

## Title

Perceptions of factors influencing engagement with health and wellbeing apps: a qualitative study using the COM-B model and Theoretical Domains Framework as an analytical framework

## Authors

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## Introduction

Smoking, physical inactivity, inadequate diet, and excessive alcohol consumption are the main risk factors for noncommunicable diseases, responsible for over 56.9 million deaths worldwide [1]. People with mental health problems often have poorer physical health and vice versa [2,3]. To reduce the burden of ill health, a range of interventions have been developed. Integration of multimedia technologies within the healthcare domain has led to the development of interventions delivered digitally via mobile phones, wearable devices and smartphone applications ('apps'). Smartphone apps are constantly available to the user and therefore act as portable tools for the delivery of easily accessible health and wellbeing interventions [4]. There is early evidence of effectiveness of apps for physical inactivity [5-8], weight loss [7,9,10], alcohol reduction in non-dependent drinkers [11] and mental health promotion [12]. Health apps are also considered a cost-effective solution [7,13] and have the potential to increase access for hard-to-reach populations that are resistant or unable to seek face-to-face support, for instance due to stigma or geographical barriers [14].

Engagement is a necessary component for the effectiveness of a health or wellbeing app. Engagement with health and wellbeing apps can be defined as '(1) the extent (e.g. amount, frequency, duration, depth) of usage and (2) a subjective experience characterised by attention, interest and affect' [15]. However, it has been argued that measuring 'effective engagement' is more important than simply the time spent on an app and the frequency of use [16]. Yardley and colleagues define 'effective engagement' with a smartphone app as involving two components: the first is the intensity of engagement that is necessary for achieving desired outcomes, with sustained app engagement over a period of weeks, months or even years (referred to as 'micro-engagement'). However, micro-engagement alone is not sufficient for behaviour change [16]. Yardley's model also emphasises engagement with the broader behaviour change process and goal (i.e. 'macro-engagement'), which is considered separate from, although intimately linked with, micro-engagement. Based on this distinction of micro- and macro-engagement with health and wellbeing apps, some factors may relate more to the former or the latter, with micro-engagement influencing macro-engagement and vice-versa. For example, engagement may be affected by common contextual factors, such as personal (e.g., their interest), environmental (e.g., where the engagement occurs, individual's lifestyle) or social context (e.g., family or culture). Due to the complexity of engagement, researchers recognise that it is difficult to define what constitutes 'good' or 'sufficient' engagement. Some individuals may require a longer period of engagement with an app than others for the desired behaviour change to occur.

Despite the promise of health apps, engagement tends to be poor [17,18]. For example, a Mobile Consumer Report found that for medical, health and fitness apps, only 20% of users use the app one day after installation, and only 8% after seven days after installation [19]. A panel-based analysis systematically examined usage patterns in 93 mental health apps and found that the median app retention rate at 15 and 30 days after installation were 3.9% and 3.3%, respectively [18].

There is a growing literature on factors influencing engagement with health and wellbeing smartphone apps. In our recent review of 41 studies, we identified 26 factors important for the uptake of and engagement with such apps [20]. In addition to a wide range of behaviour change techniques (e.g. self-monitoring, goal setting) [21,22], several other factors were identified as influential, including the role of healthcare professionals in the promotion and recommendation of health apps [23] and embedded professional support [24]. The latter was found to be particularly important for certain behaviours (i.e. alcohol reduction, suicide prevention, anxiety, self-harm), with stand-alone apps considered insufficient by users and clinicians [14]. In an assessment of 93 mental health apps, daily minutes of engagement were higher for apps that included peer support (median=35.1, IQR=N/A, n=2) and coping strategies, such as mindfulness and meditation (median=21.5, IQR=15) compared with apps that incorporated self-monitoring or psychoeducational features (median range=3.53-8.32) [18]. Few qualitative studies have been undertaken to explore factors that affect engagement with health and wellbeing apps. Those undertaken have focused on specific populations or behaviours. Existing studies have focused on weight loss behaviours and alcohol reduction, and have found that the specific content of health information messages [17,22], personalisation

of app content [25] and to the user's demographics [22] are some of the factors deemed to be important for engagement with weight loss and alcohol reduction apps. Findings from these studies highlight that the specific context in which apps are developed and used will influence user engagement. Most studies conducted to date investigate features of health apps that are desirable by a certain population, and little is known about factors deemed important for engagement with a wider range of health and wellbeing apps. These studies suggest that the context in which apps are developed and used might often be behaviour or population specific. Most studies conducted to date investigate features of health apps that are desirable by a certain population, and little is known about factors deemed important for engagement across a wider range of health and wellbeing apps [20]. Therefore, this research intends to address this gap by exploring views of the 'big four' public health priority behaviours related to prevention (smoking, alcohol consumption, physical activity, diet) and mental health. The findings from this study may inform future app development to improve user engagement with apps that target health promotion. Findings may also be particularly useful for stakeholders in public health to inform the development of interventions to promote engagement with evidence-based health and wellbeing apps, for example directly contributing to the long term plan of the England's National Health Service to become 'digital first'.

