

Original Paper

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THE DEVELOPMENT AND FEASIBILITY TESTING OF A WEB-BASED
PHYSICAL ACTIVITY INTERVENTION FOR PEOPLE WITH TYPE 2 DIABETES
LIVING IN REMOTE OR RURAL LOCATIONS

Abstract

Background: Research supports the use of web-based interventions to promote physical activity in diabetes management. However previous interventions have found poor levels of engagement or have not included health professionals and people with diabetes in the design of the tool.

Objective: To develop and explore feasibility and indicative effect of a web based physical activity promotion intervention in people diagnosed with Type 2 Diabetes living in remote or rural locations.

Methods: A qualitative approach using focus groups that included patients with diabetes and health professionals were run to identify key concepts, ideas and features which resulted in the design of a physical activity website. This site was tested using a quantitative approach with a qualitative six month pilot study which adopted a three armed approach. Participants were randomised into; control group who received written diabetes specific physical activity advice, Information Group- a web-based group who received the information online and Intervention Group- an interactive web-based group who received online information plus interactive features such as an activity log, personalised advice and goal setting.

Results: A website was designed based on patient and health professional ideas for effective physical activity promotion. This website was tested with 31 participants, 61% male, who were randomised into the groups. Website logins decreased over time: 4.5 times (month one) falling to 3 times (month six). Both the Information Group (134.6 (\pm 123.9) to 154.9 (\pm 144.2) mins) and Control Group (118.9 (\pm 103.8) to 126.1 (\pm 93.4) mins, $d=0.07$) increased time spent in moderate vigorous physical activity but decreased in the Intervention Group (131.9 (\pm 126.2) to 116.8 (\pm 107.4) mins).

Conclusions: Access to online diabetes specific physical information was effective in promoting physical activity in people with type 2 diabetes, access to interactive features was not associated with increases in activity.

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Keywords: Blood Glucose, Diabetes, Physical Activity, Rural, Web-based

Introduction

Regular physical activity has been shown to be beneficial in management of Type 2 diabetes [1-4] with guidelines recommending that adults should accumulate 150 minutes of moderate physical activity a week [5-6]. Up to 80% of people with Type 2 diabetes do not meet these recommendations [7], highlighting the need for the development of effective interventions.

Physical activity interventions have been delivered through face to face contact, telephone contact, print and mail materials and group based activities [8-9]. Although many interventions have been effective in stimulating physical activity behaviour changes, implementation of these methods of delivery into current diabetes practice has often been restricted by lack of time and appropriate personnel for effective delivery. It is also important to identify and create channels of information delivery that can reach a large and broad range of the diabetes population including those who may not or cannot access more traditional methods of delivery, for example those living in remote or rural locations [10].

Innovations in technology and access to the internet have led to an increased number of technology based interventions. Using technology to deliver an intervention offers several advantages including the potential reach, continuing availability and cost containment of the intervention [11]. Web-based interventions have been successfully implemented in promoting physical activity in diabetes self-management [12]. However, these interventions often resulted in poor levels of user engagement [13] and frequently reported major decreases in usage over time [14-15]. There is therefore a need to develop a tool with specific features that aim to increase user engagement.

The aims of this study were to utilise co-production methodology to develop a web based physical activity promotion intervention and secondly to evaluate the feasibility and indication of effectiveness of using this intervention to promote physical activity in people with type 2 diabetes living in remote and rural localities.

Methods

Study design

This study utilised a mixed-methods research design to incorporate co-production to the development of the intervention. Using a qualitative approach, focus groups were conducted with people living with type 2 diabetes to explore the key features of a web-based physical activity promotion intervention. Quantitative data was collected on overall and individual component use of the intervention and an objective measure of physical activity and sedentary behaviour was conducted. The full study was approved by the North of Scotland research ethics committee, REC reference-12/NS/0115 and was conducted according to the principles of the Helsinki agreement. ISRCTN:ISRCTN96266587

Research design of focus groups

Recruitment

Participants were recruited through purposive sampling from diabetes clinics, diabetes volunteer lists and posters put up in GP surgeries. Inclusion criteria included: diagnosis of type 2 diabetes, age > 18 years and ability to communicate verbally in English.

A total of 30 participants (18M, 12F) with a mean age of 63 ± 12 years participated in five focus groups (FG1, N=8, FG2, N= 8, FG3, N=7, FG4, N=7), held over a

four month period. One group was also run with health professionals (N= 6).

