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METHOD



Co-designing an exercise maintenance intervention for older adults exiting falls prevention programmes: a multi-stage stakeholder consultation approach

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ABSTRACT

Background: Falls Management Exercise (FaME) programmes improve physical function and reduce falls rate and risk in older adults, but after completion exercise engagement declines, leading to loss of the health benefits gained. This study aimed to co-design an exercise maintenance intervention for older adults exiting FaME programmes, addressing the critical need to sustain physical activity benefits after programme completion.

Methods: A three-stage co-design process: Stage 1 involved community-based stakeholder consultations with older adults completing FaME and rehabilitation professionals ($n = 16$) to identify acceptable intervention components. Stage 2 consisted of professional stakeholder consultations ($n = 11$) to assess feasibility. In Stage 3, the Normalisation Process Theory guided development of implementation procedures with service-providers ($n = 2$). Data were analysed using descriptive statistics and thematic analysis.

Results: Community-based stakeholders identified core components: information on local physical activity opportunities (88%), motivational strategies (81%), follow-up group meetings (69%), and health education (63%). Professional stakeholders confirmed unanimous agreement for motivational strategies and health education. Concerns emerged regarding affordability of follow-up meetings for service-providers and equity of digital interventions. Follow-up phone calls, text message reminders, self-completed functional fitness assessments and exercise snacks in face-to-face sessions emerged as additional components.

Conclusion: KESS is a rigorous, co-designed, stakeholder informed intervention targeting exercise maintenance in older adults after FaME ends. KESS aims to prevent a decline in exercise adherence and consequent increasing risk of falling, observed in FaME programme attendees >6 months after programmes end if appropriate activity is not maintained. KESS is ready for feasibility and acceptability testing.

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Falls prevention; exercise maintenance; co-design

Introduction

Falls in older adults represent a major public health challenge worldwide (Montero-Odasso et al., 2022). Globally, one in three adults aged over 65 years, and half of adults aged over 80 years, fall each year with one in five being classed as injurious falls (Ambrose et al., 2013; Tinetti et al., 1988). Falls impair quality of life (Montero-Odasso et al., 2022), yet meta-analyses show 24–42% of falls are preventable through

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strength and balance exercise interventions (Sherrington et al., 2020). Understanding the multifaceted nature of falls risk is essential for developing effective, sustainable prevention strategies.

Multiple factors increase falls risk, including social isolation, environmental hazards, medication effects, cognitive impairments, and poor muscle strength and balance (Petersen et al., 2020; Rubenstein, 2006). Physical inactivity, prevalent in older adult populations (Harvey et al., 2015), contributes to muscle weakness, poor balance, and recurrent falls (Cunningham et al., 2020). Strength and balance exercise performed for at least 2 hours per week over 6 months improves function and prevents falls (Sherrington et al., 2019). The Falls Management Exercise (FaME) programme is an evidence-based 6-month, group-based exercise intervention proven to reduce falls (Iliffe et al., 2014; James et al., 2022; Orton et al., 2021; Skelton et al., 2005; Skelton et al., 2019). However, physical activity (PA) typically declines 6–24 months after FaME programmes end (Iliffe et al., 2014; Orton et al., 2021), increasing falls risk (Orton et al., 2021; Sherrington et al., 2019). This post-programme decline represents a critical adherence gap undermining long-term effectiveness of falls prevention interventions.

Maintaining falls prevention behaviours post-intervention is a well-documented challenge across healthcare settings globally. Community-based programmes face persistent barriers to sustaining exercise engagement once structured support ends (Maula et al., 2019; Ventre et al., 2025). Hospital-based studies report parallel maintenance challenges, with intervention gains diminishing after discharge (Heng et al., 2020; Hill et al., 2015; McLennan et al., 2024). Research consistently identifies common barriers across diverse settings, including funding constraints, instructor capacity limitations, time pressures, and declining participant motivation post-intervention (Heng et al., 2020; Maula et al., 2019; McLennan et al., 2024; Ventre et al., 2025). Falls prevention research suggests that behaviour change strategies, education, social support, digital technologies, and transition support can encourage continued exercise engagement (Audsley et al., 2020; Bunn et al., 2008; Choi et al., 2021; Finnegan et al., 2019; Hawley-Hague et al., 2020; Hobbs et al., 2013; Maula et al., 2019; Morris et al., 2022). Despite the emerging evidence on strategies that may support maintenance, developing interventions that can be implemented and sustained in real-world settings remains challenging.

