

Co-design of an evidence-based health education diabetes foot app to prevent serious foot complications: a feasibility study

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Abstract

Diabetes is the most common cause of non-traumatic amputations worldwide, and education is key to prevention. Mobile phones and applications (apps) are increasingly being used. This study co-designed and assessed whether a foot health education app would be feasible and acceptable to support people with diabetes (PWD) to prevent serious foot complications.

A diabetes foot app was co-designed with PWD, experts, researchers and biomedical engineers following co-design principles. The app was piloted in a convenience sample of adults with diabetes from one community health service in metropolitan Melbourne for 12 weeks. Baseline quantitative data were collected on foot health, knowledge, self-care behaviours and attitudes. Qualitative data were collected post intervention to capture experiences of using the app, using interviews and focus groups.

The co-designed app included information on amputation risk and self-care practices to prevent serious foot complications. The content used images and simple wording, focusing on early help-seeking behaviour. Forty participants with a mean age of 66.9±17.1 years were included in the pilot. Seven participants withdrew due to personal and health-related issues.

Uptake of the app was low, with 18 participants using the app for any period of time. Qualitative interviews or focus groups were undertaken with 31 participants. Overall, the information was perceived as highly useful for newly-diagnosed PWD and worth pursuing. Future work is needed to identify which PWD would most benefit, and incorporate aspects relating to increased opportunity and motivation for behaviour change and a centralised data management system to provide updates. Copyright © 2018 John Wiley & Sons.

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Key words

diabetes; foot complications; prevention; mHealth; app; co-design

Background

Over one million Australians have diabetes¹ and, with the population aging and poor lifestyle habits, this will continue to rise, as will the rates of associated complications.^{1,2} One Australian undergoes an amputation every 3 hours as a direct result of diabetes-related foot complications, equating to over 4400 amputations annually.³ People with diabetes (PWD) with foot ulcers have significantly lower quality of life and higher rates of depression compared to the general population and to PWD who do not have foot complications.⁴ The impact on mortality is significant, with mortality rates five years after amputation in PWD up to 55%.⁵

Guidelines have been developed to assess, prevent and manage diabetes-related foot complications.^{2,6} International Diabetes Federation guidelines involve foot screening,

multidisciplinary management, education of both clients and health practitioners and appropriate organisational structure.⁶ Research indicates that a 49–85% risk reduction for amputation can be achieved by implementing these guidelines.⁷ Foot care education is an integral part of prevention.⁸

Mobile phone applications (apps) are increasingly being used to provide health education. In 2015, approximately 15 million smartphones were in use in Australia⁹ and, by March 2017, smartphone users could choose from up to 2.8 million apps.¹⁰ Mobile health (mHealth) programmes have proven efficacy in supporting health behaviour change for weight loss and disease management.^{11,12} However, these are designed with minimal input from target end-users, or adaptation to the end-users' needs.^{13,14} Co-design is a process targeting end-users and relevant

stakeholders to work together on the intervention development which increases the likelihood of it meeting end-user needs.¹⁵

We report the development of an evidence-based, co-designed education app on foot health to prevent serious foot complications in PWD. This was followed by a 12-week app feasibility study with 40 PWD to evaluate feasibility and acceptability for amputation prevention education and facilitation of foot health.

Methods

Design

The goal of this project was to work with PWD, the end-users, to generate the content of the app. No one documented co-design approach was identified to suit the purposes of the project, therefore two methods were adapted for use:

- A co-design toolkit from a New Zealand group that includes six stages: Engage; Plan; Explore; Develop; Decide; and Change.¹⁶
- A sequential approach that integrates scientific evidence, expert knowledge and experience, and stakeholder involvement in the co-design and development of a web-based health intervention as described by O'Brien *et al.*¹⁷

We then piloted and evaluated the feasibility of the app over 12 weeks utilising a convenience sample of adults with type 2 diabetes mellitus. Quantitative data were collected pre-intervention and qualitative data were collected post-intervention using interviews and focus groups to understand the subjective experiences of using the app, the relevance of the information and the usefulness of the app.

Participants

PWD were recruited from a large community health service located in metropolitan Melbourne. Inclusion criteria were: (i) PWD with low, increased or high risk of amputation; (ii) sufficient English proficiency to read, write and understand content; and (iii) using or interested in using a mobile phone.

