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# Wearables for early detection of atrial fibrillation and timely referral for Indigenous people ≥55 years: mixed-methods protocol

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## ABSTRACT

**Introduction** Digital health technologies have the potential to provide cost-effective care to remote and underserved populations. To realise this potential, research must involve people not traditionally included. No research focuses on the acceptability and feasibility of older Indigenous people using wearables for early atrial fibrillation (AF) detection. This protocol compares digital augmentation against standard practice to detect AF, evaluate heart health self-efficacy and health literacy changes and identify barriers in collaboration with Aboriginal Community Controlled Health Organisations. It will establish a framework for implementing culturally safe and acceptable wearable programmes for detecting and managing AF in Indigenous adults ≥55 years and older.

**Methods** This mixed-methods research will use the Rambaldini model of collective impact, a user-centred, co-design methodology and yarning circles, a recognised Indigenous research methodology to assess the cultural safety, acceptability, feasibility and efficacy of incorporating wearables into standard care for early AF detection.

**Analysis** Qualitative data will be analysed to create composite descriptions of participants' experiences and perspectives related to comfort, cultural safety, convenience, confidence, family reactions and concerns. Quantitative device data will be extracted and analysed via Statistical Product and Service Solutions (SPSS).

**Conclusion** Prioritising perspectives of older Indigenous adults on using wearables for detecting and monitoring cardiovascular disease will ensure that the findings are effective, relevant and acceptable to those impacted.

**Ethics and dissemination** Findings will be published in open-source peer-reviewed journals, shared at professional conferences, described in lay terms and made available to the public. The AHMRC HREC Reference Number approved 1135/15.

## STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ Indigenous governance.
⇒ Codesign using the Rambaldini model of collective impact, validated for use in Indigenous health research.
⇒ Implementation in multiple research sites (regional, rural and remote locations).
⇒ Privileging the perspectives of Aboriginal Community Controlled Health Organisations and their patients.
⇒ The research does not include people living in urban areas limiting generalisability.

## INTRODUCTION

The proliferation of comfortable and effective wearable devices has sparked public interest. Rapid advances in artificial intelligence (AI) and materials science have enabled the development of a wide variety of devices that provide real-time user-friendly, accurate biofeedback, appealing to a broad audience. Additionally, the uptake of wearable devices to monitor and modify health and fitness significantly accelerated during the COVID-19 pandemic.[1] The availability and interest in these devices have the potential to facilitate a move towards more user-centred healthcare, contributing to greater self-accountability and personal autonomy for health and well-being.[2–4]

The revolution in digital health technology has been touted as having the potential to provide cost-effective care to remote and underserved populations.[5] However, research must involve populations not traditionally included in trials for new medical devices or digital health tools to realise this potential. Ensuring equitable distribution of opportunities and benefits made possible by these new technologies is essential to prevent inadvertently further disadvantaging those who may benefit the most. The Indigenous peoples of Australia are one such group.

Indigenous Australians experience significant health gaps, including a threefold higher rate of avoidable causes of death compared with non-Indigenous Australians.[6 7] The disadvantage is increased for Indigenous people residing outside urban areas. Moreover, even in urban areas, access to hardware and Wi-Fi is not equitable in Australia, encompassing issues of both accessibility and affordability, particularly for individuals reliant on month-to-month prepaid data plans.

Despite the promise of these technologies to help close the gap and the Australian government prioritising research that utilises technology to enable Indigenous people to manage their health,[8] there is limited digital health research focusing on older Indigenous adults. While there is a growing body of literature concerning phone apps and social media use for health purposes among younger Indigenous individuals.[9–14] Research on the acceptability, feasibility and efficacy of wearable devices for monitoring and managing the health of older Indigenous people has not kept pace.[15–18] This research is especially necessary as the availability of wearable devices with functionalities to detect and monitor symptoms of chronic diseases, particularly atrial fibrillation (AF)[19–22] and other cardiovascular diseases increases.[23]

AF is the most common sustained cardiac arrhythmia, and its prevalence among Indigenous Australians is higher than non-Indigenous Australians.[24] AF often presents without symptoms and is frequently associated with debilitating stroke and heart failure.[25] Indigenous people are more likely to have untreated AF and are consequently exposed to an increased risk of AF-related stroke. Among survivors of AF-related stroke, Indigenous people experience higher mortality rates and more severe health consequences than non-Indigenous people in Australia. Furthermore, the stroke risk attributable to AF is markedly elevated among Indigenous people, contributing significantly to higher stroke incidence than non-Indigenous individuals.[26] Notably, Indigenous people develop AF at a younger age, necessitating earlier screening starting at age 55.[24]

The current management of AF emphasises several key aspects: (1) the role of blood pressure (BP) in detecting and managing AF;[27] (2) the importance of drug therapies, especially oral anticoagulants;[28] (3) lifestyle interventions;[29] (4) the integration of wearables into healthcare systems;[30] and (5) the necessity of improved health literacy and community awareness regarding AF.[26 31] Targeted strategies focusing on increasing patient understanding and building self-efficacy to promote positive health behaviours can greatly enhance AF health outcomes.[24]

There is an urgent need to increase research focusing on how older Indigenous people can use wearable devices to improve equity in accessing new technologies. This is particularly crucial for diseases like AF and other cardiovascular diseases, where the prevalence is higher among this population. The interest in using wearable devices is substantial, as these devices are readily available commercially and have proven effectiveness among other populations. Close partnering with Indigenous people to co-design safe, wearable programmes that explicitly describe how data generated from the devices is stored and accessed to minimise the potential exploitation of personal information is imperative. Additionally, it is necessary to examine how the conditions in rural and remote locations, such as extreme heat, intermittent internet connectivity, financial access and acceptability, impact the efficacy of wearable programmes. Understanding these factors will help to determine the feasibility of implementing wearable programmes within the existing healthcare system.

