Drinks*:Ration was non-judgemental and not patronising: "*I found it very appropriate and very kind of friendly, and not punitive or critical in any way*" [P12, expert, female], "*It wasn't too patronising and prescriptive it was kind of pitched at the right level I think*" [P10, veteran, male] and "*they [notifications] were nice, they didn't feel judgemental*" [P13, expert, female]. Using appropriate language was considered important for maintaining engagement, linking into Theme 3: Engagement.

'How You Compare': the value of comparing to other veterans: Many participants felt that the *Drinks*:Ration app would be perceived by veterans as valuable because it compares to other veteran users, not only the general population: "*…they would like being compared to other veterans. If it's kind of just for the general population I tend to find that they don't like that because they feel that they are different*" [P12, expert, female].

However, another raised concerns that it was a "double edged sword" because "*there's a danger that that's used as an 'oh look, I'm drinking more than you', in a banter type way*" [P5, expert, female], though this was speculative and may not work this way in practice. Overall, participants found being compared to others provided some reassurance: "*And comparing myself to others actually, and where I was apparently drinking less than others urm I thought, you know not displaying a massive issue here so that was kind of quite reassuring*" [P14, veteran, male].

Theme 3 - Engagement

The theme of engagement comprised of four subthemes: (1) notification content and frequency, (2) personalisation, (3) comparisons to other apps, and (4) informed by drinking severity. The likelihood of engaging with the app, as expressed by the current theme, was fed into by the other two themes, namely that it was a simple, easy to use app (Theme 1) and appropriate for veterans (Theme 2).

Notification content and frequency: Overall, participants were happy with the content of the notifications and appreciated reminders to use the app and log their drinking: "*Yeah definitely prompting to, remind us to do [the drinks diary] was a good one. Because I did keep forgetting to do it, urm especially if there were days where I hadn't drunk*" [P7, veteran, male]. Providing notifications with alternatives activities to drinking was also described positively: "*It was really good that the app actually sends a notification or ideas, let's say to have a soft drink. So I think that will be quite helpful*" [P12, expert, female].

The frequency of the notifications produced mixed opinions. Some felt the number of notifications was appropriate and described that "*if they'd have become more often I would have got fed up with it and kind of switched them off*" [P14, veteran, male]. Yet others "*thought there would be more notifications*" [P12, expert, female] and suggested that "*daily notifications would be a good thing. Just to see how you're doing and to outline the real danger of drinking too much*" [P11, veteran, male].

A few participants shared the view that "*maybe there could be a custom settings in terms of how often they would like to receive notifications*" [P12, expert, female], and suggested that notifications could be tailored to individual drinking habits to best meet the users' needs and preferences: "*…if you're someone that drinks throughout the day, maybe you need more notifications than someone who might just drink in an evening*" [P6, expert, female]. One participant reported that "t*he [notification] tone was quite startling … that did make me jump a couple of times*" [P7, veteran, male] so this may need more consideration, particularly for the veteran population experiencing anxiety disorders.

Personalisation: The personalisation of content, such as personalised messaging and individualised normative feedback, was generally regarded as positive. All participants reported having used at least one page that was personalised, for example, the dashboard, drinks diary and drinking recap. Participants had mixed opinions about the relevance of certain forms of feedback, such as calorie and monetary feedback. One participant reported being initially unsure about the monetary feedback: "*I kind of discounted that bit straight away because I thought 'yep that's probably London pub prices' as opposed to what I pay for alcohol*" [P10, veteran, male]. But during the interview, when they were informed that they could input their own prices, they realised the apps feedback would become more personalised and meaningful: "*but now knowing that I could change the prices on it. Actually, that would be much more accurate and personal*" [P10, veteran, male].

Comparisons to other apps: Participants who had previously used alternative alcohol reduction apps often referred back to their experiences of that app whilst evaluating *Drinks*:Ration: "*I used the 'Try Dry' app…which is much more basic than your app, but in many ways, it's all the better for it…going in to Drinks:Ration…isn't as easy*" [P4, veteran, male]. Expert users referred to apps which they signpost patients to and compared usability: "*there are apps out there…they're not as simple as you'd like them to be. Like, this one is probably the most simple, even though I think that it could be made even more simple*" [P2, expert, female].

Informed by drinking severity: None of the participants described their current drinking patterns as problematic, although some reported past difficulties; for example, "*I'm a recovering alcoholic*" [P11, veteran, male]. Participants' perception of their drinking appeared to influence the features they engaged with: "*obviously I don't drink a lot anyway…I didn't use all of the tools and analytics for the locations and things*" [P10, veteran, male]. One participant shared that: "*This is an excellent tool. I do not drink heavily, or regularly and it acknowledged this rather than being too patronising or providing inappropriate advice*" [P7, veteran, male], thus suggesting that the app can accommodate veterans with different levels of drinking severity.

Another participant shared their idea that the app should be implemented "*during initial recruitment training…for airmen and for officers*" as an adjunct to treatment for those already drinking at a hazardous and harmful level, and described *Drinks*:Ration as having potential as "*a military app that could actually work in co-operation with primary care*" [P10, veteran, male]. Alternatively, it could be used as a preventive measure rather than waiting until someone has developed problematic alcohol use.

Principal findings of the pilot study

The main findings of the pilot study demonstrated that *Drinks*:Ration resulted in high ease of use and satisfaction, and an interface that was highly appealing. It was a usable app for veterans to monitor their alcohol consumption. Quantitative analyses found the app had good usability. However, there was a discrepancy between the quantitative and qualitative findings regarding the usefulness of the app. Veteran users appeared to be more critical on the questionnaire than expert users regarding the app's usefulness. They did not all agree that the app was helpful for their health and wellbeing or that it managed their health effectively. In contrast, veterans generally regarded the app as useful in the qualitative interviews.

Pilot users reported that the successes of the app included the ease of use, its ability to meet veterans' needs, and the inclusion of features that encouraged app engagement. Some themes overlapped with our previous findings from *InDEx* [78], therefore providing further validation on the key features of smartphone-based alcohol interventions for the veteran population. One issue that arose during the acceptability testing of *InDEx* was that participants shared mixed views of how credible some of the different pages of the app were. For *Drinks*:Ration, however, none of the participants raised concerns over the credibility of the information provided on the app.

Ease of use: Across the quantitative and qualitative data, users highlighted the importance of *Drinks*:Ration being easy to use and not require too much effort to learn how to use. Being easy to use facilitated the self-monitoring of alcohol consumption, which in turn reduced user burden, especially in regard to time and effort. Being easy to use is a key quality identified by other studies evaluating alcohol reduction apps [54], [58], [70], [78]. To further enhance ease of use, since the pilot study was conducted, an overlay has been added to each page which provides instructions on how to use all features of the app on first use.

Interface and satisfaction: Participants emphasised the need for simplicity, including a simple and clear interface, to best meet the needs of veterans. The use of non-judgemental language was another strength reported by the pilot users of *Drinks*:Ration, consistent with our findings for *InDEx* [78]. The use of positive language and content that avoids patronising users, making it appropriate for veterans who may be more intolerant of being patronised. Some examples of masculine military norms include values of self-sufficiency, competence and independence, and the tendency for veterans to regard heavy drinking as acceptable for them [86]–[88].

