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A qualitative exploration of the experiences of transdermal alcohol sensor devices amongst people in receipt of treatment for alcohol use disorder

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ABSTRACT

Introduction: Transdermal alcohol sensors (TAS) have the potential to be used as a clinical tool in alcohol treatment, but there is limited research with individuals with alcohol dependence using TAS. Our study is a qualitative evaluation of the views of people attending alcohol treatment and their experiences of wearing the BACtrack Skyn, within alcohol services in South London.

Methods: Participants with alcohol dependence wore a BACtrack Skyn TAS for one week and met with the researcher every two days, for a total of four meetings (for example: Monday, Wednesday, Friday, and Monday). In the final meeting, a post-wear survey (on their physical, social and comfort experience of the TAS) and semi-structured interview were completed. The Technology Acceptance Model (TAM) informed the topic guide and data analysis.

Results: Adults (N = 16) receiving alcohol treatment were recruited. Three core topics guided analysis: perceived usefulness, perceived ease of use and attitudes towards use. Participants found the TAS easy to wear and felt positive about its appearance and comfort. The only challenges reported were side effects, mostly skin irritation. The main two perceived uses were 1) TAS working as a drinking deterrent and 2) reducing daily breathalyser visits during detox.

Conclusion: Findings support the use of TAS amongst alcohol service users. Wearing the TAS for one week was acceptable and feasible for objective alcohol concentration measurement. Participants reported high perceived ease of use and usefulness of the Skyn in the context of alcohol treatment. These results are encouraging for the use of TAS in clinical settings.

1. Introduction

Transdermal alcohol sensors (TAS) are devices that can be worn for extended periods of time and are able to continuously monitor alcohol consumption via skin excretion of sweat vapours (Barnett, 2015; Leffingwell et al., 2013; R. Swift, 2000; van Egmond et al., 2020). While current brands are targeted for public use (Brobbin et al., 2022a), the ability to measure alcohol consumption objectively and continuously could be advantageous for specialist alcohol treatment. Current typical methods used in alcohol services to measure alcohol consumption are breathalysers and self-report diaries (Kuntsche et al., 2022a; Sobell & Sobell, 1992). Breathalysers provide accurate measures but are limited to the period they can collect information (Kuntsche et al., 2022b). They are limited by the window of time that alcohol is present in the breath, a few hours following alcohol consumption, and can only capture alcohol concentration at the point of test administration. Self-report diaries can record what is consumed each day, provided they are accurately completed. This requires capacity and memory to complete each day and there is a chance of subjectivity and incorrect recall (McPhail & Haines, 2010; Schmier & Halpern, 2004; Sobell & Sobell, 1992). Therefore, the objectivity and continuous measurement that is possible with TAS, could address the breathalyser and self-report limitations.

TAS use in alcohol treatment has been suggested in previous research (Barnett, 2015; Barnett et al., 2011, 2017; Brobbin et al., 2022b; Dougherty et al., 2014, 2015). Some studies have specifically used TAS to monitor alcohol consumption whilst participants were rewarded with

Abbreviations: AMS, Alcohol Monitoring Systems; CM, Contingency Management; SCRAM, Secure Continuous Remote Alcohol Monitoring; TAC, Transdermal Alcohol Concentration; TAM, Technology Acceptance Model; TAS, Transdermal Alcohol Sensor(s); TLFB, Timeline Follow Back; UK, United Kingdom; US, United States.

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contingency management (CM) to reduce alcohol consumption (Barnett et al., 2011, 2017; Dougherty et al., 2014, 2015). CM has also been shown to be effective in successful behaviour change in both alcohol and other substance use treatments (Bigelow & Silverman, 1999; Murphy et al., 2015; Petry, 2011; Pfund et al., 2021; Prendergast et al., 2006; Stitzer, 2007). However, an important principle of CM is the reward being implemented close to the target behaviour. For alcohol, there has not been a tool that was able to objectively record alcohol concentration continuously to allow for this (Petry, 2000). With advances in TAS technology, particularly the opportunity for real-time data collection, successful alcohol CM implementation close to the target behaviour action, is now a greater possibility.