Participants who attended these groups lived in rural or remote locations in Scotland.

Data collection and analysis

Nvivo and thematic analysis were used with initial codes generated in a systematic fashion across the data set. Coding was carried out and collated into tables which were separated by themes and sub themes. This was then reviewed to ensure the themes worked in terms of each individual code. Coding checks were conducted on a subset of three of the five transcripts by researchers external to the research team to ensure consistency within themes as recommended by Barbour [16].

Research design for website testing

To test the effectiveness of the intervention in addition to the active intervention group, there were two comparator groups, one with access to the website but not interactive features to control for any effect of online information access and a second provided with written information only.

Recruitment and Randomisation

Thirty one participants, not previously involved in the focus groups, who were diagnosed with type 2 diabetes were recruited from primary and secondary care sites from 3 rural localities in Highland Region, Scotland. The aim was to recruit between 10-12 participants per group. The method of randomisation for this pilot trial was to use opaque envelopes to conceal group allocation from the researcher which the Cochrane Review reports as having a low risk of bias [17]. Envelopes were prepared by a researcher who was not involved in the study and allowed for equal numbers across the recruitment areas in each of the intervention groups.

Participants were included in the study if they met the following criteria: diagnosed with Type 2 diabetes managed through lifestyle or oral medication; over 18 years old; resident in Inverness, Isle of Skye and Sutherland areas and with access to a computer with internet access. Exclusion criteria included: Treatment with insulin therapy, to reduce the potential for immediate effects on glycaemic control and need for insulin adjustment. Unable to understand study requirements or give informed consent; visual or hearing impairments or physical disability or diabetes related complication that precluded ability to increase physical activity.

Participants met with the research nurse on three occasions; baseline, three and six months. During visit one, demographic and medical details were collected and participants were randomised using opaque envelopes into one of the three groups; interactive web group (InterG) had online access to diabetes specific physical activity information and interactive features; information web group (InfoG) were given online access to diabetes specific physical activity information but not interactive features; control group (CG) received leaflets based on the web site material. Each of the three sites was inducted into the study in a stepped wedge approach over 6 weeks.

Primary Outcome

Website measures

To assess use of the Website log-on to the site was monitored with each participant given personalised log-on details which were then used to measure contact over the six months. Access to the site without logging in was not measured. The use of interactive features on the site was recorded for each participant to assess frequency of use and thus determine those features most likely to be useful in future versions of the website.

Secondary Outcomes

Assessment of Physical Activity

To assess the effectiveness of the intervention, data on physical activity was collected along with standard anthropometric measurements and glycated haemoglobin, a measure of glycaemic control, both of which may be impacted by change in physical activity, in all groups at three intervals across the duration of the study. Participants wore an Actigraph GT3x+ (Actigraph LLC, Pensacola, FL, USA) monitor around the waist for 7 days at baseline, three and six months. Accelerometer data were downloaded and analysed using Actilife Data Analysis software (Version 6.10). A 60 second epoch was applied with a minimum wear time of ten hours per day on at least four days including one weekend day. Sixty minutes and over of consecutive 0s was considered non-wear time and was excluded from analysis. The following Freedson Adult (1998) [18] cut points were applied to categorise physical activity; Sedentary: 0 - 99 cpm, Light: 100 - 759 cpm, Lifestyle: 760 - 1951 cpm, Moderate: 1952 - 5724 cpm, Vigorous: 5725 - 9498 cpm, Very Vigorous: >9499 cpm.

Anthropometric measurements and blood sampling

All measures were carried out by a research nurse. BMI was calculated as weight (kg)/height (m)². Waist circumference was calculated in cm and was taken in the midpoint between the iliac crest and the lowest rib. A blood sample was drawn at baseline, three and six months and analysed at the hospital clinical laboratory for HbA1c using a liquid chromatography method (HPLC, Tosoh bioscience) on Diabetes Control and Complications aligned equipment.

Statistical Analysis

Data were analysed using the Statistics Package for Social Science version 22 (SPSS, IBM corp., Armonk, NY). After normality testing repeated measures ANOVA or the non-parametric Friedman k related samples tests were used, Bonferroni corrections were applied. Data is presented as mean (\pm standard deviation). As this was a pilot study a sample size calculation was not performed so in addition to the arbitrary significance level of 0.05, the effect size is reported. Effect size was calculated using Cohen's *D*; where 0.2 indicates a small effect, 0.5 indicates a medium effect and 0.8 indicates a large effect. Outliers more than three standard deviations from the mean were removed per variable.

