Diabetes Technologies; An Investigation into Diabetes-Related Distress, Satisfaction and Perceived Usability Improvements

Katie Kelly

N00150733

Supervisor: Dr Liam Challenor

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Thesis Declaration

This Thesis is entirely my own work and has not been previously submitted to this or any other third level institution.

Signed: Katie Kelly

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Glossary of Terms

T1D – Type 1 Diabetes

BGM – Blood Glucose Monitor

CGM – Continuous Glucose Monitor

T1-DDS – Type 1 Diabetes Distress Scale

GMSS – Glucose Monitor Satisfaction Scale

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1. Abstract

Type one diabetes is characterised by the body's inability to produce insulin. Individuals with type one diabetes use glucometers and insulin pumps to manage their blood sugar levels. With no prospect of a cure, it is important to continuously improve these technologies to ensure optimal diabetes health-management. Studies have found that individuals experience moderate levels of distress regardless of what technology is being used. Previous studies have also found multiple usability issues with medical devices that have had a negative impact on the healthcare provided, including diabetes technologies. The high levels of distress experienced and lack of consideration for usability demonstrates the need to account for the psychosocial outcomes in the development of diabetes technologies. The current study examines the differences in diabetes-related distress, glucometer satisfaction and perception of glucometer usability improvements. A concurrent mixed method, between groups design was employed to examine the differences in diabetes-related distress and glucometer satisfaction based on the type of glucometer being used, as well as investigating how glucometers could be improved to reduce distress from the perspective of individuals with type one diabetes. Results indicated a significant difference in diabetes-related distress based on the type of glucometer being used, but no significant difference was found in glucometer satisfaction. Additionally, the qualitative responses provided some insight into the usability improvements of glucometers to reduce diabetes-related distress. The findings provide further support for the need to incorporate usability studies in the improvement of medical devices.

2. Literature Review

2.1 Introduction

Type One Diabetes (T1D) is the body's inability to produce insulin caused by the immune system destroying the insulin producing cells (Atkinson, Eisenbarth & Michels, 2014). Approximately 8.8% of the adult population worldwide has diabetes, T1D accounting for 10-15% of that population as the prevalence of type 2 diabetes is much higher. The treatment for T1D involves taking insulin through the use of injections or an insulin pump and monitoring blood glucose (BG) levels by using a glucometer. The failure to maintain BG levels under control for long periods of time increases the risk of diabetes-related complications, such as eyes, kidneys and nerve damage (Nordwall et al., 2014). Diabetes-related complications were the seventh leading cause of death in 2016 (World Health Organisation, 2018). With no prospect of a cure, these statistics emphasise how important diabetes technology is in facilitating good glycaemic control. Without them, individuals with T1D would not be able to appropriately measure the needed insulin dosage to compensate for their daily activities. It is therefore critical that these technologies are continuously improved to reduce diabetes-related complications.

2.2 Medical Device Usability

In order to understand how usability and UX are incorporated in the design of medical devices, it is important to understand how both concepts differ. Tullis and Albert (2019) define the term *usability* is the ability to complete a task using a specific product. The term *user experience* refers to the interactivity between the user and the product, such as the thought processes and emotions that occur when completing said task. Usability seems to be a fixed concept amongst UX professionals, whereas UX is often defined by various usability attributes such as ease of use, efficiency and satisfaction (Rajanen et al., 2017).

There is a considerable lack of consideration for the usability of healthcare technology. Nielson (2005) found twenty-two separate usability issues which lead to healthcare practitioners administering patients the wrong medications, meaning

good usability can mean the difference between life and death. Considering that the majority of modern digital technologies go through vigorous user testing, the lack of concern for the usability of medical devices is disconcerting. When medical staff and patients cannot use health technologies optimally, the quality of medical help decreases. This begs the question, can the richness of UX be integrated in the complex nature of medical technologies? Despite the many existing studies on the usability and UX of medical devices, there is a lack of established guidelines explaining how both concepts should be applied to healthcare technologies due to the strict regulations surrounding the usability testing of medical devices (Bitkina, Kim & Park, 2020). The ongoing exclusion of usability and UX in medical device design is detrimental to the improvement of healthcare technologies.

2.3 Diabetes Technology

There have been unprecedented developments in innovative diabetes technologies. There are three different types of glucometers currently available to individuals with T1D. Traditional Blood Glucose Meters (BGM) provide a one off-reading of BG using a test strip and blood sample. A glucose sensor consists of a small sensor worn on the skin that is scanned by a wireless device and provides a BG reading and an arrow trend indicating BG fluctuations. A continuous glucose monitor (CGM) is a small disposable sensor placed under the skin, connected to a transmitter sending blood glucose readings wirelessly to a device and an insulin pump. The data is constantly presented on a screen with an arrow trend, as well as alarming users when their BG is too high or too low. Choosing the right glucometer is important, as some meters will have features that are better suited certain lifestyles factors, such as hobbies, work, age, type of insulin administration and personal preference. Indeed, the extensive advancements in glucometers have been positive.

2.4 Theoretical Framework for Technology Advancements

As medical technology becomes more advanced, how individuals integrate these technologies into their personal lives depend on various factors. The Technology Acceptance Model (TAM; Davis, 1986) theorises that if a user deems a type of technology useful and easy to use, they will use it. The attitudes and intentions that are formed by users learning to use new technologies prior to generating intentions directed at using the technology also play a role. However, individuals with T1D do not have the privilege of rejecting glucometers based on its usability as it is an essential part of diabetes management. In fact, it has been shown that attitudes towards diabetes technologies are negative, as Maresova and Cerna (2016) found that participants using diabetes mobile applications expressed low satisfaction with them. Additionally, participants expressed interest in using diabetes mobile applications if they were more user friendly, a component that is often overlooked in the design of medical devices as per Nielson (2005). However, this study only accounted for mobile phone applications and not for diabetes technology such as glucometers. Nevertheless, the poor attitudes towards diabetes mobile applications contributed to the abandonment of using the applications as well as negative diabetes-related outcomes. The lack of consideration for user needs in the field of healthcare technologies and negative user attitudes towards diabetes technologies indicates the increasing need to integrated human factor studies into the development of medical devices (Liberman & Barnard, 2016).

2.5 Diabetes Technology, Health Management and Psychosocial Outcomes

Recent studies suggest that CGM users experienced lower levels of diabetes-related distress compared to those using more traditional glucometers (Naranjo et al., 2016; Tanenbaum et al., 2017). This may be associated with reduced anxiety of asymptomatic hypoglycaemic episodes by alarming the user of hypoglycaemia. However, all participants exhibited moderate levels of distress, regardless of what technology participants were using. Interestingly, the authors assumed that the distress was associated with the complexities of managing T1D. This is a valid assumption supported by previous studies. A qualitative study by Balfe et al. (2013)

investigated the causes of diabetes-related distress in young adults with T1D. The most common factors identified by more than half of the participants in the study were day-to-day diabetes management difficulties and concerns about the future. Participants also expressed that the factors contributing to distress went beyond the visible components of diabetes such as injections, blood tests and diet. Other invisible factors such as the continuous need to calculate insulin doses, carbohydrate ratios and restricting specific foods also contributed to distress. Participants considered these to be significant factors preventing them from engaging in daily activities, as well as finding it difficult for them to balance their diabetes management and living a normal life. Participants who expressed finding it particularly difficult to manage their diabetes felt the most anxious about the future. The constant states of hypoglycaemic or hyperglycaemic negatively impacted on their mood, further contributing to the distress being experienced. The negative moods associated with poor diabetes management was also linked to participants fearing potential diabetes-related health complications. Additionally, higher levels of diabetes-related distress have been linked to poorer overall T1D management over long periods of time (Fisher et al., 2015; Hessler et al., 2017). It seems that the covarying relationship between diabetes-related distress and diabetes management is cyclical. Changes in distress levels correlate to higher overall BG levels, and vice versa.

The aforementioned studies provide an excellent overview of the factors of diabetes-related distress and their long-term effects. However, they are not without limitations. Balfe et al.'s (2013) study only accounted for the experiences of diabetes-related distress amongst adults in their twenties. A wider age range would have provided a more comprehensive insight into diabetes-related distress factors. The sample also included participants with type two diabetes and failed to account for any physiological differences between both conditions. This is problematic as both types of diabetes require different forms of treatment (Tan et al., 2019). The narrow age range of the sample and the researcher's assumption that both type one and type two diabetes present the same experiences significantly reduces the generalisability of the study. Although Balfe et al. (2013), Fischer et al. (2015) and

Hessler et al. (2017) provide some insight into the causes of diabetes related distress and their long-term effects on diabetes management, none of them considered how the use of technology could be contributing to an individual's distress, or how they could be improved in order to reduce distress. This makes Naranjo et al. (2016) and Tenenbaum et al. (2017)'s assumption problematic. Studying diabetes-related distress in relation to glucometers and underexplaining the results of their study as well as providing no insight in improving glucometers is counterintuitive. The significant psychological distress experienced should be accounted for when designing new diabetes technologies, as the technology itself plays an integral role in the reduction of poor health outcomes.

Individuals with T1D participate in daily decision-making processes in relation to managing their health. Sun and Costello (2017) outlined the use of patient-generated data as valuable information which allows patients to make meaningful health-management decisions. The study identified four patterns related to decision-making processes based on self-generated documentation of BG readings;

i) *Cause and effect;* inability to identify factors in fluctuating blood glucose and how much influence each factor has on specific health outcomes.
ii) *Establishing priorities*; difficulty staying accountable
iii) *Negotiating Outcomes*; inability to identify current health outcome patterns and difficulty predicting future health outcomes based on health history and actions taken
iv) *Setting visibilities*; use of medical jargon is not understood, interfaces are awkward to use making data interpretation difficult.

A major challenge is developing technologies supporting the complex and individualistic nature of these decision-making processes. One participant in Sun and Costello's study used an electronic spreadsheet to gather their own longitudinal analysis of diabetes-related health outcomes in order to locate specific patterns and problems. Other participants made use of external programs such as mobile phone applications. Some of the newer glucometers, such as CGMs have features that allow users to keep track of various BG trends. However, many of these applications require users to enter their health data into their devices manually, causing the

participants data entry to be incomplete and factors causing fluctuations in BG levels being undocumented. Additionally, the participants' usage of these applications declined or stopped after a few months as they found manually inputting their data too time-consuming. Similarly, a study by Rasche et al. (2018) examined the usability of the iBG-Star. Participants wanted automated documentation of their blood readings to make better diabetes health-related decisions, such as exercise and diet, and a better interface as some users expressed having visual difficulties. This demonstrates the need for diabetes technology to account for the highly individualised needs of users. Better intuitive interfaces would enable users to better identify cause and effect patterns between health-management decision and health outcomes. A qualitative study by Adu, Malabu, Malau-Aduli and Malau-Aduli (2019) found that although CGMs and insulin pumps enhance diabetes management, the participants experienced difficulties in meeting the financial costs of these devices. The lack of government funding reduces the accessibility of newer glucometers, posing a significant barrier to improving diabetes management throughout wider populations. Additionally, cost-efficiency analysis often discourages the introduction of innovative technologies as medical practitioners do not deem them to be advantageous enough (Bergsland et al., 2014). It may therefore be worth improving existing technologies, as this would potentially provide better access to technologies that are intuitive to individualised needs. The direct link between diabetes-related complications and distress should be a critical focal point in the development of diabetes technologies. As these statistics continuously increase, developing technologies accounting for psychosocial factors to reduce diabetes-related complications is imperative.

2.6 Diabetes Technology Usability

A study by Olsson and Forsberg (2018) investigated how individuals with T1D interacted with their CGMs and measured how satisfied they were with their current systems. The researchers used this information and developed a CGM prototype addressing the usability needs of the users. Participants favoured the prototype over the original CGM system, suggesting that the design choices of the prototype

contributed to a better user experience. However, the researchers did not effectively utilize the feedback received from the participants in redesigning the glucometer interface. The researchers predominantly used psychology design principles as a basis for the prototype design, without implementing features aimed at improving diabetes management. Participants also expressed wanting a system of systems rather than multiple systems functioning separately from each. Additionally, the interface was designed using a smartphone template, excluding users who do not use smartphones or diabetes smartphone applications.

When accounting for the distress associated with daily health-management decisions and the severe complications linked to poor diabetes management, it is evident that diabetes technology is an indispensable tool in health management. Newer research into the usability of medical devices is still in its infancy and due to the barriers involving medical device innovation, technologies with better user experience may not be developed for a long time. Many of the participants in the current research expressed dissatisfaction with their current glucometer, as well as high levels of diabetes-related distress. Glucometers, much like any other technological device, should be designed with the user's needs in mind. Enabling individuals with T1D to utilize their own generated data by creating better technologies may reduce distress and facilitate better health-management related decisions. The current research will examine if the type of glucometer has an effect on the user's experience with diabetes-related distress and their satisfaction with their glucometer. Additionally, the study will also investigate how various types of glucometers can be redesigned to reduce diabetes-related distress and facilitate health-related decisions from the perspective of individuals with T1D.

2.7 Research Questions & Hypotheses

RQ1: Does the type of glucometers used impact the levels of distress experienced by individuals with type one diabetes?

RQ2: Does the type of glucometer used have an impact on glucometer satisfaction?

RQ3: How can existing glucometers be designed in order to reduce distress?

H1: There will be a difference in the levels of distress experienced by individuals with type 1 diabetes based on the type of glucometer used.

H2: There will be a difference in the users' satisfaction with their current glucometer based on the type of glucometer being used.

H3: There will be a difference in the user's perception of the possible usability improvements of their glucometer based on the type of glucometer being used.

3. Methodology

3.1 Design

The study employed a concurrent mixed method, between groups design. The independent variable was the type of glucometer used (k=3). These options are based on the different existing types of glucometers available to individuals with T1D. These included blood glucose monitors (BGM), Sensors, and continuous glucose monitor (CGM). The dependent variables for the quantitative aspect of the study were the powerlessness, management distress, hypoglycaemia distress and physician distress aspect measured by the Type 1 Diabetes Distress Scale (T1-DDS), and glucometer satisfaction measured by the Glucose Monitoring Satisfaction Scale (GMSS). The dependent variable for the qualitative aspect of the study wass the participants' perceived usability of their current glucometer. This was done to allow participants to be intuitive with their responses. The qualitative questions were related to the preceding structured questionnaires, linking the structured and unstructured responses together (Driscoll et al., 2007).

3.2 Participants

Participants for the study were recruited using convenience sampling and snowball sampling through various social media platforms such as Facebook, Reddit and Twitter, and forums specifically for individuals with T1D, such as Diabetes.co.uk and Diabetes UK. Eligibility criteria required that participants have an official T1D diagnosis and be eighteen years old and older. 158 participants were recruited (33 males, 123 females, 1 non-binary) with a mean age of 38.76 (SD = 12.94) and a mean of 19.87 years since their official T1D diagnosis. 32 participants used a BGM, 42 used a Sensor, and 84 used a CGM. For the type of insulin administration used, 64 participants used Multiple Daily Injections (MDI) and 54 participants used an insulin pump. The treatment of participants was in accordance with the ethical standards of the Psychological Society of Ireland and was approved by the Department of Technology and Psychology Ethics Committee (DTPEC).

3.3 Materials

When participants opened the online survey, participants were presented with an information sheet (Appendix A) that informed them of their role in the study, participation was voluntary, withdrawal from the study was possible at any time and that their information would be kept anonymous and destroyed on a specific date. An online consent form (Appendix B) ensured that participants gave their informed consent to participate in the study. The demographic questionnaire (Appendix C) examined the participants' gender, age, how many years since their T1D diagnosis, the type of insulin administration used and which type of glucometer they used.

The Type 1 Diabetes Distress Scale (T1-DDS; Fisher et al., 2015; Appendix D) is a self-assessed 28-item scale measuring the participants' experience with diabetes-related distress. The scale was shortened and only assessed the powerlessness, management distress, hypoglycaemia distress and physician distress dimensions of the scale, as they were most relevant to the study based on the literature. The scale employs a six-point Likert system, rating each statement from 1 (not a problem) to 6 (a very serious problem) in relation to how much each statement relates to their own diabetes-related distress. The reliability test determined that the T1-DDS' internal reliability was good (Cronbach's Alpha = .97; Appendix F).

e.g. Statement 1: Feeling that I am not as skilled at managing diabetes as I should be.

The Glucose Monitoring System Satisfaction Survey (GMSS**;** Polonsky et al., 2015; Appendix E) employs a Likert system, which consists of 15 statements assessing the participants' satisfaction with their glucometer. The participants rated each statement from 1 (strongly disagree) to 5 (strongly agree) based on how much they agreed with the statement. The GMSS includes 4 subscales examining openness, emotional burden, behavioural burden and trust in relation to their glucometer. This scale was chosen because it specifically identifies aspects of diabetes technology needing improvement. A reliability tests determined that the GMSS' internal reliability was acceptable (Cronbach's Alpha = .74; Appendix F).

e.g. Statement 1: My current monitor helps me feel more satisfied with how things are going with my diabetes.

The qualitative aspect involved participants answering the following open-ended questions (Appendix G) in relation to diabetes technology;

i) *How could the current glucometer be improved to reduce diabetes-related distress?*
ii) *What features could be added or removed from your current glucometer to improve your diabetes management?*
iii) *Do you have any other comments regarding glucometer devices?*

These questions are based on previous studies which suggest that moderate levels of diabetes-related distress are linked to poor health management, regardless of what technology is used (Naranjo et al., 2016; Tanenbaum et al., 2017).

3.4 Pilot Study

A pilot study was conducted to assess the time it took to complete the survey and if it functioned optimally. The survey questions were also assessed for any spelling or grammatical errors and if the questionnaire was understandable. Minor adjustments were made before opening the survey.

3.5 Procedure

Snowball and convenient sampling methods were employed by advertising the survey to potential participants on various social media platforms, such as Reddit, Twitter, Facebook and on online forums specifically for individuals with T1D, such as Diabetes.co.uk and Diabetes UK. Participants were asked to follow a link that led them to the survey. The survey was open for 12 weeks**.** Upon opening the survey, participants were presented with an information sheet prior to gaining access to the survey. The researcher and supervisor's contact information were provided should the participants have any queries or concerns about the study or their data. A consent form was then given to the participants, indicating that their informed consent was given to partake in the study. The participants were then given access to the demographic questionnaire, the T1-DDS and GMSS and open-ended questions. Once the participants finished the survey, they were debriefed (Appendix H) and thanked for their time and contribution to the study. The online survey was

on closed on the 22/2/2021**.** Finally, statistical analyses of the quantitative data were conducted using IBM SPSS 25.0 and a content analysis of the qualitative data was conducted using NVivo.

