

- **Project Title.**
- **Critical.**
- **Contextual.**
- **Historical.**
- **Conceptual.**
- **Economical.**
- **Social.**
- **Environmental.**
- **Ethical.**
- **Critical.**
- **Links: Ethical approval and References.**

An app to aid Type one Diabetics in tracking their blood glucose levels.

This undergraduate research proposal investigates the scope and efficacy of the proposed application, "Sweetcycle", a mobile app which measures and tracks medical data for Type 1 Diabetics. In 2010 the disease affected over 21,000 Britons over the age of 17, and is expected to grow exponentially (Diabetes UK, 2010). Further examined are the possible details of the application, considered from a graphic design aspect with regard to user experience and infographic presentation for a complex illness. Type 1 Diabetics are expected to frequently be aware and involved in the corrections of their medication, which requires close communication with health specialists and medical device providers. There are challenges for addressing economic and environmental issues that have been ongoing since the discovery of treatment. Despite this, the application tackles social and ethical implications of the disease through a supportive interface and community. 'Sweetcycle' promotes education, encourages goals and communication with medical professionals through an accompanying website.



Type 1 Diabetes Mellitus (T1DM) is a chronic disease that occurs when the pancreas is unable to produce the hormone, Insulin. This results in unpredictable high blood glucose levels. There is currently no cure for the disease however it can be treated by administering Insulin via injections or an automatic pump. In both treatments the patient is expected to monitor their blood glucose levels to administer the correct dosage of Insulin and avoid long term health complications. A patients overall management is calculated from their average blood glucose (HBA1C). Whilst treatment is improving, the design of many new devices can often be complex and misleading to the patient. The aim of the app is to create an interface that displays information in a digestible and enjoyable way for type one Diabetics. A better user experience will lead to better management and therefore higher patient independence. Recent research proposes a yearly increase of 3.4% in Europe every year, with no clear answer as to why, we know that there are currently close to (Diabetes UK, 2010) . If the illness goes uncared for or untreated for too long it can result in life threatening altercations such as Hypoglycemia (HOG) or Hyperglycemia (HRG) and Ketoacidosis (KDA). KDA is the most serious of the three as it means the body has not had sufficient insulin over a period of time to convert sugar into energy. This can result in irreparable damage being done to the patients organs.



Whilst these new devices provide the user with an easier experience it should be noted that there is immense room for improvement within the app design. 'Dexcom' represents the best app interface in terms of design [fig.2] however it has been oversimplified to display one graph and one reading for HBA1C. This could be misleading as a median blood sugar average does not represent the amount of time the user is 'in range'. When compared to similar health tracking apps, such as 'Sleepcycle' [fig.3], an app that tracks sleep patterns, it becomes apparent that Dexcom are not taking advantage of the 'real estate', phone screens offer. 'Sweetcycle' will praise the user through a rewards system where stars are issued should all blood sugar checks be completed, these features add visual feedback intended to encourage and support the user [fig.4]. This is to integrate good habits on monitoring the illness. If the user does not meet their goal, the app can give valuable feedback through detecting patterns in the given data. For example, "You have had three hypoglycaemia's at 4pm this week", would alert the user of this pattern and issue. The app will use icons to tag points on the graph [fig.5], indicating lifestyle factors that may have affected their blood glucose such as alcohol consumption, menstruation or illness. This will also allow the user to recognise patterns. To encourage diabetics to engage with the app, push notifications will be sent to the user. The colour red with a pink hue was chosen to alert the user without alarming them. [fig.6] It is also critical that these notifications stand out against other applications due to their urgency. In conjunction with the application there is also a website to view data in-depth over a larger scope of time, this provides the user with higher reliability in measuring their HBA1C, since they are able to access a comprehensive display of their diabetic maintenance. Playful iconography and infographics are used throughout the app and website to create a pleasant experience. Research shows that information accompanied with visual graphics, is 80% more likely to be remembered than non-visual information (Glaser, R. 1983) Therefore the use of graphics is invaluable representing user data.

