

“We Need to Be Told What to Do and What to Eat”: A Qualitative Study Exploring Perioperative Patient Desires, Suggestions and Reflections on Using Digital Health Technology Before and After Bariatric Surgery.

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Research

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Abstract

Background

A patient's capability, motivation, and opportunity to change their lifestyle are significant determinants of successful outcomes following bariatric surgery. Healthier lifestyle changes before and after surgery, including improved dietary intake and physical activity levels, have been shown to contribute to greater post-surgical weight loss and improved long-term health. Integrating patient-centred digital technologies within the bariatric surgical pathway could form part of an innovative strategy to promote and sustain healthier behaviours and provide holistic patient support, to improve surgical success. This study explores the desires, suggestions, and reflections of perioperative patients in the context of integrating digital technologies within the surgical pathway.

Methods

Patients attending bariatric surgery clinics within one hospital in the North of England were invited to take part in the study. Semi-structured interviews were conducted with pre- and post-operative patients to discuss lifestyle behaviour change and perspectives of using digital technologies to complement current care. Interviews were audio-recorded and transcribed verbatim. Thematic analysis enabled the development of themes from the data. Ethical approval was obtained from the NHS Health Research Authority.

Results

Eighteen patients were interviewed. Four overarching themes were identified relating to patient perspectives of optimised technology functionality to: 1) provide tailored content and support, 2) facilitate self-monitoring and goal-setting, 3) deliver information in an accessible, trusted, and usable manner, and 4) meet patient information-seeking and engagement needs.

Conclusions

We make recommendations to address the unmet needs of this patient cohort. These findings have the potential to influence the design of person-centred, perioperative technologies.

Background

Obesity is a growing global pandemic.(1-3) Weight loss surgery (termed bariatric surgery) is regarded as the most effective method for long-lasting weight loss.(4) Despite a rise in the numbers of bariatric procedures over the past few years, recent literature has suggested that surgery is still an underutilized treatment option, where the number of American adults choosing surgery is approximately 1%.(5, 6) Despite promising weight loss outcomes following surgery, patients can experience challenges beyond the procedure itself in their bid for surgical 'success'.(7) These include facing social-pressures and stigma

in relation to the surgery(8) and psychological impacts including negative body image and depression,(9) in addition to adjusting to post-operative lifestyle recommendations to reduce weight regain.(10)

A patient's capability, motivation, and opportunity to change their lifestyle are significant determinants of successful outcomes following bariatric surgery.(11, 12) Healthier lifestyle changes before and after surgery, including improved dietary intake and physical activity levels, have been shown to contribute to greater post-surgical weight loss,(13, 14) maintenance of weight loss,(15) and better overall long-term health.(16) Currently, little is known about the optimal way to support lifestyle changes in patients undergoing surgery with digital technologies; such as the form this support system should take, when it should be delivered during the surgical pathway, or the duration of such interventions.(14, 17)

Digital health technologies (such as mobile phone applications, tailored web platforms and wearable activity trackers) provide promising opportunities for connected patient care. They act to provide education and information in an easily accessible and patient-friendly manner,(18-20) as well as encouraging patients to become active participants in their own care.(21, 22) Studies have acknowledged patients' receptiveness towards using digital technologies to complement the care pathways of other surgical procedures; this has resulted in successful behaviour change, improved recovery time, and reduced length of stay in hospital.(23-25) In bariatric surgery literature, recent studies have reported how telemedicine and digitally-supported care have been well-received by patients,(26) and have potentially improved post-operative clinic attendance and patient engagement with surgical care.(27, 28) Utilising digital technologies within the bariatric surgical pathway, both pre- and post-operatively, could form part of a remote strategy to deliver support and behaviour change advice to patients.

Existing literature has suggested that collaborative approaches in medicine, between patients and clinicians, can result in improved patient engagement, trust and satisfaction, as well as improving intended health-related outcomes.(29-31) Co-creation and experience based co-design approaches are being researched and implemented in other areas of healthcare, with their goal to improve patient-focused care.(32, 33) In order to develop useful and effective support strategies using digital technologies, it is important to first understand how patients undergoing bariatric surgery *want* to be supported. Much research has previously focused on implementing digital technologies and measuring their effectiveness in various surgical cohorts, yet there is limited work concerning the desires, suggestions and reflections of patients, particularly those undergoing bariatric surgery. This qualitative study aimed to understand how digital technologies could be used to better support patients across the wider perioperative pathway, covering pre- and post-operative timepoints, with the overall rationale of improving weight loss outcomes and surgical success. Specifically, our key research questions concerned: 1) *what* do patients want from digital health technologies, 2) *how* do they want to use them, and 3) *when* would they be of most benefit during their surgical journey?