There is more than one brand of TAS device available. The BACtrack Skyn Fig. 1 is currently available for research and criminal justice use and is one of the newest TAS with a smaller amount of previous research conducted using it (Ariss et al., 2022; Ash et al., 2022; Fairbairn et al., 2020; Fairbairn & Kang, 2019; Richards et al., 2022; Rosenberg et al., 2021; Wang et al., 2019, 2021). The two most widely validated are SCRAM and WrisTAS (Barnett, 2015; Brobbin et al., 2022b; Dougherty et al., 2015; Fairbairn et al., 2019; Greenfield et al., 2014; van Egmond et al., 2020; Wang et al., 2019). The SCRAM is currently used in the US and UK criminal justice systems with individuals involved in the criminal legal system for an alcohol-related offence. The SCRAM can be locked onto the wearer's ankle. Although these devices are currently targeted at the public or the criminal justice system, another possible application could be in clinical treatment. There has been a growth in published studies determining the various brands of TAS accuracy and suggestions for clinical use (Alessi et al., 2019; Brobbin et al., 2022b; Croff et al., 2020; Fairbairn et al., 2020; Rosenberg et al., 2021; Wang et al., 2021). Before implementation into clinical settings, the practicality of wearing TAS over extended periods needs to be explored within this population. TAS accuracy, acceptability, and feasibility are important, and necessary, for their purpose of continuous objective alcohol monitoring and must be considered before wider implementation in clinical settings. There have been previous qualitative and observational studies that have investigated TAS acceptability and feasibility (Alessi et al., 2017; Brobbin et al., 2022a; Caluzzi et al., 2019; Croff et al., 2020; Goodall et al., 2016; Merrill et al., 2022; Neville et al., 2013; Norman et al., 2020; Rosenberg et al., 2021; Villalba et al., 2020). Yet only one of these nine studies included individuals with alcohol dependence (Alessi et al., 2017).

A recent study by Richards et al. (2023) (Richards et al., 2023) interviewed individuals who were interested in reducing their drinking, with some participants having previous experience wearing the SCRAM TAS. Richards et al. (2023) found five themes: factors influencing willingness to wear it, personalised messaging of data collected, preference for length of time wearing the biosensor, sharing data collected with others and mental health support. Factors influencing willingness referred to comfort and appearance influencing the willingness to wear the device. It was suggested that the service or healthcare provider should own the device and lend it out to wearers rather than the service user owning it. We conducted our study with this same premise, with the researcher providing the participant with the TAS on the first visit and the participant agreeing to return it to the researcher on the last visit.

Fig. 1. BACtrack Skyn https://skyn.bactrack.com.

The Technology Acceptance Model (TAM) is an information technology framework for understanding users' adoption and use of emerging technologies. TAM theorises that a person's intent to use technology is predicted by the person's perception of that technology's usefulness and its ease of use (Chuttur, 2009; Davis, 1985). The TAM can act as a tool to allow researchers to evaluate potential implementation issues, particularly in clinical settings (Chuttur, 2009; Davis, 1985) which is why TAM was used in this study design with a focus on the implementation of a TAS device in clinical alcohol treatment settings.

To our knowledge, no previous study has interviewed individuals receiving treatment for alcohol dependence on their opinions of wearing a BACtrack Skyn TAS. While there has been research done with SCRAM and clinical alcohol patients (Alessi et al., 2017, 2019; Averill et al., 2018; Barnett et al., 2011, 2017; Mathias et al., 2018; Sakai et al., 2006; R. M. Swift et al., 1992), the BACtrack Skyn is very different in size, appearance, and location of wear (wrist vs ankle) to the SCRAM. Therefore, we believe it is important to explore the acceptability and aspects of each new TAS device.

2. Material and methods

This qualitative study involved wearing a BACtrack Skyn for one week, meeting with the researcher every other weekday for TAS data download and self-report Timeline Follow Back (Sobell & Sobell, 1992) and in the last meeting, a semi-structured interview was conducted covering the perceived ease of use, perceived usefulness, and attitudes towards the BACtrack Skyn. There were 16 adults currently receiving treatment for alcohol dependence. One participant decided to end wearing their TAS two days early but still completed the interview. All participants were recruited from three South London (UK) alcohol services. All interviews were conducted in private rooms to maintain confidentiality. Consent was gained for interviews to be audio recorded. This study was approved by the Surrey Research Ethics Committee (Reference: 22/LO/0426). At the end of the first meeting, participants were provided with a £10 voucher for their time and a £20 voucher at the final meeting for TAS return and completing the survey and interview. Travel expenses were reimbursed at each meeting.

