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ORIGINAL RESEARCH

Development and evaluation of a co-designed website for delivering interactive self-directed cardiac rehabilitation

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Aims The aim of this study is to report on the development and evaluation of the co-designed website for delivering interactive self-directed cardiac rehabilitation (CR).

Methods and results Multi-method user experience design framework was used to co-design the web application and complete usability testing. Participants were recruited based on their eligibility for CR. Thematic analysis collected the participants' design specifications and lived experiences. The System Usability Scale (SUS) was administered at the completion of the website development and the usability testing workshops. This collected the participants' perceptions of the website's effectiveness, efficiency, and their satisfaction. Website development and usability testing workshops included 39 and 35 participants with a mean age of 66.5 (SD 11.7) and 68.6 (SD 11.2), respectively. Both genders were equally represented across both workshops with 19 (48.7%) and 16 (45.7%) women. Workshop themes guided the design process. The mean SUS scores increased from 66.7 (SD 16.8) to 73.6 (21), $P = 0.26$. Easiness of use ($P = 0.03$), integration of the website functions ($P \leq 0.001$), and consistency ($P = 0.038$) significantly improved from website development to usability testing. The proportion of participants rating it as excellent increased from 20.5% to 42.9%, $P = 0.11$.

Conclusion The evolution of our CR website development was completed with an improvement in usability. Upcoming evaluation of this intervention will report on its effectiveness.

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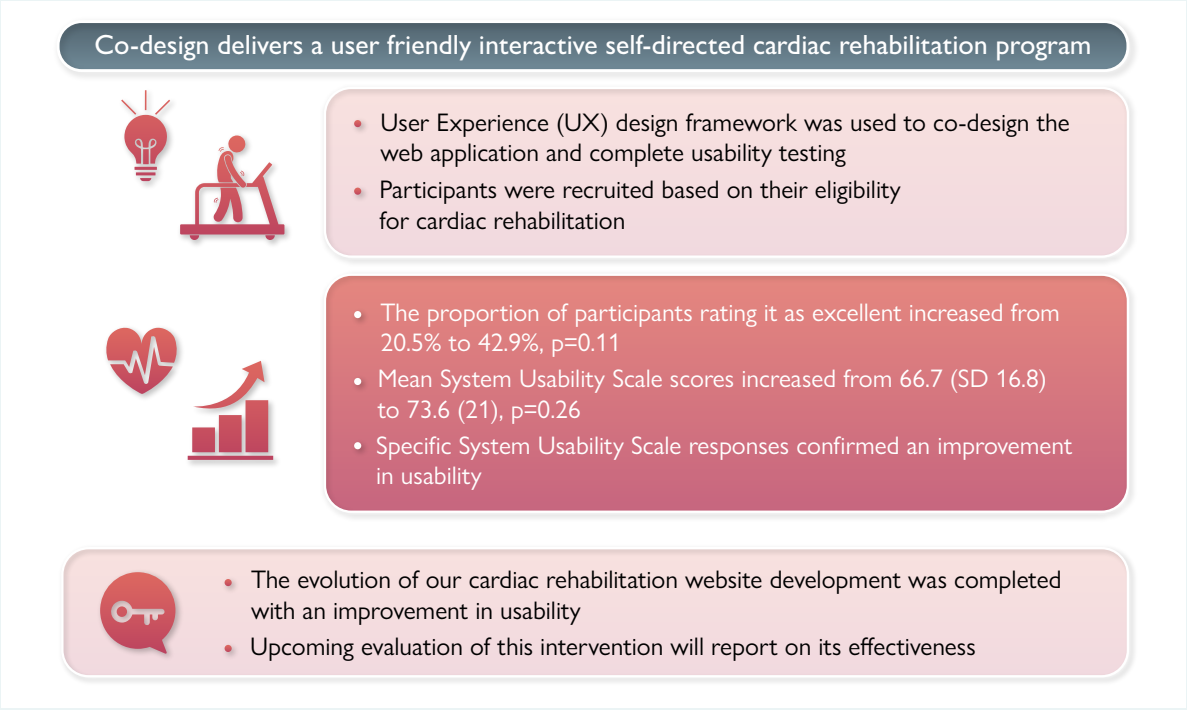
Graphical Abstract



Keywords Co-design • Cardiac rehabilitation • Web application • Remote e-health

Novelty

- Digital, interactive discharge programs can support all patients waiting to start cardiac rehabilitation programs.
- Self-directed cardiac rehabilitation supports patient ownership of behaviour change.
- The implementation of consumer designed health interventions that addresses chronic disease, inequity, and inaccessibility is key to future research models.
- This study is an exemplar of implementation research, paving the way for the undertaking of this web-based CR program, and an example for future co-designed healthcare interventions.