Method

Participant recruitment and sampling

According to the EQUATOR guidelines, the consolidated criteria for reporting qualitative research (COREQ) checklist was followed for this work.(34) Patients attending bariatric surgery clinics within one large teaching hospital in the North of England were invited to take part in the study. This included both pre-operative and post-operative patients who attended their outpatient appointments, as their experiences and perspectives of utilising digital health technologies may differ. All participants were provided with an information sheet detailing the study purpose and aims during their appointment with the surgeon. Written informed consent was obtained prior to conducting the interviews. To be included in the study, patients had to be over 18 years of age, recently undergone (within the last two years) or due to undergo bariatric surgery at the specific hospital Trust, not suffering from an acute decline in health away from baseline, able to participate in an interview, able to communicate in English, and have capacity to consent to taking part in the study. Participant recruitment was purposive, governed by the clinic list of pre-booked appointments with the surgeon.

Semi-structured interview

In-depth, semi-structured interviews were conducted by one researcher (AR) at a convenient time for the participant. All participants chose to be interviewed in the hospital, in a confidential surgery clinic room, without any other individual being present. These interviews took place between February and March 2020. Interviews were conducted until data saturation was reached, *i.e.* when themes began to repeat themselves and subsequent interviews yielded no new themes. A semi-structured interview schedule was developed based on three pilot interviews, existing studies concerning digital health technologies,(18, 19, 35, 36) and systematic reviews of the literature.(20) The schedule formed the basis of all participant interviews for this study (see Figure 1). Participant interviews included questions to elicit spontaneous discussion around their surgical experience, awareness of health and lifestyle behaviour change, patient support requirements, and perspectives on digital health technologies.

Data analysis

Semi-structured interviews were audio-recorded and transcribed verbatim. All data were anonymised at the point of transcription. Each interview was transcribed and analysed prior to conducting the next interview. Thematic analysis, as defined by Braun and Clarke,(37) was performed by two researchers (AR and AKH) to identify patterns of themes in the interview data. Transcribing the audio files and reading and re-reading the interview transcripts ensured data familiarisation. Significant phrases and sections of transcripts were identified and coded with initial descriptive codes; these were then sorted and clustered into common coding patterns, which enabled the development of analytic themes (derived from the data). Working iteratively and reflexively, the themes were continuously reviewed and refined until they were coherent and distinctive.(37) Reflexive analysis was performed at each stage of the research process through discussion (between AR and AKH) and the wider team (SPS and RDS) if needed. NVivo 12 software was used to assist in the organisation of interview data and thematic analysis. When using direct quotes from patients, non-identifiable pseudonyms were used to ensure confidentiality, *e.g.* participant 1, participant 2 and so forth.

Ethical approval

Ethical approval was obtained from the NHS Health Research Authority (HRA) and Care Research Wales (reference: 19/NE/0318).

Results

Eighteen participants in total were recruited and interviewed as part of this research. The characteristics of each participant are described in Table 1. The average age of participants was 46-years and the majority had, or were planning to undergo, a gastric bypass procedure.

Table 1: Participant characteristics

Participant N°	Sex (M/F)	Age (years)	Surgical Procedure	Pre- / Post-operative	Time since surgery (months)
1	F	29	Gastric bypass	Post	24
2	F	55	Sleeve gastrectomy	Post	12
3	F	54	Gastric band	Post	18
4	F	50	Sleeve gastrectomy	Post	24
5	M	46	Undecided	Pre	-
6	F	52	Gastric bypass	Post	9
7	F	61	Gastric bypass	Post	4
8	M	51	Gastric band	Post	24
9	F	39	Sleeve gastrectomy	Pre	-
10	M	40	Gastric bypass	Pre	-
11	F	31	Gastric bypass	Post	24
12	F	51	Gastric bypass	Post	24
13	F	58	Gastric bypass	Post	24
14	F	50	Gastric bypass	Pre	-
15	F	59	Gastric bypass	Post	24
16	F	29	Gastric bypass	Post	12
17	M	26	Sleeve gastrectomy	Pre	-
18	F	52	Gastric band	Pre	-

The analysis revealed that participants had particular needs and desires, relating to support, throughout their bariatric surgical journey. Four overarching themes were developed from the data, relating in particular to the capability and functionality of technologies to: 1) provide tailored content and support, 2) facilitate self-monitoring and goal-setting, 3) deliver information in an accessible, trusted, and usable manner, and 4) meet information-seeking and engagement needs for patients undergoing bariatric surgery (demonstrated in Figure 1). We explore these four themes, illustrating perspectives and suggestions with direct interview quotes, within this patient-informed piece of work.

Providing tailored content and support

When asked about *how* digital technologies could best be designed for patients undergoing bariatric surgery, interviewees expressed opinions about what information should be provided, how this information should be tailored, how specific features could be designed, and their visions of what their 'ideal' supportive intervention would look like.

It was deemed important that the content and support patients received from the technology was specific to bariatric surgery. One pre-operative participant described how *"the support packages should be tailored to the people rather than the procedure"* (participant 14), explaining how patients *"can lose our hair, end up with excess skin, and need to be on life-long supplements"* and how this is *"the kind of stuff"* that they need support with throughout the journey of surgery and beyond. Another participant explained how it would have been helpful to know that *"after a normal operation you'd be able to eat whatever to build up your energy levels again quite quickly... but you can't do that with bariatric surgery, you physically can't eat things immediately post-surgery"* so *"you'd need it specifically to advise on the bariatric recovery in that case"* (participant 3). There appeared to be an unmet need relating to tailored, educational- and informational-based support for this cohort.