2.1. Participants

Recruitment occurred between July and October 2022. Eligible participants were identified by service staff and, if they were interested and willing to participate, agreed to meet the researcher for a meeting to discuss the study. Recruitment also followed researchers attending service user groups within the participating services to discuss the study and collect contact details of those interested. Participants were aware of the aims and objectives of this research.

The inclusion criteria were: 1) Receiving treatment for an alcohol use disorder, 2) 18 years+, 3) Speak English competently, 4) Being able to meet the researcher throughout the study period 5) Able to provide consent.

2.2. Transdermal alcohol sensor (TAS): BACtrack Skyn

The TAS device used for this study was the BACtrack Skyn, model T15 (image 1). Skyn is worn on the wrist and measures alcohol consumption (transdermal alcohol concentration (TAC)), motion, and skin temperature (Celsius). Participants could wear the Skyn on their preferred wrist and adjust the magnetic strap for comfort. Participants were provided with a fully charged Skyn at the first meeting and were shown how to operate the TAS. BACtrack Skyn battery lasts

approximately 10 days, so participants were not required to charge it during the week. Skyn stores data for approximately 72 h and can only be paired with an Apple iOS device (iOS 13 or later). We conducted Patient and Public Involvement groups when designing the study and found that this cohort population are unlikely to own the latest Apple iPhone. Therefore, research meetings were arranged for every other weekday to download the data, to avoid it being overwritten.

2.3. Procedure

Participants had four research meetings occurring every other weekday, (for example, Monday, Wednesday, Friday, and Monday). In the first meeting, participants were instructed on how to use the TAS and arrange the subsequent meetings. Meeting #2 and Meeting #3 were to download data and to complete the TLFB since the previous meeting. The final meeting #4 included data download, TLFB, post-wear survey and the semi-structured interview.

Wearing this device was voluntary, and any removals would not have any consequences on treatment or study incentives. Skyn removal was required for showering or swimming as it is not water resistant.

All interviews were recorded via MS Teams, audio recording only no visual. During the interviews, only the researcher and the participant were present in the room. Interviews lasted between 30 and 60 min. The semi-structured interview was split into 11 sections and covered: patient background, first impressions of the Skyn, physical comfort, perceived usefulness, perceived ease of use, attitudes towards usage, self, and others' perceptions, drinking experiences, challenges experienced from Skyn wear, incentives, and suggestions for improvements. No repeat interviews were conducted, and field notes were collected. The transcripts were not returned to participants for comment.

2.4. Analysis

All interview transcripts were uploaded into NVivo 12 for coding. These were categorised into both deductive codes (based on the topic guide and core concepts of TAM) and inductive codes (from themes emerging from the data). A coding framework of the core constructs of TAM (perceived usefulness, perceived ease of use and attitudes towards use) was designed by the same researcher (EB) who had conducted all interviews and was refined within the research team (SP, PD, CD) through discussion in data sessions (Knoblauch, 2005) to overcome potential researcher bias. The coding framework was further revised as themes emerged during the analysis. Responses relating to each core construct of TAM were further organised into subheadings. The research team met regularly during the coding and analysis process to review data and emerging themes. The themes and findings were written and agreed upon through team discussion, reported below.

3. Results

3.1. Baseline characteristics

A total of 16 adults (9 = female, 7 = male) who attended an alcohol service for treatment enrolled and completed the study. The average age was 58 years, and all participants self-reported 'White' ethnicity. The main themes of the analysis are shown in Table 1 below, which follow the three core concepts of TAM: Perceived ease of use, perceived usefulness, and attitudes towards use. All participants except one had worn the TAS for eight days prior to this interview, and one for five days, and their responses were based on their personal experience of using the BACtrack Skyn.

