RESEARCH ARTICLE

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The use of mobile technology to facilitate self-management in adults with type 1 diabetes: A qualitative explorative approach

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Abstract

Aims: (a) To explore how mobile technology can support self-management in adults with type 1 diabetes (T1DM). (b) To inform a usability study in the design of a mobile application to facilitate self-management of T1DM.

Design: Qualitative exploratory design.

Methods: Semi-structured interviews were undertaken with adults with T1DM (N = 8). The data collected were analysed using a thematic analysis approach.

Results: Mobile technology has the potential to support adults in their self-management of T1DM through facilitating their decision-making, saving time and enabling them to easily share their data with their healthcare professional. Participants identified four main visualization characteristics for technology to aid in decision-making; relationships between inputs, trends, graphs and colours, and identified essential features such as ease of use, convenience and connectivity.

KEYWORDS

mobile applications, nurse, nursing, qualitative research, self-management, support, technology, type 1 diabetes T1DM, visualizations

1 | INTRODUCTION

Type 1 diabetes (T1DM) is a condition that can affect any individual regardless of age, gender or status and accounts for 10% of adults with diabetes (Diabetes UK, 2015). However, 95% of children that are diagnosed with diabetes have T1DM (RCPCH, & NPDA, 2016). This early onset of the condition could lead to individuals living for longer periods of time with high glucose levels, potentially resulting in micro- and macrovascular complications which have an impact on quality of life (Song, 2008; Wong, Molyneaux, Constantino, Twigg, & Yue, 2008). Increased complications result in a burden to health service economies, arising from individuals requiring treatment and potentially becoming unable to work due to ill health (Diabetes UK, 2012).

The day-to-day monitoring, control and treatment of T1DM are undertaken by the individual; hence, self-management strategies are key determinants of the outcomes of the condition. Outcomes are affected by adherence to insulin regimens, close monitoring of blood glucose and accurate estimation of carbohydrate intake. Consequently, effective management of T1DM requires intense and complex self-decision-making and interpretation of personal data. Some individuals with T1DM seek a personalized plan of targets, methods and technologies that allows them to more easily and effectively manage their diabetes during their various day-to-day activities, thereby potentially improving their quality of life (NICE, 2015). Digital technologies are moving forward, and individuals with T1DM are choosing to use personal devices with better capabilities than more traditional technologies and are indeed involved in designing technologies for diabetes management (Lewis, 2018). The implications for nursing practice are threefold: firstly, keeping up-to-date with such capabilities; secondly, working in partnership with patients and their carers to maximize such

use; and thirdly, working interprofessionally to advise and collaborate with disciplines involved in the development of digital technologies how the patient voice may be harnessed into technology design.

One example is mobile technologies, which have become widespread, with more than two million mobile applications (apps) available for download at the beginning of 2017 (Ferguson & Jackson, 2017). These include apps to aid self-monitoring of T1DM. However, very few of these mobile apps have been designed with input from the end-user, which questions whether they are fit for purpose. The aim of this study was to explore how mobile technology can support self-management in adults with T1DM. Subsequently, the qualitative findings informed a usability study (SWifT) undertaken by a team of computer scientists to develop a more appropriate, beneficial method of visualizing diabetes-related data (Brown et al., 2017).

