Title The roles of motivational interviewing and self-efficacy on outcomes and cost-effectiveness of a community-based exercise intervention for inactive mid-older aged adults.

Abstract

Increasing physical activity (PA) among inactive middle-older aged adults in rural communities is challenging. This study investigates the efficacy of a PA intervention supporting inactive adults in rural/ semi-rural communities. Inactive participants enrolled on either a single signposting session (n=427), or multi-session pathway combining signposting with motivational interviewing (MI) (n=478). Pre-post outcomes data assessed activity levels (IPAQ-S; SISEM), self-efficacy (NGSE) and well-being (WHO-5). Measures were repeated at longitudinal time points (26, 52 weeks) for the MI pathway. Outcomes were contrasted with results from an unmatched comparison group receiving treatment as usual (TAU). Cost-utility (QALY-ICER) and return on investment (NHS-ROI; QALY-ROI) were estimated for short (5 years), medium (10 years) and long (25 years) time horizons. Both pathways significantly increased participants' PA. The MI pathway resulted in significantly greater increases in PA than signposting-only and TAU. Improvements in psychological outcomes (NGSE; WHO-5) were significantly greater in the MI pathway than TAU. Longitudinal results indicated MI pathway participants sustained increases in light-intensity PA at 52 weeks ($p<.001$; $\eta p2=.16$). Regression analyses found baseline self-efficacy predicted increased PA at 52 weeks, while baseline well-being did not. The relationship between self-efficacy and PA increased successively across time points. However, the magnitude of participants' increased self-efficacy did not predict PA at any time point. Both pathways were cost-effective and cost-saving for participants aged ≥ 61 years from the short time horizon, with the MI pathway having greater return on investment estimates. Overall, MI increased efficacy of a signposting PA intervention, and was cost-saving for older adults.

Keywords

Self-efficacy; quality of life; exercise; motivation

What Is known about this topic

- Age-related health and lifestyle barriers increase the likelihood that adults become less active as they grow older.
- Adults living in rural areas are at increased risk of inactivity.
- Motivational interviewing and social prescribing (exercise on prescription) are techniques used in healthy lifestyle interventions.

What this paper adds

- Inclusion of a motivational interviewing component can increase the efficacy of community-based exercise interventions.

- Baseline self-efficacy predicts longitudinal maintenance of physical activity. Strengthening self-efficacy should be a core focus in the early stages of exercise interventions targeted at mid-older age groups.
- A community-based exercise intervention is cost-effective for older adults (over 60s) who continue to participate for at least one year or more.

Main text

Introduction

Physical inactivity increases risk of physical and psychological morbidity (Hamer et al., 2014; Morgan et al., 2016; Warburton, 2006). Inactivity levels in the UK are high, with around 42% of women and 34% men ≥ 19 years old failing to meet government recommendations for weekly aerobic and muscle-strengthening activity (Scholes, 2017). Inactivity increases from middle age onwards, with only 21% of UK adults aged 40-79 meeting government recommendations for exercise (Chief Medical Officers, 2019; Morgan et al., 2016; Scholes, 2017). The case for being physically active in mid-later life is strong as inactivity-related physical and mental health risks increase with age (Chief Medical Officers, 2019; Hamer et al., 2014; Warburton, 2006). Physical activity (PA) delays onset of age-related decline, reduces risk of falls, and, improves mobility, independence, mental health, quality of life and menopausal symptoms (Lees et al., 2005; Mazzeo & Tanaka, 2001; Singh, 2002; Villaverde-Gutiérrez et al., 2006; Zaleski et al., 2016). Benefits are found even after long-term inactivity, or for those who have never previously exercised regularly. Reversing physical inactivity in mid-later life is a key public health objective in the UK and worldwide (Chief Medical Officers, 2019; World Health Organisation, 2018).

Encouraging adults to maintain recommended activity levels is highly challenging for professionals. Exercise in mid-later life is impaired by age-related barriers including worsening physical and/ or mental health, weight gain, social isolation, parenting, caring, menopausal changes, feeling ‘out of place’ in sports facilities and decreased confidence and self-efficacy relating to exercise (Chief Medical Officers, 2019; Cowie et al., 2018; Morgan et al., 2016; Pereira & Power, 2017; Villaverde-Gutiérrez et al., 2006; Zaleski et al., 2016). ‘Exercise prescriptions’ for middle-older aged adults should combine encouragement with specific, educative advice (Mazzeo & Tanaka, 2001). They should consider pre-existing conditions and symptoms reported upon exertion, plus support to tackle age-related socioeconomic barriers (Mazzeo & Tanaka, 2001; Morgan et al., 2016; Singh, 2002; Zaleski et al., 2016).

Barriers are increased for those mid-older aged adults living in rural areas. Rural populations are generally older with increased health problems. Social and economic barriers to exercise in rural areas include infrequent public transport, fewer leisure facilities, longer walking distances, lower household incomes, isolated walking routes and problems created by bad weather (Local Government Association & Public Health England, 2017; Maley et al., 2010; Morgan et al., 2000; Shergold & Parkhurst, 2012).

