

BMJ Open We Walk: a person-centred, dyadic behaviour change intervention to promote physical activity through outdoor walking after stroke – an intervention development study

Jacqui H Morris ¹, Linda A Irvine,¹ Stephan U Dombrowski ²,
Brendan McCormack,^{3,4} Frederike Van Wijck,⁵ Maggie Lawrence⁵

To cite: Morris JH, Irvine LA, Dombrowski SU, *et al.* We Walk: a person-centred, dyadic behaviour change intervention to promote physical activity through outdoor walking after stroke—an intervention development study. *BMJ Open* 2022;**12**:e058563. doi:10.1136/bmjopen-2021-058563

► Prepublication history and additional supplemental material for this paper are available online. To view these files, please visit the journal online (<http://dx.doi.org/10.1136/bmjopen-2021-058563>).

Received 21 October 2021
Accepted 16 May 2022



© Author(s) (or their employer(s)) 2022. Re-use permitted under CC BY-NC. No commercial re-use. See rights and permissions. Published by BMJ.

For numbered affiliations see end of article.

Correspondence to

Dr Jacqui H Morris;
j.y.morris@dundee.ac.uk

ABSTRACT

Objectives To develop We Walk, a theoretically informed, 12-week person-centred dyadic behaviour change intervention to increase physical activity (PA) in community-dwelling people with stroke (PWS) through outdoor walking.

Design Three-phase intervention development study. Phase 1: we reviewed literature on barriers and facilitators to PA after stroke and mapped them to the Behaviour Change Wheel and Theoretical Domains Framework to define intervention components. The Health Action Process Approach determined intervention structure underpinned by person-centred principles. Phase 2: stakeholder focus groups involving PWS, their companions and health professionals reviewed the draft intervention, and experts in behaviour change were consulted. Phase 3: informed by phases 1 and 2, the intervention and form of delivery were refined, with final review through patient and public involvement.

Setting Three Scottish community rehabilitation stroke services.

Participants Twenty-three ambulatory community-dwelling PWS and their companions, thirty-seven health and exercise professionals, seven behaviour change experts.

Results Phase 1 determined key intervention components: information about benefits of walking; developing motivation and confidence to walk; facilitating dyadic goal setting and making plans together; monitoring walking, overcoming challenges; and maintaining walking behaviour. Phase 2 review by stakeholder focus groups and behaviour change experts endorsed intervention components and structure, emphasising dyadic relational aspects as central to potential success. In phase 3, intervention content and handbooks for PWS and buddies were finalised. Healthcare professionals proposed third-sector delivery as most appropriate for intervention delivery. A detailed delivery manual was developed. Participants preferred facilitated face-to-face and telephone delivery.

Conclusions Our multilens intervention development approach ensured this novel intervention was evidence-informed, person-centred, theoretically coherent provided

STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ Our previous qualitative research and an evidence review of current qualitative studies examining barriers and facilitators to physical activity after stroke informed a theory-based behavioural diagnosis that guided the development of intervention content and form of delivery.
- ⇒ Stakeholder and expert consultation informed intervention refinement, guiding change to content and form of delivery, with emphasis on the relational aspects of dyadic working as central to potential success.
- ⇒ Person-centred principles ensured relevance, meaningfulness and acceptability of the intervention to people with stroke, whatever their context.
- ⇒ Most participants were male and already physically active; so their views may not apply to all of the stroke population.
- ⇒ Third sector agencies, which may be important in future intervention delivery, were not part of the stakeholder consultation; their role should now be explored.

appropriate social support, and addressed issues of concern to PWS. This study established intervention components and structure and identified operational issues critical to future success. Future research will pilot and refine We Walk and evaluate acceptability, feasibility, effectiveness and cost-effectiveness.

Trial registration number ISRCTN34488928.

BACKGROUND

Globally, 26 million people live with post-stroke disability.¹ Improving physical function and fitness is crucial in reducing stroke burden for individuals, families and society.² Regular physical activity (PA), including walking outside, improves walking speed, capacity and cardiovascular fitness in people with stroke (PWS)³ and reduces cardiovascular

risk factors.² Walking is inexpensive, valued, familiar and accessible for 80%–95% PWS who recover ambulation.^{4,5} Furthermore, 20–30 min daily moderate-intensity walking may reduce all-cause mortality in PWS by up to 41%.^{6,7} Therefore, outdoor walking has potential as a target behaviour for an intervention to increase PA and improve mobility outcomes and cardiovascular health after stroke.⁸

Average daily step counts PA after stroke are half those of age-matched healthy people.^{9,10} PWS are sedentary for >80% of the day,¹¹ even those with ambulatory capacity, suggesting factors other than physical disability influence PA behaviour. Qualitative studies show PWS experience many psychological, physical, social and environmental barriers to PA participation,^{12–14} suggesting individually tailored behavioural approaches are necessary to promote long-term participation in regular walking. Systematic reviews show incorporating theoretically informed behaviour change strategies into post-stroke PA promotion programmes is effective, but to date, studies are small and behavioural strategies are poorly reported.^{15–17}

Social support provided by family or friends predicts long-term engagement in PA in older adults^{18,19} and may enhance uptake and maintenance of post-stroke walking.²⁰ Interventions involving pursuit of PA goals by two individuals with a socially significant relationship (eg, spouse, friend, family member, buddy) are known as dyadic interventions.²¹ One line of evidence supporting a dyadic approach to PA promotion after stroke comes from our previous qualitative study with 38 PWS and their carers.²² The study examined barriers to PA after stroke, showing many carers adopted a facilitatory role in supporting PWS to be active, so they could resume enjoyable shared activities together. Carers reported using informal approaches to support goal setting and goal achievement with the PWS and monitoring progress to support their partners' confidence and motivation. These informal, common-sense behavioural approaches led us

to conclude that a dyadic approach to PA promotion could effectively support PWS to be more active.

A second line of evidence to support dyadic interventions comes from a meta-analysis of studies with non-clinical populations, indicating dyadic interventions have moderate effects on PA outcomes when dyads agree shared goals.²¹ Systematic reviews have evaluated dyadic stroke survivor/carer interventions,²³ but their focus was stroke recovery and caregiving, not PA promotion. No dyadic interventions were identified in a review of interventions to promote PA after stroke.¹⁶ However, a systematic review of dyadic interventions for PA promotion, including other clinical and disabled populations,²¹ showed psychosocial and physical health benefits for both caregiver and care recipient, suggesting a dyadic behaviour change intervention could effectively promote post-stroke walking.

Person-centred principles emphasise autonomy and empathic understanding²⁴ to accommodate participants' psychosocial context, roles, experiences, concerns and aspirations.²⁵ Co-producing a dyadic intervention with users and key stakeholders that combines person-centred principles with theoretically based, individually tailored behaviour change strategies should increase enjoyment, enhance engagement and support PA maintenance.²⁶ Such an intervention has potential to promote PA after stroke through walking, as PWS complete rehabilitation and move to independent community living.

This paper describes initial development of We Walk, a multistage project to develop and pilot a theory-based, person-centred, dyadic behaviour change intervention to promote PA through outdoor walking in community-dwelling PWS.

Study design

Intervention development involved three phases (figure 1). *Phase 1.* Step 1a: evaluating existing evidence. Step 1b: evidence mapping to the Capability, Opportunity,

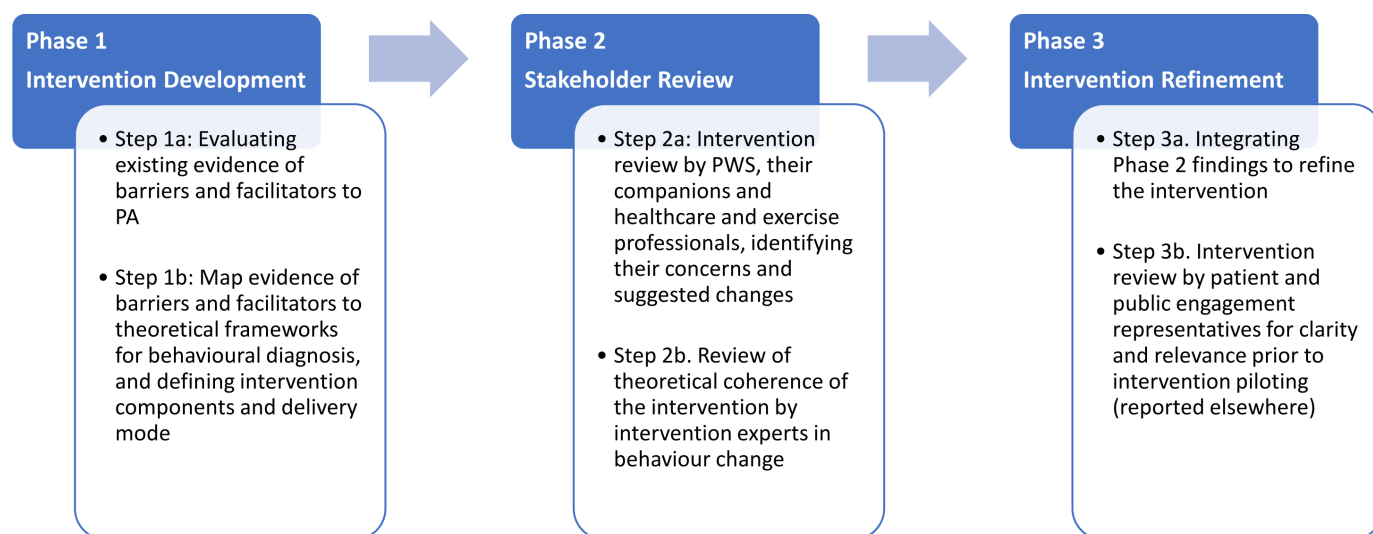


Figure 1 Intervention development and refinement stages.