2 | BACKGROUND

Individuals with diabetes may only have occasional contact with healthcare professionals (HCPs) throughout the year; therefore, living with diabetes is about caring for and managing their own diabetes. At the same time, technology is advancing rapidly with the potential to support self-management strategies. Several studies have explored the experiences of individuals with T1DM in the use of mobile apps (Froisland & Arsand, 2015; Froisland, Arsand, & Skarderud, 2012; Rossi et al., 2013,2009; Waite, Martin, Curtis, & Nugrahani, 2013). Useful features included visualizations, which identified the relationship between physiological measures and behaviours (Froisland & Arsand, 2015; Froisland et al., 2012; Rossi et al., 2009). This capability appeared to offer participants the self-confidence, perhaps via improved knowledge, to take control of their condition. In addition, positive feedback from visualizations was associated with mastery and empowerment by a group of adolescents using a mobile phone self-management application (Froisland & Arsand, 2015). Participants felt that visualizing and reflecting on pictures improved their understanding and knowledge. Likewise, several participants in the study by Froisland et al. (2012) tended to make more healthy choices when photographing and reflecting on their health behaviours, such as food intake, physical activity and insulin dosage, thereby potentially leading to better control. Similarly, Waite et al. (2013) established that feedback features such as prediction of personal trends and suggested correcting doses of insulin for carbohydrates, exercise and stress would be useful in aiding self-management for future mobile apps.

Participants in the studies by Rossi et al. (2009) and Waite et al. (2013) indicated the capability to share personal data with HCPs would encourage them to use mobile applications in the future. This concept was supported by Smith, Frost, Albayrak, and Sudhakar (2006) who suggested that visualizations aided communication between patient and physician which is significant because communication is paramount in the management of diabetes.

There is a lack of research exploring the end-users' opinions in the design of technologies aimed at self-management of T1DM. Most studies that have explored this area have been conducted among adolescents and their parents (Cafazzo, Casselman, Hamming, Katzman, & Palmert, 2012; Castensoe-Seidenfaden et al., 2017; Holtz et al., 2017). In contrast to the previous studies, adolescents in the study by Cafazzo et al. (2012) reported their requirements as data collection rather than decision-making. However, with a view to sharing data, Cafazzo et al. (2012) reported that adolescents described an approach that involved sharing their information with both parents and HCPs. Holtz et al. (2017) reinforced the notion that the app should facilitate communication between parent and child, whilst Castensoe-Seidenfaden et al. (2017) acknowledged that involving the end-user in the design of a self-management app for young people facilitated communication between patients and HCP.

As a variance of the feedback concept, Cafazzo et al. (2012) noted an increase in blood glucose (BG) monitoring when offering rewards as an incentive for inputting data. This reinforces the notion identified by Froisland and Arsand (2015) that positive feedback is associated with empowerment in adolescents, potentially resulting in improved control. Similarly, respondents in the study by Holtz et al. (2017) described rewards as a motivator to use the app.

The ability to enter data quickly and efficiently was important to users (Arsand, Tufano, Ralston, & Hjortdahl, 2008; Cafazzo et al., 2012; Rossi et al., 2009) but not always available (Waite et al., 2013). This highlights the fact that whilst mobile applications can be useful tools for self-managing T1DM there are also limitations. Moreover, much of the research into the usability of mobile apps has been limited to adolescents, which could restrict generalization of the findings to the adult population.

To explore how mobile technology can support self-management in adults with T1DM, a qualitative study was undertaken with a view to determining how the findings could be harnessed to facilitate self-management into technology design. The findings of SWifT (Brown et al., 2017) were subsequently used to design usable ways of displaying monitoring and healthcare data on a mobile technology interface associated with the design of an artificial intelligence system for adults with T1DM.

2.1 | Research question

What is the perception of adults with T1DM in the use of mobile technology in self-management of the disease?

Objective: To explore the perception of adults with T1DM in the use of mobile technology for self-management of the disease.

3 | METHODS

3.1 | Design

The research design was a qualitative study where the unit of analysis was a group of adults from the local urban area, with a diagnosis of T1DM for a duration of more than 1 year. Such a design allowed the researchers to explore and develop a greater understanding of participants' views and opinions. Data were collected through semi-structured

interviews which enabled the researcher to explore the personal experiences of the participants with the focus on the research aims.

3.2 | Study setting

The interviews took place in the Clinical Research Unit (CRU) which is a purpose-built Clinical Research Facility in the local hospital. The interviewer (RF) worked as a research nurse in the unit, however, had no previous contact with the participants.

