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Is the Health App Challenge approach of patient-led application conception, development, and review worthwhile?

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Is the Health App Challenge approach of patient-led application conception, development, and review worthwhile?

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Abstract
Objectives
A Health App Challenge, supporting young people with diabetes to develop and review their own Internet applications (apps) had previously been shown feasible. We aimed to clarify whether such patient-developed apps fill 'app gaps' and can be sustained, and if the approach can be generalized to other conditions. We asked, 'Is it worth trying to run further Health App Challenges or elements of Health App Challenges?'
Methods
Two Health App Challenges, one for diabetes and one for weight loss surgery, were run simultaneously. Each Challenge (i) invited patient review of existing apps, (ii) supported patient-led teams to design and/or develop their own apps for better health self-management and (iii) invited patient review of the patient-designed or developed apps.
Results
In the diabetes Challenge, 130 patient reviews were written for existing apps, five designs for new apps submitted and reviewed 17 times. Participants took account of the reviews and designs appeared to fill 'app gaps' in the market, but the designs were not developed as apps. In the bariatric Challenge, only 13 reviews were given for existing apps and no designs or developed apps were submitted.
Conclusions
Supporting patients to develop apps using this approach is not sustainable. However, a website where health apps and websites can be reviewed and prototype designs submitted would be worthwhile, at least for conditions with high prevalence such as diabetes. It remains unclear whether condition specific health charities could take the role of sustaining such review websites.

Keywords
Mobile application; Internet application; diabetes; weight loss surgery; patient-led; user-centred design

Introduction

A 2012 estimate put the number of health-related apps as at least 40,000 [1] and in September 2015 the number was estimated as more than 165,000 although it was claimed that consumers are interested in relatively few of them [2]. Terry reports a study by US company IMS that showed 12% of mHealth apps accounted for 90% of consumer downloads, and 36 apps generate nearly half of all downloads; 40% of apps have fewer than 5,000 downloads. Various studies have shown benefits associated with patients using apps including improved adherence [3], knowledge [4], and patient-professional communication [5]. Patients of course use apps that suit their needs and developers must have patient input to identify their preferences [6]. However, some developers only include patients at the prototype stage or later, rather than at ideas conception [7]. This can potentially result in costly and ineffective products.

Alongside this explosion in available apps we explored the role of patients in app development. Patients in the 'driving seat' can lead to better engagement and motivation in self-management behaviours [8]. The Diabetes App Challenge 2012 (DAC2012) [9] tested the idea that supporting patients to develop apps themselves may give the resulting products greater authenticity and relevance. DAC2012 was a competition inviting teams, including at least one young person with diabetes (YPD), to design and develop apps for use by other YPD to help prepare for their consultations with diabetes specialists. Registrants were supported via email and discussion forum. After app development, other YPD were invited to trial the apps and review their experiences. Six

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teams developed and submitted apps; 63% of the YPD who completed reviews found the apps useful and 55% would use them again.

Sustaining this patient-led approach was not addressed in DAC2012. Ways were needed to help patients to maintain their apps. Furthermore, DAC2012 only demonstrated feasibility of app development by patients for one age group, condition, and purpose. Health charities support patients in their own care [10] so might help run future Challenges, trialling them for other conditions and age groups to test generalizability.

Although DAC2012 produced some new functionality, four of the six apps offered functionality (data logging and help with calculating insulin doses) available in existing apps. YPD may have ideas to improve existing apps but also may lack knowledge of existing apps (and so 'reinvent the wheel'). Patients may also be limited to develop new apps that are within their technical skills rather than the 'app of their dreams'.

We concluded that it was feasible to run Challenges but that they should: (i) include a review stage to ensure that patients reviewed existing apps before developing new ones; and (ii) include submission of ideas for app design for subsequent professional implementation to remove potential technical skills imitations of patient designers. Furthermore, we needed to; (iii) test the generalizability of the 'app challenge' model to other conditions; and (iv) explore the involvement of health charities to sustain the apps developed.

The Health App Challenge 2014 (HAC2014) aimed to build upon the DAC2012, running two parallel health app challenges, one for diabetes (DAC) and one for patients pre/post weight loss surgery (Bariatric App Challenge, BAC). Our research question asked, 'Is it worth trying to run further Health App Challenges or elements of Health App Challenges? Although we did not set a target cost effectiveness ratio for apps produced and used for a given cost of running a Challenge, we expected at least to mirror the output of DAC2012.