The NHS Health Trainer model was designed to provide one-to-one, community-based support for positive health behaviour change (Bickerdike et al., 2017). Health Trainer Services (HTS) deliver manualised one-to-one interventions to develop healthier lifestyles. Health psychology behaviour-change models underpin HTS, targeting knowledge, motivation and self-efficacy (Michie *et al*., 2008). Though HTS do not specifically focus on PA, evaluations report associated increases in exercise levels. Exercise Referral Schemes (ERS) also operate around the UK, signposting to community-based exercise groups and trainers (Bickerdike et al., 2017). Evaluations of ERS report modest increases in PA and a range of positive psychological outcomes (Bickerdike et al., 2017; Hanson et al., 2013; Thomson et al., 2015). Advancing age predicts uptake and adherence, suggesting ERS particularly engage older adults (Hanson et al., 2013). Combining elements of these models could increase positive outcomes from PA interventions. Professionals may incorporate this idea into interventions designed for adults in rural communities.

This study investigates the **efficacy** of Active HERE - a brief, personalised PA intervention. Development and delivery of the programme was in Herefordshire, a large, rural English county, with a significantly older and inactive adult population (Herefordshire Council, 2020). Key research questions asked if Active HERE increased participants [a)]PA levels, [b)]psychological well-being, and [c)]self-efficacy. Intervention **cost-effectiveness** was estimated.

Participants and methods

Ethical Clearance

Granted by the Research Ethics Committee of the Faculty of Education, Health and Well-being, University of Wolverhampton.

Participation was voluntary and did not affect intervention access. Participants received written and verbal explanation of the evaluation process and of their rights to withdraw. All participants provided both written and verbal consent.

The study design was informed by a framework for evaluating public health PA interventions (Cavill et al., 2012). A quasi-experimental pre-post design was used with two intervention pathways and an unmatched comparison pathway. Pre-post data was collected at 0-12 weeks for all pathways. Additional longitudinal data (26, 52 weeks) was available for one intervention pathway.

Participants were ≥ 18 years and engaged in one of the experimental pathways between January 2016 and June 2018. All pathways recruited using non-randomised consecutive sampling.

Intervention (Active HERE)

Active HERE was a brief intervention (1- 4 sessions) engaging inactive adults with community-based entry-level PA. It was open to all Herefordshire residents aged ≥18 years. Participants selected one of two intervention pathways - *Active in the Community* (AiC) or *Active Plus* (A+). Both pathways were based on established health psychology behaviour change models (Bickerdike et al., 2017; Gardner et al., 2012). A database of entry-level PA available throughout Herefordshire was built and maintained by the delivery team.

AiC pathway

AiC was a single signposting session lasting approximately one hour. Participants discussed exercise-related preferences, potential barriers and concerns before being signposted to one or more activities.

A+ pathway

Following the initial session (as in AiC, above), A+ provided 2-3 additional motivational interviewing (MI) sessions across 12-weeks (30-60 mins). All sessions provided MI, education on exercise benefits, goal-setting exercises and personalised signposting to suitable activities.

Comparison pathway (TAU)

TAU delivered a general HTS healthy lifestyle advice intervention.

Recruitment

Participants on all pathways self-referred by telephone through the local HTS gateway. Current PA levels were assessed at referral using Sport England's SISEM measure. Respondents assessed as *inactive* were offered intervention (Active HERE or HTS), and self-selected their pathway.

Outcomes measures

Quantitative self-report questionnaires measuring PA, self-efficacy and psychosocial well-being were completed at up to four time points (Table 1).

Single Item Sport England Measure (SISEM) (Milton et al., 2011)

SISEM identifies, during the previous seven days, how often the respondent has undertaken PA ≥ 30 minutes. SISEM defines PA as enough to increase breathing rate, excluding housework or job-related activities. SISEM was used as an eligibility screening tool, with people reporting 0 days on SISEM classified as eligible to participate in this study.

International Physical Activity Questionnaire – (IPAQ-S) (IPAQ Group, 2020)

IPAQ-S is a 7-item questionnaire gauging PA undertaken during the previous seven days. IPAQ-S records the duration (*minutes*) and intensity (‘*light’,* ‘*moderate’* or ‘*vigorous’*) of weekly PA. Weighted responses are combined to calculate total metabolic equivalent time (MET-minutes) of exercise. IPAQ-S is most reliable and valid in middle-aged adult populations from developed countries (Craig et al., 2003).

World Health Organisation Well-being Index - 1998 (WHO-5) (Psykiatric Research Unit, 1998)

This unidimensional, 5-item questionnaire measures respondents’ psychological well-being over the previous two-weeks on a 6-point scale (Psykiatric Research Unit, 1998). WHO-5 has good psychometric properties and is used widely in health research across the adult age spectrum (Allgaier et al., 2013; Bech et al., 2003; Birket-Smith et al., 2009; De Wit et al., 2007; Ellervik et al., 2014; Garnefski et al., 2008; Schougaard et al., 2018; Snoek, 2006). Raw scores <13 (52%) indicate likely clinically significant distress.

New General Self-Efficacy Scale (NGSE) (Chen, Gully & Eden, 2016)

A unidimensional 8-item questionnaire measuring general self-efficacy on a 5-point scale. *NGSE* has good psychometric properties and has been used in health behaviour research (Hepburn, 2018; Vuotto et al., 2015).

