Engagement and effectiveness of digitally enabled behavioural change support for people living with type 2 diabetes

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Received: 3 June 2020
Accepted in revised form: 23 June 2020

Abstract
People living with type 2 diabetes are usually offered diabetes structured education, brief diet and lifestyle advice, or referral to weight management services. These are delivered in a face-to-face setting traditionally, but attendance and outcome data are inconsistent. Digital alternatives provide a different approach, but outcomes and engagement are poorly understood. This study aims to strengthen this evidence by evaluating a digital lifestyle change programme.

Data were analysed from participants referred as an alternative to face-to-face weight management or structured education courses. They were adults living with type 2 diabetes, with a mean baseline BMI of 35.9kg/m² (SD ±6.7). Weight data were collected using digital weighing scales, and the participants’ general practitioners collected HbA1c data. Engagement data were collected through interactions with educational articles, tracking devices, and support from peers or a health coach.

In total, 144 participants started the programme, and 94 (65.3%) submitted weight readings after 12 months. Of these, 60.6% achieved over 5% total body weight loss, and 28.7% achieved over 10% total body weight loss. The analysis found 41/144 (28.5%) participants returned to their general practice for a blood test, and 39% reduced their HbA1c to below 48mmol/mol. A higher number of interactions with the application was associated with greater weight loss.

This evidence supports the effectiveness of digital behaviour change interventions, using structured education and weight management advice. Findings provide information on engagement with these programmes, suggesting a potential association between programme engagement and weight loss. Copyright © 2020 John Wiley & Sons.

Key words
diabetes; digital; engagement; weight loss; behaviour change; nutrition; Second Nature; education

Introduction
In the United Kingdom (UK) the prevalence and costs of treating type 2 diabetes are growing. The National Health Service (NHS) diabetes spend is estimated to reach £15.1bn by 2036,1 with the majority being spent on treating complications of the disease.2 Type 2 diabetes has been generally considered a progressive condition, but evidence suggests it is possible to manage it effectively, reduce medications, and bring the disease into remission through intensive weight management and support.3–5

Despite this emerging evidence, the non-pharmaceutical treatments for people living in the UK are diabetes structured education classes, brief diet and lifestyle advice, or referral to a weight management service, which are usually delivered face-to-face.6 Digital alternatives could provide a convenient and cost-effective method of helping people access support, while encouraging engagement and promoting outcomes.

Structured education services provide learning sessions to improve the management of type 2 diabetes. These classroom-based courses aim to help people build confidence and understanding of type 2 diabetes management.6,7 Weight management programmes provide dietary advice and encourage healthier lifestyle habits.8 These programmes can help with glycaemic control and other clinical outcomes.9 There is conflicting evidence supporting the use of these programmes. Some research concludes they are likely to be cost-effective, but other studies suggest attendance can be as low
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as 22.4% and argue that there are no significant improvements in outcomes after three years.16–15 Low attendance at face-to-face services is often due to logistical or financial difficulties, or feelings of shame.14–16

Digitally delivered programmes often combine several components, including structured education, weight management advice, peer support, and tracking technology. They have demonstrated sustained significant improvements in access, engagement, weight loss, and HbA1c.17–19 However, there are few studies that evaluate the effectiveness of digital interventions for weight loss.20

The NHS released transformation funding to encourage the use of digital alternatives for diabetes structured education programmes.21 Local health economies and diabetes charities became aware of the potential benefits of digital programmes. To provide more accessible education and behaviour change support to individuals in the local area, Second Nature (formerly OurPath) partnered with Solent Diabetes Association, and NHS clinical commissioning groups in Portsmouth, Fareham and Gosport, and South East Hampshire.

This study aimed to evaluate the effectiveness of a digitally enabled behaviour change intervention. The primary outcome was weight loss. Secondary outcomes studied were HbA1c reduction and programme engagement.

Methods
Participants
Community diabetes specialist nurses were trained to identify participants and fully explain the programme. They recruited participants from their respective general practices or Diabetes Education and Self-Management for Ongoing and Newly Diagnosed (DESMOND) sessions. The offer to take part in the programme was part of their usual care for weight management and behavioural change support. There was no financial incentive to enrol in the programme.