### Theoretical framework

The COM-B (Capability, Opportunity, Motivation – Behaviour) model [26] provides a broad framework for understanding factors influencing user engagement. According to the COM-B model, behaviour (e.g. app uptake and engagement) arises from the interaction between the individual's physical (e.g. app skills) and psychological (e.g. knowledge of using an app) capability, physical (e.g. features of the app) and social (e.g. recommendations for an app) opportunity, and automatic (e.g. feedback received from an app) and reflective (e.g. user's self-confidence of using an app) motivation. The Theoretical Domains Framework (TDF) [27] is a synthesis of 33 theories and 128 psychological constructs, and includes 14 domains that can be mapped under the three main components of the COM-B model. Taken together, the COM-B and TDF provide a detailed theoretical framework that allow the careful consideration of factors influencing engagement with health and wellbeing apps (see Figure 1).

### Aim

We aimed to investigate people's experiences and reasons for engaging or not engaging with health and wellbeing apps using qualitative interviews, and then to map the identified factors onto the COM-B model and the TDF.

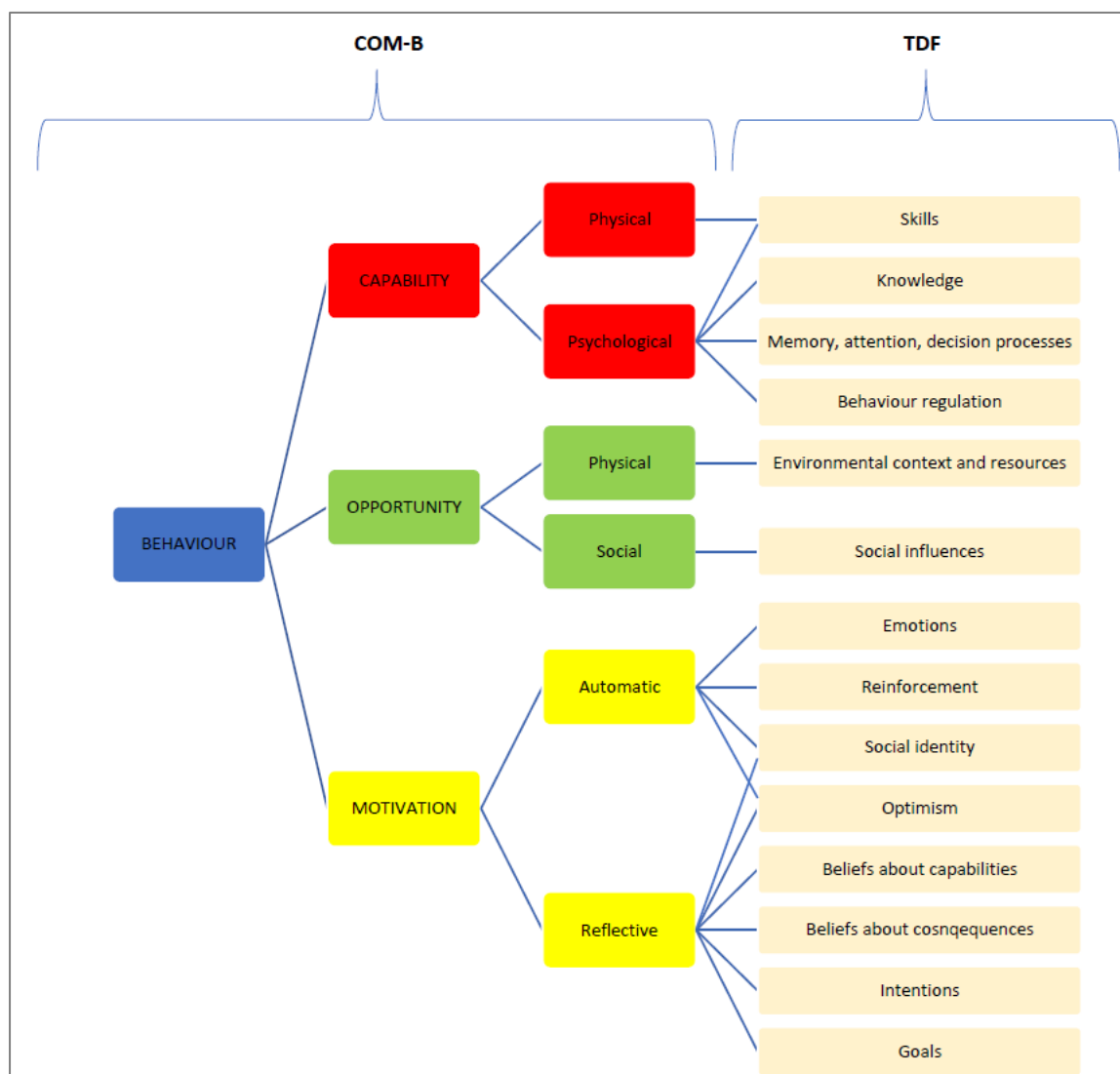


Figure 1. A visual representation of how the Theoretical Domains framework can be mapped onto the components of the COM-B model [20].

## Methods

### Study design

This qualitative study used semi-structured interviews [28], and was designed and reported in line with the Consolidated Criteria for Reporting Qualitative Research (COREQ) checklist (see Multimedia Appendix 1) [29]. The study protocol was pre-registered on the Open Science Framework [30]. This study was part of a larger project investigating both the uptake of and engagement with health and wellbeing apps, and findings of uptake were published elsewhere [31].

Ethical approval was obtained from the Faculty of Medicine and Health Sciences Ethics Committee at the University of East Anglia (Reference number: 201819 – 089).

