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ORIGINAL RESEARCH

Using codesign to develop a culturally tailored, behavior change mHealth intervention for indigenous and other priority communities: A case study in New Zealand

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ABSTRACT

The obesity rate in New Zealand is one of the highest worldwide (31%), with highest rates among Māori (47%) and Pasifika (67%). Codesign was used to develop a culturally tailored, behavior change mHealth intervention for Māori and Pasifika in New Zealand. The purpose of this article is to provide an overview of the codesign methods and processes and describe how these were used to inform and build a theory-driven approach to the selection of behavioral determinants and change techniques. The codesign approach in this study was based on a partnership between Māori and Pasifika partners and an academic research team. This involved working with communities on opportunity identification, elucidation of needs and desires, knowledge generation, envisaging the mHealth tool, and prototype testing. Models of Māori and Pasifika holistic well-being and health promotion were the basis for identifying key content modules and were applied to relevant determinants of behavior change and theoretically based behavior change techniques from the Theoretical Domains Framework and Behavior Change Taxonomy, respectively. Three key content modules were identified: physical activity, family/*whānau* [extended family], and healthy eating. Other important themes included mental well-being/stress, connecting, motivation/support, and health literacy. Relevant behavioral determinants were selected, and 17 change techniques were mapped to these determinants. Community partners established that a smartphone app was the optimal vehicle for the intervention. Both Māori and Pasifika versions of the app were developed to ensure features and functionalities were culturally tailored and appealing to users. Codesign enabled and empowered users to tailor the intervention to their cultural needs. By using codesign and applying both ethnic-specific and Western theoretical frameworks of health and behavior change, the mHealth intervention is both evidence based and culturally tailored.

Keywords

Codesign, Participatory research, Indigenous health, mHealth, Health Behavior, Noncommunicable diseases

Implications

Practice: Codesign, involving a community–academic partnership, enables and empowers end users to conceptualize and tailor a lifestyle support (mHealth) intervention to their (cultural) needs and contexts.

Policy: Effective, culturally tailored lifestyle support (mHealth) interventions for indigenous and other priority groups must consider codesign, behavior change theory, and cultural-specific models of health and well-being.

Research: Future culturally tailored, lifestyle support (mHealth) interventions for indigenous and other priority groups should be codesigned with end users and be based on culturally specific models of health and well-being as well as Western frameworks for behavior change to ensure the intervention is evidence based and meets the (cultural) needs and context of the end users.

BACKGROUND

Almost one in three adults in New Zealand is obese (31.2%), which places New Zealand third in the developed world for obesity rates [1]. Substantial health inequities exist among different population groups; Māori (the indigenous people of New Zealand; 15% of total population) and Pasifika (collective group of people representing different Pacific Island nations; 7% of total population) adults living in New Zealand experience obesity rates 1.7 and 2.4 times higher than those of non-Māori and non-Pasifika adults, respectively [2]. Unhealthy diets and physical inactivity are common preventable risk factors for obesity and increase risk of noncommunicable diseases (NCDs) as well as impacting on wider population economic and social functioning [3]. Given that obesity prevalence in New Zealand continues to rise [2], there is an urgent need for well-crafted evidence-based interventions.

Interventions designed to change health behaviors associated with an increased risk of obesity and NCDs tailored to indigenous and other minority

ethnic populations in New Zealand have shown beneficial effects compared with standard care [4]. Although effective when delivered face-to-face, such interventions are resource intensive and often lack long-term committed health funding, which makes it difficult to sustain them [5]. The broad population penetration of mobile and wireless technologies may offer a solution. Ninety-two percent of New Zealanders own a mobile phone (67% owns a smartphone [6]) and 80% have internet access [7]. Furthermore, there are no significant differences in smartphone ownership or internet access by ethnicity or education, and few differences by age (for those <65 years) [6].

Mobile health behavior change programs

Mobile health (mHealth) programs—that is the usage of mobile and wireless technologies designed to achieve medical objectives [8]—have been shown to effectively help people quit smoking [9–11], lose weight [12,13], become more physically active [14,15], and improve other secondary risk factors for cardiovascular diseases, such as blood pressure and medication adherence [16]. Nevertheless, most mHealth interventions are designed with minimal input from end users and lack tailoring to specific cultural needs. This contributes to a poor uptake and low rates of use [17]. Codesigning an mHealth program has the potential to increase the uptake by providing a sense of ownership among its end users and enabling tailoring of the intervention to their specific cultural needs and contexts.

Codesign in the New Zealand context

Codesign builds on the foundational work of community-based research by Kurt Lewin [18] and overlaps with other approaches to participatory research such as experienced-based design and active research [19]. Codesign takes a partnership approach, in which stakeholders or end users (e.g., employers, customers, patients) are actively involved in the design process to help ensure that the outcome meets their needs and expectations. Codesign originated in 1960s in industry sectors in Scandinavia, where workers influenced the design and use of computer applications at their workplace [20]. Since then, codesign principles and practices have been used in a range of other domains, including health care (e.g., [21,22]). In the present project, called OL@-OR@, we aimed to codesign a culturally tailored, evidence-based, lifestyle support mHealth program for Māori and Pasifika communities living in New Zealand.

The founding document of New Zealand is the Treaty of Waitangi signed in 1840, a treaty between Māori and the British Crown (now represented by the New Zealand Government). The principles underpinning that agreement are equal partnership, participation, and protection. These very same principles underpinned our approach to codesign. The emphasis was on shared and equal decision-making and on cocreating a new intervention; funding for this project was based on a minimum set of predefined parameters, which enabled us to engage in a partnership-building process first followed by cocreation of the intervention, in which communities informed us what they wanted and what was important for them. Although previous codesign (mHealth) projects might argue that they have used similar principles, it can be argued that projects to date have not fully embodied these principles [23].

Codesign of mHealth interventions

Within health care, codesign has been mainly employed as a way of designing better experiences for patients, carers, and staff [24–28]. To date, codesign has been used to a limited degree in the development of mHealth interventions. A systematic review by Eyles et al. published in 2016 [23] summarizes key codesign methods and processes used in nine mHealth studies. Most of these studies lacked a codesign development framework or did not report using such a framework. Also, these studies often did not report adequate detail on the intervention development processes. No previous studies have used codesign to develop an mHealth intervention for indigenous or other priority/underserved communities. Codesign has also not been used previously to intentionally inform the development of a theory-based, health behavior change intervention.