## AIM AND OBJECTIVES

The aim of this research is to determine if augmenting standard care with digital health technologies leads to earlier screening and better management of AF in Indigenous adults aged 55 and older. It will also identify what is needed to implement a wearable programme in primary care.

Objective 1: Determine the acceptability of wearable technologies for AF detection and management among Indigenous patients and clinicians.

Objective 2: Identify the necessary conditions and resources to implement a wearable programme in primary care clinics located in regional, rural and remote areas. These areas may have limited or variable internet connectivity, and participants may have limited experience with phone-based health apps and wearable devices.

Objective 3: Evaluate the self-efficacy of Indigenous adults in detecting and managing AF using digital health technology, supported by clinicians and peers.

Objective 4: Compare standard care pathway with a care pathway augmented by wearables and online closed social media heart and digital-health education groups for timely detection and effective treatment of AF in Indigenous people.

## METHODS

This mixed-methods translational research protocol will be conducted over 3 years and includes two stages.

Stage 1 involves co-developing a framework for implementing a culturally safe and acceptable wearable programme (involving patches and watches) for detecting AF in Indigenous adults aged 55 years and older residing in remote, rural and regional locations.

Stage 2 uses the co-designed framework to implement a wearable programme supported by online closed social media groups focused on heart and digital health education. This stage also evaluates changes in heart health self-efficacy and health literacy, compares the effectiveness of digital augmentation with standard practice in detecting AF and identifies implementation barriers through Aboriginal Community Controlled Health Organisations (ACCHOs) in regional, rural and remote areas.

## Indigenous governance

Health research has historically marginalised and disempowered Indigenous people. It has not prioritised Indigenous leadership or integrated Indigenous ways of thinking, learning and doing science. Moreover, research priorities have historically not come from the community but have been determined by people far removed and have not necessarily reflected the needs or wishes of community members. The emergence of digital health presents an opportunity to upgrade health research methodologies by integrating Indigenous governance and prioritising Indigenous perspectives through partnering with Elders, community members and staff working in ACCHOs. To this end, we will establish an independent Indigenous Project Governance group to provide guidance, advice and monitoring for this project. Likewise, our investigator team will include Indigenous academics and citizen scientists. Citizen scientists in our research are non-academic research collaborators, which may include clinic staff and community members.

## Patient and public involvement

The idea for this project organically grew from a multi-year partnership between the Djurali team and community partners who identified the need for a convenient and efficient method to enable early detection of AF and high BP in community members and to better engage patients in understanding and monitoring their health. This study represents the third phase of a multi-year, multi-component co-designed research programme aimed at identifying and implementing innovative methods to promote earlier detection and better management of AF in Indigenous people aged 55 and older (figure 1, Phase 3 highlighted in purple). Local ACCHO staff and members of the communities they serve will continue to be involved in the co-design and implementation of this next phase of the research.

The Rambaldini model of collective impact will guide our co-design approach (figure 2). It focuses on the collective rather than the individual and involves the people who will be impacted by the research early and throughout the work. It promotes respectful engagement and co-decision-making with Elders, ACCHOs and community members. The Rambaldini model privileges the knowledge and perspectives of Indigenous people and aligns with Indigenous ways of knowing, being and doing. The model has been validated for use with Indigenous people for health research and recognises community contributions in ways that the community members find meaningful, including co-authorship.

The Djurali team will work in lockstep with leaders and clinicians within the ACCHO to iteratively co-design the sequence of activities required to implement the wearable programme with participants and collect the necessary data to understand the programme's impact on participants and ACCHO staff. The flow of activities will encompass several components, including introducing the new technologies to clinic staff and patients, providing participant education, facilitating participant self-tracking of health data using wearable devices and data collection and extraction.

## AF care pathway

Participants who receive a possible AF report from the device will be referred to their General practitioner