With this in mind, non-judgemental language could therefore be a factor that reduces the risk of underreporting of alcohol consumption and improves levels of satisfaction and engagement with the app. This aligns with findings from another qualitative research study exploring the factors that influence the usability of a smartphone app for alcohol reduction (*DrinkLess*), but in the general population [70].

In response to the DrinkLess app, participants explained that the language used felt patronising and formal which led them to feel that they would be judged if they shared their drinking habits honestly. Instead, they would have preferred more friendly and informal language, which is what was implemented in *Drinks*:Ration. Based on the valuable feedback from participants we further clarified the language used in the app.

Usefulness: The most highly regarded and useful features of the app were the drinks diary, goal setting and drinking recap. These features cover the main BCTs which have been identified in previous research as having the greatest potential to reduce alcohol consumption through a mobile app. These are self-monitoring, goal setting, action planning, and feedback in relation to goals [65]. This is in line with our previous acceptability findings from *InDEx*, which suggested that self-monitoring facilitated a reduction in alcohol consumption [78].

The inclusion of personalised content in *Drinks*:Ration was generally regarded as positive and useful. This is consistent with previous research in the general population that suggests personalised messaging increases the acceptability of an app and improves the level of engagement [43], [89]. However, in *Drinks*:Ration, participants still raised some concerns regarding veteran engagement with the app and how accurately they would record their drinking. This is a common problem with self-report systems, and we adapted our messaging timeframe to promote engagement.

Notifications, including reminders to log drinks and drink-free days, which prompted engagement with the app were regarded as useful. Similarly, previous research has described notifications as an important feature to maintain engagement with an app [45]. Notifications, including personalised messages, were a key factor in determining the level of participant engagement with *Drinks*:Ration. Discussions over the frequency of notifications derived mixed opinions among participants. This was not, however, divided between participant type (expert or veteran) but purely individual preference and opinion.

Daily notifications were discussed as being more appropriate for veterans, whereas others felt that the frequency of notifications was already sufficient. This initiated the idea for notification settings to be further tailored to the user and their drinking and allow them to choose the frequency that best meets their needs and wants, and therefore promote app engagement. Previous research suggested that regular notifications should be implemented into future mobile health apps to encourage active engagement with the app [46], [47].

Despite its successes, generally veteran users scored the usefulness of *Drinks*:Ration lower than expert users. Veterans disagreed with statements on the MAUQ that related to the usefulness of the app for managing their health and wellbeing, and to the helpfulness of the app in managing their health effectively. These quantitative findings do not appear to harmonise with the qualitative findings. Perhaps these low ratings could be explained if the participants were considering their health as a whole rather than specifically focussing on their alcohol related health. We have adapted the app to take these factors into account.

Additionally, the veterans recruited in this pilot study did not report current alcohol misuse. Therefore, on the questionnaire, they may not have rated the app as useful to them as an individual, however, the questionnaire did not ask how useful the app may be for veterans with alcohol misuse. Instead, this was explored further during the qualitative interviews.

As described by study participants, other veteran users of the app might be a helpful comparison group. Often veterans have the perception that they are separate to the general population and have different levels of risk [86]–[88]. Our previous acceptability findings from *InDEx* suggested that the sample were sceptical of information that compared their drinking to the general population [78]. We took this on board for *Drinks*:Ration and compared to both the general population and other veteran users of the app.

When comparing veterans to other veterans could potentially cause problems, such as falsely reassuring them that their drinking habits are at an appropriate level, particularly because excessive alcohol consumption is more common in UK Armed Forces than the general population [1], [90]. The fact that *Drinks*:Ration used comparisons to both the general population and other veteran users of the app, should help users awareness of the extent to which veterans drinking habits exceed those of the general population.

Concluding remarks on the pilot study

Underestimating alcohol use is common among both general and veteran populations, with less than half of the UK Armed Forces with hazardous/harmful alcohol consumption recognising their alcohol problem [7], [8]. *Drinks*:Ration was discussed as a useful tool for increasing awareness of alcohol consumption, particularly when it contradicted their preconceptions about their drinking. This emphasises the need for alcohol interventions for this population to increase awareness of alcohol consumption. Participants did, however, describe *Drinks*:Ration as suitable for individuals with different levels of drinking severity.

Where possible, feedback from this pilot study was taken on board and incorporated into *Drinks*:Ration prior to the commencement of the RCT. Improvements made to *Drinks*:Ration included adding extra drink options, removing device notification sounds and adding a pop-up to each page which provides information about the features of the app on first use. Feedback which could not be implemented prior to the commencement of the RCT, for example personalising notification settings, may be implemented into a future version of the app.

In conclusion, this pilot study has shown that *Drinks*:Ration was easy to use for veterans, as well as having an appealing interface. It was described as a suitable and usable app for veterans to help monitor their alcohol consumption and potentially change their drinking habits. This evaluation also highlighted some issues surrounding usability and acceptability of the various features of the app and provided recommendations for improvements. These have been addressed in a revised version of the app.

Summary

- The aim of the pilot study was to **assess the usability of *Drinks*:Ration** based on expert and veteran user assessments of *Drinks*:Ration over a 14-day testing period.

- **16 participants** downloaded and tested the *Drinks*:Ration app, 14 participants went on to complete a usability questionnaire online and 12 participants went on to be interviewed.

- **Expert participants** – provide healthcare services to Armed Forces community.

- **Veteran participants** – previously served in the UK Armed Forces.

- Results from online questionnaire suggest *Drinks*:Ration has **good usability** for the target population with average score of 6.09 (out of 7) for each statement.

- Qualitative data supported that *Drinks*:Ration had a high usability for the target population. Three core themes: (**1**) **Simplicity,** (**2**) **Appropriateness for Veterans,** (**3**) **Engagement**.

- Participants provided suggestions on how to further improve the app. These were **implemented** into the app.

Chapter 5
Drinks:Ration – Randomised Controlled Trial

To date, there is no published work that seeks to test a brief fully automated smartphone intervention alcohol reduction app which is personalised to individual users and targeted to support UK military veterans. To address this, we developed the *Drinks*:Ration app (previously called *InDEx*; [77]–[79]) to support UK Armed Forces veterans to reduce the amount they drink. In this chapter, we report the findings of the RCT (F12). The main objective of the RCT was to assess the efficacy of a 28-day alcohol intervention delivered via *Drinks*:Ration in reducing self-reported weekly alcohol consumption between baseline and day 84 among veterans who drink at a hazardous or harmful levels and currently receive, or have previously received, support for mental health symptoms in a clinical setting.

Study sample

Participants were recruited via Combat Stress, a research cohort (F13) and social media (F14). All participants were, or are presently, receiving treatment through Combat Stress or had self-declared they had sought help for a mental health condition. Treatment offered via Combat Stress is for depression, anxiety, and PTSD. Combat Stress does not offer alcohol treatment services. The eligibility criteria are as follows:

Inclusion: To be able to take part in this study, participants had to be aged 18 years of age or older, live in the UK, consume more than fourteen UK units (approximately 140g) of alcohol or more per week, be a veteran and own a smartphone (F15).

Recruitment

All participants were sent an explanation of the study, link to the participant information sheet and instructions on how to download *Drinks*:Ration using a unique quick response (QR) code. Once participants had downloaded the app, they were invited to report their alcohol consumption [91] for the last 7-days and confirm they served in the UK Armed Forces. Those meeting the study eligibility criteria will be invited to register an account and complete the baseline questionnaire (day 0).