Aim of this article

The aim of this article is twofold. First, we aim to describe the codesign methods and processes used in the OL@-OR@ project. Second, we aim to describe how codesign was used to inform and build a theory-driven approach to the selection of behavioral determinants and change techniques as part of the intervention. Whereas the development of behavioral interventions is usually guided by theoretical frameworks, no previous culturally tailored behavioral interventions have used ethnic-specific paradigms for health and health promotion in this process. Our research was not guided from the start by a specific theoretical framework, but involved the combination of ethnic-specific and traditional Western frameworks to interpret the qualitative data gathered during a codesign phase. These were then used to:

- identify key content modules of the mHealth program;
- identify (culturally appropriate) determinants of behavior change;
- select relevant evidence-based behavior change techniques (BCTs), that is, the smallest components of an intervention that may have the potential to change (health) behavior, taken from behavior change theories; and
- incorporate BCTs in the mHealth intervention.

METHODS

Partnership

The OL@-OR@ project team is coled by a European nutrition professor (C.N.M.), a Māori nutrition researcher (L.T.), and a Pasifika public health researcher (T.R.F.) and includes representatives of key Māori and Pasifika community health providers across the North Island of New Zealand and a project management team. *Toi Tangata*, a Māori health promotion provider, led the engagement process with Māori (involving two communities; one each in the Wellington and Auckland regions). Two Pasifika organizations (*The Fono* in Auckland and *South Waikato Pacific Islands Community Services Trust* in Tokoroa) led engagement processes within their local communities. More details about the partnership and its history have been published elsewhere [29].

Codesign framework

For this study, we adapted the participatory codesign cycle described by Bratteteig et al. [30]. This six-step approach includes (a) opportunity identification, (b) knowledge generation, (c) elucidation of needs and desires, (d) description of the mHealth requirements, (e) envisaging the mHealth tool, and (f) prototype testing (Fig. 1). The total timeframe for codesign was 11 months (June 2016–April 2017). Training in codesign methods and facilitation of codesign workshops was overseen by a Māori partner with expertise in codesign.

We used various codesign methods to collaboratively capture and understand the needs of end users of the mHealth intervention, that is members of Māori and/or Pasifika communities. These methods fostered expression, reflection, and sharing, and informed the development of the intervention. Codesign methods—also known as generative methods—aim to go beyond the explicit and observable and provide insight in the implicit aspects of people's lives [31]. By creating a setting for collective reflection, ideas for intervention development were generated from gained insights. Details of our codesign methods are described in the following sections.

Opportunity identification

The project was envisioned as part of a National Science Challenge project that involved the academic researchers over a 2-year internal development period. As the project evolved into a proposal focused on Māori and Pasifika and using codesign, the initial team was broadened to include academic Māori and Pasifika researchers. Subsequent to the project being funded, a research collaboration between academics and Māori and Pasifika community partners was formed and an approach to the research agreed. Seven face-to-face project team meetings between the academic and community partners took place to build the partnership, establish a team culture, and build capacity. To define the project culture and partnership, project values were formulated through collective discussion and group agreement between partners. These included trust, respect, empathy, and empowering communities. The duration of these group meetings typically ranged from 2 to 6 hr. An online platform was introduced

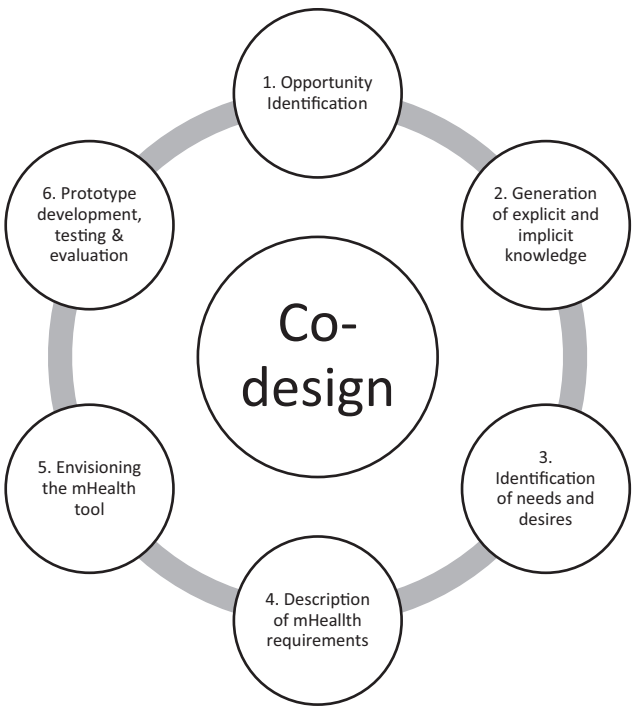

Fig 1 | Participatory codesign cycle adapted from Bratteteig et al. [30].

to facilitate communication between team members who spanned the length of the country.

Elucidation of needs and desires and knowledge generation

Focus groups with end users were organized and facilitated by community coordinators. At this stage of the codesign process, the type of mHealth intervention was not apparent, and the purpose of this first set of focus groups was to build an understanding of what aspects of health and well-being were important to these communities. These groups were structured using the following questions:

(1) What are your hopes and dreams for you, your family, and community?
(2) What do health and well-being mean to you?
(3) What kind of lifestyle behaviors are you most interested in changing?
(4) What difficulties have you had when trying to make healthy lifestyle changes?
(5) What kind of mobile technology (mHealth) tools or aids could help you to make healthy lifestyle changes?

Metaphors and storytelling were used to facilitate expression of users' thoughts for wider discussion among the group (Fig. 2). Eight focus groups were held (Māori n = 2, Pasifika n = 6; this variation was due to a different approach taken by the Māori and Pasifika research teams). Appendix 1 provides a brief overview of the focus group methodology. The focus group methodology within Māori communities is published in more detail elsewhere [29]. Comprehensive data about the Pasifika research arm of this study are available on request.

Description of the mHealth requirements and envisaging the mHealth tool

A second series of focus groups among end users was facilitated by community coordinators and focused on idea generation—or ideation—of the mHealth intervention. Creative and expressive methods were used. A total of four focus groups were held in this round (Māori n = 2, Pasifika n = 2), with a total of 25 participants (range five to eight participants per group). First, a "bus stop activity" was set up in which users were asked to engage with different mHealth tools for 5 minutes at each "bus stop." Likes and dislikes were discussed within the group. Second, participants created their own "mHealth tools" (Fig. 3). Each participant shared the story behind their design with the group. Third, profiles of hypothetical typical community members were used to describe the features and functions of an mHealth tool that was envisaged as suiting each profile. Focus groups were again audio-recorded and transcribed verbatim.