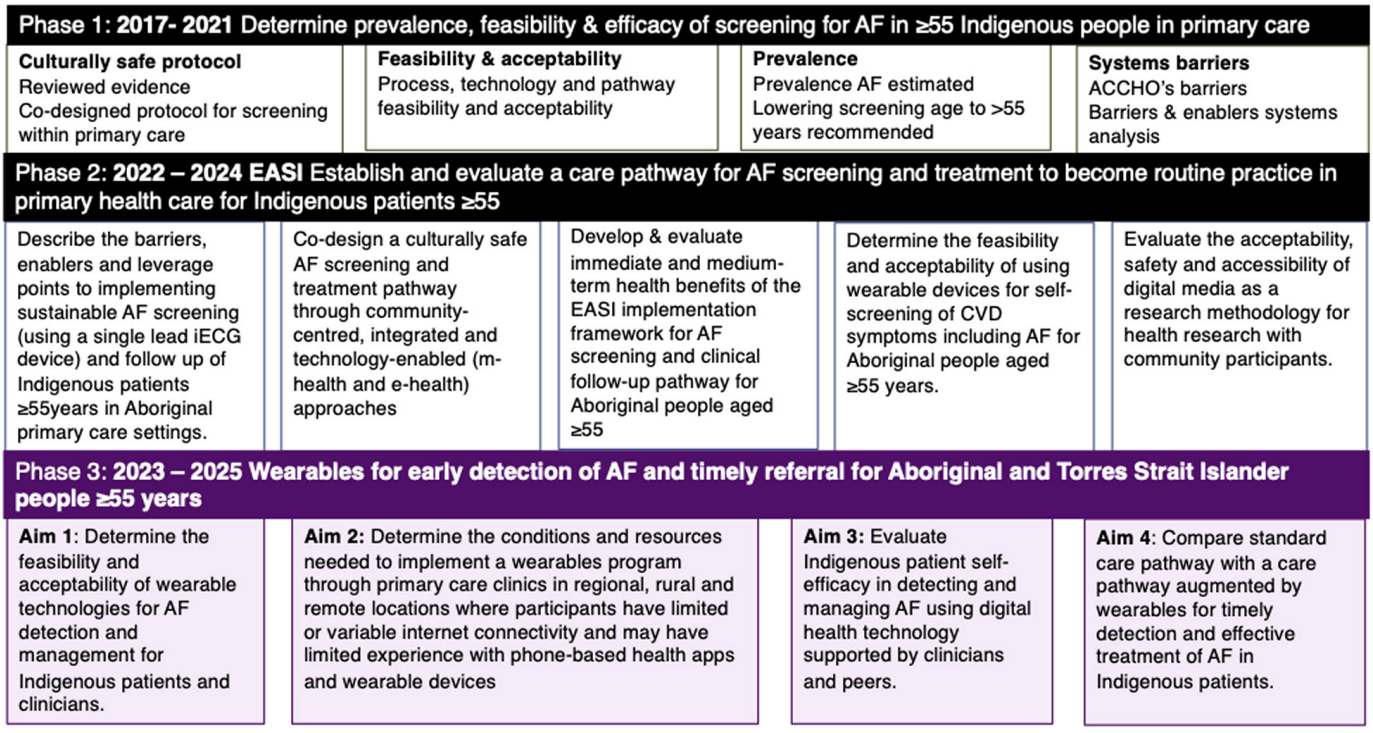


**Figure 1** Three phases of Indigenous atrial fibrillation (AF) research.

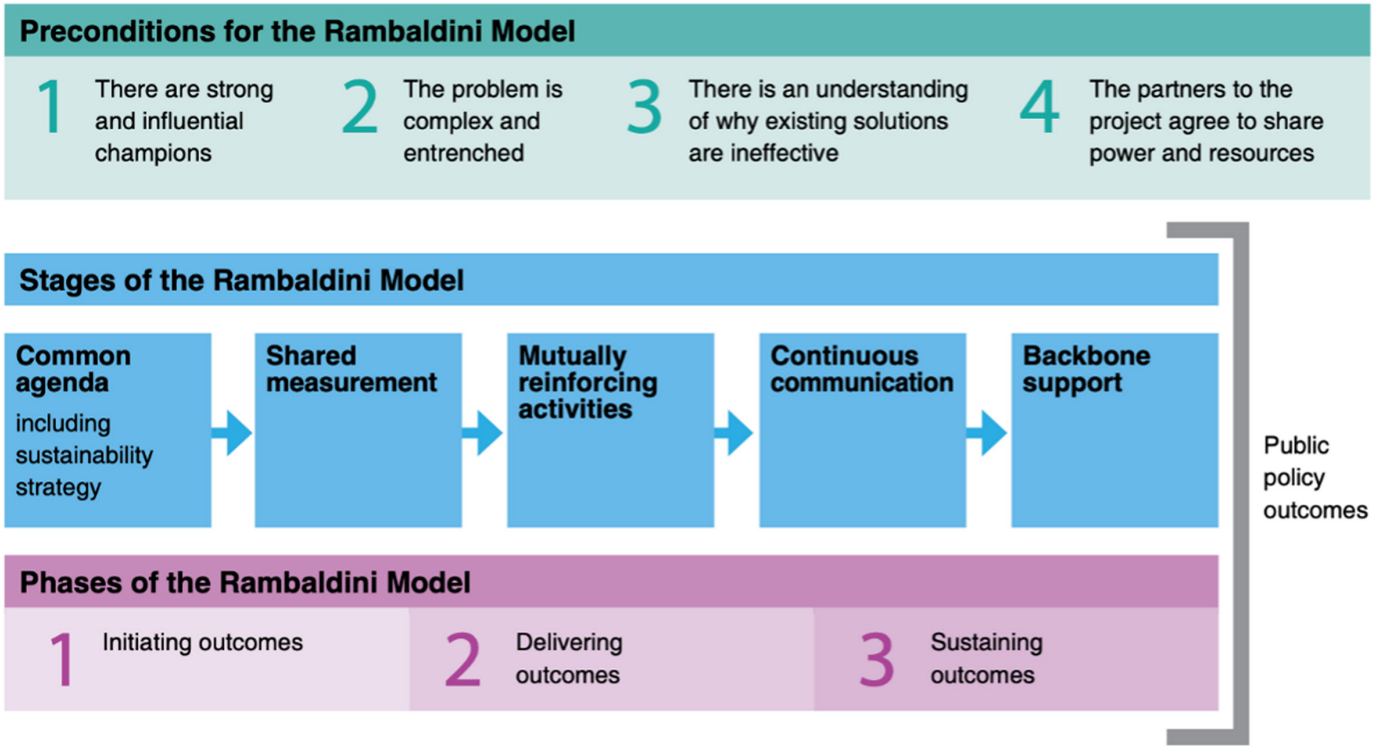


**Figure 2** Rambaldini model.

(GP) for assessment and potential referral for cardiology review.

### Eligibility—inclusion/exclusion

Indigenous adults aged 55 or older, with diagnosed hypertension. Participants will also need regular access to either an Apple Phone running iOS 12 or later or Android 8 or later and be willing to download the Health Mate app (Scan Monitor is only available for Withings ScanWatch when paired with a smartphone using the Health Mate app.) and the patch app (Biobeat patch is paired with a proprietary phone app.). Patients will not be included in the study if they have any of the following: a pacemaker or other implanted electronic device, been diagnosed with an arrhythmia other than AF or are currently prescribed long-term oral anticoagulants.

### Preprogram

Prior to implementing the wearable programme, we will convene a group of ACCHO GPs, and specialists, including cardiologists, to consider which of the many health metrics available via the devices should be made available to GPs and added to the patient medical record. To facilitate the discussion and decision-making process, we will provide the group with the current best evidence associated with each of the metrics available on the devices and use a combination of surveys and yarning circles to determine: which data will be extracted; which data will be incorporated into the medical record; when, how and by whom. We will then codesign a care pathway related to each of the extracted metrics that have been selected following this process.