Motivation, Behaviour (COMB) framework of the Behaviour Change Wheel (BCW; Michie)²⁷ and the Theoretical Domains Framework (TDF)²⁸ for behavioural diagnosis. Defining intervention components and delivery in practice, underpinned by the Health Action Process Approach (HAPA).²⁹ *Phase 2:* Step 2a: conducting focus groups (FGs) and reviewing the draft intervention with PWS, their companions, and health professionals. Step 2b reviewing for theoretical coherence with experts in behaviour change intervention development. *Phase 3.* Step 3a: integrating Phase 2 findings for intervention refinement. Step 3b: patient and public involvement (PPI) representatives reviewing intervention materials for clarity and relevance. Phases are reported below.

METHODS

Phase 1: intervention development methods

Step 1a: evaluating existing evidence

This project was conceptualised from earlier qualitative research²² and systematic reviews¹³ conducted by our team in which barriers and facilitators to PA after stroke were explored. To inform the present study, we updated our earlier systematic review of barriers and facilitators to PA after stroke.¹³ Systematic searches of CINAHL, Medline and PsycInfo from July 2011 to July 2018 identified 11 additional studies. We described and summarised themes within those studies and integrated them with our previous qualitative research and earlier review as the basis for intervention development.

Step 1b: initial intervention development

The BCW is a theory-based system for behaviour change intervention development.^{27 28} Following BCW methods, we mapped barriers and facilitators to post-stroke PA identified in phase 1a against theoretical constructs described in the COM-B model and related TDF. We identified intervention functions using behavioural diagnosis to specify target behaviours that, if changed, could bring about increased outdoor walking and identified the behaviour change techniques (BCTs) that would form the basis of the intervention.

The HAPA²⁹ is a sociocognitive framework addressing adoption, initiation and maintenance of behaviour change. It describes motivational (intention formation) and volitional phases (planning, action, maintenance) of behaviour change, supported by self-efficacy development across each phase. We used the HAPA to inform the intervention structure for delivering BCTs.

Dyadic working

Dyadic planning involves creating plans with a partner about when, where and how PA goals are achieved.³⁰ Transactive Goal Dynamics Framework³¹ conceptualises seven dyadic roles and goal pursuit permutations, illustrating how a dyad's goals are linked and coordinated. The framework enabled us to initially specify dyads would pursue shared target-orientated goals; that is,

walking goals for PWS would be the intervention target, with PWS and buddies working together to pursue them.

Person-centred principles

We adapted person-centred principles from a framework for person-centred practice²⁵ to guide intervention development and delivery. Throughout the development process, we examined decisions made, language and tone used in written materials, interactions with stakeholders, and data collection and analysis, to ensure we followed these principles, which also informed planned delivery. We intended that those delivering the intervention would take person-centred approaches to guide the dyad in implementing the intervention. For example, facilitators would encourage goal setting by sharing information, listening, ensuring conversations focused on what mattered to the dyad, identifying meaningful goals aligned with their values and lives and respecting their preferences, needs, values, interests and contexts. Agreed activities to achieve goals would be tailored accordingly.

Patient and public involvement statement

PPI informed all stages of this project. Members of two Scottish Chest Heart and Stroke Scotland support groups and local exercise groups supported the initial grant application. They subsequently advised on initial intervention content, selecting walking buddy as an appropriate term and providing feedback on study and intervention materials. Four group members provided ongoing study oversight through steering group attendance as the project progressed reviewed intervention materials at the end of the study.

Phase 2: stakeholder consultation and intervention refinement

We next sought stakeholder views on intervention content and delivery format, enabling us to adapt and refine We Walk to meet their needs.

Step 2a Consultation with PWS, their companions and health professionals

Stroke rehabilitation clinical leads in three Scottish health boards, selected for urban and rural populations, identified community-dwelling, ambulatory PWS who could provide informed consent. PWS invited and attended with their chosen companions. The clinical leads also invited health and exercise professionals involved in stroke services within their local areas. All participants received study information before giving written informed consent for participation.

Participants attended one of six stakeholder meetings held at local universities in three health board areas. Consultations aimed to collect data to inform intervention content and delivery format; examine intervention acceptability and ensure person-centredness. Findings would inform intervention refinement before pilot testing (to be reported elsewhere).

Data collection

Intervention structure and draft materials were introduced to all participants, and initial discussions and questions were addressed in small groups. Discussions were recorded in contemporaneous field notes. To obtain all perspectives and ensure no one group dominated, we next conducted FGs separately with PWS and companions; and with professionals (12 FGs in total), respectively led by LI and JM. FGs captured data relevant to each stakeholder group, exploring participants' views of intervention usefulness, acceptability and likely feasibility, dyadic working, form of delivery and person centredness. Healthcare professionals also considered intervention relevance, fit and timing concerning rehabilitation context and pathways. Groups were audio recorded and transcribed (topic guides in online supplemental material 1).

Data analysis

JM and LI read transcripts and agreed on coding. Codes were reviewed and grouped into categories relevant to intervention components. Using the six stages of thematic analysis,³² the research team interpreted findings relevant to intervention development, developed descriptive themes, and incorporated findings into the intervention in Step 2b. Data were managed in Nvivo V.12.

Step 2b Theoretical coherence of the intervention: review by experts in behaviour change intervention development

We invited an international group of experts in health psychology and PA research (n=14) to inform intervention refinement further by commenting on the draft intervention. Seven responded; five health psychologists, one expert in PA promotion, and one physiotherapist. Respondents received documentation detailing intervention functions, BCTs, and a summary intervention delivery plan. We invited them to provide comments on (1) theoretical coherence, (2) relevance and sufficiency of incorporated BCTs, (3) person centredness, with participants valued as equal partners to ensure the intervention meets their needs, (4) whether the intervention would engage stroke survivors and walking buddies.

Phase 3: intervention refinement

Step 3a Refining the intervention

Researchers summarised and collated findings and feedback from preceding phases to decide how to refine the intervention. Feedback and decisions were tabulated to illustrate the steps and decisions in deriving the intervention.

Step 3b Review by PPI group

The PPI group members reviewed the intervention structure and all intervention materials for relevance, appropriateness and ease of reading. Responses informed final intervention refinement prior to piloting.

RESULTS

Phase 1: intervention development methods

Step 1a Evaluating existing evidence

Collated findings of our updated review are presented in (table 1). Barriers to PA after stroke included negative emotional responses to PA, such as embarrassment and fear, believing PA was not helpful, limited knowledge about appropriate PA, perceptions of limited capability due to stroke, cognitive and communication impairments, low mood and confidence, and low recovery expectations. Facilitators included enjoyment, previous success in PA, and social support.

Step 1b Evidence mapping/behavioural diagnosis and defining intervention components and delivery in practice

We mapped the qualitative review findings to the COM-B and TDF (table 2). Of nine intervention functions, five were appropriate for We Walk: education, persuasion, training, modelling, and enablement (table 2). We next identified BCTs relevant to intervention functions from Michie *et al*'s taxonomy of BCTs²⁸ (table 2).

Using the HAPA, we developed a structure for intervention delivery that included discussion with the dyad of benefits of walking, exploration of how the dyad would work together, identifying and setting meaningful walking goals, monitoring progress, and undertaking coping planning, reviewing goals and problem solving. Person-centred principles appropriate for We Walk underpinned the intervention structure (box 1).

Deciding form of delivery

To avoid burdening rehabilitation services, we initially intended We Walk be delivered via a self-directed workbook. Rehabilitation professionals would provide initial instruction, followed by one follow-up telephone contact. However, in development, we recognised participants would need in-person support and time to engage with complex intervention components. Additionally, maintaining positive, person-centred written language within workbooks while explaining barriers and problem-solving strategies, conveying dyadic planning, and buddy support was challenging and undermined person-centred tailoring. We determined the intervention should be delivered through face-to-face (n=3 sessions) and telephone facilitation (n=3 sessions) with short handbooks to explain intervention components and dyad members' roles. Incorporating all components would require at least 12 weeks. We developed a draft facilitator manual explaining intervention component delivery and BCTs to be used at each contact.