Introduction

Cardiovascular disease (CVD) is an established public health burden, and the continuing leading cause of death globally.[1] It is the most common cause of hospitalization, with 23.9% of all hospital admissions attributable to CVD,[2] burdening global economies through projected increases in health budget spending, with a global forecast increase from US$863 billion in 2010 to US$1.04 trillion in 2030.[3] This upward trajectory of spending is influenced by a reduction in mortality and increase in CVD survival. However, CVD is largely preventable by addressing modifiable risk factors such as cigarette smoking, unhealthy diet, cholesterol, obesity, high blood pressure, and diabetes mellitus.[4]

Cardiac rehabilitation (CR) is a comprehensive intervention aimed at addressing CVD risk factors, available to patients following a diagnosis of heart disease, often preceded by an acute cardiovascular event with hospitalization.[5] CR programs include health education, CVD risk reduction advice, and physical activity and psychosocial management.[5] Despite its effectiveness on mortality, CVD risk factor reduction and improving psychosocial wellbeing, poor access to CR is unremitting globally, with only 5–50% of those eligible participating in a rehabilitation program.[5]

The internet is an extremely powerful tool for disseminating and accessing health information and maintaining clinical communication. Information technology is rapidly driving the evolution of healthcare services with online interventions showing encouraging results in improving patients' self-care, quality of life, and modifiable risk factors.[6,7] Remotely delivered CR is an acceptable alternative mode for completing programs.[8] Furthermore, consumer engagement with smart phones, messaging, and internet use, irrespective of age, is high.[8] Despite research into remotely delivered, digital applications for interactive, clinician led CR programs, translation into mainstream healthcare remains inadequate.[7]

Patient engagement is foundational to providing a high standard of healthcare. This engagement has evolved from designing for to designing with, recognizing the inclusion of consumers early in the design process as key to improving patient outcomes.[9,10] Effective change

management in the planning and implementation of healthcare requires active engagement and collaboration with service users. Co-design is best described as 'an approach to designing with, not for, people',[11(p14)] and is successfully undertaken when four key principles are applied to the process: sharing of power, prioritizing relationships, using participatory means, and building capacity.[11] A number of studies[12–14,15,16] have conducted acceptability and feasibility testing, explored patient's perception with products, and applied a form of co-design to the development of digital programs before, during, and after their testing CR platforms. However, the aforementioned early engagement in the design of interventions and along the design continuum is not commonly attended to and/or explicitly reported on.[17,18]

The Country Heart Attack Prevention (CHAP) Project is a National Health and Medical Research Council–funded project, which is developing, implementing, and evaluating a model of care and clinical pathway for the translation of CR and secondary prevention guidelines into practice for rural and remote patients in Australia. With the main aim of increasing attendance to and completion of CR and as a strategy, a co-designed, interactive, clinician led, web-based CR program was developed to increase flexibility and provide choices to patients. The website program content was based on Phase 2 CR education modules as recommended by current guidelines.[19,20,21] This study co-designed the website through two rounds of six workshops. Round one focused on website development, co-designing with participants, and round two was usability testing of the completed website. It was then launched for clinical use in collaboration with the Integrated Cardiovascular Clinical Network through their *Country Access to Cardiac Health* program which manages all regional and rural CR referrals.[22]

Our study aimed to develop a web application CR program to improve CR access for populations living in rural and remote South Australia through a web-based CR delivery model. The objectives were to co-design a web-based CR program for patients with CVD and to evaluate the usability of the web-based CR program.

Methods

Overview

This was a multi-method study, adopting a qualitative and quantitative approach concurrently, as guided by the user experience (UX) design methodology. User experience design is an established methodology of co-design for developing and integrating a consumer-ready intervention[23] and typically uses a multi-method approach through observational techniques, task analysis, and other feedback instrument such as feedback forms and surveys.[24] The stages of design are on an interchangeable continuum, including empathy, describing or defining the task or problem, ideating, prototyping and testing. Seeking to understand not only the problem but also those most affected by it, providing definition to action. This then guides the development of ideas and prototypes, allowing for a product to be tested.[25]

The conceptual framework for UX design highlights the evaluative process which comprises an observational assessment (the user's perspective on the design), psychometric scales (user self-evaluation), and psychophysiological measures (the bodies response when interacting with the design).[26] This study employed two of the three processes, observational assessment and a psychometric scale.