Traditional research-led intervention development approaches often fail to capture the practical constraints, priorities, and contextual factors necessary for successful real-world implementation (Yardley et al., 2015). Co-design approaches, which embed service-users and professional stakeholders within the intervention development process (Leask et al., 2019; Moll et al., 2020) are considered essential in falls prevention research to help address real-world needs (Grindell et al., 2022; McKercher et al., 2025; Morris et al., 2025). This study aimed to co-design an exercise maintenance intervention acceptable for FaME service-users and feasible for service-providers within real-world settings.

Methods

Study design

A three-stage co-design process incorporated community-based and professional stakeholder group consultations, and implementation planning discussions with service-providers (Figure 1). The mixed-

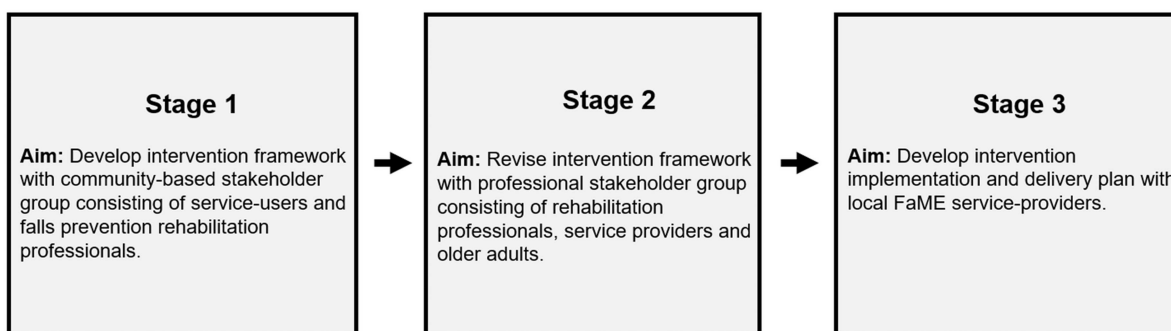


Figure 1. Overview of the intervention development stages.

method approach integrated quantitative voting data with qualitative thematic analysis of round-table discussions to ensure authentic stakeholder involvement in developing a co-designed exercise maintenance intervention (Grindell et al., 2022).

Theoretical frameworks

Self-efficacy, autonomy, and social support are key determinants of PA maintenance in older adults (Maula et al., 2019; McAuley et al., 2011). Therefore, the Social Cognitive Theory (SCT) and Self-Determination Theory (SDT) were selected to underpin the intervention development through their emphasis on the key determinants (Kwasnicka et al., 2016; Xu et al., 2025). To examine future implementation potential, the APEASE criteria (Acceptability, Practicability, Effectiveness, Affordability, Side-effects, Equality) guided intervention strategy evaluation in Stage 2 (Michie et al., 2014). NPT guided Stage 3 implementation planning at local service-provider level (May & Finch, 2009). Service-provider discussions focused on three key NPT domains: how the KESS intervention would fit within existing services (coherence), how staff could engage with the intervention (cognitive participation) and how the intervention could be delivered within available resources (collective action).

Stage 1: community-based stakeholder group consultations

Aim: To identify acceptable intervention components for service-users to receive when FaME programmes end and develop an intervention framework.

Stakeholders and recruitment: Falls prevention exercise class attendees were recruited from commissioned community-based FaME programmes delivered by Healthworks, a community health charity within Newcastle-Upon-Tyne, UK. Eligible participants were those who had completed or would complete their FaME programme within one month of the planned workshop date and were able to provide informed consent. Healthcare professionals (HCPs) and postural stability instructors (PSIs, trained to deliver FaME) were identified through local falls prevention networks using snowball sampling and invited via email. Eligible professionals included those with experience delivering falls prevention services and able to give informed consent. All interested parties were provided with a participant information sheet and given the opportunity to ask questions prior to providing informed written consent.

Procedures: A two-hour face-to-face consultation was conducted at a Northeast leisure centre with service-users, HCPs and PSIs. Stakeholder characteristics (age, gender, ethnicity and technology use) were collected before consultations. The research team presented eight evidence-based intervention components derived from falls prevention (Audsley et al., 2020; Choi et al., 2021; Finnegan et al., 2019; Iliffe et al., 2014; Maula et al., 2019) and PA maintenance literature (Hobbs et al., 2013; McAuley et al., 2011) (Table 1). Each component was described verbally and, where applicable, demonstrated using example materials (e.g. KOKU app interface [<https://kokuhealth.com/>], printed booklet samples, fitness watch functionality).