Likewise, we will collaborate with the ACCHOs to co-design the programme implementation to ensure fit and feasibility at each site (recognising that each ACCHO is different with respect to its processes and preferred ways of working). This codesign work will include yarns with staff (Aboriginal Health Workers, nurses, GPs and specialists) and community members.

One or more staff will be identified as local research assistants who will partner with the Djurali researchers to implement the programme. Other pre-programme activities will include staff training on using wearable devices for AF testing, a review of the care pathway for participants with detected AF, and support for recruitment. This support may involve organising a community launch event, depending on the preferences of each ACCHO. Community launches are effective methods for health promotion, providing education and encouraging community members to engage with the service for their health needs.

### Recruitment

Each site will identify all patients that meet the inclusion criteria. The local research assistant or clinician—independently or in collaboration with the Djurali researcher—will discuss the study with potential participants, invite them to participate and facilitate informed consent. Participants will receive a Participant Information Statement (PIS) and have the opportunity to ask questions and consult with others before signing the consent form. Consent can be given either through a paper-based form or an online form, based on the preferences of the sites,

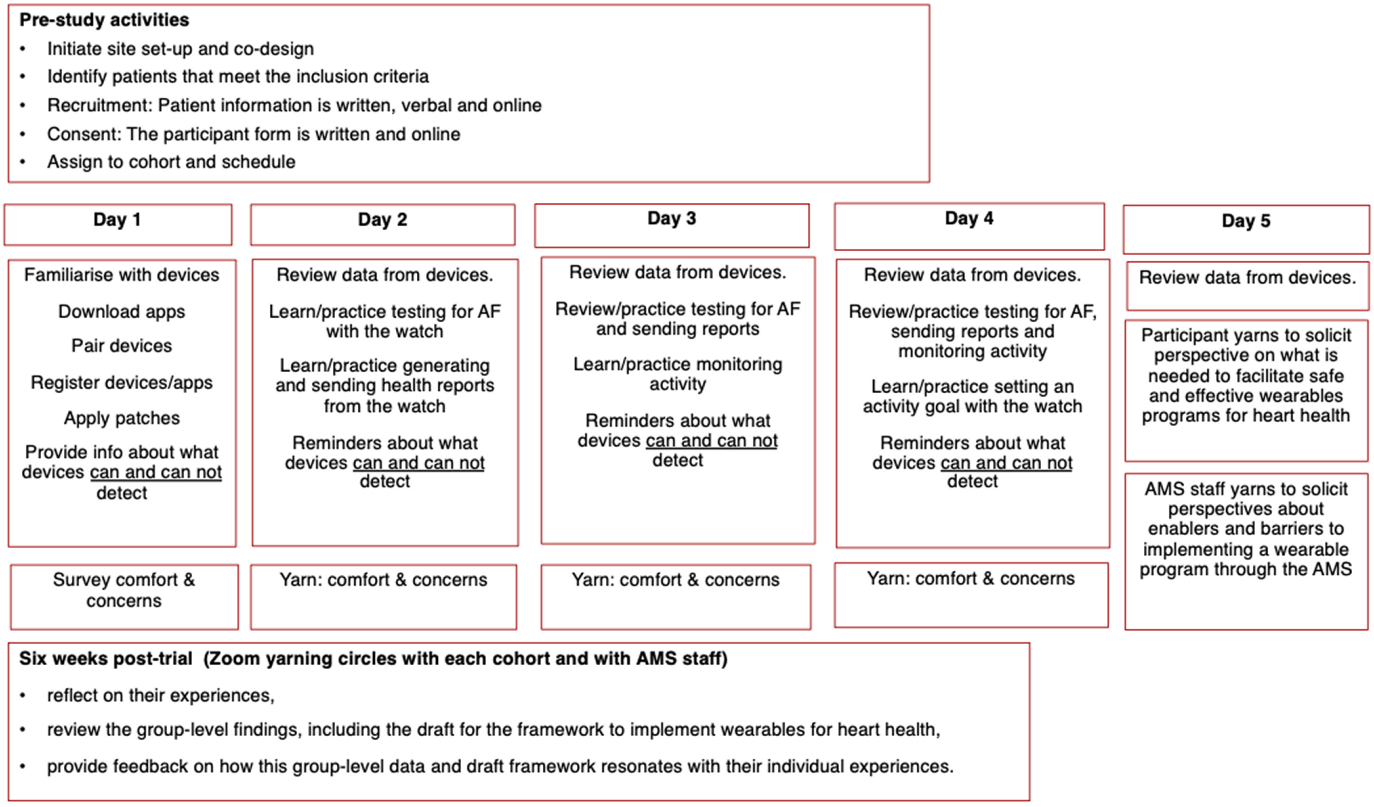


**Figure 3** Part 1 study flow.

and stored according to the university's data management policy. As an incentive to complete each survey, participate in yarns and download data from wearable devices, participants will receive a $25 voucher. This effective recruitment strategy provides a small recognition of their time and is required for AHMRC ethics approval.

## Devices

We will use the Withings Scan watch which has TGA approval (ARTG 354677) to detect and monitor AF and the BioBeat which has TGA approval (ARTG 338811) 5-day patch to detect and monitor AF and BP or the LifeSignals 1AXe Biosensor, which collects HR and ECGTGA approval (ARTG 379712).

Withings Scan watch is a medical device in the form of a smartwatch. The watch includes a lead I electrocardiograph (ECG), reflectance photoplethysmography (PPG) and a reflectance pulse oximetry sensor.[32] The technology enables mobile heart rate and rhythm measurement by PPG, with a single-channel electrocardiogram available to confirm AF. PPG is also used to measure functional oxygen saturation of arterial haemoglobin ($SpO_2$).[32] All data collected through the watch is synced with the smartphone HealthMate app, and daily/weekly reports can be downloaded and/or sent to the patient's GP (figure 3). The Withings Scan watch was selected based on the following features: the ability to take an ECG, the battery life of 30 days, its attractive appearance and waterproofing, the ability to function at 25–40°C, its reasonable cost, the scans it produces are billable to Medicare, and its ability to connect with an app available for both Apple and Android devices.