Based on all focus group data, the research team and Māori and Pasifika partners worked together to jointly formulate short, concise, and actionable "Point-of-Views" statements and "How-Might-We" questions, such as "How might we make it easier for users to make healthy choices?" or "How might we ensure that resources are interactive and fun?" In addition, key content domains, determinants and features of the mHealth intervention were identified by Māori and Pasifika partners. These findings are described in more detail in the articles authored by the Māori and Pasifika teams [29].

Although the research was designed without a specific health behavior theory, the findings reflect

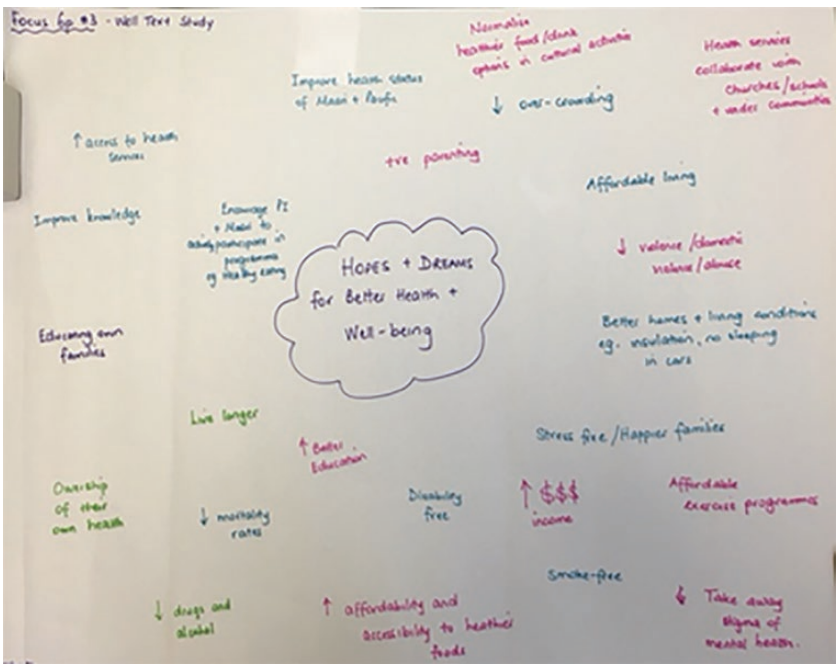

Fig 2 | Identification of needs and desires of targeted users during focus group.

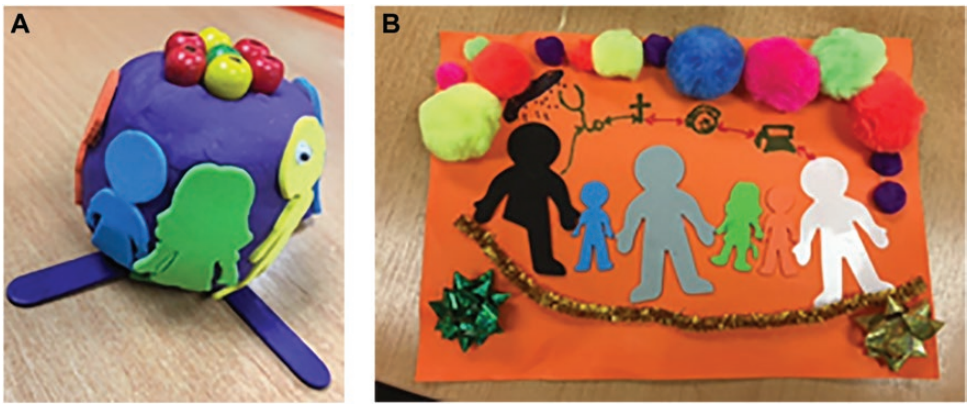

Fig 3 | Examples of features and functionalities of "mHealth tools" created by targeted users during focus group.

holistic models of health that represent the worldviews of Māori and Pasifika. These worldviews tend to be more collectivist and less material and acknowledge the importance of relationships with the physical, mental, emotional, and spiritual environments as well as emphasizing the importance of kinship ties. These models have been described in contemporary culturally specific theoretical frameworks, including the *Te Whare Tapa Whā* model for Māori health [32] (Fig. 4), the *Te Pae Mahutonga* model for Māori health promotion [33] (Fig. 5), and the *Fonofale* model for Pasifika health [34] (Fig. 6) developed for Pasifika use in New Zealand.

Prototype testing

Taking the high level of input from the focus groups, and working with the academic research team, a graphic designer created the first of many wireframe prototypes of the mHealth tool, that is, screen blueprints that represent the skeletal framework of the app. Adopting an iterative feedback process, communities were asked to provide feedback on the wireframes. Each feedback cycle was used to revise and improve the prototype and develop the core concepts for a smartphone app, as the identified and agreed mHealth tool. This process was repeated three times over a 3-month period. Following this period, a face-to-face and video-conference group meeting took place with Māori and Pasifika partners in which the final prototype format was discussed and a broad consensus was reached regarding content, features, and functionalities (i.e., not everything could be adopted due to various reasons, such as time and technology constraints). During the subsequent development of the actual app, there was a process of continual refinement based on ongoing input from the community partners.

Fig 4 | Te Whare Tapa Whā model of Māori health [32]. The model depicts a *wharenui* [Māori meeting house]. With its strong foundations and four equal cornerstones or sides, it illustrates the four dimensions of Māori well-being: *Taha Tinana* [physical health], *Taha Wairua* [spiritual health], *Taha Whānau* [family health], and *Taha Hinengaro* [mental health]. Should one of the four dimensions be missing or in some way damaged, a person, or a collective may become "unbalanced" and subsequently unwell.

