

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

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

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16 Increasing physical activity (PA) among inactive middle-older aged adults in rural
17 communities is challenging. This study investigates the efficacy of a PA intervention
18 supporting inactive adults in rural/ semi-rural communities. Inactive participants
19 enrolled on either a single signposting session (n=427), or multi-session pathway
20 combining signposting with motivational interviewing (MI) (n=478). Pre-post
21 outcomes data assessed activity levels (IPAQ-S; SISEM), self-efficacy (NGSE) and
22 well-being (WHO-5). Measures were repeated at longitudinal time points (26, 52
23 weeks) for the MI pathway. Outcomes were contrasted with results from an
24 unmatched comparison group receiving treatment as usual (TAU). Cost-utility
25 (QALY-ICER) and return on investment (NHS-ROI; QALY-ROI) were estimated for
26 short (5 years), medium (10 years) and long (25 years) time horizons. Both pathways
27 significantly increased participants' PA. The MI pathway resulted in significantly
28 greater increases in PA than signposting-only and TAU. Improvements in
29 psychological outcomes (NGSE; WHO-5) were significantly greater in the MI
30 pathway than TAU. Longitudinal results indicated MI pathway participants sustained
31 increases in light-intensity PA at 52 weeks ($p<.001$; $\eta^2=.16$). Regression analyses
32 found baseline self-efficacy predicted increased PA at 52 weeks, while baseline well-
33 being did not. The relationship between self-efficacy and PA increased successively
34 across time points. However, the magnitude of participants' increased self-efficacy
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3 did not predict PA at any time point. Both pathways were cost-effective and cost-
4 saving for participants aged ≥ 61 years from the short time horizon, with the MI
5 pathway having greater return on investment estimates. Overall, MI increased
6 efficacy of a signposting PA intervention, and was cost-saving for older adults.
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15 **Keywords**

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18 Self-efficacy; quality of life; exercise; motivation
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24 **What Is known about this topic**

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- 30 • Age-related health and lifestyle barriers increase the likelihood that adults
31 become less active as they grow older.
 - 32 • Adults living in rural areas are at increased risk of inactivity.
 - 33 • Motivational interviewing and social prescribing (exercise on prescription) are
34 techniques used in healthy lifestyle interventions.
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52 **What this paper adds**

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

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6 Encouraging adults to maintain recommended activity levels is highly challenging for
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8 professionals. Exercise in mid-later life is impaired by age-related barriers including
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10 worsening physical and/ or mental health, weight gain, social isolation, parenting,
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12 caring, menopausal changes, feeling 'out of place' in sports facilities and decreased
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14 confidence and self-efficacy relating to exercise (Chief Medical Officers, 2019; Cowie
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16 et al., 2018; Morgan et al., 2016; Pereira & Power, 2017; Villaverde-Gutiérrez et al.,
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18 2006; Zaleski et al., 2016). 'Exercise prescriptions' for middle-older aged adults
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20 should combine encouragement with specific, educative advice (Mazzeo & Tanaka,
21
22 2001). They should consider pre-existing conditions and symptoms reported upon
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24 exertion, plus support to tackle age-related socioeconomic barriers (Mazzeo &
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26 Tanaka, 2001; Morgan et al., 2016; Singh, 2002; Zaleski et al., 2016).

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

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51 The NHS Health Trainer model was designed to provide one-to-one, community-
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53 based support for positive health behaviour change (Bickerdike et al., 2017). Health
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55 Trainer Services (HTS) deliver manualised one-to-one interventions to develop
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57 healthier lifestyles. Health psychology behaviour-change models underpin HTS,
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3 targeting knowledge, motivation and self-efficacy (Michie *et al.*, 2008). Though HTS
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5 do not specifically focus on PA, evaluations report associated increases in exercise
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7 levels. Exercise Referral Schemes (ERS) also operate around the UK, signposting to
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9 community-based exercise groups and trainers (Bickerdike *et al.*, 2017). Evaluations
10
11 of ERS report modest increases in PA and a range of positive psychological
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13 outcomes (Bickerdike *et al.*, 2017; Hanson *et al.*, 2013; Thomson *et al.*, 2015).
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15 Advancing age predicts uptake and adherence, suggesting ERS particularly engage
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17 older adults (Hanson *et al.*, 2013). Combining elements of these models could
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19 increase positive outcomes from PA interventions. Professionals may incorporate
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21 this idea into interventions designed for adults in rural communities.
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26 This study investigates the **efficacy** of Active HERE - a brief, personalised PA
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28 intervention. Development and delivery of the programme was in Herefordshire, a
29
30 large, rural English county, with a significantly older and inactive adult population
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32 (Herefordshire Council, 2020). Key research questions asked if Active HERE
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34 increased participants ^{a)}PA levels, ^{b)}psychological well-being, and ^{c)}self-efficacy.
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36 Intervention **cost-effectiveness** was estimated.
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44 **Participants and methods**