Methods

Design

The HAC2014 project supported patients to design, develop and review health apps for their health condition. Two Challenges were run simultaneously, for patients with diabetes and for patients' pre/post weight loss surgery. Each Challenge comprised three stages: (1) online patient reviews of existing health apps, (2) support for patients to submit design entries and/or completed apps, and (3) online patient reviews of submitted designs or developments (Figure 1). The Challenges were run via the project website (www.healthappchallenge.org.uk) with communication and support between project team and participants by email.

Definition of 'app'

Throughout HAC2014 we used a broad definition of 'apps', including

(i) applications designed and published specifically for target mobile platforms, e.g. for iPhone on iOS through iTunes or Android phone through Google Play;
(ii) websites such as discussion forums, information websites or blogs that may or may not be responsively designed for mobile devices;
(iii) social media e.g. a specific Twitter or Facebook group.

Stage one – Reviews of existing apps

From end of May to early September 2014 we invited people with diabetes and people pre/post bariatric surgery living in the UK to add reviews of apps they had used to a 'Trip Advisor' (/www.tripadvisor.co.uk) style website. As an incentive we offered a prize draw of £200 for a review selected at random, for each condition. Reviewers could add new apps to the list or add further reviews to apps already reviewed. The reviewer form asked for app details (i.e. name, type, and link to location online), review (open text) and rating (out of five), basic demographic data (i.e. age group and gender), email address (not published but so we could contact them regarding prize draws), username (e.g. pseudonyms or real names to identify reviews) and where they heard about HAC2014. Reviews were checked for inappropriate content, correct links to app location and for spam before being added to the project website.

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Stage two – Patient app designs and/or patient-developed apps
In this stage (June 2014 - January 2015), we invited people with diabetes and pre/post bariatric surgery to either (i) create apps, or (ii) design apps (i.e. a visual and descriptive 'mock-up' of an app, presented using, for example Word, PowerPoint, or YouTube). Developers and designers could work in teams as long as the main applicants were patients with the relevant condition living in the UK. There were no age restrictions but applicants aged under 16 were asked to work in teams including their parent or guardian. As incentives, we offered, on submission, £300 to teams submitting apps and £100 to teams submitting designs.

The designer/developer form asked for age group, gender, app development skills, email address (so the project team could support them during their app design/development), and where they heard about the HAC2014. The project team offered registrants:

(i) Links to the HAC2014 review pages, to make use of patient reviews for ideas of 'app gaps' in the market;
(ii) Dedicated email address for technical support provided by HandiHealth (http://handihealth.org/)
(iii) Current draft of an information booklet 'Health App Challenge best practice model', that included information and links regarding intellectual property, different types of app and a 'how to' guides for app development. This booklet was revised many times through HAC2014 based on patient, expert and project team input to meet participants' needs (Appendix A);
(iv) Match-making facility, i.e. for those who wanted to collaborate with others (face-to-face or remotely depending on circumstance), we asked permission to send email introductions with others also seeking collaborators (e.g. a person with diabetes without app developing skills and a person without diabetes with app developing skills); and
(v) Email support and information for any design/app and team needs, highlighting that the HAC2014 project team included an intellectual property expert, diabetes and bariatric clinician, and technical experts.

When ready to submit, teams emailed submission forms to the project team along with web addresses for published apps, live websites, or social media platforms, or if submitting designs, documents (e.g. Word, PDF), mock-up tool URLs, video links or other suitable methods. The submission form also asked for team member names, motivation for the specific design, and if they had first checked for 'app gaps' against existing apps.

The project team checked designs/apps for suitability (e.g. for any glitches, accuracy of content, safety and security of use). Any issues were raised with developer teams who were supported to make required changes. Apps or designs were added to the project website review pages within one week.

Stage three – Reviews of patient app designs/developed apps
As submitted apps and designs were added to the website review pages, we invited people with diabetes and people pre/post bariatric surgery living in the UK to review them. The review page and process was the same as for existing apps (Figure 2). We offered prize draws of £200 for each condition for each review. This stage ran from May 2014 to March 2015. At the end of stage 3, teams with the best bariatric and diabetes app or design as reviewed by other patients, were awarded an additional £200.

Teleconference week
Mid-way through the Challenges (mid-September 2014), we held a teleconference week as an opportunity for developers/designers, reviewers and other interested parties to network with intellectual property specialists, clinicians, developers, and other professionals, voice opinions or ask questions and learn more about the app development process. There were five, one-hour teleconference sessions that ran Monday to Friday, starting at 1:00pm each day. The project team made notes on the discussions including useful links and resources, emailed them to attendees and incorporated them into the best practice model booklet.