Table 1. Intervention components presented to community-based stakeholders.

Component	Description	Evidence source	Presentation method
Local PA information	Signposting to community exercise opportunities	Finnegan et al. (2019), Hobbs et al. (2013)	Verbal description with example leaflet
Motivational strategies	Goal setting, self-monitoring, reinforcement, relapse prevention	Hobbs et al. (2013), McAuley et al. (2011)	Verbal explanation with verbal and written examples
Follow-up group meetings	Post-programme meetups	Audsley et al. (2020), Maula et al. (2019)	Verbal description and written examples
Health education	Benefits of continued exercise and healthy eating	Finnegan et al. (2019)	Verbal presentation and written examples
Digital exercise support	KOKU digital intervention for guided home exercises	Choi et al. (2021)	Verbal description and live app demonstration and play
Printed exercise booklets	Illustrated home exercise guides	Audsley et al. (2020), Iliffe et al. (2014)	Verbal description and physical booklet samples
Fitness watches	Wearable activity monitors	Maula et al. (2019)	Verbal description and device demonstration
Peer connectivity	Strategies to maintain participant contact	Audsley et al. (2020), Maula et al. (2019), McAuley et al. (2011)	Verbal description with examples

PA, Physical Activity; KOKU app, Keep On Keep Up application.

Audio-recorded round-table discussions explored the acceptability and effectiveness of each component. At the end of each discussion, stakeholders completed anonymous voting forms to rate components as definitely include, include as an option, or definitely exclude from the exercise maintenance intervention.

Data Analysis: Voting data were analysed descriptively and organised hierarchically by 'definitely include' responses. A three-tiered traffic-light classification system was applied to visualise stakeholder consensus: high consensus (green) represented components with $\geq 60\%$ of stakeholders selecting 'definitely include'; moderate consensus (amber) indicated 25–59% agreement; and low consensus (red) reflected $\leq 24\%$ agreement. Audio recordings were transcribed and analysed thematically using NVivo14 by two independent researchers. The purpose of the hierarchy was to quantify the level of agreement of each intervention strategy to create an intervention framework. Themes in the qualitative data were used to help understand nuances in the voting results and contextualise how each intervention strategy might be effectively implemented.

Stage 2: professional stakeholder group consultations

Aim: To assess intervention feasibility using APEASE criteria and refine the framework for real-world delivery.

Stakeholders and recruitment: Professional stakeholders included HCPs, PSIs, service managers, a public health commissioner, a clinical academic, and older adult representatives all with experience of falls prevention. Stakeholders were identified by local service-providers through snowball sampling. Stakeholders were invited to contribute to co-design discussions via email. Interested parties were provided with a participant information sheet and given the opportunity to ask questions prior to giving informed written consent.

Procedures: Two-hour consultations were conducted online via Microsoft Teams. Researchers presented Stage 1 findings and the intervention framework. Stakeholders were asked to consider and evaluate each component specific aspects using the APEASE (Michie et al., 2014) criteria as follows: Acceptability (would service-providers and service-users find this appropriate?), Practicability (can it be delivered at scale?), Effectiveness (will it help older adults stay active?), Affordability (is it financially viable for service-providers and service-users?), Side-effects (any unintended consequences?), and Equality (would it increase or decrease inequalities?). Anonymous online voting forms assessing feasibility against all APEASE criteria were completed the day after consultations took place.

Analysis: Voting data were summarised descriptively according to APEASE criteria. For each intervention component, stakeholder agreement was assessed across all six APEASE criteria (Acceptability, Practicability, Effectiveness, Affordability, Side-effects, and Equality). A three-tiered traffic-light consensus classification was applied based on the total number of respondents (out of 10) who agreed across all APEASE criteria: high consensus (green) represented $n \geq 9$ –10 respondents agreeing across all six APEASE criteria; moderate consensus (amber) indicated $n = 6$ –8 respondents agreeing across most criteria; and low consensus (red) reflected $n \leq 5$ respondents agreeing across most criteria. Intervention components achieving $\geq 6/10$ agreement on at least five APEASE domains were considered acceptable for inclusion.

Transcribed workshop discussions were analysed thematically (Braun & Clarke, 2006), with themes organised by intervention component. The qualitative analysis identified contextual factors influencing APEASE ratings and modifications that could improve acceptability.