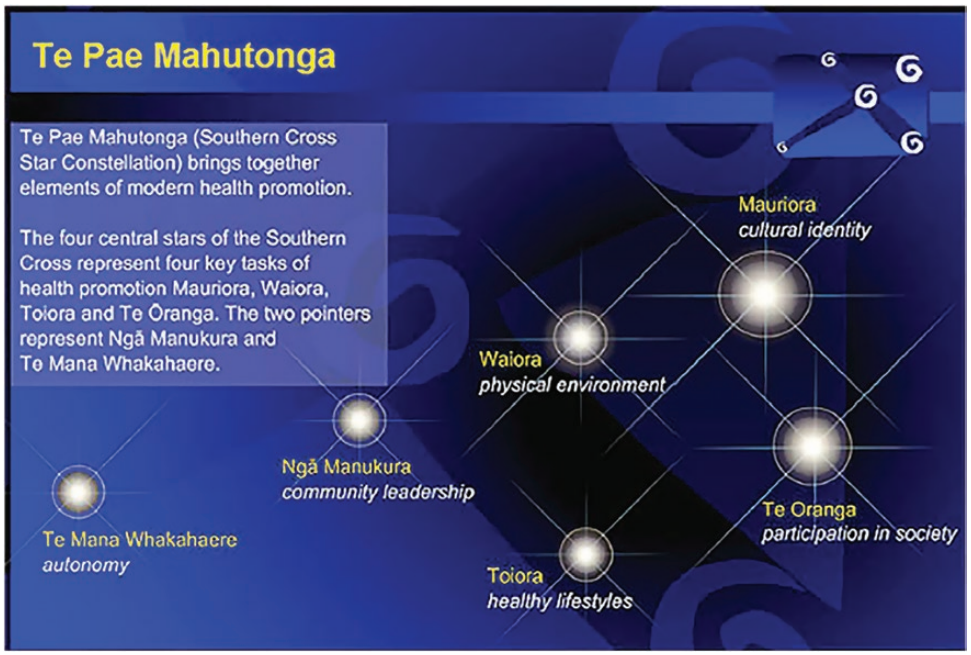

Fig 5 | *Te Pae Mahutonga* model of Māori health promotion [33]. *Te Pae Mahutonga* is the name for the constellation of stars popularly referred to as the Southern Cross. It is used as a symbolic map for bringing together the significant components of health promotion. The four central stars can be used to represent the four key tasks of health promotion: *Mauriora* [cultural identity], *Waiora* [environmental protection], *Toiora* [healthy lifestyles], and *Te Oranga* [participation in society].

Content development of behavior change intervention

Alongside the above codesign phases, four steps were undertaken to develop the content of the behavior change intervention, including (a) identification of key content modules, (b) identification of relevant determinants of behavior change, (c) selection of appropriate BCTs, and (d) incorporating BCTs in mHealth intervention. The findings from the Māori and Pasifika partners were compared with a "traditional" Western theoretical approach to the development of behavior change interventions—the Theoretical Domains Framework (TDF)—to marry the desires of the communities with the evidence of what has been effective in behavior change. This approach did not privilege one knowledge base over another, but rather tried to bring together the different sources of knowledge.

Theoretical Domains Framework

Michie et al. [35] have combined 128 determinants of behavior change included in 33 psychological theories within the TDF (Fig. 6). The most recent version of this validated framework consists of 14 domains, each consisting of a set of theoretical

Fig 6 | Fonofale model of Pasifika health [34]. The model incorporates the metaphor of a Samoan house with the foundation (i.e., family), posts (i.e., physical, spiritual, mental, and other [sexuality, age, gender, socioeconomic status]), and roof (i.e., culture) encapsulate in a circle (i.e., environment, time, and context) to promote the philosophy of holism and continuity. It is a dynamic model in that all aspects depicted in the model have an interactive relationship with each other.

TDF domain	Description
Knowledge	An awareness of the existence of something
Skills	An ability or proficiency acquired through practice
Social/professional role and identity	A coherent set of behaviours and displayed personal qualities of an individual in a social or work environment
Beliefs about capabilities	Acceptance of the truth, reality, or validity about an ability, talent, or facility that a person can put to constructive use
Optimism	The confidence that things will happen for the best, or that desired goals will be attained
Beliefs about consequences	Acceptance of the truth, reality, or validity about outcome of a behaviour in a given situation
Reinforcement	Increasing the probability of a response by arranging a dependent relationship, or contingency, between the response and a given stimulus
Intentions	A conscious decision to perform a behaviour or a resolve to act in a certain way
Goals	Mental representations of outcomes or end states that an individual wants to achieve
Memory, attention and decision processes	The ability to retain information, focus selectively on aspects of the environment, and choose beween two or more alternatives
Environmental context and resources	Any circumstance of a person's situation or environment that discourages or encourages the development of skills and abilities, independence, social competence, and adaptive behaviour
Social influences	Those interpersonal processes that can cause an individual to change their thoughts, feelings or behaviours
Emotion	A complex reaction pattern, involving experiential, behavioural, and physiological elements, by which the individual attempt to deal with a personally significant matter or event
Behavioural regulation	Anything aimed at managing or changing objectively observed or measured actions

Fig 7 | Theoretical Domains Framework [36].

constructs, such as knowledge, skills, motivation, and goals [36]. The TDF has been widely used to identify theoretical domains within behavior change and implementation interventions (e.g., [37–41]). Although perceived as a useful, flexible framework that can be used across different contexts, to our knowledge, the model has not been widely used for developing culturally tailored interventions (Fig. 7).

Step 1: Identify key content modules

In this first step, the academic research team summarized the themes identified as relevant for Māori and Pasifika health and well-being in the focus groups into the following content modules: physical activity, healthy eating, gardening, connecting, (extended) family, managing weight, motivation and support, time management, smoking, alcohol, education/health literacy, and mental well-being/stress. Māori and Pasifika partners were also asked to add other important content modules not identified by the academic research team and to rank each module on a scale from 1 ("least important") to 5 ("most important"). Modules were prioritized based on these rankings and those that ranked highest were selected as key modules to include in the mHealth intervention (Table 1). Modules with lower rankings were included in the intervention on a submodule level, for example, interwoven through features of the intervention.

Step 2: Identify relevant determinants of behavior change

At step 2, the qualitative data from the codesign phase were used to understand which factors—or determinants—would impede or enable change in relevant health behaviors, as perceived by Māori and Pasifika. Findings were interpreted using the

Table 1 | Ranking of key content modules of the mhealth intervention by Māori and Pasifika partners during a project team meeting

Module	Pasifika ratings	Māori ratings
Gardening	5	3
Healthy eating	5	2
Managing weight	5	1
(Extended) family	4	5
Motivation and support	4	4
Physical activity	4	3
Connecting	4	2
Education/health literacy	3	2
Mental well-being/stress	2	3
Time management	2	0
Smoking	0	2
Alcohol	0	2

1 = most important module, 5 = least important module.

Te Whare Tapa Whā model, *Te Pae Mahutonga* model, and the *Fonofale* frameworks. The behavioral determinants that were identified based on these ethnic-specific models were compared with domains embedded within the TDF. We report on the differences and similarities between the determinants as identified by the ethnic-specific models and the TDF, that is, which determinants of health behavior change overlap and which were only identified using ethnic-specific frameworks.