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Recruitment

Advertising materials (Appendix B) were tailored to whether audiences were interested in reviewing, designing or developing, whether they had the condition or not, and on their level of app design skills. We recruited via:

(i) Email to known contacts and relevant healthcare groups, online news outlets, charities and computer science departments.
(ii) Social media pages including the Health App Challenge's own Twitter, Facebook and YouTube accounts;
(iii) Online discussion forum posts to diabetes or bariatric specific sites;
(iv) Paid 'Champions'. i.e. people with diabetes or pre/post weight loss surgery who were frequent social media users. Making use of their online presence and audience, they Tweeted and posted within Blogs and Facebook.

Online survey

In May 2015 an anonymous online survey was circulated via email and online advertising to HAC2014 participants and other stakeholders. It asked for thoughts on the HAC2014 approach and interest in taking part, running or supporting a future Challenge.

Results

App reviewer participants

In total 114 people reviewed existing apps and patient designs (Table 1). Almost half of reviewers were recruited by Facebook (53/114, 46.5%), with a large proportion of these just reviewing The Diabetic Lounge on Facebook (37/53, 69.8%). Other recruitment routes were Twitter (15/114,13.2%), direct email and discussion forum chat (15/114,13.2%), word of mouth (11/114, 9.6%), Champion (7/114, 6.1%), Internet search (5/114, 4.4%), news article (5/114, 4.4%), and non-internet (3/114, 2.6%).

Reviews of existing apps

For the DAC, 113 reviews were submitted for 20 existing apps between 96 reviewers (Table 2). The apps received an average of 5.65 reviews each (ranging from 1 review to 41 reviews) and an average star rating of 4.7 (ranging from 1 to 5 stars) (Figure 3). Most reviews (50/113, 44%) were of iOS apps, followed by Facebook (42/113, 37%) (Table 2). Twelve apps had data recording or tracking, five information and support, and 3 nutrition/exercise as their main function (Table 3).

For the BAC, 13 reviews were submitted for 7 existing apps between 10 reviewers (Table 2). The apps received an average of 1.86 reviews each (ranging from 1 to 3 reviews) and an average star rating of 4.3 (ranging from 3 to 5 stars) (Figure 3). Most reviews (5/13, 38%) were of iOS apps, followed by website apps (4/13, 31%) (Table 2). Three apps had data recording/tracking, three information and support, and one app had nutrition/exercise as the main function (Table 3).

App design/developer participants

Overall, 46 people (38 for DAC and 8 for BAC) registered interest in designing and developing apps for the two Challenges. For the DAC, 23/46 (60.5%) people continued correspondence with the project team, 16 (42.1%) indicated app design and development plans and 8 (21.0%) participated. For the BAC, 2 out of 8 (25.0%) continued corresponding with the project team but none indicated app design or development plans and none participated.

The 8 DAC participants submitted 5 app designs between 5 teams. The teams comprised one self-made team of 4 people (1 User (person with condition wanting to create an app), 2 Techs (someone with technological skills) and 1 User/Tech, and 4 teams of one (2 Users, 1 User/Tech and 1 Tech/HCP (health professional with technological skills). Five were male and 3 were female; one under 20 years of age, three between 20-39 years of age, two between 40-59 years of age and two over 59 years of age. Three were recruited by word of mouth, 2 by Internet search, 2 by non-Internet methods and 1 by direct email.

No published apps were submitted to the DAC, and no designs or published apps were submitted to the BAC.

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Patient app designs
The five diabetes app designs were Dap'n, EasyDiabetes, BWell Sugars System, Better BGs and Gluco-Drive. Designers reported in the submission form, their motivation for the app design and detailed the intended functions (Table 4).

Four of the five design teams (80%) had checked to see what apps already existed on the market prior to submitting their app design. Two teams indicated that no other apps were similar to their design, and two felt that some apps included elements of their design functions but did not fill the needs gap.

Reviews of patient app designs
For the DAC, 17 reviews were submitted for the 5 patient designs between 9 reviewers (Table 5). The apps received an average of 3.4 reviews each (ranging from 0, due to a late entry, to 8 reviews) and an average rating of 4.1 (ranging from 1 to 5). Figure 4 gives example of patient reviews.

Designer/developer support
Thirty-five (76.1%) out of 46 registrants who were 'User' or "Tech' (rather than 'User/Tech') were offered 'match-making' into teams to maximise skills and knowledge. Eight people responded to the offer (8/35, 22.9%) from the DAC and were match-made into three teams. However due to time and technical conflicts, they did not continue as teams for the Challenges.