Quantitative analyses

Statistical analyses were conducted using SPSS 24. Results were considered statistically significant at p<.05. Differences between categorical demographic variables were assessed using χ^2 analyses. A series of mixed design ANOVAs were run. There was a between groups factor Pathway, which had up to three levels: A+, AiC, and comparison/TAU pathway (Com). The within groups factor was Time with up to four time points (0, 12, 26, 52 weeks). As shown in Table 1, for most measures, only two groups or two time points were compared. There were seven continuous dependent variables: 1) weekly participation in PA (SISEM), 2) total duration of PA (IPAQ-S), 3) duration of light PA (IPAQ-S), 4) duration of moderate PA (IPAQ-S), 5) duration of vigorous PA (IPAQ-S), 6) self-efficacy (NGSE), 7) well-being (WHO-5). Interaction effects between time and intervention pathway were followed-up with simple effects tests. Effect sizes are reported as partial eta squared (ηp^2) and interpreted as small (≤.01), medium (≤.06), or large (≤.14). Effect sizes for χ^2 tests are reported as Cramer's V and interpreted as weak (.10 - <.20), moderate (.20 - <.40), relatively strong (.40 - <.60), or strong (≥ .60).

Cost-utility and return on investment (ROI) analyses

Cost-utility and ROI analyses were undertaken using Sport England's Model for Estimating Outcomes and Values in the Economics of Sport tool (MOVES v2.0). MOVES was developed with the purpose of informing decision-makers planning and evaluating PA interventions. The tool estimates anticipated cost-utility and ROI relating to health and health-related quality of life (Sport England, 2020).

Avoided cases of disease are modelled using UK epidemiological data referencing prevalence and disease-related morbidity and mortality data for eight common health conditions: type 2 diabetes, ischaemic heart disease, stroke, dementia, depression, breast and colon cancers, and hip fracture. The model compares physically active populations against those who are inactive. Disease-related risk and impact are adjusted according to activity level, intensity and maintenance.

Two ROI figures are reported. NHS-ROI estimates cost savings as a result of avoided disease cases, relative to direct NHS costs for one year of treatment. An ROI of 100% means that £2 of NHS cost savings are projected for every £1 spent on intervention delivery. QALY-ROI estimates the monetary value associated with quality adjusted life years (QALYs) resulting from the intervention. QALYs measure a person's quality of life over a defined period of time. The National Institute for Health and Care Excellence (NICE) accepts values <£20,000 per QALY as cost-effective (NICE 2013). QALY-ROI is calculated by multiplying QALYs gained as a result of avoided disease cases by £20,000. Zero-benefit is assumed for those engaged with PA for <1 year. MOVES 2.0 accrues diminishing returns for additional activity, meaning benefits are greatest in the least active groups. The model does not account for differences in health profile relating to geographic area, social care costs or costs of sports-related injuries (Sport England, 2020).

Cost-utility was calculated using an incremental cost-effectiveness ratio (ICER). QALY-ICER is the ratio of the change in costs to the increase in QALYs gained from the intervention. Even where ROI is negative (i.e. provision costs are greater than benefits accrued), an intervention is still considered by NICE to be cost-effective if the QALY-ICER is <£20,000:

$$QALY\ ICER = \frac{\text{"}with\ intervention\ cost\text{"} - \text{"}without\ intervention\ cost\text{"}}{\text{"with intervention QALY"} - \text{"}without\ intervention\ QALY\text{"}}$$

Cost utility and ROI analyses were conducted only for Active HERE participants >45 years due to low participation of those <45 years. In the absence of longitudinal data on maintenance levels beyond 52 weeks, projections were calculated for two median durations of ongoing participation: 5 years, a realistic scenario based on available data, and 3 years, which represents a higher rate of drop-off than observed during the study period. Calculations were undertaken using three time horizons: short (5 years), medium (10 years) and long (25 years).

RESULTS

Participant demographics

Table 2 presents demographic data for the 905 Active HERE participants, of whom 53% participated in A+ and 47% in AiC.

Participation in PA: baseline – 12 weeks (SISEM measure).

At 12-weeks, all pathways saw PA increase, with greatest changes on the A+ pathway (69.3%) and the lowest for TAU (22.6%). A statistically significant and strong main effect of time (n=596; $F(1, 593)=183.747$, $p<0.001$, $\eta p^2= 0.24$) indicated a general increase in activity at 12 weeks compared to baseline levels.

A significant interaction (see Figure 1) was found between time and pathway type, though this was a small effect (n=596; $F(2, 594)=9.03$, $p<0.001$, $\eta p^2 = 0.03$). Simple effects analyses showed that activity increased in all pathways: TAU ($F(1, 593)=11.58$, $p=.001$, $\eta p^2 =.02$), AiC ($F(1, 593)=126.93$, $p<.001$, $\eta p^2=.18$) and A+ ($F(1, 593)=306.79$, $p<.001$, $\eta p^2=.34$), but Bonferroni post-hoc tests comparing post-minus-pre difference scores indicated that in the A+ pathway ($p=.001$) but not in the AiC pathway ($p=.247$) activity increased significantly more than for TAU.