Step 3: Select appropriate BCTs

In step 3, the ideas, priorities, and determinants that came out of the codesign phase were matched with evidence-based BCTs. The Behavior Change Taxonomy of Michie et al. [42] was used in this step. This taxonomy consists of 93 BCTs clustered into 16 groups.

Step 4: Incorporate BCTs in intervention

Finally, the selected BCTs were incorporated into features and functionalities of the mHealth intervention. During our team meeting in December 2017, Māori and Pasifika partners established that a smartphone app was the optimal vehicle for the intervention, based on the information the communities provided during the focus groups. In this last step, the team closely collaborated with graphic designers and app developers to produce app designs and function flows, which were actively sent to the community teams for feedback and sense making.

Data analysis

Qualitative data collected during the codesign process included transcripts of audio-recordings, photographs, notes, and observations of both sets of focus groups, "Point-of-View" statements and "How-Might-We" questions. All data were compiled and analyzed (by hand) by Māori and Pasifika researchers using thematic analyses until key themes achieved saturation across all focus group data. Data were validated and checked by the community facilitators to ensure that the themes represented the key findings from each group discussion and to ensure that a collective understanding was created. Further details on the focus group methodology and findings of the thematic analyses are reported elsewhere [29] and are available on request. Codesign data and findings of the thematic analyses were subsequently used to select behavioral determinants and BCTs for the mHealth intervention.

Ethical considerations

The study was approved on 19 April 2016 by the New Zealand Northern A Health and Disability Ethics Committees (reference 16/NTA/29). All participants in the codesign phase of the project gave written informed consent prior to taking part in the focus groups. All participant data was treated as confidential and stored securely at the National Institute for Health Innovation, the University of Auckland.

RESULTS

Step 1: Identify key content modules

Both Māori and Pasifika partners prioritized three content modules: (a) physical activity, (b) family, and (c) healthy eating (including fruit and vegetable gardening; Table 1). Māori community partners identified additional ethnic-specific themes relevant for overall Māori health and well-being. These were connecting to *whanaungatanga* [sense of family connection], *mātauranga* [knowledge], *whakapapa* [belonging, line of descent from one's ancestors], *rangatiratanga* [leadership, self-determination], *whakapono* [faith], and *whakataukī* [significant sayings/proverbs]. These themes were interwoven through the content and features of the intervention using the *Te Whare Tapa Whā* and *Te Pae Mahutonga* models because these incorporate key well-being elements for Māori.

Step 2: Identify determinants of behavior change

We identified barriers and enablers for changing health behavior within each content module of the intervention, as shown in Tables 2–4. Participants indicated that they often lack sufficient knowledge to make the right decisions for healthy eating: "Sometimes you eat all this food and you don't even know what's going in your body half the time." Also, *Mātauranga* [cultural or indigenous knowledge] played an important role for many Māori participants when making healthy decisions, as illustrated by the following "Point-of-View" statement: "Participant XX would like to connect to her *whakapapa* [line of descent from one's ancestors] as she believes this will have a huge impact shifting her mindset about the health of her people and *whānau* [extended family] but she is too *whakama* [ashamed] to ask for help." An important factor that facilitates physical activity was being able to do such activities together with family members (family engagement).

Social comparison and being able to do things together with family and friends were often mentioned as factors that make physical activity fun and easier to do: "I want health and fitness to be fun, so I can do with my children and *moko* [grandchildren], it's about parking up the competitiveness so it's just about enjoying it." Many also spoke about the pivotal role of communication or *Whanaungatanga* [sense of family connection]: "You know, being able to hook up with others. You know I got a feijoa tree so being able to hook up with some who has an apple or an orange tree and let's trade."

Many Pasifika participants mentioned the importance for Pasifika youth to be perceived as valuable contributors to the health and well-being of their community. Young Pasifika want to know and maintain their culture as an important part of their identity, and they want to be the change-makers of the future. Empowerment or *Rangatiratanga* [self-determination] were perceived as strong enablers of health behavior change.

Step 3: Select relevant BCTs

Tables 2–4 show the selected BCTs. Of the 93 BCTs summarized in the Behavior Change Taxonomy, we selected 17 relevant BCTs (physical activity: 15, family/*whānau*: 6, healthy eating: 10).

Participants indicated that social support is an important strategy to improve physical activity, illustrated by the importance of competitiveness: "Competitiveness is in our blood." The thematic analyses of the Māori focus groups showed that participants acknowledged that group activity is more beneficial for their overall well-being and that it is not just about having the opportunity to work with a group of people, it is the support as well [29].

Table 2 | Selection of behavior determinants and change techniques for key content module "physical activity"

Examples of codesign findings	Determinant	Behavior change technique selected to address determinant	Behavior change technique incorporated into app
• "By having knowledge and information people can make an informed choice" (PTA)	Knowledge[a]/beliefs about consequences[a]	• Provide information about behavior-health link	• App includes (links to) cultural-tailored information about physical activity and health
• "Increase their knowledge of what's available and to improve access & support to services that improve nutrition and physical activity" (PPOV)		• Provide information on consequences of behavior	• App includes (links to) health services (e.g., health care providers, gyms, etc.)
• "Community-wise probably for me more education focus groups and church groupings as well that they are consistent on-going and free. And focus groups for different ages suitable for youth and pre-schoolers" (PFG2)			• Regular notifications will include general information about physical activity
• "Effects of physical activity on *tinana* [body], e.g. what happens with our muscles when we exercise" (TM)			
• "Participant XXX would like to connect to her *whakapapa* [line of descent from one's ancestors]; as she believes this will have a huge impact shifting her mindset about the health of her people and *whanau* [extended family] but she is too *whakama* [ashamed] to ask for help" (MPOV)	*Mātauranga* [(indigenous) knowledge][b]/*Whakapapa*	• Teach to identify (environmental) cues/elements	• Users can tag their location when setting and achieving behavioral goals and share this with relevant others • App includes pictures and information of meaningful ancestral historical places which help them relate to *whakapapa* • Users can upload or record and share their own (health-related) *karakia* [prayers]
• "I want health and fitness to be fun, so I can do with my children and *moko* [grandchildren], it's about parking up the competitiveness so it's just about enjoying it" (MPOV)	*Whanau* [extended family]/connectedness[b]	• Provide opportunities for social comparison	• Users can set personal physical activity challenges and invite their community and family members to join them
• "Competition with family and friends" (PFG4)		• Plan social support	• Progress in obtaining physical activity goals can be shared with others
• "Competitiveness is in our blood" (MFG1)			• User can invite others, create groups, or connect with Facebook contacts
• "Participants acknowledged that group activity is more beneficial for their overall well-being...It's not just about having the opportunity to work with a group of people, it's the support as well" (MTA)			
• "Personally I think it's holding myself accountable to my health to a fine state, not knowing what to do but having a lot of services around me to actually teach me or really slap me in the hand to tell me hey you're doing this wrong. So yeah there's more step of changes and gradually changing my health" (PFG2)	Motivation and goals[a]	• Prompt goal setting	• App enables user to set personal behavioral "challenges" and guides the user in setting regular SMART goals or tasks which will help the user in gradually obtaining these challenges. A preset library will include SMART goals for users to select from or they set their own goals