Teleconference week
Attendees for one or more telephone conferences were 5 health technology experts, 4 health professionals, 3 IP experts, 2 patients, 2 app developers, and 2 charities. Various topics were discussed with the most frequent themes being funding, medical device definition, intellectual property, software coding and collaborative development.

Online survey
Seventy-five people (18 HAC2014 participants and 57 others) completed the online survey. Most responders were patients (49/75, 65.3%) or health professionals (18/75, 24.0%). Other responders included charities, an app developer, app provider, academic, organisation and media company (8/75, 10.7%). Two people missed some questions. Two-thirds (50/73, 68.5%) would be interested in taking part in future HACs.

Discussion
Designs and apps submitted
Although we were successful in engaging diabetes patients to review existing apps and submit app designs, in contrast to DAC2012, no published apps were submitted, although designs did appear to fill 'app gaps'. There was some engagement from bariatric patients in reviewing existing apps but despite some initial interest, no designs or published apps were submitted.

Reviews of existing apps
The inclusion of the existing app review element to the HAC2014 model was in response to app submissions in the DAC2012 replicating functions of existing apps, possibly due to a lack of market awareness. The element aimed to provide a source of advice for others looking at apps and to encourage patient designers to look for 'app gaps' in the market, or improve upon existing apps.

We were successful in recruiting diabetes patients to contribute varied and ample existing app reviews for the designers to make use of this element in the DAC. Ratings were mostly positive, indicating that reviewers were sharing recommendations, rather than avoidances. They did not discuss what they considered missing from the market, but included some constructive suggestions for improving the designs amongst their reviews. App-user views given in online review sites are important both for reviewers to voice experiences, influencing peer choices, and for developers to improve their apps, influencing the market by identifying user needs and preferences [11].

Twenty apps were reviewed with 113 reviews (62 reviews for traditional apps e.g. iOS, and 51 reviews for other apps e.g. Facebook group). The findings were less successful for the BAC, and are discussed below. The online community is often quick and willing to give opinions and feedback, and although not as detailed as face-to-face focus groups [12], can be a cost effective source of user

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views. Comparatively, this online user app review method is not unique, and there are far more apps to choose from and user-reviews to view within app stores than DAC generated (e.g. a brief search of the word 'diabetes' within UK app stores, found approximately 100 (iOS) and 250 (Android) diabetes apps). However, such stores do not include Facebook groups or websites, which accounted for almost half (45%) of the DAC existing app reviews. Although their inclusion may be considered by most, beyond the definition of an app [13], they are no less important to patients in terms of supporting diabetes self-management behaviours [14]. MyHealthApps (http://myhealthapps.net/) is a site that presents health specific apps recommended by patients (among others) and currently includes 43 diabetes apps (54% more than DAC). However, there is no option for users to add reviews or ratings. NHS Health Apps Library (http://apps.nhs.uk/) permits user reviews and ratings, but has been less successful than DAC for engaging diabetes reviews, with only 13 diabetes apps (35% less than DAC) and 15 diabetes app reviews (87% less than DAC), and only includes (after NHS review) developer-elected apps. So far, the existing app review element of the HAC2014 remains the only site of user generated review content, health app specific, and with a combination of user-elected and broad definition app inclusion.

Getting developers to use such reviews was considered effective in the DAC as 4/5 designers stated they had made use of the existing app review element and that their designs did fill 'app gaps' in the market. Details of the designs are discussed below.

Patient app designs

Invitation to submit designs, in addition to developed apps, aimed to address possible skillset limitations that may have prevented some participants in DAC2012 from creating apps that were functionally different from existing data logging and insulin dose calculation apps. Most HAC2014 designers claimed that their designs were justified as functionally different from existing apps.

Although it may seem like diabetes app development is an already saturated market, there remains room for improvement [1]. Many are not designed to fit individual users' needs and tend to focus on one or two functions, most notably data logging [15]. Submitted designs provided insight into unmet needs that diabetes health apps should address [16].

Dap'n addressed the need for secure messaging with health professionals and communication with peers for help and advice. The benefits of peer and health professional support on self-management behaviours have been well documented [17], and apps with peer-peer social support elements can have a positive impact on self-management behaviours [18]. However, there remains a lack of integration of apps to communicate with health professionals, although not without reasonable concern from professionals regarding confidentiality and professional conduct for example [19]. Most app communication between patient-professional currently deals with prompts or reminders [20] rather than, as Dap'n identified, for data transfer, combined with easy communication links.