Participants were over 18 years old, had a diagnosis of type 2 diabetes and BMI over 29kg/m². Participants had access to a smartphone or tablet device and were comfortable using technology.

Study design and procedure
This service evaluation did not require Institutional Review Board approval as the study did not include any personally identifiable information. Data were collected from participants who had consented for their anonymised data to be collected for medical research purposes as part of the programme, and for their data to be part of analysis and publication. The programme was part of usual care and participants were not randomised to treatment. Anonymised data were collected between 22 January 2018 and 16 July 2018.

Second Nature is a three-month remote behavioural change programme with mentoring from a registered dietitian or nutritionist (health coach), peer group support, structured education articles and activity tracking technology. These elements were accessed via a smartphone or web-based application (see Figure 1). Each participant received an instructional handbook, recipe book, wireless weighing scales, and a wristband activity tracker.

The programme supported participants in making changes to behaviours while educating them on improving physical and mental wellbeing. The behaviour-change techniques were adopted from the ‘Behaviour Change Wheel’.22 The adoption of new behaviours was facilitated by encouraging self-monitoring changes, providing social rewards, goals, and education from credible sources.23

Participants were allocated a health coach for personalised support via text-based messaging between 8am and 8pm, Monday to Friday. The support was provided via private messaging and as part of conversations within the group of 10–14 peers. Clinical advice on nutrition, how to overcome barriers to positive thinking, and ways to increase healthy habits was provided. The group support was designed to provide social accountability and motivation.24

Participants accessed the educational information in different mediums, such as video and plain text. The information covered themes such as the role of insulin, managing nutritional needs, and stress management. Each participant had access to the same content over identical lengths of time and was encouraged to frequently engage with the app and monitor progress against their goals. Health coaches were notified when a participant had low engagement, which enabled them to contact people who struggled to participate.

Data collection
Participants uploaded weight data using the weighing scales provided. The data were collected from the anonymous database for analysis.
HbA1c data were collected at the participant’s general practice, as part of routine care. The data were collected from the referring health care professional at baseline, six and 12 months and reported to the study team.

Engagement data were collected and extracted for each participant from a database, which captured interactions with the three main components of the smartphone application: Learn, Track, and Support. Learn interactions were defined as the number of articles read by participants. Track interactions were defined as the number of times a participant registered or viewed weight or steps readings. Support interactions were defined as the number of messages sent or read in either the private or group chat channels.

**Analysis**

Weight readings registered six weeks before or after 12 months from each participant’s start date for the programme were extracted from the database. The lowest weight reading within this timeframe was analysed. For the collection of weight data, the scales parsed readings through a weight validation algorithm, which accepted weight readings within an expected range. Engagement data were collected and extracted from the database for analysis.

The R open-source statistical language was used through the R-Studio interface to calculate statistical tests with p-values and generate visual representations of the data. One-way Student t-tests were used, with the null hypothesis being an average weight loss of 0kg (no weight loss). The test hypothesis was that the population mean was greater than 0. P-values reported in this publication also held significance at 95% level using a null hypothesis of 5.5kg weight loss.

**Results**

**Baseline characteristics**

In total, 190 people entered the service, 150 completed the registration and 144 participants started the programme. Of the 144 participants, 94 (65.3%) participants submitted weight readings 12 months after starting the programme, meeting the criteria for the data analysis (see Figure 2).

A higher proportion of females to males took part in the programme with 80/144 (55.5%) female, and 64 (44.4%) male (see Table 1). The mean starting BMI was 35.9kg/m² (SD ±6.7) and the mean starting weight was 102.7kg (SD ±20.7).

**Primary outcome**

Data from 94 participants who provided readings at 12 months showed a statistically significant change in weight (see Table 2) when compared to baseline (mean -7.8kg; -7.5%; p<0.001; SD ±8.6).

Male participants achieved a significant weight reduction with an average of 8.7kg weight loss (SD ±7.0). Females achieved a significant weight reduction with an average of 6.4kg weight loss (SD ±6.9). (See Figure 3.)