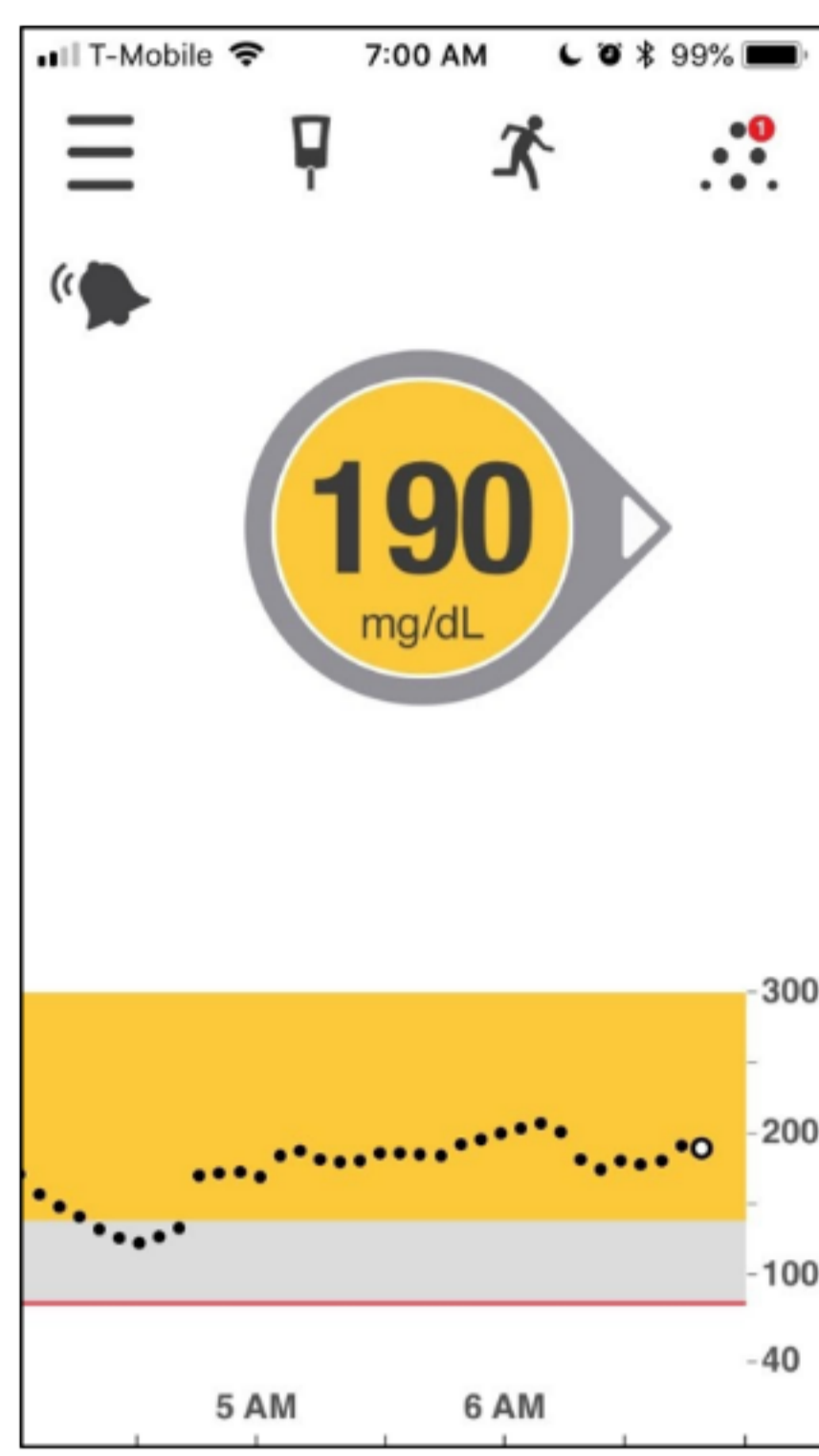
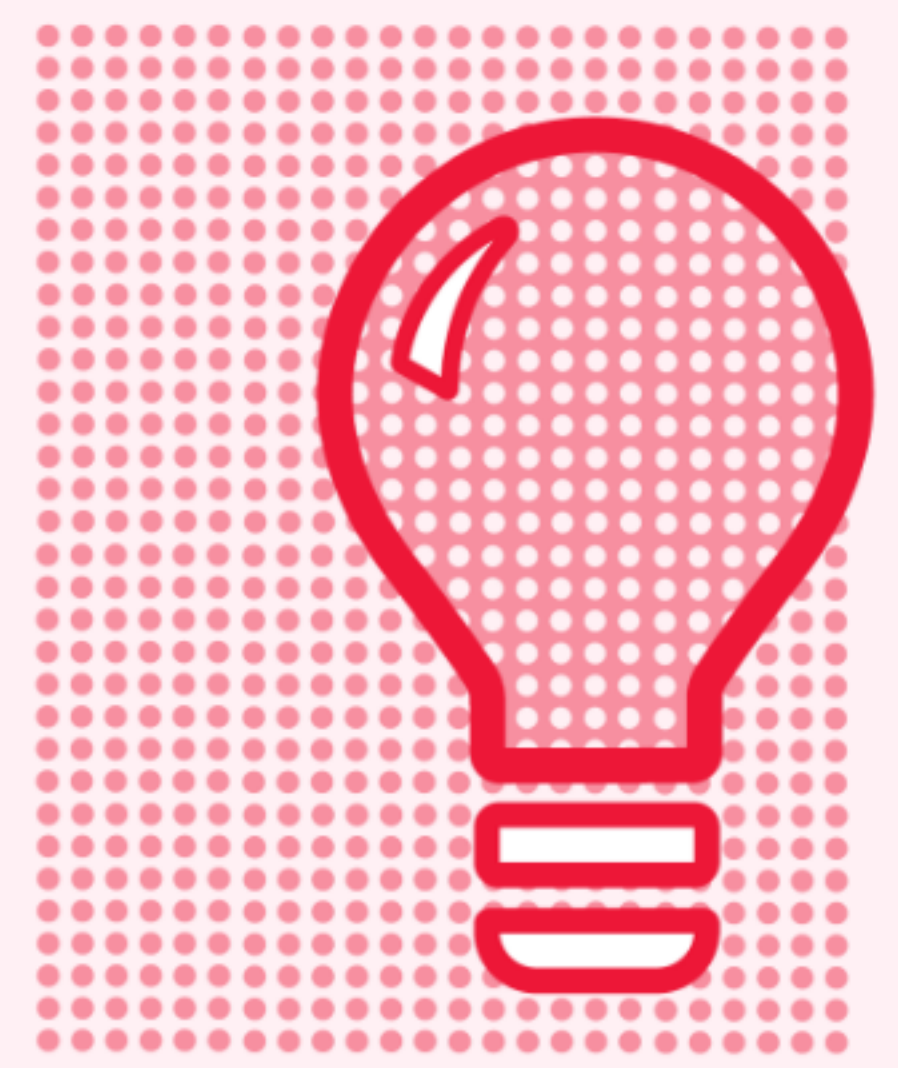


Figure 2. Image displaying Dexcom G6 app interface. Brown, A. and Close, K. (2018) G5 app screenshot (left) vs G6 app screenshot (right) Available at: <https://diatribe.org/dexcom-g6-review-no-fingersticks-cgm-one-button-insertion-and-10-day-wear> (Accessed: 01/10/19)



Figure 3. Image displaying 'Sleep Cycle' App Interface. App Store (2019) Sleep cycle: smart alarm clock Available at: <https://apps.apple.com/gb/app/sleep-cycle-smart-alarm-clock/id320606217> (Accessed: 01/10/19)