3.3 | Sample

Adults with T1DM were identified from the local CRU recruitment register with permission from the associated University. This is a register of individuals who have previously agreed to be contacted about research studies. In addition, an advert was designed to circulate to the local university, the local special interest groups in diabetes, Diabetes UK, the county group for young people with diabetes and groups for people with diabetes via Facebook (with related permissions of the owner of the Facebook page).

Inclusion criteria were as follows: aged over 18 years, diagnosis of T1DM for more than 1 year and English speaking with the ability to give informed consent.

Four males and four females took part in the study, (N = 8). Age range was between 27–57 years. Duration of time with T1DM ranged from 2–47 years.

The original target was to recruit between 10–15 participants. Whilst there are no definitive rules for sample size in qualitative research, the aim being to achieve data saturation, it was felt 10–15 participants would be sufficient to achieve this within the allocated study period (Polit & Beck, 2006). However, ongoing analysis revealed no new information, suggesting data saturation had been reached at N = 8.

3.4 | Data collection

Data were collected through face-to-face semi-structured interviews, conducted by author one (RF), which lasted between 30–60 min. Interviews were audio recorded with the consent of the participant. Any information which had the potential to be misconstrued, or which was unclear to the author, was clarified to avoid any potential biases or prejudices, to ensure credibility of the data collected. Field notes were taken immediately after each interview in an attempt to capture the overall experience and conditions of the interview, including any significant body language noted. Each recording was transcribed verbatim immediately following the interview, either by RF or another member of the research team. Each transcript was then sent to the participant to review to ensure it was an accurate representation. All transcripts were saved to the secure password-protected server used by the University and accessed only by the research team. The interview questionnaire (Appendix 1) was designed with the research aim in mind and consisted of open-ended questions which allowed for adaptation based on participants' responses (Gillman, 2005; Pope & Mays, 2006). Data were collected throughout November and December 2015.

3.5 | Data analysis

Analysis of the data was guided by the thematic analysis framework described by Braun and Clarke (2006). Transcripts were read thoroughly, in conjunction with the field notes, by author one (RF) and inductively coded. The coding of data was further guided by the research aims. Transcripts were re-read focusing on initially ensuring no codes had been missed and subsequently to ensure the themes aligned with the data. These themes were also discussed with author two (MW).

3.6 | Rigour and trustworthiness

Author one (RF) is a senior research nurse, and analysis of the data and development of themes were discussed with author two (MW), as a more experienced qualitative researcher, to ensure that the evidence supported the interpretations. Transcripts were sent to each participant for review to ensure that an accurate representation had been recorded. Participants were recruited from a range of sources, a wide age range and varying lengths of time with T1DM, with inclusion criteria, sampling, data collection and analysis all described in detail (Shenton, 2004).

Field notes were taken which acknowledged the interviewer's (RF), thoughts and feelings and potential bias. Fundamental decisions in coding and development of themes were documented to provide an audit trail (Bryman, 2012). Quotes from participants, identified by a number (e.g. P1), are included to illustrate themes.

3.7 | Ethical considerations

Research Ethics Committee approval was obtained from the university ethics committee where the first author was a master's student and the second author, a tutor. Written consent was obtained from all participants prior to each interview. As the interviews had the potential to identify unmet needs regarding the self-management of the participant's condition, a plan was in place to refer participants to their healthcare provider to discuss any identified issues.

Interviews took place in a private room with the aim of maintaining confidentiality. Each participant was assigned a study number in an attempt to maintain anonymity (Silverman, 2006). Interview transcripts were identified by the participant study number and were stored separately from any identifiable data. All information was stored securely by author one, RF to ensure confidentiality.

4 | RESULTS

The participants comprised of four males and four females (N = 8). Demographic characteristics of these participants are presented in Table 1.