With regards to the content of the technology, discussions centred on dietary-focused forms of support. Patients' suggestions and desires ranged from the inclusion of *"options of what I could have for a snack"* (participant 5) and *"something with a meal plan available"* (participant 9), to designing *"an app with recipes on it"* so patients could *"keep coming back to it"* for healthier meal options (participant 5). Patients favoured prescriptive approaches to content when it came to describing 'ideal' technology-enabled support, stating that the intervention should tell them what to do and what to *"stick to"* (participant 8). One pre-operative patient suggested the integration of features such as *"a list of what you're not allowed to eat anymore"* would be most helpful so they could *"easily keep away from it (unhealthy foods)"* in a bid to *"keep on track"* with their anticipated weight-loss (participant 14). Some participants stated that immediately following surgery, they wished for stricter support mechanisms delivered *via* digital technologies, especially to support them in adjusting to their new post-operative lifestyle and dietary intake. One participant discussed that *"in the first couple of weeks (following surgery), we need to be told what to do, what exactly to do... like what to eat and what to avoid"* (participant 9).

A number of participants considered it important that technology content also focused on the wider elements of healthy lifestyle support, including increased physical activity and reduced in alcohol intake: *"If you called it a 'lifestyles package' for after bariatric surgery then you can mention things like diet but also (alcohol) drinking and exercise"* (participant 9). Patients demonstrated awareness that positive behaviour changes in these areas also contributed to bariatric surgery success, with one participant specifically discussing how they were *"trying to look for better choices – like a better choices app"* to support their journey (participant 5).

Another participant described how building reminders and prompts into the technology could promote positive health behaviours. The tone and content of these prompts were perceived to be important, combining messages of monitoring and activity with motivational statements. The same participant described how patients should be given control over the technology settings so they could decide on the correct tone for them.

“I would want something to just give you little reminders – maybe even “have you been weighed this week?”, “have you been for a walk?”, “don’t let yourself slip”, things like that. But erm, nothing too forceful... Not the whole powered sort of, gym messages, like “get up fatty!” (laughs)” (Participant 10)

A post-operative patient reflected that, regardless of the technology delivery method used, *“the most important thing is that you’re not left alone after the operation... (as) there’s so many unknowns [sic]”* (Participant 11). Instead, calling for tailored, digital support to be on hand throughout the whole surgical journey to provide reassurance to patients both pre- and post-operatively.

Facilitating self-monitoring and goal-setting

Both pre- and post-operative participants reflected on the usefulness of self-monitoring and goal-setting functionalities, so as to help track progress throughout the surgical journey. One participant felt it would be useful to self-monitor *“calories... and nutritional information”* in food when adjusting to new meal plans (participant 14), with another participant describing the usefulness of *“comparison photos”* that could be uploaded to an app to *“see how much of a difference there has been”* (participant 15), or having *“graphs to track”* their weight-loss over time (participant 7). The suggestions for digital self-monitoring to support in this way appeared to acknowledge the determination of this cohort in striving for surgical success.

Self-monitoring features were also discussed in association with motivation and emotional-investment in the surgical journey, where one participant described how observing *“how much (weight) you’ve lost”* can *“keep people’s spirits up”* (participant 15). Another participant explained how automated messages of *“congratulations”* were encouraging and *“if it calculates your BMI going down as well, I think that would be a really good motivational tool”* (participant 7). Patients recognised how technology could encourage and ‘push’ them to undertake positive health behaviours, like physical activity.

One participant described how wearable technology enticed them *“into doing more steps or exercise”* (participant 1), with another referring to gamification features, with different ‘levels’ of increased difficulty for patients to work through, to encourage engagement with the technology.

“I’d want it to have different levels too - like the first month, the second month, unlocking the next bit... Then it’s all there for you and you can keep going back and checking on the app... I can know I’m on track then.” (Participant 14)

When it came to engaging with the surgical journey, one participant described the common post-operative pitfall of getting *“so hung up on what we’re eating and whether it’s right or wrong”* (participant 11).

Instead, they recognised the benefit that could come from setting *“daily goals about exercise”* to *“give us something else to think about... and work towards”* to achieve optimal post-operative outcomes (participant 11). The same participant reflected on how goal-setting would have widened their personal knowledge of *“what to do after”* surgery, meaning they were able to *“recover better”* (participant 11). Another participant drew on personal experiences with the *“NHS Patient Access app”* (participant 7), suggesting the inclusion of specialist-bariatric advice, linking *“the full app to your NHS number so it’s all personalised”*, and using the home screen with *“tabs at the bottom for specific stuff... like graphs to track (your progress)”* (participant 7).