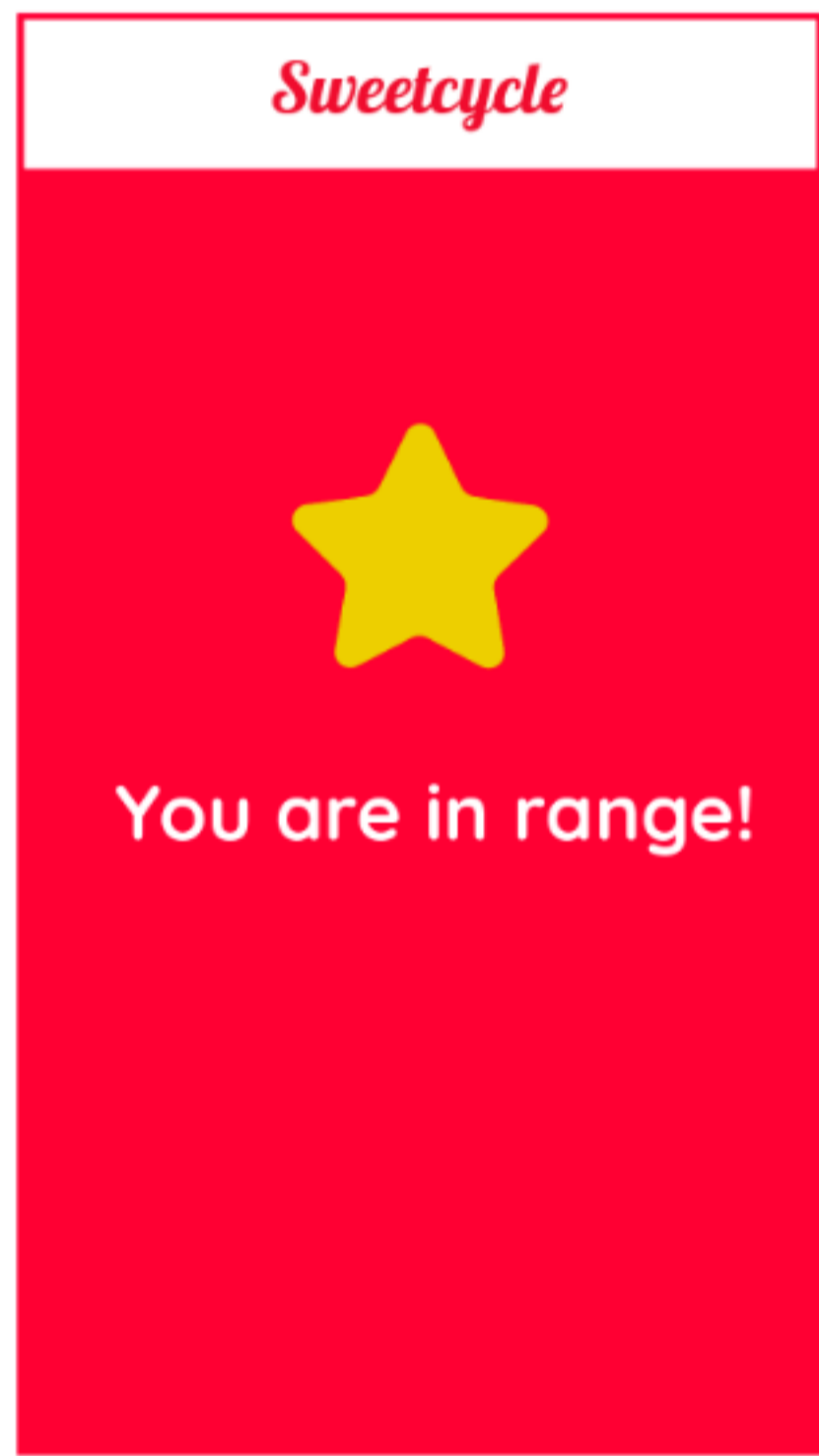


Figure 4. Example of 'Sweetcycle' rewards.

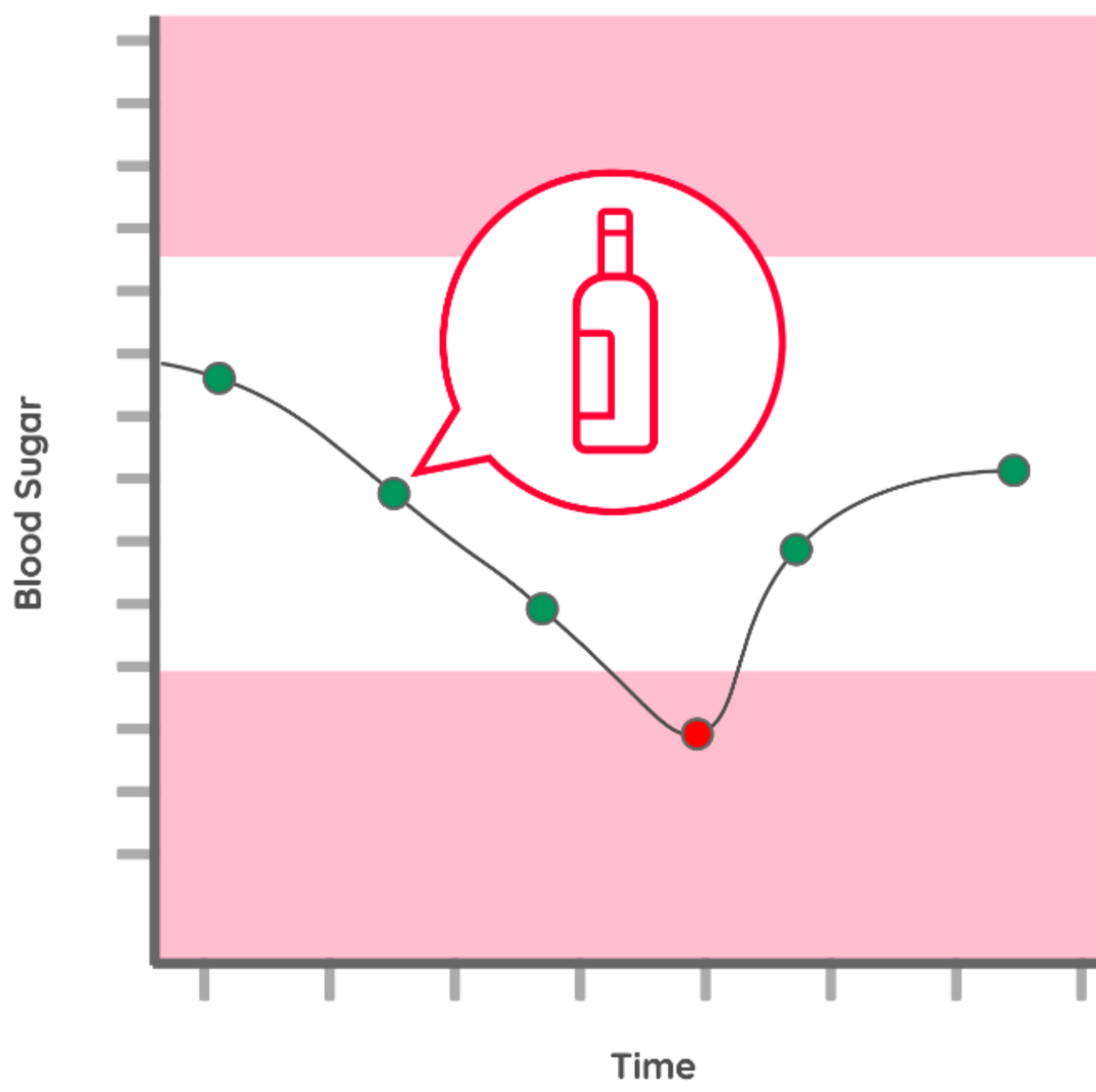


Figure 5. Example of 'Sweetcycle' icon tags for graphs.