Table 2 | Continued

Examples of codesign findings	Determinant	Behavior change technique selected to address determinant	Behavior change technique incorporated into app
• "I find it daunting getting up in the morning to walk up maunga [mountain]" (MPOV)		• Prompt intention formation	• App includes a culturally appropriate reward system for completing behavioral goals
		• Provide contingent rewards	• Regular notifications will be sent that prompt action toward achieving goals
• "Youth want to be perceived as valuable contributors to the health and wellbeing of their community" (PTA)	Empowerment/*Rangatiratanga* [self-determination][b]	• Provide general encouragement	• App enables individual users to initiate physical activity challenges and events and to invite community and family members to join them
• "Where people can take more leadership within the tool, e.g. by inviting people to bring others together to an event" (TM)		• Prompt identification as a role model	• Pop-ups instruct users goal-setting and provide tips on how to achieve them
• " XXX would like to empower whānau to be the drivers of their own health, but feels that Māori in his community are not given an opportunity to lead" (MPOV)		• Provide instruction	• Regular notifications including information about the functionality of the app to empower user in setting goals
• "XXX lacks the confidence in her ability to do things outside of her role as a mother because she has never really had the time for herself" (MPOV)			• Regular notifications to motivate and encourage users in achieving their goals
• "I find it a useful tool and how it would benefit the others in the group I though too was that if we were doing a challenge that the whole group was focused you know and was lapped into the same route but it was tracking you know their own personal monitoring so yeah that's a useful tool" (PFG2)	Behavioral regulation/self-monitoring[a]	• Prompt self-monitoring of behavior	• Users will track their progress toward achieving goals
• "A feedback function: how they feel e.g. smiley face—I felt great" (MTA)		• Prompt review of behavioral goals	• Completion of goals will be depicted in a culturally appropriate way (i.e., footsteps will mark progress toward achieving a healthy lifestyle, as an analogy of journey in New Zealand made by Māori ancestors
		• Provide feedback on performance	• App includes a physical activity tracker (e.g., step count) • Users can share their progress with relevant others in their community and family
• "Time is the cause of lots of things, never enough time to do things" (MTA)	Barriers[a]	• Prompt barrier identification	• Prompts and notifications will help users to remind them of their goals and will provide tips for achieving goals
• "What stops me, the limitations to these aspirations is just those 21st century ones like money, money and time. You know it being so busy, you know so much things always to do" (MFG2)			

TM team meeting (prototyping); *MTA* Māori Thematic Analysis; *PTA* Pasifika Thematic Analysis; *PFG2* Pasifika Focus Group round 2; *MFG2* Māori Focus Group round 2; *MPOV* Māori Point of View, *PPOV* Pasifika Point of View.

[a]Determinant identified using the Theoretical Domains Framework.

[b]Determinant identified using *Te Whare Tapa Whā* and *Fonofale* models of health.

Table 3 | Selection of behavior determinants and change techniques for key content module "family"

Examples of codesign findings	Determinant	Behavior change technique selected to address determinant	Behavior change technique incorporated into app
• "Increase their knowledge of what's available and improve access to services that support improved nutrition and physical activity" (PPOV) • "I know gyms don't work for everybody, that exercise and physical activities that we enjoy as a family so we're lucky enough to have a lake in town" (PFG2)	Knowledge (about task environment)[a]	• Provide information about behavior-health link	• App includes information about health services/ events for the whole family
• "The needs of the family is a top priority, and it must be one of balanced health and wellbeing approach" (PTA)	*Whanau* [extended family]/ connectedness[b]	• Prompt (family) goal setting	• Users can set behavioral goals and invite community and family members to join them
• "I find it a useful tool and how it would benefit the others in the group I thought too was that if we were doing a challenge that the whole group was focused you know and was lapped into the same route but it was tracking you know their own personal monitoring so yeah that's a useful tool" (PFG2)		• Provide opportunities for social comparison • Plan social support	• Users can share their progress in achieving behavioral goals • Users can invite others to download the app and join them in achieving behavioral goals, create groups, and connect to Facebook
• "Stay in the loop with what's on" (PPOV)	Communication[b]/ *Whanaungatanga* [sense of family connection][b]	• Provide opportunities for social comparison • Plan social support	• Users can invite others to health events • Users can share their progress in achieving behavioral goals • User can invite others to download the app and join them in achieving behavioral goals, create groups, and connect to Facebook
• "Youth want to be perceived as valuable contributors to the health and wellbeing of their community" (PTA)	Empowerment/*Rangatiratanga* [self-determination][b]	• Prompt identification as a role model	• App enables users to initiate behavioral challenges and events and invite others to join them
• "They [younger generation] are the future older generation and role-models of the younger generation, and thus having the knowledge and information would empower young people to make a mindset shift" (PTA) • "They [young Pasifika people] want to know or maintain their culture as an important part of their own identity" (PPOV2) • "They [young Pasifika people] want to be the change-makers of the future" (PPOV2)		• Provide general encouragement	• Users can upload or record and share their own (health-related) prayers

PTA Pasifika Thematic Analysis; PPOV Pasifika Point of View; *PFG2* Pasifika Focus Group 2.

[a]Determinant identified using the Theoretical Domains Framework.

[b]Determinant identified using *Fonofale* model of health.