Some participants also discussed the value of sharing their data with healthcare professionals and the increased sense of motivation and accountability to *“break those (bad) habits”* (participant 10) when knowing someone else was *“keeping an eye”* (participant 11). Another participant felt that shared monitoring could act as a reassurance-mechanism for patients, where they weren’t being left to *“fend for themselves”* in the run up to surgery or as soon as the surgery was over (participant 4). A sense of shared responsibility for the success of surgeries was discussed when considering healthcare professional-led monitoring. One participant supported the inclusion of shared-monitoring capabilities so that both patients and healthcare professionals can *“notice if they’re slipping”* off the post-surgical diet, implying that patients alone may not be able to recognise bad habits re-forming.

Delivering information in an accessible, trusted and usable manner

All participants offered suggestions on technology delivery methods and how they would like the intervention to be available to them, including *via* phone-based applications (apps), online forums, and the use of social media platforms like Facebook. The majority of participants discussed that their preferred delivery method would be accessible through their smartphone *via* an app, with one patient explaining *“practically everyone knows how to use a phone for stuff now. Everything’s on it... So, if you could put an app on there, I reckon that’s the best way”* (participant 15). Other participants also reported how frequently they used their phones and how people rarely *“go anywhere without it”*, offering the potential for ongoing engagement even *“if I’m out for the day or away on holidays or whatever, I can still log in”* to use it (participant 14). Many interviewees desired a delivery system that was *“nice and clear”* (participant 3), with one remarking they did not want another *“dry or crisp NHS website”*, instead preferring a *“modernised”* app or discussion page (participant 4).

As an alternative delivery method, some participants reported being members of bariatric groups on Facebook. A few participants reported social media and Facebook to be an acceptable delivery format, offering familiarity and reassurance: *“I use Facebook all the time... it’s amazing”* (participant 9). However, participants also questioned the reliability of information posted on Facebook, describing it as *“obviously everyone’s own experiences, but it might not necessarily be the safest”* (participant 11). One participant described how some of the posts they had read were *“full of nonsense”* and so he got rid of his account. In his view, *“an app would be better”* as he *“would probably trust it (the content) more than Facebook”* (participant 5). Furthermore, another drawback of Facebook was how one *“need[ed] to scroll back to find*

the information", whereas an app could contain *"a specific folder or tab so you could go back to it (information)"* (participant 9). Other participants described their positive experiences of 'closed' groups with smaller numbers of individuals. One female patient discussed a private WhatsApp group which contained five other post-operative patients and felt that the *"how are you all doing?" messages*" (participant 4) were helpfully shared amongst themselves. This indicates that some post-operative patients might find it helpful to surround themselves with like-minded individuals.

Many participants highlighted how information needs to be quick and easy to locate, with one participant suggesting it should be kept *"all together in one place"* (participant 9) and another describing how *"that way you can keep coming back to the information any time you wanted to, rather than looking for the leaflets they gave us"* (participant 5). Another participant described organising the information with *"tabs at the bottom (of the screen) for specific stuff"* like *"appointments for follow ups"* (participant 7).

Previous technology use was considered alongside accessibility and information provision. One participant described usability as something that depends *"on your character. I'm not very techno-loving or anything, but I'd give it a go (laughs)"* (participant 6). Some participants discussed usability from the perspective of others, particularly older family members. One interviewee considered her 63-year old mother, describing how *"she can use Google now, but it's took a long time to get her to do that [sic]. But then again, my husband's Dad, he's 73 and he would definitely use digital stuff"*. Interestingly, she also appreciated that usability *"is a bit dependent on the person too, not just their age"* (participant 9). Some interviewees viewed usability in the same context as familiarity, and referred to strategies to overcome this through the use of patient education.

Another participant offered suggestions of how to design the technology so that users of all literary-abilities could engage, through the use of 'happy' or 'sad' faces, or colours, for instance.

"I've met a lot of people that can't read or write... you could do happy face, sad face, whatever... Or amber colour for not advisable, red for bad or danger, green for good" (Participant 12)

Meeting patient information-seeking and engagement needs

With regards to using a form of digital technology for support, participants shared varying opinions about *when* it would be of most benefit. This benefit appeared to relate to (a) the timing of intervention implementation on the surgical journey (for example, seeking pre-operative information or post-operative reassurance) and (b) the timing of engagement with technologies (for instance, the value of interventions offering functions of 'real-time' use and 'ad hoc' use).

When considering their implementation within the surgical journey, some participants believed pre-operative digital support would be useful in helping to acquire knowledge about the upcoming surgery *"it's an operation at the end of the day and you're changing your insides so I think it's important to fully know (about) it"* (participant 10), and their preparedness for it *"at least you know what to expect, what is coming either before or after the procedure, and what to do"* (participant 9). After struggling with their own

surgical outcomes, one participant suggested a potential role of pre-operative digital support relating to the psychological preparation ahead of surgery. They discussed how pre-operative interventions could better educate patients and meet information-seeking needs, as well as manage post-operative weight loss expectations: *“if something could teach me like how to expect, what to expect after (the surgery), it might have helped... ‘cause I thought the weight loss would be much faster and I look no different now”* (participant 3). Similar thoughts were raised by other participants, with one participant explaining how it *“would be really useful to have a map or plan to know what’s going to happen, and when, so we know it’s a full process for us to refer to and not panic”* (participant 4). Another suggested designing *“a checklist... like all part of your own bariatric package”* where you could *“tick off each bit”* when it was achieved (participant 3). Patients may find benefit from seeing the phases of the journey and understanding what was going to happen next.