Results

Web features developed in response to the focus groups

Excerpts from focus groups are displayed in Table's 1 and 2.

Focus Group Quotes			
Sub Themes from Focus Groups	Example excerpt highlighting sub theme meaning	Participant Type	Excerpt Number
Importance of Support	<i>'I need help in exactly what I need to do; it's not the advice of what to do it's the support of doing it'</i>	Patient	1.0
Monitoring Physical activity and diabetes	<i>'sitting down and thinking about what I've done, when I've done it and if I haven't done it I think it would make me think about why I'm not being active'</i>	Patient	2.0

	<i>'by displaying your activity say in graph form, it would give you some sort of target and to help you evaluate the days you weren't active'</i>	Patient	2.1
Methods to Increase User Engagement	<i>'if you do lands' end and do it in bite size chunks it doesn't matter how long it takes you to do it, you will still have done it at the end'</i>	Health Professional	3.0

Table 1: Quotes from focus groups used to design key features of the website.

Virtual coach

Groups highlighted a perceived need for support to increase their physical activity (Excerpt 1.0). To accomplish this, the website was centred on a virtual coach, Dave, and all interface conversations with the site were between the user and Dave. This was to ensure that people felt that the website provided personal advice structured to each individual.

Ask the expert

The need for support led on to the creation of an 'Ask the expert' section of the website to allow users the opportunity to speak to the physical activity expert, Dave. This allowed users the chance to ask physical activity related questions related to their diabetes to a physical activity expert through the interface of Dave.

Physical activity tracker

A tool for users to evaluate the physical activity they had undertaken was suggested to enable users to make more active choices (Excerpt 2.0). A tracker diary to help monitor activity was built into the site. This tracker allowed users to enter type and duration of the activity displayed in a bar chart permitting users to see days they were active and days they weren't active (Excerpt 2.1). A range of physical activity

options were available on the dropdown list, based on the American College of Sports Medicine (ACSM) list of activities [19]. The website remembered the activities entered and if more than one activity was carried out in the one day the activities were stacked.

Goals and challenges

An online physical activity consultation based on the Transtheoretical model [20] was developed allowing each user to set up realistic incremental goals based on current behaviour. The consultation was conducted through a web interface and gave personalised advice based on what was entered.

Any activity entered into the site was converted into walking using MET (Metabolic Equivalents) values [19] and the distance was added into a challenge (Excerpt 3.0). Users could pick a challenge to complete over a few weeks or months and in theory complete a hypothetical marathon through any number of activities emphasising the spectrum of activity at a level to suit each individual.

Activities in local areas

A Google map was created of physical activity opportunities in Highland region pinpointed so users could zoom into their area and find out what was available. This was developed through contact with the Highland council and local groups to ensure opportunities on the map were current. All pinpoints on the map had contact details or web links to the person or facility running the activity.

Online intervention

Baseline characteristics of the groups are described in Table 3. Statistical tests (one-way ANOVA (continuous data), chi square or Fisher's exact tests (categorical data)) indicated a significant difference between groups for weight, $F(2, 28) = 3.6$,

p<0.04. This was accounted for by the higher percentage of males (80%) in the InfoG and when looking at BMI there were no significant differences across the group.

Duration of diabetes was highest in information web group and lowest in interactive web group (9.3±5.5 vs 5.7±1.6 yrs).

Characteristic	Interactive Web Group (N=11)	Information Web Group (N=10)	Control Group (N=10)
Gender (% male)	54.5	80	40
Age yrs	67.3 (±10.4)	66.2 (±8.4)	66.5 (± 6.0)
Duration of diabetes yrs	5.7 (±1.6)	9.3 (±5.5)	6.9 (±4.1)
Weight kg	83.1 (±11.6)	100 (±15.9)	88.7 (±16.1)
BMI Kg/m ²	30.3 (±4.2)	32.98 (±5.45)	31.4 (±5.8)
Metformin therapy (%)	81	50	60
Lifestyle only (%)	18.2	50	40

Table 3: Baseline demographic characteristics of participants in the interactive web, information web and control group. Results are expressed as mean ± SD

Study attrition

Five participants withdrew from the study (three InterG, one InfoG one CG), see Figure 1 for flow diagram of recruitment and attrition.