### Participants and recruitment

Participants were recruited through social media. Recruitment through Facebook is known to be an effective way to reach adults interested in health and wellbeing apps [32]. It is fast and cost-effective, and has been found to provide better representation and improved participant selection compared with traditional recruitment methods [32]. Eligible participants for this study 1) were aged 18 years or over; 2) were able to give consent; 3) owned a smartphone; 4) would consider using a smartphone app to change their behaviour in the future; 5) could travel for an interview. Purposive sampling was used to ensure diversity of the sample (age, gender, ethnicity, educational level, employment) [33]. An invitation for an interview was sent to 38 participants out of which 14 individuals did

not respond and six subsequently cancelled for personal reasons leaving a total of 18. The recruitment and the interviews took place in batches of 3 or 4, and the recruitment stopped when data saturation was reached.

### Measures

To determine eligibility and to describe the sample, data were collected on 1) age, 2) gender, 3) ethnicity, measured using the Office for National Statistics' index, 4) level of education, 5) employment status, 6) whether they had ever used a health or wellbeing app, 7) whether they currently use a health or wellbeing app, 8) last time they downloaded an app, and 9) frequency of app use.

### Procedure

Participants read the information sheet available online. Those who expressed interest to participate were required to fill in an online screening questionnaire to assess their eligibility (Multimedia Appendix 2.). The questionnaire was hosted by 'Jisc Online Surveys' software. Participants meeting the inclusion criteria received a comprehensive participant information sheet via email and were invited for an interview where written consent was obtained. Participants received a £20 gift voucher for their participation.

The interviews were conducted by a female researcher (DS) between July and August 2019. The interviews took place face-to-face in Norwich, England, at the University of East Anglia (n=17) or in the participant's home (n=1). One participant was not included in this study as they had no previous experience of using health or wellbeing apps. No one else was present during the interviews. The interviews lasted between 26 and 63 minutes. Semi-structured interview techniques were used to elicit data on participants' experiences of and views on engagement with health and wellbeing apps. The final topic guide was informed by feedback from key stakeholders, including patient and public involvement representatives and domain experts from Public Health England. A think aloud task (reported elsewhere) [31] was followed by several questions regarding participants' experiences of engagement with apps (see Multimedia Appendix 3 for the topic guide).

### Data analysis

The interviews were audio-recorded and transcribed verbatim. Framework analysis approach was applied to analyse the data. This followed the stages of familiarisation, identification of thematic framework, indexing, charting, mapping and interpretation [34]. For pragmatic reasons, a second author (OP) independently coded three randomly selected transcripts (representing approximately 15%). The deductive framework was based on the TDF. Through repeated discussions between the first and second authors, the deductive thematic framework was refined iteratively and discrepancies were resolved through discussion with a further author (FN). DS completed the indexing, using QSR NVivo 12, and charting. During charting responses were clustered based on the thematic framework. This was followed by mapping and interpretation, where the data was examined to identify patterns. To increase the trustworthiness of the findings, peer debriefing by the University College London Tobacco and Alcohol research group, with extensive experience of the application of the COM-B model and TDF in health research, was used to ensure the accuracy of data interpretation and data analysis. Peer debriefing is a form of analytical triangulation where researchers not directly involved in the study are prompted to provide input and critical opinions on various aspects of a project [35]. The use of the TDF in the deductive framework analysis approach was particularly useful for coding the results under several factors, which may otherwise have been overlooked. It was expected to explore a large number of factors as the TDF has 14 constructs, as opposed to other well-known methods. However, researchers were aware that findings will not be coded under all available constructs. Constructs under which no findings were coded were omitted from the results section.

### External validity

Member checking was conducted to ensure the trustworthiness of the results and to further minimise researcher bias [36]. After the interview participants were told that the researchers may contact them to share the findings and ask their views on them. Six randomly selected participants (30% of the total sample) were contacted and invited to provide feedback on the summary of findings and the conclusion. The purpose was to investigate whether participants agreed with the interpretation of the results and whether they felt their opinion was captured and

appropriately presented. Incentives were not offered for their input. Two participants responded and indicated that they agreed with the interpretation.

### Reflexivity

DS, a PhD candidate, conducted the interviews after receiving extensive training in qualitative research methodology and kept field notes and research journal during data collection. There was no prior relationship established between her and participants. The co-authors have experience in mixed-methods research and the application of the COM-B model and the TDF. Efforts to establish good rapport with the participants was made throughout. The interview was individually adapted to the flow of discussion made by each participant. Most participants (n=15) stated that they wished to find out more about the findings of the research. She also shared her research interests with participants after the interview.

## Results

### Participant characteristics

Eighteen adults (mean age = 43, range 21-68) were recruited, of whom 10 were females, 14 were White British, 13 were employed full time, 8 had college degree or higher. Eleven participants reported currently using at least one health or wellbeing app at the time of the interview. Three participants expressed their intention to change one behaviour, with all other participants interested in changing more than one behaviour (e.g. losing weight, being more active, managing their mood). One participant had never used health apps before and did not wish to express their views on engagement; therefore, the findings of this paper are based on the views and experiences of the remaining 17 participants about their engagement with health and wellbeing apps (see Multimedia Appendix 4).

### Factors influencing engagement with health and wellbeing apps

An overview of the factors mapped under the constructs of the TDF and components of the COM-B can be found in Table 2. All relevant data was coded under 10 out of 14 constructs of the TDF. There was no data that could not be coded under any of the constructs of the TDF.