EasyDiabetes addressed the need for nutritional information, although this function is commonly found in exiting apps. One particular function of the design, however, identified a need for information on correct injection site techniques. This is an area correlated to adherence in type 2 diabetes [21], and has received minimal attention from the existing app market. One app, Lilly Glucagon [22], specifically focuses on injection site information, but is aimed at those who support people with diabetes, rather than patients themselves, unlike EasyDiabetes aimed specifically towards adolescents with diabetes, who may benefit most from establishing correct techniques early on [23].

BWell Sugars System addressed the need for easy data entry. Although the designer had not checked against existing apps, and designed an app with a function highly popular in the current market, the motivation for this design identified a need for an uncomplicated tool for data entry and tracking, where a need remains for interface simplification [24] and where app ease of use can impact perceived usefulness [9]; and satisfaction [25].

Better BGs addressed calculation support needs. The designer was motivated by a need for more 'intelligent' and 'real-time' calculations. There are a number of insulin dose calculator apps available, yet few provide confidence in their accuracy of dose recommendations [26].

Gluco-Drive did not address the identified unmet needs of patients, nor was it designed by a patient, an exception to the rule due to initial collaborative efforts within a patient-led team. It did however

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identify a relevant concern about diabetic driver safety when blood glucose levels are extreme [27]. It is an area of regulatory interest [28], with recommendation to check blood glucose levels before driving, and intermittently for long journeys [29], which the app design addresses.

Design inclusion element

The inclusion of design as well as developed app entries was an important element of HAC2014 as without this no one would have taken part. Design entries allow participants ease of making changes based on feedback, more time to refine ideas, in particular, to seek guidance from regulatory bodies if a design may be considered a medical device and to seek guidance from medical experts for content accuracy. However, HAC2014 design entries were less easy to review and although we were successful in engaging patients to review designs, perhaps more would have engaged if they also had functioning apps to trial; DAC2012 had 80% more patient reviews (despite the potential for limited use from a rushed product [30]).

Improved tools for developing apps

New tools for developing apps are becoming available. For example, since HAC2014, ResearchKit (www.apple.com/uk/researchkit/) an open source framework for building apps, was launched in the UK in August 2015. Such tools might make development and design more within the reach of patients.

Limitations

Supporting patient designers/ developers

Despite interest from health professionals, app developers and others, and supportive survey feedback, we were unsuccessful in facilitating collaborative teamwork in app design or development. We had anticipated a mixture of designs and published apps to be submitted to HAC2014, however, submissions exclusively consisted of the five designs, compared to six completed apps, as in the DAC2012. Despite registration from patients and app developers, few responded to the offer of 'match-making', with only three teams match-made, none of which proceeded to submission. In DAC2012, two of the six developer teams that submitted apps were match-made. There may have been trust issues and hesitance in communicating online with unknowns [31] but no more than in DAC2012. Participants may have been hesitant to commit to development, due to the HAC2014 emphasis on finding an 'app gap' and creating something novel, or the broader design specification (i.e. anything for self-management in general vs. pre clinic preparation) where too much choice may lead to decision aversion [32]. There is an extensive body of research on user participation in the design and development of software [33] but a simple practical reason for match-made teams not working so well in HAC2014 as in DAC2012 may simply be timing. Young people, students in particular, may be keener to participate in such Challenges if they correspond with academic work such as projects and not during exam preparation time. (In the UK most University computing and science courses tend to have their exam period in May-July.)

Generalisability of the 'app challenge' model to other conditions

The low response rate and engagement for the BAC left us unable to identify if the model is successful for conditions beyond diabetes. Despite some interest, no pre/post bariatric surgery designs or apps, and few existing app reviews, were submitted. The probable reason for minimal engagement compared with the DAC is the size of populations, with far fewer people being pre/post bariatric surgery than people with diabetes [34]. The size of the diabetes population means that apps are very popular commercially and in research [35] with roughly ten times as many apps as are available in bariatric surgery [35, 36]. On the other hand, there are vast numbers of general fitness tracking and nutrition measuring apps that bariatric (as well as diabetic) patients may use that are not considered condition-specific. In order to reach the smaller audiences of certain conditions for future Challenges, alternative advertising strategies will need to be considered.

Sustainability of the HAC2014 model and developed apps

Although we identified opportunities such as crowd funding and in-app advertising as possibilities, and although one designer has used their HAC2014 design entry as a 'pitch' to both commercial and NHS funding contests, we did not establish financial support to develop and maintain apps long-term. We were unable to gain interest from health charities in funding future HACs, nor gather enough feedback from charities in the online survey to understand possible reasons. From experiences with the two supporting charities, it appears that one may have been too small to financially afford running future

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challenges, and the other moving away from the app development agenda. The HAC2014 approach was relatively novel, and to engage potential facilitators requires an awareness and knowledge of the process. The booklet dissemination and online news helped towards this but a more in-depth exploration with those interested in running future challenges would be beneficial. The survey gathered most interest from patients and health professionals (89.3% of respondents), potential future participants, however without interest from potential organisers, remains unsustainable.