Interviewees recognised the value of real-time information seeking in the initial post-operative period, for instance: *“‘cause, say you were standing in the supermarket and you thought ‘oh I could really fancy that, but I don’t know if I’m allowed it”, then you’d be able to look it up and see if you can have it or not. That would be really practical and handy”* (participant 14) and *“I think if you could make something that had a meal plan we could access straight after the surgery... rigidly... what to stick to for the first few weeks, then that would be good [sic]”* (participant 5). In a cohort required to change their lifestyle behaviours, even before having the surgery, perhaps technologies delivering short-term descriptive support would be beneficial.

Participants also considered technologies playing a role in terms of long-term support. Interviewees recognised that engagement with technologies would likely be higher in the initial post-operative period *“once you’ve had it (surgery), you’re in it, and probably will need the information there and then...”* (participant 10), but that each participant’s engagement needs will change, the further along their post-surgical surgery they are. Being able to engage with the technology again, when needed, was deemed important: *“it might be something where it (intervention usage) tails off a bit, once you start getting the hang of things, what to eat, how much you can tolerate and stuff. But also, if anything happened and I wanted to ask questions, then I picture being able to use it as and when”* (participant 14).

Two participants (one pre- and one post-operative) acknowledged that technologies could play a role in complementing current practice to improve patient support between annual follow-up appointments. One post-operative participant explained that *“once you got a few months in it was more ‘well, I’ll see you in 12 months unless you have problems’ and that’s not supportive enough”*. They believed there to be benefit from continued technology-enabled engagement throughout this time, specifically linking with a healthcare professional for *ad hoc* advice: *“if I’d had more contact with the dietician, digitally, I could maybe have stayed on track better”* (participant 11). Recurring messages of prescriptive and descriptive approaches, where post-operative participants appear to cede complete control over their journey and outcomes, perhaps demonstrates a lack of belief that they can make and sustain positive behaviour changes on their own. One pre-operative participant perceived the value of ongoing support from technologies in a more self-determined manner: *“I want to make sure I get it (dietary intake) right. I want*

to avoid any complications and give myself the best chance of success". They went on to describe their ideal technology-enabled support system, combining technology alongside face-to-face appointments, stating: *"I think using tech and still having the (face-to-face) appointments will give me as much support as I need"* (participant 5).

Of all the participants interviewed, only one recommended implementing an intervention that spanned both the pre- and post-operative periods. This patient was 2-years post-surgery and their views combined those of pre- and post-operative patients, as discussed above, and described how supportive 'boosts' from the technology continued on a long-term basis could help to promote positive behaviours: *"from the minute you decide to go through with it (surgery), you probably would benefit from having something there just for peace of mind... definitely (implementing) from the start, but also so they can keep using it after (surgery) too for those little boosts and support"* (participant 16).

Discussion

This patient-informed study identified the desires, suggestions, and reflections of bariatric patients in the context of using digital health technologies as support tools during surgery. By collecting both pre- and post-operative patient perspectives, we highlighted *how* digital support strategies could be delivered, *what* content is perceived as useful, and *when* technologies could be implemented within the current NHS bariatric surgery pathway. Our findings discussed four key themes, related to technology functionality and capability, that enable better tailored and targeted digital health technologies for bariatric surgical patients.

Study participants described a range of potential technology suggestions to meet their pre- and post-operative needs. Patients discussed how digital health technologies should enable easy access to specialist and tailored information, located in one place. Comparable with findings in wider digital health literature, patients also highlighted how technologies should provide individualised feedback and reviews on post-operative progress.(38) Personalisation of feedback has previously been associated with positive health behaviour change and increased patient engagement with care.(39-41)

One participant suggested connecting the technologies to health system identifiers, such as an individuals' NHS number, to support the delivery of personalised care. Numerous participants referred to the surgical journey as a process, suggesting that it may benefit from technology-enabled checklists to create an engaged 'package of care' between patients and clinicians; a novel finding from this research. Patients envisaged this to be of particular use in the post-operative period, enabling better control over their recovery and diet, as well as better understanding their follow up care. References were made to designing helpful prompts for patients. This echoed previous findings where the tone and delivery of these prompts or messages were deemed crucial in motivating sustained positive health behaviours in cancer patients.(42-44)