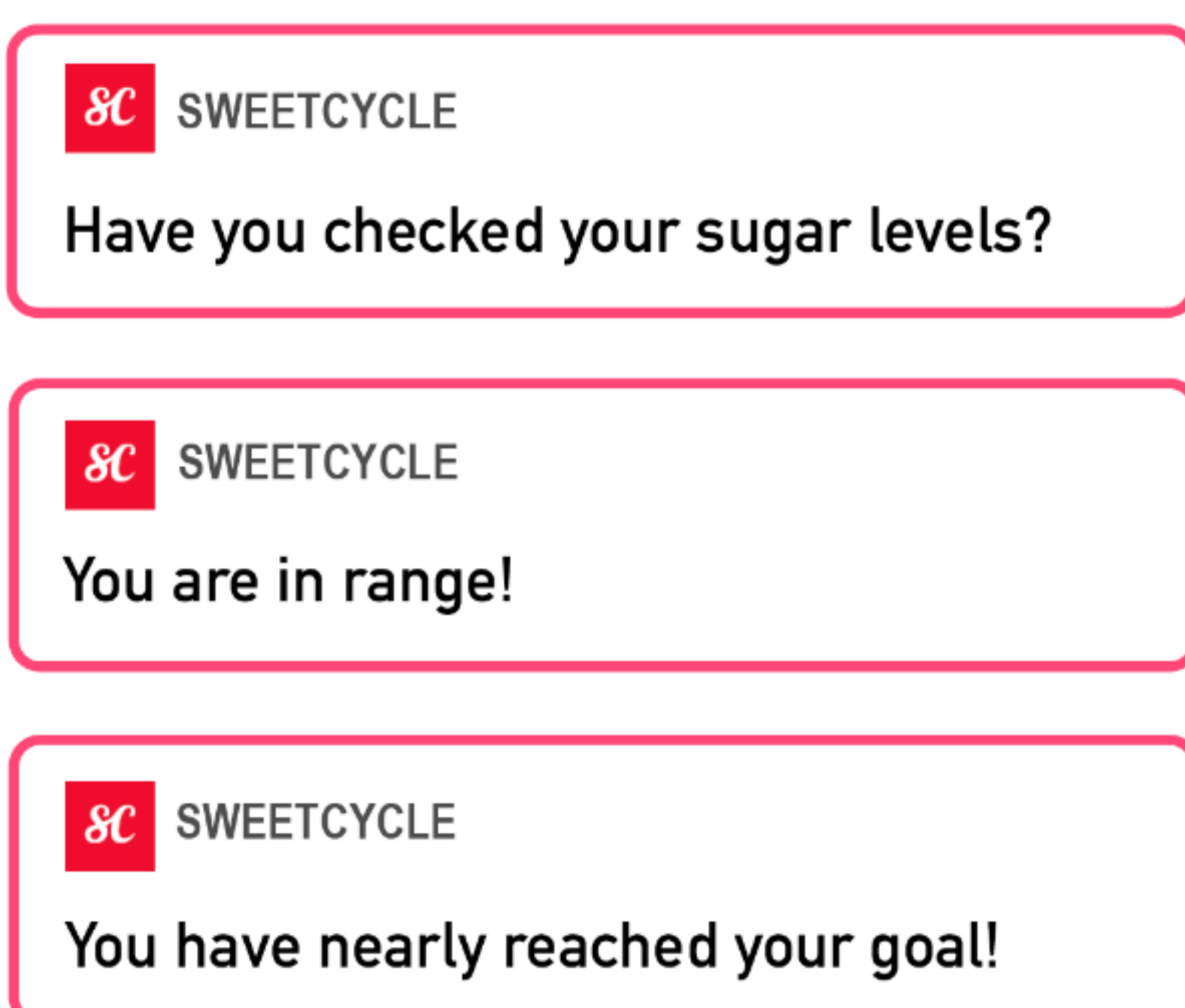


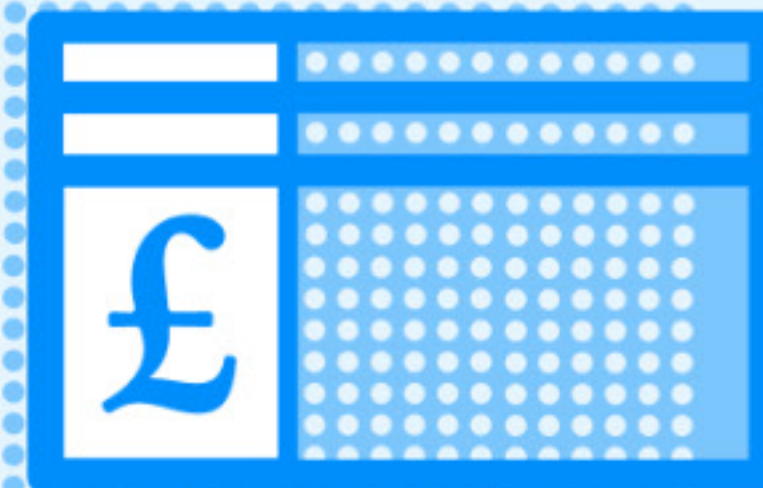
Figure 6. Example of 'Sweetcycle' push notifications.



Figure 7. Example of 'Sweetcycle' web icons for education. Displaying the lifestyle factors that effect blood glucose.

Economical.

As mentioned before, there are a wide range of health risks posed to T1DM patients. If T1DM is left untreated it can lead to hospitalisation for KDA. Senator Jane Smith of North Carolina states one day in a USA hospital for KDA can exceed \$10,000 with two days easily exceeding \$20,000. According to a 2015 research study (Previously Healthy) “more than 12,700 paediatric patients in the US are diagnosed with DKA each year”, the annual cost being \$90 million. Along with these immediate problems, further complications such as Diabetic Retinopathy, liver failure and amputation can occur leading to more costs on top of the individual still being Diabetic. During 2012, the UK spent £1.802 million on type 1 Diabetes alone with a further £14 million (Diabetes UK, 2019) spent on Diabetic medical emergencies and treatment. With the current trajectory of closed loop insulin delivery systems, and the development of non invasive sensors and measures, It is entirely possible for mobile application to follow suit as seen with Dexcom, which makes the application a step towards a fully autonomous closed delivery system which can sense blood glucose change with absolute minimal patient intervention. These possibilities are already being studied intensely and investment into these future projects could save millions in the long term for the UK. (Artificial pancreas: past, present, future, 2011)



The environmental implications of type one Diabetes are beyond the scope of 'Sweetcycle' due to the necessary disposable aspect of medical equipment. However improvements in blood glucose control will result in fewer complications and the additional medical equipment that accompanies these secondary diseases. Due to the digital aspect of 'Sweetcycle', environmental progress can be made by reducing the amount of paper in the NHS supply chain. NHS Paperless 2020 is a five year plan that aims to digitalise medical records to improve on efficiency within the organisation but also to reduce their carbon footprint. One way they are hoping to address this is in the reduction of paper use, almost 3.6 million reams of non recycled paper were used in the NHS supply chain (2016/2017). This is equivalent to 29,062 tonnes of CO₂. [table.1] The Sweetcycle app aims to promote the assistive digitalisation of health records and habits. This is crucial as long term health complications such as T1DM, can create medical histories that consist of thousands of pages.



	Reams of paper procured*	Tonnes CO ₂ Produced in Manufacture	
		Paper procured through NHS Supply Chain in 2016/17	Equivalent CO ₂ had only 100% post-recycled paper been procured
Virgin Paper	3.571 million	28,925	15,712
75% Post-Recycled Paper	10,000	53	44
100% Post-Recycled Paper	19,000	84	84
Total Tonnes CO₂ Produced in Manufacture		29,062	15,840

*for the purpose of these calculations, a 'ream' of paper is classed as 500 sheets of white A4 paper at 80gsm.

Table 1. Tonnes of CO₂ Produced during the manufacture of paper procured through NHS Supply Chain in 2016/17, and equivalent emissions had all paper been produced from recycled sources. Roddis, N. (2017) The Impact of Paper Procurement in the NHS. Available at: [https:// networks.sustainablehealthcare.org.uk/networks/green-nephrology/impact-paper-procurement-nhs](https://networks.sustainablehealthcare.org.uk/networks/green-nephrology/impact-paper-procurement-nhs) (Accessed: 23/10/19)

The “Sweetcycle” app attempts to bridge the social connection between the user, their support circle and their medical specialist team. Doctors are also able to gain a useful insight into the self care measures and checks done by the patient independently. The website also includes information to educate people affected by the disease. This will include information on symptoms through iconography [fig.7] and serve as a safe platform for the users to contact support services and seek advice. It is the hope of sweetcycle that such a comprehensive application could have a wide scope of effect for family relationships and unity in handling Diabetic pressures at home. Higher rates of patient independence will result in less appointments regarding stress and mental health. Studies like (2012, Diabetes expenditure) and (Good Metabolic Control Is Associated With Better Quality of Life, 2001) show a direct correlation with the frequency of management around blood glucose, Insulin delivery and the patient’s quality of life. In the long term, this may take pressure off the NHS, who currently have departments dedicated to the mental wellbeing of Diabetics.