Table 4 | Selection of behavior determinants and change techniques for key content module "healthy eating"

Examples of codesign findings	Determinant	Behavior change technique selected to address determinant	Behavior change technique incorporated into app
• "It would be useful for the community to have an app that would help people to read labels" (PFG2)	Knowledge[a]/beliefs about consequences[a]	• Provide information about behavior-health link	• App includes information about healthy eating (e.g., portion sizes, reading labels, water intake, etc.)
• "By having knowledge and information people can make an informed choice, like access to quality vs. poor quality food" (PTA)		• Provide information on consequences	• App includes links to health services (e.g., health care providers, gyms, etc.)
• "To understand that NCDs are preventable" (PPOV)			• Regular notifications providing information/tips on healthy eating
• "Family gardens, connecting with nature and using land and resource for *rongoa* [medical use of plants]. So getting back and connecting with nature again" (PFG2)	Cultural identity[b]/*Mātauranga* [(indigenous) knowledge]	• Provide information on behavior-health link	• App provides historical stories about *Atua* of different foods (e.g., *Atua* of cultivated food, *Atua* of wild food, etc.)
• "Link food messages to traditional messages" (TM)		• Teach to identify (environmental) cues/elements	
• "Link food consumption to an *Atua* [Gods from Māori mythology]" (TM)			
• "We have *marae* [focal point in Māori communities] gardens but they are not maintained these days and there's no *kai* [food] coming out of it. It's all overgrown" (MFG2)	Skills[a]	• Provide instruction	• App includes gardening tips, information about seasonal fruits/vegetables, local options, and a guide on how to start your own vegetable garden
• "Learning how to cook delicious healthy meals. Learning how to provide my own veggie garden" (PFG2)		• Model/demonstrate the behavior	• User can create own recipes and share these with others
		• Prompt practice	• User can search for recipes in a database created by all users of the app
• "Competitiveness is in our blood" (MFG1)	*Whanau* [extended family]/connectedness[b]	• Provide opportunities for social comparison	• Users can set personal healthy eating and cooking challenges and invite their community and family members to join them
• "We do really well when we know that fizzy drinks are only allowed once a week and so that's when I would buy it and I've noticed the last few weeks it's now nearly every day or every second day. I've got to be harder in my household to encourage healthy eating, go back to doing exercise you know those sorts of things" (PFG2)		• Plan social support	• Progress in achieving healthy eating goals can be shared with others

Table 4 | Continued

Examples of codesign findings	Determinant	Behavior change technique selected to address determinant	Behavior change technique incorporated into app
• "You know, being able to hook up with others. You know I got a feijoa tree so being able to hook up with some who has an apple or an orange tree and let's trade" (PFG2) • "I like to idea of a community garden so people can go buy cheap vegetables" (PFG2) • "In the community there's heaps of space maybe to start family veggie gardens" (PFG2)			• User can invite others, create groups, and connect to Facebook
• "It is more expensive to buy and eat healthy" (MFG2)	Barriers[a]	• Prompt barrier identification	• Prompts and notifications will help users to remind them on their goals and will provide tips for achieving goals
• "My goal is to have a *maara kai* [vegetable garden in community] but I have limited time and resources" (MPOV) • "XXX would like to initiate a *kai* plan in his role in *whanau ora* [family health] but the cost of *kai* [food] is really expensive" (MPOV) • "XXX finds it frustrating because he is restricted by time to spend on working alongside *whanau* [extended family] to achieve their *hauora* [health and well-being]"		• Prompt goal setting	• Guided goal setting will help users to gradually achieve their goals in a creative and fun way together with family and community members

PTA Pasifika Thematic Analysis; *PFG2* Pasifika Focus Group round 2; *MFG1* Māori Focus Group round 1; *MFG2* Māori Focus Group round 2; *TM* team meeting (prototyping); *PPOV* Pasifika Point of View; *POV* Māori Point of View.

[a]Determinant identified using the Theoretical Domains Framework.

[b]Determinant identified using *Te Whare Tapa Whā* and *Fonofale* models of health.

We also identified the BCT prompting goal setting; participants indicated that guidance around making small steps to gradually change their health behavior is important: "Personally I think it's holding myself accountable to my health to a fine state, not knowing what to do but having a lot of services around me to actually teach me or really slap me in the hand to tell me hey you're doing this wrong . . . so yeah there's more step of changes and gradually changing my health."

Getting instruction on how to perform the behavior was also indicated as a key factor when it comes to healthy eating. Many spoke about gaining skills on how to maintain their vegetable (community) garden or how to follow recipes: "We have *marae* [focal point of Māori communities] gardens but they are not maintained these days and there's no *kai* [food] coming out of it. It's all overgrown."

Step 4: Incorporate BCTs into a smartphone app

All features and functionalities of the app resulted from codesign and joint prioritization with community partners. Through the codesign and early development phases, it became evident that despite Māori and Pasifika partners having similar ideas and functions with regard to BCTs, there were clear differences with regard to the specific content (e.g., expressions, language, historical references and stories, resources, etc.) and look and feel of the app (colors, images). As such a decision was made to develop separate Māori and Pasifika versions of the app guided by the culturally specific models. This separation ensured that the features and functionalities could be distinctly culturally tailored and therefore appealing for the user.

An example of how a BCT was incorporated into the app relates to the way users are prompted to set behavioral goals. Both versions of the app prompt the user to set behavioral goals, called "challenges" (e.g., "climb Mount Eden" [hill in Auckland]). The app guides the user in setting tasks within each challenge which are specific, measurable, attainable, realistic, and time based (e.g., "walk for 45 minutes twice this week" or "buy a new pair of walking shoes this week"). The user can invite others to join their challenge or task(s). The app depicts the completion of challenges as coloured footsteps, which is an analogue to the journey their *tūpuna* [ancestors] took (Fig. 8, screens A–C).

The home pages of the Māori and Pasifika versions emerged through the codesign phase as needing to be different. This is because the home page is the "hook" with which the user will engage with the app and continue to engage and invest in its use. The Pasifika version depicts a traditional sailboat which symbolizes ancestral migration around the Pacific Islands (Fig. 8, screen D). Each sail represents a different aspect of health, and the boat represents the "foundation" of health, which for Pasifika is centered on the family. This symbolization is inherently interwoven with the *Fonofale* model. The home page of the Māori version depicts a *wharenui* [meeting house]—which symbolizes *Te Whare Tapa Whā* and represents the holistic view of Māori health whereby health cannot be achieved without addressing both mental, physical, and spiritual health, and the kinship ties of *whanau* [extended family] (Fig. 8, screen E).