There is potential for further exploration in making use of existing online platforms, which charities may prefer to 'sponsor' or endorse rather than manage. This might include collaboration with existing health app review sites with online networking community forums for patient-led app design and development. NHS England recently launched their Code4Health project [37], which aims to provide such a platform for networking and collaborations which may fit this ideal. It may also help address concerns of app development lacking health professional input [38, 39]. As with the HAC2014, intellectual property ownership information for potential collaborators will need to be clarified for legal reasons. However, in the experience of DAC2012 and HAC2014, none of the participants took action to protect their ideas, which may be due to altruism or minimal (if any) potential monetary gain in health applications.

Apps gaps versus design improvements

Compared to DAC2012, the HAC2014 focussed more, but not entirely, on 'app gaps'. Greater emphasis on new functionality could be seen as a limitation given that the most successful is not necessarily the first but the best design. Our frequent use of the phrase 'app gap' was partly because of its 'catchy' sound but we did not intend to exclude improved usability of existing function. Certainly we encouraged patients to suggest better design of existing functions as well as new functionality. However, as our DAC2012 experience had shown that through lack of awareness some groups designed apps with existing functions that were already well served, we gave more focus to 'app gaps' and new functionality.

Quality control

Our paper has only addressed whether the 'app challenge' approach offers opportunities to make apps more useful to patients. Others such as the NHS Health Apps library have sought to put in place ways of assuring quality control in apps but Boulos et al argue that the best first line of defence will always be to educate consumers [1]. Many will also argue that we also need before/after (perhaps randomised) trials that estimate the effectiveness of the use of apps, although given the speed of development of the technology not all agree that this methodological approach is feasible [40].

Conclusion and Recommendations

The HAC2014 did not engage patients to develop their own apps, but was more effective at identifying 'app gaps' than DAC2012 through the inclusion of app design entries. The inclusion of existing app reviews supported the design innovation, and provided opportunities for patients to share reviews of condition specific apps, including websites and social media, that they consider useful in diabetes management. We were unable to generalise the approach to other conditions and neither study was able to identify sustainability in the model through to app development. There is interest from patients and health professionals in this approach, but further research is needed to engage people with conditions other than diabetes and the sustainability of running future challenges perhaps concentrating the HAC model on review and design rather than full development (Figure 5). Potentially, replicating elements of the challenge model through collaboration with existing platform bases such as existing online patient review sites and multi-disciplinary health app networking forums may be beneficial.

Given the cost and effort of running such a Challenge, supporting patients to develop apps using the 'app challenge' approach is probably not worthwhile nor sustainable. However, greater value should be placed on app reviews. There is an online audience ready to give opinions, and people listen to reviews when choosing apps. Harnessing patient views both on existing apps and general app functions, unrestricted by developmental skills or market availability, may help identify needs and improve self-management support tools. A website where health apps and websites can be reviewed and prototype designs submitted would be worthwhile, at least for conditions with high prevalence such as diabetes. It remains unclear whether condition specific health charities could take the role of sustaining such review websites.

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Table 1. HAC app reviewer demographic data

	Challenge		
	DAC (n=104)	BAC (n=10)	Both (n=114)
Gender			
Male	43 (41.3%)	5 (50.0%)	48 (42.1%)
Female	61 (58.7%)	5 (50.0%)	66 (57.9%)
Age			
Under 20	9 (8.6%)	0 (0.0%)	9 (7.9%)
20-39	45 (43.3%)	4 (40.0%)	49 (43.0%)
40-59	37 (35.6%)	5 (50.0%)	42 (36.8%)
60 +	13 (12.5%)	1 (10.0%)	14 (12.3%)
Reviewed			
Existing apps	95	10	105
Peer entries	8	n/a	8
Both	1	0	1

Table 2. Existing app reviews by app type and method of access

		Number of reviews						
	Number apps	Apple/iOS	Android	Windows	Website	Facebook	Total reviews	Number reviewers
Diabetes	20	50	11	1	9	42	113	96
Bariatric	7	5	3	0	4	1	13	10

Table 3. Existing app reviews by app main function and average star rating.