Total duration (MET-mins) of PA: baseline – 12 weeks (IPAQ-S measure) comparing AiC with A+ *pathway.*

A statistically significant and strong main effect of time indicated a general increase in the total duration of PA (MET-minutes) from 0-12 weeks ($F(1, 487) = 225.20$; $p<.001$; $\eta p^2 = 0.32$). There was also a significant main effect of pathway (F(1, 487)=54.23, p<.001, $\eta p^2 =.10$) and a medium-sized interaction (see Table 3) between pathway and time, with A+ participants experiencing a higher average increase in amount of weekly activity (MET-minutes) than those following the AiC pathway ($F(1, 487) = 25.05$, $p<.001$, $\eta p^2 = 0.05$). Simple effects showed that there was significantly improved total MET-mins scores in both AiC ($F(1, 487) = 44.63$, $p<.001$, $\eta p^2 = 0.08$) and A+ $F(1, 487) = 227.71$, $p<.001$, $\eta p^2 = 0.32$) pathways, but the effect was stronger in the A+ pathway.

Level of light-intensity PA: baseline – 12 weeks (IPAQ-S) comparing AiC with A+ *pathway.*

A significant, moderate strength main effect of time was found. Levels of light-intensity activity at 12 weeks were higher than compared to baseline ($F(1,488) = 55.54$, $p<.001$, $\eta p^2 = 0.10$). There was a main effect of pathway ($F(1, 487)=54.99$, $p<.001$, $\eta p^2=.10$) and a significant but small interaction was found (see Table 3): simple effects showed that those on the A+ pathway significantly increased light activity ($F(1, 487)=83.08$, $p<.001$, $\eta p^2= .15$) those on AiC did not ($F(1,487) = 3.54$, $p=.060$, $\eta p^2 = 0.006$).

Levels of moderate-intensity PA: baseline – 12 weeks (IPAQ-S) comparing AiC with A+ pathway.

Moderate level PA increased from baseline to 12-weeks and this was a strong main effect of time ($F(1,487) = 187.24$, $p<.001$, $\eta p^2 = .278$). There was no main effect of pathway ($F(1,487) = 2.62$, $p=.106$, $\eta p^2 = .005$) and no significant interaction ($F(1,487) = 1.86$, $p=.173$, $\eta p^2 = .004$), thus both A+ and AiC pathways saw increases in moderate exercise at 12 weeks (see Table 3).

Outcome for levels of vigorous-intensity PA - baseline – 12 weeks comparing AiC with A+ pathway.

Just one participant engaged in vigorous PA at baseline, though this did not exceed the exclusion threshold of 30 minutes per week. At 12-weeks, some 23 participants (4.5%) were undertaking vigorous weekly activity. Despite vigorous intensity activity only being undertaken by 1 out of every 20 participants, there was a strong main effect of time (F(1,487) = 13.30, p<.001, ηp^2 = .27). There was no main effect of pathway (F(1,487)<1) and no significant interaction (F(1,487)<1), thus both A+ and AiC pathways saw increases in vigorous exercise at 12 weeks (see Table 3).

Longitudinal outcomes – duration (MET-mins) of light PA: baseline, 12, 26 and 52 weeks (IPAQ-S) in A+ group only.

Light activity MET-mins was measured across all four time points in the A+ group only. There was a moderate main effect of time (F(3, 234) = 11.81, p<.001; ηp^2=.13), showing a longitudinal increase in light PA in those who were measured across all four time points (*baseline, 12, 26 and 52 weeks; see Table 4*). Within group contrasts showed that duration of light activity was significantly higher than baseline at 12 weeks (F(1, 78) = 48.64, p<.001; ηp^2=.384), 26 weeks (F(1, 78) = 14.00, p<.001; ηp^2=.15) and 52 weeks (F(1, 78) = 14.86, p<.001; ηp^2=.16).

Demographic subgroup differences

No significant associations were observed between the demographic variables of gender, age, or deprivation quintile with activity levels from baseline to 12-weeks. However, Active HERE did attract significantly older participants (≥45 years) than TAU (χ^2(df = 2) = 25.01; p<.05).

The majority of Active HERE participants were >45 years old (Table 2). An association was found between pathway and completion rate in older participants (≥61 years), who were more likely to complete the A+ than AiC pathway (χ^2 (df = 1) = 20.993; p<.001). This was a moderate effect size (Cramer's V = 0.303).

There was no significant association between pathway type and completion rate for middle-aged participants (46-60 years), who were more likely to complete than not complete both the A+ and AiC pathways, (χ^2 (df = 1) = 3.399, p>.05, Cramer's V = 0.194).

Subgroup differences for outcomes

Outcome for well-being (WHO-5): baseline - 12 weeks, comparing TAU with the A+ group

Baseline well-being scores for A+ and TAU were broadly equivalent, and indicated clinically significant distress (Psykiatric Research Unit, 1998). There was a main effect of time ($F(1, 240)=53.69$, p<.001, $\eta p^2=.183$) with a general improvement in well-being at 12-weeks. There was a main effect of pathway ($F(1, 240)=3.87$, $p=.050$, $\eta p^2=.02$) and also a significant interaction ($F(1, 240)=7.95$; $p=.005$; $\eta p^2=.03$), with simple effects showing that although well-being had improved significantly in the TAU group ($F(1, 240)=6.44$, $p=.012$, $\eta p^2=.003$) the improvement was even greater in the A+ group ($F(1, 240)=122.13$, $p<.001$, $\eta p^2=.34$) (see Table 5). At 12-weeks, mean scores for those following A+ were now significantly elevated above the cut-off for clinically significant distress (Psykiatric Research Unit, 1998).