Phase 2: stakeholder consultation and intervention refinement

Stakeholder views on intervention content, delivery format are reported below. The findings enabled us to adapt and refine We Walk in response to their views.

Participants

Participants were 23 community-dwelling, ambulatory PWS (6 female, 17 male, aged between 50 and 83 years,

Table 1 Description of summarised barriers and facilitators to physical activity after stroke

Barriers and facilitators	Summarised themes from qualitative studies and reviews
Emotional responses to PA	Negative emotional responses to PA rose from perceptions of negative consequences of engaging in PA. Fear of falling, of subsequent stroke, pain and other harms were emotional responses causing anxiety and creating barriers to PA. Unsuccessful attempts at PA could lead to frustration because desired goals could not be achieved, leading to lowered perceptions of competence. Embarrassment arose from survivors' perceptions of how others judged competence for PA and was heightened by perceptions of physical capability, reinforcing fears of facing others when engaging in PA. ^{12-14 41-47}
Knowledge about appropriate PA	Limited knowledge of appropriate PA and beliefs that exercise after stroke might be harmful was a barrier, often arising from lack of knowledge about appropriate PA and community services to support it. Many survivors desired instruction in PA from health professionals however the focus on basic functional activities in rehabilitation meant there was little emphasis on PA. Advice from health professionals and family about risk avoidance often enhanced survivors' fears about negative consequences. ^{14 26 29 44 47-49}
Beliefs about PA	Beliefs in benefits of PA for recovery, mood, general health and relief of boredom increased willingness to participate, in contrast to beliefs that PA was not helpful, or detrimental. Previously active PWS tended to express positive beliefs about benefits and generate determination for PA participation despite perceived and actual disabilities as a mechanism for returning to valued life activities. Those with limited experience of PA considered it had lower value and was not easily incorporated into everyday life. Age influenced PA beliefs, with some older survivors believing that exercise was not appropriate for the elderly. ^{12-14 26 41 44 46 49}
Perceptions of physical capability	Physical effects of stroke, including poor balance, fatigue, and lack of energy and fitness, limited what stroke survivors perceived they could achieve, sometimes leading to feelings of physical incompetence and lack of control. These feelings were also influenced by perceived failure to achieve anticipated improvement despite PA participation. Comorbidities contributed to limitations in physical capability. ^{12-14 26 41-43 45-48}
Communication	Aphasia could lead to difficulty participating in organised activities because PWS felt embarrassment when others had limited knowledge about how to modify their communication to meet the needs of the PWS. Patience, clear instructions and use of demonstration and gesture from instructors were helpful. ^{12 45}
Cognitive capabilities	Poor memory and cognitive impairments could cause problems with outdoor orientation and following and remembering instructions, sometimes leading to anger and frustration when attempts at PA were unsuccessful. The cognitive overload of participating in physical activities with others was also a barrier to participation. ^{12 44 46 47 49}
Mood	Low mood and depression led to loss of hope for recovery and negatively affected motivation to be active, while participation in PA could improve mood and experience of depression. ^{12 13 42 48}
Self-efficacy	Self-efficacy for PA was linked to feelings of competence linked to perceptions of physical capabilities, and previous experiences of PA. Previous PA enhanced post-stroke participation in PA but the impact of stroke diminished self-efficacy for PA, negatively influencing motivation; however, this could be ameliorated by support from professionals or other survivors. Where people successfully engaged in PA, confidence and motivation were enhanced. ^{13 14 26 42 46 48}
Expectations for recovery	Where expectations for recovery were low, engagement in activity was less likely and disability was accepted as unmodifiable. In this situation, basic physical functioning was the main goal. Where expectation and focus was on return to pre-stroke condition and life roles, PA was seen as a route towards fulfilling expectations, despite uncertainty about whether that was possible. These expectations led to determination and heightened likelihood of engaging in PA. PA was thus empowering, providing sense of control over restoring pre-stroke identity. ^{12-14 26 41 44 47 49}
Motivation	Motivation to be active was linked to perceptions of capability to be active and self-efficacy. Desire to be active, successful PA participation and enjoyment were important influences on motivation. Survivors who self-reported being not interested, sometimes linked to fatigue and lack of energy professed lower motivation. Being active before or after stroke, increased motivation through experience of physical and psychological benefits and enjoyment. ^{12 13 44 46 47 49}
Environmental factors	Desire to be outside was an important facilitator to activity, however multiple environmental barriers were identified across the studies including weather, transport, accessibility to places to be active, cost of transport and access to facilities, neighbourhood factors including safety, pavement and road conditions, steps and stairs, crowds. These factors could lead to vulnerability that acted as a barrier. Planning to overcome environmental barriers was vital where survivors had determination to be active. ^{12 13 26 41-44 46-49}
Social influences	Social support from family, friends was often vital to PA participation. When family were supportive in facilitating activity, this was beneficial; however, fears of family about falls or beliefs about survivors limited physical or cognitive competence meant they could be overprotective, acting as a barrier to activity because of safety concerns. Overly protective safety concerns from health professionals about risks rather than benefits of PA could also act as a barrier, however supportive professionals were often facilitatory. Survivors' beliefs about being a burden to others also limited the support they sought. In contrast, shared experiences of other stroke survivors were key influences on PA by providing models for recovery and offering a vision of hope. ^{13 14 26 41 42 44 46-49}
Strategies to support PA	Strategies for uptake and maintenance included setting goals and action plans, preparing to be active by laying out clothes and planning routes, and treating PA as a task requiring routine. Beliefs in ability to cope when plans were not enacted and having coping strategies were facilitators. Monitoring progress and goal achievement reinforced participation and with regular routines, supported maintenance. ^{12 13 26 41 43 44 46 47}

and between 3 months and 24 years post stroke). PWS were from a range of sociodemographic backgrounds, with Scottish Index of Multiple Deprivation Index

scores ranging between 1 (most deprived) and 10 (least deprived),³³ and across urban and rural settings. All were ambulatory, and 15 participated in regular exercise or

Table 2 Intervention functions and behaviour change techniques

COM-B	TDF	What needs to happen for behaviour to occur	What needs to be addressed by the intervention (based on evidence)	Intervention functions	Key BCTs identified for inclusion
Capability Physical	Physical skills	People with stroke (PWS) need to be physically capable of walking outside	<ul style="list-style-type: none"> ▶ Physical capability of PWS will vary ▶ Dyads will need reassurance that recommended walking will match physical capability 	Education	4.1. Instruction on how to perform the behaviour 9.1. Credible source
Capability Psychological	Knowledge	PWS need to know how to walk outside and what counts as walking	<ul style="list-style-type: none"> ▶ Lack of knowledge about the benefits of walking after stroke ▶ Uncertainty about how much is appropriate for age and disability ▶ Some PWS may want professional guidance 	Education Persuasion Training Modelling	3.1. Social support (unspecified) 4.1. Instruction on how to perform the behaviour 5.1. Information about health consequences 9.1. Credible source
	Cognitive and interpersonal skills	PWS need to have the cognitive and interpersonal skills to walk outside	<p>Cognitive: Tailor delivery, dyadic support and written materials to account for impaired cognitive skills:</p> <ul style="list-style-type: none"> ▶ Cognitive impairments ▶ Orientation problems when walking outdoors ▶ Loss of confidence in outdoor walking ▶ Low self-esteem caused by post-stroke disabilities <p>Interpersonal: Tailor delivery, dyadic support and written materials to account for:</p> <ul style="list-style-type: none"> ▶ Impaired communication skills/aphasia ▶ Provision of support to overcome communication barriers to walking outdoors ▶ Different dyadic relationships (buddies as volunteers, spouses, other PWS) 	Education Persuasion Training Modelling	3.1. Social support (unspecified) 4.1. Instruction on how to perform the behaviour 8.1. Behavioural practice/rehearsal
	Memory, attention and decision processes	PWS need to remember to walk and take up opportunities for walking	<ul style="list-style-type: none"> ▶ Cognitive impairment causing problems in remembering to walk and deciding where and when to walk ▶ Decisions to change sedentary lifestyle pre-stroke and to walk more 	Education Persuasion Training Modelling	3.1. Social support (unspecified) 4.1. Instruction on how to perform the behaviour 4.2. Information about antecedents 7.1. Prompts/cues 8.1. Behavioural practice/rehearsal
	Behaviour regulation	PWS need to be able to integrate walking into their daily life, and plan and monitor their walking behaviour	<ul style="list-style-type: none"> ▶ Tailoring to account for cognitive impairment ▶ Sedentary lifestyle pre-stroke ▶ Cognitive impairment 	Education Modelling	1.1. Goal setting (behaviour) 1.4. Action planning 1.5. Review behaviour goal(s) 7.1. Prompts/cues 8.1. Behavioural practice/rehearsal 1.7. Review outcome goal(s)
Opportunity Social	Social influences	PWS need a supportive social environment: family, friends and health professionals	<ul style="list-style-type: none"> ▶ Social support is central to the intervention ▶ Selection of appropriate walking buddies ▶ Walking buddies may need guidance and training in working in a dyad with the PWS 	Persuasion Modelling	3.1. Social support (unspecified) 12.2. Restructuring the social environment
Opportunity Physical	Environmental context and resources	PWS need to have the environmental conditions to be able to walk outside	<ul style="list-style-type: none"> ▶ Plan times for walking that suit the PWS and buddy ▶ Plan safe and enjoyable routes ▶ Find alternatives in bad weather. 	Education Enablement	3.1. Social support (unspecified) 4.1. Instruction on how to perform the behaviour 7.1. Prompts/cues