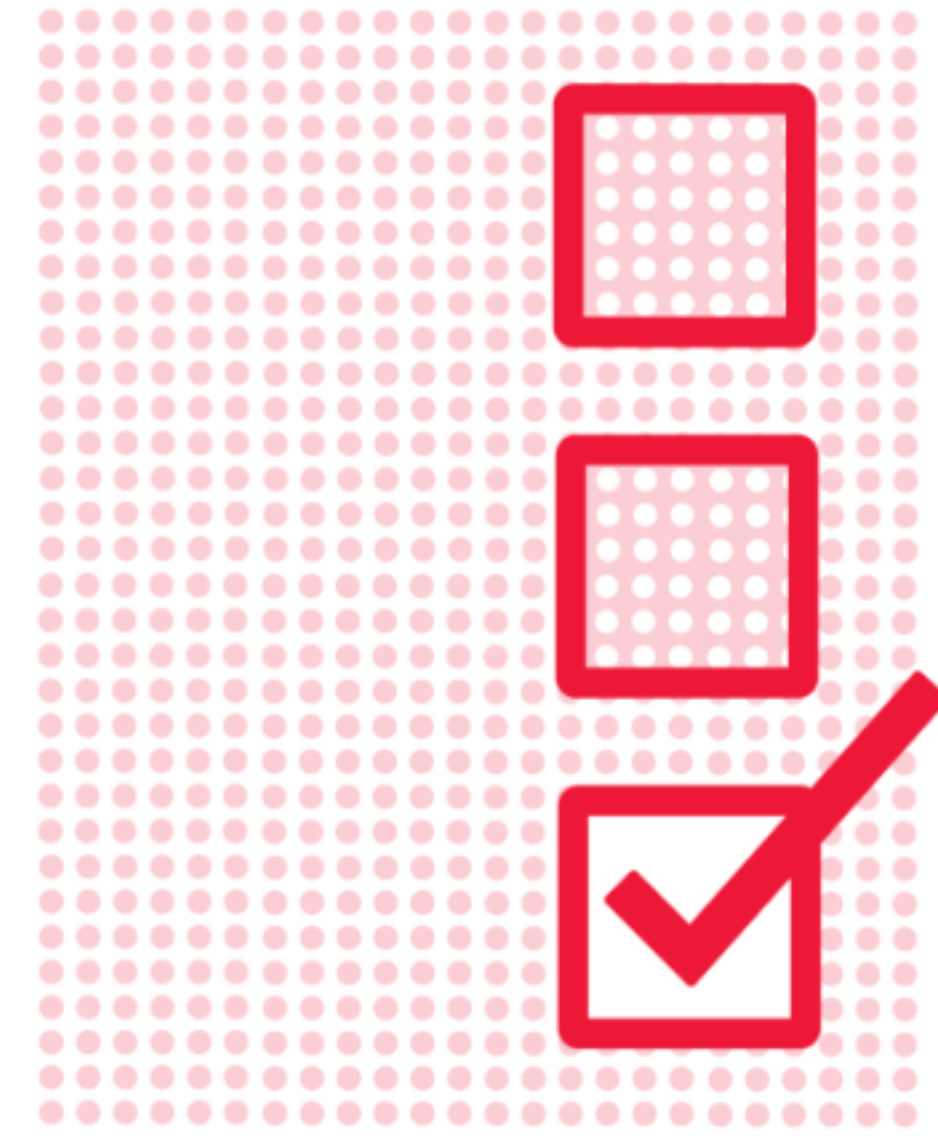
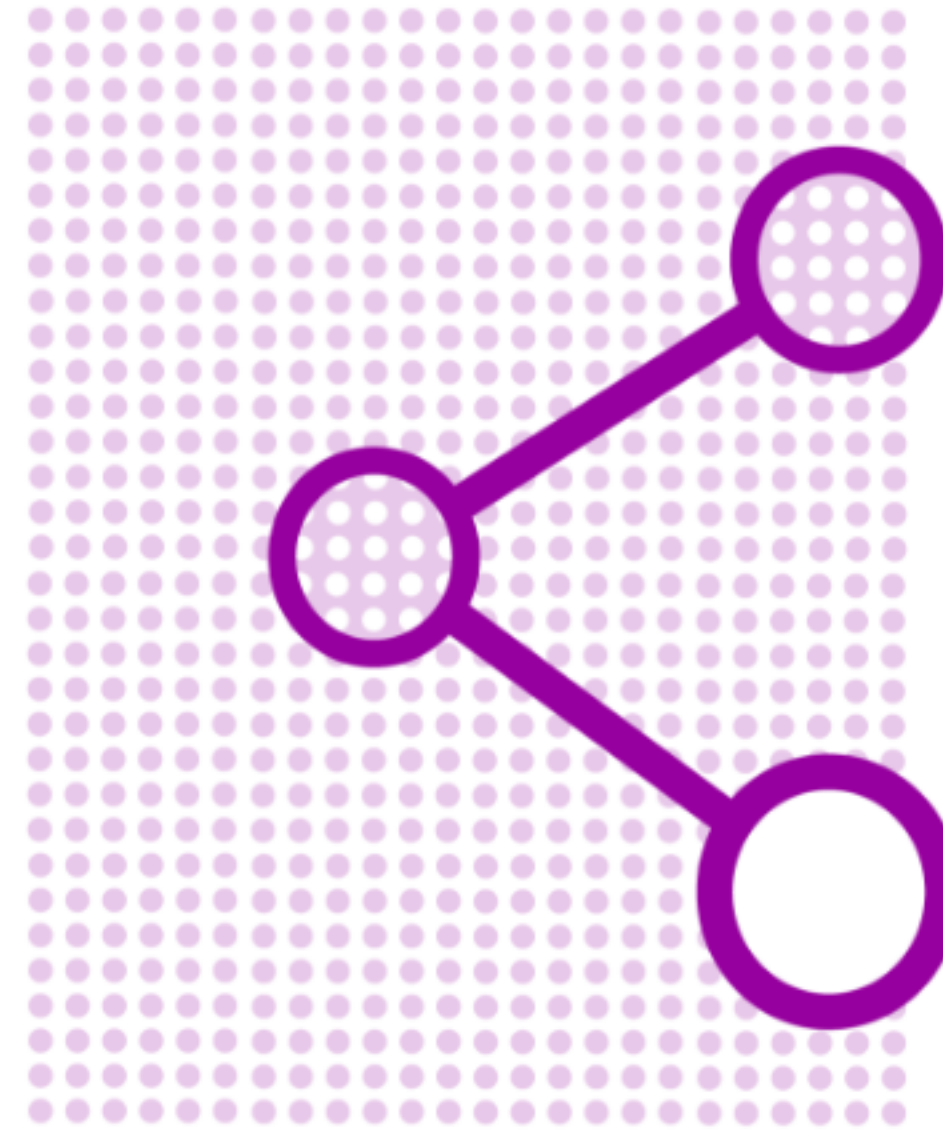
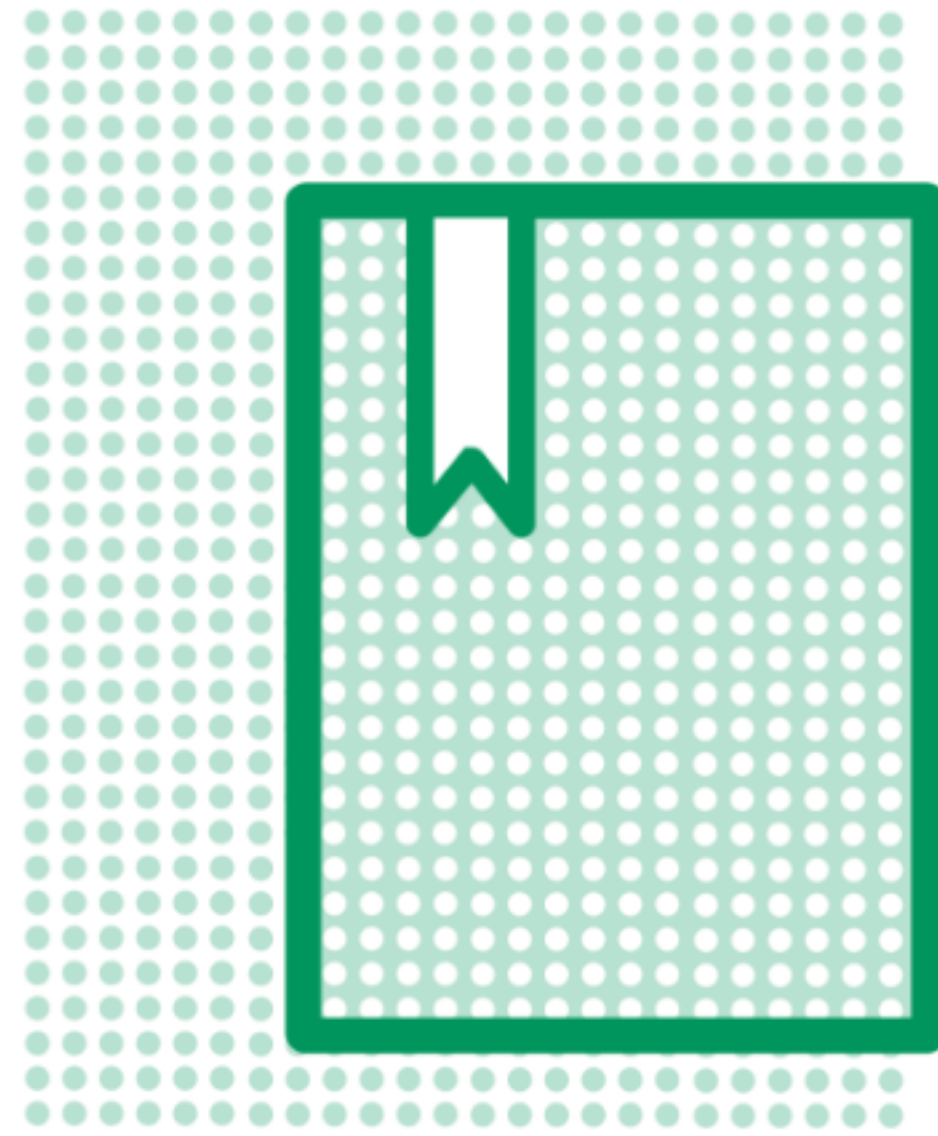
Due to the demanding nature of the illness, studies have shown that a patient's mental health and their support circles play a pivotal role for good blood glucose management, this was discussed with a focus group in a study by Junior Diabetic Research Foundation [JDRF] with Dr. Jill Weissberg-Benchell. She is a certified Diabetic educator and psychologist who begins a dialogue with several patients on how Diabetics should develop healthy attitudes to selecting or removing people in their support circles. If left without the proper guidance and emotional assistance these issues can manifest into Depression, a more volatile HBA1C and greater susceptibility to the side effects of HOG and HRG. The focus group also discusses how their condition is spoken about in their circles and what type of language they deem constructive and deconstructive towards their attitudes in health management. One example of this includes redacting "blood tests" with "blood checks" [fig.4] this is done so as to combat the idea of a patients HBA1C, being an examination of how well they manage their condition. The aim of Diabetic care should be a constructive and include constant praise [fig.6] as this has proven better blood glucose control and mental health in type one Diabetics. Dr. Weissberg-Benchell warns that constant criticism is ineffective in both judicial corrections and in teaching the severity of diabetic management, as they do not help a developing young adult learn the information to manage their condition independently. This correlation between stress and Diabetic glycemic stability is proven amongst studies carried out by notable charities such as JDRF and Diabetes UK which work to support patients in providing effective counselling.