App function	n	No. of reviews (%)	Average star rating (/5)
Diabetes	20	113	4.7
Information and support	5	48 (42.5%)	4.4
Data recording and tracking	12	40 (35.4%)	4.7
Nutrition/exercise	3	25 (22.1%)	5.0
Bariatric	7	13	4.3
Information and support	3	7 (53.9%)	4.0

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Data recording and tracking	3	4 (30.8%)	4.2
Nutrition/exercise	1	2 (15.4%)	4.5

Table 4. Design function and motivation for design from the designers' perspective.

Name	Design function	Motivation for design
Dap'n	Information and support: Social communication aimed to support the completion of daily self-management medication tasks	A lack of co-ordinated fast response support to medication difficulties
EasyDiabetes	Nutrition/exercise: Multi-function organiser aimed at young people with diabetes included meal calorie and carbohydrate information, injection site information, and health goals and reminder alarms setting	Teenage issues of unease in showing injection sites, weight management and forgetfulness of regular blood glucose testing
BWell Sugars System	Data recording/tracking: Aimed to simplify data management and tracking in a basic and visual blood glucose data entry and trends overview system	A lack of suitable and simple assistance in recording and tracking blood glucose
Better BGs	Insulin dose calculator: Calculates accurate 'on board' blood glucose and insulin and predicts dosage/carb needs, aimed to reduce carbohydrate and insulin dose guesswork	A need for better blood glucose control and a lack of tools to help accurately predict future blood glucose levels
Gluco-Drive	Alert/reminder: Aimed to improve driver safety by reminding people with diabetes to check if blood glucose levels are within safe ranges prior to driving	Concern about preventable road traffic accidents of those with poor blood glucose control suffering a hypoglycaemia or ketoacidosis while driving

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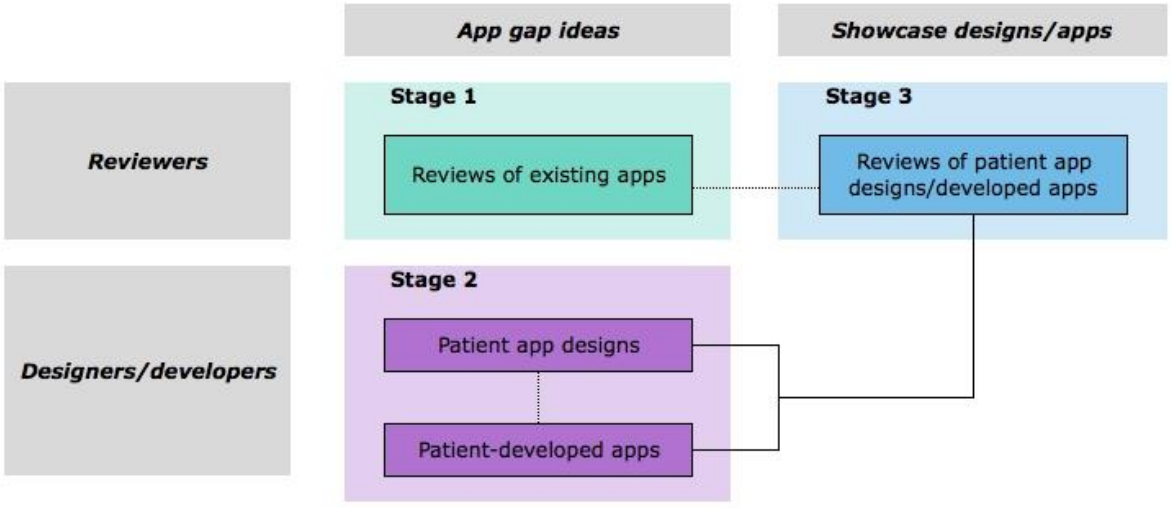
Table 5. Frequency of patient-design reviews and rating out of five by reviewers.

App type	No. of reviews (%)	Average star rating (/5)
Dap'n	3 (17.6%)	5.0
EasyDiabetes	8 (47.1%)	4.6
BWell Sugars System	2 (11.8%)	4.0
Better BGs	4 (23.5%)	2.5
Gluco-Drive	0 (0.0%)	n/a
Total	17	4.1

Highlights

- Health App Challenge model developments identified effective and ineffective elements.
- Existing app review element identified that patients are willing to feedback app use experiences.
- Patient designs supported by existing app observations, identified 'app gaps' in the market.