Changes in primary outcome

Website measures

Total log in counts for the website was 262. Over the first three months each participant logged in on average 13 times (12.5 ±15.7) dropping to 11 times (11.3 ± 37.1) from three to six month follow up. There was a large range in number of times of logging in, starting at zero up to 50 times in one month. In the last 2 months only one person continued to use the website. Table 4 highlights log-in rates per month of study.

Month	Minimum	Maximum	Sum	Mean(\pm SD)
Month 1	0	14	48	4.4 (\pm 4.2)
Month 2	0	27	55	5 (\pm 7.7)
Month 3	0	16	34	3.1 (\pm 4.9)
Month 4	0	39	40	3.6 (\pm 11.7)
Month 5	0	50	50	4.5 (\pm 15.1)
Month 6	0	34	34	3.1 (\pm 10.3)

Table 4: Log in rates/month broken down into intervention months

Out of the features, only goal setting and log book were used; the log book used 142 times in the first three months increased to 191 times in the second; goal setting 108 times in the first three months dropping to 61 times in the second. Usage broken down per month is highlighted in figure 2. The most common goal was walking with 41 goals set in the first three months and 83 in the second. Other goals included swimming, stair climbing, cleaning, cycling, gardening and circuit training.

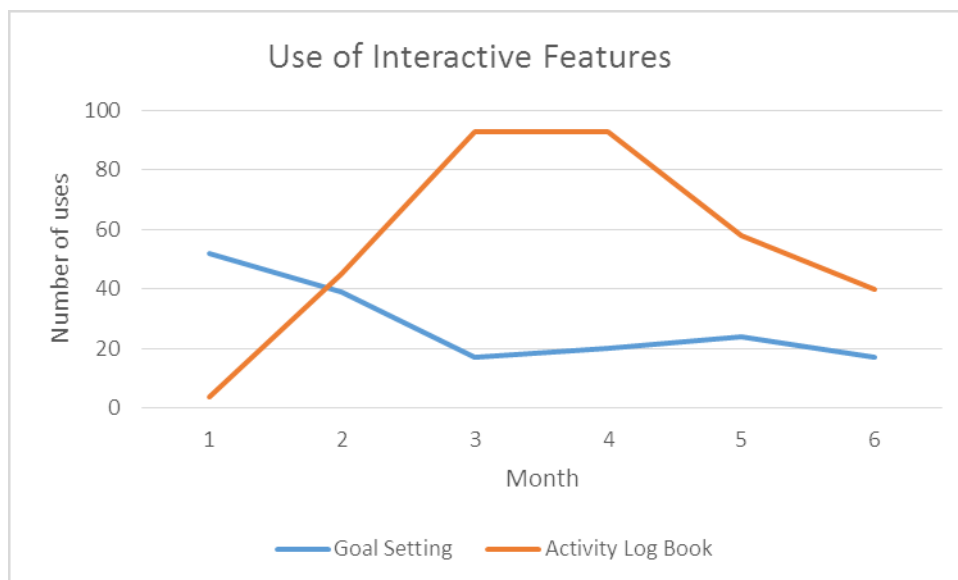


Figure 2: Use of interactive features over time

Changes in Secondary Outcomes

Table 5 reports the Actigraph accelerometer defined physical activity results broken down into groups at baseline, three and six months.