The qualitative approach was framed by social constructionism using a phenomenological approach, defining workshop outline and content, including questions proposed to participants and data analysis. This involved two rounds of six co-design workshops, for website development and then website usability testing. Co-designers collaborated with researchers iterating high-fidelity computer-generated prototypes during website development and interacted with the completed website during usability testing.

Procedures

Both the website development and usability testing workshops were conducted in six rural South Australian Local Health Networks (LHN). The same CR services were attended, with the exception of one LHN that was unavailable for usability testing and replaced with an alternate service. All workshops included the same participants from website development to usability testing. Patients and family members living in rural and remote areas of Australia were invited to participate based on their eligibility for CR as outlined by the National Heart Foundation of Australia.[20] Patients who were included had experienced unstable angina, non-ST-segment elevation and ST-segment elevation myocardial infarction, stable angina, coronary artery bypass surgery, percutaneous coronary interventions, and heart failure.[20] This study also included participants with valve devices, permanent pacemakers and implantable defibrillators, heart transplants, and arrhythmias.[20] Participants were adults aged from 18 years and above. The study was granted ethical and governance approval (EGR/20/RSS/15–19) by the Southern Adelaide Clinical Human Research Ethics Committee. Participants were identified and approached by CR clinicians in the LHN and completed a consent before commencing the workshop.

The empathy and definition in the design process had been previously established, enabling the ideation and testing phases to be conducted in this study.[27] During the website development workshops, participants worked with researchers iterating high-fidelity computer-generated prototypes using iterative, parallel, and competitive processes.[28] Workshops were 2 h in duration and conducted as a whole group activity, enabling participants to share their design ideas on the format within the website, their preferences for receiving education, and the language used to deliver the CR modules. While looking at the prototypes, set cues were used to guide the discussions, these included questions (1) could you use it without help?, (2) is the navigation of the website clear?, (3) is the language clear and easy to understand?, and (4) does it look good?

Usability workshop activities facilitated data collection and include small groups of 2–4 participants who had tablets and time to freely engage with the site and content. These groups discussed formatting within the website, the delivery modes for education, particularly the video, animation, and hyperlinks, font size, and general aesthetics. They were guided by a checklist of tasks to complete while using the website, fostering an independent experience. Usability testing also sought to elicit the participants' perceptions of the website relevance and applicability as a CR program.

Outcomes

Observational assessment of participants lived experiences and design specifications was achieved through audio recordings that were then transcribed verbatim.

The psychometric outcome measure employed was a validated product satisfaction survey, the System Usability Scale (SUS), and was administered at the completion of the website development workshops and the usability testing workshops. The SUS is a simple 10-item Likert scale giving an overall view of subjective assessment of usability.[29] The selected statements in the SUS cover a variety of aspects of system usability including effectiveness, efficiency, and satisfaction.[29,30] Participants ranked each question from 1 to 5 based on how much they agree with the statement they are reading. Five means they strongly agree, one means they strongly disagree.[29] The SUS is scored from 0 to 100, with a score 68 indicating okay usability, 68–80.3 good usability, and >80.3 excellent usability.[29] Reliability analysis shows the 10 items on the SUS having acceptable reliability, ω=0.91.[31,32] Convergent validity has been established through correlation with the three items on the Client Satisfaction Questionnaire (CSQ-3), $r_s = 0.49$, 0.46, and 0.38.[31]

Qualitative analysis

Workshop audio recordings were transcribed by a professional transcribing service. The de-identified workshop transcripts were entered into NVivo with an electronic record saved of both the transcripts and code books (QSR International Pty Ltd, 2020). Braun and Clark[33] inductive thematic analysis guided the coding of workshop audio recordings. K.N., S.C., L.G., and N.B. met twice to establish the analysis approach and assign tasks. Familiarization with the topic was established through organic and subjective coding by K.N., S.C., L.G., and N.B. individually. Nodes were established independently and then examined collaboratively by the researchers involved with the coding to identify themes. K.N., S.C., L.G., and N.B. along with others in the research team met once after recurrent themes had been identified to confirm final themes. Verbatim quotes were extracted to illustrate themes and subthemes.

Reporting bias was mitigated with coders being from different research disciplines: nursing, pharmacy, health science, and health economics.