**Table 2. Perception of factors influencing engagement with health apps**

| COM-B <sup>a</sup> component | TDF <sup>b</sup> construct                                | Factors                 | Description  |   |
|------------------------------|---|-------------------------|--|---|
| Psychological Capability     | Knowledge   | User guidance           | <ul style="list-style-type: none"> <li>• Instructions on how to effectively use a health app</li> </ul>  |   |
|                              |   | Statistical information | <ul style="list-style-type: none"> <li>• A visual or numerical summary of progress or quantification of the behaviour</li> </ul>                             |   |
|                              |   | Health information      | <ul style="list-style-type: none"> <li>• Educational information related to health and wellbeing aspects</li> </ul>  |   |
|                              | Memory, attention Decision processes Behaviour regulation | Reduced cognitive load  | Reminders  | <ul style="list-style-type: none"> <li>• The app is not too time consuming, easy to use and requires minimal input</li> </ul> |
|                              |   |                         | Self-monitoring  | <ul style="list-style-type: none"> <li>• Preferably customisable, notification-type messages</li> </ul>                       |
|                              |   |                         | Routines   | <ul style="list-style-type: none"> <li>• The ability of the app to support self-regulation of the target behaviour</li> </ul> |
|                              |   |                         | Safety netting   | <ul style="list-style-type: none"> <li>• The ability to support routine/habit formation</li> </ul>                            |
| Physical Opportunity         | Environmental resources                                   | Safety netting          | <ul style="list-style-type: none"> <li>• Retaining the app for a potential precipitating event in the future</li> </ul>                                      |   |
|                              |   | 'Stepping stone'        | <ul style="list-style-type: none"> <li>• App as a first step in the behaviour change process</li> </ul>  |   |
|                              |   | Tailoring               | <ul style="list-style-type: none"> <li>• Innovative features and adaptability, and an interactive, two-way communication between the app and user</li> </ul> |   |

|                       |                            |                            |  |
|-----------------------|----------------------------|----------------------------|--|
| Social Opportunity    | Social influences          | Peer support               | <ul style="list-style-type: none"> <li>• Including social interaction with users with similar needs within the app or within their community; a choice to connect to social media platforms, competitions and challenges with others or with themselves</li> </ul>                           |
| Reflective Motivation | Beliefs about capabilities | Social support (practical) | <ul style="list-style-type: none"> <li>• Possibility to contact health professionals and practitioners within the app</li> </ul>   |
|                       |                            | Self-confidence            | <ul style="list-style-type: none"> <li>• Perceived capability to change one's behaviour using an app</li> </ul>  |
|                       |                            | Goal setting               | <ul style="list-style-type: none"> <li>• Establishing what the user would like to achieve</li> </ul>   |
|                       |                            | Action planning            | <ul style="list-style-type: none"> <li>• Establishing how the user would like to achieve set goals</li> </ul>  |
| Automatic Motivation  | Reinforcement              | Commitment                 | <ul style="list-style-type: none"> <li>• The level of commitment while engaging with an app to change the behaviour and achieve set goals.</li> </ul>  |
|                       |                            | Feedback                   | <ul style="list-style-type: none"> <li>• Feedback regarding the user's performance</li> </ul>  |
|                       |                            | Rewards                    | <ul style="list-style-type: none"> <li>• Tangible (objects, discount, etc.) and intangible (badges, certificates, etc.) rewards in response to the user's effort</li> <li>• Gamification elements</li> <li>• Additional ways to provide reinforcement (e.g. encouraging messages)</li> </ul> |
|                       | Emotions                   | Encouragement              | <ul style="list-style-type: none"> <li>• Additional ways to provide reinforcement (e.g. encouraging messages)</li> </ul>   |
|                       |                            | Positive emotions          | <ul style="list-style-type: none"> <li>• Triggered by included user guidance, statistical information, additional health information, embedded professional support, community networking possibilities, tracking features and rewards</li> </ul>  |
|                       |                            | Negative emotions          | <ul style="list-style-type: none"> <li>• Triggered by lack of user guidance, invasive push-notifications, cognitive overload, unrevealed in-app costs</li> </ul>   |
|                       |                            | Mixed emotions             | <ul style="list-style-type: none"> <li>• Triggered by reminders</li> </ul>   |

<sup>a</sup>COM-B: capability, opportunity, motivation, behaviour model.

<sup>b</sup>TDF: theoretical domains framework.

## Capability to engage with health and wellbeing apps

### Knowledge

Many participants perceived their knowledge on how to use an app, as well as embedded statistical and health information, as an important influence on their engagement with an app. We inferred this from the desire many people reported for clear *user guidance* and, in some cases, for help on how to increase their capability to perform a behaviour (e.g. demonstration of the behaviour). One participant explained that they had stopped using an app in the past due to there being "*insufficient guidance on how to use it.*" (P8)

"So this is where I start getting, well why are you asking me these questions if you're not going to let me carry on with it and that's where I start getting confused, going back, not really understanding where I need to go from here." (P15)

Further, the importance of *statistical information* about their progress and achievements was reported by most participants:

"It's nice to see your progress on a graph and it's just very clear. It's a single screen, you have icons for all the activities that you've done during the day." (P6)

In addition, most participants expressed the need for relevant and comprehensive *health information*.

"Knowledge is key." (P14).

Several participants stated that having educational articles embedded would help them to build knowledge, and to understand and to manage their behaviour better. Not getting enough health information was reported as the main reason for one participant to look for a different app.