	Interactive web			Information web			Control		
Months	0	3	6	0	3	6	0	3	6
Light	1136.8	896.8	1160.4	1169.9	1225.2	1211.6	1271.2	951.8	1249
(mins/wk)	(±334.7)	(±176.4)	(±302.2)	(±501.0)	(±422)	(±376)	(±288.3)	(±280.8)	(±313.1)
Lifestyle	360.5	294.5	332.8	301.4	397.9	361.6	374.9	303.8	459.3
(mins/wk)	(±182.9)	(±145.7)	(±302.2)	(±191.2)	(±188.9)	(±188.9)	(±174.3)	(±56.3)	(±149.8)
Moderate	127.1	72.2	108.4	127.5	134	140.1	112.9	83.4	121.7
(mins/wk)	(±127.0)	(±64.1)	(±108.3)	(±178.0)	(±147.8)	(±40.9)	(±102.7)	(±66.8)	(±96.7)
Vigorous	4.8 (±3.9)	2.0 (±1.7)	8.4 (±5.9)	7.1 (±2.1)	8.5 (±2.7)	14.8	5.7 (±1.4)	2.5	9.6 (±1.5)
(mins/wk)						(±4.6)		(±0.8)	
MVPA	131.9	74.2	116.8	134.6	142.5	154.9	118.9	86.5	126.1 (±
(mins/wk)	(±126.2)	(±65.6)	(±107.4)	(±123.9)	(±135.9)	(±144.2)	(±103.8)	(±74.1)	93.4)
Step count	33,571	22,949	30,058	33,655	35,271	37,083	33,412	25,716	34,597
(steps/wk	(±20,134)	(±10,398)	(±16,116)	(±24,684)	(±20,679)	(±25,387)	(±20,845)	(±10,414)	(±17,675)
)									
Sedentary	3,275	2,509	3,004	3,202	3,129	3,055	2,993	2,429	2,833
time (total	(±646)	(±756)	(±485)	(±759)	(±997)	(±807)	(±662)	(±776)	(±764)
mins/wk)									
Sedentary	72.5	41.4	37.7	69.5	78.8	55.4	68.2	47.4	47.6
time (max	(±16.8)	(±35.4)	(±38.4)	(±17.4)	(±21.6)	(±7.4)	(±22.6)	(±25.8)	(±35.8)
bout in									
mins)									
Sedentary	22.4	22.4	22.8	22.8	23.5	22.8	21.6	21.6	21.6
time	(±1.2)	(±2.3)	(±3.9)	(±3.0)	(±2.6)	(±4.1)	(±2.8)	(±2.9)	(±2.6)
(mean									
bout in									
mins)									

Table 5: Mean ± SD changes in Actigraph accelerometer defined physical activity data broken down into groups and collection dates.

Moderate to Vigorous Physical Activity (MVPA)

The InterG dropped from 131.9 (\pm 126.2) to 74.2 (\pm 65.6) mins/week increasing to 116.8 (\pm 107.4) mins/week, $d= -0.12$ at six months. The CG dropped from 118.9 (\pm 103.8) to 86.5 (\pm 74.1) mins/week increasing to 126.1 (\pm 93.4) mins/week at six months, $d=0.07$. The InfoG increased from 134.6 (\pm 123.9) to 142.5 (\pm 135.9) mins/week at three months and 154.9 (\pm 144.2) mins/week at six months, $d= 0.15$.

Total Sedentary time

The InterG decreased from 3,275 (\pm 646) to 2,509 (\pm 756) mins/week and 3,004 (\pm 485) mins/week at six months, $d= 0.5$. In the InfoG, sedentary time decreased from 3,202 (\pm 759) to 3,129 (\pm 997) mins/week at three months and 3,055 (\pm 807) mins/week at six months, $d= 0.18$. Within the control group there was a decrease in total sedentary time from 2,993 (\pm 662) to 2,429 (\pm 776) mins/week at three months and 2,833 (\pm 764) mins/week at six months, $d= 0.2$.

Actigraph values as wear time percentage

	Interactive web			Information web			Control		
Months	0	3	6	0	3	6	0	3	6
Light	23.2	24	25	24.3	25	25 (\pm 4)	26.7	25.2	26.7
(%/week)	(\pm 4.9)	(\pm 6.1)	(\pm 4.6)	(\pm 4.1)	(\pm 3.4)		(\pm 4.5)	(\pm 6.3)	(\pm 7.4)
Lifestyle	7.3	7.8	7.2	6.3 (\pm 3)	8.1	7.6 (\pm 3)	7.8	7.6	9.8
(%/wk)	(\pm 2.5)	(\pm 2.8)	(\pm 2.3)		(\pm 3.6)		(\pm 3.5)	(\pm 3.3)	(\pm 5.1)
MVPA	2.7	1.9	2.2 (\pm 3)	2.8 (\pm 3)	3 (\pm 1.9)	3.5	2.5	2.3	2.7 (\pm
(%/wk)	(\pm 2.2)	(\pm 2.3)				(\pm 2.8)	(\pm 1.9)	(\pm 2.5)	2.3)
Sedentary	66.7	66.5	65.6	66.6	63	62.8	62.9	64.4	60.7
time	(\pm 7.6)	(\pm 6.1)	(\pm 6.1)	(\pm 7.5)	(\pm 6.4)	(\pm 7.2)	(\pm 6.3)	(\pm 10.4)	(\pm 11.9)
(total									
%/wk)									

Table 6: Mean \pm SD Actigraph accelerometer defined physical activity data broken down into wear time percentage

The InterG increased in light intensity percentage from 23.2 (± 4.9) at baseline to 24 (± 6.1) at three months, $d= 0.1$. They also increased in lifestyle intensity percentage from 7.3 (± 2.5) at baseline to 7.8 (± 2.8) at three months, $d= 0.18$. Sedentary behaviour percentage decreased slightly in the InterG group from 66.7 (± 7.6) at baseline to 66.5(± 6.1) at three months, $d= 0.02$.