Continued

Table 2 Continued

COM-B	TDF	What needs to happen for behaviour to occur	What needs to be addressed by the intervention (based on evidence)	Intervention functions	Key BCTs identified for inclusion
Motivation Reflective	Beliefs about capabilities	Stroke survivors need to be confident in their ability to walk outside	<ul style="list-style-type: none"> ▶ Lack of confidence ▶ Low expectation for recovery ▶ PWS may not want social support ▶ Buddies beliefs about the PWS' capability may differ 	Persuasion Modelling	3.1. Social support (unspecified) 15.1. Verbal persuasion about capability 15.3. Focus on past success
	Beliefs about consequences	PWS need to have: positive beliefs and few negative beliefs about consequences	<ul style="list-style-type: none"> ▶ Negative beliefs about the consequences of being active ▶ Lack of knowledge about successful outcomes. 	Education	5.1. Information about health consequences 5.2. Saliency of consequences
	Social/professional role and identity	PWS need to see walking as part of their social engagements and their identity	<ul style="list-style-type: none"> ▶ PWS may not see walking as part of their 'sick role' or ▶ Walking can be perceived as essential for PWS who want to be independent, regain pre-stroke identity, be in control and re-establish social contacts and status. 	Persuasion	13.1. Identification of self as role model 13.5. Identity associated with changed behaviour
	Optimism	PWS need to be optimistic about the future	<ul style="list-style-type: none"> ▶ Low expectation for recovery ▶ Depression and low mood 	Persuasion	3.1. Social support (unspecified) 15.3. Focus on past success
	Intentions	Stroke survivors need to want to change their walking behaviour	<ul style="list-style-type: none"> ▶ PWS who are eligible for We Walk have recovered sufficiently to walk outside, so would have some intention to engage in walking. 	Persuasion Modelling	1.9. Commitment 3.1. Social support (unspecified) 6.1. Demonstration of the behaviour 9.3. Comparative imagining of future outcomes
	Goals	PWS need to have a vision of what they want to achieve by walking	<ul style="list-style-type: none"> ▶ Goals and action plans should be negotiated with the dyad to ensure they are realistic and acceptable to both ▶ Goals should also be monitored for progress and reviewed and updated 	Education Enablement Training Persuasion Modelling	1.1. Goal setting (behaviour) 1.3. Goal setting (outcome) 1.7. Review outcome goal(s)
Motivation Automatic	Reinforcement	PWS need to have positive associations with walking behaviour	<ul style="list-style-type: none"> ▶ PWS identified many benefits of taking part in physical activity (physical, social, psychological). 	Education Persuasion Modelling	3.1. Social support (unspecified) 7.1. Prompts/cues
	Emotion	PWS need to be aware of emotional responses to walking and use them constructively	<ul style="list-style-type: none"> ▶ Fear of falling, causing harm or further stroke ▶ Reduced risk of stroke and other harms ▶ PWS and buddies may have different emotional responses to walking outdoors together. 	Persuasion Modelling	1.2. Problem solving 3.3. Social support (emotional) 11.2. Reduce negative emotions

Box 1 Person-centred principles applied to we walk

1. Account for what the person values about his/her life and how he/she makes sense of what is happening from their perspective, psychosocial context and social role.
2. Facilitate involvement in decision-making by the person and their buddy by considering values, experiences, concerns and future aspirations.
3. Be underpinned by knowledge of the person, their beliefs and values and their experience
4. Recognise the uniqueness of the individual, and maximise personally relevant resources through recognition of important agendas in their life
5. Pay attention to the whole person

walking as PA. PWS brought 14 companions (13 female, 1 male). Thirty-seven rehabilitation, health and exercise professionals participated (22 physiotherapists, 8 occupational therapists, 5 stroke nurses, and 2 local exercise services coordinators). The 12 FGs each involved between 6 and 8 participants.

FG findings

FG findings relating to each intervention component are presented below, supported by illustrative quotes.

Walking

Most PWS emphasised enjoyment, social and health benefits of walking after stroke, but acknowledged developing confidence and skills could be slow. Finding personally relevant solutions to challenges and developing

determination, resilience and motivation to persist, when fatigued or unmotivated, in inclement weather and difficult terrain was challenging but essential because persistence in walking more led to increased confidence and well-being.

the biggest thing is trying to tell people to have motivation to do, to get them self better... it's self-motivation, I think that's the secret. (FG4 Male PWS1)

Before the stroke I didn't believe I would enjoy walking, but I enjoy walking now and get cabin fever if I hadn't had a walk... (FG4 Male PWS 2)

Walking goals

In line with person-centredness principles, PWS agreed with our premise that walking goals should be personally meaningful but achievable while challenging enough to push them to progress.

There's my goal there in front of me, that's what I'm going to try an achieve rather than saying, 'Oh, wait a minute, I've got to do ten thousand steps today.' Well, if you don't do your ten thousand steps you can get disheartened. But then, if there is a goal in front of you if you choose your goal each day... Aye, it becomes a whole different entity then... (FG1 Male PWS 1)

Form of delivery

PWS considered written material impersonal, reflecting our concerns about We Walk delivery using a self-directed handbook. Many PWS were overwhelmed by post-stroke paperwork, preferring tailored face-to-face delivery that addressed their heterogeneity (eg, mobility, balance, ability of the buddy to provide support, and the type of relationship between the two).

I think it should be face to face. After a stroke they give you piles of paperwork...You don't read it. Everybody that has had a stroke, their needs are different. Anything you put in black and white isn't gonnae suit everyone... (FG 1 Male PWS 2)

The dyad: buddy selection

The term 'Walking Buddy' was considered appropriate for the walking companion. Participants preferred to select buddies, but developing a relationship with a new buddy was also considered possible. Shared interests and time to develop trust were critical. Buddies would require knowledge of stroke and its impact and be knowledgeable and sensitive to PWS's experiences of stroke and physical capabilities. Other PWS could be ideal buddies because of their shared experience.

I've got a skill set now I didn't have before that people could tap into. ... if somebody has shared interests then you can do things together quite easily and talk when you're doing it. (FG6 Male PWS 1)

Dyadic goal setting and planning

Many participants thought walking buddies could motivate PWS through external accountability; however, adapting to fluctuations in fatigue and how PWS felt was critical. Relational aspects of dyads were considered easier when the buddies were known to PWS, but only if their autonomy in decision-making and goal-setting was respected. Aligned to the goal-setting framework we had identified, participants were clear that walking goals for PWS would be the intervention target, with PWS and buddies working together to pursue them

And then if you've got something to motivate you to move, once you get out of bed daily, that helps. Because if you get into a routine of doing stuff then that makes it much easier whereas if you do it weekly, I'd say if you've got a helper who comes... male stroke survivor in (FG 5, Male stroke survivor)

Every time we went out a walk, my wife grabbed my arm and it's stifling me, stopping me moving...the person you're going out with walking, has got to realise, you've got to let them do their own thing (FG 1 PWS Male Stroke survivor 2)

Health professionals, PWS, and companions suggested buddies needed tailored guidance about the role. Overburdening buddies was a concern expressed by health-care staff in particular, where buddies were the primary carer.

... whatever sense of partnership they're going to commit to you know helping this person on their journey towards recovery. So it's important the facilitator has that conversation with both of them (FG4 PWS Female Companion 2).

I think a lot of the patients will use the word burden, they don't want to put more onto the families and things, they're maybe already doing part of the caring role so, it does get really complicated. (FG2 HCP Female Physiotherapist 1)

Self-monitoring

Monitoring walking was seen as important for motivation. Many PWS already monitored walking, including places walked to, steps per day, time spent walking, and distance covered. Some used wearable fitness trackers and mobile phones, but physical capability to apply them, experience and attitudes to technology and cognitive capability to use data to influence behaviour determined preference use and utility. PWS and buddies viewed pedometers as potentially useful.

'Well if this suits you, use this, if you prefer pedometers you could use that, if you prefer Fitbit you can use that'. So you give flexibility, people can pick and choose what they think works best for them. (FG3 PWS Female companion 1)

Most PWS viewed recording and reflecting on progress in achieving walking goals as motivational, and would

complete diaries. However, for some, physical and mental effort involved seemed overwhelming. Diary format had to be short and simple, with some preferring electronic diaries.