Outcome for self-efficacy (NGSE): baseline - 12 weeks, comparing TAU with the A+ group

Baseline self-efficacy scores for the A+ and TAU were broadly equivalent. There was a main effect of time ($F(1, 241)=47.68$, $p<.001$, $\eta p^2=.17$) and of pathway (F(1, 241)=12.33, p=.001, ηp^2=.05) and a significant interaction (F(1, 241)=8.53, p=.004, ηp^2=.03). Simple effects showed that at 12 weeks although self-efficacy had improved significantly for the TAU group (F(1, 241)=5.05, p=.026, ηp^2=.02) the improvement was even greater in the A+ group (F(1, 241)=112.81, p<.001, ηp^2=.32) (see Table 5).

Predicting maintenance of PA over time (Total MET-minutes, IPAQ-S) with self-efficacy and well-being

In participants who recorded PA (total MET-minutes) at all four time points (n=74), we tested whether baseline self-efficacy and well-being respectively predicted total MET mins at baseline, 12, 26 and 52 weeks.

Self-efficacy:

In those whose PA (total MET-minutes) was measured at all four time points (n=74), baseline self-efficacy predicted PA most strongly at 52 weeks. A multivariate regression using Pillai's trace found an overall significant relation between self-efficacy and PA (V=.15, F(4, 69)=3.04, p=.023; ηp^2=.15) with univariate analyses showing that the relation between baseline self-efficacy and PA grew stronger at each successive time point: baseline (F(1, 72)<1, ηp^2=.002, B=4.67), 12 weeks, (F(1, 72)=3.35, p=.071, ηp^2=.04, B=32.14), 26 weeks (F(1, 72)=2.97, p=.084, ηp^2=.04, B=37.28) and 52 weeks (F(1, 72)=9.23, p=.003, ηp^2=.11, B=63.09). Thus self-efficacy at baseline best predicted PA at the final time point.

An additional multivariate regression (V=.14, F(4, 49)<1, ηp^2=.03) examined whether *improvement* in self-efficacy from baseline to 12 weeks predicted PA over time (12, 26 and 52 weeks). This was not the case: increase in self-efficacy did not predict total MET-minutes at any of the time points ($p \geq .313$).

Well-being:

Again, in those whose PA (total MET-minutes) was measured at all four time points (n=74), baseline well-being predicted PA best at 12 weeks, but the effect diminished with successive time points. In a multivariate regression using Pillai's trace, well-being significantly predicted PA overall (V=.14, F(4, 69)=2.81, p=.032; ηp^2=.14) with univariate analyses showing that the relation between baseline well-being and PA was not significant at baseline (F(1, 72)=3.24, p=.076 ηp^2=.04, B=4.06), was significant at 12 weeks, (F(1, 72)=10.70, p=.002, ηp^2=.13, B=9.19), but tailed off at 26 weeks (F(1, 72)=2.90, p=.093, ηp^2=.04, B=6.18) and 52 weeks (F(1, 72)=1.84, p=.179, ηp^2=.03, B=4.96). Thus baseline self-efficacy was a more powerful predictor than well-being of sustained PA (i.e. at 52 weeks).

Cost of intervention

Cost of establishing Active HERE included community-based recruitment, locating and assessing community-based activities for quality and suitability, developing and maintaining a comprehensive activity database, and marketing Active HERE to public and local sports sectors. Following the set-up phase, ongoing costs lessened, now primarily revolving around database maintenance, ongoing recruitment and core intervention work. Therefore two programme costs are reported for each pathway:

'programme lifetime' representing cost per participant over the full duration of the programme (£230 per A+ participant and £115 per AiC participant) and 'established phase' representing cost per participant from the second year of operation onwards (£195 per A+ participant and £98 per AiC participant).

ROI and cost-utility (≥61 years)

QALY-ICER indicated a cost saving for both A+ and AiC pathways across short, medium and long time horizons, for both 'lifetime' and 'established' phases, and for the lowest levels of ongoing participation. Both intervention pathways were assessed to be cost-effective @£20,000 per QALY, with >99% probability (Table 6; Table 7).

A positive QALY-ROI was calculated across both A+ and AiC pathways and in all instances. Modelled projections for QALY-ROI were higher for A+ than AiC, and in all instances were strong, with >95% probability that a positive ROI would be realised.

A positive NHS-ROI was calculated in all instances for the A+ pathway, with >95% probability. The majority of the projected avoided cases requiring treatment were hip fractures, dementia and heart disease. Modelled NHS-ROI was lower for the AiC pathway, with the 'established' phase calculated to have >95% probability of cost savings only in the medium and long term. The 'lifetime' phase was also calculated to have >95% probability of cost savings at the medium and long time horizons, but only for the longer duration (median 5 years) of ongoing participation.

ROI and cost-utility (46-60 years)

QALY-ICER calculations for AiC indicated cost savings from the medium time horizon onwards. Cost savings were also indicated for A+, but only for the longer duration (median 5 years) of ongoing participation. AiC was assessed to be cost-effective @£20,000 per QALY in the short, medium and long term, with >95% probability (Table 7). A+ was assessed to be cost-effective @£20,000 per QALY at the medium and long time horizons, with >99% probability (Table 6).