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APP / WEBSITE NAME	RATING	REVIEWS	
● **HAC MOCK-UP Gluco-Drive (Other)**	☆☆☆☆☆	NEW	Review
gather (Android)	★★★☆☆	1	Review
Diabetes.co.uk (Website)	★★★★★	3	Review
● HAC MOCK-UP Dap'n' (Other)	★★★★★	3	Review
● HAC MOCK-UP BetterBGs (Other)	★★★☆☆	4	Review
ezbds (Apple / iOS)	★★★★★	4	Review
The Diabetic Lounge (Other)	★★★★★	41	Review
MyFitnessPal (Android)	★★★★★	1	Review
My dario (Android)	★★★★★	1	Review
My dario (Apple / iOS)	★★★★☆	6	Review

I love this app! Counting carbs is difficult. Especially when eating out and you font have your scales with you. So this app gives pictures with portion sizes and tells you how many grams of carbohydrate and calories is in it. It does individual foods and drinks but also common meals and takeaways! It makes guestimating much easier and more precise. However, there are foods that I\'ve searched for that are not on it so it\'s not perfect. But overall very useful.	Laois01	★★★★☆	16/06/2014
I have learned a lot about diabetes by reading other people's comments and had a few questions answered when I need an immediate answer. It's fantastic for support too and unlike other sites nobody here judges me or scares the life out of me (other sites have had me wondering if I should call 999 haha) great support network	Sez	★★★★★	05/02/2015
Although american this site does provide the newer sufferer with a starting point and some useful guidance on juggling the eternal triangle of the amount of exercise vs food intake vs dosage.	pumpy	★★★☆☆	08/09/2014

Of all the apps I've looked at, this one particularly stands out to me personally. I love the concept of setting challenges and presenting health monitoring in a 'game' form. I think the app idea is very unique and whilst it is a big idea (in the fact of getting clinics and GPs involved) I think it would be very much worth pursuing. You've done a fantastic job with presenting your idea and I love the concept UI. Fantastic job.	Pelez	★★★★★	04/03/2015
If the model for monitoring and predicting future BG was accurate and could be relied upon this would be a great bit of kit.	Simfish85	★★★☆☆	05/03/2015
very good! well done	jazz	★★★★☆	19/01/2015

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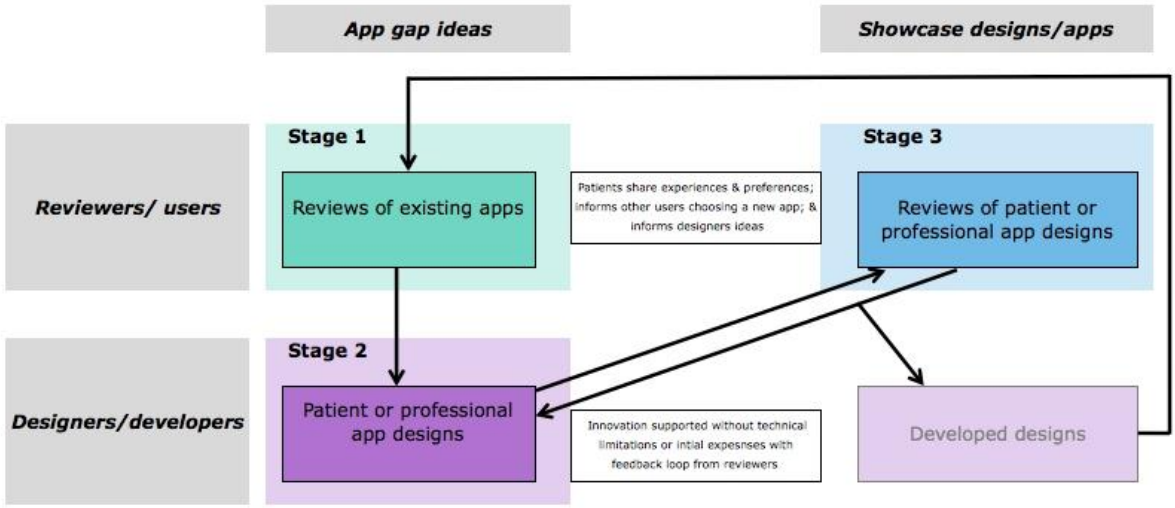

Fig. 1 Health App Challenge participation model.
Fig. 2 Health App Challenge review section. Peer creations highlighted among added existing apps.
Fig. 3 Example reviews of existing diabetes apps: (Top to bottom) Carbs & Cals, The Diabetes Lounge and diabetesdaily.com.
Fig. 4 Example reviews of peer app designs: (Top to bottom) Dap’n, Better BGs and EasyDiabetes.
Fig. 5 Revised Health App Challenge participation model showing how consumer feedback informs each stage.

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