In-line with current research, perspectives of becoming 'digitally engaged patients' were discussed by many of the participants.(45) For this cohort, the focus of their engagement centred on the monitoring of

post-operative progress, primarily the ability to track surgically-induced weight loss. Previously, interactive health technologies with monitoring capabilities have been credited as transformers of healthcare by supporting engaged self-care and promoting positive health behaviours.(46) As well as individualised feedback, the potential for individualised goal-setting may further support a generation of digitally engaged patients with bariatric conditions. Working towards achievable targets has been deemed an effective strategy to successfully motivate behaviour change.(47) Wider literature echoes that individualised goal-setting has demonstrated improvements in sedentary behaviour,(48, 49) personalised feedback and messages of encouragement have provided cancer patients with a sense of accomplishment,(50) and visual tracking of physical activity (*e.g.* daily step-counts) has been reported as motivational.(42, 49) Perhaps the same approach could be used for patients undergoing bariatric surgery, with a focus on achievable targets of weight loss combined with dietary intake and physical activity. Uniquely, one participant reflected on gamification when designing technologies (in a game format) to support staged surgical recovery. A study focusing on increased physical activity to aid recovery following cancer surgery expressed similar findings; these authors also identified that personalised difficulty settings in the 'game' boosted patient satisfaction and engagement with the intervention.(51)

As in previous digital health research, themes of usability were discussed by participants, particularly around their existing familiarity *vs.* unfamiliarity with technologies.(52) Reflections from the perspective of older relatives highlighted that digital literacy and generational bias may still be a challenge to overcome when considering the implementation of health technologies.(42, 53, 54) Whilst technologies are now implemented more readily within healthcare, some patients may still prefer face-to-face encounters with clinicians, rather than virtual ones.(45) We should be mindful to acknowledge this and, as suggested by participants, work to complement technology integration with educational support materials.

There appears to be value in implementing technologies both pre-operatively and post-operatively. Echoing participant reflections in this study, pre-operative interventions have previously been linked with promoting positive behaviour change culture.(18, 19, 55) This is closely linked with theories of surgical teachable moments, arguing that patients are highly susceptible and motivated to change following the initial decision to undergo surgery.(56, 57) Highlighting the perspectives of participants in this study, digital health technologies may present a promising opportunity to prepare patients prior to surgery, as well as provide continued support between routine post-operative follow-up appointments.

Participant responses also highlighted a desire to engage with the technology on an *ad hoc* basis. The benefit of being able to engage 'when required' seems logical, particularly for a patient cohort with changeable post-operative needs over time. Participants in this study also considered that intervention usage and engagement rates would likely be higher soon after surgery, but reduce over time once they better adjusted to post-surgical life. These thoughts echo similar findings within the literature that support engagement decline, however these were previously related to a novelty phenomenon associated with digitally-supported care,(58, 59) rather than a result of reduced patient support-requirements. This draws attention to the importance of finding optimal 'engagement balance' with any digital health technologies

implemented for patients. Currently, there is insufficient evidence to state the optimal initiation point of digital technologies within the bariatric surgical pathway.

Participants raised contrasting views that suggested a fine balance existed between them accepting and abdicating responsibility over their recovery and subsequent surgical 'success'. Prescriptive and descriptive approaches to technology content were desired by some, where they wanted the technology to provide them with regulated and specific advice, like directed post-operative meal plans. Yet, previous studies have noted this approach to have questionable success when it comes to motivating and sustaining behaviour change.(60) Instead, authors have cited the importance of empowered patient-health provider strategies.(61, 62) Self Determination Theory (SDT) provides a theoretical framework through which to understand participant motivations and behaviours.(63) When SDT has been applied to other health behaviour contexts (such as programmes for smoking cessation(64) and weight-loss(65)), findings have suggested that the more autonomously motivated participants were, the more successfully they implemented behaviour change. Reflecting on these findings from the literature, it could be suggested that patients with higher levels of independent motivation and acceptance of responsibility are more likely to have successful surgical weight loss; both in the short-term, as well as sustained over the longer-term. Technology-enabled monitoring has also been recognised to boost autonomous motivational levels;(63) however, it may be considered unsustainable to have long-term monitoring done by healthcare professionals as patients desire. Monitoring opportunities and timescales should be considered when it comes to digital technology design and functionality to support and motivate these patients in their surgical journey. The value of digitally-enabled peer-networking within the bariatric surgical journey could be considered as an area for future research; in particular, *how* and *when* digital health technologies could support with, and facilitate, this.(20)

Strengths And Limitations

Our results have important implications for the design, delivery, usability and implementation of digital technologies for patients undergoing bariatric surgery. Uniquely, our findings collate participant desires, suggestions and reflections concerning digital technology use across the whole bariatric perioperative pathway. This study is one of the first to incorporate pre- and post-operative participants, building evidence on the optimisation of technology-based support to span the perioperative journey when undergoing bariatric surgery. Further studies may wish to deepen the insights gained from this work to more closely investigate the patient journey, exploring the changing mindsets of patients from pre- to post-surgery which may implicate the technology design.