There may be some who believe that the inclusion of a playful interface could take away from the severity and urgency of the notifications it is communicating, however others would argue that the use of negative language in order to correct behaviour is not the most effective method of correction. It would have been a great improvement to further include perspectives on the apps design from a more culturally diverse group of collaborators, so as to not neglect Diabetics from other areas of the globe. If this project were not confined to a time limit it would have been beneficial to include a food search index which would denote nutritional information on many different foods and drinks, with comparisons to well known products so as to accurately display its effect on blood glucose. Alongside this it could have been beneficial to include a page for news surrounding changes in Diabetic treatment and in medical technology being developed for the future. This would help strengthen the social aspect of the application. Ultimately these features were removed, as it would disrupt the simplicity of the application and may result in an overwhelming amount of information.

Many difficulties and dangers exist around T1DM and whilst its management and maintenance is constant and demanding, the patients of this illness are heavily involved with the promotion of research funding and in the discussions around new technologies usability and how well it caters to the modern market of Diabetic treatment. Its effect on the economic market has boomed in the private healthcare states of America, its reach is not limited to just its carrier but to their families and communities also. The application's utility functions in consequential effect of these themes, to help type one Diabetics manage their condition more effectively, whilst also providing the means to strengthen their support network, whether family, friends or doctors which inspire more positive self care habits.





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Regarding Mental Health:

Mental health services are free on the NHS.

There are some mental health services that allow people to refer themselves. This commonly includes patients with long term medical complications such as Type One Diabetes.

Always inform your GP and Diabetic team of mental health, they will be able to provide tailored long term support.