The control group increased sedentary behaviour percentage from 62.9 (± 6.3) at baseline to 64.4 (± 10.4) at three months, $d= 0.17$.

Changes in physiological measures

All changes in physiological data are displayed in Table 7. Waist circumference decreased in the InfoG from 118.3 (± 12.7) cm to 113.6 (± 10.3) cm, at three months increasing to 114.2 (± 11.1) cm at six months, $d= 0.34$. It decreased in the CG from 108.3 (± 13.4)cm at baseline to 107.2(± 14.4)cm at three months and 101.0 (± 11.7) cm at six months, $X^2= -2.091$, $p<0.02$, $d= 0.5$.

The InterG HbA1c decreased from 57.7 (± 11.2) mmol/mol to 56.7 (± 10.0) mmol/mol and 54.1 (± 9.5) mmol/mol, $d= 0.34$; the InfoG increased from 52.4 (± 8.2) mmol/mol to 55.8 (± 8.0)mmol/mol to 55.0 (± 4.7) mmol/mol, $d= -0.38$; the CG dropped from 55.3 (± 13.7) mmol/mol to 54.4 (± 15.6) mmol/mol and 50.5 (± 5.9) mmol/mol, $d= 0.45$.

	Interactive web			Web Information			Control		
Months	0	3	6	0	3	6	0	3	6
Weight	83.1	84.5	81.8	100.0	100.1	99.0	88.7	87.1	87.7
(kg)	(± 11.6)	(± 13.1)	(± 12.8)	(± 15.9)	(± 14.4)	(± 15.8)	(± 16.1)	(± 15.7)	(± 5.6)
BMI	30.3	30.5	29.3	32.98	33	32.7	31.4	30.9	31.0
(kg/m²)	(± 4.2)	(± 4.0)	(± 4.1)	(± 5.45)	(± 5.1)	(± 5.6)	(± 5.8)	(± 5.8)	(± 5.6)
Waist	104.0	106.0	102.8	118.3	113.6	114.2	108.3	107.2	101.0
circumference	(± 10.9)	(± 10.4)	(± 10.2)	(± 12.7)	(± 10.3)	(± 11.1)	(± 13.4)	(± 14.4)	(± 11.7)

(cm)									
HbA1c	57.7	56.7	54.1	51.8	55.7	57.5	55.3	54.4	50.5
(mmol/mol)	(±11.2)	(±10.0)	(±9.5)	(±8.0)	(±7.6)	(±9.1)	(±13.7)	(±15.6)	(±5.9)
HbA1c (%)	7.5	7.4	7.1	6.9	7.3	7.5	7.2	7.1	6.8

Table 7: Mean ± SD changes in physiological measures broken down into groups and collection dates.

Discussion

Principal Results

This composite study is unique in that it reports on patient identified features of a web-based physical activity promotion intervention, overall and individual component use of the online intervention together with change in physical activity. Patient identified features included a physical activity tracker; user support; goal-setting; ask the expert; what is on and interactive challenges. Of the identified and included features within the online intervention, only the activity log book and goal setting were used.

Overall access to the website was good, specifically in the first three months of the intervention. This reduced in the second half of the intervention which is common in web-based interventions [13, 21]. However, when education was combined with interactive elements it did not result in any significant changes in physical activity. The two interactive features that were consistently used were goal setting and the physical activity log book, of these neither appeared to be particularly effective in increasing physical activity in contrast to previous research where those who used goal setting and log books had greater increases in physical activity [11].

Including patients in the design was key in the development of the current intervention. Even though the ISO principles, recognised to ensure quality management, [22] were followed, with more time, user-design workshops would have been helpful.

These workshops would allow those using the site to test the features they deemed to be useful in an iterative fashion in process evaluation to determine their role in promoting activity. Longer term interventions should be conducted to assess sustainability and strategies to increase engagement with the site.