Just by writing it down, it would be visible to see for those that like doing a diary... Write it in the diary 'cause you don't always see progress. (FG4 Female Companion 2)

So, I don't need to mark that down because I know I'm capable of doing that and I'm not lying in the chair done in. But it's not for everybody. (FG1 Male PWS 3)

Intervention timing

We intended to deliver We Walk as community rehabilitation was ending. However, most PWS said adjusting to post-stroke life took time, and they may not be ready for We Walk immediately. Instead, they wanted information about We Walk during rehabilitation and to decide when participation was appropriate for them.

We've seen people at the self-management course, 'Oh, I had my stroke nine weeks ago.' And it's really too early for them to take it in... the stroke nurse or the OT people, they're the ones that should say, 'Why don't you try that, have you ever thought about that?' (FG2, PWS Male Stroke Survivor 4)

Facilitator role

We intended, and pre-project discussions had suggested, that rehabilitation professionals would facilitate intervention delivery, given their role in facilitating transitions between rehabilitation and active lifestyles in the community. While they viewed PA promotion as providing continuity with rehabilitation, many considered intervention delivery over 12 weeks unfeasible within community rehabilitation, which was typically shorter. Although supportive in principle, time-limited service delivery protocols left little flexibility for intervention delivery.

The amount of time you can give them when someone's achieving outdoor mobility in the community, you almost have to discharge at that stage. You know you can't follow them on weeks after weeks as we're not really covered. (FG5 HCP, Female Physiotherapist)

Delivery through professional or volunteer facilitators within stroke charities or other community organisations was viewed as more feasible, given that charities already provide some supportive services. Healthcare professionals proposed that they could be involved in training and supporting those facilitators and in facilitating links between rehabilitation and third sector organisations delivering We Walk.

So I think there's erm, we have to look at third sector and, and council exercise providers... You know a charity based person, you know all the professionals could feed into a training session that's run by somebody

that has been upskilled by whoever. You know from the charity. (FG5 HCP, Male Physiotherapist)

The person-centred approach

Throughout intervention development, we sought consistency with person-centred principles. Congruently, PWS and their companions viewed themselves as people not defined by their stroke. Data showed they considered good communication, shared decision-making, respect for their values, capabilities, and desired achievements would be crucial to the intervention's success and dyadic working.

I think it's about the relationship between you and your buddy and it's that listening thing so you both know what each other are thinking... If you don't listen to somebody, truly listen to them, then you'll never get anywhere. (FG2 PWS, Female stroke survivor)

Overall usefulness of we walk

PWS were positive about the concept of We Walk because they saw outdoor walking as a fundamental skill that met their desire to prevent further stroke and improve health. Walking was an enjoyable activity that could be sociable because it enabled the community participation valued by PWS. Confidence for walking could be improved through small successes that incrementally enhanced confidence and improved walking and recovery over time, and We Walk could support that process.

What I found helpful was identifying and believing in the benefits of walking. When I had the fall two years ago, I had to start walking again outside. Walking on the road, the bumps on the road, getting the confidence to get up there and back down again... (FG2, male stroke survivor)

You can do it once, but you have to keep it going to get your brain working and things like that... the more you do it, the easier it gets. (FG2, male stroke survivor)

In summary, participants agreed We Walk could support PWS to meet their desire to participate in regular outdoor walking. An individually tailored, person-centred approach was vital to engagement and making the intervention meaningful irrespective of physical capabilities. Personal selection of walking buddies sensitive to needs of PWS was another key finding. Face-to-face facilitation at the right time for PWS; clarity of the buddy's role and the dyadic relationship, person-centred tailoring, and delivery outside health service care pathways were considerations for intervention refinement.

Step 2b Theoretical coherence of the intervention: review by experts in behaviour change intervention development

Feedback from experts is described in detail in [table 3](#). Key suggestions were: a reduction of content in session 1 by reorganising BCTs across sessions 1 and 2, ensuring walking buddies understood their role through

Table 3 Summary of feedback and decisions made to refine the intervention

Intervention element	Study phases	Topic	Feedback	Details of decisions made
Intervention (feedback from researchers and stakeholder consultations)	1a,b), 2a)	Acceptability of We Walk as a concept	Walking seen as enjoyable, accessible, sociable, a fundamental skill that can improve health.	Provide guideline evidence of benefits, emphasise tailoring to preferences and capabilities
	1c), 2a)	Intervention Duration	Participants needed time to work through components of the intervention	Intervention duration needs to be 12 weeks
	2a)	Acceptability of dyadic intervention	Concept of walking buddy acceptable to person/people with stroke (PWS) and families. Buddy qualities and relationship with PWS seen as crucial to acceptability and success.	Buddies to be invited by PWS where possible. Where buddies are volunteers or not someone the PWS knows, careful introduction and relationship building is required. Someone with shared interests would be preferred. Strategy for ensuring good match is vital. Study materials to emphasise expectations of buddy role
	1a) 2a)	Dyadic working: name of walking partner	Buddy, peer and partner considered, buddy equitable and neutral, supportive and friendly	The term buddy selected and used in study materials
	1c, 2a)	Dyadic working	Need to ensure engagement of both dyad members in the intervention, as equal partners, for the dyad to work	Engage the buddy as much as the PWS, and ensure they are clear about the role they are expected to play in the intervention. Have two handbooks, written specifically for each member of the dyad, explaining their roles
	1c), 2a)	Dyadic working	Need to define dyadic goal pursuit permutation	Flexible suggestions for person-centred goal-setting incorporated into stroke survivor and buddy handbooks. Places, distance, step goals, can be targets to achieve, while bearing national and international public health guidelines in mind
	2a)	Framing walking Goals	PWS emphasised need to be personalised to individual desires and tailored to their capabilities	PWS's walking is the goal, stroke survivor and buddy together pursuing that Goal; reflect shared pursuit in materials
	2a)	Self-monitoring progress towards goals	Monitoring walking helped review progress and enhance motivation. Pedometers acceptable but did not work for all. Other strategies suggested	Pedometers to measure progress in We Walk, offered to buddies and PWS. Measuring distance walked or places walked, step-count using fitness tracker, smart watch or pedometer, or time walked all acceptable.
	2a)	Self-Monitoring progress towards goals	Diary seen as useful for planning, motivation, and reflection. Writing difficult for some, effort too much	Diary to prompt weekly goal setting and dyadic planning to achieve goal, prompt reflection on progress and next steps were provided. Simple diary developed as progress log. Alternative formats, photo, voice recording, electronic also available
Form of delivery (feedback from researchers during intervention development and PWS)	1c, 2a)	Form of delivery	Delivery intended as brief introduction by HCP then self-directed by dyad using handbook. Difficult to maintain positive person-centred language in handbook when discussing challenges. Necessary content too much to incorporate in handbook. PWS and carers preferred face to face and would engage better.	Mixture of face-to-face delivery (two sessions) and telephone contacts (three) with accompanying handbook for buddy and PWS. Detailed manual for intervention delivery by facilitator, describing the purpose of each contact, intervention components covered, and the BCTs that are incorporated was developed.
	1c, 2a)	Form of delivery	Ensure person centredness is central to the intervention, ensure language and tone feels right to PWS Intervention delivery framework reflects person-centred approach	Review language used in intervention materials to ensure intervention is not directive, but takes account of uniqueness and values of participants, provide dyad with autonomy in making decisions that are right for them. Materials reviewed by PPI group to ensure acceptability and ease of use.
Intervention element	Study phases	Topic	Feedback	Details of decisions made
Intervention Delivery Context (feedback from PWS and healthcare professional consultations)	2a)	Intervention delivery	Although healthcare professionals saw the intervention as important and filling a gap in stroke services, they reported operating within time limited service delivery protocols, with little flexibility over current work commitments. Practitioners were therefore unclear about how they could manage to fit delivery of a 12-week intervention into their normal working practice within services as they stand.	Intervention could not be delivered within NHS services Researcher to deliver intervention within pilot study (reported elsewhere) but voluntary agencies to be employed for scaling-up. Feasibility of delivery by voluntary agencies will have to be explored for scale-up to randomised controlled trial, and future implementation
	2a)	Timing for participation in the intervention	Because it was person centred, PWS considered the intervention could be relevant at any point during post-stroke recovery	Consider timing from perspective of participants and fit with where PWS are within NHS pathways and end of rehabilitation