Modelled projections for QALY-ROI were higher for AiC than for A+. A positive QALY-ROI was calculated across both A+ and AiC pathways at the medium and long time horizons, with >95% probability that a positive ROI would be realised. Short time horizon QALY-ROI projections were positive, but lower probability, for AiC, and negative for A+.

NHS-ROI was calculated to be negative for both pathways at the short time horizon. Modelled projections showed higher NHS-ROI for AiC than A+. Cost savings were projected from the medium time horizon, but there was not a >95% probability of cost savings until the long time horizon, and only then for the longer duration of ongoing participation.

Discussion

Active HERE engaged mainly mid-older aged inactive adults in weekly PA through an open-access, personalised signposting intervention based in the local community, and resulted in maintenance of this behaviour for significant numbers of participants. The addition of MI increased the effectiveness of personalised signposting. Maintaining weekly PA over time is a key challenge for adults in mid-older age, and risk of relapsing back to inactivity is significant at the end of targeted PA interventions (Amireault et al., 2013). Yet, maintenance is necessary in order that the benefits of exercise to adults' physical and mental health are achieved. Discontinuation of gains in PA reverses the improvements to physical conditioning achieved during periods of activity (Amireault et al., 2013; Karinkanta et al., 2009). Cost-effective, brief and open-access interventions such as Active HERE provide a valuable addition to public health programmes by creating lasting change in target communities.

Inactive adults are at increased risk of reduced psychological well-being (Galper et al., 2006; Hamer et al., 2014). Active HERE significantly increased psychological well-being in an inactive cohort who on average were found to have clinically significant low well-being at baseline. PA has been widely found to enhance psychological well-being and increase effectiveness of clinical treatments for depression in middle-older age adults (World Health Organisation, 2018). Elevated mood is also likely to create a positive 'feedback loop' increasing intrinsic motivation to maintain regular PA. Interestingly, the current study found that psychological well-being at baseline most strongly predicted PA at 12 weeks, but did not predict PA long-term. A possible explanation for this is that participants experienced a boost in well-being as they engaged in the regular exercise throughout the intervention, which is in line with other research citing the positive association of psychological well-being with PA (Galper et al., 2006; Hamer et al., 2014). This increase in well-being is an important outcome of exercise and is likely to have provided some motivation to continue with the intervention. However, an implication of the present study is that increased psychological well-being does not significantly contribute to maintenance of regular PA long term.

Active HERE was based around the health psychology models underpinning the HTS programme. Self-efficacy broadly refers to an individual's confidence in their autonomous ability to accomplish significant behaviours. Experimental research has found that self-efficacy predicts health-related behaviours, including maintenance of exercise, and is a central component in Self-Determination Theory (SDT) (Deci & Ryan, 1985). SDT predicts that behaviour change is most likely to be maintained by those individuals who are intrinsically motivated and self-efficacious towards the behaviour (Amireault et al., 2013; Deci & Ryan, 1985; Janssen et al., 2014; Selzler et al., 2016; Sheeran et al., 2016). In line with SDT, our longitudinal analysis found that baseline levels of self-efficacy were the strongest predictor of whether a participant sustained PA long-term when followed up one year post-baseline. Furthermore, it was baseline self-efficacy, rather than improvement of self-efficacy in the first 12 weeks, which was the more powerful predictor of PA at 52 weeks. These findings suggest the importance of public health messages that highlight the benefits of mid-older aged adults undertaking PA. Provision of safe, entry-level exercise programmes for this age-group is vital to ensure these inactive individuals feel safe and able to increase their PA levels. By focussing on MI and tailored recommendations in the first intervention session, A+ participants' self-efficacy was supported and developed from baseline. Distinct features of the Active HERE delivery model may also have increased self-efficacy by tackling common barriers to access and help-seeking. For example, Active HERE's non-clinical delivery format and self-referral route may have reduced stigma, which has been found to prevent people with mental health problems or obesity-related issues seeking support (Schnyder et al., 2017; Silveira et al., 2013). Subsequent A+ sessions celebrated success and tailored recommendations to overcome any emerging barriers, and this may be reflected in the finding that self-efficacy increased over time. The current study therefore supports the assertion that interventions based around established behaviour change models, which include methods to overcome commonly reported practical and psychosocial barriers, are most likely to be effective in supporting lasting behaviour change.

Active HERE was assessed to be cost-effective. For participants ≥61 years, both pathways were cost-saving, with A+ estimated to provide greater ROI than AiC. The addition of MI was linked to improved outcomes, higher completion rate and increased net cost savings from the short time horizon though, as participants self-selected their pathway, other factors may be present. For participants aged 46-60, addition of MI also improved outcomes, but did not significantly increase completion rate or cost savings, with AiC estimated to provide greater ROI than A+. This may indicate that older participants were more likely to experience barriers to participation, which were addressed effectively by additional MI support. Another consideration is that projected cases avoided were mainly hip fractures, dementia and heart disease, which are more prevalent in older people. This suggests that cost savings are likely to be realised more quickly with the older age group.

ROI and cost-effectiveness were projected to increase over time for both pathways and both age groups. Projections were higher following the set-up phase, due to the reduced cost per participant once the programme was established. This indicates there are financial benefits to be derived from sustaining successful interventions, and in undertaking preventative projects to realise greater financial savings in the medium and long term.