Co-design of app

A diabetes foot health education app, 'Healthy Feet', was co-created

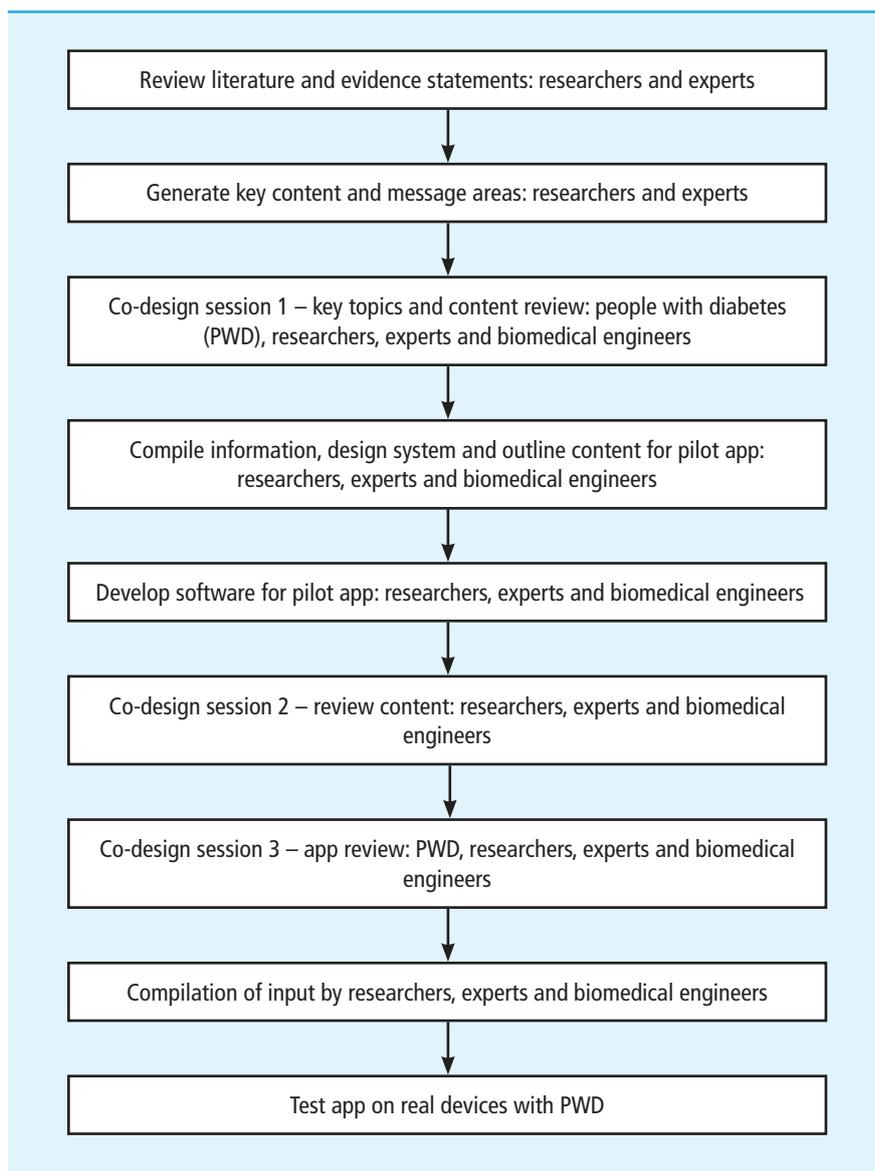


Figure 1. Outline of the co-design process

over six months with three groups: PWD; experts in diabetes foot management; and biomedical engineers. The aim of the app was to supplement health care provider intervention to encourage improved self-care with a focus on earlier help-seeking to prevent serious foot complication development. PWD were included in the app development process to ensure its relevance to them and match their understanding.¹⁸ The process is described below and is outlined in Figure 1.

Review the literature: Two experts and a researcher collated literature in diabetes foot health education, management and self-care practices using the International Working

Group on the Diabetic Foot guidance,¹⁹ National Health and Medical Research guidelines² and systematic reviews.

Generate key messages and content:

Based on the literature collated in the above first step, two experts and one researcher brainstormed the top three key areas in preventing foot complications in diabetes that PWD could accomplish: (i) Daily foot care; (ii) Consulting health providers; and (iii) Education. A presentation was developed with a clear outline of what the literature says on these areas, using terms that were easy to understand by lay audiences. This was to shape the co-design session with PWD.

Co-design session 1 – key topics and content review: This involved eight PWD, two experts, one researcher and two biomedical engineers.