A Biobeat patch is a medical device in the form of a stick-on patch. The patch uses PPG technology to continuously measure cuffless BP, heart rate, respiratory rate, stroke volume and cardiac index.[33] All data collected from the BioBeat is recorded in the device and transmitted to the phone App. The Biobeat patch was selected for this research for the following reasons: it can provide a continuous measure of BP for up to 5 days, is easy to apply and is billable to Medicare (Medicare is the universal healthcare scheme funded by the Australian government and available to all citizens and permanent residents. Medicare funds healthcare treatment, services, medications and devices.) and allows remote monitoring via an online dashboard.

1AXe Biosensor is a medical device in the form of a stick-on patch. The data are collected on the patch then the collected data are sent to a certified cardiac technician using an app on a tablet. From there, the cardiac technician will create the Holter ECG monitoring report, and data will be available via an online dashboard. The 1AXe was selected for this study to provide a Holter report for GPs, potentially providing increased treatment access and convenience for clinics in remote locations.[34] This patch is also billable to Medicare which builds sustainability into the programme, especially for participants on low-fixed incomes.

Table 1 Data sources and collection dates for each cohort

| Collection method | Data | Timing | |
|---|---|---|---|
| | | Stage 1 | Stage 2 |
| Bio beat Ambulatory Blood Pressure Monitor (ABPM) | Blood pressure; heart rate; respiratory rate; blood saturation stroke volume; Cardiac Index, stroke volume, ECG, pulse | Key metrics collected on day 5 | Key metrics collected on day 3 |
| 1AXe Biosensor Holter monitor | Heart rate; ECG (Holter monitor report) | Key metrics collected on day 3 | Key metrics collected on day 3 |
| Withings SCAN watch | Heart rate; ECG; oxygen saturation; breathing disturbance tracking; signs of AF; sleep cycle; activity tracking (walking, running, swimming); intensity of use | Days 1–5 | Days 1–28 Downloads days 5, 12, 19 and 28 |
| Researcher-assisted online surveys | Digital Health Literacy Questionnaire Health Self-Efficacy 6 Questions | | Day 1 and day 28 |
| Researcher-assisted online surveys | Patient experience with wearables | Days 1 and 5 | Days 1, 5 and 28 |
| Yarning circles (online via social media closed group streaming) (We will use yarning (groups and individual yarns) as our primary technique to collect and analyse data related to patient experience. Yarning is a recognised and validated Indigenous methodology for qualitative research.) | Patient experience, concerns, recommendations, social media experience and participation | 6 weeks post programme | Before day 5, Between day 6 and 12<br>Between day 13 and 19<br>Between day 20 and 28 |

## Data collection

Key quantitative data sources include data extracted from digital technologies (patches/bio beat dashboard or Holter report, watches/Health Mate app) and validated psychometric measures of self-efficacy and health literacy via interviewer-assisted surveys. Each participant will be assigned a unique research number (coded to location), which will be disassociated with the patient's name on the last day of the study (see table 1). Qualitative data will be collected via yarning circles and surveys. All qualitative data will be deidentified in transcripts before uploading to NVivo. We will use Statistical Product and Service Solutions (SPSS) to analyse quantitative data and NVivo to analyse the qualitative data. Individual data from the watch and the patches will be held in the participant's medical record, accessible to their clinicians and owned by the ACCHO, in alignment with data sovereignty principles.[35] All other data will be deidentified and stored by the research team in accordance with the university's data management policy and the AHMRC ethics committee requirements. A summary of the potential data collection is provided in table 1. We will extract quantitative data from the patches via an online dashboard or the Holter report on day five and from the Health Mate app/Withings SCAN watch weekly. The partnering ACCHOs will provide access to their WiFi for the purposes of the research.

## Program flow

### Stage 1: Codevelop a framework for implementing a culturally safe and acceptable wearable (patches and watches) programme

Once consented, each participant will be placed into a cohort with 4–6 other local participants and will follow the study flow (as shown in figure 4), including individual sessions with the Djurali researcher/local research assistant, small group yarns, GP and specialists' involvement and data collection and co-design processes. In small cohorts, participants will be familiarised with the devices, assisted in downloading the phone apps, provided watches and assisted in applying their patches. Participants will be provided verbal and written information and regularly reminded about what to do if their device detects AF and if they have any concerns or questions. Participants will be informed about why the detection of AF is important and will also learn about the potential care pathways if AF is detected, including that their doctor may recommend treatments, including medicines. Participants will be informed and regularly reminded of what the devices can and cannot detect, for example, the devices cannot detect symptoms of a heart attack. They will also learn that the