The proportion of people achieving more than 5% weight loss and more than 10% weight loss was also analysed for participants who met the criteria for data analysis. After 12 months, 57/94 (60.6%) participants achieved over 5% weight loss and 27/94 (28.7%) participants achieved >10% weight loss (see Table 3).

**Secondary outcomes**

Data from 41 participants who returned to their general practice
to have their HbA1c re-tested after 12 months, as part of their routine care, showed a statistically significant change in HbA1c compared to baseline (mean -10.4mmol/mol; p=0.001; SD ±8.6). (See Table 4.)

HbA1c data from 16/41 (39%) male participants and 25/41 (60.9%) female participants were analysed (see Figure 4). On average, male participants achieved an HbA1c reduction of 12.2mmol/mol. Female participants achieved an HbA1c reduction of 7.7mmol/mol. Of those participants, 16/41 (39%) reduced their HbA1c to below 48mmol/mol.

Engagement data were collected from all participants during the three-month programme. This captured interactions with the main components of the application: Learn, Track, and Support (see Table 5). From the participants with data available, 134/144 (93%) had at least one interaction during the programme.

Figure 5 shows that participants with high engagement levels with all aspects of the application achieved 9.5kg weight loss after 12 months compared to low engagers who achieved 6.7kg. High engagers with support interactions achieved 9.2kg weight loss after 12 months, compared to low engagers achieving 5.7kg. High engagers with tracking technology achieved 8.3kg, compared to low engagers who achieved 6.9kg weight loss at 12 months. High engagers with educational content achieved 8.1kg weight loss, compared to 7.9kg at 12 months for the low engagers.

Lost to follow up
The baseline characteristics of participants lost to follow up are given in Table 6.

Of the starting participants, 94/144 (65.3%) registered a weight reading 12 months after starting the programme. Only 41/144 returned to their general practice for a blood test to measure their HbA1c 12 months after starting the programme.

Of the participants who did not register a weight reading after 12 months, 41/50 (82%) recorded at least one weight reading before the 12-month milestone. The last recorded weight loss of these participants was 4.9±7.8kg. The average time since starting the programme for these last recorded readings was 36.6 weeks.

Of the participants who did not return to their general practice for a 12-month follow up HbA1c blood test, 42/103 (41%) returned for a test before the 12-month milestone. The last recorded HbA1c reduction for these participants was 14.6±15.3mmol/mol. The average time since the programme start for the last recorded HbA1c reduction was 20.8 weeks.

Of the participants who did not register weight readings after 12 months, 47/50 (94%) had some
level of engagement with the 12-week programme. This group consisted mostly of 22/50 (44%) people with engagement levels in the lower third of the cohort, with an average number of 137 interactions during the programme.

There were 11/50 (22%) people from the middle third of engagement and 14/50 (28%) people from the higher third of engagement, with an average number of 443 interactions and 846 total interactions respectively.

Discussion
Of the participants with data available, a statistically significant change in weight was observed compared to baseline. For many of the participants, weight loss exceeded 5%, which is associated with a reduction in HbA1c improvement in cardiovascular disease risk factors, and decreased diabetes and hypertension medication use.25

The analysis showed 39% of participants with data available reduced their HbA1c to below 48mmol/mol, the threshold below which the National Institute for Health and Care Excellence (NICE) recommends people living with type 2 diabetes maintain.20 Although type 2 diabetes has been considered a progressive disease,1 the data that we have available could support evidence that reducing HbA1c, through intensive weight management, might lead to diabetes remission; however, a larger sample of HbA1c data is needed. Future studies investigating medication reduction are also needed when examining diabetes remission. The restoration of the pancreatic first-phase insulin response was not established within the remit of this study, but these findings may support weight loss being a powerful tool for reversing the progression of consistent hyperglycaemia.25

The data showed an association between weight loss and programme engagement. Support interactions provided the most robust association with weight loss, emphasising the potential value of social support for facilitating behaviour change, which is supported by other studies.27,28 This is encouraging due to the inconsistent findings around engagement and outcomes of face-to-face programmes,10–13 in addition to the lack of engagement and outcome data for digital interventions.20 Future research is needed to establish whether there is an association between personal attributes and level of engagement with the programme.