The Boyd Co-design Framework¹⁶ was followed, using the steps of Engage, Plan, Explore, Develop, Decide and Change. The researcher *engaged* PWD to establish meaningful relationships by organising the session at a time and location amenable to PWD. Refreshments and time to get to know the other participants and experts were provided. The researcher then *planned* the session, working with PWD so that they understood the goals of the project and the app. Discussions were held to ensure that the goals were meaningful to PWD and that their input was important to shape the app to be something that might make a difference to other PWD, *exploring* their experiences so they could make the app content relevant to them. The next step was to *develop* the app. Key topic headings based on the literature were presented: (i) Daily foot care; (ii) Consulting health providers; (iii) Education. Information about each topic was discussed, where participants were asked for each key topic: ‘What do *you* think is important to know about diabetes and keeping your feet healthy?’ and ‘What helps or stops *you* from being able to do the things we know can keep your feet healthy?’ An example of how these could be presented in an app was shown to participants, and each section was reviewed, with input provided by the group.

Compile information and undertake system design: This was led by two biomedical engineers, with input from two experts and a researcher. Information obtained from the PWD identified that PWD wanted only a small amount of text, but to have access to additional information if they so wished. Most people wanted practical advice that was presented in simple, easily understood terms, with many pictures that could guide them on what to look out for and when to seek help. Some interaction was proposed – including being able to enter appointments, reminders and contacts for local health care providers. This provided guidance

to the biomedical engineers in their system design.

The primary step in system design was to select the platform for the app development. An Android platform was selected for the app development as this type of device is most commonly used. Android Studio²⁰ was used to build the app. The co-designed content of the app led to defining the app layout to support uninterrupted information flow while providing a user-friendly and interactive layout. The co-creation process identified the need to incorporate simple design and buttons that could be pressed for easy access to information. Based on the input from participants, the layout was developed to allow easy information flow, interaction and ease of use. Participants also identified which colours were to be used and the background for the pages. These were applied and then presented in front of the co-creation team for further approval, with feedback incorporated and with every iteration of the app design, ensuring any new features that were incorporated did not alter the content flow. The app layout design was modified multiple times before the final version of the app was piloted.

Compile content of app to meet the needs of PWD: This was led by a researcher and an expert. The input from participants of the co-design session identified the need for eight topic headings that users could access for further information: (i) Where do I start?; (ii) How do I find out my foot ulcer risk level? (iii) I know my foot ulcer risk level; (iv) When to seek urgent help?; (v) First aid; (vi) Information for carers; (vii) Education; (viii) Disclaimer and acknowledgements.

Each section needed to include: small amount of text – PWD wanted a focus on the practical aspects; the use of simple, easily understood terms; and a heavy focus on pictures to show PWD what simple foot problems look like that might escalate into more serious foot complications. The researcher and expert then sourced existing resources from peak bodies and the literature, compiling content to meet the needs raised by PWD.

Develop software design for the pilot app: Using the content developed by the experts and researchers, and the input from the first co-design session, the biomedical engineers developed the software design of the app. The app was developed on the Android Studio²⁰ and then downloaded on the Android based smartphones. The app was first demonstrated to the co-design stakeholders using a laptop and projection on a big screen so groups could review the app together. Later, individuals were provided the app to test on a smartphone.

Co-design session 2 – review content: This was undertaken with four experts, two researchers and two biomedical engineers. At this stage, a pilot working model was developed, showing each page, its links and content. Each page, section and link was reviewed in this co-design session to ensure that the content was evidence based, understandable and would meet the brief raised by the PWD in the first co-design session. Many changes were proposed in this session, and the app was adapted by the biomedical engineers, with guidance provided by the researchers and experts.

Co-design session 3 – app review with five PWD: Using the same approach as the first co-design session, this was held in a known location, easy to access and at a time that suited participants. Time was given for PWD to introduce themselves, and refreshments were made available to support an environment that would encourage participation. The PWD were re-introduced to the project, its goals and the goals of the session. The amended pilot working model of the app was shown. Each page, its links and content were reviewed to ensure that the content was understandable and would meet the brief raised by the PWD in the first co-design session. Changes were proposed in this session, including: specific pictures of serious foot complications, so that they could see when they needed to seek help; and the need for more in-depth content behind the simple explanations. Discussion was had

on interactive components – with debate on whether notifications and prompts to undertake self-care would be helpful or irritating to PWD. There was no consensus.

The end result of system co-design, *decided* by participants, led to the app having all the important topics being provided as a link button in the menu page. Navigation to the corresponding topics was assisted by pressing buttons which had the links to each topic and sub-topics. Back navigation was provided by an arrow symbol at the left-hand top corner of the app screen. Message boxes/alerts were also provided to facilitate smooth navigation.