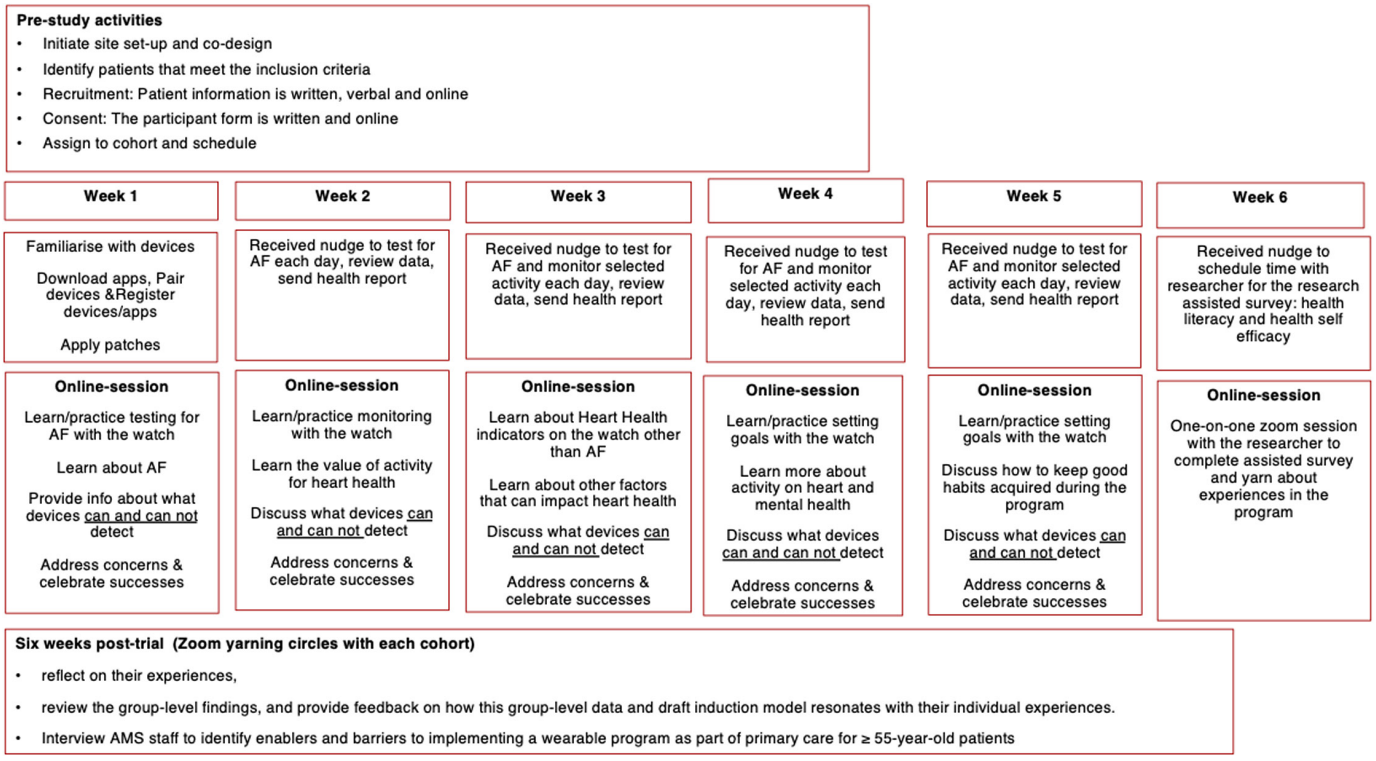


**Figure 4** Part 2 study flow of 6-week wearable programme compared with usual care.

screening is not exact, and it is possible that they have AF or some other heart condition that the devices did not detect. They will also be informed that the devices can be wrong and how the care pathway uses further assessment to determine the presence of AF.

Yarning sessions with the researcher will enable the participants to voice initial concerns and ask questions. The researcher-assisted survey will quantify initial comfort levels with the patch and the watch. We will facilitate yarning circles with each cohort to provide support and motivation for using the devices. On days 2–4, participants will review the data from their devices and practice using their watch's functions. On day 5, participants will complete a researcher-assisted survey to quantify their comfort, perceptions of convenience and feelings of cultural safety during the first 5-day study. They will participate in yarns to reflect on and review their experiences.

Throughout the programme and formally on day 5, we will actively engage participants to voice their ideas and recommendations to enhance the experience for themselves and future participants. The ACCHO staff will regularly be consulted throughout the programme to ascertain and address any concerns or barriers that have surfaced. They will also be invited to participate in a yarning session on the final day to reflect on their experiences with the programme and to provide recommendations and suggestions for improvements. A small group of participants and staff will be invited to participate in one or more online yarns to refine the framework post-programme.

Post 6 weeks, the participants and staff will be invited to online yarns via Zoom to reflect on their experiences. This will include reviewing the group-level findings, including the draft framework to implement culturally safe and effective wearables for heart health and providing feedback on how this group-level data and draft framework resonates with their individual experiences. Aims 1 and 2 will be achieved in this first stage (Aim 1: Determine the feasibility and acceptability of wearable technologies for AF detection and management for Indigenous patients and clinicians. Aim 2: Determine the conditions and resources needed to implement a wearable programme in a remote location that regularly experiences extreme heat, where participants have limited or variable internet connectivity and potentially have limited experience with phone-based health apps and wearable devices).

### Stage 2: Compare digital augmentation (wearables, social media closed groups and telehealth) against standard practice to detect AF, evaluate heart health self-efficacy and health literacy changes and identify barriers

In stage 2, we will use the co-designed framework (from stage 1) to implement a wearable programme to augment the standard care for AF detection within the ACCHO. Once consented, each participant will be placed into a cohort with 4–6 other local participants and will follow the study flow (figure 4), including participating in weekly closed social media groups, individual sessions with the researcher, GP and specialists' involvement and data collection processes. Day 1 will involve familiarisation with devices, downloading and registering apps, learning the basic functionality of the watches and learning how to change the adhesives for the patches.

We will commence the online closed groups in week 1. Participants will attend these weekly online sessions with their cohorts. The closed social media group sessions will include educational sessions related to heart health and additional training to use other features of the watches, such as setting activity goals, counting steps or tracking other types of exercise. Participants will be encouraged to track their activity using one or more of these functions. Additionally, participants will receive daily nudges via SMS to self-test for AF daily, monitor activity and use their watch to generate and send weekly health reports from the device. Participants will meet with the local research assistant weekly to review individual data and arrange referrals if needed. Daily reports will be downloaded from the bio-beat dashboard.

To ensure cultural safety and appropriateness, we will adapt the Self-Efficacy for Managing Chronic Disease 6-Item Scale, which has validated measures of self-efficacy.[36] In addition, qualitative data will be collected via online yarning circles and surveys to examine patient perceptions and acceptance of online training.