3.6 Ethics

Due to the discussion of distress within a vulnerable population (i.e., individuals with T1D), certain measures were put in place to ensure that the study was feasible and that participants would not be psychologically or physically harmed. Ethical approval was sought from the Department of Technology and Psychology Ethics Committee (DTPEC) prior to participant recruitment by submitting an ethics form B (Appendix I) along with supporting documents. Ethical approval was granted on the 17th of June, 2020 (Appendix J).

Further ethical considerations were accounted for during data collection. Participants were presented with an information sheet explaining their role in the study and that ethical approval was obtained from the DTPEC. Participants were informed that their participation was voluntary and withdrawal was possible at any time. Participants' data would remain anonymous, stored securely by password protection and destroyed on a specific date. Only the researcher and their supervisor would have access to the raw data. The researcher's contact information was provided should the participants have any concerns or queries about the research or want their data removed. The completion of the consent form was compulsory in order to ensure that participants gave their informed consent prior to being given access to the questionnaire.

The T1-DDS scale was adapted by only including subscales that are relevant to the literature and the study's research questions. This shortened the length of time it takes to complete the survey to reduce the possibility of participants experiencing survey fatigue.

Finally, participants were debriefed and thanked for their time. Support services and their contact details were provided in case the participant had a negative experience while completing the study.

4. Results

Participants identified the type of glucometer and type of insulin administration they used on a general demographic questionnaire. The Type 1 Diabetes Distress Scale measured the participants' level of distress in relation to their diabetes management. The Glucose Monitor Satisfaction scale measured the participants' satisfaction with their current glucometer.

Kruskall-Wallis H tests were conducted to determine any differences in the participants' diabetes-related distress and glucose meter satisfaction based on the type of glucometer being used. Further Mann-Whitney U tests were conducted to determine where the differences lie between in each group. See Appendix K for SPSS outputs.

A content analysis was then conducted on the responses to the open-ended questions (Appendix L) to identify themes in relation to the design of glucometers**.**

4.1 Descriptive Statistics

SPSS was used to conduct descriptive statistics. The means and standard deviation for diabetes related distress and glucose meter satisfaction are presented in Table 1.

Table 1

Means and standard deviations diabetes-related distress and glucose meter satisfaction.

Dependent Variables	*N*	*M*	*SD*
Diabetes-related distress			
Overall Scores	157	2.71	.95
Glucometer Satisfaction			
Trust	154	8.82	1.62
Openness	155	12.23	2.03
Emotional Distress	157	12.82	3.40
Behaviour Distress	154	11.76	2.24
Overall Scores	154	41.92	7.52

The participants' type of glucometer and insulin administration are presented in Table 2. The most commonly used glucometer was a CGM and MDI was the most commonly used insulin administration. See Figure 1 and 2.

Table 2

Glucometer type and insulin administration type frequencies

Independent Variable	Frequency	Percent	Cumulative Percent
Glucometer Type			
BGM	31	19.7%	19.7%
Sensor	42	26.8%	46.5%
CGM	84	53.5%	100%
Total	157	100%	
Insulin Administration Type			
MDI	63	40.1%	25.5%
Pump	54	34.4%	100%
Total	157	100%	

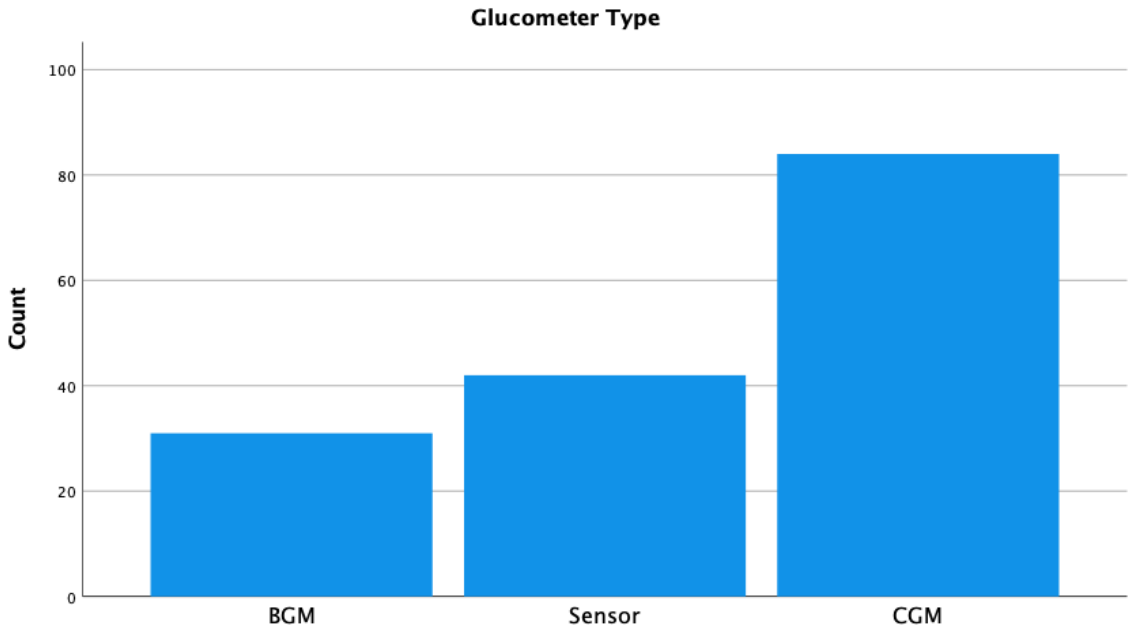

Figure 1.

Glucometer type count for participants

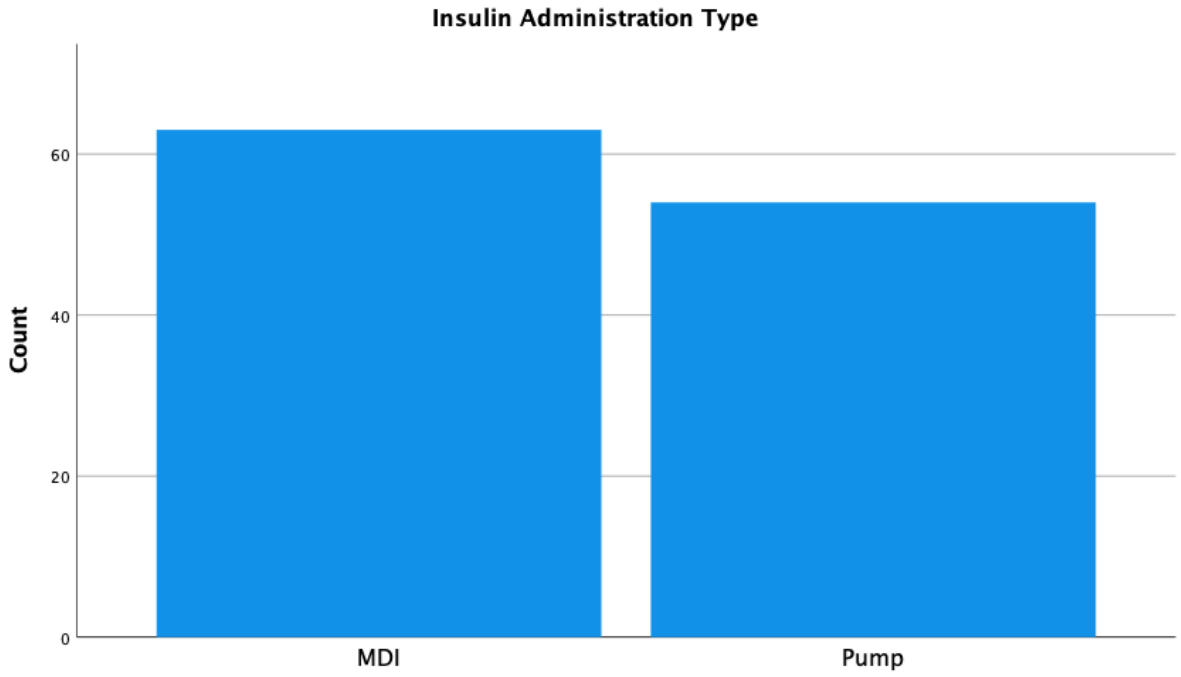

Figure 2.

Insulin administration type for participants

4.2 Inferential statistics.

4.2.1 Analysis 1: The effect of glucometer type and insulin administration on diabetes-related distress.

Hypothesis 1 predicted that there would be a significant difference in the levels of distress experienced by individuals with type 1 diabetes based on the type of glucometer used. A Kruskal-Wallis H test showed that there was a statistically significant difference in diabetes-related distress based on the type of glucometer being used (Gp 1, N = 31: BGM, Gp 2, N= 42: Sensor, Gp 3, N = 84: CGM) $\chi 2(2) = 15.160$, $p = 0.001$, with a mean distress score of 106.61 for BGM users, 77.64 for Sensor users and 69.49 for CGM users. Hypothesis 1 was therefore supported.

Further post hoc analyses were conducted to determine where the differences lie between each group. Mann-Whitney U tests were conducted to determine if there were differences in distress score between BGM users, Sensor users and CGM users.

There was a significant difference in distress scores between BGM users and Sensor users (U = 410, z = -2.691, p = .007). A Mann-Whitney U test determined that distress scores for BGM users (mean rank = 27.47) and Sensor Users (mean rank = 18.19) were significantly different (U = 113, z = -2.361, p = .019) amongst those using MDI, but not amongst participants using insulin pumps (U = 21.5, z = -1.067, p = .286.)

There was a significant difference in distress between BGM users and CGM users (U = 687, z = -3.878, p = .000). A Mann-Whitney U test determined that distress scores for BGM users (mean rank = 22.63) and CGM Users (mean rank = 15.55) were significantly different amongst those using MDI (U = 95.5, z = -1.993, p = .046), but not amongst participants using insulin pumps (U = 21.5, z = -1.067, p = .286.)

Finally, there was no significant difference in distress scores between Sensor users and CGM users (U = 1580, z = -.953, p = .341) regardless of what type of insulin administration the participants were using.

4.2.2 Analysis 2: The effect of glucometer type and insulin administration on glucometer satisfaction

Hypothesis 2 stated that there would a difference in the users' satisfaction with their current glucometer based on the type of glucometer being used. A Kruskal-Wallis H test showed that there was no statistically significant difference in glucometer satisfaction based on the type of glucometer being used (Gp 1, N = 31: BGM, Gp 2, N= 42: Sensor, Gp 3, N = 81: CGM), $\chi2(2) = 0.444$, p = 0.801, with a mean satisfaction score of 81.71 for BGMs, 74.69 for Sensors and 77.35 for CGMs. Hypothesis 2 was therefore rejected.

4.3 Analysis 3: Qualitative analysis of the participants perception of how the design of their glucometer could be improved.

Hypothesis 3 stated that there would be a difference in the participants' perception of usability improvements based on the type of glucometer being used, examined by the three open-ended questions at the end of the survey. A content analysis was conducted to identify the most common usability issues based on the participants' type of glucometer being used. The participants' overall qualitative responses in relation to their glucometer are presented as a wordle in Figure 3. Themes from participants' responses in relation to the improvements of their glucometer are presented in Table 3. Overall, the participants' responses were consistent with glucometer usability issues identified in the literature. However, some themes were more prominent depending on the group. Hypothesis 3 was therefore supported. All participant responses to the open-ended questions can be seen in Appendix K.

Figure 3

Wordle: open-ended responses

Table 3
Content Analysis Themes – Sample quotes and theme counts

BGM Users		
Themes and Sub-Themes	Theme Count	Sample Responses
Design		
Device Feedback	3	*"Some positive reinforcement would be nice. Eg a message that says "good work you're in range""*
Aesthetic	1	*"not as clunky and ugly"*
Pattern Identification	7	*"Option to add the type of carb/ more tailored to my reactions to food. i.e. pasta, fast food causes me to drop very quickly if I take the full recommended dose"*
Size	1	*"Smaller, less bulky"*
Functionality		
Accuracy	1	*"Sometimes error messages appear that aren't accurate!"*
Automation	1	*"A meter that connects to the phone and connects to pump that can automatically decrease or increase levels."*
Usability		
Device Compatibility	5	*"Connection to smart watch to display latest reading and time taken"*
Ease of Use	4	*"This particular meter makes it a little more annoying to navigate logs of past readings without using the accompanying app, which can be annoying when I don't have the time or cellular data to connect at that moment."*
Customizability	2	*"More options for muting items, or a way to turn off certain tracking questions*."

Sensor Users		
Themes and Sub-Themes	Theme Count	Sample Responses
Design		
Alarm Setting	17	*"Reduce the alarms and non stop warnings, loss of sensor signal, calibrate reminders. Its all non stop. I've had to turn off so many features because it was a full time job keeping the pump and sensor happy."*
Device Feedback	4	*"A feature which allows you to see what insulin is on board and how long that insulin will be working for"*
Interface Design	2	*"The colour system - green = in range, orange = high , red = low can be triggering and disheartening"*
Pattern Identification	5	*"Add a feature so that the type of exercise being undertaken can be entered (ie. whether it is aerobic, strength, walking etc.) as this affects how my blood glucose results change during exercise."*
Size	6	*"Smaller in size so it is less obvious and harder to get caught on clothes etc"*
Functionality		
Accuracy	12	*"I have the Freestyle Libre and I wish it were more accurate. I realize there is a time delay, but this is independent of that "feature". If readings are very off, I should be checking with a finger stick, but most of the time I don't unless the readings are in the "you should be dead" category."*

Automation	3	*"By using a system that does everything in 1. E.g continually checks blood and adjusts insulin dose accordingly."*
Calibration	2	*"Less of a delay. Sensor currently has a 15 minute delay."*
Usability		
Customizability	2	*"There is no bolus advisor integrated, currently I go between 3 apps (carbs & cals, MySugrApp, and the Libre, so all the data is scattered. This is really frustrating for trying to track events and takes up a lot of time.. and I feel like I'm expected to just do it all the time and not complain."*
Device Compatibility	9	*"The sooner they work in tandem with insulin pumps the better"*
Ease of Use	5	*"It could be easier to scan"*
Service Length	1	*"extend sensor use to 30 days from present 14."*

CGM Users		
Themes and Sub-Themes	Theme Count	Sample Responses
Design		
Alarm Settings	17	*"Honestly, I would be incredibly happy with an update to the alarm sounds. The current alerts are very jarring, which is great for alerting me to a serious hypo in progress. But will illicit feelings of anger and the thought of throwing my pump/CGM receiver (integrated) has come to mind on occasion."*

Device Feedback	8	*"Reminder to check bg 15 minutes after correcting a hypo or hyper"*
Interface Design	8	*"I'm using an accu check Aviva and I find it would get a great help if it lit up with my numbers."*
Pattern Identification	12	*"I would add the "change between readings" (the +5 or -15) that is available in the sugarmate widget to the dexcom widget. I use that reading often to gauge how my bg is changing and make decisions based on it. I find the trend arrows to not be useful or inaccurate."*
Size	7	*"A smaller device that's more comfortable to wear and less noticeable"*
<u>Functionality</u>		
Accuracy	20	*"If talking about my CGM then accuracy is the first improvement that comes to mind. CGM is often 3-4 mmols off what the Glucometer reads."*
Calibration	8	*"I use Medtronic cgm and it requires multiple calibration finger sticks every day which defeats the purpose of using it."*
<u>Usability</u>		
Device Compatibility	22	*"It would be nice to have more cell phone compatible stuff"*
Ease of Use	4	*"Make it easier to input info such as carbs, exercise, insulin dose. A little bit cumbersome."*

Service Length	14	*"Lasting longer periods of time (a sensor that could be replaced once a month would be great)."*

5. Discussion

5.1 Overview of findings

The acceptance for hypothesis 1 is supported by the literature. When only accounting for the type of glucometer being used, overall distress scores were highest amongst BGM and lowest amongst CGM users, with the average overall distress scores ranging from 69.49 and 106.61. These findings are consistent with Naranjo et al. (2016) and Tanenbaum et al.'s (2017) findings that individuals with type one diabetes will experience moderate to high levels of distress regardless of what type of glucometer they used. Furthermore, significant differences in distress levels were found when accounting for the participants' insulin administration types as well as the type of glucometer they are currently using. There was a significant difference in distress scores between BGM and Sensor users that used MDI as insulin administration, but no difference was found between BGM and sensor users that used an insulin pump. Similarly, distress scores significantly differed between BGM and CGM users that used MDI, but not amongst participants using an insulin pump. No significant difference in distress scores was found between Sensor and CGM users, regardless of what insulin administration participants used. These secondary findings also validate Naranjo et al. (2016) and Tanenbaum's (2017) studies, while also providing an insight into the role other technologies play in contributing or reducing diabetes-related distress, such as an insulin pump and insulin pens.

Interestingly, no support was found for hypothesis 2, which stated that there would be a significant difference in the participants' glucometer satisfaction based on the type of glucometer being used. These findings are contradictory to both hypothesis 1 and the qualitative data analysis. Due to the significant differences in distress between each group, it would have therefore been expected that participants using BGMs to score significantly lower in glucometer satisfaction compared to participants using Sensors or CGMs. This is in contrast with previous findings that satisfaction with diabetes technology is usually low, highlighted in Maresova and Cerna's (2016) study. This discrepancy could be due to the study being the first of its kind to compare satisfaction in between different types of glucometer,

rather than examining satisfaction in relation to diabetes mobile apps or only one type of glucometer.

The qualitative analysis identified themes that were consistent with studies in the literature review, as well as providing additional information in relation to the usability improvements of glucometers. One of the most prominent concerns participants had about their glucometer was the Accuracy of the device. One participant using a CGM stated *"CGM is often 3-4 mmols off what the glucometer reads".* Another participant using a Sensor stated, *"If readings are very off, I should be checking with a finger stick, but most of the time I don't unless the readings are in the "you should be dead" category."* Considering insulin dosage requires accurate readings from the user's glucometer, the high instance of this theme is concerning. These findings further highlight Nielson's (2005) argument that good medical usability can be the difference between life or death, as inaccuracies in healthcare technologies can lead to administering the wrong dosage of medication. One participant in the study had to revert back to using a BGM from using a CGM, stating *"…im weary from the constant errors and wrong readings. I miss it as it gives me confidence (when it works) so I know what I am at all times".* Furthermore, these inaccuracies have led to participants having to calibrate their device with a BGM frequently, defeating the purpose of making diabetes management more convenient and less distressing.