Compilation of input: The information provided in the co-design session was incorporated into the app. Additional pictures were sourced from peak bodies, and text was modified to address the specific queries raised by participants. The final content of the app is outlined in Appendix 1 which can be found online at www.practicaldiabetes.com. The user is invited to select their area of interest by touching the section of interest. Each section has areas that users can then pursue, following prompts to get additional information; an example is shown in Figure 2. The inclusion of interactive components was limited – this was a logistical decision as there was limited time to make significant changes within the project timeframe. Three features were included: a search feature, calendar reminder and contacts (outlined in Table 1). Given the participants were equivocal about the utility and acceptability of prompts, a decision was made to not include them.

Test app on real devices with PWD: The developed app was downloaded onto a smartphone (Android version 4.4) and provided to participants with a user guide, as part of the last step of Boyd’s co-design process of *Change*.¹⁶ Participants were asked to use the device over a 12-week period to trial the functionality, content and usefulness of the app.

Data collection and outcomes of the pilot

Demographic information, foot risk status based on the amputation risk

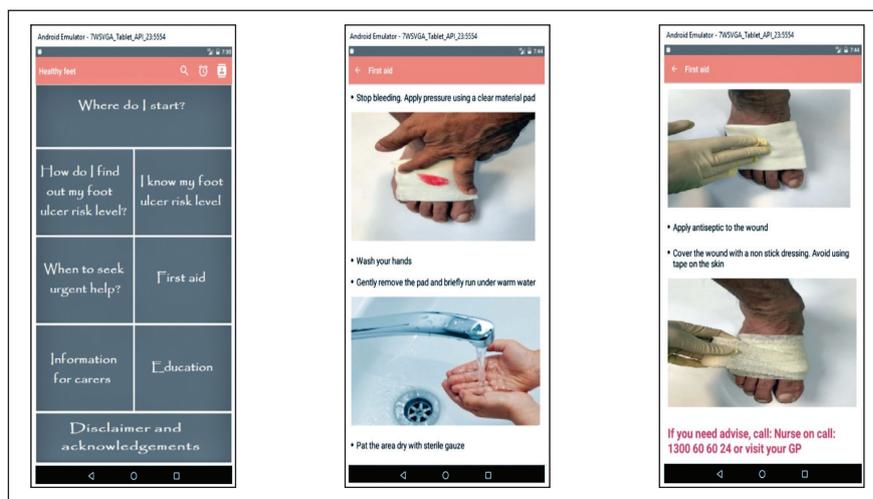


Figure 2. Screenshot of the app menu page and an example showing first aid advice

| Interactive features | Content |
|----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Search | This button allows the user to open the Google search engine. This will facilitate the user to check and gain more knowledge in any topics he/she is reading in the app |
| Calendar reminder | This feature enables the user to set reminders for their routine medical check-up, foot check-up and other associated components that will contribute to optimising foot health |
| Contacts | The user can save the contacts of their podiatrist or endocrinologist or other health care provider by clicking on the contact icon and saving in the allocated space, and make calls or send SMSs through the app |

Table 1. Details of the three interactive features included in the Diabetes Foot App

classification system,¹⁹ and medical and diabetes education history were collected. Foot health, foot care knowledge, attitudes and self-care behaviours assessments²¹ and surveys^{22,23} were also collected at baseline (outlined in Table 2).

Usage of the app and data access was recorded using the inbuilt frequency counter on the smartphone. Interviews provided PWD with an opportunity to describe the key issues of using the app for their foot care knowledge, self-care and management practices.

Ethics

Ethics approval was obtained through the relevant Human Research Ethics Committees, and each participant provided written consent to participate in the study.

Analysis methods

Demographic data were reported descriptively. Quantitative data were presented as means and standard

deviations or, if non-normally distributed, median and range.

Interviews were recorded verbatim and professionally transcribed and transcriptions checked for accuracy. Three researchers (RO, TA, RV) coded the interview transcripts using thematic analysis.²⁴

Results Participants

Forty individuals provided consent to participate, with characteristics summarised in Table 2. Seven participants withdrew from the study due to personal and health-related issues.