[F12] A full explanation of the study design can be found in **Appendix 7 – Randomised Controlled Trial Approach**.
[F13] We recruited participants via the King's Centre for Military Health Research Health and Wellbeing study.
[F14] Participants were recruited via Twitter and Facebook using public tweets and posts, including paid promotion.
[F15] It is important to note that in the UK, individuals are defined as veterans if they have completed a minimum of one day paid employment in the UK Armed Forces.

Intervention (active arm)

The intervention arm in the RCT received the *Drinks*:Ration app with all functionality including push notifications and SMS messaging. Control participants had access to only the 'questionnaire and feedback' module and did not receive any form of personalised messaging except to prompt for questionnaire completion and reminders to review alcohol consumption feedback.

Participants in both arms completed additional questionnaires on their mood and general mental health during the weekly questionnaires. These responses were used to personalise the content of the app and push notifications and SMS messaging delivered to the intervention arm only.

Participants in both arms were asked to use the app for 28-days. After which, they could continue to use the app, however they would not receive personalised messaging.

Study participation, sample characteristics, and attrition

Between October 2020 and April 2021, 2708 individuals were invited to take part, of whom 2531 (93.5%) did not respond to the invite or declined to take part. 177 (6.5%) participants were invited to complete a baseline assessment, of these, 54 (2.0%) were found to be ineligible based on study criteria (**Figure 5**).

Therefore, a total of 123 (4.5%) participants completed baseline assessment and were randomised into the study. Of these, 78 (63.4%) completed outcome assessment at day 28, 79 participants (64.2%) completed outcome assessments at day 84 and 27 (22.0%) participants completed outcome assessments at day 168. A total of 19 participants withdrew from the study by day 84. This included 7 participants who withdraw due to the limited functionality of the control version of the app.

62 participants were randomised to the intervention arm and 61 to the control arm . The mean age was 47.6 (95% CI: 45.8 to 49.3). 117 (95.1%) participants were male and 95 (77.2%) were married or in a long-term relationship. 87 (70.7%) had served in the Army, and on average participants served 14.40 years (95% CI: 2.9 to 15.9) in the UK Armed Forces.

On average, participants had an AUDIT score of 16.7 (95% CI: 15.2 to 18.1) at baseline, with the majority reporting no probable PTSD (*n*=66; 53.7%). Conversely, 65 (52.9%) reported probable depression. Most participants entered the study with an Android device (*n*=67; 54.5%) and were recruited via the clinical group (*n*=59; 48.0%). 79 (64.3%) of participants completed the primary outcome at day 84, with 76 (61.8%) completing the secondary outcome (at day 168).
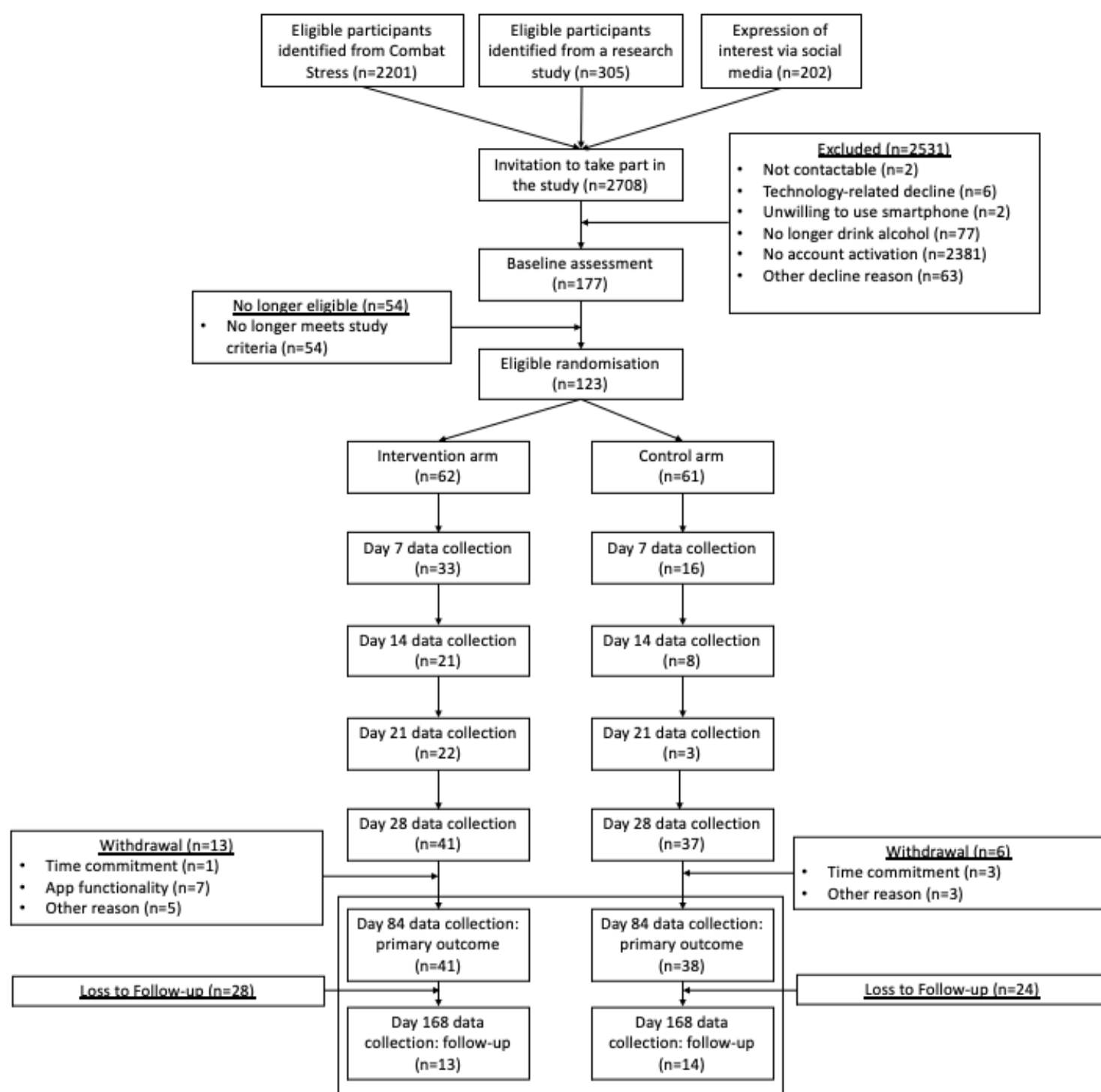
[16] Full demographics details can be found in **Appendix 9** – **Randomised controlled trial** detailed results.

Figure 5: Consolidated standards of reporting trials diagram for recruitment into the randomised controlled trial.

Primary results (F17)

Our primary results are shown in **Table 3**. Overall, we found that participants in the intervention arm had significantly larger reductions in self-reported alcohol unit consumption from baseline (marginal unit mean=56.3 [95% CI=50.6 to 62.0) to day 84 (marginal unit mean=28.1 [95% CI= 21.1 to 35.1) compared with those in the control arm (from 54.0 [95% CI=48.2 to 59.8] to 43.5 [95% CI=36.3 to 50.8]; interaction *p*=0.006).