"I used Medtronic CGM and it requires multiple calibration finger sticks everyday which defeats the purpose of using it".

Some participants expressed frustration with the alarm settings on their devices and the lack of customisability to suit their needs, providing further validation for the argument that the exclusion in medical device usability elicits negative attitudes towards their devices amongst the participants (Maresova & Cerna, 2016).

"The current alerts are very jarring, which is great for alerting me to a serious hypo in progress. But will illicit feelings of anger…"

Additionally, participants also expressed better customisability in relation to pattern identification, which is an integral part of keeping blood glucose readings in range and avoiding diabetes complications. On participant stated wanting "*a feature*

so that the type of exercise being undertaken can be entered" and an *"option to add the type of carb/more tailored to my reactions to food…".*

The above findings support Sun and Costello's (2017) work on the daily decision-making processes individuals with type 1 diabetes make to manage their health. Adding features that help individuals identify patterns specific to their health would be a beneficial addition to glucometer as it addresses the highly individualistic nature of type 1 diabetes.

Finally, support was found for usability improvements in relation to the physical and interface design of glucometers. Participants expressed wanting better overall interfaces across all three groups, as well as wanting a better physical design for the meters. One participant stated "*The colour system – green = in range, orange = high, red = low can be triggering and disheartening"*. Another stated they wanted their glucometer be *"not as ugly and clunky".* These findings support Olsson and Forsberg's (2018) study, that found that better design contribute to a better user experience.

5.2 Theoretical and practical implications

The current study found that the type of glucometer significantly impacts the level of distress experienced by individuals with type 1 diabetes. When recalling Davis' Technology Acceptance Model (1985), the perceived usefulness and perceived ease-of-use are two significant factors that influence an individual's decision to use a new piece of technology. Although participants in this study may perceive their glucometer as useful as tools to enhance their health, the qualitative data found that many of the participants expressed wanting devices with better usability. The themes identified in relation to the usability improvements in combination with the moderate to high distress scores suggest that negative experiences or attitudes towards technology are not enough to deter an individual from using a specific type of technology, especially if that device is used to take care of an individual's health. These findings therefore partially refute Davis's Technology Acceptance Model.

With regards to practical implications, the findings of this study could be useful to healthcare practitioners that work with patients with diabetes. It could help

them determine which combination of glucometer and insulin administration type will best suit certain lifestyles while also taking into account the potential distress that could be experienced based on the themes identified in the qualitative aspect of this research. Additionally, the findings in this study could also be useful for those working in the field of healthcare technology development as it provides further insights into how the usability and functionality of glucometers could be improved.

5.3 Strengths

Previous research has not included different types of glucometers when examining their usability, allowing this research to provide unique insights into the field of research. Although studies such as Olssen and Forsberg's (2018) provide an excellent insight into the usability of CGMs, participants in the current study expressed finding the cost of CGMs to be a major barrier to accessing these devices. BGM users have often been excluded from usability studies, possibly due to more individuals adopting more modern forms of diabetes technologies, such as CGMs and Sensors. Should this study have only accounted for participants using modern types of glucometer, 20% of the participants recruited for this study would have been excluded from participating. The inclusion of all three types of glucometers gives a broader insight as to how various types of glucometers can be improved without limiting the research to one type of technology, while also accounting for individuals who do not have access to or do not want to use more advanced forms or diabetes technology.

"…the newer ones can be very complicated with lots of features, I'm sure they are useful for many people, but I prefer the simpler one…"

Additionally, previous research rarely takes the type of insulin administration used into consideration when examining the usability of diabetes technology. As seen in the qualitative aspect of the current study, many participants expressed that they favoured different combinations of technology for managing their health and wanting better device compatibility options for their glucometer, including their insulin pumps. It seems as though a closed loop system, which involves the glucometer and the insulin pump communicating with one another works best for

better diabetes-management. This provides further insight into the individualistic nature of diabetes management and that certain combinations of diabetes technology work best to account for individual's certain lifestyle factors or preferences.

This research also presented strong research methodologies. The type 1 diabetes-related distress scale having a Cronbach's alpha of .97 and the glucose monitor satisfaction scale having a Cronbach's alpha of .74 shows high internal reliability and validity, which also increases the replicability of the study. Additionally, the use of both quantitative and qualitative research methods was beneficial in providing a deeper insight into the participants' experience in using glucometers.

5.4 Limitations

While the study presented a number of strengths, it is not without limitations. Firstly, there are some evident issues with the sampling of the study. The study primarily focused on individuals who have type 1 diabetes, and excluded those with type 2 diabetes, who make up a larger portion of the diabetic population. Although individuals with type 2 diabetes also use glucometers and other diabetes technologies to manage their diabetes, the time constraints and nature of this research study, it would not have been feasible to gather, analyse and report this quantity of data. Furthermore, given that there is an estimated 422 million people worldwide who have diabetes (World Health Organization, 2021), the small sample size of the study (N = 158) does not provide an accurate enough representation of the entire diabetic population. Results of this study should therefore be interpreted with caution. Additionally, the number of participants in each group was uneven, with the lowest number of participants in one group being 32 and the highest being 82. The unequal number of participants in each group created unequal variances within the sample, meaning that non-parametric tests had to be employed to analyse the data, reducing statistical power and increasing the likelihood of Type 1 errors (Rusticus & Lovato, 2014).

Secondly, many participants did not answer the open-ended questions. The high omission rate was possibly due to survey fatigue, resulting from the participants having to complete the open-ended questions after completing the quantitative scales. Future research should account for this factor to avoid loss of data.

Finally, due to the ongoing Covid-19 situation, the researcher was unable to employ another researcher to conduct an inter-rater reliability analysis on the qualitative data, reducing the reliability of the qualitative results.

5.5 Suggestions for future research

There is an abundance of opportunities to further progress the research in the field of healthcare technology and medical UX. Future research could take this study's data into consideration and design prototypes that address the common issues that contribute to diabetes-related distress. Further qualitative measures, such as usability tests or user interviews could be employed to determine how glucometer design and functionality could be further refined and improved.

Conducting a similar study that investigates the distress experienced in relation to the different types of insulin pump technologies could also provide an insight as to how they contribute to distress and how they could also be designed to account for diabetes-related distress.

Although useful in the context of healthcare and medical treatment, the GMSS measures the participants' satisfaction with their glucometer and how it impacts on their quality of life. Future studies should consider using other measures such as the System Usability Scale (SUS) by Brooke (1996), which might provide a better insight into glucometer satisfaction with regards to technology usability.

5.6 Conclusion

The current study was ambitious in its goals. Medical UX is a complicated and highly regulated field, and face challenges not observed in other technological fields. This means that less value is placed on the UX/UI systems of healthcare technologies. The high instances of distress amongst the participants in the study demonstrates that diabetes-related distress in relation to technology use hasn't

been adequately addressed. Other modern technologies such as smartphones go through rigorous usability checks prior to being released on the market. This begs the question, why aren't medical devices given the same attention? Although much of the health management for diabetes is down to the individual, the study demonstrates that there is an abundance of opportunity to make medical technologies better to improve diabetes healthcare.

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7. Appendices

Appendix A – Information sheet

Information Sheet

Study Title: Investigating distress, glucometer satisfaction and perceived glucometer usability improvements from the perspective of individuals with Type 1 Diabetes.

Purpose of the Research

Studies have shown that diabetes-related distress is linked with poorly managed glycaemic control, regardless of what type of glucometer is being used. Researchers associated the diabetes-related distress with the health-management decisions that individuals with type one diabetes on a daily basis. This demonstrates the lack of user consideration when designing these devices. The purpose of this research is to examine if the type of glucometer (BGM, Sensor and CGM) has an effect on diabetes-related distress and glucometer satisfaction. The study will additionally examine how current glucometers can be potentially improved to reduce user distress from the perspectives of individuals with T1D.

Invitation

You are being invited to consider taking part in this research study. This project is being undertaken by Katie Kelly, as part of an MSc. in Cyberpsychology, in the department of Technology and Psychology in IADT. The project is supervised by Liam Challenor, who may be contacted at Liam.Challenor@iadt.ie.

Before you decide whether or not you wish to take part, it is important for you to understand why this research is being done and what it will involve. Please take time to read this information carefully and discuss it with friends and relatives if you wish. If you wish to ask any questions, or if anything is unclear to you and would like more information, please contact the researcher at N00150733@student.iadt.ie. This study has been approved by the IADT Institute Research Ethics Committee.

Do I have to take part?

You are free to decide whether you wish to take part or not. If you do decide to take part you will be asked to indicate your consent through completion of a short form. You are free to withdraw from this study at any time and without giving reasons.

If I take part, what do I have to do?

You will be asked to

- Read a consent form and tick boxes which indicate your agreement to take part
- Complete a demographic questionnaire about yourself (e.g. age, gender, time since T1D diagnosis, current type of glucometer being used).

- Complete the Type 1 Diabetes Distress Scale, assessing your experience with type 1 diabetes related distress.
- Complete the Glucose Monitor Satisfaction Scale, assessing your satisfaction with your current glucometer.
- Answer two open-ended questions at the end of the survey.
- Submit your answers and read the debrief from.
- The study takes approximately 20 minutes to complete.

What are the benefits and risks (if any) of taking part?

There are no direct benefits to you. However, your involvement in the study may provide useful knowledge regarding in the user needs of glucometer design and their potential improvements.

You may experience feelings of distress after completing the survey. If this is the case, please make use of the helplines provided at the end of the survey.

How will information about me be used and who will have access to it?

All data will be anonymous, confidential, and for research purposes only. The data collected will be collected as part of the researcher's thesis as part of the MSc in Cyberpsychology at the Dun Laoghaire Institute of Art, Design and Technology. The project, including findings of the research, will be viewed by the supervisor and examiners, but individual data will not be identifiable in any way in the published accounts. The information collected will remain entirely anonymous and will not be used in future research studies.

The data will be stored securely in a password protected computer, and kept for at least one year and no more than seven years, after which it will be destroyed. The data will only be accessible by the researcher and their supervisor. No information collected will be traced back to any participant of the study. Should you wish that your data be removed from the study, please contact the researcher before 22/2/2021

If you wish to obtain a copy of the research paper, you can contact Katie Kelly at N00150733@iadt.ie.

What if there is a problem?

If you have a concern about any aspect of this study, you may wish to speak to the researcher(s) who will do their best to answer your questions. You should contact Katie Kelly at N00150733@iadt.ie, or their supervisor Liam Challenor at Liam.Challenor@iadt.ie.

Thank you for taking the time to read this information sheet.

Appendix B – Consent Form

Consent Form

Title of Project: Investigating distress, glucometer satisfaction and perceived glucometer usability improvements from the perspective of individuals with Type 1 Diabetes.

Name of Researcher: Katie Kelly

Name of Supervisor: Liam Challenor

Please tick box

- I confirm that I have read and understand the information sheet for the above study and have had the opportunity to ask questions.
- I understand that my participation is voluntary and that I am free to withdraw at any time.
- I am over the age of 18 years
- I agree to take part in this study.
- I understand that data collected about me during this study will be anonymized before it is submitted for publication.

Reference Number:

Please create a reference number using the initials of a parent's name and the last 3 digits of your mobile phone. This enables the researcher to identify your data should you wish to withdraw your responses.

Example: JS123 (Parent's name: John Smith, Last 3 digits of phone number: 123). Please keep a note of this.

_____

Unique code of participant

Appendix C – Demographic Questionnaire

Demographic Questionnaire

1) What is your gender?
    - Male
    - Female
    - Prefer not to say
    - Non-binary
2) How old are you? _____
3) How long have you had type one diabetes for? Please indicate in years.
   _____
4) Which of the following types of glucometers do you use? If you use more than one glucometer, please select the monitor that is most used.
    - Blood glucose machine (i.e. traditional blood sample on test strip)
    - Blood glucose sensor (i.e. freestyle libre etc.)
    - Continuous glucose monitor (i.e. Dexcom etc.)
5) What type of insulin administration do you use?
    - MDI (Multiple daily injections)
    - Insulin pump

Appendix D – The Type 1 Diabetes Distress scale

The Type 1 Diabetes Distress Scale

Living with type 1 diabetes can be tough. Listed below are a variety of distressing things that many people with type 1 diabetes experience. Thinking back over the past month, please indicate the degree to which each of the following may have been a problem for you. For example, if you feel that a particular item was not a problem for you over the past month, you would select “not a problem”. If it was very tough for you over the past month, you might select “A very serious problem”.

1. Feeling that I am not as skilled at managing diabetes as I should be.
2. Feeling that I don’t notice the warning signs of hypoglycemia as well as I used to.
3. Feeling discouraged when I see high blood glucose numbers that I can’t explain.
4. Feeling that I can’t tell my diabetes doctor what is really on my mind.
5. Feeling that I am not taking as much insulin as I should.
6. Feeling that there is too much diabetes equipment and stuff I must always have with me.
7. Feeling that I don’t check my blood glucose level as often as I probably should.
8. Feeling worried that I will develop serious long-term complications, no matter how hard I try
9. Feeling that I don’t get help I really need from my diabetes doctor about managing diabetes.
10. Feeling frightened that I could have a serious hypoglycemic event when I’m asleep.
11. Feeling that my diabetes doctor doesn’t really understand what it’s like to have diabetes.
12. Feeling that I’ve got to be perfect with my diabetes management
13. Feeling frightened that I could have a serious hypoglycemic event while driving
14. Feeling that no matter how hard I try with my diabetes, it will never be good enough.
15. Feeling that my diabetes doctor doesn’t know enough about diabetes and diabetes care.

16. Feeling that I can’t ever be safe from the possibility of a serious hypoglycemic event
17. Feeling that I don’t give my diabetes as much attention as I probably should.

Appendix E – The Glucose Monitoring System Satisfaction survey

The Glucose Monitoring System Satisfaction survey

The researcher is interested in your thoughts and feelings regarding your current glucose monitor. For each item below, select the option that best indicates how much you agree or disagree with each statement as it pertains to your current monitor. Some patients use more than one monitor. Please consider the monitor you use the most or consider to be your primary monitor when answering these questions.

1. Helps me feel more satisfied with how things are going with my diabetes.
2. Makes me think about diabetes more than I want to.
3. Takes too much time to use.
4. Doesn't seem to be as accurate as I would like it to be.
5. Makes me worry a lot.
6. Is too much of a hassle to use.
7. Gives me numbers that I don't entirely trust.
8. Helps me feel less restricted by diabetes.
9. Makes me feel more frustrated with my diabetes.
10. Helps me be more spontaneous in my life.
11. Causes too many skin irritations or bruises.
12. Often gives me results that don't make sense.
13. Makes me feel more down and depressed.
14. Helps me be more open to new experiences in life.
15. Is too painful to use

Appendix F – Cronbach's Alpha Outputs

Reliability

Scale: T1DSS

Case Processing Summary

		N	%
Cases	**Valid**	154	98.1
	Excluded	3	1.9
	Total	157	100.0

Reliability Statistics

Cronbach's Alpha	N of Items
.917	13

Scale: GMSS

Case Processing Summary

		N	%
Cases	**Valid**	154	98.1
	Excluded	3	1.9
	Total	157	100.0

Reliability Statistics

Cronbach's Alpha	N of Items
.737	15

Appendix G – Open-ended Questions

1. How could the current glucometer be improved to reduce diabetes-related distress?
2. What features could be added or removed from your current glucometer to improve your diabetes management?
3. Do you have any other comments regarding glucometer devices?

Appendix H - Debrief

Debrief

Thank you very much for taking part in this research study.
The study in which you just participated is investigating the distressed experienced by type on diabetics based on the type of glucometer, glucose monitor satisfaction and how these glucose monitors could potentially be improved from the perspective of individuals with type 1 diabetes.

If you have questions about this study or you wish to have your data removed from the study, please contact me at the following e-mail address: N00150733@student.iadt.ie.

Alternatively, you may contact my supervisor, Liam Challenor, at Liam.Challenor@iadt.ie
We thank you sincerely for contributing and assure you that your data is confidential and anonymous, and if published the data will not be in any way identifiable as yours.
If you have been affected by the content of this study in any way, the organizations below may be of assistance:

Samaritans Contact Details:
Phone number: 116123
Email: jo@samaritans.ie
Website: https://www.samaritans.org/

Juvenile Diabetes Research Foundation
Website: https://www.jdrf.org/t1d-resources/

Diabetes UK Helpline
English Phone Number: 0345 123 2399
Scottish Phone Number: 0141 212 8710
Website: https://www.diabetes.org.uk/how_we_help/helpline

Diabetes Ireland Helpline
Phone Number: 1850 909 909
Website: https://www.diabetes.ie/

Katie Kelly.

Appendix I – Ethics B form

DEPARTMENT OF TECHNOLOGY AND PSYCHOLOGY ETHICAL APPROVAL FORM B*

Four printed copies of this form should be submitted to the chair of the ethics committee

Title of project Investigating distress, glucometer satisfaction and perceived glucometer usability improvements from the perspective of individuals with Type 1 Diabetes.