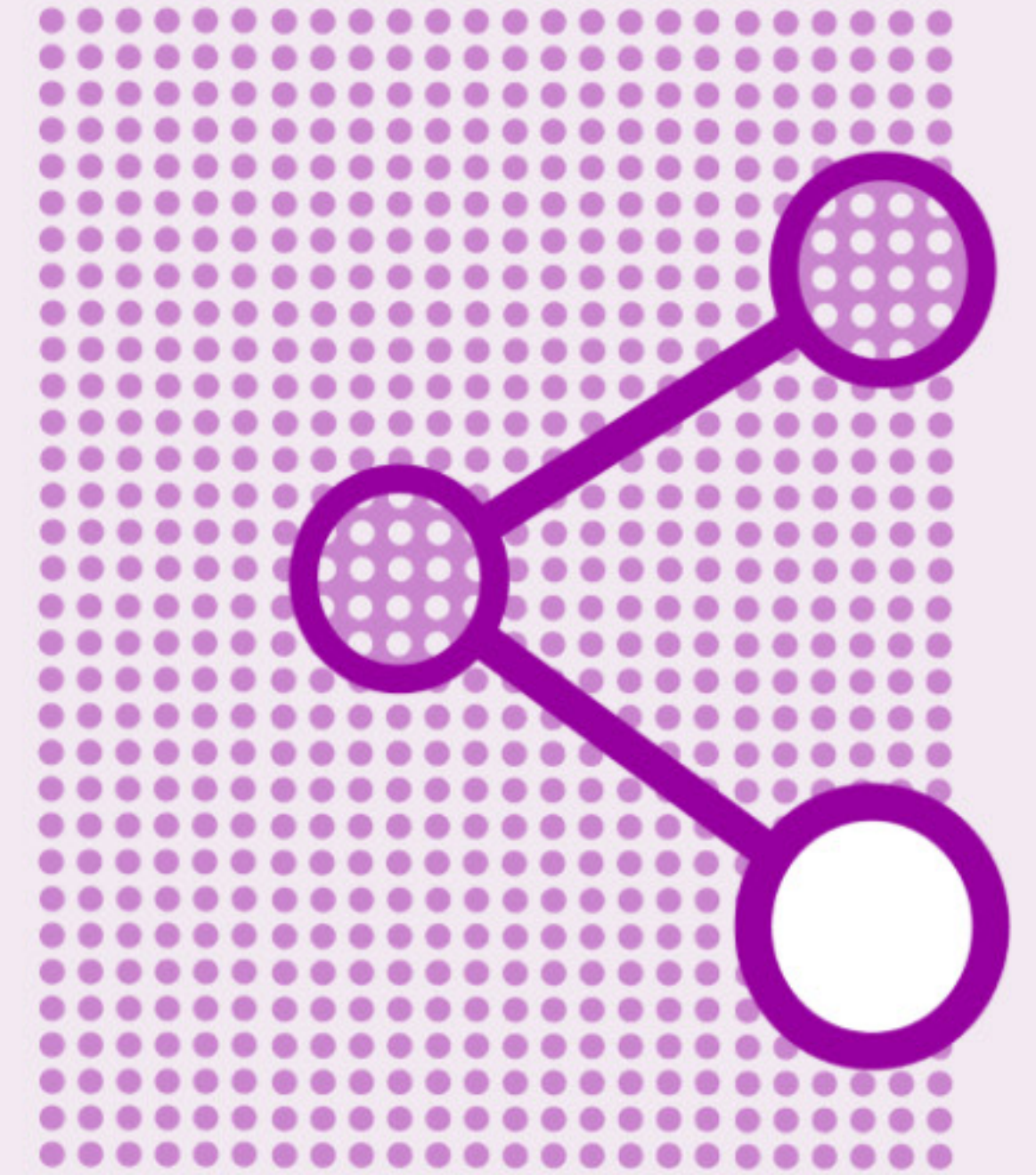
If you want to talk to someone right away, the mental health helpline page (at: <https://www.nhs.uk/conditions/stress-anxiety-depression/mental-health-helplines/>) has a list of organisations you can call for immediate assistance.

These are helplines with specially trained volunteers who will listen to you, understand what you are going through and help you through immediate crisis. The charity, Samaritans, operates a free service 24 hours a day, 365 days a year for people who want to talk in confidence. They are available to call on 116 123 or visit their website at: <http://www.samaritans.org/how-we-can-help-you/contact-us>

Regarding Physical Health:

If it is physical health which is of a concern, contact your GP or Diabetic Team.

NHS 111 is a fast and easy way to seek help (available 24 hours a day, 365 days a year) Calls are free from landlines and mobile phones. You should call the NHS 111 service if you need medical help or advice which is not life threatening. For more urgent medical concerns, call 999 (available 24 hours a day, 365 days a year) for immediate medical assistance.



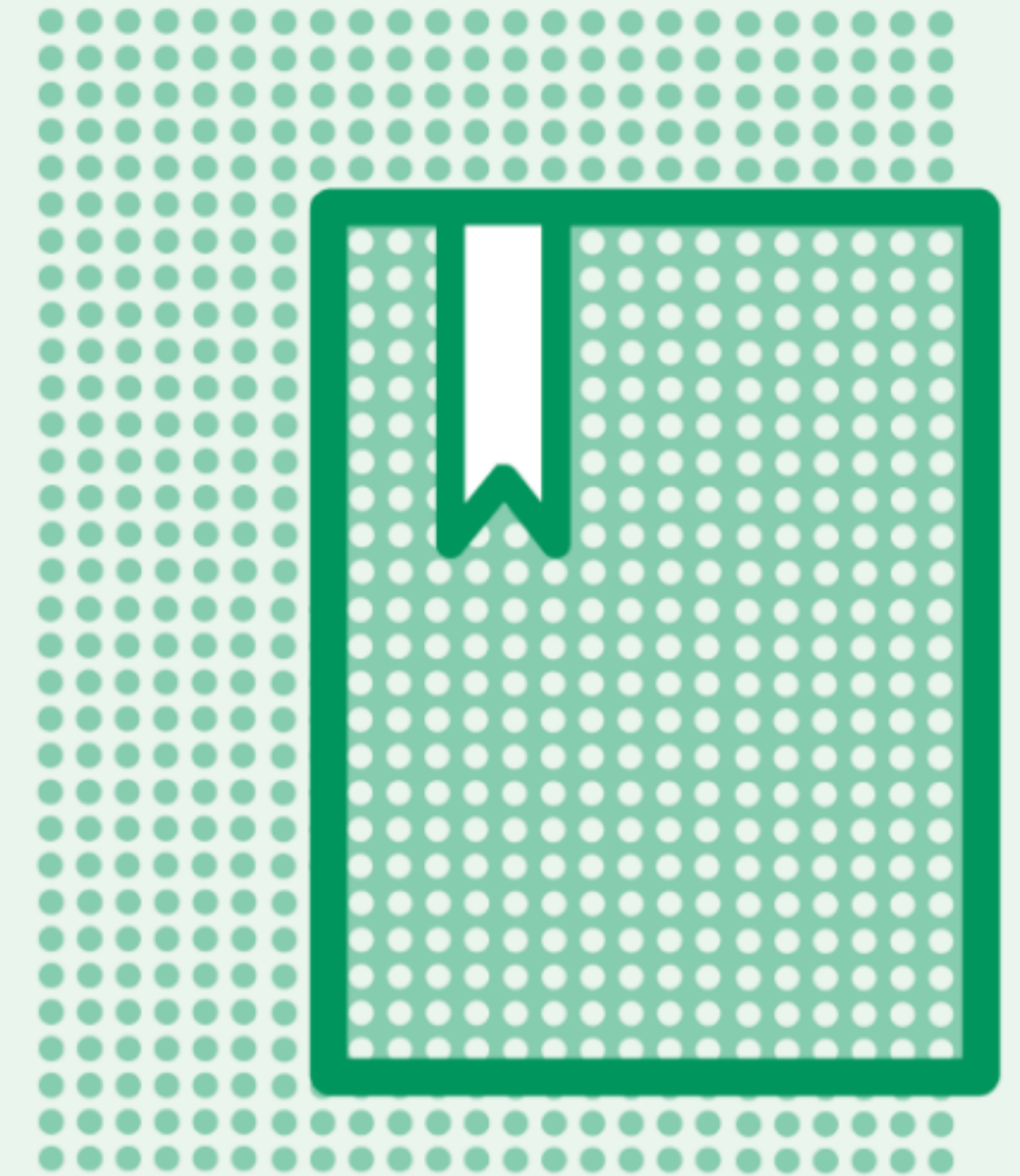
An app to aid type one Diabetics in tracking their blood glucose levels.