Continued

Table 3 Continued

Intervention element	Study phases	Topic	Feedback	Details of decisions made
Theoretical coherence of the intervention (assessed by experts in behaviour change)	2b)	Intervention content (BCTs) and theoretical coherence of the intervention	Address needs of walking buddy and discuss how they can be an effective buddy	Buddy role explained in buddy handbook, with discussion at recruitment and at every contact about role and any perceived burden of the role. Relational issues will determine buddy interactions. Need to understand these more fully before upscaling to a trial. Explore within pilot study
	2b)	Intervention content (BCTs) and theoretical coherence of the intervention	Habit formation should be emphasised more by discussing maintenance early	BCT 7.2 Prompt/cues and 12.2. Restructuring the social environment elevated to core BCTs at the goal setting session. Importance of routine, and doing what they enjoyed emphasised, so that it becomes part of daily routine. Maintenance discussed early in the intervention
	2b)	Intervention content (BCTs) and theoretical coherence of the intervention	Considered theoretically coherent. Too many BCTs/Should include more	Originally selected BCTs according to our mapping seen as relevant, but not all core. Identified core BCTs with remaining. BCTs used to tailor the intervention as relevant. It was decided not to include more BCTs as suggested by one reviewer. Review BCT use during pilot, determine need for additional BCTs
	2b)	Intervention content (BCTs) and theoretical coherence of the intervention	Clarify how feedback on diaries would be provided	Covered by BCTs 2.2. Feedback on behaviour and 2.7. Feedback on outcome(s) of behaviour in the sessions. Intended to use diaries for feedback. Participants asked to return diaries/send photograph of pages to use in reflective discussion. Diary feedback an essential intervention component. Implications for participants of return of diary to facilitator
Materials (feedback from PPI group)	2c)	Acceptability of handbooks to PWS and potential buddies	Study materials, the pictures had no-one with a walking stick	Reviewed materials and changed photographs to represent stroke more accurately. Photographs of younger people and different ethnic groups were included
	2c)	Acceptability of handbooks to PWS and potential buddies	Text in the handbooks should be shorter, benefits of walking more should be foregrounded early in the workbook, with quotes from other PWS. Importance of planning walks to keep things interesting and to ensure there are resting spots if required. Having a mobile phone in case of falls was also important.	Reviewed materials, benefits highlighted, shortened text, added quotes, emphasised importance of planning the walk

explanation within the buddy handbook and in sessions 1 and 2; discussing habit formation throughout the intervention, and clarifying how the facilitator would provide feedback through review of diary entries. Findings were incorporated into the intervention, as described in phase 3a, below.

Phase 3: Intervention refinement

Step 3a Refining the intervention

Details of feedback obtained in phase 2, decisions made in response to findings and their implications are described in [table 3](#).

Overall stakeholders viewed We Walk as relevant and coherent, but some key changes were required. Change in delivery form from workbooks to two facilitated face-to-face and three telephone contacts over 12 weeks, guided by a detailed delivery manual, with short handbooks for PWS and buddies would facilitate personally tailored intervention delivery. The timescale would enable dyads to engage with We Walk and develop personally relevant walking goals and plans, give time to change behaviour and establish PA patterns that could be maintained in the long term.

PWS viewed the relationship with a compatible buddy as crucial. Ensuring dyadic compatibility and clarity about

roles and expectations was vital, but must be without obligation if PWS felt the arrangement would not work. The buddy role required clear explanation by the facilitator. Buddy handbooks and intervention delivery manual would emphasise respect for goals and desire for autonomy of PWS, while demonstrating sensitivity to fluctuating capabilities. PWS emphasised the need to tailor the intervention to account for fatigue, which is a major problem for many PWS.¹¹ BCTs for problem-solving and coping planning were included to support the PWS in pacing to manage fatigue and maintain motivation. Weekly review of progress would enable participants to reflect on progress and to adjust goals to account for fluctuations in how they felt. Buddies needed to support the PWS to adapt to fluctuating fatigue and emotional states, and their role will be emphasised in the buddy handbook and throughout face-to-face intervention sessions with the facilitator.

Self-monitoring and diary completion needed to be pragmatic, reflecting our person-centred philosophy. Participants, including buddies, would receive pedometers; but could use preferred monitoring methods (phone, wearable fitness tracker, distance, time). Completing simple written or electronic diaries would facilitate

reflection on progress, informing dyadic planning and weekly goal-setting. Diary entries would be reviewed in face-to-face sessions with facilitators and returned by post or electronically for discussion in telephone consultations, prompting reflection.

Phase 1 and phase 2 data showed that a facilitator should deliver the intervention, explaining and discussing dyadic working, the role of the buddy and delivering BCTs according to the delivery manual. In subsequent piloting, this would have to be a researcher facilitator, who would collect detailed fieldwork data to better understand the facilitator role, dyadic dynamics and determine how to meet the needs of PWS, enabling refinement of the delivery manual for later implementation. For testing in a trial and future implementation, our data showed health-care professionals would not have resources to act as facilitators to deliver We Walk, suggesting external facilitators, such as those from third sector organisations, could support delivery. Future piloting will therefore establish training required for third sector facilitators; how they can support dyadic planning, and resource implications for the third sector (time, travel, training). Undertaking these steps will pave the way for delivery by third sector organisations.

The review of included BCTs indicated not all BCTs were core; therefore, we determined core BCTs with remaining

BCTs used selectively to tailor the intervention. Finally, we developed a logic model to illustrate pathways between proposed intervention inputs, core BCTs, processes and outcomes for behaviour change (figure 2).

Step 3b Review by PPI group

Intervention materials were reviewed by our PPI group, comprising four male PWS and their female companions. They suggested simplifying text, foregrounding benefits of walking early in the intervention, and including relevant images of PWS, including those who use walking sticks, into written materials. (table 3). The materials will be used in the subsequent piloting phase of the study, to be reported elsewhere.

DISCUSSION

We integrated review evidence, theoretical constructs, and person-centred principles with qualitative data from FGs to develop a theory-informed dyadic behaviour change intervention to promote outdoor walking after stroke. Stakeholder views guided refinement of content, form of delivery and dyadic working and highlighted the importance of person-centredness to PWS and their companions.

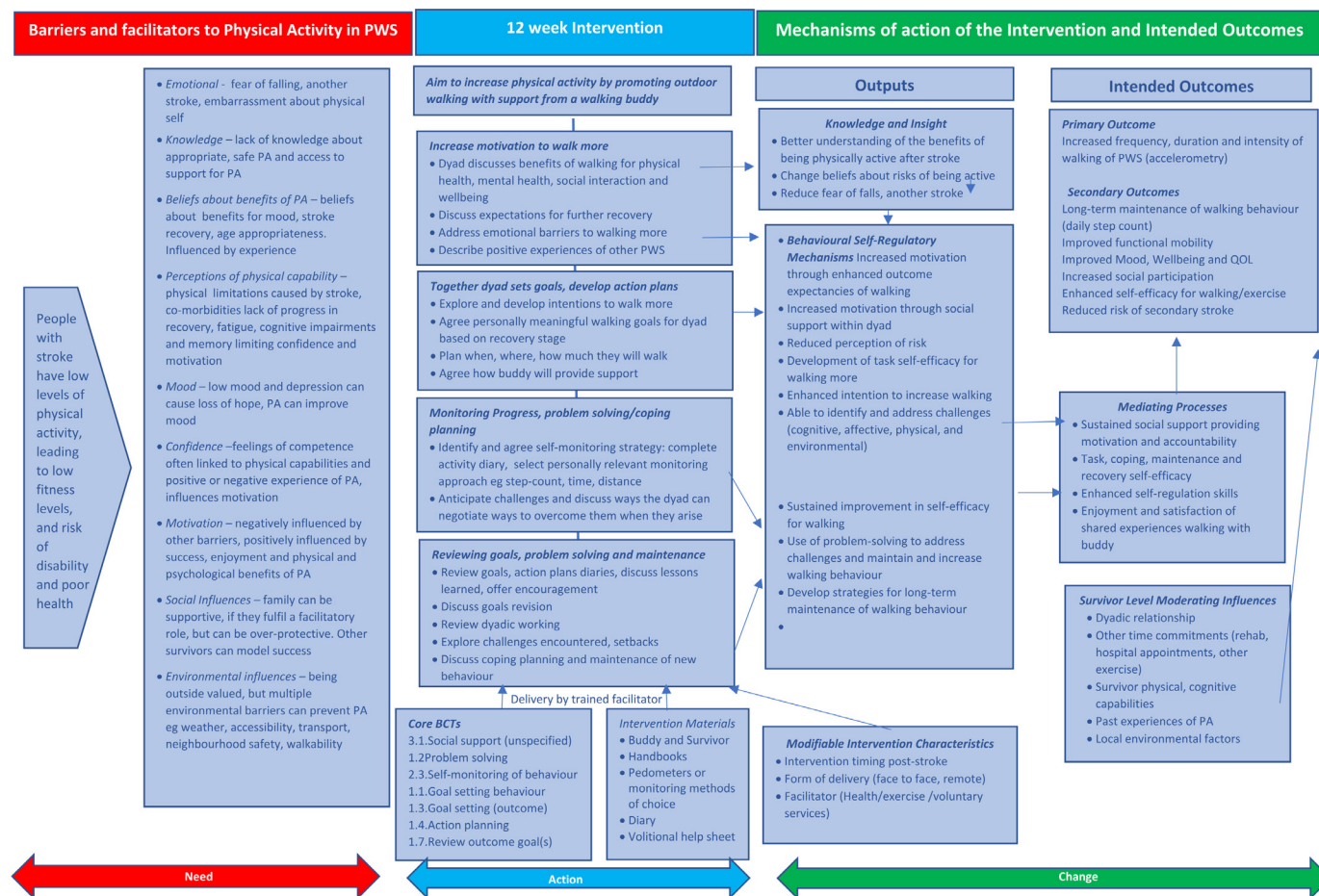


Figure 2 We Walk logic model. PWS, people with stroke; PA, physical activity.