Name of researcher Katie Kelly

Email contact N00150733

Name of supervisor Dr. Liam Challenor

		Yes	No	N/A
1	Will you describe the main research procedures to participants in advance, so that they are informed about what to expect?	✓		
2	Will you tell participants that their participation is voluntary?	✓		
3	Will you obtain written consent for participation (through a signed or 'ticked' consent form)?	✓		
4	If the research is observational, will you ask participants for their consent to being observed?			✓
5	Will you tell participants that they may withdraw from the research at any time and for any reason?	✓		
6	With questionnaires, will you give participants the option of omitting questions they do not want to answer?	✓		
7	Will you tell participants that their data will be treated with full confidentiality and that, if published, it will not be identifiable as theirs?	✓		
8	Will you debrief participants at the end of their participation (i.e., give them a brief explanation of the study)?	✓		
9	If your study involves people between 16 and 18 years, will you ensure that passive consent is obtained from parents/guardians, with active consent obtained from both the child and their school/organisation?			✓
10	If your study involves people under 16 years, will you ensure that active consent is obtained from parents/guardians and that a parent/guardian or their nominee (such as a teacher) will be present throughout the data collection period?			✓
11	Will your project involve deliberately misleading participants in any way?		✓	
12	Is there any realistic risk of any participants experiencing either physical or psychological distress or discomfort?	✓		
13	Does your project involve work with animals?		✓	
14	Do you plan to give individual feedback to participants regarding their scores on any task or scale?		✓	

15	Does your study examine any sensitive topics (such as, but not limited to, religion, sexuality, alcohol, crime, drugs, mental health, physical health)		✓		
16	Is your study designed to change the mental state of participants in any negative way (such as inducing aggression, frustration, etc.)			✓	
17	Does your study involve an external agency (e.g. for recruitment)?			✓	
18	Do participants fall into any of the following special groups?	People with learning or communication difficulties		✓	
		Patients (either inpatient or outpatient)	✓		
		People in custody		✓	

If you have ticked **No** to any of questions 1 to 10, or **Yes** to any of questions 11 to 18 you should refer to the PSI Code of Professional Ethics and BPS Guidelines. There is an obligation on the lead researcher to bring to the attention of the Department of Technology and Psychology Ethics Committee (DTPEC) any issues with ethical implications not clearly covered by the above checklist.

* This Ethics B form should be completed by researchers whose studies involve any ethically questionable practices.

I consider that this project **may** have ethical implications that should be brought before the DTPEC.

Please provide all the further information listed below, adhering closely to the suggested word counts.

1. Purpose of project with very clear and specific justification for the study [its potential benefits], given the acknowledged sensitivity of the topic of study or the methods used (approximately 100 words)

The technology used by those with diabetes is necessary for managing their health. The current study will examine the distress and glucometer satisfaction based on the type of glucometer used, as well as the perceived usability improvements from the perspective type 1 diabetics. Previous deemed the moderate levels of distress experience is linked with the complexities of managing a chronic illness, overlooking how diabetes technologies can also affect distress. The research, being type 1 diabetic, understands the frustration of ineffectively using self-generated-data by the glucometer, which can have serious implications for one's health. The study would provide an insight into the T1D glucometer user need and usability improvement in order to reduce distress, which will in turn reducing health complications.

2. Proposed methodology (approximately 300 words). This must include:
    a. Participants: recruitment methods, number, age, gender, exclusion/inclusion criteria.
    b. Brief description of methods and measurements.

The study will attempt to recruit a minimum of 200 recruit participants who have type 1 diabetes by employing a snowball and convenient sampling method. The study will be advertised on forums dealing specifically with diabetes. Participants must be 18 years old and over, and cannot have type 2 or gestational diabetes, as they are treated differently than type 1 diabetes. The independent variable is the type of glucometer used, and the depend variables are distress, glucometer satisfaction and perceived usability improvements.
Participants will read the information sheet informing them of the purpose of the study, and participation is voluntary. Should they decide to participate, they will read and complete a consent form. The participants will then complete a demographic questionnaire, asking for their age, gender, nationality, time since diagnosis, and type of glucometer being used, which are as follows; i) blood glucose monitor, ii) sensor, and iii) continuous-glucose monitor. The participant will then answer two likert scales. The T1-DDS, assesses the level of distress experienced in relation to diabetes management. The GMSS assesses the participants' satisfaction with their glucometer. Finally, the participant will answer open ended-questions examining how the participants' perception of glucometer usability improvement. The participant is debriefed and thanked for their time. Researcher contact information is provided should the participants have any queries. The results from the quantitative scales are analyzed using SPSS and the results from the open-ended questions are analyzed using MAXQDA software by doing a thematic analysis.

3. A clear but concise statement of the ethical considerations raised by the project and how you intend to deal with them (approximately 100 words).

The study will be dealing with the sensitive topic of distress, as well as recruiting those with type 1 diabetes, who are considered a vulnerable population. Steps will be taken to ensure that the study is feasible and that participants will not be harmed in participating in the study. The information will state that participations is voluntary, and withdrawal from the study will be possible at any time. The participants' data will remain anonymous, only the researcher and the supervisor will have access to the raw data, which will be password protected. The supervisor's contact information will be provided should the participant want their data removed. The data will be destroyed on a specific date one the research is completed. The T1-DDS is a significantly large survey. It will be adapted, only including subscales relevant to the literature, shortening the length of time it takes to complete the survey to avoid survey fatigue. Hotlines will be provided in the debrief in case the participants were negatively affected by the survey.

4. Copies of all materials to be used in your study should be attached to this form. This must include consent and participant information arrangements and debrief forms. It should also include copies of all standardized and/or non-standardized questionnaires and instruments, as well as any interventions and/or audio-visual materials which will be used. Please note that these materials will not be returned to you, so you should ensure that you retain a copy for your own records. All loose materials (such as DVDs, handouts etc.) should be clearly labeled with your name. There is no word count limit on appendices, but no appendices should be included that will not be used as materials in your study.

Three copies of this form, along with all materials to be used in your study, should be submitted to the DTPEC for consideration.
If any of the above information is missing, your application will not be considered at the DTPEC meeting, and your research may be significantly delayed.

I am familiar with the PSI Code of Professional Ethics and BPS Guidelines (and have discussed them with the other researchers involved in the project). I have read and understood the specific guidelines for completion of Ethics Application Forms.

Signed Katie Kelly Date 8/4/2020
Applicant

Signed _____ Print Name _____ Date_____
Supervisor

Appendix J – Ethics Approval

Dear Katie

The Department of Technology and Psychology Ethics Committee have met and considered your application for your research project entitled "Investigating distress, glucometer satisfaction and perceived glucometer usability improvements from the perspective of individuals with Type 1 Diabetes".

Their decision is as follows:

Changes required but these can be approved by the supervisor without resubmission to the DTPEC

Please find below a list of required changes which need to be made to your application.

1. There are minor typographical errors in the materials (e.g. "of" vs "on" in the information sheet) – make sure that all materials are carefully proofread
2. Give a date that participants need to contact you by to remove their data
3. Is the area of residence question necessary? If not then remove it
4. Is there a more specific helpline that could help participants in distress? For example, something run by a government-associated health organisation? Give more targeted resources – diabetes association or somewhere they can access targeted support.
5. Try to ensure that this questionnaire is not issued during a pandemic related lockdown – however we recognise that this may not be possible
6. Info sheet – department of Technology and Psychology in IADT.
7. Don't use acronyms for scales on info sheet – they're probably meaningless to participants – briefly describe the scales.
8. If the participants potentially use more than one monitor this needs to be made clear in the section where they're asked which one they use.
9. Debrief – don't just give the title of the study again – describe it.

We wish you the very best with the next stages of your research, and we hope that you have a very good summer.

Best

Grainne

Dr. Gráinne Kirwan CPsychol

Lecturer in Psychology

Department of Technology and Psychology
IADT
Kill Avenue, Dun Laoghaire, Co. Dublin, Rep. of Ireland, A96 KH79
www.grainnekirwan.com

Appendix K – SPSS Outputs

T1-DSS; Descriptive Statistics

	N	Range	Minimum	Maximum	Sum	Mean		Std. Deviation
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic
Glucometer Type	**157**	**2**	**1**	**3**	**367**	**2.34**	**.063**	**.789**
T1DSS TOTAL	**157**	**4.29**	**1.12**	**5.41**	**426.18**	**2.7145**	**.07599**	**.95220**
Valid N (listwise)	**157**							

		N	Range	Minimum	Maximum	Sum	Mean	
Glucometer Type		Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error
BGM	**T1DSS TOTAL**	31	3.59	1.47	5.06	103.38	3.3348	.17273
	Insulin Type	22	1	1	2	29	1.32	.102
	Valid N (listwise)	22						
Sensor	**T1DSS TOTAL**	42	3.64	1.18	4.82	112.73	2.6840	.14519
	Insulin Type	36	1	1	2	45	1.25	.073
	Valid N (listwise)	36						
CGM	**T1DSS TOTAL**	84	4.29	1.12	5.41	210.07	2.5008	.09399
	Insulin Type	59	1	1	2	97	1.64	.063
	Valid N (listwise)	59						

T1-DSS; Tests of Normality

	Glucometer Type	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
T1DSS TOTAL	BGM	.154	22	.189	.961	22	.516
	Sensor	.116	36	.200*	.951	36	.109
	CGM	.112	59	.065	.940	59	.006

	Insulin Type	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
T1DSS TOTAL	MDI	.085	63	.200*	.976	63	.262
	Pump	.137	54	.013	.936	54	.006

T1-DSS; Kruskall-Wallis Tests

	Ranks		
	Glucometer Type	N	Mean Rank
T1DSS TOTAL	BGM	31	106.61
	Sensor	42	77.64
	CGM	84	69.49
	Total	157	

Test Statistics[a,b]

	T1DSS TOTAL
Kruskal-Wallis H	15.160
df	2
Asymp. Sig.	.001

Ranks

Insulin Type		Glucometer Type	N	Mean Rank
.	T1DSS TOTAL	BGM	9	26.83
		Sensor	6	25.00
		CGM	25	17.14
		Total	40	
MDI	T1DSS TOTAL	BGM	15	42.10
		Sensor	27	27.26
		CGM	21	30.88
		Total	63	
Pump	T1DSS TOTAL	BGM	7	38.21
		Sensor	9	31.61
		CGM	38	24.55
		Total	54	

Test Statistics[a,b]

Insulin Type		T1DSS TOTAL
.	Kruskal-Wallis H	5.601
	df	2
	Asymp. Sig.	.061
MDI	Kruskal-Wallis H	6.451
	df	2
	Asymp. Sig.	.040
Pump	Kruskal-Wallis H	5.207
	df	2
	Asymp. Sig.	.074

T1-DSS; Mann-Whitney Tests

Ranks

Insulin Type		Glucometer Type	N	Mean Rank	Sum of Ranks
.	T1DSS TOTAL	BGM	9	8.28	74.50
		Sensor	6	7.58	45.50
		Total	15		
MDI	T1DSS TOTAL	BGM	15	27.47	412.00
		Sensor	27	18.19	491.00
		Total	42		
Pump	T1DSS TOTAL	BGM	7	9.93	69.50
		Sensor	9	7.39	66.50
		Total	16		

Test Statistics[a]

Insulin Type		T1DSS TOTAL
.	Mann-Whitney U	24.500
	Wilcoxon W	45.500
	Z	-.295
	Asymp. Sig. (2-tailed)	.768
	Exact Sig. [2*(1-tailed Sig.)]	.776[b]
MDI	Mann-Whitney U	113.000
	Wilcoxon W	491.000
	Z	-2.351
	Asymp. Sig. (2-tailed)	.019
Pump	Mann-Whitney U	21.500
	Wilcoxon W	66.500
	Z	-1.067
	Asymp. Sig. (2-tailed)	.286
	Exact Sig. [2*(1-tailed Sig.)]	.299[b]

Ranks

Insulin Type		Glucometer Type	N	Mean Rank	Sum of Ranks
.	T1DSS TOTAL	BGM	9	23.56	212.00
		CGM	25	15.32	383.00
		Total	34		
MDI	T1DSS TOTAL	BGM	15	22.63	339.50
		CGM	21	15.55	326.50
		Total	36		
Pump	T1DSS TOTAL	BGM	7	32.29	226.00
		CGM	38	21.29	809.00
		Total	45		

Test Statistics[a]

Insulin Type		T1DSS TOTAL
.	Mann-Whitney U	24.500
	Wilcoxon W	45.500
	Z	-.295
	Asymp. Sig. (2-tailed)	.768
	Exact Sig. [2*(1-tailed Sig.)]	.776[b]
MDI	Mann-Whitney U	113.000
	Wilcoxon W	491.000
	Z	-2.351
	Asymp. Sig. (2-tailed)	.019
Pump	Mann-Whitney U	21.500
	Wilcoxon W	66.500
	Z	-1.067
	Asymp. Sig. (2-tailed)	.286

Ranks

Insulin Type		Glucometer Type	N	Mean Rank	Sum of Ranks
.	T1DSS_TOTAL	BGM	9	23.56	212.00
		CGM	25	15.32	383.00
		Total	34		
MDI	T1DSS_TOTAL	BGM	15	22.63	339.50
		CGM	21	15.55	326.50
		Total	36		
Pump	T1DSS_TOTAL	BGM	7	32.29	226.00
		CGM	38	21.29	809.00
		Total	45		

Test Statistics[a]

	T1DSS_TOTAL
Mann-Whitney U	687.000
Wilcoxon W	4257.000
Z	-3.878
Asymp. Sig. (2-tailed)	.000

Ranks

Insulin Type		Glucometer Type	N	Mean Rank	Sum of Ranks
.	T1DSS_TOTAL	Sensor	6	20.92	125.50
		CGM	25	14.82	370.50
		Total	31		
MDI	T1DSS_TOTAL	Sensor	27	23.07	623.00
		CGM	21	26.33	553.00
		Total	48		
Pump	T1DSS_TOTAL	Sensor	9	29.22	263.00
		CGM	38	22.76	865.00
		Total	47		

Test Statistics[a]

Insulin Type		T1DSS_TOTAL
.	Mann-Whitney U	45.500
	Wilcoxon W	370.500
	Z	-1.476
	Asymp. Sig. (2-tailed)	.140
	Exact Sig. [2*(1-tailed Sig.)]	.143[b]
MDI	Mann-Whitney U	245.000
	Wilcoxon W	623.000
	Z	-.801
	Asymp. Sig. (2-tailed)	.423
Pump	Mann-Whitney U	124.000
	Wilcoxon W	865.000
	Z	-1.272
	Asymp. Sig. (2-tailed)	.203
	Exact Sig. [2*(1-tailed Sig.)]	.213[b]

GMSS; Descriptive Statistics

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Glucometer Type	157	1	3	2.34	.789
GMS TOTAL	154	24.07	62.27	41.9152	7.51876
Valid N (listwise)	154				

Descriptive Statistics

Glucometer Type		N	Minimum	Maximum	Mean	Std. Deviation
BGM	Glucometer Type	31	1	1	1.00	.000
	GMS_TOTAL	31	30.20	62.27	43.5634	8.60620
	Valid N (listwise)	31				
Sensor	Glucometer Type	42	2	2	2.00	.000
	GMS_TOTAL	42	30.13	58.27	41.6000	7.87438
	Valid N (listwise)	42				
CGM	Glucometer Type	84	3	3	3.00	.000
	GMS TOTAL	81	24.07	60.27	41.4477	6.87298
	Valid N (listwise)	81				

GMSS; Tests of Normality

	Glucometer Type	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
GMSS TOTAL	BGM	.120	22	.200*	.947	22	.281
	Sensor	.140	36	.074	.947	36	.083
	CGM	.086	57	.200*	.987	57	.801

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Insulin Type	Statistic	df	Sig.	Statistic	df	Sig.
GMSS TOTAL	MDI	.086	63	.200*	.974	63	.192
	Pump	.090	52	.200*	.978	52	.459

GMSS; Kruskall-Wallis Tests

Ranks

	GlucometerType	N	Mean Rank
GMS_TOTAL	BGM	31	81.71
	Sensor	42	74.69
	CGM	81	77.35
	Total	154	

Test Statistics[a,b]

	GMS_TOTAL
Kruskal-Wallis H	.444
df	2
Asymp. Sig.	.801

Ranks

Insulin Type		Glucometer Type	N	Mean Rank
.	GMS_TOTAL	BGM	9	17.78
		Sensor	6	24.42
		CGM	24	19.73
		Total	39	
MDI	GMS_TOTAL	BGM	15	38.20
		Sensor	27	24.80
		CGM	21	36.83
		Total	63	
Pump	GMS_TOTAL	BGM	7	25.64
		Sensor	9	35.06
		CGM	36	24.53
		Total	52	

Test Statistics[a,b]

Insulin Type		GMS_TOTAL
.	Kruskal-Wallis H	1.262
	df	2
	Asymp. Sig.	.532
MDI	Kruskal-Wallis H	7.359
	df	2
	Asymp. Sig.	.025
Pump	Kruskal-Wallis H	3.509
	df	2
	Asymp. Sig.	.173

GMSS; Mann-Whitney Tests

Ranks

Insulin Type		Glucometer Type	N	Mean Rank	Sum of Ranks
.	GMS_TOTAL	BGM	9	6.94	62.50
		Sensor	6	9.58	57.50
		Total	15		
MDI	GMS_TOTAL	BGM	15	27.37	410.50
		Sensor	27	18.24	492.50
		Total	42		
Pump	GMS_TOTAL	BGM	7	7.00	49.00
		Sensor	9	9.67	87.00
		Total	16		

Test Statistics[a]

Insulin Type		GMS_TOTAL
.	Mann-Whitney U	17.500
	Wilcoxon W	62.500
	Z	-1.122
	Asymp. Sig. (2-tailed)	.262
	Exact Sig. [2*(1-tailed Sig.)]	.272[b]
MDI	Mann-Whitney U	114.500
	Wilcoxon W	492.500
	Z	-2.311
	Asymp. Sig. (2-tailed)	.021
Pump	Mann-Whitney U	21.000
	Wilcoxon W	49.000
	Z	-1.116
	Asymp. Sig. (2-tailed)	.264
	Exact Sig. [2*(1-tailed Sig.)]	.299[b]

Ranks

	Glucometer Type	N	Mean Rank	Sum of Ranks
GMS_TOTAL	BGM	31	38.97	1208.00
	Sensor	42	35.55	1493.00
	Total	73		

Test Statistics[a]

	GMS_TOTAL
Mann-Whitney U	590.000
Wilcoxon W	1493.000
Z	-.681
Asymp. Sig. (2-tailed)	.496

Ranks

Insulin Type		Glucometer Type	N	Mean Rank	Sum of Ranks
.	GMS_TOTAL	BGM	9	15.83	142.50
		CGM	24	17.44	418.50
		Total	33		
MDI	GMS_TOTAL	BGM	15	18.83	282.50
		CGM	21	18.26	383.50
		Total	36		
Pump	GMS_TOTAL	BGM	7	22.64	158.50
		CGM	36	21.88	787.50
		Total	43		

Test Statistics[a]

Insulin Type		GMS_TOTAL
.	Mann-Whitney U	97.500
	Wilcoxon W	142.500
	Z	-.425
	Asymp. Sig. (2-tailed)	.670
	Exact Sig. [2*(1-tailed Sig.)]	.677[b]
MDI	Mann-Whitney U	152.500
	Wilcoxon W	383.500
	Z	-.161
	Asymp. Sig. (2-tailed)	.872
	Exact Sig. [2*(1-tailed Sig.)]	.874[b]
Pump	Mann-Whitney U	121.500
	Wilcoxon W	787.500
	Z	-.148
	Asymp. Sig. (2-tailed)	.882
	Exact Sig. [2*(1-tailed Sig.)]	.885[b]

Ranks

Insulin Type		Glucometer Type	N	Mean Rank	Sum of Ranks
.	GMS_TOTAL	Sensor	6	18.33	110.00
		CGM	24	14.79	355.00
		Total	30		
MDI	GMS_TOTAL	Sensor	27	20.56	555.00
		CGM	21	29.57	621.00
		Total	48		
Pump	GMS_TOTAL	Sensor	9	30.39	273.50
		CGM	36	21.15	761.50
		Total	45		

Test Statistics[a]

Insulintype		GMS_TOTAL
.	Mann-Whitney U	55.000
	Wilcoxon W	355.000
	Z	-.885
	Asymp. Sig. (2-tailed)	.376
	Exact Sig. [2*(1-tailed Sig.)]	.402[b]
MDI	Mann-Whitney U	177.000
	Wilcoxon W	555.000
	Z	-2.217
	Asymp. Sig. (2-tailed)	.027
Pump	Mann-Whitney U	95.500
	Wilcoxon W	761.500
	Z	-1.890
	Asymp. Sig. (2-tailed)	.059
	Exact Sig. [2*(1-tailed Sig.)]	.058[b]

Appendix L – Qualitative responses

Participant qualitative responses – BGM Group

How could your current glucometer be improved to reduce diabetes-related distress?	What features could be added or removed from your current glucometer to improve your diabetes management?	Do you have any other comments regarding glucometer devices?
I'd like to be able to compare with historic data in the BGM. Also maybe compare to other T1s. Some positive reinforcement would be nice. Eg a message that says "good work you're in range"		
make it more user-friendly, not as slow, not as clunky and ugly		
More cost effective CGM that connects to the phone and connects to pump that can automatically decrease or increase levels.		
This particular meter makes it a little more annoying to navigate logs of past readings without using the accompanying app, which can be annoying when I don't have the time or cellular data to connect at that moment. I also only got it a while ago and I still have no idea if it is rechargeable or if the batteries are meant to be replaced because the packaging was very unclear about this. (OneTouch Verio Reflect).		
More options for muting items, or a way to turn off certain tracking questions.		