Knowledge survey mean (±SD) scores were 17.5±5 out of 27 (65%), indicating a lower level of foot care knowledge. The foot self-care practices average baseline percentage score of participants in this survey was 41%, with a mean of 12.4±3.5 out of a maximum of 30, indicating a low level of self-care practices. Results of the attitudes to the self-care survey identified that participants

| Variable | | All participants (n=40) |
|----------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|
| Age, mean years \pm SD | – | 66.9 \pm 17.1 |
| Diabetes type, n (%) | <ul style="list-style-type: none"> • Type 2 • Type 1 | 33 (82.5) 2 (5) |
| Duration of diabetes, mean years \pm SD | – | 17.1 \pm 10.3 |
| Employment, n (%) | <ul style="list-style-type: none"> • Full time • Part time • Retired • Other (e.g. disability pension, volunteer worker, unemployed, baby sitter, carer of kin) | 2 (5) 3 (8) 25 (63) 10 (25) |
| Education, n (%) | <ul style="list-style-type: none"> • Some high school/no diploma • High school graduate or equivalent • Trade/technical/vocational training • Bachelor degree • Masters degree • Doctoral degree | 14 (35) 17 (43) 3 (8) 3 (8) 2 (5) 1 (3) |
| HbA _{1c} , mean % | – | n=17: 7.16 |
| Diabetes managed by, n (%) | <ul style="list-style-type: none"> • GP • Carrington Health (multidisciplinary team support) • Endocrinologist | 29 (88) 2 (6) 2 (6) |
| Comorbidities, n (%) | <ul style="list-style-type: none"> • No. of comorbidities, median (range) • Cardiovascular disease • Transient ischaemic attack • Hypercholesterolaemia • Hypertension • Osteoarthritis • Obesity • Chronic kidney disease • Retinopathy • Peripheral neuropathy • Peripheral arterial disease • Depression • Other • No. of medications, median (range) | 4 (1–10) 7 (18) 3 (8) 25 (63) 27 (68) 18 (45) 16 (40) 8 (20) 7 (18) 12 (30) 8 (20) 12 (30) 17 (43) 6 (1–24) |
| Smoking history, n (%) | <ul style="list-style-type: none"> • Current smoker • History of smoking | 9 (23) 6 (15) |
| Previous diabetes education, n (%) | <ul style="list-style-type: none"> • Yes • No | 32 (87) 5 (13) |
| Risk of amputation, n (%) | <ul style="list-style-type: none"> • Low • Increased • High | 4 (10) 18 (45) 18 (45) |
| Foot health status (max score 90), median (range) | – | 7 (0–32) |
| Knowledge survey (max score 27), median (range) | – | 18 (7–25) |
| Self-care practices (max score 30), median (range) | – | 12 (7–23) |

Table 2. Participant characteristics

acknowledged that PWD are more likely to develop foot complications, although only 55% thought that they, personally, were likely to develop a foot complication. Results are shown in Table 3.

App use

Each participant was shown how to use the app on the day it was provided to them. Subsequently the app usage data were cleared and participants were given the smartphone to take home and use. Three participants' smartphones were faulty and required replacement. Data on the app usage through the smartphones were limited to 18 participants, as 19 participant phones could not be accessed at follow up, and three participants were not using the phone during the study period for unspecified reasons. Overall, of the 18 participants with data, the app was used for a median of 16 minutes per day (range 2–17) over a median of four days (range 1–29 days). The median total duration of app use by the participants was 70 minutes – enough time to go fully through the app at least once, although it varied considerably across participants (range 2–1337 minutes).

Qualitative findings

Qualitative interviews or focus groups were undertaken with 31 participants. Average duration was 23 minutes (range 5–65 minutes). These were held in a private room at the local community health service, selected because it was familiar and accessible to participants.

Many participants expressed that the information would be highly useful for people newly diagnosed with diabetes or who had no previous exposure to foot care education. Five themes were identified from the qualitative data: (i) Personal context; (ii) External context; (iii) Content; (iv) Ease of use; and (v) Target audience. These are described in Appendix 2, available online at www.practicaldiabetes.com.

Discussion

This study is the first to co-design a foot health education app for PWD. Participants who used this app stated that pursuing development of the app was worthwhile, particularly

for newly-diagnosed PWD, or those who have had little diabetes education. The participants also recommended a holistic diabetes app containing information on all diabetes-related complications, as well as blood glucose self-management. Further, more interactions within the app were recommended. Participants stated the 'Healthy Feet' app is a feasible and acceptable option, but some expressed preferences for other options to receive their diabetes foot education.

In Australia, we have high smartphone use by community members.⁹ There are a high number of apps on the market with an estimated 20% increase annually.²⁵ However, while many are marketed very effectively, these lack proof of efficacy and have been developed without input from the end-users. A scoping review of mHealth in older people identified the need for continued engagement with end-users and a collaborative team approach.²⁶ Further, it also recommended that there be early establishment of the specific app features and hardware considerations perceived to be acceptable, and compatible with the needs of the end-users²⁶ – confirming our approach to co-design the foot app using PWD, experts and biomedical engineers so that the content and format would be evidence based and aligned with the needs of PWD.