Further to this, not all researchers involved with the coding had attended all or some of the workshops. Finally, thematic analysis was completed in NVivo, with an electronic record saved of both the transcripts and code books.

Quantitative analysis

The survey and SUS data were analysed using the Statistical Package for the Social Sciences (IBM SPSS) Statistics 28.0.0.0. Descriptive statistics were generated for continuous measures. The SUS was used to measure objective feedback. The mean SUS scores were compared between the website development and usability testing rounds of the workshops using the independent *t*-test. System Usability Scale score categories were compared between the workshops through χ^2 test.

Sample size

No formal power calculations were used as this study applied a workshop and descriptive approach, for which it is not indicated. However, the UX design methodology reports sample sizes for formal usability studies require 10–12 participants, while less formal usability studies require 4–5 participants.[34] Therefore, this study aimed to recruit 10 participants per workshop, overrecruiting by two participants, allowing for attrition.

Results

A total of 74 participants were recruited for the two rounds of six workshops or website development ($n = 39$) and usability testing ($n = 35$) (*Table 1*). Females were equally represented across both workshops 19 (48.7%) and 16 (45.7%) (*Table 1*). Participants were predominantly Australian born 28 (71.8%) and 26 (62.8%), with mean ages of 66.5 (SD 11.7) and 68.6 (SD 11.2), respectively (*Table 1*). More than half had a myocardial infarction 24 (61.5%) (*Table 2*). With respect to information technology engagement, most used a smart phone 27 (69.2%) and 22 (62.8%), National Broadband Network (NBN) internet connection 27 (69.2%) and 18 (51.4%), and Facebook 31 (79.5%) and 20 (57.1%), respectively (*Table 3*).

Themes identified

Five primary themes were identified that reflected the participants' preferences for the appearance and functionality of the website: (1) managing fear of the unknown; (2) usability; (3) connectivity; (4) format of information; and (5) behaviour change empowerment (*Table 3*). These themes highlighted the reasoning behind the design preferences and usability outcomes measured by the SUS, while emphasizing the required commitment to recovery and behaviour change. Of these primary themes, managing fear of the unknown was reviewed and categorized as an overarching theme as it pervaded all workshops without specificity to precise design ideas. These themes were common to all groups in the website development and usability workshops, with a stronger presence in usability testing.

Managing fear of the unknown

Managing fear of the unknown permeated workshop discussion, indirectly influencing the development of the website, and confirming its current and future role in CR program modalities. Subthemes from

Table 1 Participant characteristics

Characteristics		Website development workshop, $n = 39$ (%)	Usability workshop, $n = 35$ (%)
Age, mean (SD)		66.5 (11.7)	68.6 (11.2)
Sex	Male	20 (51.3)	18 (51.4)
	Female	19 (48.7)	16 (45.7)
Workshop	Mount Gambier	7 (17.9)	5 (14.2)
	Whyalla	6 (15.4)	6 (17.1)
	Murray Bridge	6 (15.4)	6 (17.1)
	Barossa	8 (15.4)	4 (11.4)
	Wallaroo/Port Lincoln	6 (15.4)	8 (22.8)
	Berri	6 (15.4)	6 (17.1)
Cardiac rehabilitation program completion	Yes	39 (100)	25 (71.4)
Employment status	Employed full time	7 (17.9)	4 (11.4)
	Employed part time	6 (15.4)	3 (8.6)
	Unemployed	2 (5.1)	2 (5.7)
	Retired	24 (61.5)	25 (71.4)
Education level	Primary education	3 (7.7)	2 (5.7)
	Secondary education (Year 9 and above)	19 (48.7)	15 (42.8)
	Certificate	9 (23.1)	11 (31.4)
	Advanced diploma	3 (7.7)	2 (5.7)
	Bachelor's degree	5 (12.8)	3 (8.6)
Country of birth	Australia	28 (71.8)	26 (74.2)
	England	8 (20.5)	3 (8.6)
	Other (USA, South Africa, Northern Ireland, Scotland, New Zealand)	3 (7.7)	5 (14.2)

managing fear of the unknown were the gap between cardiac event and commencing a CR program, lack of/or overwhelming information, the benefit of hybrid CR, and how these themes can positively impact on mitigating fear.

The workshops explored managing fear of the unknown and how the gap or time lag from hospital discharge and Phase 1 CR to commencing Phase 2 CR contributed to this. Participants found this to be a 'no man's land' situation where they were overwhelmed while also lacking knowledge about what had happened, what should be happening, and what will happen.