Easier to use lancing device that doesn't take much hassle to change lancet. Easier way to download/ upload results and share with medical team for reports. Ability to link with phone and computer and potentially with other devices such as CGM or to combine pump data with meter data to compare insulin/carb amounts and blood sugar readings.		
If it could be smaller. Overall the meters are fine and can be carried on person without causing distress.		
It could indicate trends, if my blood sugar is going up or down it would be useful to know	It would be useful to be able to set a reminder, such as test again in 1 hour or in 2 hours	I find the newer ones can be very complicated with lots of features, I'm sure they are useful for many people, but I prefer the simpler ones that just tell you your blood sugar level without adding in carb values and insulin dosages etc
it could have a trending arrow to indicate where my BG is going. up or down.		
I'm not sure how to answer this question. The purpose of a glucometer is to tell you what your blood sugar level is. If having a high or low sugar reading causes stress, then the person should focus on better management and make corrections to their insulin needs. Maybe the glucometer could give you	My current glucometer gives results in 5 seconds, which is light years faster from when I was diagnosed 31 years ago. They are also a lot smaller, so other than adding the words encouragement, I can't think of any additional improvements.	

words of encouragement which would help with distress from blood sugar reading.		
Sometimes error messages appear that aren't accurate! Also it can be a little difficult to position the meter to collect the blood drop resulting in a wasted test.	Am pretty happy with it overall .. the lancet and meter are in the same device so that is quite handy.	
I'm prescribed a glucose monitor and a CGM. I've not worn the CGM in about 4 weeks because im weary from the constant errors and wrong readings. I miss it as it gives me confidence (when it works) so I know what I am at all times. The only recommendation I have is to improve sensor reliability & accuracy.		
Smaller, less bulky	Option to add the type of carb/ more tailored to my reactions to food. I.e. pasta, fast food causes me to drop very quickly if I take the full recommended dose	No, the meter I use is decent in that I only need to count my carbs, and don't have to start calculating my ratio - I enter my carbs and the meter works out how mich I need to take
Built in strips and needle all in one machine	Remove all the unnecessary technology but add event markers e.g. alcohol, exercise, time of month.	Medtronic CGM guardian 3 sensor is very inaccurate
Connection to insulin pump sometimes fails but other than that it's fine. Previously used a sensor but had a reaction to the adhesive so had to stop using it	Connection to smart watch to display latest reading and time taken	Blood glucose app and attachment for phone would be great. Phone could be your meter with some sort of attachment that plugs into charging point etc

Participant qualitative responses – Sensor Group

How could your current glucometer be improved to reduce diabetes-related distress?	What features could be added or removed from your current glucometer to improve your diabetes management?	Do you have any other comments regarding glucometer devices?
It's silly, but if a glucometer has a backlit display, have a user-controlled brightness level, or an "invert color" selection ("dark mode"). I had to quit using a Dexcom because the updates to the reader was blinding to me & I could no longer read the display. I'd like to invert the display of my Freestyle Libre.		
Individiualized Alarms. The possibillity to calibrate the device. RealTime Glucose Data. Better Statistics. Smartwatch support. Better cloud support. Stronger Bluetooth signal. Smaller Device		
I have the Freestyle Libre and I wish it were more accurate. I realize there is a time delay, but this is independent of that “feature”. If readings are very off, I should be checking with a finger stick, but most of the time I don’t unless the readings are in the “you should be dead” category.		
It could be easier to scan, less loading times, it could connect to my pump. A lot of diabetes related stress comes from		

knowing that there is the technology out there to make my life easier but because companies want to make money from it it's restricted or not available yet.		
Connectivity to my pump		
I'd love for it to be more accurate. For me, it consistently reads lower than blood by 0.8 to 2.0 mmol/l. Because I keep a tight range, this means I often need to double check my Libre readings with a finger prick to prevent treating hypo's that aren't there.		Every glucometer I've used worked just fine.
I don't think it can. Some things with type 1 just suck and theres nothing improving a glucometer would do to improve it.		I think every type 1 diabetic should be allowed a dexcom on the nhs but that's a dream! Option to add notes and type on freestyle Libre when using the reader.
Alarms with different tones for high or low blood glucose.		Switching to a flash monitoring system took away a great deal of distress caused by not knowing what was happening in between finger prick tests.
Better alarms and warnings.		
Countour Next - no issues Freestyle Libre - accuracy issues. Always reads lower than a finger prick, however amount varies from sensor to sensor. Difficult to entirely trust the Libre sensor readings.	I also use the test strips for the Freestyle Libre. They are individually wrapped which is annoying - they are hard to open if hands are slightly wet/ cold. We are not always testing in the comfort of our own home & also having so much packaging in wasteful.	Consultants need to understand the accuracy issues of the Libre. I usually wake up with a finger prick BG in the 4s or 5s - so on the Libre readout I often appear hypo and this is obviously in the download the consultant sees. At first, although I told her the Libre was reading low,

		she did not appear to believe me and questioned my hypo awareness. Before the next visit I made sure I tested each morning with the Libre strips as well as the sensor so I could prove my point (these finger prick tests also show up in the Libre download). But obviously this was stressful. No one likes to have their hypo awareness questioned, especially when they are not having hypos!
It is difficult to think of anything because this device give me so much more useful information from one scan than my previous devices (using finger-prick tests) but I would feel much happier using it if the plastic waste from each sensor could be recycled (or at least that there was less plastic waste for each sensor).	Add a feature that would enable me to use the insulin calculator from a flash result without having to carry out a finger-prick test. Add a feature so that the type of exercise being undertaken can be entered (ie. whether it is aerobic, strength, walking etc.) as this affects how my blood glucose results change during exercise.	I feel that people get a bit 'hung up' about the accuracy of these, when what they really should do is work out which particular values on their own personal meter indicate a possible hypo etc.
More accuracy	Remove need for scanning	
Greater accuracy	Alarms added Already prescribed Libre 2 which has this facility	The sooner they work in tandem with insulin pumps the better
I am pretty happy with my glucometer.	Bluetooth for my actual glucometer that can sync up better with my libre.	
If it communicated with my pump.	Wi-Fi connection to my pump.	Easier to check my glucose level.
Continuous monitoring not just when I scan		
Have a better way to stay attached to my arm.	It's simple and that's what I like. No noises or disruptions.	

	Alarms that alert you when going low/high that are available on funding	
By using a system that does everything in 1. E.g continually checks blood and adjusts insulin dose accordingly.		
It could be more accurate, I'm always worried when I use it that the result will be way off	A better adhesive between the sensor and the sticker that holds it on. It stays on my skin but the sensor starts to peel off of the sticker	
Often says un able to give reading try again in ten minutes so have to use old machine then (finger pricker)	A more accurate meter that works in your arm much like implant that that women have (one that under skin) that lasts longer	If having a low or a high make a noise to worn you with libre before starts to become a problem
Accuracy needs to be increased	Added high or low sugar alerts	
Alarms for hypo's Give an indication of on board insulin	A feature which allows you to see what insulin is on board and how long that insulin will be working for Alarms for background insulin to insure it's taken at the same time each day	The colour system - green = in range, orange = high , red = low can be triggering and disheartening
If it alerted about lows... if it was available on lti and not have to be self funded	Ketone monitoring	Time consuming and alot to carry around. Cgms are the way forward and need to be on lti
Give me alerts.	Alerts when sugars go high or low	
Be more accurate	Built in bluetooth	Like the free style sensor be available free to all type 1 diabetics
More accurate would be very helpful	Alerts for hypos without buy extras like the maoi etc	
...extend sensor use to 30 days from present 14.	If long acting insulin could be added as mine only shows rapid acting. Both	Been very helpful for me.

	are visible when downloaded.	
	Alerting automatically when going low and high removes risk when driving and stop the filling in medical form which is total discrimination against diabetics as their is next no risk of a low when using a dexcom	Dexcom should be automatically give the to all diabetics that are type 1 and stop the discrimination based on age .
Be more readily available and funded by hse		
Reduce the alarms and non stop warnings, loss of sensor signal, calibrate reminders. Its all non stop. I've had to turn off so many features because it was a full rime job keeping the pump and sensor happy.	If the sensor reacted to high or low blood sugars itself. Without warnings etc. If the warning messages were single screens so you can just press ok and not have to take it out and read the message to stop the non stop alarm. 1 alarm is enough yet it keeps going until its stopped. The high blood sugar warning is unnecessary too. We know what a high reading is.	
Less visible	Closed loop system	Access to CGMs should be freely available for all type 1s with peer training as opposed to dependency on nurses to provide training.
Less visible. It would be nice if my sensor could go somewhwre besides my arm.	Less of a delay. Sensor currently has a 15 minute delay.	They are a little expensive. They cost the government about the same as the strips did. I don't understand why the strips were given free but the sensor is not.
There is no bolus advisor integrated, currently I go between 3 apps (carbs & cals, MySugrApp, and the Libre, so all the data is	Bolus advisor on the libre app for android.	I think the costs are insane for flash sensors and CGMs and it's so sad that people need to prove their diabetes is

scattered. This is really frustrating for trying to track events and takes up a lot of time.. and I feel like I'm expected to just do it all the time and not complain.		bad enough or they have so much anxiety developed that they need it.
Smaller in size so it is less obvious and harder to get caught on clothes etc. Ability to recycle it to not cause as much waste.	Libre 3 had been announced but most in UK still on Libre 1. Libre 3 with Bluetooth making it essentially a CGM and smaller size sounds ideal, just have to wait for it. Lack of recycling concerning. Used sensors contain eg batteries lots of metals and plastic casing. Applicator has large spring and needle housing so I sharps. Rest of libre kit should be OK to recycle, and non-recyclable elements should be able to be returned to Abbott. Abbott supply individually wrapped capillary test strips which are difficult to open and wrapping can't be recycled.	
	Smaller with attached injector. More robust	Could have cartidge that supports more tests (100 instead of fifty). Cheaper
	have to keep purchasing replacement strip cartridges which are costly and go out of date.	Over all wish it was easier in this day and age.....

Participant qualitative responses – CGM Group

How could your current glucometer be improved to reduce diabetes-related distress?	What features could be added or removed from your current glucometer to improve your diabetes management?	Do you have any other comments regarding glucometer devices?
Speaking of my glucometer that I use to calibrate my CGM and check outside of my CGM. It's too big, for 20 years it's always the same problem, sometimes the glucometers themselves are made quite small, but the accompanying lancing device and test strip container make a large package that doesn't fit in a pocket. There are some options out there that try and solve this problem, (accuchek make a device that is all in one) but I never found it too great.		
Length of service		
Medtronic CGM Alarms should automatically stop when the condition is no longer true.		
Better original software. Open source community is way ahead the commercial products.		
Reduce the sensor warm up time. Alarm more when I'm high.		
clearer patters, more accurate readings		
The cost is a major financial stress, having to decide how much per month having an alarm is worth doesn't feel healthy. The libre read		

incredibly inaccurately for me and customer service provided no support - the same issues aren't showing up with dexcom but being able to calibrate the sensor is a major stress relief. My phone isn't compatible with the dexcom software through the app store so I've needed to go third party which works okay.		
Honestly, I would be incredibly happy with an update to the alarm sounds. The current alerts are very jarring, which is great for alerting me to a serious hypo in progress. But will illicit feelings of anger and the thought of throwing my pump/CGM receiver (integrated) has come to mind on occasion.		
Making sure the readings are accurate in the first day of wearing the cgm		
better user interface, more options for adjustments, better Bluetooth connectivity, less errors		
Connecting faster to my phone after charging the transmitter.		
Last longer and be cheaper		
The adhesive causes rash and it doesn't heal before I need to use the same site again		
Longer wearability of the sensors		

More customizability in alarm settings including the tones available. The current tones included with the dexcom app are grating to say the least. I understand they're supposed to be hard to ignore but not every message from my dexcom is that urgent. It would be nice to be able to pick less annoying tones for alarms that are not as important rather than having to turn them off entirely. Also, having alarms that adapt to your glucose range. For instance I would like to know a lot sooner if I'm 89 and dropping rather than 200 and dropping. The dexcom tends to do just a vibration alarm first and the the second alarm five minutes later will be loud. This is fine if my blood sugar is high enough (>120). But if I'm sitting steady at 90, the first alarm will only vibrate to tell me I'm 80 and dropping quickly (which I may not notice) and the second alarm five minutes later will sound out loud to tell me I've dropped even further. At this point I may already be well into the 60-70 range and it's a bit panic inducing. If it had sounded an alarm the first time, rather than a vibration, I could act to		

prevent a low much faster.		
Less sensor errors and failures		
It's a process to connect the sensor and app with cgm and then I need to wait 2 hours before it can be used when changing sensor(approx 10 days). Could be more efficient. Also the sensor doesn't always last the full 10 days and needs to be replaced early		
More control over the types of alerts and how those alerts are configured.		
I use dexcom. My biggest issue is it's size. Already quite small, but could be smaller. The extra information has helped me better manage. The different sets of alarms and alerts are helped up for reducing stress.		
My glucometer system involves a pin-prick blood test, which calibrates to a continuous BG monitor, which automatically updates my insulin pump. This calibration has to occur every 8 hours, and an audible and vibration alarm go off simultaneously when this calibration has to occur - and it doesn't stop until you acknowledge this on the pump. I sleep a lot. If I got to bed at 10 I won't be up until 8:30 or so, and so my pump will stop receiving data about my		

BG ~6am. I have dawn phenomenon so this 6-9am window is when my BG is most erratic without insulin or carb adjustment. If the continuous BG monitor I use had a longer window, this would be less annoying. It's more a frustration than distress. Giving a second reader for the Guardian 3 CBG monitor, as they need to be charged and reattached to a new sensor on the body- when I'm charging it, i can't wear it and so can't get any info. It can take a long time for the Guardian 3 to set up ('warm up'), calibration is fine (usually an hour), but sometimes out of the blue there is a notification on the pump of 'sensor updating' and that takes 3 hours at a time. During that time there's no information on what your BGL is.		
Better reaction time for hypo alarms. It's set to go off every 30 minutes (default) but it goes off every few minutes if multiple categories apply- eg - sugars below the level I set, that level will hit 3.1 in 20 mins (urgent low level set by company) and when it is urgent low - 3.1 or under. So if my sugar level is 2.4 the alarm will go off 3 times at different	Bypassing the other 2 alarms after the urgent alarm is hit.	Fantastic device. Automatically links to my phone and the data goes to my clinic too without me needing to do anything.

intervals and I can't stop it. Eg every 5 minutes an alarm is going off. However it takes at least 20 minutes before my sugar levels will increase after treating the hypo.		
	Longer sensor life.	
More accurate readings	Running A1c estimate	I like the Dexcom and TSlim combination
Make it smaller, last longer, and less expensive.	Integrate it with my insulin pump in a closed loop system requiring little input from me. Have all my diabetes data on my cell phone.	
My chief concern with my dexcom is its occasional inaccuracy. For instance once my dexcom read 80 but my finger stick was 60 (there were no obvious reasons for the inaccuracy, my bg was steady and I was well hydrated), this caused a lot of concern for me because I often like to leave my bg steady in the 80-110 range when I am at home because it helps to lower my average which reduces the chance of complications (as opposed to always running 110-150 which I know some T1s do), however, if I think I'm at 80 but I'm really at 60 I am causing my body unnecessary harm from the low bg	I would not remove any features. I would add the ability to raise "Critical Low" alerts from 55 to 70. I would also like to see the option for more alarms, for instance being able to have a low alarm at both 80 and 100. It would be nice to have a less annoying at 100 so I could be made aware that my bg is at that level but not necessarily so low I need to be concerned, and then have the more urgent alarm set at 80. Secondly I would add the "change between readings" (the +5 or -15) that is available in the sugarmate widget to the dexcom widget. I use that reading often to gauge how my bg is changing and make decisions based on it. I find the trend arrows to not be useful or inaccurate.	I believe the continuous glucose monitor is a necessity for anyone with type 1 diabetes. With it I maintain an a1c of 5.5 and 90% in 70-150 range while still eating a moderately high carb diet and not worrying too much about lows. Without it I would be in a constant never ending fear of lows and would have to run my bg much higher with an unsafe a1c >7.