This study provides some support for the use of online diabetes education in the promotion of physical activity. Although no significant change was reported in physical activity levels, a trend towards increasing physical activity was recorded in the InfoG group with 50% in the InfoG meeting the current guidelines for physical activity at the end of the study. Online tailored physical activity advice has been shown to be effective in the general population [23] with interactive emails resulting in greater increases in physical activity. These are encouraging findings and endorse access to specific web-based information to increase time spent in physical activity. Access to diabetes specific physical activity information should be considered in endeavours to support patients with type 2 diabetes in becoming more physically active.

Access to interactive features resulted in a non-significant drop in physical activity. The reason for this is unclear but this pattern was mirrored in the CG and seasonal reasons described in other studies could be postulated to explain the pattern [24] however, a stepped wedge method was used in recruitment into the trial with equal numbers of participants randomised into each group per site and each site starting the intervention at a separate time. Given these results were not observed in the InfoG makes it less likely and raises the question of whether issues with the interactive part of the website may have been a factor.

There was no significant difference in wear time across all groups and time points and all participants met wear time criteria defined in the methods section. There were discrepancies in the data for the InterG group in terms of light, lifestyle and sedentary time and for the control group in sedentary time from baseline to three months. However, none of these were significant and had low effect sizes. The main actigraph secondary outcome was MVPA and there was no difference in weekly wear time percentage compared to minutes.

The current intervention did not contain any specific information on decreasing sedentary behaviour but there was a trend towards decreases in total time spent in sedentary behaviour which may have been at the expense of increasing physical activity which concurrently decreased. Thereafter, as physical activity increased total sedentary time subsequently also increased in parallel possibly due to a compensatory increment in resting time as individuals became more active. The benefits of decreasing sedentary spells are becoming more widely studied with improvements in metabolic health suggested [25] and an acknowledgment that decreasing sedentary time is just as important as increasing physical activity in terms of health outcomes [26]. Moreover, evidence has shown that even people who meet the current guidelines for physical activity suffer adverse effects from too much sitting time irrespective of meeting physical activity guidelines [27].

Although the study was not powered to detect significant changes and the mean HbA1c level reflected reasonable control at baseline, in the majority of patients in the InterG there were non-significant decreases in HbA1c across the six months. This may reflect the shorter duration of diabetes and higher percentage of participants receiving oral anti-diabetic therapy in this group. The explanation for the upward trend in HbA1c with increases in MVPA in the InfoG is not clear although, has been reported in other

studies [28]. Possible reasons may include; changes in diet or medication associated with increased physical activity a component that was not a measured outcome of this study.

Waist circumference was used as a surrogate marker for abdominal fat mass and significant reductions were observed in the InfoG despite a lack of change in weight, studies have shown that even without weight loss increased physical activity is associated with reductions in fat mass [29], which can improve insulin sensitivity and in turn lead to improvement in blood glucose levels.

Limitations of the study

The study had a small sample size with only 31 participants in total. As this was a pilot intervention no sample size calculation was undertaken and effect size reported as an alternative. Future research should include in depth follow up such as qualitative interviews to explore the issues participants may or may not have had with the interactive features and provide feedback on what was useful and/or effective in promoting activity and engagement with the site.

All groups received new information on top of usual care procedures. The information received was diabetes specific physical activity advice to aid in the promotion of physical activity. This new information as well as increased patient contact could influence outcomes.

Comparison with Prior Work

Unlike previous work, this paper reports on the development and feasibility testing of the co-designed tool. It reports what health professionals and people with type 2 diabetes considered to be essential tools for engagement with the site and support to increase physical activity and compared this with what was actually used. This study

supported the use of a web-based physical activity promotional intervention to communicate personalised physical activity education which resulted in increased physical activity behaviour in people with type 2 diabetes.

Conclusion

Web based physical activity information was associated with a trend towards increased in physical activity across a six month intervention in people with type 2 diabetes.

What's new?

- Web based physical activity promotion information may be effective for promoting higher levels of physical activity across a six month in people with type 2 diabetes.
- Interactive features on a web based physical activity promotion intervention were not effective in increasing physical activity participation.

Conflicts-of-Interest disclosure

There were no conflicts of interest between the authors in the manuscript.

Abbreviations

(ACSM) American College of Sports Medicine, (BMI) Body Mass Index, (CG) Control Group, (GP) General Practice, (InfoG) Information Group, (InterG) Intervention Group, (MET) Metabolic equivalents, (MVPA) Moderate to Vigorous Physical Activity, (PA) Physical Activity

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