Furthermore, participants identified that contributing to their fear during this period was lack of information or alternatively too much complex information, often relating to new medications or starting medications for the first time. Many expressed concerns that they could not remember vital information about their new routines or what the medications themselves were for and their side effects.

> *'The problem I found with that is it went in one ear and out the other. I really wasn't in the state where I could consider what they were saying. It took me all my time to decide what I had to remember and what I … worry about trying to remember'*

The website was discussed throughout the workshops, with participants favouring it as not only a formal alternative or hybrid program modality, but also as a discharge program, or CR Phase 1b. This would address the knowledge gap, with patients having access to information and education in a format and timeframe that circumvented brain fog and fear in the early days after hospital discharge.

Participants in the co-design and usability testing workshops had all completed a traditional centre-based program, with positive patient reported outcomes. However, they felt the option to complete a hybrid program would maximize the benefits of CR.

This hybrid option was explored, identifying its potential to positively impact on patients who may return to work early, allow for last-minute non-attendance, completing a week at home, due to unforeseen circumstances inhibiting attending in person, and to facilitate deeper knowledge acquisition through the websites content. Participants shared their positive experiences with their own CR program which was centre-based and conducive to community and comradery building, thus allaying fear and the sense of being alone when newly diagnosed. Their reflections elicited some thoughts on how the website could replicate, if only in part, this crucial factor in managing fear.

Participants had also enjoyed the contact and support of their CR clinician throughout their program and sought to know how this would be addressed if completing CR via the website. This consideration was established before conducting development workshops, with a clinician led and managed program planned.

Table 2 Cardiovascular condition

Cardiovascular condition	Website development workshop, *n* = 39 (%)	Usability testing workshop, *n* = 35 (%)
Acute myocardial infarction	24 (61.5)	16 (45.7)
Coronary artery bypass graft	3 (7.7)	5 (14.2)
Heart failure	3 (7.7)	3 (8.6)
Coronary artery disease	5 (12.8)	11 (31.4)
Spontaneous coronary artery dissection	1 (2.6)	2 (5.7)
Cardiac effusion	1 (2.6)	1 (2.3)
Atrial fibrillation	2 (5.1)	7 (20)
Percutaneous coronary intervention	4 (10.2)	6 (17.1)
Heart transplant	0	1 (2.8)

Table 3 Information technology characteristics

Information technology characteristics		*Website development workshop, n = 39 (%)*	*Usability testing workshop, n = 35(%)*
Technology	Smartphone	27 (69.2)	22 (62.8)
	iPad/tablet	19 (48.7)	15 (42.8)
	Home computer	24 (61.5)	15 (42.8)
	No technology use	1 (2.6)	1 (2.8)
Internet connection	NBN connection	27 (69.2)	18 (51.4)
	Home internet	9 (23.1)	8 (22.8)
	SIM card on phone	9 (23.1)	8 (22.8)
	No internet connection	0	3 (8.6)
	Other	1 (2.6)	1 (2.8)
Social media	Facebook	31 (79.5)	20 (57.1)
	WhatsApp	7 (17.9)	6 (17.1)
	Instagram	10 (25.6)	5 (14.2)
	LinkedIn	3 (7.7)	3 (8.6)
	Twitter	4 (10.2)	3 (8.6)
	TikTok	0	2 (5.7)
	No social media use	0	8 (22.8)

Usability

During website development workshops, participants discussed the nuances around user experience and technology highlighting program setup/accessibility/access, ease of login, and limitations and benefits of activity tracking. Participants felt either personal guidance by the CR clinician or a readily available checklist would be required to eliminate obstacles in both setting up their program and ongoing ease of use would help if the process were overwhelming or confusing. Ideas around how this could be approached included a telephone and email support system, a checklist/tips and tricks list that is received at enrolment with, and the option to set up with the clinician at the pre-assessment appointment.

Ease of login was topical early on and in all website development workshop discussions. Problem solving around this issue included having a clear and uncomplicated login page, with the capacity of remembering a password if using a private device, and instructions on how to save the icon to the home screen of a smart device or bookmarking the website URL on your computer.

> *'The only thing that I sort of do and have found, you can go into login do the whole thing and then I go in a second time, can't find it or you get lost; that is where I have got caught a number of times'*

When shown the high-fidelity prototype login page, participants responded with concerns about the size of the login invitation, suggesting it be larger, being the first thing that is seen.