TABLE 1 Demographic characteristics of participants

Participant No.	Recruitment method	Gender	Age	Age at onset of diabetes	Insulin	BG meter	Monitoring equipment used now
01	CRU recruitment register	Male	44	30	Injections	Nexus Gluco RX	Spreadsheet on phone
02	CRU recruitment register	Male	53	30	Injections	Freestyle Optium Neo	Tablet/excel
03	CRU recruitment register	Female	28	16	Injections	Accu-Chek Aviva	iPhone
04	CRU recruitment register	Male	32	28	Injections	Freestyle Optium Neo	BG meter and phone
05	CRU recruitment register	Male	41	Mid–30s	Injections	Optium Xceed	BG meter and phone
06	CRU recruitment register	Female	57	10	Injections	True result	Log book
07	Local university	Female	52	50	Injections	Nexus Gluco RX	Log book
08	Local university	Female	27	16	Pump	Paradigm Medtronics	BG meter

TABLE 2 Examples of codes, sub-themes and themes

Examples of codes	Sub-themes	Themes
Relationship between inputs, for example, insulin, BG, diet, exercise		
Integrate weight, BP, BG, insulin	Relationships	
Combine BG, insulin, carbs		
Trends, patterns, averages	Trends	Aiding Decision-Making
Colours for high and low BG		
Different colours for insulin and BG	Colours	
Line graph of glucose levels		
Line graph with carbs on one	Graphs	
Line graph to see ups and downs		
Inconvenience of monitoring method, no easy method		
Lack of time, time consuming	Barriers to self-monitoring	
Monitoring equipment too expensive or not available		
Ability to personalize		Easing Accessibility
Ease of use		
Convenient	Characteristics for technology	
Accurate		
Download data, data feed from monitor		
Large screen to see data	Connectivity	
Send BG data to HCP		Sharing of Information
Link to share data with HCP	Share data with HCP	

4.1 | Themes

Three main themes were identified from the data: (a) Aiding Decision-Making; (b) Easing Accessibility; (c) and Sharing of Information (Table 2).

4.1.1 | Aiding decision-making

All the participants identified the need for the technology to aid in their decision-making through different visualization characteristics.

Four main characteristics were identified by participants to facilitate self-management: relationships between inputs, trends, graphs and colours. The ability to visualize the relationship between inputs, such as BG, insulin, exercise and food, was a principal feature in facilitating decision-making:

> Well I think it would be good to be able to integrate weight, blood pressure readings, the HbA1c in time phased collection of all the other blood sugar and insulin intake. So that you could plot any trends in relation to the various inputs. (P1)

> If there was something that combined the 3, the blood glucose, the insulin amount and the carbs altogether that would be quite interesting.....So I don't do it because there isn't really an easy way of doing it. (P2)

> .....Because there was a relationship between amount of carbs I've eaten, amount of insulin and what the sugar level is, so I'd want to be able to see this three interlinked... (P3)

Other participants noted a useful feature for technology was the capacity to identify and visualize trends or patterns from their BG readings:

> Well I mentioned earlier if there's maybe a pattern in the morning, I think it's specific times of the day, if you can sort of pick out all your morning readings and see if there's a pattern always.......Yeah, I think maybe looking at, you know, comparing the readings for the same time of day, might be useful. (P7)

> I suppose kind of the pattern over the day, maybe even an average pattern over a week or something like that, just to kind of put it into perspective sort of how you're going and are you higher in the morning at 8 am kind of thing. Because I guess when you do the readings but don't take that overall approach you kind of lose track of .. ok I'm always high at this time why is that? (P8)

In addition, colours were identified as a useful highlighter for BG readings to easily distinguish between high, low or normal:

> ....so I think if you could set a monitor to what you should be, when you download the information, it turns your readings either a red, or an amber or a green, or instantly flag up in visual terms, where you know, a problem might be. (P7)

> I think colouring is important.....different colour for the line of your blood sugars, I'm not really bothered about which colours just to have some consistency again it helps you understand the trends that you are seeing. (P4)

> Yes that would highlight the low and highs. Just quickly looking at something and then you know...... Well you know greens and reds green is in the right zone, blue for too low and red for too high (P6)

whereas, graphs, in particular line graphs, were recommended as a straightforward way of visualizing glucose levels with a view to maintaining good control:

> err I think the simplest way is really a line graph of the glucose levels....kind of setting a low or upper limit of what your individual target so or what the medical advice target is and then you can see the data within hopefully within that band or you can see where it falls outside those bands. (P2)

> ....I would have thought probably a line graph, so you could have your carbs running on one line, maybe your physical activity running on another line and then insulin – all of them. I think that would be incredibly helpful actually, because you could really predict then if any of them is out of kilter.... (P5)

> I suppose a kind of a line graph would be in my head the kind of best thing because you get to see the ups and the downs.... (P5)

As adults with T1DM rely on their own decision-making skills to self-manage their condition, it is important to incorporate this capability into the design of new technology aimed at supporting T1DM.

4.1.2 | Easing accessibility

Accessibility of any new technology was portrayed through both current barriers to self-management and suggested characteristics for the technology. Barriers to current methods of self-management were described as being time consuming, inconvenient, not easy to use, too expensive or not available, whereas participants suggested the following characteristics should be employed within the technology, be easy to use, convenient and have the ability to personalize to each individual.

For most, time was a significant factor and the main emphasis of new technology was the facility to be quick and easy to use:

> It's a discipline we don't always have or have the time and luxury to sit down and have that discipline. (P2)

> I have actually got one app which is carb and calorie counting and I don't find it particularly useful, to me

it's just a bore, having to go on to it and then you have to select your meal, then you go through this, then you go through that, that is just time consuming. (P6)

Because I don't have time I just want something quick and easy to use. I just want something quick and easy to use….and then I can analyse it later. (P6)

…I think but for me, because I'm so busy all the time, if it's a quick simple thing I would go for it. (P8)

Additionally, many of the participants highlighted the need to be able to personalize:

.,..But the ease of input and then the control of erm how that data is actually displayed, so you can set your own parameters you can set your own individual insulin carbohydrate ratios etc. so you can personalise it to you. (P2)

….it would be useful if I don't have, I don't know, option to put it myself if I definitely know how much carbs are there… (P3)

Barriers to self-management were identified by some participants as the inconvenience of their current methods of self-monitoring:

Before I did write it down from the machine but again the book's getting lost, the not enough pages, you can't extend it, you can't put more, you can't put a note, you have to put it very small, it's all very messy and time consuming. (P3)

I think it is recording but to be honest I never stop and analyse it. I know it is recording something, it's not sophisticated enough I can just see it goes berserk….I don't know what it is… (P6)

….it's pretty basic, although apparently not as basic as the one they want to change it to….Well they're saying that mine's more expensive, the test strips are more expensive…. (P5)

Accessibility of technology addresses some of the barriers that adults with T1DM face in their daily life and is an important consideration when designing technology to overcome such obstacles.

4.1.3 | Sharing information

Most participants identified the need to share their data, including visualizations, with their HCP, and connectivity was identified as being an important factor to facilitate this:

….yes, because so many things are up loadable, photos from cameras, where you just take out a card and put in the side of the computer and there you go. ….yes, so you could see a history of your readings in one go on the screen. (P7)

I can download it, connect to wifi I can immediately download it as a pdf and send it to my doctor within half an hour then it's done. It's just easy to use. (P3)

…..if there was a data feed going from my Optium or whatever machine that was going to a website where I could access the data and they could see it as well when I was at the surgery that would be, yeah, good… (P5)

Whilst adults with T1DM manage their own condition on a day-to-day basis, they require an easy method of sharing their information with their HCP, which technology could be designed to facilitate.

5 | DISCUSSION

The findings revealed adults with T1DM have specific requirements from mobile technology that could aid self-management of their condition. This was communicated via three themes: aiding decision-making, easing accessibility and sharing of information.