1. Lasting longer periods of time (a sensor that could be replaced once a month would be great). 2. Having far shorter warm up periods (2 hours plus without glucose readings is too long). 3. Having better Bluetooth range (it is incredible that current generation glucose sensors have such poor Bluetooth range while a large number of other consumer Bluetooth equipment has far better range). This causes an unacceptable number of "loss of connection" events to insulin pumps and cell phones from the sensor.	The same as stated in the previous question.	
Make it longer wearing or a permanent sensor		Wish they were universally covered by all health insurance/ pharmacy plans
Ability to switch from audible alerts to on body vibrations for notifications. Reduce irritating adhesive.	Add on body vibration alerts	
Be more accurate or just not as far off. Also don't like how Dexcom shows every 5 minutes so if I just ate I see the trend of it going up. Would be nice to be able to click the app then see what my sugar is rather than seeing the number and the trends but couldn't imagine life without it!	Dexcom G6 has so much wasted trash and plastic and that's what really bothers me. Wish each insertion device could be reusable or something	So thankful for these devices. I have a tandem pump along with the Dexcom G6 and love them. Wish the pump was tubeless but I'd also lose it if I was lol
Smaller and less noticeable, more accurate		

I have problem after it suspended and my bg is started to go up it still not restart the insulin so its late when it does and i go high. Im hyop unavare and rarely treat my low during my sleeps.	It would be nice to have more cell phone compatible stuff	
I think if the sensor wear was longer. Data has shown that the longer you wear a sensor, the more accurate it become.	Being able to view on my watch, even when I am greater than 20 feet away from my mobile device	I wish that anyone that wanted a sensor could have it. It is absurd that not all insurance plans cover or pay for them. There has been so much clinical data that has proven that people that wear sensors have better glycemic control and overall better health outcomes
	Closed loop system with pump	Number 14 would not let me enter a response. I think the cgm I use is cost prohibitive. Even with insurance the costs are very high to maintain
More accuracy when bg moves to high and low ranges. It seems that the meter is pretty accurate on the medium range.	Spot analysis. If the device can tell the spot of my body where I installed the sensor is a difficult part to measure for the device.	More aggressive research and development.
Improve adhesive — change to Dexcom in past year causes rashes unless I take steps at my own cost to pre-treat prior to insertion.	Reduce the warm-up time from 2 hours to 30 minutes.	Lifesaver for any long-term T1D who had only urine glucose testing for many years. I am grateful!
Improve first-day accuracy when starting a new sensor. CGM's are cost prohibitive for many people. Every type 1 should have this valuable tool.	My pump uses the cgm when making adjustments in my insulin. I would like the trending arrows to be incorporated also as that would provide important information.	My cgm has given me peace and security..
Dexcom - have real numbers instead of High or Low for extremes.		Wish it would last more than 10 days.

Below 40, it just says Low. Over 400, it jut says High. Wish it gave a real number.		
Last longer than 10 days.	Make your main device, sync with phone and watch if you add an event to one, it shows on all.	
Be more accurate immediately after correcting a hypo	Reminder to check bg 15 minutes after correcting a hypo or hyper	Want a Loop system trial with Dex and Omnipod synergizing
When it alerts for a high reading, not to repeatedly alarm after you've given a correction dose until it is back in range	If I could also track food/carbs on the "events" tab	Dexcom has changed my life! I'm going to run a marathon this year. I didn't feel it was possible when I was using finger prick testing
Having a dexcom gives me an instant look at my sugars are and how they have been trending 24 hours a day. Alarming system has reduced my anxiety ten fold and can now sleep at night knowing I will be woken up by an alarm.	Not having to apply yearly for dexcom. Having access to it continuously	Dexcom is life changing and it is a basic need that every one should have access to
More accuracy - which is the case with every type of diabetes technology. Dexcom lags behind readings from a finger stick test	Hypo alarms that keep going off	The CGM for me was life changing. There is no comparison between checking on a glucometer and having continuous readings from the dexcom
I had been using an abbot Glucose blood monitor which I gave up using as the strips were in a wrapper and I found it hard to access the strips when going hypo as they were hard to get out.	I'm using an accu check Aviva and I find it would get a great help if it lit up with my numbers. I'm sure that some may do this but I've been using the accu check for years and always go back to it as it's my favourite. Also has the best finger pricked.	

A smaller device that's more comfortable to wear and less noticeable	Connecting to my pump	I think a cgm helps a lot, especially when you feel unmotivated as it's very easy to see your blood sugars with little to no effort
I use Medtronic cgm and it requires multiple calibration finger sticks every day which defeats the purpose of using it. The glucometer should be able to link with the pump such that I do not need to touch my pump, all access should be through glucometer.	Enhanced features on glucometer to control pump and give doses through meter	
Find i can lose signal easy and hard to regain signal if dropping fast		
Less expensive when self-funding & don't have to change it as often.	Add a place to input the amount & time of insulin you take after checking sugars.	Too expensive to self fund.
Having used the Dexcom G5 and now the G6, I am much more confident in all aspects of its working. It's much easier to put on and much fewer calibrations. I also have a Medtronic 640g and Enlite cgm but I self find the Dexcom because I would feel much less secure without it.	Perhaps extended wear past 10 days would be beneficial.	
If it told me what bolus to give for corrections	Carbon counting and insulin adjustment recommendations	
Predictation of BG if I do nothing, as in if I ignore it, based on past experience will it likely come down or go up, so I don't feel the need to correct to early.	If it could transmit to my phone so I can access historical data without the rigmarole of having to connect it to something would be good.	CGMs may be the biggest game changers in the history of diabetes management since the invention of insulin therapy

If talking about my CGM then accuracy is the first improvement that comes to mind. CGM is often 3-4 mmols off what the Glucometer reads. My glucometer is actually good with no real improvements needed	except for the ability of it to follow me around so it's always at hand nothing comes to mind	
I use a G6 and there are definitely times that it is inaccurate particularly at start and end of 10 day sessions and this can lead to frustration, stress and distress! Also, the compression lows at night can cause an issue with anxiety about night time hypos which until I got the G6 was a huge issue for me.	Accuracy improved; packaging size and waste reduced not an actual real issue but does annoy me that to recycle same you have to remove needle and there is so much plastic!	As real as having a G6 I have various meters and to be honest the degree of variance in the readings is something else; there is only one on the newly issued approved list that is anything close to as accurate as an actual venous blood test! Tested when I was getting bloods done in doctors in January and only 1/3 were close to random glucose test coming back from lab.
I'm using Medtronic CGM, when it works it brilliant and then when it doesn't work properly it's so frustrating, especially when alarms go off or it gives incorrect low blood sugar alarms and switches off my insulin while I am asleep resulting in a high the next morning	More accuracy and easier to connect a new sensor	I find the contour next glucometer that I use twice a day to calibrate quite good and it requires less blood than my old monitor and gives you time to add extra blood if there wasn't enough
App to link to phone or smart watch	Space to log type of food/activity to allow more useful trends to be identified	
Longer lasting		
Improved design to attach to body. I need a second person to help me.	To give me a bolts if my BS are going high	They can overreact and wake me or give me constant alarms. When it

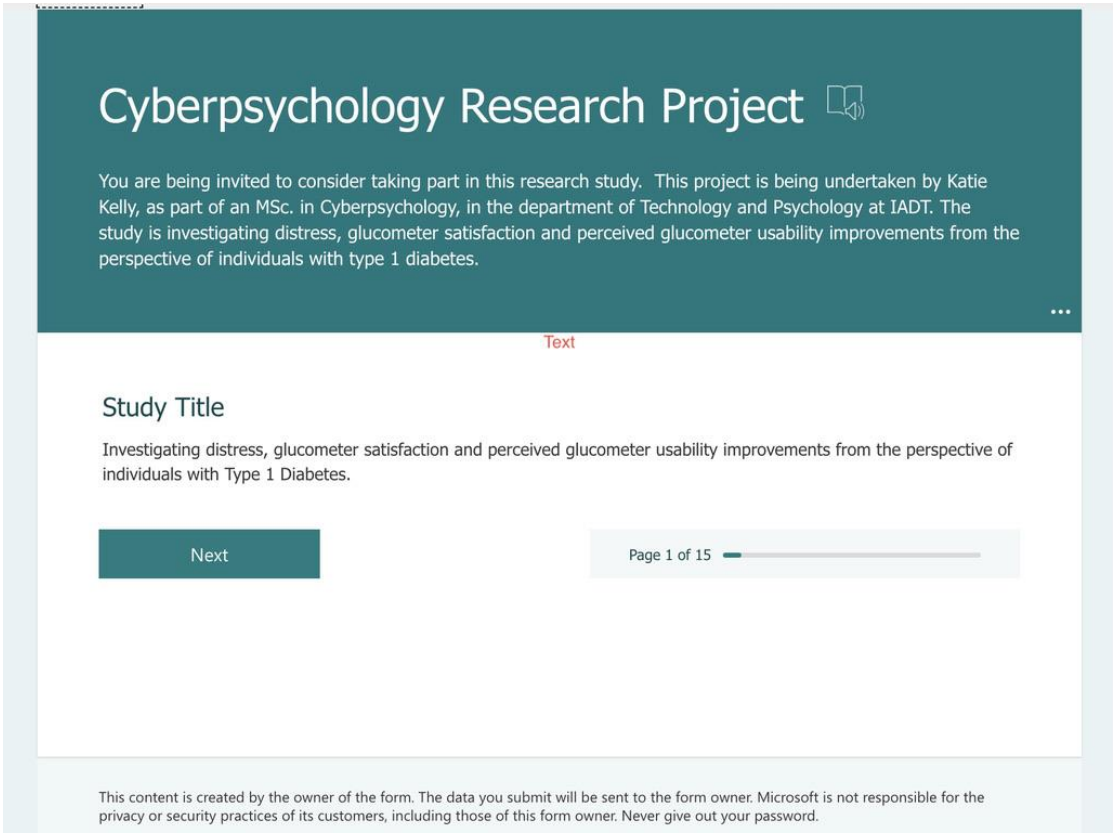
		stops my basal it sends my BS high.
Be accurate. The cgm is way off when compared to the glucometer	Precision	
My CGM has allowed me to have my glucose readings directly on my phone, if I'm going somewhere for a short period I don't bring my glucose meter. This has resulted in less stress because I don't need to drag my glucose meter along, I have a trend which tells me if I'm high or low this has helped a lot, always knowing what my sugar is	If the CGM I use could last longer before it needs changing every 6 days, if the app allowed me to view my on board insulin like the free style libre did it would help me to calculate intermittent insulin doses more accurately for corrections etc	A CGM once it's set up and settled for a few hours on the body is excellent for reducing my anxiety with relation to a fear of hypoglycaemia. I have a result continually I can intervene if my BSL is dropping rapidly or rising rapidly to avoid undesirable events. I travel a lot on public transport and checking an app on my phone is a lot more convenient and gives me more privacy when I want to know my BSL. I don't have anxiety in general but balancing blood sugars especially in public places can cause some, having a CGM has helped immensely
Causes skin irritation	Longer sensor life	The dexcom g6 has improved my quality of life massively since being diagnosed as I was afraid of doing a lot of stuff alone before I got it like going biking or going on long car journeys incase I had a hypo
have internal strips like some models but also be connected to the pump	probably just be able to plug it in and download results	
I would love a light on my blood sugar meter for night time readings	I have the Medtronic guardian sensor, it is very unreliable on day 1 of sensor change. The readings are in accurate, often say low when in range. This means more	I wish I had pushed for a Dexcom when I asked my endo for the CGM. Medtronic seem to have the monopoly on the Irish market. Dexcom is definitely the best

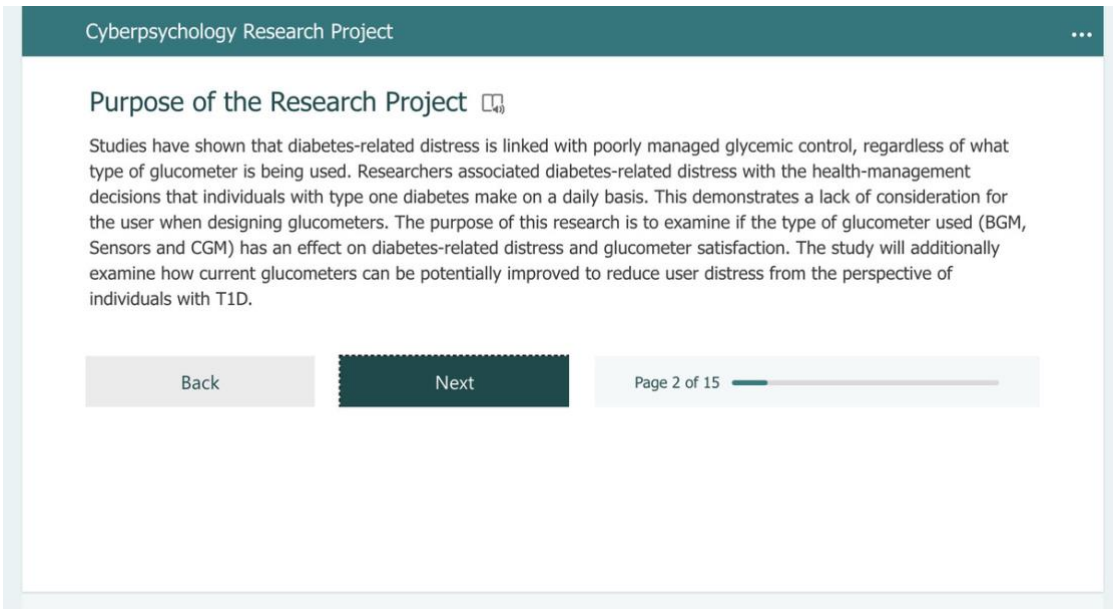
	finger pricking, anxiety and distrust with the accuracy CGM data. I finger prick for every meal as I cannot trust the accuracy	currently available in Ireland
To be closed loop with my pump.	To work with my pump to reduce highs. Current pump and sensor work together to prevent lows.	Optimistic re new development in technology, such as arrival of Medtronic 780g.
Good, upload my pump to cloud, Software not that easy to interpret.	Have to finger prick 5/7 day to celebrate Medtronic Guardian3 CGM	Would not want to give up my CGM as has eliminated Night Time Hypo on pump while I sleep, Wake time hypo I can treat easily but was unaware I was having sleeping hypo on pump til I got CGM with hypogurd which will suspend the pump for up to two hours, and avoid sleeping hypo. Used to wake up from sleeping hypo in the morning very tired and put it down to being over tiered going to bed.
It occasionally gives me incorrect readings when the sensor is changed but it works itself out after a few hours. I've only had one compression low	Perhaps make it smaller but I believe the Dexcom g7 is on the way.	CGM's are definitely the way forward having done glucometers for so many years!!
If I didn't get a rash from my dexcom g6 it would help	Longer live from transmitter would be great and I would be happy to fund attachments like patches etc	Really great devices , I can't survive without my dexcom. I have readings directed to my watch which really helps me controlling my blood sugars
More scheduling options for when you want the alarm to be quiet/vibrate only. Able to change the alarm more easily. The alarms are very shrill and	Link directly to a smart watch rather than via the phone to smart watch All info in one app rather than using clarity.	All Type 1 diabetics should automatically be entitled to a CGM for better control. Follow option is great. My partner sees my glucose

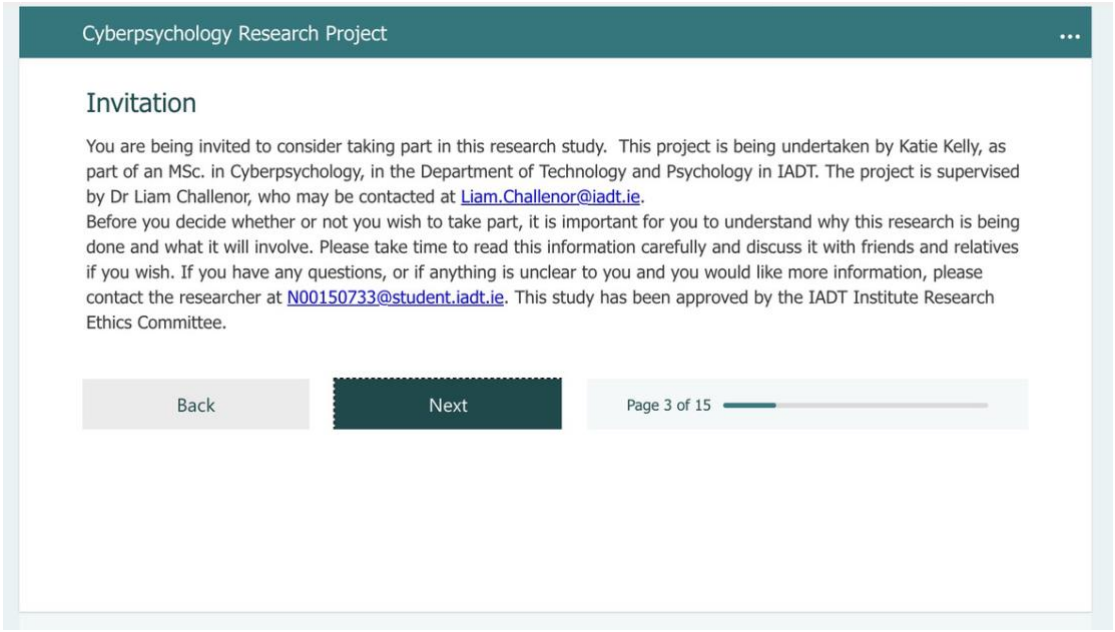
loud. When the alarm would alert in work people thought it was the fire alarm. It's very embarrassing. Maybe it should vibrate first, then if you don't check it within 30 seconds it should make a small alarm sound, then another 30 seconds the big alarm sound. Or at least an option to set it this way.	Being able to see 24 hour without having to turn the screen as my screen is always locked on portrait. Being able to select how many hours of data you can see at a time.	information, he gets a notification if I am urgently low so he phones me to check that I am OK. He can also see if I've had a bad day so he will know that I'm possibly in a bad mood.
I used Dexcom along with Accu-chek Aviva Dexcom figure need to be more accurate with less sensor issue, Accu-chek should include ketone testing also	Bluetooth technology to be added to the Insulin pen so that the amount of Insulin take and time shows on the Dexcom would be fantastic, or tech to have the calculations made on the Accu-check linked into the Dexcom to avoid multiple places where you need to add data, that would be amazing	Having data linked across devices can go a long way to helping type 1 Diabetics I use multiple devices and a software called diasend to make this happen it shouldn't have to be this difficult, also closed loop cgm/pump systems seem to be a talked about subject now let's hope the technology behind them is reliable enough e.g minimal errors etc
Clearer error reporting when there is an issue.	More integration options with 3rd party apps for data analytics and sharing. Improved mobile apps/widgets, for viewing real-time data.	
Make it easier to input info such as carbs, exercise, insulin dose. A little bit cumbersome.		Excellent. Has made managing my diabetes so much easier. Instant view of blood sugar levels & shows trends and what happens during the night. Also me to explore more food/exercise and monitor impact it has on levels