The ACCHO staff will regularly be consulted throughout the programme to ascertain and address any concerns or barriers that have surfaced. They will also be invited to participate in staff yarning sessions on day 14 or 15 and the final day to reflect on their programme experiences and provide recommendations and suggestions for improvements. Staff directly involved with the participants will be asked to rate how engaged they think the participants are in their care because of participating in this programme and to describe any changes in heart health self-efficacy and health literacy they noticed in participants.

Post 6 weeks, the participants and ACCHO staff will be invited to online yarns via Zoom to reflect on their experiences, review the group-level findings and provide feedback on how this data resonates with their individual experiences. We will also revisit the framework for implementing wearable heart health programmes for Indigenous people through ACCHOs and invite feedback and suggestions for refinement.

### Data analysis

Survey data will be downloaded and summarised. Yarns will be recorded, transcribed and loaded into NVivo for analysis. NVivo data will be analysed to create composite descriptions of participants' experiences and perspectives related to each area of interest: comfort, cultural safety, convenience, confidence, family reactions and concerns. We will record any additional themes that are apparent from the data analysis. Quantitative data will be extracted from the devices and analysed via SPSS. Likewise, data from the Self-Efficacy for Managing Chronic Disease 6-Item Scale and quantitative data from the surveys will be uploaded to SPSS for analysis.

### Ethics and data dissemination

The study will adhere to the guidelines for ethical research in Indigenous populations. An amendment for this study was approved by The Aboriginal Health and Medical Research Council of NSW; AHMRC HREC Reference Number: 1135/15. Findings from all studies will be published in open-source peer-reviewed journals and shared at professional conferences. Moreover, the findings will be described in lay terms and disseminated via written presentation and video to research partners, made available to other ACCHOs and shared on Djurali website and social media.

### Limitations and strengths of this study

The studies in this protocol are potentially too brief to measure the long-term use and acceptability of the devices once the novelty wears off. Additionally, limiting the eligibility to ≥55 years old potentially misses the opportunity to detect AF or educate younger people about heart health. However, it is important to balance the burden of testing with the expected prevalence, which is known to be higher for ≥55s.

This research will benefit from Indigenous governance and co-design using the Rambaldini model for collective impact, validated for health research with Indigenous people, that privileges the perspectives of Indigenous people.

Implementing the research in multiple sites (regional, rural and remote) maximises the generalisability of findings. Moreover, relying on long-term partnerships and privileging the perspectives of ACCHO and their patients will significantly improve the transferability of findings. This research is the first to examine if augmentation with wearable devices results in earlier detection of AF and changes in health literacy and self-efficacy. Moreover, the research will establish a framework for safely and effectively deploying wearable programmes with ACCHOs for Indigenous people.

## DISCUSSION

This paper presents a mixed-methods translational research protocol that will privilege the perspectives of ACCHOS and Indigenous patients. Through co-design, this research will develop a framework for implementing wearable programmes for detecting and monitoring AF and other cardiovascular diseases. We will test and refine the framework by implementing 28-day wearable programmes in four research sites, to compare the feasibility, acceptability and impact of augmented digital health technologies with standard care in detecting and managing AF among Indigenous patients.

This is the first research project to prioritise older Indigenous people's perspectives on using wearables to detect and monitor any cardiovascular disease. The Rambaldini collective impact approach, implemented in this protocol, necessitates active engagement and commitment from all stakeholders involved. It promotes community capacity building and transferability by integrating local culture and local health organisations' practices throughout the design and implementation of the

wearable programme. This deep collaboration, alongside local capacity building and transferability, is crucial in research involving Indigenous populations to ensure cultural safety, efficacy and sustainability; aspects often lacking in previous health research endeavours. Using Indigenous (yarning) and Western methods (qualitative and quantitative) maximises the likelihood of effectively scaling the research findings. Likewise, this protocol privileges the perspectives and needs of the ACCHOs and their patients, thereby maximising the feasibility and sustainability of new practices co-developed through this research. Given the persistent burden of cardiovascular disease experienced by Indigenous populations, this research project represents a significant stride towards addressing this issue.

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**Competing interests** None declared.

**Patient and public involvement** Patients and/or the public were involved in the design, or conduct, or reporting, or dissemination plans of this research. Refer to the Methods section for further details.