> *'What you want people to do is to log in, so that should be prominent. That should be the first thing they see'*

During usability testing workshops, the login function was not assessed as we were using a generic logged in test program. Participants did however respond to the completed website login page positively regarding the earlier request for simplicity in setup and use.

> *'The basic setup is, yeah user friendly, easy to read'*

Further thoughts about usability expressed were reporting activity, with participants shown examples of how this could look like on the website, asking about how activity could be measured and reported if not using a wearable device. They accepted the current medium within the website for entering activity data based on minutes and type but highlighted the need for significant personal motivation to benefit from this setup.

Format of information

During the website development workshops, while viewing the high-fidelity prototype images, participants discussed what design aspects would make the information in the website interesting and meaningful, particularly regarding its positive impact on behaviour change. Feedback and design ideas focused on colour, naming, and design of icons for modules, goal setting, displaying program progress, the use of video/pictures/font size/over text, and language used within the website. Initially, when workshopping design ideas, participants expressed a general concern about keeping it uncomplicated and simple, to avoid confusion both in the use and understanding of content.

The colours presented on the prototypes were met with underwhelmed impressions, as our early prototypes had a brown, maroon colour. Participants agreed that brown was not an appealing colour.

> *'Looks like a dodgy bank. It actually, it's almost puts a block in front of you, it makes you apprehensive, it needs to be a more inviting color, it's the wrong color'*

They did however agree on brighter colours such as purple or blue with the website using this final design input.

Further design input was given on the prototypes of the home page containing the list of modules to be completed by the client. Discussion focused on the colour of the icons, and the picture represented on the icon. Participants liked the descending list of modules; however, they suggested the icons to be blue and represent the modules content. This design element evolved over the development workshops, utilizing a parallel and competitive iterative process, until we had a version that had representative white pictures with a blue background that participants loved.

Goal setting is an essential component to behaviour change, with intrinsic motivation the most powerful factor on positive change.[35] The early website prototypes for the goal setting fields presented to participants were a basic box format with free text field for goal setting. Participants discussed the pros and cons of this free text option, suggesting a pre-populated drop-down option menu or a combination of both.

They identified that early in their own CR journey, goal setting can be an overwhelming and negative experience, often only being able to establish one quite simple goal in the early days. They addressed the need to keep it simple. Therefore, the aesthetic of the goal setting field did not change, with the ability to write down four goals maintained, and only one goal as mandatory, indicated by a red asterisk, with the option to add more or change as clients progressed through their program.

The early iterations of the website CR modules displayed the clients progress by page number, for example 9 of 30. Participants felt this could lead to frustration and feeling overwhelmed.

> *'It's just that when you see 22 of 109 it feels like you're climbing a mountain. And … you want to climb a little hill; you don't want to be climbing a mountain'*

Participants discussed a simple yet effective approach to address this, while still tracking module progress, was to have a progress bar, often used in exercise videos, displaying a percentage of completion.

A critical area of design input that was highly impactful on the final website pertained to how educational content was displayed and communicated. Participants overwhelmingly preferred audio-visual formatting, videos, infographics, pictures, and links. However, many said they would also like corresponding text for more in-depth reading, if so desired. The prototypes evolved with these design specifications iterated. They also suggested that the combined modules, smoking cessation, and alcohol be separate modules, reflecting the variety of CR risk factor modifications required by clients, rather than a one size fit all approach. The completed website included all three design specifications and participant specifications relating to the language on the website, throughout, and specifically relating to module titles.

Connectivity

Internet availability and device ownership play a key role in client engagement with digital health interventions. Accordingly, while discussing design specifications, participants shared their thoughts on issues around age and technology use, poor internet access, and data usage costs in rural areas. They also highlighted the need for the website to be device agnostic.

> *'Consider platforms the website is available on, not just desktop/laptop'*

We were able to test and show this on tablets, smart phones, and laptops during the usability testing workshops.