*“It’s got to have the information that I want and have it easily accessible.” (P2)*

### Memory, attention, decision processes

Participants perceived *reduced cognitive load* and customisable, notification type *reminders* as factors that positively affect their capability to engage with an app. All participants described favouring apps with *reduced cognitive load*. This included apps with limited complexity, less data input, and a limited number of available features to choose from.

One participant suggested that an app should apply a multi-level approach with *“a light version of an app and then enhanced”* (P15). They described that an app might have a simple version for basic users with no registration and minimum data input and a more advanced version with all features available for power users.

Several participants expressed that a time-consuming app would be immediately deleted.

*“A mood tracker is something I probably wouldn’t use because it looks like it would require a lot of data of me putting in and typing it on to stuff.” (P7)*

Although push notifications were considered more or less annoying, many participants described *reminders* as being particularly useful. One participant described that not being reminded to engage with an app led him to disengage.

*“Because I wasn’t reminded, I stopped using it. And I think that’s really important.” (P1)*

However, a few participants who reported not finding notifications useful stated that they would immediately turn reminders off or delete the app.

*“I’m sure there are many apps I’ve deleted because of reminders.” (P7)*

Others suggested that *reminders* might cause harm. For example, one participant described uninstalling a smoking cessation app as reminders were periodically reminding them about their addiction, thus serving as a prompt that induced cigarette cravings. Two participants proposed that opting in to receive reminders would be desirable instead of opting out. In addition, one participant suggested that human-like reminders in the form of text messages would be less likely ignored, and would create the perception of a human touch within the app.

*“I think text messages would work better because I don’t ignore my text messages and my WhatsApp messages because there’s real people connected to those, you know? (...) if I could think of an ideal it would be a text message that kind of asked you a question and you replied and it felt like it was a human being.” (P6)*

### Behaviour regulation

Participants perceived that *self-monitoring*, established *routines*, as well as *safety netting* and ‘stepping-stone’ characteristics of the app, would enhance their engagement with an app.

All described *self-monitoring* features as important in behaviour regulation, even when there is no particular goal set or when achieving the goal shows a delay.

*“Monitoring, really because the goal is probably going to go a bit by the wayside because work has been too busy and life has changed and lots of stuff has happened this year. So I’m behind my goal but I still use it as a monitor.” (P17)*

Some participants reported that a daily *routine* of using an app would make engagement with it more accessible and continuous. Two participants described how using a weight management app for a week was necessary for



them to get into a routine and helped them staying engaged after that. However, one of them explained that it felt difficult using the app at the beginning, although after a few days it got easier.

A number of participants explained they perceived physical activity apps as *stepping stones* to physical activity services with the app acting as an intermediate tool in behaviour change. Two participants described that an app helped them to get enough experience and practice home-workouts that boosted their confidence to sign up for a gym membership eventually.

*"You can just literally do it at home [fitness app] until you feel I suppose a bit more confident to go out and join [the gym]." (P10)*

Many of the participants described apps as a *safety netting* tool (e.g. relapse prevention). Several reported a tendency to re-engage with a weight management app periodically and when necessary to regulate their weight, for example before or after a holiday season, or an important upcoming event because the app had helped them achieve their goals in the past.

*"I think I have periodically come back to it and thought 'no it worked before, it'll work again'." (P13)*

## *Opportunity to engage with health and wellbeing apps*

### Environmental resources

Participants perceived that *tailoring* the technology was a factor that would influence sustained engagement. Many participants expressed the need for features that would create a better physical opportunity to engage with an app, and a more personalised experience during the engagement. Many participants described seeking to engage with apps that provide two-way communication that can adapt to the person's needs based on how they interact with such tools. Several participants mentioned the inclusion of innovative features. These features consisted of embedded artificial intelligence to receive health-related advice and tailored content, facial recognition and recognition of non-verbal cues for better outcomes in physical activity, e.g. correcting posture, and using the phone's camera for providing nutritional data of cooked food.

*"If it's smart, as well. Has it got a little bit of artificial intelligence built into the background? Is it using my data? Is it saying "do you know what? Actually, you've done really well this week, you've used the app this amount of times. How are you feeling?" (P2)*

One participant described that the lack of novelty of an app would lead them to disengage with it. In contrast, another reported the opposite; they would feel put off if they would need to learn new features.

*"It's no good downloading an app and then six months later looking at that app and it's still the same, that would stop me." (P14)*

*"If something's working we want it to stay as it is, we don't want it to change, and even if there are improvements to it, if it's new it can kind of put people off in a way." (P13)*

Syncing with wearables or other additional devices was described as desirable by many.

### Social influences

*Peer support* and *social support (practical)* were perceived by participants as factors that may sustain engagement with an app. Several participants perceived networking within an online community necessary *peer support*. Some described that sharing and exchanging experiences with others would encourage and motivate them in their journey. Others suggested anonymity for users as well as a moderation of discussions to avoid "misinformation" (P12).