Stage 3: implementation planning

Aim: To refine the intervention into deliverable protocols with service-providers.

Stakeholders: Healthworks PSI and service manager.

Procedures: The intervention framework was organised into a draft schedule of activities (originally 6 sessions post-FaME), emailed to stakeholders and discussed in an online meeting. Discussions were guided by three Normalisation Process Theory domains (May & Finch, 2009). These explored: coherence (how KESS integrated with existing FaME delivery), cognitive participation (PSI willingness, training needs, and perceived programme value), and collective action (practical delivery considerations including time, resources, and workload). Fieldnotes documented schedule modifications, barriers and solutions.

Analysis: Fieldnotes were used to finalise the schedule of activities, develop the 2-day PSI KESS training programme, standard operating procedures and participant resources.

Ethics statement

Ethical approval was obtained from Northumbria University's Research Ethics Committee [30/01/2024, Reference: Audsley-2024-6365-5990] and study protocol registered on ClinicalTrials.gov [NCT06447948].

Results

Stage 1: community-based stakeholder group results

Stakeholders: In Stage 1, 18 individuals expressed interest (12 FaME class attendees, 6 professionals), with 16 attending the stage 1 consultation. Two individuals opted out due to scheduling conflicts and lack of interest. The 16 stakeholders who attended the Stage 1 consultation were: 10 FaME class attendees (median age 81 years, IQR 76-84 years, range 66-87 years; 9 female, 10 Caucasian) and 6 HCPs/PSIs (median age 40 years, IQR 33-47 years, range 23-47 years; 5 female, 6 Caucasian). Technology use was relatively high among the 10 FaME class attendees, with 9 owning smartphones, 6 owning tablets, and 7 using WhatsApp.

Voting Results: Voting responses revealed clear stakeholder preferences for intervention components. Results are presented in a three-tiered traffic-light hierarchical framework based on 'definitely include' responses (Table 2).

Thematic analysis

Stakeholder consultations revealed intervention-specific themes across 6 key areas, highlighting both barriers and facilitators for each component see Table 3 and supplementary material 1. The thematic analysis revealed cross-cutting themes of personalisation, accessibility, and the critical importance of promoting social connection within the intervention design.

Table 2. Stage 1 KESS intervention framework based on community-based stakeholder results.

Intervention Component	Definitely Include n(%)	Include as Option n(%)	Definitely Exclude n(%)	Consensus Level*
Tier 1: Core Components				
Information on local PA opportunities	14 (87.5)	2 (12.5)	0 (0)	High
Motivational strategies	13 (81.25)	3 (18.75)	0 (0)	High
Follow -up group meetings	11 (68.75)	5 (31.25)	0 (0)	High
Health education	10 (62.5)	6 (37.5)	0 (0)	High
Tier 2: Optional Components				
KOKU app	7 (43.75)	7 (43.75)	2 (12.5)	Moderate
Exercise booklets	7 (43.75)	7 (43.75)	2 (12.5)	Moderate
Fitness watches	4 (25)	4 (25)	8 (50)	Moderate
Tier 3: Excluded Components				
Peer connectivity	0 (0)	14 (87.5)	2 (12.5)	Low

Three-Tiered Intervention Framework Model Based on Community Stakeholder Voting ($n = 16$).

Consensus classification

- High consensus: $n = 10$ to 16 of 16 stakeholders ($\geq 60\%$).
- Moderate consensus: $n = 4$ to 9 of 16 stakeholders (25 to 56%).
- Low consensus: $n = 0$ to 3 of 16 stakeholders ($\leq 24\%$).

Table 3. Thematic analysis and representative quotes outlining community-based stakeholder group discussions.