We acknowledge that there were some limitations with this work. Firstly, the research predominantly focused on a small sample of patients in the North of England and, secondly, as is common with bariatric surgery, this sample included more female participants than male. In addition, we did not assess or sample participants by socioeconomic status. It is possible that participants of different socioeconomic classes may have varied experiences with technologies, and our results should therefore be interpreted

with this in mind. Our study also focused solely on the desires, suggestions and reflections of bariatric surgical patients, and thus the results may not be generalisable to other elective surgical procedures.

Conclusions

Perceptions of patients undergoing bariatric surgery validate the integration of digital health technologies within the surgical care pathway, offering enhanced connectedness and support. Findings from this research have the potential to influence the design and targeting of future digital technologies to best support patients. To achieve surgical success, digital strategies should consider the incorporation of specialist information tailored to the bariatric surgery cohort, and implementation of self-monitoring and goal-setting functionalities. Further, to address specific unmet support needs of this patient cohort, digital health technologies should enable the provision of a 'package of care' to offer long-term lifestyle support.

Declarations

Ethical approval and consent to participate: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Ethics approval for this study was granted from NHS Health Research Authority and Health and Care Research Wales, reference: 19/NE/0318. All participants received a participant information sheet detailing the study purpose and procedures. All participants provided informed written consent to participate and were guaranteed the following: that their involvement would not affect their treatment or care in any way, that the study records would be kept confidential and that their contributions would be unidentifiable.

Consent for publication: Written consent was provided by all participants in order to present anonymised and unidentifiable data within this report. Consent was obtained and approved alongside the ethics approval for the study, granted by NHS Health Research Authority and Health and Care Research Wales, reference: 19/NE/0318.

Availability of data and materials: The anonymised dataset (participant interviews) used during the current study are available from the corresponding author on reasonable request.

Competing interests: The authors declare that they have no competing interests.

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Authors' contributions: All authors were responsible for the study conception and design. AR performed the data collection. AR and AKH performed the data analysis and liaised with RDS and SPS if needed. AR led the writing of this manuscript as part of their PhD doctoral candidature, with all co-authors commenting on various drafts. All authors have read and approved the final manuscript for submission.