Be more accurate	Link to pens or pump to calculate insulin dose	CGM should be available to all
If it was a closed loop system it would be a game changer		
I use the guardian sensor and it requires two hours to calibrate after charging but charge can be slow so normally do it over night which means I have an anxious night each week. Reducing charge and calibration time would greatly help		

Appendix M – Microsoft Word Survey Screenshots






Cyberpsychology Research Project
Invitation
You are being invited to consider taking part in this research study. This project is being undertaken by Katie Kelly, as part of an MSc. in Cyberpsychology, in the Department of Technology and Psychology in IADT. The project is supervised by Dr Liam Challenor, who may be contacted at Liam.Challenor@iadt.ie.
Before you decide whether or not you wish to take part, it is important for you to understand why this research is being done and what it will involve. Please take time to read this information carefully and discuss it with friends and relatives if you wish. If you have any questions, or if anything is unclear to you and you would like more information, please contact the researcher at N00150733@student.iadt.ie. This study has been approved by the IADT Institute Research Ethics Committee.
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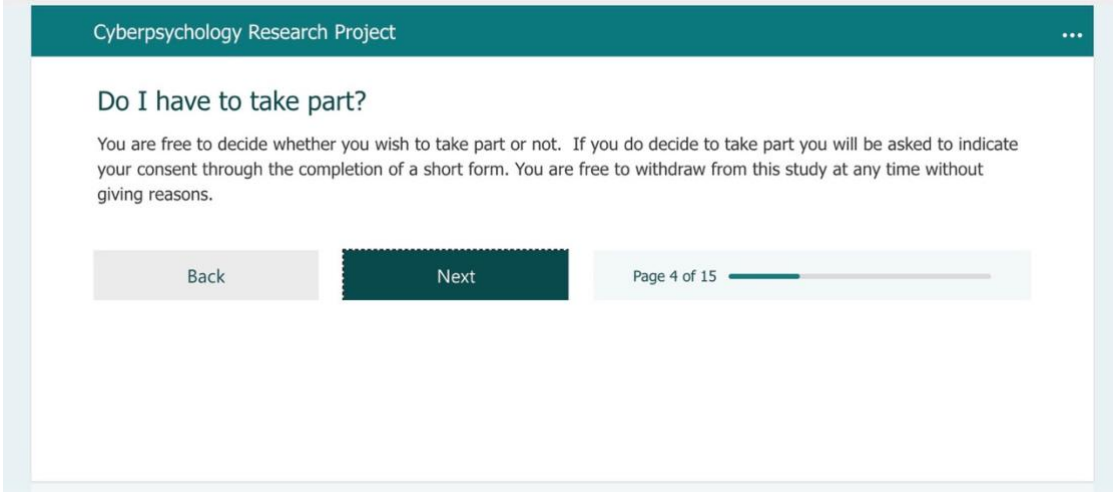
Cyberpsychology Research Project
Do I have to take part?
You are free to decide whether you wish to take part or not. If you do decide to take part you will be asked to indicate your consent through the completion of a short form. You are free to withdraw from this study at any time without giving reasons.
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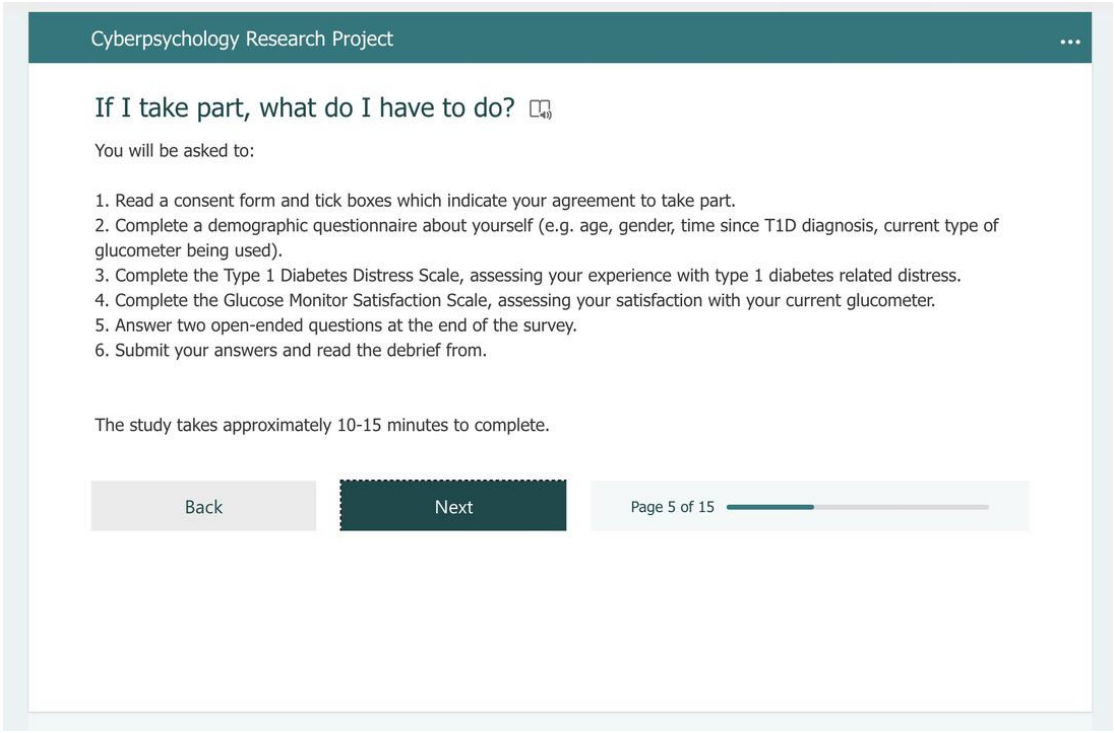
Cyberpsychology Research Project
If I take part, what do I have to do?
You will be asked to:
1. Read a consent form and tick boxes which indicate your agreement to take part.
2. Complete a demographic questionnaire about yourself (e.g. age, gender, time since T1D diagnosis, current type of glucometer being used).
3. Complete the Type 1 Diabetes Distress Scale, assessing your experience with type 1 diabetes related distress.
4. Complete the Glucose Monitor Satisfaction Scale, assessing your satisfaction with your current glucometer.
5. Answer two open-ended questions at the end of the survey.
6. Submit your answers and read the debrief from.
The study takes approximately 10-15 minutes to complete.
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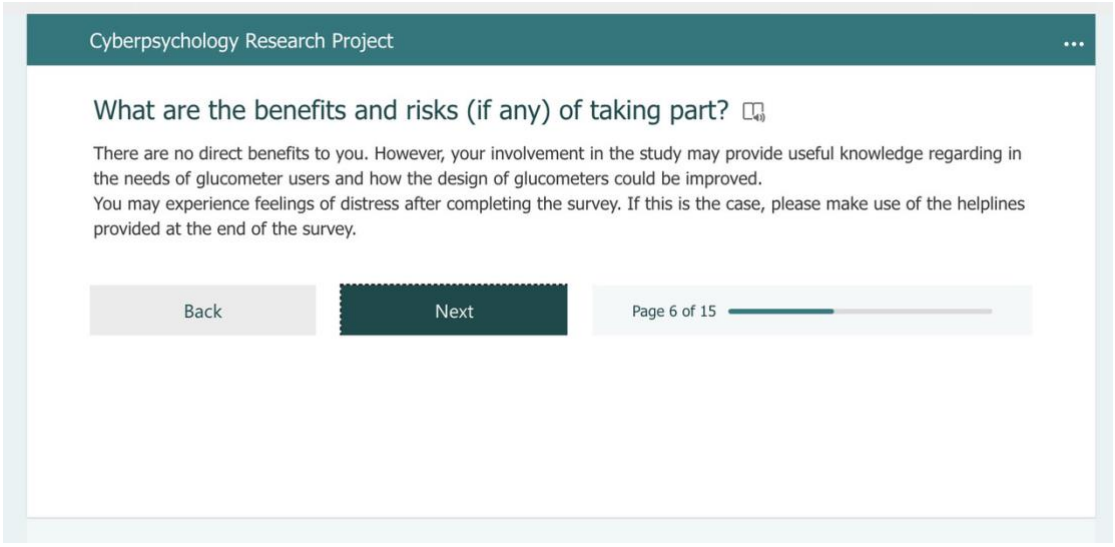
Cyberpsychology Research Project
What are the benefits and risks (if any) of taking part?
There are no direct benefits to you. However, your involvement in the study may provide useful knowledge regarding in the needs of glucometer users and how the design of glucometers could be improved.
You may experience feelings of distress after completing the survey. If this is the case, please make use of the helplines provided at the end of the survey.
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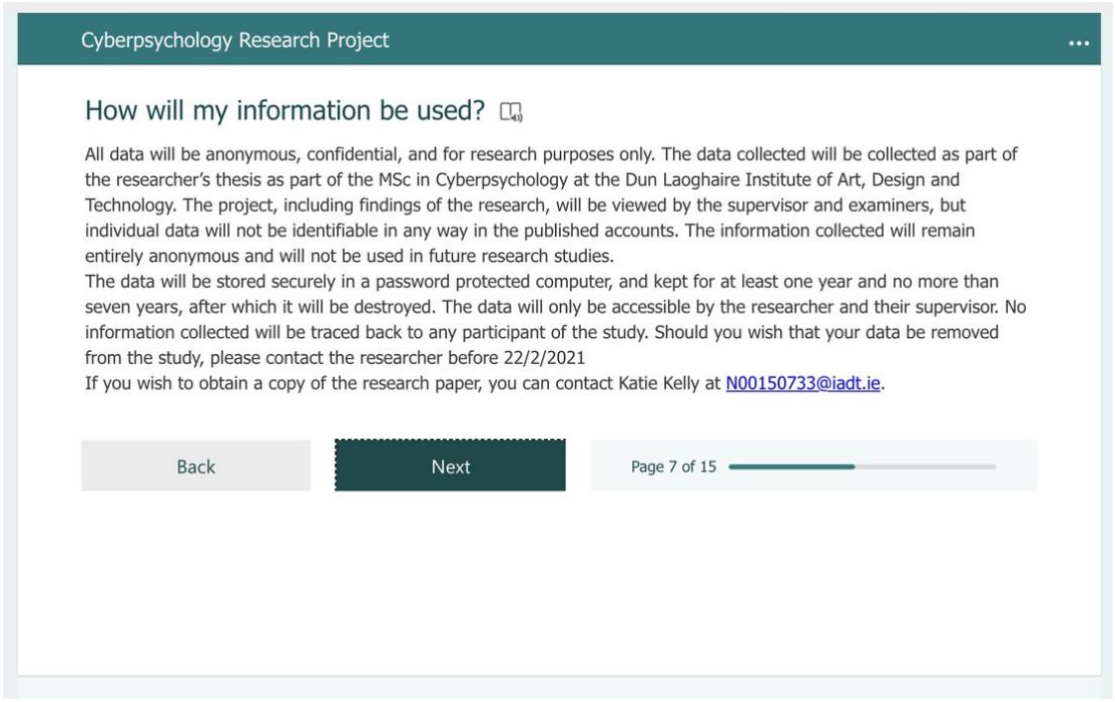
Cyberpsychology Research Project
How will my information be used?
All data will be anonymous, confidential, and for research purposes only. The data collected will be collected as part of the researcher's thesis as part of the MSc in Cyberpsychology at the Dun Laoghaire Institute of Art, Design and Technology. The project, including findings of the research, will be viewed by the supervisor and examiners, but individual data will not be identifiable in any way in the published accounts. The information collected will remain entirely anonymous and will not be used in future research studies.
The data will be stored securely in a password protected computer, and kept for at least one year and no more than seven years, after which it will be destroyed. The data will only be accessible by the researcher and their supervisor. No information collected will be traced back to any participant of the study. Should you wish that your data be removed from the study, please contact the researcher before 22/2/2021
If you wish to obtain a copy of the research paper, you can contact Katie Kelly at N00150733@iadt.ie.
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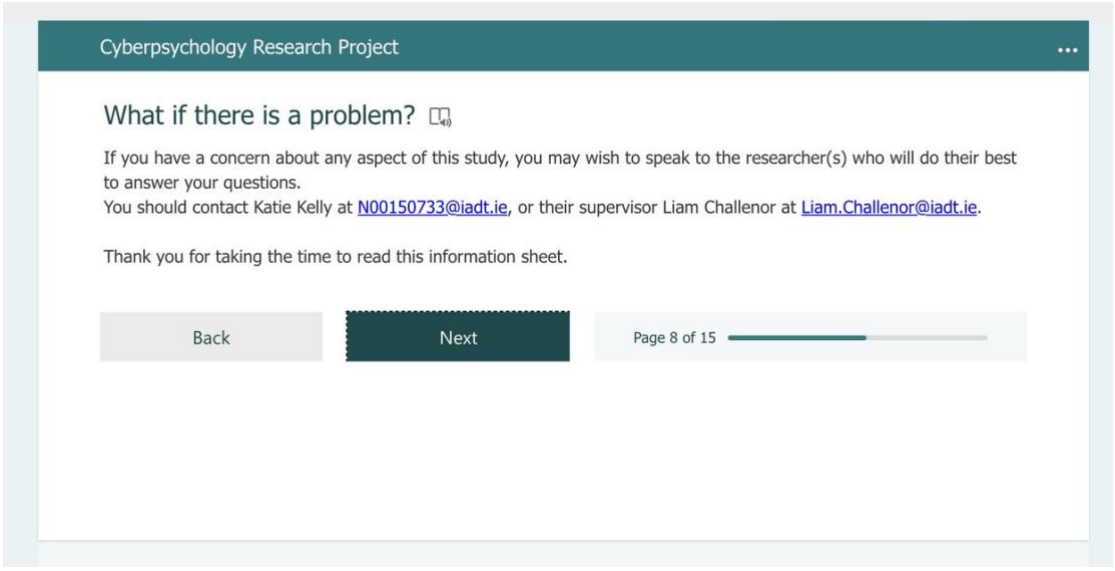
Cyberpsychology Research Project
What if there is a problem?
If you have a concern about any aspect of this study, you may wish to speak to the researcher(s) who will do their best to answer your questions.
You should contact Katie Kelly at N00150733@iadt.ie, or their supervisor Liam Challenor at Liam.Challenor@iadt.ie.
Thank you for taking the time to read this information sheet.
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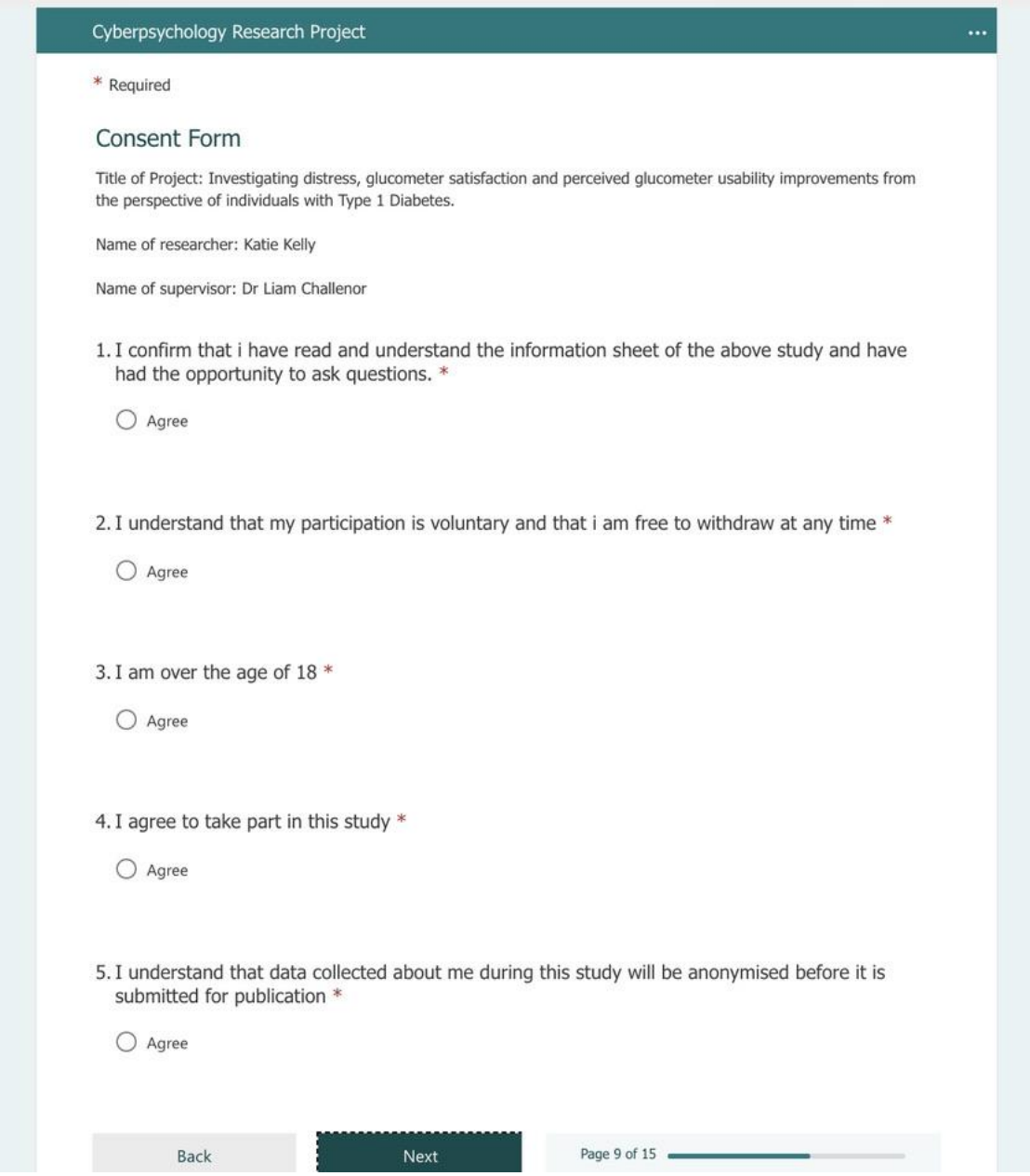

Cyberpsychology Research Project

* Required

Consent Form

Title of Project: Investigating distress, glucometer satisfaction and perceived glucometer usability improvements from the perspective of individuals with Type 1 Diabetes.