Themes	Quotes
Information on local physical activity opportunities received universal support, though stakeholders emphasised the need for current, accessible information including venue accessibility, cost, and age-appropriate options. Professionals noted significant resource requirements for maintaining up-to-date service directories.	<i>"If you haven't got all the information, you're not going to know where to go" (R6_Service-user)</i> <i>"Keeping on top of that list would be a significant part of our job" (R9_Professional)</i>
Motivational strategies generated strong consensus for peer support, flexible goal setting, and routine development, with stakeholders emphasising the importance of contingency planning and avoiding rigid expectations that could lead to feelings of failure.	<i>"Not being too rigid in your goals... if you don't achieve it once, you're like, oh well, failed" (R6_Service-user)</i>
Follow-up group meetings received unanimous support from service-users primarily for social connection and loneliness reduction rather than exercise motivation, with emphasis on commitment and peer accountability.	<i>"I think it would be great, as you mentioned... Whether it would encourage me to exercise, I don't know. But it would be nice to meet people." (R4_Service-user)</i>
Health education was viewed positively but considered less effective than other components, with preferences for accessible delivery by PSIs rather than complex medical information.	<i>"My doctor tends to send me a ton of stuff that bamboozles me... I tend to ask my class instructor" (R2_Service-user)</i>
Technology-based vs paper-based interventions for home exercise (KOKU digital strength and balance exercise intervention (Choi et al., 2021), exercise booklets (LaterLife Training, 2024), fitness watches) revealed divided opinions largely dependent on digital literacy and experience, with consistent themes around the need for ongoing technical support and accessibility concerns.	<i>"If you had support ... show you how to use it and if that (support) was ongoing" (R5_Service-user)</i> <i>"What's the kind of rules around sharing phone numbers... I can imagine that's a bit of a minefield" (R9_Professional)</i>

Stage 2: professional stakeholder group results

Stakeholders: In Stage 2, 11 individuals were invited, and all (100%) attended a stage 2 consultation. The professional stakeholders who participated were falls prevention HCPs/PSIs ($n = 7$), clinical academics ($n = 1$), older adult representatives ($n = 2$), and public health commissioners ($n = 1$) (median age 46 years, IQR 44–55 years, range 27–76 years; 9 female, 11 Caucasian).

APEASE Assessment Results: 10 out of the 11 stakeholders completed the online voting forms; 1 stakeholder did not return their form for unknown reasons. Feasibility evaluation revealed distinct patterns of professional stakeholder agreement across intervention components (Supplementary material 2).

Eight intervention-specific themes emerged from stakeholder group discussions. The thematic analysis revealed how stakeholders reasoned through their APEASE evaluations. Cross-cutting themes included personalisation needs, resource sustainability concerns, and the importance of promoting individual choice within the intervention design, see supplementary material 3. Table 4 presents a three-tiered traffic-light consensus framework based on the level of agreement across all APEASE criteria and the key considerations arising from the thematic analysis that influenced ratings.

Stage 3: implementation planning results

Stakeholders: In stage 3, two service-providers (one PSI and one service manager) were invited and attended the implementation planning workshop.

Coherence: The hybrid model combining home-based exercise with monthly group follow-up aligned with existing FaME structures. However, KESS requires coordination with local community exercise providers for participant transitions, and availability of age-appropriate groups varies geographically across all four Healthworks sites. Service-providers noted that while two Healthworks sites could offer internal follow-on exercise services, two sites would need partnerships with external leisure centres for GP referral schemes.

Collective action: Sixty-minute sessions in familiar venues were deemed feasible with existing resources. Service-providers identified practical challenges around PSI-led clinical assessments, particularly time constraints within the 60-minute sessions, leading to adoption of the home-based FFMOT. The home-based Functional Fitness MOT (FFMOT) (De Jong et al., 2018; LaterLife Training, 2024) is a self-administered battery of functional tests compared to age- and sex-matched normative data. Home-based FFMOT results would inform feedback, goal setting and action-planning in subsequent group sessions.

Table 4. Stage 2 KESS intervention framework, based on the mixed method APEASE evaluation of professional stakeholder results.