To our knowledge, this is the first dyadic intervention for PA promotion after stroke. We combined evidence, theory, person-centred principles and stakeholder perspectives to ensure the intervention was adaptable to the varied contexts, experiences and values of PWS. This integrated approach was, to our knowledge, novel in intervention development for stroke. Our approach aligns with other studies of people with disabilities, in recognising individualised tailoring as vital for promoting PA participation.^{17 34}

The BCW, specifically COM-B and TDF^{28 35 36} guided behavioural diagnosis, specifying intervention functions and BCTs. Using HAPA²⁹ to structure We Walk enabled development of the intervention structure to support shifts from motivation to enact and maintain walking. It supported careful selection of relevant BCTs identified by behavioural diagnosis, a challenge noted by other researchers.³⁷ We combined selected BCTs in a logical, staged sequence to enhance walking behaviour.

FG participants were mainly male with female companions therefore findings may not apply to all stroke survivors. Many PWS were also physically active; therefore, their views may not reflect those of less active survivors. Nonetheless, their challenges and successes in maintaining motivation and developing self-efficacy shaped the intervention. Despite functional and ambulatory capability, many PWS remain inactive for up to 81% of the day.¹¹ To address the capacity/behaviour gap, we developed a person-centred approach to intervention development. The dyadic person-centred intervention approach intends to support PWS in developing motivation and increasing outdoor walking by identifying personally meaningful goals, person-centred action planning, problem-solving, monitoring, and reflection on their progress. The person-centred approach means We Walk has potential to provide support for behaviour change to ambulatory PWS irrespective of their levels of disability. Nonetheless, further research, including empirical piloting and feasibility studies, will be necessary to enable us to identify stroke sub-populations with whom the intervention is most likely to be effective before undertaking a definitive randomised controlled trial.

We concluded in section 3a) the likely scenario for delivery by third sector organisations. A study limitation was not including a range of third-sector stakeholders to explore how they could support delivery. Our initial intention was that healthcare professionals would deliver We Walk. They indicated the 12-week duration of the intervention would not fit well with timescales in community rehabilitation and that third-sector delivery would be more appropriate. Development of the facilitator role and exploration of how third sector organisations can deliver the intervention will be the subject of future piloting work.

PWS supported the partner-oriented goal-pursuit we identified through the Transactive Goals Dynamics Framework.³¹ A meta-analysis of randomised controlled trials of dyadic interventions for PA supported this approach,²¹ showing dyadic interventions targeting goals of one dyad

member had larger effect sizes for PA compared with those targeting shared goals. Findings reflect our data indicating PWS would like the dyad to focus on their walking goals. PWS also emphasised relational aspects of the dyad, specifying sensitivity and adaptability as desired walking buddy characteristics. Reflecting our findings, the meta-analysis of dyadic interventions found type of dyad (spousal, friend/peer) can influence PA.²¹ Peer-friend dyads exerted larger effects than other dyad types, with authors suggesting responsiveness to each others' goals within close relationships may best facilitate goal achievement. Our qualitative data suggested spousal interactions could positively or negatively influence dyadic working. Perceptions of pressure or control by spouses may not always support PA in a dyadic intervention. Other PWS suggested family involvement was central to the dyad because family supported their management of recovery. These positive and less positive relational nuances on dyadic working align with a qualitative study of dyadic support for PA people with osteoarthritis.³⁸ The studies highlight relational aspects of dyadic interventions, indicating careful training of facilitators in supporting dyads is vital.

We found no other studies of dyadic interventions promoting community walking after stroke. However, a qualitative evaluation of a dyadic intervention to promote participation in Tai-Chi with people with dementia³⁹ also highlighted the necessity of clarifying the buddy's role and the important role of the instructor/facilitator. Congruent with our intervention, the study emphasised action and coping planning for developing self-efficacy in both dyad members.

Development and feasibility studies of a community-based peer-led walking intervention to increase PA in inactive older people⁴⁰ reflected similar intervention development processes to We Walk. Authors used social-cognitive theory and a socioecological model to develop and include BCTs; however, the final BCTs and intervention structure aligned with We Walk. Congruently, participants in both studies emphasised tailoring, selecting personal goals, using self-monitoring to increase motivation, planning, enjoyment and desired buddy attributes. The community delivery model with peer supporters as buddies used in that study could provide a template for implementing We Walk through third sector organisations.

CONCLUSION

The theoretically informed person-centred approach we took to developing a dyadic intervention to promote walking behaviour is novel in stroke and seeks specifically to address known barriers and facilitators to PA experienced by PWS. Careful stakeholder consultation throughout informed development ensured the intervention meets needs of PWS and is theoretically and pragmatically coherent. Uncertainties remain about how stroke dyads will work in practice; future research will pilot and optimise We Walk, and evaluate dyadic working, acceptability, feasibility and effectiveness.

Author affiliations¹School of Health Sciences, University of Dundee, Dundee, UK²Kinesiology, University of New Brunswick Fredericton, Fredericton, New Brunswick, Canada³Nursing, Queen Margaret University Edinburgh, Musselburgh, UK⁴Nursing and Midwifery, University of Sydney, Sydney, New South Wales, Australia⁵School of Health and Life Sciences, Glasgow Caledonian University, Glasgow, UK**Twitter** Jacqui H Morris @jacquimorris11, Stephan U Dombrowski @sdombrowski and Brendan McCormack @ProfBrendan**Collaborators** None.

Contributors JHM led the design and overall conduct of the study as chief investigator and led the writing of the manuscript. JHM is responsible for overall content as the guarantor. LAI, with JHM and SUD undertook intervention mapping and initial intervention development, study setup, recruitment and data collection, coordinated PPI consultations, and contributed to data analysis and interpretation and manuscript writing. SUD advised on behavioural theory and supported intervention development and manuscript development. BM was a co-investigator who contributed to study design, interpretation of findings, and led the development and integration of person-centred principles across the study. FVW was a co-investigator who contributed to study design, recruitment of participants and interpretation of findings, advising on physical activity matters. ML was a co-investigator who contributed to the design and interpretation of qualitative data.

Funding This work was supported by the Chief Scientist Office, Scottish Government, grant number HIPS-17-03.

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.

Ethics approval This study involves human participants and was approved by ID number 19/NS/0077 North of Scotland Ethics Committee. Participants gave informed consent to participate in the study before taking part.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available upon reasonable request. Data are available on reasonable request. Access to data can be arranged by contacting the study chief investigator: Dr Jacqui Morris (j.y.morris@dundee.ac.uk) to discuss data sharing, data requirements and conflicts of interest, in line with UK and other regulations, including ethics approvals.

Supplemental material This content has been supplied by the author(s). It has not been vetted by BMJ Publishing Group Limited (BMJ) and may not have been peer-reviewed. Any opinions or recommendations discussed are solely those of the author(s) and are not endorsed by BMJ. BMJ disclaims all liability and responsibility arising from any reliance placed on the content. Where the content includes any translated material, BMJ does not warrant the accuracy and reliability of the translations (including but not limited to local regulations, clinical guidelines, terminology, drug names and drug dosages), and is not responsible for any error and/or omissions arising from translation and adaptation or otherwise.

Open access This is an open access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited, appropriate credit is given, any changes made indicated, and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>.