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Figures

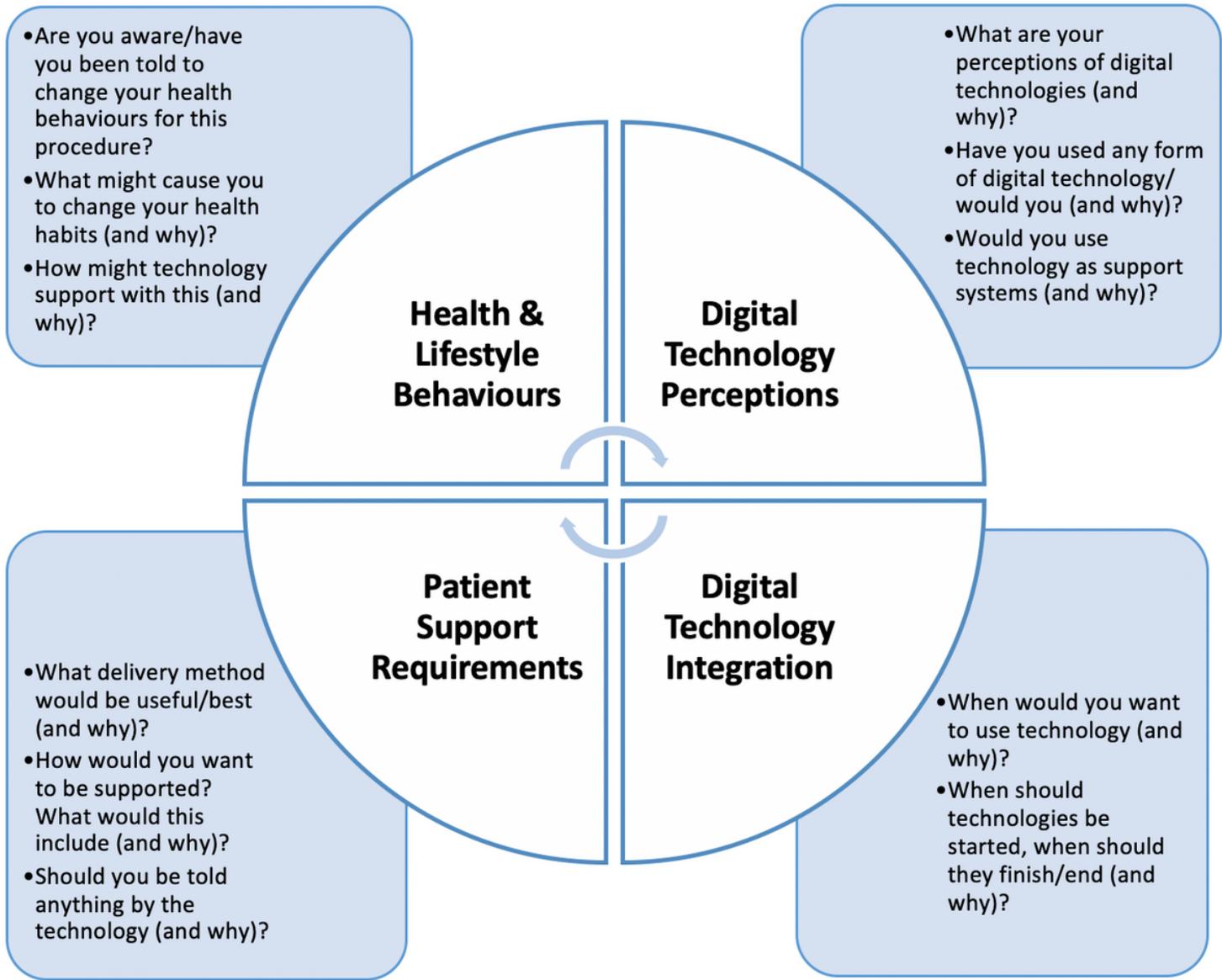


Figure 1

Semi-structured interview schedule and key questioning themes utilised in participant interviews.

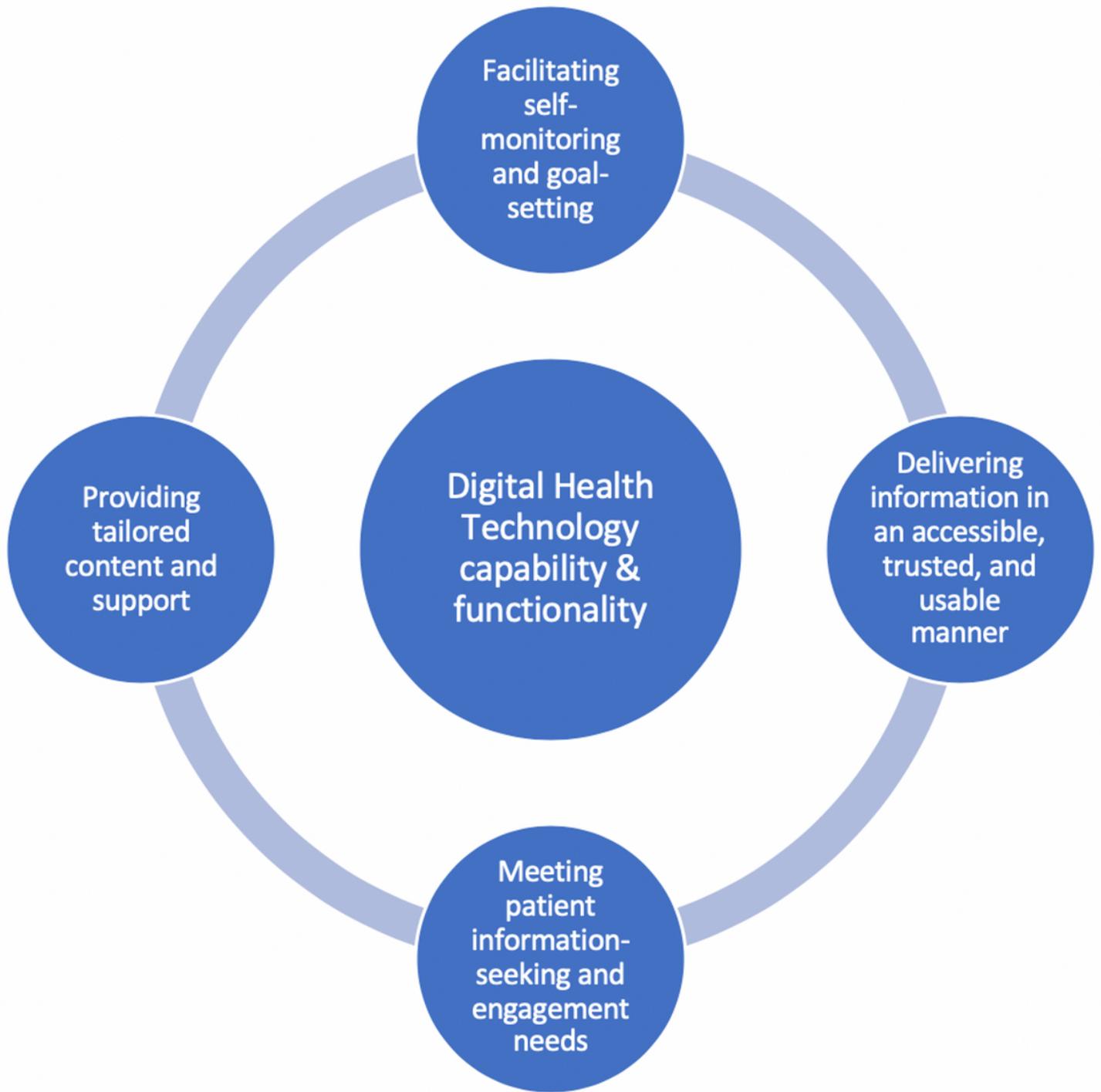


Figure 2

Overarching themes concerning the capability and functionality of digital technologies to better support patients.