3.2. Perceived ease of use of the BACtrack Skyn

3.2.1. Ease of use

A challenge regarding ease of use that was reported was the side effects of wearing the TAS. Side effects were reported by six participants (itching, soreness, and a rash). No other criticisms of the TAS were reported. All participants mentioned how simple it was to use. Some participants said they were nervous about using a new piece of technology or had described themselves as 'technology illiterate'. Although, in the interview, several commented that no knowledge or skills were required to use it, for example:

> I Don't think you need any skills (to use the TAS)… No, it's just straightforward. Didn't add on any time, didn't add on any time, not at all… **Participant 1 [Female, 63 years]**

3.2.2. Training

Before the study, participants reported a mixture of feelings about wearing the TAS. Some felt nervous, others were not concerned, and others were excited about wearing it. In the first meeting, participants were provided with information on how it worked and reminders for how it should be worn, where it should be placed on the wrist, how to check it was on and charged, and where the on/off button was located. All said that the training was easy to follow, straightforward and informative enough for them to wear and use the TAS without issue. When asked if participants ever felt the need to look back over the leaflet during the week, all participants answered 'no'. Similar responses were provided when asked if there was anything else they would like to have received in the training session. To illustrate the simplicity of wearing TAS, one participant commented:

> It's just like wearing a watch. **Participant 7 [Male, 56 years] .**

3.3. Perceived usefulness of the BACtrack Skyn

3.3.1. Use within alcohol services

There was a range of responses given when asked when the best time for TAS use would be as part of alcohol treatment. Suggestions included: before, during or post-alcohol detoxification. The main reason participants thought TAS would be useful within the detoxification period, was to reduce the frequency and need for attending the service for breathalyser measurements. Instead, if key workers could monitor remotely then they could see accurate and real-time alcohol data without the need for frequent face-to-face meetings, for example:

Table 1
Key themes from people receiving alcohol treatment interviews.

Key themes
Perceived ease of use of the BACtrack Skyn
Ease of use
Training
Perceived usefulness of the BACtrack Skyn within alcohol treatment
Use within alcohol services
Benefits of the BACtrack Skyn
Attitudes towards using the BACtrack Skyn
Device appearance
Device comfort

> I think it's a good thing, what they're doing, if it stops people from having to come to have breathalysers every day, but it's if they're willing to wear it every day, people, which I said to you the other day. **Participant 5 [Female, 40 years] .**

Those that thought that post-detoxification may be the best time to use the device considered TAS usefulness as a reminder and deterrent for relapse to drinking alcohol. They noted it would not stop someone craving alcohol but might make them reconsider, stop, and think, before consumption.

> Yeah, I can see it help. Going back to when I was drinking, I don't think it would necessarily stop. You know, I think people would think 'oh I can't drink because someone would know', because that wouldn't stop you. But monitoring when you've gone through withdrawals and then need a detox. Monitoring withdrawals in detox, it's good because if you're under supervision or under a doctor, they can always check the levels of alcohol when you've been drinking. What makes you drink at certain times. **Participant 1 [Female, 63 years] .**

Overall, participants believed the TAS would be useful for tracking alcohol consumption, providing an objective measure, and the ability to discuss the patterns of use and talk through triggers and thoughts with their key worker. Participants were also interested in being able to view the data themselves and receive personalised messages about their consumption or abstinence. While it was recognised that TAS alone would not be enough to stop alcohol consumption, knowing someone can monitor them was reported as comforting and useful for treatment. When asked about TAS usefulness one participant stated:

> I do think that, absolutely [that a continuous measurement would be useful]. Yeah, but not to make people feel guilty, and go oh god, you said you only had 10 units and you've had 20 units. You can't guilt trip people because then that would mess it up. Just as a genuine log of what is happening, because once you start drinking… you do lose track, you get blackouts, you forget how much you've had and all that. So, I think it's a very useful tool, yeah, I like it. **Participant 4 [Female, 49 years] .**

Another participant described TAS use as a deterrent for alcohol consumption:

> When you look at [the TAS]… and drink when that's on. It's not gonna stop alcohol, but… a red flag is good… that split second is just very important for people like me. You look at it [the TAS]. It gives you a warning, a red flag coming up there, just look at the watch [TAS] …The extra handbrake on your car, you know what I'm saying? – I think it's quite good anyway. **Participant 9 [Male, 55 years] .**

3.3.2. Benefits of the BACtrack Skyn

One of the benefits reported by participants was that the TAS could reduce the frequency of attending the service for breathalyser measurements, particularly during the detoxification period. Also, it could benefit service users who are still consuming alcohol, by having someone monitor their alcohol use. Then, action could be taken if their alcohol consumption is increasing before a full relapse or hospitalisation occurs. For example:

> I think it can be helpful to have your alcohol intake measured and you know if somebody can step in before you end up in the hospital, which costs a lot of money. I would drink and drink until there was an intervention, that somebody found me or something like that and took me to A&E [hospital emergency department]. **Participant 1 [Female, 63 years] .**

Another benefit participants noted, was that the TAS made them think twice about their actions and that it reminded them of their recovery goal. Participants felt it was a good motivator and deterrent to alcohol consumption. For example:

> Yeah, in early stages (of treatment), … if the treatment was right, you'd have to get professional treatment. Then when you are kind of moving away from that it'd be good too. That [the TAS] is a deterrent because when you come out of treatment and you're on your own, your head's a bit like, 'will I or won't I', so that would help I'd imagine. **Participant 7 [Male, 56 years] .**

Most participants said it was a good thing if the TAS could reduce the frequency of visits during the detoxification period:

> Well, I think If I was going for a detox or withdrawal. I think it's handy if you have to go and have a breathalyser, so it is quite good if somebody could receive the information so they can see if you had been drinking, that makes that a lot easier. **Participant 1 [Female, 63 years] .**

One participant also stated that they liked the frequency of visits to the data download meetings. They felt like they had a purpose and activity on those days.

3.4. Attitudes towards using the BACtrack Skyn

3.4.1. Device appearance

All participants admired and complimented the Skyn design. Many compared it to more commonly available health monitors, such as an Apple Watch or FitBit. Participants commented on the discrete appearance. In addition, without knowing the brand and device participants believed it would be hard for others to know its purpose. Although a common suggestion was to have the option of other colours to allow it to become more personal to the wearer, they all thought the colour black was practical and made it look smart to wear. For example:

> I think the appearance of it is fantastic, I think how it's used is fantastic, … I think the whole device was perfect. It wasn't something that made me scratch, made me itch, wasn't a horrible colour that stood out of place, it's perfect. **Participant 6 [Female, 64 years] .**
>
> It's quite discreet because you wouldn't really know what it was really, to be honest. It just looks like a monitor, it could be for anything really, and that's probably the best thing about it. **Participant 14 [Female, 31 years] .**

3.4.2. Device comfort

Almost all stated that the TAS was comfortable to wear and that any initial discomfort they did experience reduced over time. A few participants mentioned that on occasion it was uncomfortable and sometimes produced side effects. Side effects included rash or itchiness on their wrist but were reduced if they removed it for a few hours. Participants believed that side effects were caused by hot weather or water getting under the strap when washing hands. All participants rated their side effects as mild to moderate and were not a cause for concern or medical attention. In general, participants preferred the comfort of the metal magnetic strap compared to a traditional watch buckle strap. One participant described the Skyn comfort as:

> Yeah, didn't bother me. I didn't realise it was there… not really, once you got used to it being on. **Participant 8 [Male, 54 years] .**

3.4.3. Descriptions of the side effects included

> I didn't notice it then, a couple of days later I started getting a bit sweaty, itchy, when the weather was really hot. I don't think that would happen so much in the winter. And then I just put it back on again, so it was no problem. **Participant 4 [Female, 49 years] .**

When one participant was asked about what it was about the TAS which caused their irritation, they responded, '*the length of time on one wrist*' **Participant 7 [Male, 56 years] .** Another participant described the magnetic strap as 'tiny bit irritating with the hairs when it catches' Participant 14 [Female, 31 years].

There was one of the 16 participants who ended participation two days early due to becoming distressed about the TAS. They described wearing the TAS as:

> I found it a bit obstructive, a bit irritating, and didn't want it on there because I'm used to being like this with nothing on. I didn't mind how it looked, or how it felt even, I think it was just me being aware of what it was and why it was there [because she was receiving alcohol treatment]. I mean you can see I don't wear a watch or rings. It didn't hurt [wearing the TAS], I was aware of it, it wasn't painful in any way. **Participant 11 [Female, 61 years] .**

4. Discussion

This study aims to assess the acceptability and feasibility of TAS with people attending community alcohol treatment and explore their perceived use of TAS within clinical settings and how they believe TAS could be for their alcohol treatment. This is the first study (to the authors' knowledge) to include perspectives from individuals with alcohol dependence receiving alcohol treatment who have worn a BACtrack Skyn in the UK. Our study demonstrates the potential for use with individuals with alcohol dependence currently receiving alcohol treatment.