Name of researcher: Katie Kelly

Name of supervisor: Dr Liam Challenor

1. I confirm that i have read and understand the information sheet of the above study and have had the opportunity to ask questions. *

Agree

2. I understand that my participation is voluntary and that i am free to withdraw at any time *

Agree

3. I am over the age of 18 *

Agree

4. I agree to take part in this study *

Agree

5. I understand that data collected about me during this study will be anonymised before it is submitted for publication *

Agree

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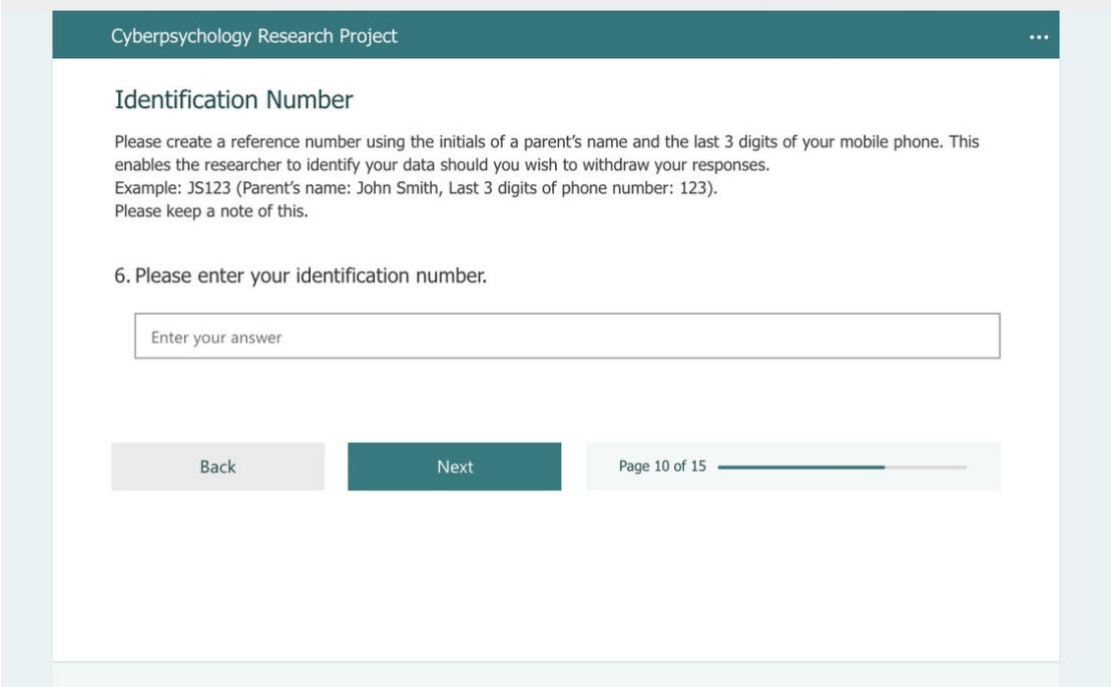
Cyberpsychology Research Project
Identification Number
Please create a reference number using the initials of a parent's name and the last 3 digits of your mobile phone. This enables the researcher to identify your data should you wish to withdraw your responses.
Example: JS123 (Parent's name: John Smith, Last 3 digits of phone number: 123).
Please keep a note of this.
6. Please enter your identification number.
Enter your answer
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Demographic Questions

7. What is your gender?

- ◯ Male
- ◯ Female
- ◯ Non-Binary
- ◯ Prefer not to say

8. How old are you?

Please enter a number greater than or equal to 18

9. How long have you had type one diabetes? Please answer in years.

The value must be a number

10. Which one of the following types of glucometers do you use?

If you use more than one type of glucometer, please select the monitor that you use the most.

- ◯ Blood glucose monitor (i.e. traditional blood sample on test strip)
- ◯ Blood glucose sensor (i.e. Freestyle Libre etc.)
- ◯ Continuous glucose monitor (i.e. Dexcom etc.)

11. What type of insulin administration do you use?

- ◯ MDI (Multiple Daily Injections)
- ◯ Insulin Pump

Cyberpsychology Research Project ...

Type one Diabetes Distress Scale

Living with type 1 diabetes can be tough. Listed below are a variety of distressing things that many people with type 1 diabetes experience. Thinking back over the past month, please indicate the degree to which each of the following may have been a problem for you. For example, if you feel that a particular item was not a problem for you over the past month, you would select "not a problem". If it was very tough for you over the past month, you might select "A very serious problem".

12. Question

	Not a problem	A slight problem	A moderate Problem	A somewhat serious problem	A serious problem	A very serious problem
Feeling that I am not as skilled at managing diabetes as I should be	○	○	○	○	○	○
Feeling that I don't notice the warning signs of hypoglycemia as well as I used to	○	○	○	○	○	○
Feeling discouraged when I see high blood glucose numbers that I can't explain	○	○	○	○	○	○
Feeling that I can't tell my diabetes doctor what is really on my mind.	○	○	○	○	○	○
Feeling that I am not taking as much insulin as I should	○	○	○	○	○	○
Feeling that there is too much diabetes equipment and stuff I must always have with me	○	○	○	○	○	○
Feeling that I don't check my blood glucose level as often as I probably should	○	○	○	○	○	○
Feeling worried that I						

Feeling worried that I will develop serious long-term complications, no matter how hard I try	○	○	○	○	○	○
Feeling that I don't get the help need from my diabetes doctor about managing diabetes	○	○	○	○	○	○
Feeling frightened that I could have a serious hypoglycemic event when I'm asleep	○	○	○	○	○	○
Feeling that my diabetes doctor doesn't really understand what it's like to have diabetes	○	○	○	○	○	○
Feeling that I've got to be perfect with my diabetes management	○	○	○	○	○	○
Feeling frightened that I could have a serious hypoglycemic event while driving	○	○	○	○	○	○
Feeling that no matter how hard I try with my diabetes, it will never be good enough	○	○	○	○	○	○
Feeling that my diabetes doctor doesn't know enough about diabetes and diabetes care	○	○	○	○	○	○
Feeling that I can't ever be safe from the possibility of a serious hypoglycemic event	○	○	○	○	○	○
Feeling that I don't give my diabetes as much attention as I probably should	○	○	○	○	○	○

Cyberpsychology Research Project ...

Glucose monitor satisfaction scale

The researcher is interested in your thoughts and feelings regarding your current glucose monitor. For each item below, select the option that best indicates how much you agree or disagree with each statement as it pertains to your current monitor. Some patients use more than one monitor. Please consider the monitor you use the most or consider to be your primary monitor when answering these questions.

13. Question

	Strongly Disagree	Disagree	Neutral	Agree	Strongly agree
Helps me feel more satisfied with how things are going with my diabetes	○	○	○	○	○
Makes me think about diabetes more than I want to	○	○	○	○	○
Takes too much time to use	○	○	○	○	○
Doesn't seem to be as accurate as I would like it to be	○	○	○	○	○
Makes me worry a lot	○	○	○	○	○
Is too much of a hassle to use	○	○	○	○	○
Gives me numbers that I don't entirely trust	○	○	○	○	○
Helps me feel less restricted by diabetes	○	○	○	○	○
Makes me feel more frustrated with my diabetes	○	○	○	○	○
Helps me be more spontaneous in my life	○	○	○	○	○
Causes too many skin irritations or bruises	○	○	○	○	○
Often gives me results	○	○	○	○	○

my diabetes

Makes me think about diabetes more than I want to	○	○	○	○	○
Takes too much time to use	○	○	○	○	○
Doesn't seem to be as accurate as I would like it to be	○	○	○	○	○
Makes me worry a lot	○	○	○	○	○
Is too much of a hassle to use	○	○	○	○	○
Gives me numbers that I don't entirely trust	○	○	○	○	○
Helps me feel less restricted by diabetes	○	○	○	○	○
Makes me feel more frustrated with my diabetes	○	○	○	○	○
Helps me be more spontaneous in my life	○	○	○	○	○
Causes too many skin irritations or bruises	○	○	○	○	◉
Often gives me results that don't make sense	○	○	○	○	○
Makes me feel more down and depressed	○	○	○	○	○
Helps me be more open to new experiences in life	○	○	○	○	○
Is too painful to use	○	○	○	○	○

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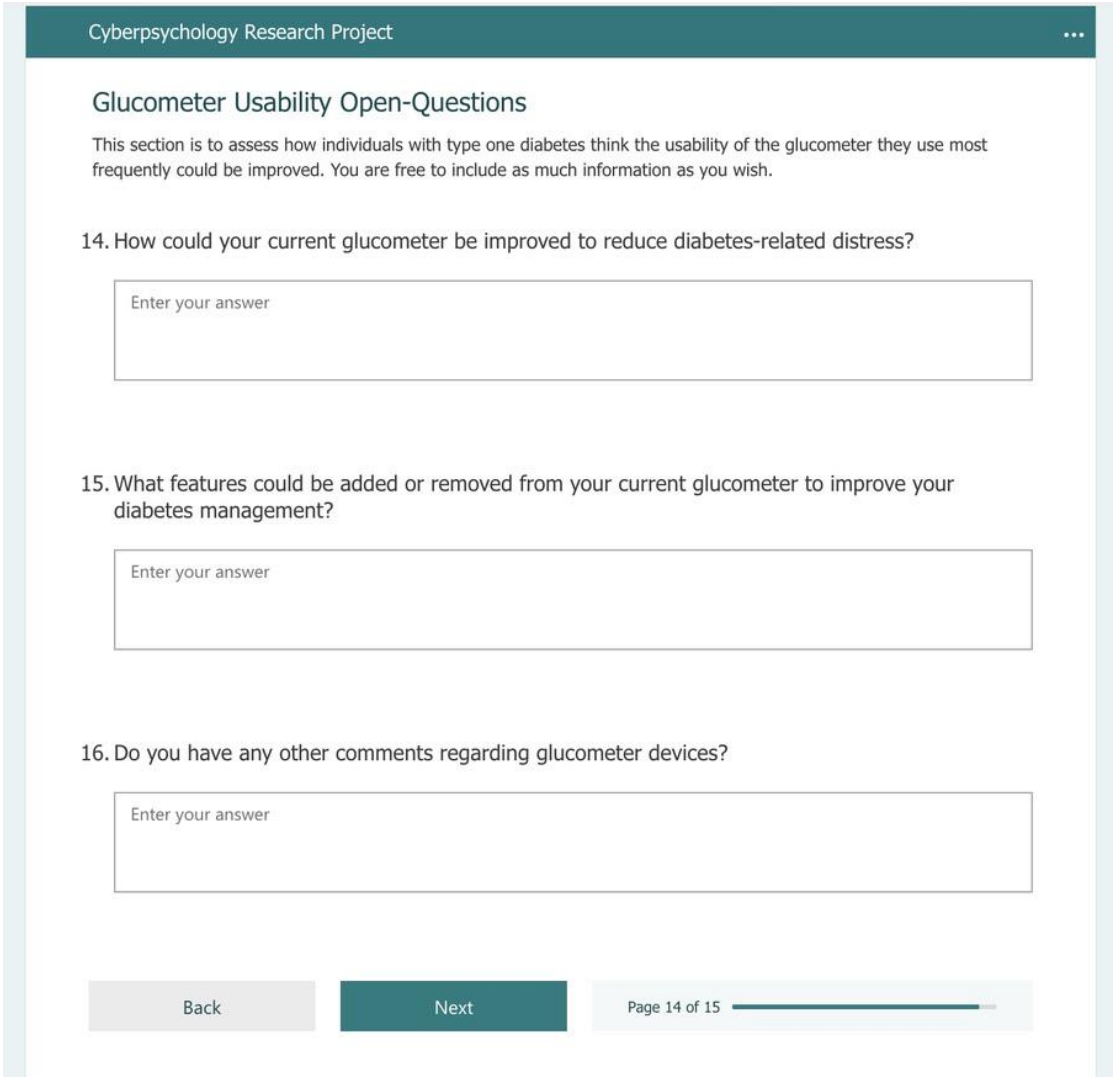
Cyberpsychology Research Project
Glucometer Usability Open-Questions
This section is to assess how individuals with type one diabetes think the usability of the glucometer they use most frequently could be improved. You are free to include as much information as you wish.
14. How could your current glucometer be improved to reduce diabetes-related distress?
Enter your answer
15. What features could be added or removed from your current glucometer to improve your diabetes management?
Enter your answer
16. Do you have any other comments regarding glucometer devices?
Enter your answer
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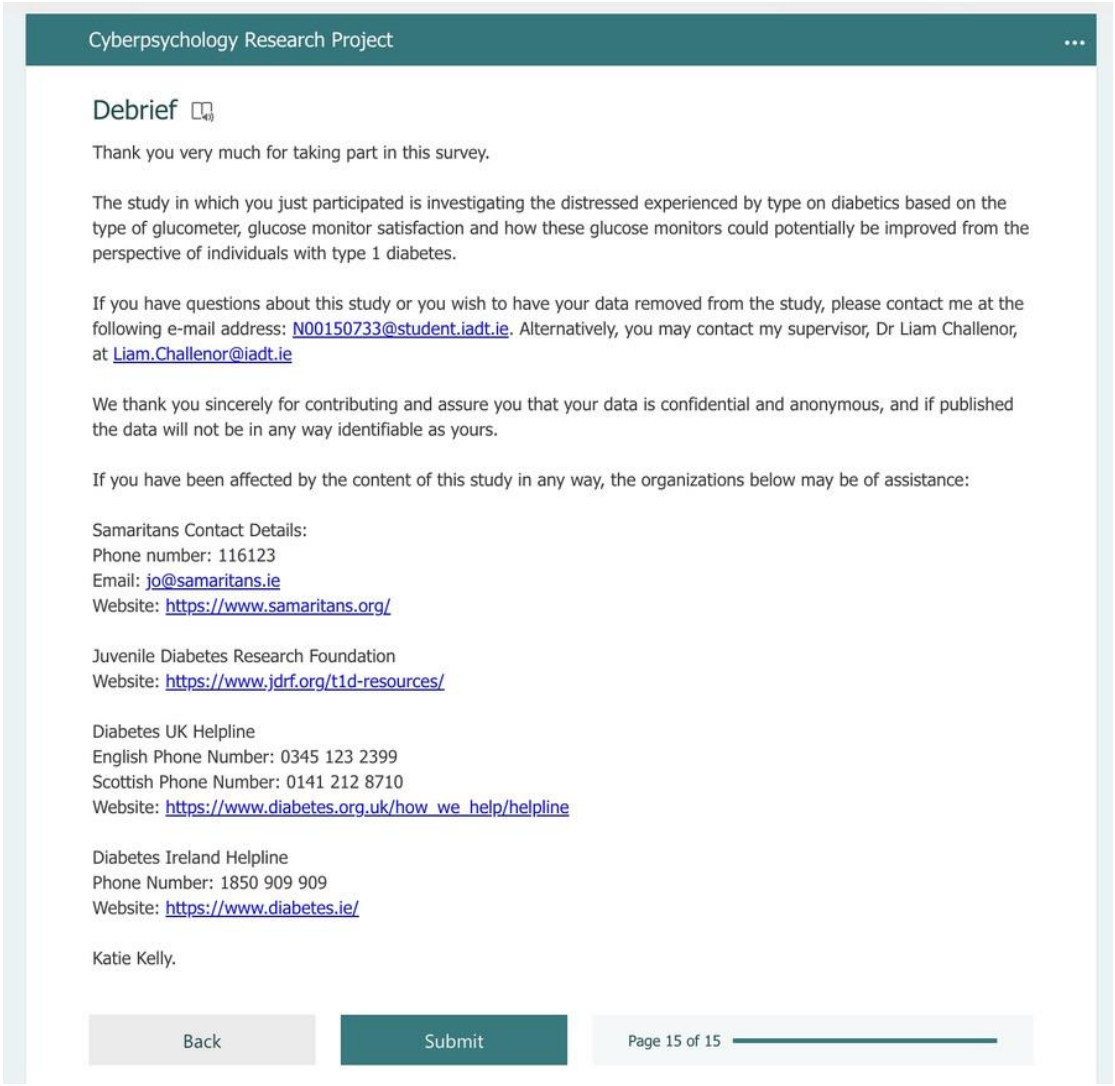

Cyberpsychology Research Project ...

Debrief

Thank you very much for taking part in this survey.

The study in which you just participated is investigating the distressed experienced by type on diabetics based on the type of glucometer, glucose monitor satisfaction and how these glucose monitors could potentially be improved from the perspective of individuals with type 1 diabetes.

If you have questions about this study or you wish to have your data removed from the study, please contact me at the following e-mail address: N00150733@student.iadt.ie. Alternatively, you may contact my supervisor, Dr Liam Challenor, at Liam.Challenor@iadt.ie

We thank you sincerely for contributing and assure you that your data is confidential and anonymous, and if published the data will not be in any way identifiable as yours.

If you have been affected by the content of this study in any way, the organizations below may be of assistance:

Samaritans Contact Details:
Phone number: 116123
Email: jo@samaritans.ie
Website: https://www.samaritans.org/

Juvenile Diabetes Research Foundation
Website: https://www.jdrf.org/t1d-resources/

Diabetes UK Helpline
English Phone Number: 0345 123 2399
Scottish Phone Number: 0141 212 8710
Website: https://www.diabetes.org.uk/how_we_help/helpline

Diabetes Ireland Helpline
Phone Number: 1850 909 909
Website: https://www.diabetes.ie/

Katie Kelly.

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