Behaviour change empowerment

While reflecting on their own journey post-cardiac event, and the upheaval it can bring, participants identified the need for the education and general information on the website to be framed positively. Change is a

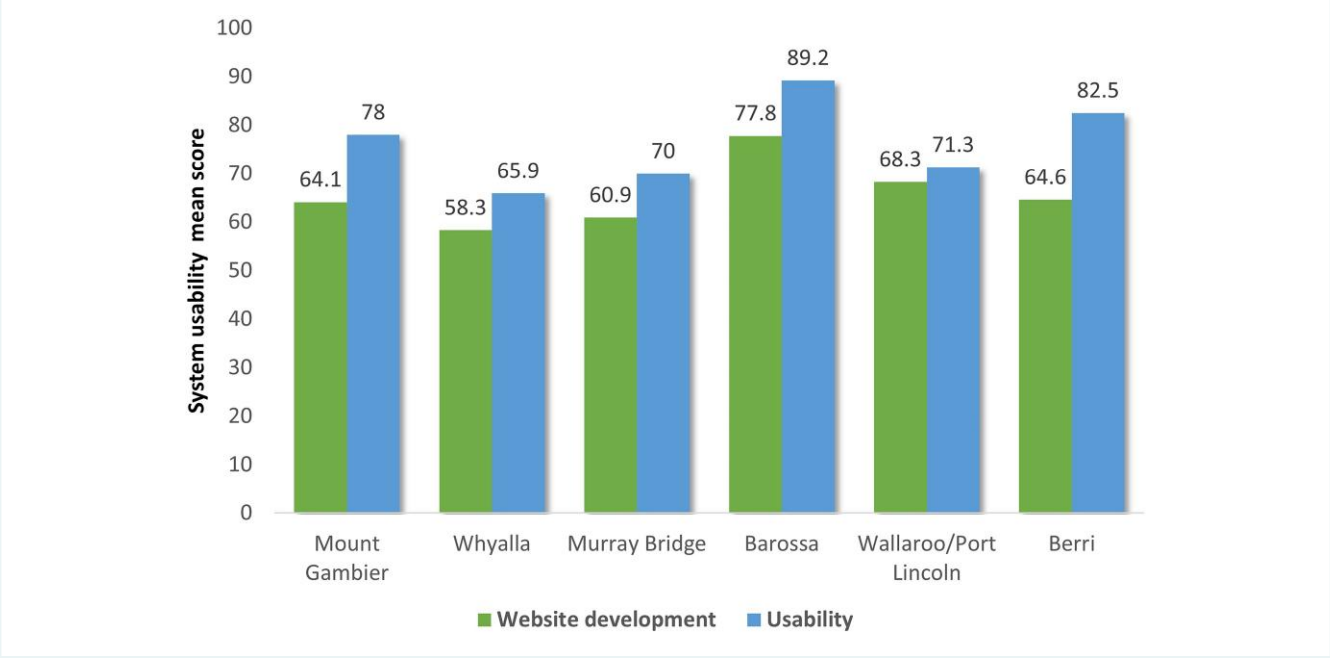


Figure 1 Mean workshop System Usability Scores.

pervading reality, be it goal setting around diet, smoking, weight, activity, etc., and inevitably overwhelming. Participants emphasized that communicating risk modification education in an approachable, connected manner can increase intrinsic motivation to start changing behaviours, and develop long-term habits.

> *'Because quite often people, they need hope and if you can get it right, and people see that, then they'll think okay, I can see where this is going'*

and

> *'Or how can, you know even change the terminology, how can we talk about quitting smoking or, initial assessment and goals, again I think that's a bit clinical'*

These insights influenced the design of the infographics, with educational information presented with interesting and enjoyable alternatives. Furthermore, videos focused on clients understanding of the cardiovascular system and condition, empowering knowledge, behaviour change thinking. This content was received as reassuring, positive, and empowering.

> *'What I'm saying is, this computer, the way they wrote this program, even though I had no education, it connected with me. And that's what you need to be able to do with this'*

Usability evaluation

There was an improvement in the mean SUS scores, from 66.7 (SD 16.8) during website development to 73.6 (SD 21) in the usability testing phase, $P = 0.26$. The proportion of participants rating it as excellent increased from 20.5% to 42.9%, $P = 0.11$ (*Figure 1*). The individual mean SUS sores were non-significant between website development and usability testing; however, questions 3 (*I thought this website was easy to use*, $P = 0.03$), 5 (*I found the various functions in this website were well integrated*, $P \leq 0.001$), and 6 (*I thought there was too much inconsistency in this website*, $P = 0.038$) were significant (*Table 4*).

Discussion

For this study, we organized co-design workshops on website development and usability testing, which were attended by individuals who had completed or were undertaking a centre-based CR program following a precipitative cardiac event or diagnosis and their family members. The mean age of participants, and their technology and social media use, was consistent with current literature.[8,36] During the workshops, participants explored their needs, preferences, and perceptions regarding remotely delivered CR via a web-based program. Themes were identified across the website development and usability testing workshops, informing on design features, enabling parallel and competitive iterative processes, resulting in the final website. The participants' input defined specific needs within the website for usability, and interactive and engaging content. Usability of the completed website improved from the website development to completion phase.