Our models demonstrated that between baseline and day 84, weekly alcohol consumption reduced by -10.5 [95% CI= -19.5 to -1.5] units in the control arm and -28.2 [95% CI= -36.9 to -19.5] units in the intervention arm (*p*-value for difference between arms at day 84=0.003). The difference in unit marginal means was -15.44 [95% CI= -25.52 to -5.35] units of alcohol in favour of the intervention arm. There was also evidence of a strong effect between the two groups by day 28, but no evidence of an effect between the two groups by day 168 for self-reported alcohol consumption (**Figure 6**).
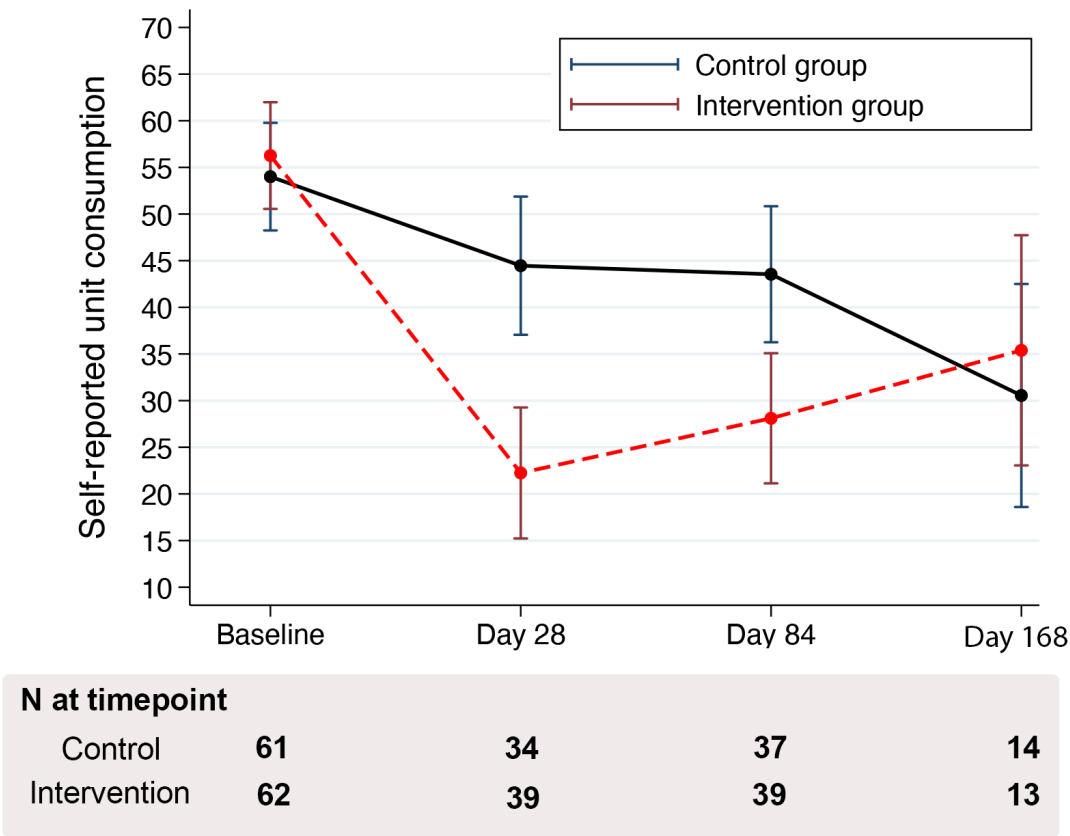

N at timepoint				
Control	61	34	37	14
Intervention	62	39	39	13

Figure 6: Trajectory for self-reported alcohol unit consumption as estimated from the mixed model.

For our secondary outcome, which was change in AUDIT score by day 84, we again found that participants in the intervention arm had significantly larger reductions in AUDIT score from baseline (score marginal mean: 16.3 [95% CI=15.0 to 17.5) to day 84 (score marginal mean=10.1 [95% CI=8.5 to 11.8) compared with those in the control arm (from 16.0 [95% CI=14.6 to 17.3] to 14.1 [95% CI=12.4 to 15.7]; interaction *p*=0.003). The difference was -3.9 [95% CI= -6.2 to -1.6] score on the AUDIT in favour of the intervention arm.

There was no evidence of an effect between baseline and day 168 for AUDIT score.

And finally, for the changes in quality of life domain scores, we found that between baseline and day 84, as compared with to the control arm, the intervention arm showed significantly greater improvements in physical health (difference in score marginal means: 1.35 [95% CI=0.72 to 1.92]), psychological (difference in score marginal means=1.11 [95% CI=0.41 to 1.81]) and environment domains (difference in score marginal means=0.95 [95% CI=0.34 to 1.56] (**Table 3**).

There was no evidence of an effect for social relationships between baseline and day 168.

Table 3: Estimated mean change between each measure, timepoint and arm. The difference in the rate of change between each arm compared with baseline is reported.

	Baseline	Day 28	Day 84	Day 168	Baseline to Day 28	Baseline to Day 84 Primary Outcome	Baseline to Day 168 Secondary Outcome
SELF-REPORTED UNITS CONSUMED OVER THE PREVIOUS WEEK							
Control	54.0 (48.2 to 59.8)	44.5 (37.1 to 51.9)	43.5 (36.3 to 50.8)	30.6 (18.6 to 42.5)	<0.001	0.006	0.797
Intervention	56.3 (50.6 to 62.0)	22.2 (15.2 to 29.3)	28.1 (21.1 to 35.1)	35.4 (23.1 to 47.7)			
AUDIT 10 SCORE							
Control	16.0 (14.6 to 17.3)	16.5 (14.7 to 18.2)	14.1 (12.4 to 15.7)	13.2 (10.6 to 15.9)	0.001	0.003	0.675
Intervention	16.3 (15.0 to 17.5)	12.1 (10.5 to 13.7)	10.1 (8.5 to 11.8)	12.7 (9.9 to 15.4)			
QUALITY OF LIFE: PHYSICAL HEALTH							
Control	12.3 (11.9 to 12.6)	13.4 (12.9 to 13.8)	12.6 (12.2 to 13.0)	12.6 (11.9 to 13.3)	0.656	<0.001	0.144
Intervention	12.24 (11.9 to 12.6)	13.18 (12.8 to 3.6)	13.9 (13.5 to 14.4)	13.33 (12.6 to 14.0)			
QUALITY OF LIFE: PSYCHOSOCIAL							
Control	10.9 (10.5 to 11.3)	11.2 (10.6 to 11.7)	11.5 (10.9 to 11.9)	11.1 (10.3 to 11.9)	0.559	0.009	0.540
Intervention	11.0 (10.6 to 11.4)	11.5 (11.0 to 12.0)	12.6 (12.1 to 13.1)	10.8 (10.0 to 11.6)			
QUALITY OF LIFE: SOCIAL RELATIONSHIPS							
Control	10.3 (9.8 to 10.8)	11.3 (10.6 to 12.0)	11.4 (10.8 to 12.1)	9.9 (8.9 to 0.9)	0.369	0.154	0.935
Intervention	10.4 (13.4 to 14.3)	11.9 (11.3 to 12.5)	12.3 (11.7 to 13.0)	10.0 (9.0 to 11.1)			
QUALITY OF LIFE: ENVIRONMENT							
Control	13.8 (13.4 to 14.1)	13.9 (13.4 to 14.3)	13.8 (13.4 to 14.3)	13.8 (13.1 to 14.5)	0.833	0.011	0.947
Intervention	13.8 (13.4 to 14.3)	14.0 (13.6 to 14.4)	14.8 (14.4 to 15.2)	13.8 (13.1 to 14.5)			

Note: Derived from model, which was adjusted for age, sex, number of days off work due to alcohol consumption and outcome measure.