We found in our results participants were interested in the data collected and personalised messaging during TAS wear. Enabling real-time use of the data also increases the options for use. The second main benefit for service users was to reduce the frequency of breathalyser visits during detoxification. Participants accepted the use of TAS within alcohol treatment and believed TAS would be useful at a range of treatment stages suggesting a variety of uses. There is also evidence for its feasibility, we found participants dealt with the responsibility of the Skyn well. No participant lost or damaged the TAS, and all attended each meeting. However, there are some broader factors of Skyn wear that need to be considered before wider implementation.

It has been shown that healthcare physicians, providers and patients may use technology differently than how others would use the same technology (Holden & Karsh, 2010; Yarbrough & Smith, 2007). The purpose and design need to be considered in both general and clinical contexts if TAS were to be used by healthcare providers. Differences between the public and clinical population need to be understood for TAS acceptance and how the purposes and benefits change when used with a different population. The TAM has conceptualised usefulness and ease of use as important predictors to consider when implementing new technology (Gagnon et al., 2012). If the user of the TAS does not perceive the technology as useful for their alcohol treatment, then most likely they will not initially volunteer to use a TAS or engage with it. Studies using TAS have then shown how use, especially when combined with CM can reduce alcohol consumption (Barnett et al., 2011, 2017; Dougherty et al., 2014, 2015). Therefore, if TAS were to be implemented in clinical treatment, clearly demonstrating to service users the ability of TAS and how it adds to treatment and will benefit them, would be essential. Providing sufficient TAS training will also be needed for both service users and staff to signify TAS usefulness. Similarly, staff attitude and presentation of the technology will be important when first talking to the service user about using TAS as a treatment tool. If staff have a positive attitude about TAS use, then their service user could be more likely to develop a positive attitude toward TAS, as staff and service factors can influence the quality of healthcare provided (Mosadeghrad, 2014).

TAS use in clinical settings would allow for objective, continuous monitoring to allow for more knowledge of patients' behaviour patterns for the ability to personalise feedback and treatment. The ability to act on this in near-real time could be used to reduce relapses and potentially deliver contingency management (Barnett et al., 2011, 2017; Dougherty et al., 2014, 2015). Our findings provided insight into another benefit of Skyn: its ability to act as a drinking deterrent, a signal to 'stop and think' before drinking. Skyn could be used for different reasons in various stages of treatment: before detoxification to determine the amount of alcohol being consumed and patterns of drinking; during detoxification to ensure no alcohol consumption and to reduce the need for daily breath analysis; post-detoxification to monitor alcohol consumption, act as a deterrent and work towards reduction or abstinence; to provide motivation to maintain abstinence and demonstrate their abstinence to themselves, clinicians, family and friends.

The TAS used in criminal justice sentences, the SCRAM, has been found to result in stigma experienced by wearers (Richards et al., 2023; Villalba et al., 2020). Our findings revealed that no participant felt uncomfortable wearing the BACtrack Skyn in public. Participants felt that the purpose of the device was not obvious and praised its appearance and style, suggesting that the BACtrack style would not lead to stigmatisation of wearers. However, it was noted that while the TAS could be a useful tool it does not have the benefit of addressing the root cause of alcohol dependence and our participants recognised this too.

Skyn requires more commitment and responsibility than the already implemented SCRAM. The South Dakota project (Kilmer et al., 2013) in the US has proven SCRAM use to be effective amongst individuals involved in the criminal legal system for alcohol-related, drink-driving, and domestic violence sentences. It has been used for several years with many individuals and has since been adopted in North Dakota (Midgette et al., 2021), and implemented in both England and Wales's criminal justice systems. However, there are some key differences between criminal justice and clinical settings. These differences include strict sanctions and consequences in place when breaking a criminal sentencing order, and that SCRAM is locked onto the individual, compared to clinical treatment where there are often no consequences if the client chooses to break or leave treatment. Alcohol consumption within treatment is not punished and there would be no consequences to the individual for not completing their alcohol treatment. However, there is the potential for clinicians to use data collected by a TAS as a reason to withhold treatment or terminate a detoxification programme. It needs to be considered how this potential issue would be addressed in services to make sure a device that intends to aid treatment is not utilised against the wearer.