You are invited to participate in a research study to understand the devices and methods used by Type one diabetics to track their blood glucose levels. We hope to gain a further understanding of the methods and devices to inform decisions regarding the design for the app 'Sweetcycle'. You were selected as a possible participant in this study as you are Type one Diabetic or a guardian of a Type one Diabetic. Your participation in the study is expected to take no longer than the following questionnaire.

Your participation in this study is entirely voluntary. You can decide to participate now, but withdraw your consent at any time without having to give reasons or answer any further questions. Please contact me through the DiabetesUK Forum under the username Sweetcycle.

Your participation in this research will be recorded in the form of the feedback from the questionnaire. The resulting recording will be stored via a password protected hard drive from a personal laptop, and destroyed by 1st July 2020. You will not be referred to by name in the final project. All participants will remain anonymous throughout the entire project.

This research is being undertaken as part of my undergraduate dissertation. The findings will be included in my final piece of work, and this will be submitted to the University of West London and read by lecturers and examiners. I have not got any plans for further publication of the findings, and will not disseminate this research study further without contacting you again for your express consent. The final app and products of it will be included as part of my portfolio.



'Sweetcycle' is an undergraduate university project and currently a prototype.

Name of Researcher: Phoebe Watts

Title of Project: An app to aid type one Diabetics in tracking their blood glucose levels.

Goal: To create a 'go to' app for Type one Diabetics that does more than only tracking blood sugar levels.

I have first hand experience of living with Type one Diabetes and have recognised that many of the apps available to us do not take full advantage of the technology available in 2019.

Aims of the Project:

- Creating a national campaign to raise awareness for Type one Diabetes.
- Promoting the Type one Diabetic community.
- An enjoyable user experience, through digestible, playful infographics.

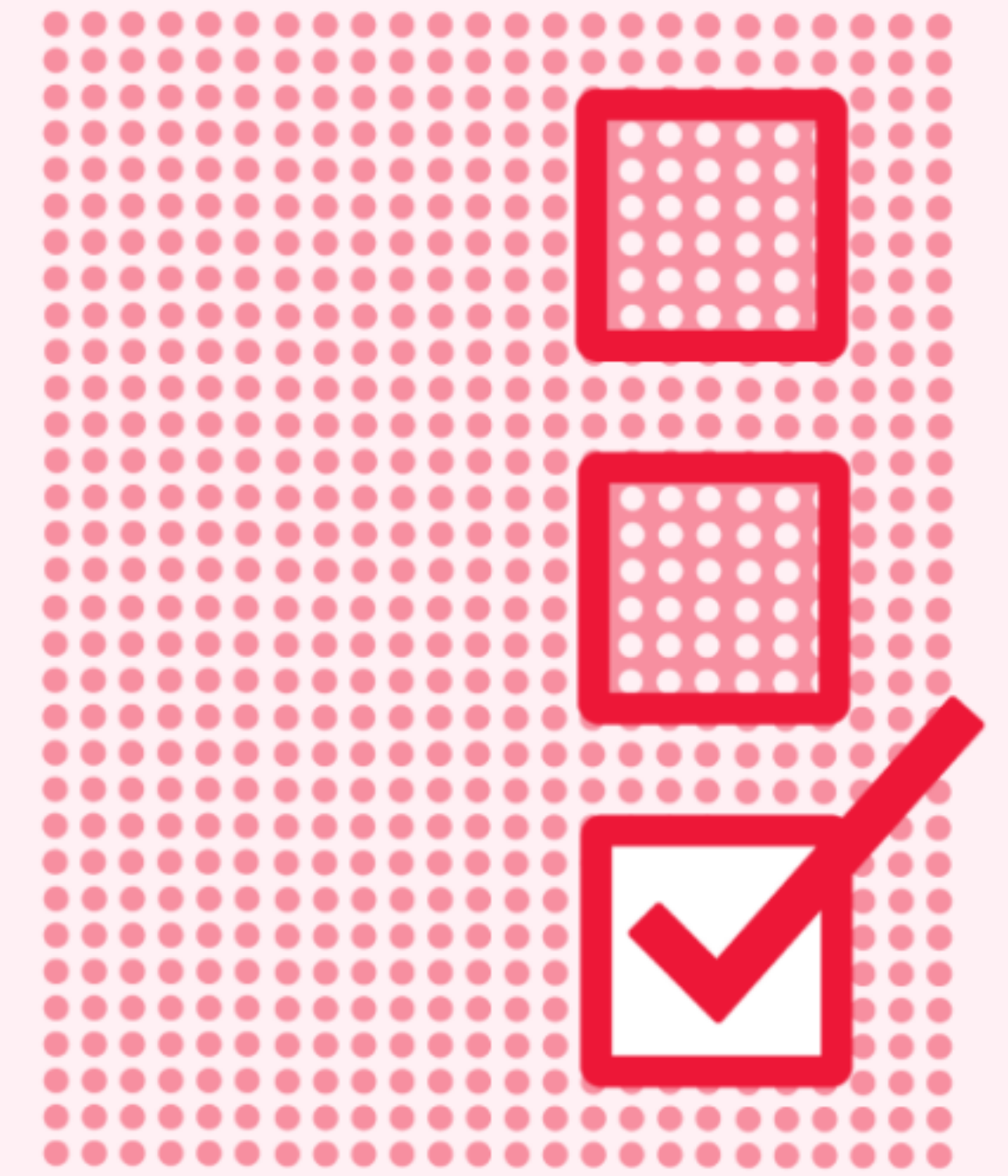
System: your own personal way of logging your Diabetes, (For example, if you use a diary, what are the benefits and disadvantages of this).

By completing this questionnaire, you are providing an invaluable source of information that will influence features of the final product.

Please only answer the questions that apply to you.

All questions are optional.

<https://surveyhero.com/c/b3c8d0cb>



Sweetcycle