Engagement

Over the study participants in the control arm used the app for a median of 1 week (IQR=1 to 2), initialised the app a median of 3 times (IQR=2 to 9) and had a median session duration of 60.9 seconds (IQR=35.7 to 75.6). Participants in the intervention arm used the app for a median of 3.5 weeks (IQR=2 to 6), initialised the app a median of 13.5 times (IQR=4 to 27) and had a median session duration of 43.8 seconds (IQR=32.3 to 67.9; **Table 4**).

Participants in the intervention arm reported a median of 7 drinking days (IQR=4 to 11), a median of 3.5 drink free days (IQR=2 to 7) and a median of 12.8 units of alcohol per drinking day (IQR=4.4 to 16.5). A median of 18 push notifications (IQR=9 to 19) were sent to participants in the intervention arm, along with a median of 12 SMS text messages (IQR=10 to 14).

Table 4: Intervention arm engagement with the Drinks:Ration stratified by page between baseline and day 168 based on app analytics data.

	Control	Intervention
	Median (IQR)	**Median (IQR)**
Engagement Measure		
Initialisations	3 (2 to 9)	13.5 (4 to 27)
Session count	24 (16 to 45)	54 (27 to 150)
Session duration	60.9 (35.7 to 75.6)	43.8 (32.3 to 67.9)
Server interactions	7 (5 to 8)	13 (8 to 19)
App recorded interactions		
Drinking days	*	7 (4 to 11)
Drink free days	*	3.5 (2 to 7)
Units consumed per drinking day	*	12.8 (4.4 to 16.5)
Notifications		
Push notifications	1 (1 to 1)	18 (9 to 19)
SMS text messages	2 (0 to 2)	12 (10 to 14)
Weeks active	1 (1 to 2)	3.5 (2 to 6)

*Participants in the control arm were not able to provide this information.

App use of participants in the intervention arm is shown in **Table 5**. Participants engaged with all modules of the app, but most of the app engagement was spent using the screening module (mean: 201.0 [SD=994.6) and normative feedback module (mean: 510.4 [SD=1012.7]).

Table 5: Intervention arm engagement with the *Drinks*:Ration stratified by page between baseline and day 168 based on app analytics data.

Page	Ever accessed *n* (%)	Number of times accessed Mean (SD)	Number of times accessed Median (IQR)	Average time (seconds) Mean (SD)
Screening	62 (100)	4.9 (4.9)	2 (2-6)	201.0 (994.6)
Normative Feedback	62 (100)	8.7 (9.9)	5.5 (3-10)	510.4 (1012.7)
Consent	62 (100)	3.3 (0.9)	3.5 (3-4)	59.0 (24.4)
Dashboard	60 (96.8)	34.8 (60.5)	10.5 (4-42)	301.1 (304.4)
Add Drinks	55 (88.7)	30.1 (53.0)	11 (3-38)	367.4 (505.0)
Timeline Follow Back	52 (83.9)	3.1 (2.11)	2 (2-4)	1293.6 (846.5)
Drinks Diary Information	52 (83.9)	17.1 (23.3)	11 (2-22)	895.3 (1038.9)
Drinks Diary	50 (80.7)	8.2 (13.1)	3 (1-8)	147.9 (232.5)
View Goals	47 (75.8)	3.3 (0.7)	2 (1-4)	60.6 (130.1)
User Account	40 (64.5)	3.0 (8.5)	1 (0-3)	55.2 (148.1)

*During the study, Apple changed policies related to how developers could track and monitor usage of an app. This required specific user content, which could be modified outside the app. It is therefore not possible to ascertain if a user did not give data because they were not using the app, or if they declined to share app usage statistics.

Usability

Participants completed an app usability questionnaire at day 28 (**Figure 7**). During this questionnaire, participants respond to a set of usability questions on a scale of 1 to 7, with a higher value indicting improved usability. Participants in the control arm reported an overall app usability score of 4.1 (SD=1.5), ease-of-use score of 4.4 (SD=1.6), interface and satisfaction score of 4.1 (SD=1.6), usefulness score of 3.6 (SD=1.7). This was lower than the intervention arm, who reported an overall app usability score of 5.9 (SD=1.1), ease-of-use score of 5.9 (SD=1.2), interface and satisfaction score of 5.9 (SD=1.1), usefulness score of 5.7 (SD=1.1).
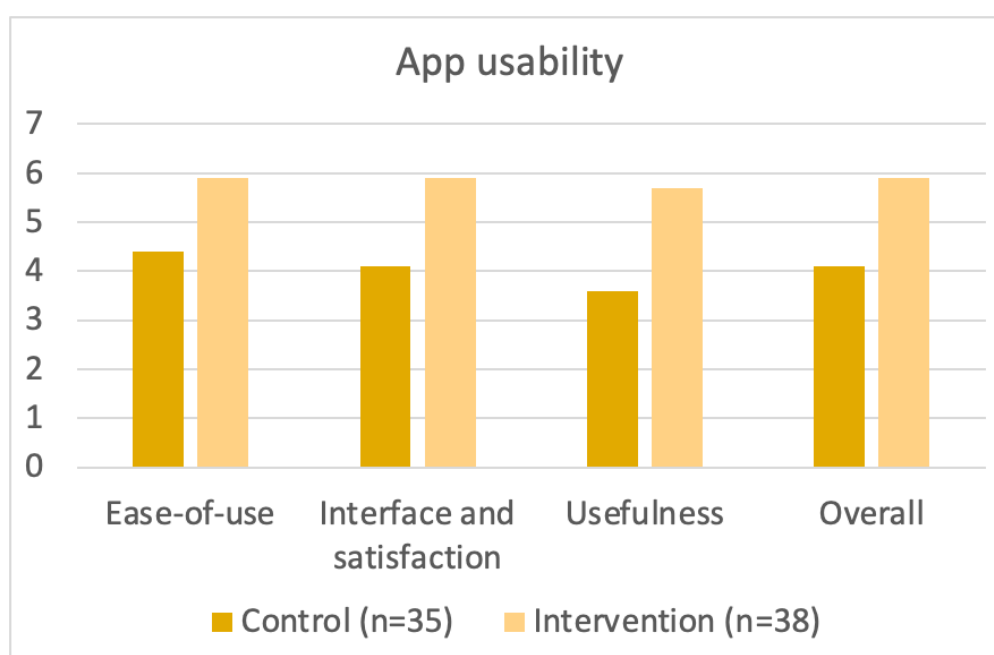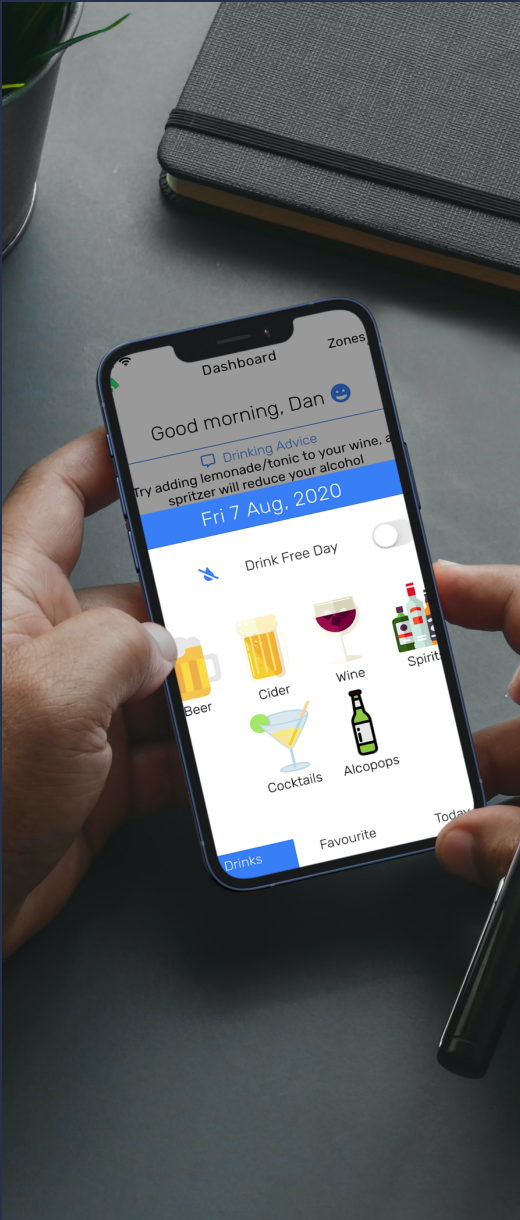