Another factor that increases the burden of Skyn is the data storage limit. The Skyn can currently store data for up to approximately 72 h before it starts to over-write data and requires an up-to-date iOS Apple device for data download. However, this may be an issue when considering implementing Skyn in clinical settings. Staff or researchers may need to meet within this 72-hour period to sync with a staff iPhone to not lose data. While this was possible in our study and all participants attended every meeting, this is not practical. Options to overcome this include: the service user could be provided with a smartphone, or service users would be required to visit their service every other day. Another option would be for BACtrack, or subsequent TAS companies designing TAS for clinical purposes, to take this issue into consideration and increase data storage to as long as possible (perhaps to 1 or 2-week storage), or be able to sync with a home hub, as the SCRAM does. Each one of these options would have their own challenges. Previous research providing smartphones found a number were damaged or not returned (Mun et al., 2021) and service staff have acknowledged it would be challenging to see their service users as regularly as every other day (Brobbin et al., 2023, under review).

There is also the ethical consideration of continuous monitoring. There has been an increased interest in continuous health monitoring, with a range of applications (García-Magariño et al., 2019; Huifeng et al., 2020; Memon et al., 2020; Ming et al., 2020). Being able to record health signs 24/7 allows for detailed, in-depth knowledge that can

provide a greater understanding, of health problems, and collect and track this health data. However, wearers may be worried about data security and privacy (Darwish et al., 2019). The only information that is recorded is alcohol consumption as TAC ug/l (air) and skin temperature (Celsius). However, despite explaining this, this study still experienced individuals unwilling to wear the TAS due to GPS tracking concerns. While a common benefit reported was consistent monitoring, this could also be seen as a disadvantage and could seem like an invasion of privacy. If the TAS wearer was involved in a criminal investigation, for example, driving under the influence, there could be implications of police accessing this data to use as evidence within their investigation. This links to the importance of how TAS is presented to staff and service users and could be an influencing factor in perceiving the monitoring as a benefit rather than an invasion of privacy. Data privacy and possible ethical concerns also need to be considered in a range of circumstances.

5. Limitations

There are two limitations to this study. Firstly, as Skyn only syncs with iPhones of the latest iOS software and a limited number of those in alcohol treatment have access to a new iPhone, all data downloads were completed by the researcher. In the future, if compatible phones could be provided to the participants it would be good to explore their ability to sync the TAS with their phone allowing for real-time data access. Similarly, if Skyn was worn for longer than 10 days and they were required to charge Skyn this would change their user experience of the TAS. Secondly, this study only asked participants to wear the Skyn for one week and service users and staff may want clients to wear a TAS for periods longer than this, alongside their alcohol treatment. Therefore, future work could also explore a longer time frame of TAS wear.

6. Conclusion

TAS allow for continuous and objective measurement of alcohol consumption in treatment settings. This study highlights that Skyn can also act as a deterrent (or reminder) about a service user's alcohol consumption. Although this specific brand of TAS is not designed for clinical treatment, our study supports the use of Skyn in this setting. The BACtrack Skyn was used with individuals currently accessing alcohol treatment with little challenge, and our results suggest TAS are seen as an acceptable and feasible treatment tool amongst this population.

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Author contributions

EB: conceptualisation, methodology, analysis, investigation, resources, data curation, visualisation, project administration and writing and revising the article; SP: conceptualisation, methodology, analysis design and review, supervision, revising the article; PD: conceptualisation, methodology, supervision, revising the article; CD: conceptualisation, methodology, supervision, revising the article.

CRediT authorship contribution statement

Eileen Brobbin: Writing – review & editing, Writing – original draft, Visualization, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Stephen Parkin:** Writing – review & editing, Supervision, Methodology, Formal analysis, Conceptualization. **Paolo Deluca:** Writing – review & editing, Supervision, Methodology, Conceptualization. **Colin Drummond:** Writing – review & editing, Supervision, Methodology, Conceptualization.

Declaration of competing interest

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Data availability

Data will be made available on request.

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