Evidence exploring the effectiveness of face-to-face interventions that combine weight management with diabetes structured education is limited. However, these results suggest that combining self-monitoring, structured education, and professional support could be an effective combination for type 2 diabetes.

<table>
<thead>
<tr>
<th>Engagement Level</th>
<th>Overall Interactions Mean (SD)</th>
<th>Lower Engagement (Lower Third) Mean (SD)</th>
<th>Moderate Engagement (Middle Third) Mean (SD)</th>
<th>High Engagement (Upper Third) Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Interactions</td>
<td>360.9 (±285.8)</td>
<td>107.2 (±45.9)</td>
<td>297.8 (±73.52)</td>
<td>686.0 (±251.9)</td>
</tr>
<tr>
<td>Total Learn Interactions</td>
<td>75.7 (±50.3)</td>
<td>27.6 (±16.3)</td>
<td>66.6 (±18.0)</td>
<td>134.5 (±28.2)</td>
</tr>
<tr>
<td>Total Track Interactions</td>
<td>106.2 (±143.2)</td>
<td>20.4 (±6.0)</td>
<td>52.1 (±17.9)</td>
<td>256.3 (±197.7)</td>
</tr>
<tr>
<td>Total Support Interactions</td>
<td>156.9 (±148.2)</td>
<td>22.5 (±21.3)</td>
<td>118.6 (±43.1)</td>
<td>333.7 (±100.3)</td>
</tr>
</tbody>
</table>

Data represent the mean (SD) for each variable.

Table 5: Engagement level per interaction type

Figure 5. Engagement levels and weight loss at 12 months
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These findings are supported by research into digital programmes that combine these elements, which suggest sustained significant improvements in outcomes; however, there are still challenges with digital solutions, such as low engagement which might limit their effectiveness.

Limitations
Overall, 50/144 participants did not submit weight readings during the specified 12-month data collection window. The study was not conducted under controlled conditions and participants were not actively encouraged to register weight readings or engage after the programme. This could suggest weight loss can positively influence motivation leading to increased engagement with self-monitoring, as shown in similar research. Participants who registered weight readings in the data collection window achieved more weight loss than those whose readings fell outside the window. This could suggest those who weighed frequently were more likely to be motivated, and more likely to lose weight, introducing a self-selection bias.

HbA1c data were only available for 41 participants. Due to the real-world setting of this study, it was challenging to ensure every participant returned to their general practice for a follow-up blood test, as this was not a requirement for participation in the programme. Other methods to collect HbA1c data, such as using a home blood collection kit, could be used in future studies.

The average baseline weight and HbA1c were slightly higher for participants who were lost to follow up. Further research is needed to establish how the weight loss journey affects the overall weight loss, and whether early weight loss success can predict outcomes.

Definitions of engagement with digital programmes are often ambiguous as features can vary between services. For this analysis, peer or health coach interactions, reading of learning material, and self-monitoring were used to demonstrate proactive engagement. The researchers also defined the degree of engagement (lower, moderate, high) by segmenting total interactions into equal thirds, allowing for a fair comparison between each group. The analysis did not explore long-term engagement, as the main elements of the programme only lasted for three months.

Conclusion
This study may support the effectiveness of digital behaviour change interventions. The findings suggest that combining type 2 diabetes self-management training alongside intensive weight management advice can facilitate a significant reduction in weight loss and HbA1c. It supports evidence that suggests an association between engagement with digital programmes and weight loss.

Further research is needed to confirm this association.

Acknowledgements
This programme was generously funded by Solent Diabetes Association. We thank our colleagues from Portsmouth, Fareham and Gosport and South-East Hampshire Clinical Commissioning Groups, Southern Health NHS Trust, Solent NHS Trust and Queen Mary’s Hospital for their support and expertise.

Declaration of interests
Charlotte Goward, Michael Whitman, Mark Davies and Tamara Willner are Second Nature employees.

References
References are available in Practical Diabetes online at www.practicaldiabetes.com.
Digitally enabled behavioural change support for type 2 diabetes: a service evaluation

References