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50 Granted by the Research Ethics Committee of the Faculty of Education, Health and
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52 Well-being, University of Wolverhampton.
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55 Participation was voluntary and did not affect intervention access. Participants
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57 received written and verbal explanation of the evaluation process and of their rights
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59 to withdraw. All participants provided both written and verbal consent.
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3 The study design was informed by a framework for evaluating public health PA
4 interventions (Cavill et al., 2012). A quasi-experimental pre-post design was used
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6 with two intervention pathways and an unmatched comparison pathway. Pre-post
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8 data was collected at 0-12 weeks for all pathways. Additional longitudinal data (26,
9
10 52 weeks) was available for one intervention pathway.
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15 Participants were ≥ 18 years and engaged in one of the experimental pathways
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17 between January 2016 and June 2018. All pathways recruited using non-randomised
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19 consecutive sampling.
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23 24 25 Intervention (Active HERE)

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28 Active HERE was a brief intervention (1- 4 sessions) engaging inactive adults with
29
30 community-based entry-level PA. It was open to all Herefordshire residents aged ≥ 18
31
32 years. Participants selected one of two intervention pathways - *Active in the*
33
34 *Community* (AiC) or *Active Plus* (A+). Both pathways were based on established
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36 health psychology behaviour change models (Bickerdike et al., 2017; Gardner et al.,
37
38 2012). A database of entry-level PA available throughout Herefordshire was built and
39
40 maintained by the delivery team.
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48 49 AiC pathway

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

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3 *Single Item Sport England Measure (SISEM)* (Milton et al., 2011)
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6 SISEM identifies, during the previous seven days, how often the respondent has
7
8 undertaken PA \geq 30 minutes. SISEM defines PA as enough to increase breathing
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10 rate, excluding housework or job-related activities. SISEM was used as an eligibility
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12 screening tool, with people reporting 0 days on SISEM classified as eligible to
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14 participate in this study.
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21 *International Physical Activity Questionnaire – (IPAQ-S)* (IPAQ Group, 2020)
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24 IPAQ-S is a 7-item questionnaire gauging PA undertaken during the previous seven
25
26 days. IPAQ-S records the duration (*minutes*) and intensity (*'light'*, *'moderate'* or
27
28 *'vigorous'*) of weekly PA. Weighted responses are combined to calculate total
29
30 metabolic equivalent time (MET-minutes) of exercise. IPAQ-S is most reliable and
31
32 valid in middle-aged adult populations from developed countries (Craig et al., 2003).
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39 *World Health Organisation Well-being Index - 1998 (WHO-5)* (Psychiatric Research
40
41 Unit, 1998)
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44 This unidimensional, 5-item questionnaire measures respondents' psychological
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46 well-being over the previous two-weeks on a 6-point scale (Psychiatric Research Unit,
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48 1998). WHO-5 has good psychometric properties and is used widely in health
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50 research across the adult age spectrum (Allgaier et al., 2013; Bech et al., 2003;
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52 Birket-Smith et al., 2009; De Wit et al., 2007; Ellervik et al., 2014; Garnefski et al.,
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54 2008; Schougaard et al., 2018; Snoek, 2006). Raw scores <13 (52%) indicate likely
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56 clinically significant distress.
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6 *New General Self-Efficacy Scale (NGSE)* (Chen, Gully & Eden, 2016)
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9 A unidimensional 8-item questionnaire measuring general self-efficacy on a 5-point
10 scale. *NGSE* has good psychometric properties and has been used in health
11 behaviour research (Hepburn, 2018; Vuotto et al., 2015).
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19 Quantitative analyses