Our study revealed the principal requirement of mobile technology was the ability to aid decision-making in self-managing T1DM. Four main visualization characteristics were identified to facilitate this: relationships between inputs, trends, graphs and colours. The main feature participants sought to visualize was the relationship between inputs, such as BG, exercise, insulin dose and food, with a view to identifying the trends or patterns between these features. This finding was echoed in several studies (Froisland & Arsand, 2015; Froisland et al., 2012; Rossi et al., 2009; Smith et al., 2006). Interestingly, in these studies, this capability appeared to offer participants the self-confidence to take control of their diabetes. Furthermore, Rossi et al. (2013) reported the visual evidence of the relationship between food and BG levels facilitated better control through reduced risk of grade 2 hypoglycaemic events.

In our study, feedback through the use of colours for identifying high, low or normal BG levels and line graphs highlighting the BG levels were highlighted as useful "cues to action" and increased understanding of trends. Similarly, although colours and graphs were not specifically mentioned, positive feedback, through visualizing and reflecting on pictures, was associated with improved knowledge and empowerment in a study by Froisland and Arsand (2015). Likewise, studies by Smith et al. (2006) and Froisland et al. (2012) reported that photographs of participants' health-related behaviours acted as "cues to action" and resulted in them making more healthier choices.

In contrast to our study, Cafazzo et al. (2012) found that adolescents used technology to collect data rather than to aid decision-making, highlighting the difference between age groups. However, these researchers designed their app with a view to enabling adolescents to take a greater role in decision-making, highlighting the importance of this feature in self-management of T1DM (Cafazzo et al., 2012).

Accessibility of any new technology was paramount, with ease of use and convenience identified as essential features to reduce the time spent managing the condition through inconvenient methods of self-monitoring. This is consistent with research by Kirwan, Vandelanotte, Fenning, and Duncan (2013) and Waite et al. (2013) who established that mobile applications should be user-friendly and fit in with individuals' lifestyles.

Similarly, in their study aiming to develop an understanding of self-monitoring of blood glucose in individuals with both type 1 and type 2 diabetes, Fisher, Kohut, Schachner, and Stenger (2011) reported a reduction in the recommended frequency for BG monitoring due to lack of time commitment, whilst participants in the study by Wong, Neistein, Spindler, and Adi (2015) conveyed that a lack of time had an impact on their decision to download and retrospectively review their BG data.

The ability to personalize the technology to their own individual needs was a key aspect for our participants, which is supported in a study by Arsand et al. (2008), where participants voiced their desire to configure the mobile applications under investigation, to their own requirements and Holtz et al. (2017) who expressed the "capability to customise" as a motivator to use a health-tracking app. By being able to personalize technology to their own requirements, individuals are potentially offered the opportunity to make it both convenient and easy to use.

Connectivity was highlighted as an important feature, not only in giving the ability to visualize data on a bigger screen (PC), but also as a means to share that data with HCPs. Arsand et al. (2008) corroborate the importance of being able to download data onto a PC, thereby offering the opportunity to perform more detailed examination of the data. Supporting the notion of data sharing through the use of mobile applications are studies by Rossi et al. (2009) and Waite et al. (2013) who reported this feature as being a motivator to use mobile applications. Individuals with T1DM require support from their HCP in maintaining independent control of their condition which may be facilitated by incorporating this type of feature in any new technology design (Minet, Lonvig, Henrikson, & Wagner, 2011; Rankin et al., 2012; Ridge, Treasure, Forbes, Thomas, & Ismail, 2012).

Our recommendations include incorporating the desired visualizations and features, which individuals with T1DM have identified as potentially useful and useable in this research, into new technology design. This could potentially enhance use of these affordances of technology by individuals to improve self-monitoring and control. Whilst it is clear that individuals with T1DM are open to the use of technologies to independently self-manage their condition, it is crucial to recognize and consider their perceived barriers in the design of any new technology.

Following our interviews, another researcher from the SWifT team went onto interview five of the same study participants with a view to gaining more in-depth information about visualizations to develop a mobile application to aid self-management as a component of a system that uses self-management for T1DM (Brown et al., 2017). Their findings triangulated with our results, thereby offering further assurance that the findings came from the data.