*"I like the idea that it's round the clock support, because so very often with mental health issues it's kind of 2 o'clock in the morning that they are the worst, and that is when you need to talk to somebody, and the idea of having a community who you don't have to explain how you're feeling sounds really good." (P11)*

Embedded social media to share their progress with others was reported useful feature only by a few participants who were using physical activity or weight management apps. However, a couple of participants highlighted that this feature should be optional. Physical activity and weight management app users also described challenges and competitions as motivating and fun:

*“There’s challenges, which will help you with your weight loss, your fruit and vegetable intake, the exercise challenges that you can do, either with yourself or your friends, which are good for motivation.” (P15)*

All participants expressed their preference for an app that would offer built-in professional support, such as health practitioners, coaches and dieticians (*social support, practical*). One participant with an existing medical condition described the need for health practitioner support within an app. Additionally, two participants described that built-in support would help with accountability, and one participant indicated they would be willing to pay to access an app with in-built support. Another participant commented that the embedded professional support was the best feature of a mental health app they were using:

*“Yeah if you could sort of talk to a healthcare professional in that app I think that would be better, because then they would have the up to date I suppose treatments and methods so that you know you’re not going on old information.” (P10)*

*“I: If you would need to say just one thing that is the best in the app, what would that be? P: The support.” (P11)*

## Motivation to engage with health and wellbeing apps

### Beliefs about capabilities

Apps were perceived by several participants as useful tools to enhance their *self-confidence* in changing their behaviour. One participant described that the community networking opportunities further helped her *self-confidence* and motivated her to use the app:

*“The app made me feel more confident in doing it, even it was just basic home exercises.” (P7)*

### Goals

*Goal setting* and *action planning* were perceived as key factors for sustained engagement and motivators of behaviour change. *Goal setting* was reported to be valuable by all to address behaviour change, but half of the participants described the need for *action planning* features to help them achieve their set goals:

*“I’d want something which was a bit more than press one button every day to say you haven’t smoked; it was great for the first 10 minutes of using the app because I got all this information about ‘wow thousands of pounds and the health benefits’, and then after that it was literally just press this button to say you haven’t smoked, and that wasn’t really enough for me.” (P13)*

### Beliefs about consequences

Several participants expressed that their level of *commitment* to achieve their goal shaped the level of engagement with the app they used:

*“The app, the initial – the main reason you’re on that app is to get your result of what you want to achieve, what you want to do to help you stay on track.” (P9)*

### Reinforcement

Many participants perceived *feedback*, *rewards* and *encouragement* automatic motivational factors that may sustain engagement with an app. A number of participants expressed that they needed continuous *feedback* to reinforce their continuous use:

*“I think an app that might give you feedback, a notification, that would keep me entertained and would keep my level of focus and wanting to continue with it.” (P3)*

Intangible *rewards* (i.e. badges, certificates) were described as another form of reinforcement by several participants, for motivating them and as “nice” (P14) or something to “show off” (P5). However, some other participants described intangible rewards as “irrelevant”. They reported that the tangible rewards they received in the past including cinema tickets, lower insurance premiums, loyalty points that can be exchanged for objects or a free water bottle, provided better motivation to engage with the app than intangible ones. In addition, a few participants expressed the need for *encouragement* in the form of motivational messages:

*“In this context, so badges, you earn nine of 24 badges so far. For me a little bit irrelevant actually, what are you going to do with it, there’s other reasons why you’re quitting, not to get the badges.” (P16)*

## Emotions

Participants expressed positive emotions regarding available user guidance, statistical information, additional health information, embedded professional support, the possibility for community networking, self-monitoring features and rewards. However, negative emotions were expressed by lack of user guidance, invasive push-notifications and cognitive overload. Finally, reminders were person dependent and triggered mixed feelings across participants.

## Discussion

### Principal findings

This study applied the COM-B and the Theoretical Domains Framework (TDF) to explore users’ views about factors that influence engagement with health and wellbeing apps. We found that *knowledge*, such as user guidance and statistical information, *memory, attention and decision processes*, such as reduced cognitive load, *environmental resources*, expressed by the tailored technology, and *social influences*, referred as peer and professional support, are most important factors for these participants for engagement.

Many factors that were identified in this study are consistent with previous literature. Previous research found that engagement with health apps is greatly influenced by factors affecting users’ capabilities including different types of knowledge (user guidance, statistical information, health information) [20,37], reduced cognitive load, reminders and self-monitoring features [20,22,38]. These factors could be targeted during app development updates of existing apps to improve user engagement. In line with previous findings, reminders were not found to be universally useful [20]. One possible explanation is that reminders may be behaviour-dependent and person-dependent. Some participants reported that they had stopped engaging with a health app because they were not reminded to continue using it, while others tended to ignore or delete apps that sent reminders. This research is the first to identify a novel factor, the perception of certain apps as ‘stepping stones’ to more intensive behaviour change. For example, a home-based workout app or a walking app could seek to provide enough self-efficacy and competence for an individual to join a gym or start using a running app. An explicit ‘stepping stone’ approach could be a useful addition for apps targeting behaviours that are harder to achieve because of negative emotions, such as embarrassment, shame or pressure, including those targeting sedentary behaviour. This novel finding shows that sustained engagement is not always necessary to support desired health and wellbeing outcomes through additional behaviour change activities.

Engagement is further influenced by users’ physical opportunities, such as tailored technology, and social opportunities, peer support including community networking, embedded social media and social competitions, and professional support [20,24,25,38]. Some users would want the app to be based on machine learning opportunities and on two-way interaction with users. The adaptable nature of an app and the provision and level of artificial intelligence (AI) included may also play a key feature in engagement. These factors may be harder to include once an app is developed; therefore, it might be important to consider these aspects in the development process. Indeed, such tailored technology may be the most important aspect to consider. For example, while there may be financial considerations precluding the provision of personal professional support within an app, this service may be developed using AI. These forms of technological personalised models in health behaviours such as nutrition or

smoking, including machine learning models, has been suggested to aid the process of making decisions about diet and food [39]. However, AI was not yet found in diet monitoring apps [40]. A randomised controlled trial found that participants allocated to an advanced version of a smoking cessation app with an AI chatbot had 107% higher engagement with the app, and over twice the odds of being abstinent at one month follow up, compared with participants using the standard version of the app [41]. Furthermore, timely AI-based behaviour change support received just-in-time may further increase behaviour change. Although unguided interventions can be effective, having professional support within an app tend to increase effective engagement [16]. Simple interventions that does not require professional support can be more widely disseminated and are more cost-effective than those with embedded professional support [16].