Figure 7: App usability responses collected at day 28.

Adverse events and technical issues

In total, 2 out of 123 participants were identified as having a single adverse event of consuming more than 25 units of alcohol within 24 hours during the study period. Following our risk protocol [92], a signposting booklet to relevant charities was provided as well as a call with the study clinical lead. After a clinical interview, both participants were allowed to continue in the study. There were no other adverse events identified.

Summary

- Overall, **123 participants** were recruited.

- Our analysis demonstrated that, as compared to the control arm, participants in the intervention arm had a **significantly greater reduction in alcohol consumption** between baseline and day 84 follow-up.

- Participants in the intervention arm consumed on **average 15.4 units of alcohol less** than the control arm.

- Our analysis demonstrated that participants in the intervention arm had **significantly greater improvements in physical health, psychosocial and environment domains** compared to the control arm.

- Participants in the intervention arm used the app for a median of **3.5 weeks**.

- Overall, participants in the intervention arm rated the usability of the app **5.9 out of 7, indicating high usability**.

Chapter 6
Reflections on our recruitment strategy

With a growing strain on healthcare services, particularly in the wake of the Covid-19 pandemic, digital technologies are becoming a necessary adjunct in healthcare delivery and monitoring, and have the potential to revolutionise clinical practice and research [93]. The Covid-19 pandemic, and the associated lockdowns and social distancing measures, have stimulated international changes in healthcare service delivery and research on a massive scale [94]. Over the last decade there has been increased awareness around the potential to use digital technology to improve access to health services.

One of the impacts of the pandemic has been to accelerate this move. mHealth apps are one form of digital intervention being used to promote health related behaviour change ([30], [95]) for example, to promote a reduction in alcohol consumption [25], [58]. In this section, we explore our experiences of recruiting participants during the pandemic, and lessons we learnt. Smartphone-based brief alcohol interventions offer the potential to manage alcohol consumption and have several advantages over traditional interventions, including that they can be used anywhere and at any time, helping to target 'hard to reach' populations and those underserved by current treatment options [96].

Additionally, digital technologies can help bridge the treatment gap caused by geographical inequalities. Smartphone apps are accessed at the user's discretion, providing control to the user and potentially reducing any perceived power imbalance with professionals. Increasing anonymity can reduce the perceived stigma associated with seeking face-to-face help for alcohol misuse [75].

Recruitment is one of the most challenging parts of psychological research, with only 20% of clinical trials completed on time, mainly because of participant recruitment challenges [97]. For smartphone-based alcohol interventions to be useful, it is important to understand both how and why people engage with research studies of this nature. Social media offers a unique opportunity for recruitment and intervention in the context of health research, and it is becoming a popular recruitment tool due to its wide scope. It is usually easily accessible, making it a viable strategy to reach large populations [98].

The most popular social media platforms (*e.g.* Facebook, Twitter, Instagram) host several hundred million users. For instance as of 2021, Facebook had more than three billion users worldwide and over 100 billion messages were shared daily [99]. This gives it great potential for recruiting participants into research quickly. The ability of social media to target specific populations is a unique advantage over traditional approaches such as flyers, newspaper adverts and radio adverts.

Previous research has proposed social media as an effective recruitment strategy for research studies [98], [100], [101]. But the results are often inconsistent with one review reporting social media as the most effective recruitment strategy in only 12 out of 30 included studies, when compared to traditional methods [102].

The review described characteristics such as participant age or being a 'hard-to-reach' population as influential on the effectiveness of social media as recruitment strategy [102]. A review on the use of Facebook for recruitment into health research reported that most studies included in the review recruited young age groups or focused on specific demographics [103]. Given the vast number of unique users, social media sites, including Facebook, are turning to monetised advertising. One systematic review exploring the use of Facebook in recruiting participants for health research, reported that Facebook advertising was a successful tool for participant recruitment as it was able to access 'hard to reach' populations [103]. Facebook advertisements (ads) can target specific groups of people by selecting a set of criteria, for example, demographics such as age, gender and geographical location [104], [105].

The benefits of Facebooks ads include shorter recruitment periods, and improved participant selection of young and 'harder to reach' demographics when compared to traditional recruitment methods such as email invitations [103].This may lead to reduced costs because a shorter recruitment period means less staff time. Yet, the use of social media advertising, such as that provided by Facebook, has associated costs so the cost versus yield of this strategy needs to be considered.

It is particularly challenging to recruit into RCT because participants must be willing to be assigned randomly to the intervention or control arm of the study, and once recruited, RCTs require commitment to follow-up [101]. A recent review suggested that poor recruitment was a key predictor of RCTs being discontinued, noted in over 75% of such trials [106]. Response rates are widely considered to be a key indicator of data quality [107].

Recruitment strategies

Recruiting participants into health research should involve strict participant inclusion criteria. Traditional methods of recruitment for research projects include letters and flyers. But it is important to recognise that these methods often miss underrepresented populations and can be slow [108], [109].

Treatment-seeking veterans, the target population for this study, are considered to be a 'hard to reach' population, especially due to the poor rates of treatment-seeking among this population, with only around 50% of veterans seeking help for their mental health [110]. Additionally, research has reported that it takes, on average, 11 years after leaving service for veterans to seek support [111]. Untreated mental health difficulties can have a negative impact on mental and physical health and wellbeing of veterans [112], [113]. This might potentially lead to an increase in alcohol consumption because individuals may use alcohol as a coping mechanism for their mental health difficulties.

We contacted several UK military and veteran organisations and charities to help us to promote the study. In total, more than 20 agreed to promote the study through sharing details on their social media platforms (including Facebook, Twitter and Instagram), on the organisation/charity website, and/or in digital newsletters. Our final recruitment strategy used Facebook advertising to further promote the study. Facebook ads were targeted towards 21-60 year olds living in the UK who met specific criteria. To develop and define the criteria for recruitment, we consulted experts in the field.