Intervention Component	APEASE Criteria Meeting Agreement*	Overall Consensus	Key Implementation Considerations and Representative Quotes.
Tier 1: Core Components			
Motivational strategies & health education	Acceptability (10/10) Practicability (10/10) Effectiveness (10/10) Affordability (10/10) No side-effects (10/10) Equality (10/10)	High	Unanimous support in voting results and discussions across all APEASE criteria. <i>"We need people to be internally motivated... the self-reporting of whether people feel like they are doing something which is beneficial to them"</i> (Public Health Commissioner 1) <i>"If you're having a really bad day, they would do something... it's supporting people to manage those dips"</i> (R_Clinical Academic 1)
Information on local PA opportunities	Acceptability (10/10) Practicability (10/10) Effectiveness (9/10) Affordability (10/10) No side-effects (10/10) Equality (6/10)	High	High support across all APEASE criteria, with practicality, side effect and equity concerns discussed in maintaining list currency and class accessibility. <i>"From previous services that I've been in, we have tried to do that and it's been really hard for us to keep up because people lose funding or new things pop up"</i> (Service provider 3) <i>"Unwanted side effects are that people phone up and complain if the classes on the lists are no longer running"</i> (R_Service provider 6) <i>"The problem we have in the north of the city and the east of the city is that those classes don't run, so people are reluctant to kind of travel across."</i> (R_Service-provider 4)
Follow-up group meetings	Acceptability (10/10) Practicability (6/10) Effectiveness (9/10) Affordability (5/10) No side-effects (6/10) Equality (7/10)	Moderate	Moderate support across APEASE criteria, discussed as "gold standard" with affordability and practicality considerations around service commissioning. <i>"I think that getting people back after the intervention is gold standard really, isn't it?"</i> (R_Public Health Commissioner 1) <i>"I think if it was commissioned because I think that time's already tight"</i> (R_Service provider 1)
Follow-up support via telephone from instructors	Acceptability (7/10) Practicability (6/10) Effectiveness (9/10) Affordability (6/10) No side-effects (8/10) Equality (9/10)	Moderate	Moderate support across APEASE criteria, considered acceptable for older adults to receive and clinical settings to deliver, but uncertainty arose around APEASE for community-based delivery. <i>"I do think the text message reminder is really useful"</i> (R_Older adult representative 1). <i>"Yeah, we do our groups. If our patients don't attend, we ring them and find out why. And if they dipped like we talked about before we generally review them one on one and then put them back on programmes."</i> (R_Service provider 5). <i>"I think it's really desirable... if it's something that the exercise instructors feel that they can support"</i> (R_Service provider 2).
Tier 2: Optional Components			
Exercise booklets	Acceptability (10/10) Practicability (10/10) Effectiveness (10/10) Affordability (10/10) No side-effects (9/10) Equality (9/10)	High	Universally high APEASE ratings. Effectiveness concerns around exercise booklet as a stand-alone intervention were discussed due to user engagement. <i>"To give somebody a leaflet and send them on their way... Is quite unrealistic"</i> (Public Health Commissioner 1) <i>"I'm not very well motivated. If I'm on my own... I've got dozens of beautiful exercise sheets given to me by various physios and they all sit on my bedside, and occasionally I might... but just to actually commit... is quite difficult"</i> . (R_Older adult representative 2).
KOKU digital intervention	Acceptability (10/10) Practicability (8/10) Effectiveness (10/10) Affordability (9/10) No side-effects (7/10) Equality (1/10)	High	High support across most APEASE criteria due to KOKU's age-appropriateness and ease of use. Equality concerns around digital exclusion, which could be counterbalanced if offered alongside exercise booklets. <i>"So easy to use and just to follow through that, it's great. I can see that that'd be a real asset"</i> R_Service provider 1). <i>"I think in terms of equity, I think you'll always have to potentially offer both options. You know an app and a written booklet"</i> (R_Service provider 2).
Tier 3: Excluded Components			
Fitness watches	Acceptability (5/10) Practicability (2/10) Effectiveness (5/10) Affordability (3/10) No side-effects (6/10) Equality (1/10)	Low	Low stakeholder support across most APEASE criteria. Implementation concerns around acceptability, practicality and effectiveness linked with personal preference. <i>"What's important is the tracking of physical activity as a motivational strategy... the ways in which people do that is down to personal preference"</i> (R_Service provider 2) <i>"If you offered me a fitness watch, I wouldn't accept it because I can't wear watches"</i> (R_Older adult representative 2) <i>"Obviously we're all different and I would not choose to use a fitness watch"</i> . (R_Older adult representative 1)

Three-Tiered Model based on APEASE criteria voting results. Numbers (n=) indicate the level of consensus in support of each intervention strategy for service-providers to deliver. Total professional stakeholder sample number 10.

Consensus classification

- High consensus: $n \geq 9$ to 10 respondents across all APEASE criteria.
- Moderate consensus: $n = 6$ to 8 respondents across most criteria.
- Low consensus: $n \leq 5$ respondents across most criteria.

Group exercise provision suggested in Stage 2, was integrated into sessions in the form of short exercise snacks to avoid overloading session time. The schedule expanded from 6 to 8 sessions based on service-provider feedback about content volume and avoiding overloading participants.