ORCID iDsJacqui H Morris <http://orcid.org/0000-0002-9130-686X>Stephan U Dombrowski <http://orcid.org/0000-0001-9832-2777>**REFERENCES**

- Johnson CO, Nguyen M, Roth GA, *et al*. Global, regional, and national burden of stroke, 1990-2016: a systematic analysis for the global burden of disease study 2016. *Lancet Neurol* 2019;18:439-58.
- D'Isabella NT, Shkredova DA, Richardson JA, *et al*. Effects of exercise on cardiovascular risk factors following stroke or transient ischemic attack: a systematic review and meta-analysis. *Clin Rehabil* 2017;31:1561-72.
- Saunders DH, Sanderson M, Hayes S, *et al*. Physical fitness training for stroke patients. *Cochrane Database Syst Rev* 2020;3:CD003316.
- Friedman PJ. Gait recovery after hemiplegic stroke. *Int Disabil Stud* 1990;12:119-22.
- Benzo RP, Chang C-CH, Farrell MH, *et al*. Physical activity, health status and risk of hospitalization in patients with severe chronic obstructive pulmonary disease. *Respiration* 2010;80:10-18.
- Towfighi A, Markovic D, Ovbiagele B. Impact of a healthy lifestyle on all-cause and cardiovascular mortality after stroke in the USA. *J Neurol Neurosurg Psychiatry* 2012;83:146-51.
- Billinger SA, Arena R, Bernhardt J, *et al*. Physical activity and exercise recommendations for stroke survivors. *Stroke* 2014;45:2532-53.
- Stretton CM, Mudge S, Kayes NM, *et al*. What does real-world walking mean to people with stroke? an interpretive descriptive study. *Disabil Rehabil* 2022;44:1-8.
- Fini NA, Holland AE, Keating J, *et al*. How physically active are people following stroke? systematic review and quantitative synthesis. *Phys Ther* 2017;97:707-17.
- Tudor-Locke C, Craig CL, Brown WJ, *et al*. How many steps/day are enough? for adults. *Int J Behav Nutr Phys Act* 2011;8:79.
- Tieges Z, Mead G, Allerhand M, *et al*. Sedentary Behavior in the First Year After Stroke: A Longitudinal Cohort Study With Objective Measures. *Arch Phys Med Rehabil* 2015;96:15-23.
- Outermans J, Pool J, van de Port I, *et al*. What's keeping people after stroke from walking outdoors to become physically active? A qualitative study, using an integrated biomedical and behavioral theory of functioning and disability. *BMC Neurol* 2016;16:137.
- Morris J, Oliver T, Kroll T, *et al*. The importance of psychological and social factors in influencing the uptake and maintenance of physical activity after stroke: a structured review of the empirical literature. *Stroke Res Treat* 2012;2012:1-20.
- Morris JH, Oliver T, Kroll T, *et al*. Physical activity participation in community dwelling stroke survivors: synergy and dissonance between motivation and capability. A qualitative study. *Physiotherapy* 2017;103:311-21.
- Morris JH, Macgillivray S, McFarlane S. Interventions to promote long-term participation in physical activity after stroke: a systematic review of the literature. *Arch Phys Med Rehabil* 2014;95:956-67.
- Hendrickx W, Vlietstra L, Valkenet K, *et al*. General lifestyle interventions on their own seem insufficient to improve the level of physical activity after stroke or TIA: a systematic review. *BMC Neurol* 2020;20:168-68.
- Stretton CM, Mudge S, Kayes NM, *et al*. Interventions to improve real-world walking after stroke: a systematic review and meta-analysis. *Clin Rehabil* 2017;31:310-8.
- Arden-Close E, McGrath N. Health behaviour change interventions for couples: a systematic review. *Br J Health Psychol* 2017;22:215-37.
- Lindsay Smith G, Banting L, Eime R, *et al*. The association between social support and physical activity in older adults: a systematic review. *Int J Behav Nutr Phys Act* 2017;14:56.
- Kwasnicka D, Dombrowski SU, White M, *et al*. Theoretical explanations for maintenance of behaviour change: a systematic review of behaviour theories. *Health Psychol Rev* 2016;10:277-96.
- Carr RM, Prestwich A, Kwasnicka D, *et al*. Dyadic interventions to promote physical activity and reduce sedentary behaviour: systematic review and meta-analysis. *Health Psychol Rev* 2019;13:91-109.
- Morris JH, Oliver T, Kroll T, *et al*. From physical and functional to continuity with pre-stroke self and participation in valued activities: a qualitative exploration of stroke survivors', carers' and physiotherapists' perceptions of physical activity after stroke. *Disabil Rehabil* 2015;37:64-77.
- Pucciarelli G, Lommi M, Magwood GS. Effectiveness of dyadic interventions to improve stroke patient-caregiver dyads' outcomes after discharge: A systematic review and meta-analysis study. *European Journal of Cardiovascular Nursing* 2020.
- Yardley L, Morrison L, Bradbury K, *et al*. The Person-Based approach to intervention development: application to digital health-related behavior change interventions. *J Med Internet Res* 2015;17:e30.
- McCormack B, McCance T. *Person-Centred nursing and health care - theory and practice*. Oxford: Wiley Publishing, 2017.
- Lange E, Palstam A, Gjerdtsson I, *et al*. Aspects of exercise with person-centred guidance influencing the transition to independent exercise: a qualitative interview study among older adults with rheumatoid arthritis. *Eur Rev Aging Phys Act* 2019;16:4.

- 27 Michie S, van Stralen MM, West R. The behaviour change wheel: a new method for characterising and designing behaviour change interventions. *Implement Sci* 2011;6:42.
- 28 Michie S, Richardson M, Johnston M, *et al*. The behavior change technique taxonomy (V1) of 93 hierarchically clustered techniques: building an international consensus for the reporting of behavior change interventions. *Ann Behav Med* 2013;46:81–95.
- 29 Schwarzer R, Lippke S, Luszczynska A. Mechanisms of health behavior change in persons with chronic illness or disability: the health action process approach (HAPA). *Rehabil Psychol* 2011;56:161–70.
- 30 Knoll N, Hohl DH, Keller J, *et al*. Effects of dyadic planning on physical activity in couples: a randomized controlled trial. *Health Psychol* 2017;36:8–20.
- 31 Fitzsimons GM, Finkel EJ, vanDellen MR. Transactive goal dynamics. *Psychol Rev* 2015;122:648–73.
- 32 Braun V, Clarke V. Using thematic analysis in psychology. *Qual Res Psychol* 2006;3:77–101.
- 33 Government S. Scottish index of multiple deprivation 2020, 2020. Available: <https://www.gov.scot/collections/scottish-index-of-multiple-deprivation-2020/> [Accessed 30 Mar 2022].
- 34 Jaarsma EA, Smith B. Promoting physical activity for disabled people who are ready to become physically active: a systematic review. *Psychol Sport Exerc* 2018;37:205–23.
- 35 Michie S, Johnston M, Abraham C, *et al*. Making psychological theory useful for implementing evidence based practice: a consensus approach. *Qual Saf Health Care* 2005;14:26.
- 36 Michie SA, West RM. *The behaviour change wheel. A guide to designing interventions*. Great Britain: Silverback Publishing, 2014.
- 37 Whittal A, Atkins L, Herber OR. What the guide does not tell you: reflections on and lessons learned from applying the COM-B behavior model for designing real life interventions. *Transl Behav Med* 2021;11:1122–6.
- 38 Soto SH, Berry DC, Callahan LF. A qualitative exploration of dyadic influence on physical activity between Latinas with osteoarthritis and a supporter of their physical activity. *Arthritis Care Res* 2020;10.
- 39 Barrado-Martín Y, Heward M, Polman R, *et al*. Acceptability of a Dyadic tai chi intervention for older people living with dementia and their informal carers. *J Aging Phys Act* 2019;27:166–83.
- 40 Tully MA, Cunningham C, Cupples ME, *et al*. Walk with me: a protocol for a pilot RCT of a peer-led walking programme to increase physical activity in inactive older adults. *Pilot Feasibility Stud* 2018;4:117.
- 41 Anderson S, Whitfield K. An ecological approach to activity after stroke: it takes a community. *Top Stroke Rehabil* 2011;18:509–24.
- 42 Simpson LA, Eng JJ, Tawashy AE. Exercise perceptions among people with stroke: barriers and facilitators to participation. *Int J Ther Rehabil* 2011;18:520–30.
- 43 Barnsley L, McCluskey A, Middleton S. What people say about travelling outdoors after their stroke: a qualitative study. *Aust Occup Ther J* 2012;59:71–8.
- 44 Nicholson S, Sniehotta FF, van Wijck F, *et al*. A systematic review of perceived barriers and motivators to physical activity after stroke. *Int J Stroke* 2013;8:357–64.
- 45 Blonski DC, Covert M, Gauthier R, *et al*. Barriers to and facilitators of access and participation in community-based exercise programmes from the perspective of adults with post-stroke aphasia. *Physiother Can* 2014;66:367–75.
- 46 Barclay R, Ripat J, Mayo N. Factors describing community ambulation after stroke: a mixed-methods study. *Clin Rehabil* 2015;29:509–21.
- 47 Robinson CA, Shumway-Cook A, Ciol MA, *et al*. Participation in community walking following stroke: subjective versus objective measures and the impact of personal factors. *Phys Ther* 2011;91:1865–76.
- 48 Robinson CA, Matsuda PN, Ciol MA, *et al*. Participation in community walking following stroke: the influence of self-perceived environmental barriers. *Phys Ther* 2013;93:620–7.
- 49 Nicholson SL, Donaghy M, Johnston M, *et al*. A qualitative theory guided analysis of stroke survivors' perceived barriers and facilitators to physical activity. *Disabil Rehabil* 2014;36:1857–68.