Agreed criteria included: (1) interests, such as Royal Air Force, Veterans Day, British Armed Forces, Army, Veterans, Royal Marines, Marines, Navy, Special Forces, Armed Forces, Remembrance Day, Air Force, and (2) school/university/employers, such as Royal Navy, The Royal British Legion, British Armed Forces, Royal Marines, HM Armed Forces, Royal Air Force or British Army.

Overall, we exceeded its recruitment target (n=168), with half of the sample (n=84, 50.0%) being recruited via social media, including Facebook advertising. Facebook ads were active for a period of 88 days between January and April 2021. The ads were viewed by a total audience of 29,416 people, of whom, 88% were male and the approximately half were aged between 55-60 years old. Potential participants could register their interest and complete a short eligibility questionnaire via the study website. 3,059 potential participants clicked the link on the advert and 87 potential participants registered their interest in the study (see **Figure 8**).

Figure 8: Recruitment breakdown for Facebook advertisements.

Of these potential participants, those who met inclusion criteria for the study were then asked to provide a contact email address to receive additional information about the study and instructions on how to download the app. Of those who registered their interest, 48 participants downloaded and signed up to the app (0.2% of total audience) and 27 were eligible for inclusion in the RCT (0.1% of total audience).

Reasons for ineligibility included, (1) not reporting drinking at least 14 UK units of alcohol per week, (2) not having sought formal help for mental health, and (3) not being a veteran of the UK Armed Forces. It is not possible to identify the reasons for declining or ineligibility for each individual recruitment strategy, only for the study as a whole. The total cost for Facebook advertising was £1,139.95 (USD $1,567.43), costing £13.10 (USD $18.10) per expression of interest, £23.75 (USD $32.66) per consent and £42.22 (USD $58.05) per eligible consent for the RCT.

Challenges for Recruitment

When considering potential strategies for recruiting military veterans for alcohol misuse research, there are several potential barriers to participation which may hinder recruitment targets. When considering all recruitment strategies used in this study, four key groups of challenges to recruitment were encountered:

1. alcohol consumption (not meeting eligibility for trial), e.g. non-drinkers.
2. communication and technology-related, *e.g.* emails bouncing, technical issues and unwillingness to use smartphone.
3. data-related and other barriers, *e.g.* not providing baseline data.
4. Covid-19 pandemic.

Figure 9 shows the breakdown of reasons given for declining to participate in the study (*n*=245) and ineligibility after sign-up (*n*=53) across all recruitment strategies.

Figure 9: Reasons for declining participation and ineligibility for all recruitment strategies used for the *Drinks*:Ration study.

Alcohol consumption

For the participants recruited via partner organisations, one of the most common reasons provided for declining the invitation to take part in the *Drinks*:Ration study was either being a non-drinker, or consuming less than the amount of alcohol outlined in inclusion criteria (14 UK units of alcohol per week). After reading the participant information sheet, these individuals self-disclosed via email that they did not meet the study eligibility criteria and declined the invitation to take part (*n*=77; 31.4%). Additionally, of those who proceeded to sign up to the app, 31 were excluded from the RCT because they did not meet the required levels of alcohol consumption of 14 UK units per week.

This recruitment challenge relating to alcohol consumption was unexpected given the literature on drinking culture in the military. Previously, the UK Armed Forces have used alcohol to encourage bonding between personnel and to cope with difficult experiences. Alcohol misuse is more common in the UK Armed Forces compared to the general population (10% versus 3%, respectively) [4]. Given the high prevalence of alcohol misuse in the UK Armed Forces, potentially the sample targeted for recruitment may not be representative of the wider UK Armed Forces veteran population.

Despite this, in the veteran population more broadly, research suggests that alcohol use among veteran populations is reducing, particularly since the start of the pandemic [4], [114]–[117]. This could be one reason why recruiting UK help-seeking military veterans with hazardous, and, or harmful alcohol use has been particularly challenging for this study.

Communication and technology

When sending participation invitations to potential participants via partner organisations, one key issue that arose was being non-contactable (n=97; 40.0%), for instance having an invalid email address which caused the initial email to bounce. To account for these communication difficulties, a random sample of 100 potential participants who had not responded to the email invitations were contacted via postal mail out. But this only led to 2/100 (2.0%) responses.

The total cost of materials required for the postal mailout was £99.67 (USD $137.03), therefore, the cost per consent was £49.84 (USD $68.54). It also required a full day's work by a Research Assistant (not included in the total costs). Therefore, a postal mail out was regarded as not time- or cost-efficient to continue for all other non-responders.

A few potential participants experienced technology-related challenges, including technology-related issues (n=8; 3.3%) such as technical problems when downloading the app, and unwillingness to use a smartphone. Despite the fact the app was available to iOS and Android users, and there was provision of technical support, some participants experienced technical issues during the downloading and sign-up stage of the study. Future studies should consider these limitations and ensure that their technology is compatible with a wide variety of smartphone devices.

For those who reported unwillingness to use a smartphone, this was because they did not own a smartphone. Therefore, it is important to consider bias towards those already using smartphones. It is imperative for future studies to consider the type of participant group they would like to recruit and why. Future research should consider providing a web-based version of the app for participants with technical issues and those who do not own a smartphone.

Data-related and other barriers

Of all potential participants, 21 (8.5%) did not complete the baseline questionnaires when signing up to the app and therefore were ineligible to proceed with trialling the app in the RCT. Without this information, we would be unable to compare outcome data to baseline data to determine the efficacy of the app. All participants who signed up but did not complete baseline measures were contacted via email to offer support. The reasons for not completing baseline measures remain unclear. However, one potential explanation could be that these individuals were not prepared to spend the time required to complete the baseline measures.

Another obstacle faced during recruitment was participants having previous negative experiences with partner organisations (*n*=22; 9.0%). This led them to withdraw their consent to be contacted by the partner organisation and therefore decline the invitation to take part in this study. For this reason, social media for recruitment may be advantageous over partner organisations. However, future research using social media as a recruitment strategy should take this into consideration as highlighting relationships with partner organisations may influence the uptake from the ads.

Covid-19 pandemic

When considering challenges to recruitment for this study, the Covid-19 pandemic may have had the largest impact. Due to the nature of the pandemic, recruitment was challenging, and we had to seek alternative recruitment strategies than were set out in the study protocol [92]. The original recruitment strategy was to recruit patients engaged in mental health treatment at a partner organisation, Combat Stress, a UK veterans mental health charity.

Of those who were invited to take part in the study, we only had a 3.3% (72 out of 2207) response rate. This recruited less than 50% of the target number of participants required. We then invited a sample of potential participants from another partner organisation, the King's Centre for Military Health Research, based at King's College London University. Access to veterans via this organisation provided a 3.9% (12 out of 305) response rate, still leaving us short of the target number of participants.

One potential reason for the poor response rates could be digital fatigue. The Covid-19 pandemic with the associated lockdowns and social distancing measures have forced a rapid change in our use of digital technologies, including for education and employment, healthcare and even social interaction. For many, the thought of taking on yet another digital based commitment may have been too much. For those invited via partner organisations, some had already been contacted to take part in other research so did not want to take on another commitment. Additionally, recent research on a sample of treatment-seeking military veterans found that symptoms of PTSD and CMDs were the most commonly reported to be exacerbated by the pandemic [117]. A deterioration in mental health caused by the pandemic may be another potential explanation for the low response rates.