Cognitive participation: Stakeholders viewed KESS as a valuable role extension that would support participant transitions from FaME services. Behaviour change theory and delivery, successful ageing education and FFMOT were identified as training needs, with particular emphasis on delivering ageing-related content in motivating ways. These needs were incorporated into the 2-day KESS training programme.

Final KESS intervention

The multi-stage co-design process resulted in the rigorous development of the Keep Exercising and Stay Steady (KESS) programme: an 8-session group intervention delivered over 8 months by trained PSIs. The programme employs a hybrid delivery model with 3 sessions embedded within existing FaME 24-week programmes and 5 additional sessions delivered monthly over 6 months post- FaME completion (supplementary material 4 contains a TIDieR Checklist detailing the KESS intervention). Sessions are delivered in familiar community venues where original FaME programmes occurred, by the same PSIs.

Programme Structure: Each 60-minute session has a different focus but largely incorporates a variety of tailored behaviour change strategies, health education and exercise snacks delivered via a group motivational interviewing approach (Supplementary material 5).

Core components

- Tailored motivational strategies including home-based FFMOT assessments, goal setting, relapse prevention, action-planning, self-monitoring activity, follow-up calls and text message reminders.
- Health behaviour education focusing on successful ageing, frailty avoidance, and reducing social isolation via community engagement activities.
- Tailored transition support to local PA opportunities and home-based exercise.
- Group-based social support and structured peer interaction activities.

Optional components

- Choice between digital (KOKU digital intervention (Choi et al., 2021) via digital tablets) and traditional (illustrated booklets (LaterLife Training, 2024) home exercise support).
- Support for participants preferred PA monitoring tools.

Implementation support

- Comprehensive 2-day training programme, collaboratively developed with a recognised not for profit training provider, a frailty specialist and a behaviour change researcher.
- Standard operating procedures and session-by-session implementation manuals.
- Participant resources including the LaterLife Training (LLT) Active Calendars (LaterLife Training, 2024), FFMOT at Home booklet (LaterLife Training, 2024), and local resources for PA opportunities. Participants were signposted to online social groups that promote PA habits, such as Make Movement Your Mission (Bosco et al., 2022).

Discussion

This rigorous multi-stage co-design process successfully developed a theoretically grounded, stakeholder-informed intervention that bridges the gap between FaME programme completion and exercise maintenance. The co-design approach, increasingly recognised as essential in falls prevention research (McKercher et al., 2025; Morris et al., 2025), promotes intervention acceptability for both service-users

and service-providers. The approach also addresses real-world implementation challenges that often impede intervention translation from research to practice (Leask et al., 2019).

High agreement across community and profession stakeholder groups demonstrates remarkable consensus regarding essential elements for exercise maintenance, challenging common assumptions about tensions between user wants and service constraints (Altman et al., 2018). Unanimous professional support for motivational strategies and education reflects a paradigm shift from traditional exercise prescription towards applied behaviour change approaches that address the complex interplay of individual, social, and environmental factors influencing PA (Maula et al., 2019; Pettersson et al., 2021; Yang et al., 2024). While education is effective in hospital falls prevention (Morris et al., 2022), evidence suggests that educational interventions alone may not sustain these benefits over time (Kempegowda et al., 2018), reinforcing our focus on strategies beyond initial education delivery.

Systematic review evidence shows that behavioural interventions can increase PA at 12 months in older adults, with tailored interventions incorporating transition support and goal setting appearing most promising (Hobbs et al., 2013; Stockwell et al., 2019). Exercise snacks and habit formation strategies also show promise for maintaining physical activity in later life (Du et al., 2025; Fleig et al., 2016; Karlsson et al., 2025). By practising exercise snacks during KESS sessions and encouraging participants to attach them to existing home routines (e.g. one leg balance whilst teeth brushing), the intervention transforms conscious exercise into automatic behaviour, addressing the common challenge of post-programme adherence (Finnegan et al., 2019; Pettersson et al., 2023). Integrating these evidence-based strategies, KESS addresses key factors for sustaining exercise beyond the initial PA intervention period where many interventions fail.

Information on local PA opportunities achieved high acceptability amongst professional stakeholders. Yet, community-based stakeholders emphasised transport accessibility, costs, and venue suitability issues that could exclude those with mobility limitations. These findings reflect broader evidence that older adults face compounded barriers to PA participation, including transport poverty and venue accessibility that information provision alone cannot address (Maula et al., 2019; Yang et al., 2024). This mirrors challenges identified in hospital-to-community transitions internationally (Hill et al., 2015; McLennan et al., 2024). The co-design approach adopted a pragmatic equity-focused solution, offering PA information alongside both digital and non-digital home-based exercise choices, maintaining choice to engage with different exercise options.