5.1 | Limitations

This research was undertaken by a novice researcher (RF) and, therefore, is at risk of potential bias in interpreting and developing themes from the data. To reduce this bias, all themes were clarified with an experienced researcher (MW). In addition, the results were triangulated with another researcher from the SWifT group (Brown et al., 2017), further enhancing the credibility of the findings (Patton, 1999).

Only adults were recruited to the study which potentially limits the generalizability of the findings across the whole population of individuals with T1DM.

5.2 | Implications for clinical practice

The results from this study have implications for nursing practice and other HCPs involved in the support of people with diabetes. Individuals with T1DM are required to maintain independent control of their condition and are open to the use of technology to facilitate this; however, they require support from their HCP to overcome the barriers to accomplishing this.

This study has highlighted the importance of listening to the patient's voice, particularly in the design of new technologies aimed to facilitate the self-management of T1DM. It has also demonstrated how interdisciplinary research by nurses in collaboration with computer scientists can further the field for the benefit of patients. If technologies are to be used effectively and efficiently, they need to be designed with input from the end-user (Arsand & Demiris, 2008). Furthermore, involving nurses and other HCPs in the design may result in technology that is compatible with the healthcare systems already in place, leading to quicker and easier integration into practice (Castensoe-Seidenfaden et al., 2017).

Given that individuals with T1DM are interested in current technologies to facilitate self-management, nurses in all settings need to develop and maintain knowledge of the potential use and limitations of these technologies to assist individuals with T1DM in making informed choices. This has the potential to improve self-management of T1DM, thereby reducing complications and improving the quality of life for these individuals. Ultimately, improving self-management for these individuals may reduce the burden to the health service of both caring for and treating the complications of T1DM.

6 | CONCLUSION

In conclusion, this study has explored the opinions and views of adults with T1DM in how mobile technology can facilitate self-management of their condition and has demonstrated how this information can inform the design of a mobile application. It has shown that mobile technology has the potential to support adults through facilitating their decision-making, saving time and enabling them to easily share their data with their HCP. Four main characteristics for visualizations have been identified along with suggested concepts for new mobile technologies to aid self-management.

Whilst the principal findings of this study corroborate current knowledge, this work provides a very important difference because it explores the thoughts and beliefs of people with T1DM in how mobile technology can aid their self-management and these aspects have been incorporated in the development of new technology to facilitate self-management of T1DM (Brown et al., 2017).

CONFLICT OF INTEREST

No conflict of interest has been declared by the author(s).

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APPENDIX 1

SEMI-STRUCTURED INTERVIEW SCHEDULE

1. Can you describe your personal experiences of monitoring your diabetes?

2. Do you collect information? If so what? (prompt if necessary) blood glucose, insulin dose, medication, exercise, diet
   - How do you collect this information and have you any examples? (ask for permission to see their method of collecting data and take still photo)
   - Could you tell me about any other ways you have collected data previously and how you found these.

3. Do you use a blood glucose meter, if so can you tell me about the type of blood glucose meter you currently use?
   - Are you able to upload this to a computer and if so, have you ever done this? How did you find this experience?
   - How is this done? e.g. USB lead, blue tooth

4. Could you tell me how you use the information you collect?
   - Why they collect this data
   - Do you ever show this data to a healthcare professional? If not would you like to?
   - Would you prefer to be able to collect other data and if so, what would you be interested in collecting?

5. What are your thoughts on how collecting your diabetes data could be made easier?
   - Ways of viewing your data
   - Easier to interpret and use
   - Methods of collecting data

6. Have you ever used any type of mobile device or application or computer to collect and manage your data?
   - If yes, could you describe in detail what you used, how you did this and how you found this experience
   - If no, reasons why not and would you ever consider this and is there anything that would motivate you to try this method?

7. What are your thoughts and ideas on how monitoring your diabetes could be made easier for you?