Currently, there is substantial variability in the style, structure and content of diabetes foot care education programmes, and uncertainty as to the most effective format.⁸ A recent study identified that written foot health information was more effective at improving foot health while interactive foot health education improved confidence in undertaking preventive activities, suggesting that the most effective foot care education should include both components.²¹

The co-designed app in the current study, as a concept, was received very positively. While the participants stated that the content was appropriate and useful, there was an array of preferred media: some preferred the app, while others preferred a larger screen (using a tablet or laptop) or hard copies of the information, and yet others wanted face-to-face meetings. Thus, the

| Question | Response options | Baseline assessment (n=40), n (%) |
|---------------------------------------------------------------------------------------|----------------------------|-----------------------------------|
| Foot problems are more likely to lead to complications in people with diabetes | Agree/strongly agree | 39 (97.5) |
| | Disagree/strongly disagree | 1 (2.5) |
| Do you think you are likely to develop foot complications? | Very likely/quite likely | 22 (55) |
| | Not likely | 18 (45) |
| I feel well informed about the risk of developing diabetes-related foot complications | Agree/strongly agree | 37 (92.5) |
| | Disagree/strongly disagree | 3 (7.5) |
| How well do you understand how to prevent diabetic foot complications? | Very well/moderately well | 35 (87.5) |
| | Not at all well | 5 (12.5) |
| Would you like more information about diabetes foot complications? | Yes | 34 (85) |
| | No | 5 (12.5) |
| | Missing data | 1 (2.5) |
| How often do you feel overwhelmed with the demands of living with diabetes? | Never/rarely | 14 (35) |
| | Sometimes | 20 (50) |
| | Often | 6 (15) |

Table 3. Foot self-care attitudes responses

information needs to be provided to community members in a range of media forms; education developers need to be prepared to adapt the education in multiple forms to ensure maximum access to target community members. Further, this app had limited interaction with participants. While the aim was to include more behavioural aspects, developing the basic information for the app was considerably more time consuming than anticipated. Future work is needed to identify the best ways to increase opportunity and motivation,²⁷ and how best to incorporate these aspects. In addition, adequate time to co-design these aspects must be factored into any project; difficult given limited and highly competitive funding opportunities. This app was co-designed with predominantly older PWD. Participants suggested a separate app be co-designed with younger people with type 1 diabetes, given technology usage and information needs are different between these population groups.²⁸ An app that allows easy customisation for the individual user based on their level of awareness, and

demographic factors such as age and gender may be useful.

Our aim was to have the app support PWD to seek help early for any foot complications and to undertake self-care activities that would reduce serious foot complications. Behaviours most likely to prevent amputation in PWD include: raising awareness and understanding of risk factors for amputations; avoiding injuries; daily foot inspection; foot hygiene; appropriate sock and footwear selection; appropriate nail care; footwear fitting; and seeking health provider support.^{29,30}

To date, most research in the prevention and management of diabetes-related foot complications has involved increasing the knowledge and confidence of PWD in relation to the self-care for their foot. A systematic review evaluating these education programmes has found insufficient evidence these are effective in achieving clinically relevant reductions in foot ulcer and amputation incidence, despite an array of education media being used.³¹ However, previous work has methodological limitations such as small sample sizes and high attrition rates,

Key points

- Mobile phones are accessed by many community members, and mobile health apps are being developed to support improvements in health and wellbeing
- Co-design involves targeted end-users and other relevant stakeholders in intervention development
- This small feasibility study identified that a diabetes foot health education using an app is worth pursuing, particularly in newly-diagnosed people with diabetes, although other mediums for education may be preferred by some
- Future work should focus on identifying and incorporating motivational aspects for self-care behaviour uptake to prevent amputations in people with diabetes

limiting the generalisability of findings.⁸ A range of psychosocial factors play a key role in diabetes self-management activities, including: lowered perception of risk;³² incorrect beliefs regarding the symptoms associated with serious foot complications; lack of understanding of serious foot complications; and low perceived personal control over serious foot complications.³³ Our cohort showed a disconnect between knowing that the risk of serious foot complications is high, yet stating their own personal risk is low, despite their actual foot health risk being high. Therefore, future mHealth interventions need to be tailored and tested to include these psychosocial behaviour change aspects. This

takes considerable time to co-design with all relevant key stakeholders, and this additional time needs to be factored into future projects.

Our study included the end-users in the app development, a key strength. Limitations include the recruitment of a convenience sample of PWD, which may not be reflective of the population with PWD, thus limiting generalisability. We cannot exclude recall bias, and no attempt was made to adjust for individual differences in foot-related education before recruitment.