Our findings reveal a tension between digital intervention acceptability and equity concerns. While professional stakeholders rated digital interventions highly for effectiveness, they expressed strong concerns about widening inequalities, a paradox that reflects broader challenges in digital health implementation (Hepburn et al., 2025). Community stakeholders emphasised that digital inclusion requires ongoing support beyond technology provision, reflecting recognition that digital interventions may exclude older adults unless barriers are addressed (Wale et al., 2024). The KESS intervention addresses this through hybrid delivery (offering both digital and paper-based options) to accommodate different user preferences and abilities.

Community-based stakeholders emphasised the importance of maintaining social connections developed during FaME programmes. Although relatively few participants maintain exercise long-term, group-based falls prevention programmes can offer social support benefits to some attendees (Bunn et al., 2008; Lafond et al., 2019), with those maintaining PA levels post-programme reporting sustained social networks (Maula et al., 2019). The KESS intervention therefore combines opportunities for continued social engagement with behavioural strategies and flexible exercise options, recognising that exercise maintenance requires addressing both personal and community dimensions of physical activity.

Methodological strengths and limitations

The multi-stage co-design approach incorporating diverse stakeholder perspectives, including the experiences of falls prevention programme completers whose perspectives may differ from dropouts and general older adult populations (Cornwall & Jewkes, 1995; McGowan et al., 2025) is the study's primary strength. The co-design methodology, while ensuring local relevance and stakeholder engagement, inherently limits generalisability to other contexts which is a key limitation. While the intervention framework may be

transferable, specific implementation procedures developed in Stage 3 may require substantial adaptation for different contexts (Murray et al., 2010). Despite reflecting typical falls prevention programme demographics, there was a high percentage of female and Caucasian service-users in Stage 1 which may limit representativeness of different perspectives, preferences and barriers to exercise maintenance. Addressing limitations may require additional consultation to ensure intervention appropriateness across different geographical areas, settings and stakeholder groups.

Implications for practice, policy, research

KESS provides a replicable and scalable framework for exercise maintenance interventions. The co-design methods offer a template for adaptation to local contexts and needs. The tiered approach, balancing standardisation with personalisation presents a pragmatic model that is adaptable for other chronic disease management contexts. Professional stakeholder feedback underscores the systemic barriers to maintenance support within current funding structures. Policy makers should consider developing specific funding streams for maintenance interventions that bridge the gap between rehabilitation and long-term prevention.

Future research is needed to evaluate the KESS interventions acceptability, clinical and cost effectiveness and implementation potential across diverse service settings and population groups. Long-term follow-up would provide crucial evidence regarding intervention endurance and clinical significance. Economic evaluations incorporating implementation costs and healthcare utilisation are needed to inform policy decisions regarding maintenance intervention commissioning and sustainability.

Conclusion

This multi-stage co-design process successfully developed an evidence-based exercise maintenance intervention addressing the critical gap when older adults exit FaME programmes. The intervention framework, informed by diverse stakeholder perspectives, is now ready for feasibility and acceptability evaluation.

Author contributions

- SA, NA, GB, PC, SM, AOD, ES, DAS, BL contributed to the study conception and design.
- SA, GB, SM, AOD, VM contributed to the data acquisition and analysis.
- All authors contributed to data interpretation, manuscript writing and revision.

Disclosure statement

DAS and BL are directors of Later Life Training, a not-for-profit organisation that delivers PSI training, FFMOT training, produces annual Active Calendars and delivers Make Movement Your Mission free to older adults on Facebook and You Tube. PC is the chief executive officer for the non-for-profit charitable organisation Healthworks (Newcastle). ES is the Director of KOKU Health Ltd. The rest of the authors report no conflict of interest.

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Data availability statement

The datasets generated and analysed during the current study are not publicly available due to ethical restrictions to protect participant confidentiality, as participants did not consent to public data sharing. Aggregated data may be available from the corresponding author upon reasonable request.

Informed consent statement

All participants provided informed written consent prior to participation.

Institutional review board statement

☑ The study was conducted in accordance with the Declaration of Helsinki and was approved by Northumbria University's Research Ethics Committee (30/01/2024, Reference: Audsley-2024-6365-5990).

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