Practitioners working in both primary care and local communities are challenged by the imperative to increase PA levels among inactive adults. Those working with mid-older aged populations, and those in rural and semi-rural communities, face increased challenge. Theoretically-based interventions, like Active HERE, offer practitioners an evidence-based, time-limited, cost-effective model that can be implemented across adult age ranges and health status. The community-based nature of Active HERE, leveraging existing exercise practitioners and community venues, increased cost-effectiveness by reducing delivery costs. Though beyond the scope of this cost-effectiveness evaluation, it is likely that the project also added value to the local sports and exercise economy, increasing promotion and participation. The model is one of partnership and shared benefits to public health, primary care and community services.

Limitations

Pragmatic barriers prevented longitudinal follow-up with either TAU or AiC pathways. Sample sizes for longitudinal analyses (multivariate regressions) were somewhat underpowered: our sample size for these analyses went up to 74 but a sample size of 185 was needed to achieve 80% power to detect a medium effect size (ηp^2=.06).

Conclusion

Active HERE successfully engaged mid-older aged inactive adults, living in a largely rural area, with regular PA. Change was maintained over time for a significant number of participants. Supplementing personalised signposting with MI increased the effectiveness of the intervention. Active HERE was shown to be cost effective, with net cost savings for older adults (≥61 years) in the short, medium and long term, with savings increasing over time. The model, based around health-psychology theories of behaviour change, increased participants' self-efficacy and psychological well-being, and created holistic impact that reached beyond increasing weekly levels of PA. Future work is needed to confirm causal relationships between variables, additional impacts on participants' lives, and socioeconomic impacts on rural health and sports sectors.

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Table 1 Measures taken and time points for each pathway

	SISEM†	IPAQ-S‡					WHO-5§	NGSE¶
Pathway	0-12 weeks	Total 0-12 weeks	Light 0-12 weeks	Moderate 0-12 weeks	Vigorous 0-12 weeks	Total 26, 52 weeks	0-12 weeks	0-12 weeks
Active in the Community	✓	✓	✓	✓	✓			
Active Plus	✓	✓	✓	✓	✓	✓	✓	✓
Comparison	✓						✓	✓

†Single Item Sport England Measure. Number of days of exercise ≥ 30 minutes, over previous seven days.
‡International Physical Activity Questionnaire- Short Form, assessing metabolic equivalent time (MET-minutes) of weekly physical activity across light, moderate and vigorous intensities.
§World Health Organisation Well-being Index
¶New General Self-Efficacy scale

Table 2 Participants' characteristics

Variables	Active Plus (A+) (n=478)	Active in the Community (AiC) (n=427)	*p*-value (A+ vs. AiC)
Gender (%)			
Female	74%	76%	n.s.
Male	26%	24%	
Age (% bands)			
18 – 34 years	11%	12%	n.s.
35 – 44 years	9%	11%	
45 – 59 years	28%	22%	
≥ 60 years	43%	45%	
No response	9%	10%	
Long-term health condition(s) (%)			
None	39%	79%	p<.001
One	31%	15%	
Two	15%	4%	
Three	8%	2%	
≥ 4	7%	0%	
Employment status (%)			
Retired	38%	36%	p<.001
Employed (full-time)	12%	22%	
Employed (part-time)	11%	8%	
Self-employed	5%	4%	
Unemployed	12%	4%	
Permanently sick/disabled	8%	2%	
Other	11%	11%	
No response	3%	13%	

n.s. = No significant difference

Table 3 Mean physical activity (IPAQ-S)† in MET-minutes at baseline and 12 weeks in Active in the Community (AiC) and Active Plus (A+) groups (standard deviations in parentheses).

	Total MET-mins		Light MET-mins		Moderate MET-mins		Vigorous MET-mins	
	Baseline	*12 weeks*	*Baseline*	*12 weeks*	*Baseline*	*12 weeks*	*Baseline*	*12 weeks*
AiC	189.07	444.69	172.14	235.76	11.35	179.35	5.58	29.58
	(374.26)	(447.56)	(353.13)	(320.70)	(68.07)	(279.01)	(81.84)	(153.01)
A+	381.82	893.29	362.04	635.05	19.78	224.97	0.00	33.28
	(545.08)	(729.30)	(534.00)	(658.84)	(134.36)	(342.07)	(0.00)	(170.78)
Total	297.07	696.05	278.54	459.49	16.07	204.91	2.45	31.66
	(486.63)	(659.60)	(472.34)	(572.09)	(110.22)	(316.40)	(54.27)	(163.05)

†International Physical Activity Questionnaire Short Form. Records duration (minutes) and intensity (‘light’, ‘moderate’ or ‘vigorous’) of weekly physical activity. Weighted responses are combined to calculate total metabolic equivalent time (MET-minutes) of exercise.

Table 4 Mean light physical activity in MET-minutes at baseline, 12 weeks, 26 weeks and 52 weeks measured in Active Plus (A+) group only (standard deviations in parentheses).

	Light MET-mins†			
	Baseline	*12 weeks*	*26 weeks*	*52 weeks*
A+ (n=79)	229.75 (376.79)	550.56 (528.69)	431.72 (506.90)	464.51 (556.59)

†Total metabolic equivalent time of light exercise over previous seven days.