**Patient consent for publication** Not applicable.

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## REFERENCES

1 Corbett P, Schwager E. Technology, media & Telecommunication (TMT) [Internet]: Deloitte. 2021. Available: https://www2.deloitte.com/au/en/blog/technology-media-telecommunications-blog/ 2021/digital-consumer-trends-touch-less-healthier-wiser.html
2 Maxwell H, O'Shea M, Stronach M, *et al*. Empowerment through Digital health Trackers: an exploration of indigenous Australian women and physical activity in leisure settings. *Ann Leisure Res* 2021;24:150–67.
3 Mano RS. Social media and online health services: A health empowerment perspective to online health information. *Computers in Human Behavior* 2014;39:404–12.
4 Paré G, Leaver C, Bourget C. Diffusion of the Digital health self-tracking movement in Canada: results of a national survey. *J Med Internet Res* 2018;20:e177.
5 WHO. Atlas of eHealth country profiles 2015: the use of eHealth in support of universal health coverage. 2016. Available: https://apps.who.int/iris/bitstream/handle/10665/204523/9789241565219_eng.pdf;jsessionid=F2D2D5F81811F592D6DF9A57E1D0EAC0?sequence=1
6 AIHW. *Aboriginal and Torres Strait Islander Health Performance Framework 2020 summary report*. Camberra: Australian Institute of Health and Welfare, 2020.
7 Australian Institute of Health Welfare. *Rural and remote health*. Canberra: AIHW, 2022.
8 Australian Digital Health Agency. *Australia's national digital health strategy*. Canberra: Australian Digital Health Agency, 2017.
9 Sweet MA. Social media: new links for indigenous health. *Med J Aust* 2013;199:18.
10 Povey J, Mills PPJR, Dingwall KM, *et al*. Acceptability of mental health Apps for aboriginal and Torres Strait Islander Australians: A qualitative study. *J Med Internet Res* 2016;18:e65.
11 Hefler M, Kerrigan V, Freeman B, *et al*. Using Facebook to reduce smoking among Australian aboriginal and Torres Strait Islander people: a Participatory grounded action study. *BMC Public Health* 2019;19:615.
12 Hefler M, Kerrigan V, Henryks J, *et al*. Social media and health information sharing among Australian indigenous people. *Health Promot Int* 2019;34:706–15.
13 Carlson B, Frazer R, Farrelly T. That makes all the difference": aboriginal and Torres Strait Islander health-seeking on social media. *Health Promot J Austr* 2021;32:523–31.
14 Frazer R, Carlson B, Farrelly T. Indigenous articulations of social media and Digital assemblages of care. *Digital Geography and Society* 2022;3:100038.
15 Henson C, Chapman F, Shepherd G, *et al*. Mature aged aboriginal and Torres Strait Islander adults are using Digital health Technologies. *Digit Health* 2022;8:20552076221145846.
16 Henson C, Chapman F, Shepherd G, *et al*. How older indigenous women living in high-income countries use Digital health technology. *J Med Internet Res* 2023;25:e41984.
17 Bradshaw PJ, Alfonso HS, Finn J, *et al*. A comparison of coronary heart disease event rates among urban Australian aboriginal people and a matched non-aboriginal population. *J Epidemiol Community Health* 2011;65:315–9.
18 Thompson PL, Bradshaw PJ, Veroni M, *et al*. Cardiovascular risk among urban aboriginal people. *Med J Aust* 2003;179:143–6.
19 Steinhubl SR, Waalen J, Edwards AM, *et al*. Effect of a home-based Wearable continuous ECG monitoring patch on detection of Undiagnosed atrial fibrillation: the mSToPS randomized clinical trial. *JAMA* 2018;320:146.
20 Eerikäinen LM, Bonomi AG, Dekker LRC, *et al*. Atrial fibrillation monitoring with wrist-worn Photoplethysmography-based Wearables: state-of-the-art review. *Cardiovasc Digit Health J* 2020;1:45–51.
21 Wang Y-C, Xu X, Hajra A, *et al*. Current advancement in diagnosing atrial fibrillation by utilizing Wearable devices and artificial intelligence: a review study. *Diagnostics (Basel)* 2022;12:689.
22 Biersteker TE, Schalij MJ, Treskes RW. Impact of mobile health devices for the detection of atrial fibrillation: systematic review. *JMIR Mhealth Uhealth* 2021;9:e26161.
23 Duncker D, Ding WY, Etheridge S, *et al*. Smart Wearables for cardiac monitoring—real-world use beyond atrial fibrillation. *Sensors (Basel)* 2021;21:2539.

24 Gwynn J, Gwynne K, Rodrigues R, *et al*. Atrial fibrillation in indigenous Australians: A Multisite screening study using a single-lead ECG device in aboriginal primary health settings. *Heart Lung Circ* 2021;30:267–74.
25 Chan N-Y, Orchard J, Agbayani M-J, *et al*. Asia Pacific heart rhythm society (APHRS) practice guidance on atrial fibrillation screening. *J Arrhythm* 2022;38:31–49.
26 Katzenellenbogen JM, Vos T, Somerford P, *et al*. Burden of stroke in indigenous Western Australians: a study using data linkage. *Stroke* 2011;42:1515–21.
27 Stergiou GS, Kyriakoulis KG, Stambolliu E, *et al*. Blood pressure measurement in atrial fibrillation: review and meta-analysis of evidence on accuracy and clinical relevance. *J Hypertens* 2019;37:2430–41.
28 Atherton JJ, Sindone A, De Pasquale CG, *et al*. National heart foundation of Australia and cardiac society of Australia and New Zealand: guidelines for the prevention, detection, and management of heart failure in Australia 2018. *Heart Lung Circ* 2018;27:1123–208.
29 Middeldorp ME, Ariyaratnam J, Lau D, *et al*. Lifestyle modifications for treatment of atrial fibrillation. *Heart* 2020;106:325–32.
30 Lewy H. Wearable Technologies – future challenges for implementation in Healthcare services. *Healthc Technol Lett* 2015;2:2–5.
31 Hochhauser S, Rao S, England-Kennedy E, *et al*. Why social justice matters: A context for suicide prevention efforts. *Int J Equity Health* 2020;19:76.
32 Withings. *Scan Monitor Instructions for Use*. Issy-les-Moulineaux: Withings, 2020.
33 Clinichain. *Biobeat Patch Smartmonitoring*. Netherlands: Clinichain, 2023. Available: https://www.clinichain.com/wp-content/uploads/2018/11/BioPatch.pdf
34 Maiam nayri Wingara. Indigenous data sovereignty: key principles. Maiam Nayri Wingara aboriginal and Torres Strait Islander data sovereignty collective. 2018.
35 Lowitja Institute. Indigenous Data Governance and Sovereignty Carlton South: Lowitja Institute, . 2021Available: https://www.lowitja.org.au/icms_docs/328550_data-governance-and-sovereignty.pdf
36 Pereira LD, Cunha Bellinati NV, Kanan LA. Self-efficacy for managing chronic disease 6-item scale: assessing self-efficacy in chronic disease management/self-efficacy for managing chronic disease 6-item scale: Avaliacao DA Autoeficacia no Gerenciamento DA Doenca Cronica/self-efficacy for managing chronic disease 6-item scale: Evaluacion de la Autoeficacia en La Gestion de la Enfermedad Cronica. *Revista Cuidarte* 2018;9.