Users' reflective motivation, including beliefs in their capabilities (self-confidence) and consequences (commitment) as well as goals (goal setting and action planning), are essential for engagement. While the first two are harder to address because these are within-person factors, the latter could be easily implemented as features of the app. One possible way to increase self-confidence and commitment is perhaps to address these within the app by using quizzes or articles [42], (e.g. for commitment 'How to stay on track to achieve your goal?') or check-in messages using AI [41].

Emotions are considered automatic motivation factors and are a powerful driver of behaviour that affect adherence, for example engagement with a health app [43]. It is noteworthy that we did not identify emotions directly influencing engagement or we failed to identify them. However, we found evidence that the other factors affected participants' emotions. Appealing features, such as statistical and health information, embedded peer and professional support, and tracking features and rewards, triggered positive emotions. In contrast, lack of user guidance, invasive notifications and cognitive load triggered negative emotions. A better understanding of how the presence or absence of specific features affect participants' emotions may be useful for the development of new or refinement of existing apps, which, consequently, may lead to better engagement with health apps.

### Strengths and Limitations

A strength of the study is the methodology used. First, to assure that the research was as relevant and meaningful as possible, the study protocol was developed with policymakers and patient and public representative involvement in the design of the topic guide. Second, the research was further informed by well-established theoretical models; the COM-B and the TDF and peer debriefing was used to help the data interpretation and data analysis [35]. Third, the purposive sampling technique allowed the recruitment of a diverse sample regarding their gender, educational level and employment status. Finally, member checking was conducted, a technique used to establish the credibility of the findings by sending a brief summary of it to randomly selected participants [36].

The study has several limitations. The recruitment of a sample of participants with more diverse demographics might have identified additional factors that are important for engagement. Several participants were not using health or wellbeing apps at the time of the interviews and had not downloaded any health and wellbeing apps in the past 6 months prior the interview. This may have led to limitations associated with the challenges of retrospective recall. Although the research aimed to recruit heterogeneous sample to capture a wide with 'big four' public health priority behaviours related to prevention (smoking, alcohol consumption, physical activity, diet) and mental health apps, a homogeneous sample may have allowed for a more in-depth understanding of engagement with apps for specific behaviours. The study only included participants who considered using a smartphone app to change their behaviour in the future. Including participants who have used health and wellbeing apps in the past, but are less receptive to using them now, may have provided additional perspectives on factors influencing app engagement. Findings may be influenced by the intention-behaviour gap, with participants reporting on factors perceived as important for changing their behaviour through an app; however, this does not mean that they would act on their intention. One example of this is the finding that many participants wanted access to an online community. Although, online communities typically suffer from the '90-9-1 principle', whereby the content in online communities is generated by 1% of the members with 9 percent editing or modifying it, while 90% are passive observers [44], this may not be the case with a closed community built to support behaviour change, where

individuals are seeking support from each other. Additionally, the meaning of the term engagement was not explicitly defined during the interview when individuals shared their experiences and views of engagement. Their interpretation of engagement is likely a mixture of micro-and macro-engagement and a distinction between these two levels of engagement was not considered when interpreting findings. Additionally, the meaning of the term engagement was not explicitly defined during the interview when individuals shared their experiences and views of engagement. Their interpretation of engagement is likely a mixture of micro-and macro-engagement and distinction between micro- and macro-engagement was not considered when interpreting findings. Finally, out of six participants contacted, only two responded to the request for external validation. Therefore, it is not clear whether the other participants disregarded our request or disagreed with our interpretation.

### Implications and future research

This research provides insight for stakeholders in public health, policymakers, and developers of apps that target disease prevention and health promotion. Our findings may also be used to inform the development of interventions aiming to promote engagement with evidence-based health and wellbeing apps. In the UK, this aligns with the priorities of the National Health Service's the NHS Long Term Plan (i.e. 'digital first').

Our main finding is centred around providing necessary support for increased engagement with health apps. We found that embedded professional support may have a substantial impact on engagement, although it may not be beneficial for all health behaviours. Embedded social support may be particularly important for some behaviours that are more likely to be complex and require intensive support in order to maintain engagement. These behaviours are the ones that require reassurance, guidance or emotional support [16], such as apps targeting substance misuse, or the ones developed to improve mental health. While it is not always feasible to develop an app with embedded professional support, there might be different ways to address this need outside of the app. For instance, there may be a way to provide support within the community-based care to assist with the uptake of health apps and with the progress or potential barriers of engagement. Another way to mitigate the absence of embedded professional support is to investigate the potential efficacy of advanced computational techniques, such as AI, to mimic the support provided by healthcare professionals (e.g. in the form of chatbots or other types of conversational agents). There is an urgent need for more research on the optimal type (e.g. technology-mediated or 'blended') and timing of support needed within various health and wellbeing smartphone apps.