A key feature of the mHealth intervention is that it provides the user with contingency rewards (i.e., tokens) when behavioral goals are achieved. Māori and Pasifika identified their competitive spirit as an important element of the behavior change intervention, which aligns with the BCT contingency rewards as a way of explicitly linking rewards to the achievement of specified behaviors. Both Māori and Pasifika versions of the app have a reward system for completing behavioral tasks and challenges, which uses culturally tailored symbology. In the Pasifika version, users collect coconuts for each completed task (e.g., "drink 8 glasses of water a day"), which "grow" into a coconut tree as more tasks are completed and the user approaches their challenge completion (e.g., "lose 2 kilograms"; Fig. 8, screens F–G). In the Māori version, users receive *kete* for each completed task, a symbol representing a sacred basket of knowledge. By collecting *kete*, users can earn other rewards that closely relate to their cultural history, such as a *waka* [canoe] (representation of Māori ancestral migration to New Zealand and also used to transport goods, produce and people along many of the coast and inland waterways) or a *patu* (a historical Māori weapon; Fig. 8, screens H–J).

DISCUSSION

This unique case study describes how codesign was used to develop a culturally tailored, behavior change mHealth intervention to redress disparities in preventable health risks of NCD among Māori and Pasifika communities in New Zealand. The purpose of this case study was twofold: (a) to provide an overview of the codesign methods and processes used and (b) to describe how codesign was used for selecting determinants of behavior and BCTs.

Strengths and limitations

Common ways of culturally adapting or tailoring health interventions include language translations, reading-level adjustments, cultural idiom, and adjustments to technological components of the intervention [43]. For example, the recent development of a text message program for pregnant/young mothers from multiple ethnic and cultural minority groups in New Zealand used focus groups with end users, consultation with cultural experts, and a literature review to develop a culturally appropriate program [44]. Four culturally distinct versions of the program were developed, including differences in

Fig 8 | Examples of how behavior change techniques are incorporated in a codesigned smartphone app and tailored to Pasifika and Māori culture (wireframes). (A) Prompt specific goal setting, (B) set graded tasks, (C) provide feedback on performance, (D) home page—Pasifika, (E) home page—Māori, (F–G) provide contingency rewards—Pasifika, and (H–J) provide contingency rewards—Māori.

terminology and language, reference to culture-specific foods, practices, traditions, and activities. A major strength of the OL@-OR@ project, however, is that we were able to go beyond these more common ways of culturally tailoring. The codesign approach in this project was firmly embedded within a community–academic partnership. This approach enabled and empowered users to conceptualize and tailor the intervention to their cultural needs and contexts. By using codesign methods, culturally specific models of health and well-being, and validated theoretical frameworks of behavior change, we designed an mHealth intervention that we believe will potentially drive healthy behavior changes and an improved sense of well-being for end users.

Another strength of the project concerns the use of the codesign data to inform a theory-driven and systematic way of developing the behavior change content of the intervention. This research project did not start with a specific theory in mind as we wanted the communities to lead the conversation and identify the issues they were most concerned about with regard to NCDs and tools that they would find helpful. Ethnic-specific models provided a context for understanding the Māori and Pasifika health values and to help select the most appropriate constructs from behavior change theories.

By using ethnic-specific models of health for interpreting the codesign data, we ensured that the selected behavioral barriers, enablers, and change techniques align with the cultural needs and wants of the user. Comparing these with domains and techniques embedded within the TDF and Behavior Change Taxonomy, respectively, confirmed that our intervention aligns with evidence-based behavior change principles. However, we identified several unique cultural-specific determinants that were not included in the TDF, such as the pivotal role of indigenous knowledge, family connectedness, family health, and holistic health. This finding stresses the importance of using ethnic-specific models when developing culturally tailored interventions.

A limitation of the study may be reflected in the identified behavior change determinants and techniques that may not be generalizable across different groups of people (e.g., ethnicity, age, or gender) and thus will be most relevant to the participants of this study.

Implications for future studies

Although codesign studies involving ethnic minority and indigenous communities are increasingly recognized as best practice in New Zealand [17,45], this is just the beginning of an ideal model for codesigning a culturally tailored behavior change intervention. Rather, we have provided a starting point which others can build on in using this participatory methodology. We suggest that future culturally tailored, lifestyle support (mHealth) interventions for indigenous and other priority groups should be codesigned with end users and look beyond "traditional" Western approaches to ethnic-specific paradigms that reflect users' perceptions and ensure the intervention is both evidence-based and meets the end users' cultural needs and context.

The next step in the OL@-OR@ project will be to determine the impact of the smartphone app on preventable risk factors for NCD among our target communities, including healthy eating, physical activity, smoking, and alcohol use in a community-based,

cluster-randomized controlled trial. The findings of this evaluation study will be of utmost importance because few studies have evaluated health care programs or services delivered for New Zealand indigenous communities to date [46].

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Compliance with Ethical Standards

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Authors' Contributions: L.T.M., R.F., G.H., A.J., R.W., and C.N.M. conceived the original idea for the study and sought and obtained funding. C.C., S.D., T.V., A.H., M.V., and C.P. acted as Māori and Pasifika community representatives in the study. They organized and facilitated the focus groups with members of their community and attended each team meeting. J.G. is the project manager responsible for the day-to-day running of the project; D.G. is a PhD student on this project; and M.V. is the research fellow involved in the project. This article was written by M.V. with input from all coauthors. C.N.M. is guarantor for this article. All authors read and approved the final manuscript.

Ethic Approval: All procedures performed in the study were in accordance with the ethical standards of the national research committee and the 1964 Helsinki declaration and its later amendments or comparable standards. The study was approved on 19 April 2016 by the New Zealand Northern A Health and Disability Ethics Committees (reference 16/NTA/29). This article does not contain any studies with animals performed by any of the authors.

Informed Consent: Informed consent was obtained from all individual participants included in the study.

APPENDIX 1. OVERVIEW FOCUS GROUP METHODOLOGY

A detailed description of the focus group methods and findings among Māori has been published elsewhere [29]. A manuscript describing the methods and findings of focus groups among Pasifika participants has been submitted for publication, and more details are available from the authors on their request. This section provides a brief overview. For the Pasifika focus groups, participants were recruited using a nominative and purposive sampling process to ensure a diversity of Pasifika ethnicity, social-economic background, and health experiences were represented. For the Māori focus groups, community meetings with end users were organized to inform them and to create a collective understanding of the project within the communities. This approach followed a Māori-specific approach to research, following principles underlying Māori culture. Focus groups with Māori end users were held in two geographically and tribally separate areas. Trained Māori and Pasifika community coordinators facilitated each focus group in their respective regions and communities. They also made notes, observations, and photographs during the groups.

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