Limitations of recruitment strategy

There are some potential limitations of the recruitment strategies outlined in this chapter. It is important to consider and acknowledge that these limitations may have affected the sample recruited. Recent research suggests that mHealth studies show inconsistencies in sample age, and are unable to recruit samples representative of geographical and ethnic diversities [118].

In our study, an effort was made to reach female veterans as well as male veterans by contacting female veteran organisations and charities to help advertise the study. In our samples, females represented 7.7% and males represented 92.3% of study participants. In the UK Armed Forces, personnel are made up of approximately 10% females and 90% males [119], so these numbers are already relatively comparable to the wider military community. In addition, as males are at an increased risk of drinking excessively [120], it is possible that they may naturally be more highly represented in study samples.

We initially delayed recruitment by six months, from April 2020 to the start of October 2020, aiming to minimise the impact of the Covid-19 lockdown. But, social distancing and restrictions to daily living remained in place, and shortly after beginning recruitment, the UK entered its second national lockdown. It is therefore important to consider the impact of the lockdown on recruitment. With national lockdown measures in place, many individuals were spending an increasing amount of time online, for instance an Ofcom Report from 2021 reported that the UK's internet use surged to record levels in 2020, with adults spending on average three and a half hours per day online and approximately one and a half hours watching online services, with approximately 80% of time spent online was using mobile devices [121].

This may have biased the sample towards individuals who were confident with technology and more willing to participate in a study which required them to download and sign-up to the app themselves. Internet use increases were more pronounced during the three UK national lockdowns [121]. This surge in internet use over the course of the pandemic may have led to digital fatigue and may begin to explain why we initially struggled to recruit for the study. Unfortunately, we were unable to analyse the demographics or the reasons for non-response for those who did not respond to invitations from partner organisations to take part in the study.

Non-response was assumed to be refusal to participate in the study. Given the nature of the Covid-19 pandemic, which has created an opportunity to expand and utilise digital technology, and the shift to digital technology in healthcare delivery and research, future research should consider exploring the impact of the pandemic on recruitment strategies in various fields.

Another potential limitation of using social media for recruitment is digital exclusion, as it excludes those who do not have access to the Internet. Factors which contribute to the risk of digital exclusion include a lack of skills, access and motivation [122]. However, the proportion of people with access to the Internet is steadily increasing.

An Office of National Statistics report from 2020 reported that 96% of households in Great Britain had internet access, increasing from 93% in 2019 and 57% in 2006 [123]. Individuals with severe mental illness are also at an increased risk of digital exclusion [124].

This vulnerable population may be disproportionately reliant on digital technology due to the provision of self-help strategies and the increased risk of self-isolation during the Covid-19 pandemic [124]. However, some symptoms of severe mental illness and experience of psychiatric inpatient care may hinder their use of digital technology for this group.

Additionally, participant recruitment solely via social media would exclude individuals who do not use social media. A cross-sectional study exploring the profile of UK veterans seeking support for mental health difficulties reported that the population were likely to be older (45+ years; [12]), and therefore may have been less likely to use social media. Research is beginning to raise the question as to whether samples recruited via social media are representative of the general population [125].

Despite the limitations, strengths included exceeding the minimum targets for participant recruitment despite the challenges faced. In addition, our study contributes to the growing evidence base on the use of social media and Facebook ads for recruiting into health research.

Summary

- Overall, **168 participants** were recruited.

- Recruitment occurred via **3 methods**: (1) Combat Stress (n=72), (2) KCMHR cohort (n=12), and (3) social media (n=84).

- Several **challenges** to recruitment including (1) low/no alcohol consumption, (2) communication and technology-related challenges, (3) data-related and other challenges, (4) Covid-19 related challenges.

- There were several reasons why individuals **declined** to take part including being a non-drinker, unwillingness to use a smartphone and opting out of communication from a partner organisation.

- There were several reasons why individuals were **ineligible** for the RCT including being a non-drinker/not consuming 14 units of alcohol per week, not being a veteran of the UK Armed Forces and never sought formal help for mental health.

- We found that recruiting via Facebook advertisements **was effective** and resulted in a high return in participants.

Chapter 7
Discussion

This report presents one of the first RCTs to date to examine the efficacy of a fully automated 28-day brief alcohol intervention delivered via a smartphone app in a help-seeking sample of UK veterans with hazardous alcohol consumption. We presented a systematic review, where we explored the literature related to notifications to drive positive behaviour change. We found that the literature was limited, with one a few studies using notifications for behaviour modification. We then presented our pilot study findings, where we assessed the Drinks:Ration app in a small group of users. This pilot enabled us to test new features, and further refine our main RCT protocol.

And finally, we undertook the main RCT, where we found that *Drinks*:Ration app was effective in reducing alcohol consumption in help-seeking veterans. We found, that on average, participants in the intervention arm consumed 15 fewer units than the control arm ay day 84. A similar pattern was also observed for AUDIT score, where those in the intervention arm reported on average 4 points lower than the control arm. We also identified improvements in quality-of-life domains for physical health, psychosocial and environment.

Overall, the intervention arm achieved significantly better reductions in alcohol consumption and AUDIT score, while quality of life on three domains improved. These effects were only observed in the short-term, and were not present at the final outcome assessment.

Next steps and recommendations

The results of this report have implications for the ways in which help-seeking veterans can receive support for alcohol misuse. To ensure a broad and realistic discussion of the implications of this research, a joint stakeholder event, in partnership with MeT4VeT [F18], was held towards the end of the project. Representatives from secondary mental health care providers, providers of veterans' mental health treatment and support and academics attended including:

- King's College London
- Combat Stress
- Forces in Mind Trust
- Help for Heros
- NHS
- Ministry of Defence

- Samaritans
- We are with you
- The Royal British Legion
- Anglia Ruskin University
- Veterans Office (Scotland)

[F18] Funded by the Forces in Mind Trust, MeT4VeT is a smartphone app designed to support veterans' mental health using innovative self-help tools.

After hearing the research findings presented in this report, stakeholders worked together in two groups to discuss the results of the research, the potential impact on practice and policy, and future research directions. The session culminated in in a set of key recommendation for the academic, public and Government sectors to address. Our recommendations are:

- Accelerating the use of digital technology in clinical settings to support the armed forces community.
- The development of a holistic framework to signpost the armed forces community to the most appropriate digital support for their needs.
- Future research focusing on the use of notifications and how they influence positive changes in behaviour.
- Conducting further research to assess the generalisability and scalability of *Drinks*:Ration at a national level.
- Developing methods to interrogate data collected via digital technologies in near real time to support treatment delivery.
- *Drinks*:Ration is uniquely placed to support those who consume alcohol as a coping mechanism to manage other mental health problems.
- Exploring the use of *Drinks*:Ration in different settings and occupations.
- Future research is focused on ascertaining the economic and societal impact of alcohol misuse of the armed forces community.

Next steps and recommendations

In this report, our findings provide scientific support that *Drinks*:Ration was efficacious in reducing alcohol consumption in help-seeking veterans. These findings support the widespread dissemination of Drinks:Ration in this population. Future research is needed to evaluate *Drinks*:Ration in different occupations and populations. Further, we have provided a reflection on our experiences of recruiting help-seeking veterans, to support the developed of more integrated recruitment strategies.

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