Table 5 Mean well-being scores and self-efficacy scores at baseline and 12 weeks in the Active Plus (A+) group and comparison group (standard deviations in parentheses).

	Well-being†		Self-efficacy‡	
	Baseline	*12 weeks*	*Baseline*	*12 weeks*
A+	45.32	60.50	28.75	31.98
	(21.94)	(20.91)	(4.04)	(4.07)
Comparison	43.76	50.51	27.58	28.88
	(18.13)	(19.30)	(5.62)	(5.52)
Total	44.99	58.40	28.50	31.32
	(21.17)	(20.95)	(4.44)	(4.59)

†Assessed by WHO-5 measure. Score range 0-100%. Higher scores indicate better quality of life. Scores ≤ 52% indicate likely clinically significant distress.
‡ Assessed by New General Self-Efficacy scale. Score range 0-40. Higher scores indicate better self-efficacy.

Table 6 Active Plus returns on investment and cost utility

		3 years median ongoing participation						5 years median ongoing participation					
		Programme Lifetime			*Established Phase*			*Programme Lifetime*			*Established Phase*		
Age	Time horizon	ROI_{NHS}[†]	ROI_{QALY}	$ICER_{QALY}$[¶]	ROI_{NHS}	ROI_{QALY}	$ICER_{QALY}$	ROI_{NHS}	ROI_{QALY}	$ICER_{QALY}$	ROI_{NHS}	ROI_{QALY}	$ICER_{QALY}$
≥61	5 years	87%	225%	Cost-saving	123%	286%	Cost-saving	112%	258%	Cost-saving	149%	326%	Cost-saving
	10 years	179%	712%	Cost-saving	223%	845%	Cost-saving	241%	863%	Cost-saving	299%	1021%	Cost-saving
	25 years	203%	1452%	Cost-saving	255%	1682%	Cost-saving	299%	1848%	Cost-saving	363%	2197%	Cost-saving
46-60	5 years	*-52%*[§]	*-17%*[§]	£11,601[‡‡]	*-42%*[§]	*0%*[§]	£7,677[††]	*-43%*[§]	*-6%*[§]	£8,651[††]	*-33%*[§]	9%[§]	£5,601[††]
	10 years	*-15%*[§]	147%	£1,009	4%[§]	201%	Cost-saving	16%[§]	210%	Cost-saving	34%[§]	268%	Cost-saving
	25 years	9%[§]	582%	Cost-saving	32%[§]	716%	Cost-saving	81%[‡]	923%	Cost-saving	113%	1110%	Cost-saving

Active Plus was a multi-session motivational interviewing and signposting pathway.
ROI_{NHS}: NHS return on investment (net cost savings); ROI_{QALY}: Quality adjusted life years return on investment; $ICER_{QALY}$: Incremental cost-effectiveness ratio.
[†]Probability of positive return on investment >95% in all cases, except[‡] >90%, [§]<90%
[¶]Probability that cost-effective @£20,000 per QALY >99% in all cases, except[††] >90%, [‡‡]<90%

Table 7 Active in the Community returns on investment and cost utility

		3 years median ongoing participation						5 years median ongoing participation					
		Programme Lifetime			*Established Phase*			*Programme Lifetime*			*Established Phase*		
Age	Time horizon	ROI_{NHS}[†]	ROI_{QALY}	$\text{ICER}_{\text{QALY}}$[¶]	ROI_{NHS}	ROI_{QALY}	$\text{ICER}_{\text{QALY}}$	ROI_{NHS}	ROI_{QALY}	$\text{ICER}_{\text{QALY}}$	ROI_{NHS}	ROI_{QALY}	$\text{ICER}_{\text{QALY}}$
≥61	5 years	15%[§]	88%	Cost-saving	34%[‡]	118%	Cost-saving	29%[§]	106%	Cost-saving	54%[‡]	141%	Cost-saving
	10 years	59%[‡]	361%	Cost-saving	88%	439%	Cost-saving	96%	435%	Cost-saving	135%	541%	Cost-saving
	25 years	68%[‡]	770%	Cost-saving	96%	912%	Cost-saving	124%	1022%	Cost-saving	166%	1217%	Cost-saving
46-60	5 years	*-31%*[§]	13%[§]	£5,559[††]	*-17%*[§]	35%[§]	£2,655	*-20%*[§]	27%[§]	£3,220	*-5%*[§]	50%[‡]	£768
	10 years	15%[§]	230%	Cost-saving	37%[§]	289%	Cost-saving	60%[‡]	318%	Cost-saving	87%[‡]	392%	Cost-saving
	25 years	46%[§]	795%	Cost-saving	70%[‡]	946%	Cost-saving	138%	1242%	Cost-saving	183%	1499%	Cost-saving

Active in the Community was a single session signposting pathway.
ROI_{NHS}: NHS return on investment (net cost savings); ROI_{QALY}: Quality adjusted life years return on investment; $\text{ICER}_{\text{QALY}}$: Incremental cost-effectiveness ratio.
[†]Probability of positive return on investment >95% in all cases, except[‡] >90%, [§]<90%
[¶]Probability that cost-effective @£20,000 per QALY >99% in all cases, except[††] >95%

Fig. 1. SISEM measure of physical activity: pathway by time interaction.