Conclusions

Participants who trialled a co-designed app to prevent diabetes-related foot complications confirmed that an app of this kind was feasible and

acceptable, that the concept was sound and that it was worth pursuing further development of the current app. In its current form, there were self-care attitude improvements. Further work to identify the best way to address behavioural aspects and how to incorporate them into this app is necessary prior to evaluating its effectiveness on improving foot health and preventing serious foot complications.

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Declaration of interests

There are no conflicts of interest declared.

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| Topic area | Content |
|----------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Where do I start? | <p>This section helps those users who do not know anything about diabetes foot ulceration and their current risk for developing a foot ulcer. When the user touches the tab labelled 'Where do I start?', the app moves to another page where a short summary about the consequences of having a foot ulcer are explained simply. The summary is followed by 3 tabs with the following headings, taking the user to the different pages when touched:</p> <ul style="list-style-type: none"> • <i>Different risk factors.</i> The risk factors leading to foot ulceration are explained separately, with the topics displayed in tabs that can be pressed for access to the information. These topics are: (i) nerves and feelings in the feet; (ii) blood supply and circulation; (iii) foot function and shape; (iv) skin, nails and self-care practices; and (v) history of foot ulcer and amputation. Each section has explanations through images and simple language • <i>What is a serious foot problem?</i> This page defines a serious foot problem and provides a link to descriptions and images of possible serious foot problems, and that help needs to be sought from health care providers to prevent these problems from escalating • <i>Risk of developing serious foot problem.</i> This section explains the different levels of foot risk and associated symptoms. They are grouped in the accepted classification of: (i) low risk; (ii) increased risk; (iii) high risk; and (iv) current foot ulcer. Each risk level can be accessed in a separate tab to outline what each risk level means. There are also tabs to sections of: <ul style="list-style-type: none"> – 'What do I need to know?' This includes information about the risk level selected – 'What do I need to do?' This includes the self-management information recommended to prevent serious foot complications – 'First aid' – providing simple advice on how to best treat skin damage on the feet. Described more fully in a section below <p>Each section is described using simple language and many images</p> |
| How do I find out my foot ulcer risk level? | <p>The app is designed as an educational and awareness-creating tool; therefore this section does not advise any methods to find out users' foot risk level – rather, it encourages the user to have a clinical check-up. To provide a better understanding of what to expect in a clinical check-up, there is a pictorial representation of the tests under the section 'What is a foot check?' This includes: How to assess for nerves and feelings in the feet; Blood supply and circulation; Foot function and shape; Skin, nails and self-care practices; History of foot ulcer and amputation</p> |
| I know my foot ulcer risk level | <p>This section is designed for users who are already aware of their foot ulcer risk level. This section takes users to the different levels of foot risk, as selected by them: (i) low risk; (ii) increased risk; (iii) high risk; and (iv) current foot ulcer. By pressing on the appropriate tab, the user is redirected to the corresponding risk level. The content is as described in the section above</p> |
| When to seek urgent help? | <p>This section provides a visual example of emergency foot conditions which require immediate action through a series of images. The user is encouraged to seek urgent care if they see their foot exhibits similar or the same appearance</p> |
| First aid | <p>This section contains pictorial representation of the first aid required when the user has a break in the skin on the foot. The section also provides an Australian nurse on-call phone number to contact in times of emergency</p> |
| Information for carers | <p>This section explains what carers must do for different levels of foot risk, with tabs to sections entitled 'What do I need to know?', 'What do I need to do?' and 'First aid'. In addition, to facilitate understanding of foot complications for those carers who have no knowledge, this section also contains a link to the 'Where do I start?' tab, as well as links to the 'When to seek urgent help?' section</p> |
| Education | <p>This page contains links to educational documents and websites containing reputable information. This includes information on local resources, a daily foot care checklist, resources provided from the Australian Centre of Behavioural Research in Diabetes on peer support diabetes, diabetes distress, diabetes and anxiety, diabetes and depression. This section needs internet connection</p> |
| Disclaimer and acknowledgements | <p>This includes the information that the app does not replace a health care provider. Acknowledgements of support and sources of information and images are provided here</p> |