To better meet users' needs, the design of apps would ideally be informed by a user-centred and iterative development process, supported by mixed-methods research including in-depth interviews. As app engagement is generally greater in those with higher socioeconomic status [45], involving individuals with lower socioeconomic status is particularly important [16]. Furthermore, people directly affected by the digital divide, or digital exclusion and who may struggle to benefit from health apps due to a lack of skills or low digital literacy, could be targeted by offering app-use tutoring. While this may require investment or relocation of resources within community health care settings, it may increase the reach of health apps and lead to a greater public health benefit. Furthermore, we noted a possible tension between users wanting the app to be easy to use (which may be facilitated by providing user guidance) but at the same time not too time-consuming. As the provision of user guidance helps individuals with limited technological skills, we believe such features should still be prioritised. Undoubtedly, finding the balance between producing an app with all features necessary for behaviour change to occur and ensuring the app is intuitive enough will pose a challenge for app developers.

Additionally, more experimental research would help us to better understand the effects and potential interactions between the engagement factors identified in this study including usability (ease of use), reminders, embedded support, rewards and goal management. Table 3 provides a summary of considerations to help app developers and commissioners design interventions to increase effective engagement. These factors are structured around the COM-B and TDF.

Table 3. Considerations for policy makers, industry, healthcare providers and app developers for maximising engagement with health and wellbeing smartphone apps.

| COM-B <sup>a</sup> component | Considerations for policy makers, health app portal providers, app developers  |
|------------------------------|--|
| 1. Capability                | <ol style="list-style-type: none"> <li>1.1. Provide user guidance on how to use an app, visual and/or numerical summary of progress and evidence-based additional health information related to the behaviour targeted by the app</li> <li>1.2. Minimise time required to use app where possible</li> <li>1.3. Provide customisable reminders that users could opt out</li> <li>1.4. Provide the option of self-monitoring features</li> <li>1.5. Promote safety-netting and relapse prevention features such as the possibility to restart or reengage with the app later</li> <li>1.6. Promote a routine for engagement with an app e.g. highlighting the role that routine may play in effectiveness of an app</li> </ol>   |
| 2. Opportunity               | <ol style="list-style-type: none"> <li>2.1. Collaborate with interaction design experts and end-users to enhance the aesthetics of apps</li> <li>2.2. Provide the possibility for community networking within the app and linking to social media as an optional feature to share progress where appropriate</li> <li>2.3. Offer the possibility for social competition and challenges where appropriate</li> <li>2.4. Consider the provision of embedded professional support, and if this is not feasible, providing offline one-to-one support with the uptake of and the engagement with health apps. This may improve motivational factors, such as commitment, self-confidence and perceived competence of engaging with a health app</li> <li>2.5. We advise that exploration should be made for where engagement enhancement could be made with appropriate and proportionate machine learning and artificial intelligence or other forms of learning system.</li> </ol> |
| 3. Motivation                | <ol style="list-style-type: none"> <li>3.1. Develop a time-efficient app that would require as much engagement as is required to achieve the desired outcome. This might be different for different behaviours</li> <li>3.2. Include reinforcement in forms of feedback, encouraging messages and rewards</li> <li>3.3. Offer intangible rewards, such as certificates or badges</li> <li>3.4. Offer tangible rewards that can be converted as discount in other places (e.g. health insurance providers or pharmacies, sports parks)</li> <li>3.5. Include goal setting as well as action planning features on how to achieve set goals (when applicable)</li> <li>3.6. Take into account user's emotions about certain features by involving users in the development and update of health apps as lack of some features could provoke strong negative emotions such as disappointment and might lead to rapid disengagement</li> </ol>  |

<sup>a</sup>COM-B: capability, opportunity, motivation, behaviour model.

## Conclusion

People perceive their capability to engage with an app as an important influence on their sustained engagement with it. This perception was inferred from people's desire for apps to contain clear user guidance, require less cognitive load and support easy self-monitoring. Tailored technology and peer and professional support may influence users' opportunity to engagement with an app and goal setting with action planning may play a key role in motivation to engage with an app.

## Declarations

**Conflicts of interest:** JB has received unrestricted research funding to study smoking cessation from pharmaceutical companies who manufacture smoking cessation medications. JB, FN, OP and DS are unpaid members of the scientific committee for the 'Smoke Free' app and have no financial interest in the app.

**Contributorship:** DS, FN, AJ, TC and JB conceptualised the study design. DS wrote the study protocol with contributions from FN, AJ, TC, JB. All authors commented on the topic guide. DS conducted stakeholder communication with PPI representatives and PHE. DS undertook recruitment of participants, data collection, data analysis, interpretation and report writing. OP double coded a proportion of the transcripts. DS, OP and FN finalised



the final thematic framework. DS prepared the manuscript. All authors read, commented and contributed on the final manuscript. DS is funded through a PhD studentship, provided jointly by Public Health England and the University of East Anglia. OP receives salary support from Cancer Research UK (C1417/A22962).

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## Abbreviations

COM-B model: Capability, Opportunity, Motivation – Behaviour model

COREQ: Consolidated Criteria of Reporting Qualitative Research

GDPR: General Data Protection Regulation

NHS: National Health Service

NHSAL: National Health Service Apps Library

OYA: One You Apps portal

PHE: Public Health England

SD: Standard deviation

TDF: Theoretical Domains Framework

UK: United Kingdom

Multimedia Appendix 1. COREQ checklist

Multimedia Appendix 2. Screening questionnaire

Multimedia Appendix 3. Topic Guide

Multimedia Appendix 4. Participants characteristics

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