Digital CR programs are successful alternative modalities to centre-based CR, with recent studies indicating either similar to or greater improvement in outcomes to centre-based program and providing worthy alternatives to a centre-based, supervised program.[7] Furthermore, it has been shown that people with CVD, who are situationally limited in attending centre-based CR, preferred a home-based program.[37] Despite the plethora of studies and research in remote, digital CR, these alternative options are not widely available, nor progressing to clinical integration.

Web-based CR has the potential to engage patients who are unable to attend or wary of engaging in a centre-based program. In one study, more than half of the participants stated that had they not done their program remotely, via a web program, they would not have attended at all.[38] Non-adherence to remotely delivered digital CR presents similar issues as with centre-based delivery as outlined in previous studies.[7] The development of this website, through the co-design process, has addressed non-adherence by incorporating features such as program streaming, based on CVD diagnosis, personal goal setting, and the ability to communicate through private messaging with their CR clinician. Furthermore, the notification function to clinicians, from a patient's program, allows for these clients to be integrated into current CR services.

Table 4 Mean System Usability Scale questions

Question number	Question	Website development workshop ($n = 39$), mean (SD)	Usability workshop ($n = 35$), mean (SD)	P-value[a]
1	I think that I would like to use this website frequently.	3.7 (1.1)	4.2 (1.0)	0.08
2	I found this website unnecessarily complex.	2.1 (1.0)	2.1 (1.2)	0.95
3	I thought this website was easy to use.	3.4 (1.0)	4.0 (2.0)	0.03[a]
4	I think I would need assistance to be able to use this website.	2.2 (1.1)	2.5 (1.4)	0.25
5	I found the various functions in this website well integrated.	3.8 (0.9)	4.2 (1.0)	<0.001[a]
6	I thought there was too much inconsistency in this website.	2.4 (1.0)	2.1 (1.4)	0.038[a]
7	I would imagine that most people would learn to use this website very quickly.	3.5 (1.0)	4.0 (1.0)	0.05
8	I found this website very cumbersome/awkward to use.	2.3 (1.1)	1.9 (1.3)	0.23
9	I felt very confident using this website.	3.6 (1.1)	4.0 (1.3)	0.21
10	I need to learn a lot of things before I could get going with this website.	2.3 (1.2)	2.3 (1.5)	0.91

SD, standard deviation.
[a]Statistically significant at $P<0.05$.

Limitations

The main limitation to this study was that participants had all completed a face-to-face CR program which means that the co-design lacked the input of those who had declined or dropped out of their program. We mitigated this selection bias by clinicians being the ones recruiting the participants. The trust relationship between the clinician and the participants might have helped with the engagement of participants that would have been otherwise less likely to participate.

Member checking on quote's interpretation was not permitted as names were not used during the workshops, with further de-identification of these group discussions in the transcription process. Finally, generalizability of these findings to groups with low literacy and non-English speaking populations is limited due to the high proportion of people with a high education level and English as a first language in the workshops.

Conclusion

Co-design is a rapidly emerging approach in person-centred research; however, studies are often not explicit, in presenting details of the developmental framework, methods, and reporting of co-design outcomes.[10,39] Our website has been co-designed using a framework that guided workshops, website development planning, execution, data collection, and reporting. This website has been incorporated in regional and metropolitan CR services in South Australia, being made available to patients who are referred for CR. It has the potential to address known barriers to attending centre-based CR and enhancing behaviour change empowerment.

The evolution of our CR website development was completed with an improvement in usability. During the evaluation of usability, its role as a hybrid and/or bridging program was identified, contributing positively to the uncertainty experienced by cardiovascular patients after an event, diagnosis, and hospital discharge. Further evaluation, based on the quality indicators for CR accreditation and clinical outcomes, will provide evidence on its effectiveness, patient-reported outcomes, and experiences.

Author contributions

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Supplementary material

Supplementary material is available at *European Journal of Cardiovascular Nursing* online.

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Conflict of interest: None declared.

Data availability

All data are incorporated into the article and its online supplementary material. The data sets generated during and/or analysed from this study are not publicly available due to participants being identifiable if sharing the data from participation in the workshops.

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