Appendix 1. Details on the content of the Diabetes Foot App

| i. Personal context: This relates to the individuals' perception of their knowledge and risk of serious foot complications | |
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| Subcategories | Quotes |
| Knowledge and self-care practices increased | '... I think the app was good. I've got it downloaded now on my phone so I can read through it... every time I saw it... it reminded me... visually it stuck in my head and so I checked my feet. I moisturised my feet, I checked my nails, I made sure that my shoes were right... I did everything that I would normally know to do because this [study mobile phone] was like... a prompt.' PWD 01 |
| Already had the knowledge | '...because what I eventually saw on there, I already knew.' PWD 02 |
| Sufficient risk prevention measures were already in place | 'We've had problems before and it happened so quickly. We'd go to either straight to the doctor or straight to the emergency, and so there's absolutely nothing that it could tell me, that I don't know already.' PWD 03 |
| App increased their awareness of foot complications | 'I just – I didn't know. I didn't have an understanding of it. That was my – I knew you could get foot complications. But I never thought into that. Now, I know – you know if you've got a scratch you've got to be very aware. If you get a lump or something you've got to be – you and seek help straight away, so it doesn't flow out of control.' PWD 04 |
| Behaviour change needed only when a problem develops | 'If you get something then you sort of think, oh, I should find out about that. But when you haven't got it you think, oh, that's never going to happen to me.' PWD 05 |
| Other health issues | 'When you've got coeliac disease, on top of kidney problems, and then you've got diabetes, it just gets too hard and you throw your hands in the air some nights.' PWD 06 |
| ii. External context: This theme involved those aspects which had an impact on participants' perceptions and ability to undertake self-care, beyond the personal context related to diabetes | |
| Carer responsibilities | 'Well, as much as I know I should look in my shoes, I don't. Every morning I get up and my concern is getting my Dad out of the bed, because I'm a carer for him. I don't have a lot of time for myself, and there's no minute where I'm ever alone.' PWD 07 |
| Physical barriers | 'Believe it or not, checking your feet is not a one-person job. You have to have two people.' PWD 08 |
| Contradictory information | 'I think I found from the moment that I got diagnosed with diabetes that one says one thing, another says the other, and in the end I just thought okay, I'm type 2. I'll do my very best to stay away from sugar, I'll take the tablet, and that's as far as I've gone.' PWD 09 |
| iii. Educational preference: This involved participants having different preferred methods to receive information on foot health | |
| Varied use of smartphone features | 'We use our mobile phones to make phone calls and that's virtually it. We're not on the phones all the time or anything like that.' PWD 03 'I answer [the mobile phone], and if I don't answer it, it goes to message bank. Then I collect it at the end of the day. That's it. I don't want to know any more about the phone. Everyone keeps raving about apps. I don't know where they are.' PWD 06 |
| App-based education is good | 'I actually liked the fact that it was on the smartphone because if I was out and wanted to have a quick look I could.' PWD 07 |
| Larger screen would make information easier to view | 'You're probably better to have that app on a tablet... Arms are not long enough and the screen's too small and it's very hard.' PWD 10 |
| Preference for other methods of information exchange | 'Maybe if it can fit on one page, maybe you can put just the basic things on one page and like a magnet or something, we can stick on a fridge. So you don't have to use the smartphone.' PWD 11 'It is and I really think that just to hand a person something like that and expect them to educate themselves I don't think's going to work. I don't think it's going to work. I don't think there's anything better than getting a group of people together and having the pictures on the screen and talking to them and educating the people that way.' PWD 12 |

Appendix 2. Quotes from participants with diabetes after using the app. (Continued on next page)

iv. Content: Relates to the perception of participants on the content within the app

| Subcategories | Quotes |
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| The information was relevant and of interest | 'I think the majority of it worked quite well. You could go into just one section and go through things. You didn't have to go through the whole app because you're cross-referenced a number of the images and statements to various sections.' PWD 13 |
| Participants wanted varied levels of information | 'I thought it was – look, it's very basic.' PWD 14 'Some of the information was a bit too – I had to read it and I think it was a little bit too hard... You need to break it down more simply.' PWD 15 |
| Preferred app to include all aspects of diabetes management, not just foot complications | 'For me to be a hundred per cent on board with the whole – either foot check or test strip check, or whatever, I'd like to have an app that basically gives me all that on a daily basis. I would most probably go along and do that. But it's having one for that, and then maybe another one for that, and all that. It just goes out the window for me.' PWD 09 |
| Needs more interaction | 'To me, something like that would be a – maybe a checklist that could be customised. I guess if there were certain things that were indicated on the checklist, it could go further into that. I would see that as being a really useful thing where people – where you are prompted to do a check, where you pick the phone up or you get a reminder once a week...' PWD 16 |

v. Target audience: This related to the participant thoughts on who would benefit most from the app

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| Newly diagnosed would benefit most | '...if people are newly diagnosed I think it's a good starting point. I mean it's different for us because we've had it for a while... and we've had all the information. But if you're newly diagnosed I think it's a great starting off point.' PWD 07 |
|------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

Appendix 2. Quotes from participants with diabetes after using the app. (Continued from previous page)