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22 Statistical analyses were conducted using SPSS 24. Results were considered
23 statistically significant at $p < .05$. Differences between categorical demographic
24 variables were assessed using χ^2 analyses. A series of mixed design ANOVAs were
25 run. There was a between groups factor Pathway, which had up to three levels: A+,
26 AiC, and comparison/TAU pathway (Com). The within groups factor was Time with
27 up to four time points (0, 12, 26, 52 weeks). As shown in Table 1, for most
28 measures, only two groups or two time points were compared. There were seven
29 continuous dependent variables: 1) weekly participation in PA (SISEM), 2) total
30 duration of PA (IPAQ-S), 3) duration of light PA (IPAQ-S), 4) duration of moderate
31 PA (IPAQ-S), 5) duration of vigorous PA (IPAQ-S), 6) self-efficacy (NGSE), 7) well-
32 being (WHO-5). Interaction effects between time and intervention pathway were
33 followed-up with simple effects tests. Effect sizes are reported as partial eta squared
34 (ηp^2) and interpreted as small ($\leq .01$), medium ($\leq .06$), or large ($\leq .14$). Effect sizes for
35 χ^2 tests are reported as Cramer's V and interpreted as weak (.10 - <.20), moderate
36 (.20 - <.40), relatively strong (.40 - <.60), or strong ($\geq .60$).
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Cost-utility and return on investment (ROI) analyses

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3 Cost-utility and ROI analyses were undertaken using Sport England's Model for
4 Estimating Outcomes and Values in the Economics of Sport tool (MOVES v2.0).

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7 MOVES was developed with the purpose of informing decision-makers planning and
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9
10 evaluating PA interventions. The tool estimates anticipated cost-utility and ROI
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12 relating to health and health-related quality of life (Sport England, 2020).

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15 Avoided cases of disease are modelled using UK epidemiological data referencing
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17 prevalence and disease-related morbidity and mortality data for eight common health
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19 conditions: type 2 diabetes, ischaemic heart disease, stroke, dementia, depression,
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21 breast and colon cancers, and hip fracture. The model compares physically active
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23 populations against those who are inactive. Disease-related risk and impact are
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25 adjusted according to activity level, intensity and maintenance.
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30 Two ROI figures are reported. NHS-ROI estimates cost savings as a result of
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32 avoided disease cases, relative to direct NHS costs for one year of treatment. An
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34 ROI of 100% means that £2 of NHS cost savings are projected for every £1 spent on
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36 intervention delivery. QALY-ROI estimates the monetary value associated with
37
38 quality adjusted life years (QALYs) resulting from the intervention. QALYs measure a
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40 person's quality of life over a defined period of time. The National Institute for Health
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42 and Care Excellence (NICE) accepts values <£20,000 per QALY as cost-effective
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44 (NICE 2013). QALY-ROI is calculated by multiplying QALYs gained as a result of
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46 avoided disease cases by £20,000. Zero-benefit is assumed for those engaged with
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48 PA for <1 year. MOVES 2.0 accrues diminishing returns for additional activity,
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50 meaning benefits are greatest in the least active groups. The model does not
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52 account for differences in health profile relating to geographic area, social care costs
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54 or costs of sports-related injuries (Sport England, 2020).
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3 Cost-utility was calculated using an incremental cost-effectiveness ratio (ICER).
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5 QALY-ICER is the ratio of the change in costs to the increase in QALYs gained from
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7 the intervention. Even where ROI is negative (i.e. provision costs are greater than
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9 benefits accrued), an intervention is still considered by NICE to be cost-effective if
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11 the QALY-ICER is <£20,000:
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$$14 \quad QALY \text{ ICER} = \frac{15 \quad \text{"with intervention cost"} - \text{"without intervention cost"}}{16 \quad \text{"with intervention QALY"} - \text{"without intervention QALY"}} 17$$

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19 Cost utility and ROI analyses were conducted only for Active HERE participants >45
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21 years due to low participation of those <45 years. In the absence of longitudinal data
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23 on maintenance levels beyond 52 weeks, projections were calculated for two median
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25 durations of ongoing participation: 5 years, a realistic scenario based on available
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27 data, and 3 years, which represents a higher rate of drop-off than observed during
28
29 the study period. Calculations were undertaken using three time horizons: short (5
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31 years), medium (10 years) and long (25 years).
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39 RESULTS

40 Participant demographics

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42 Table 2 presents demographic data for the 905 Active HERE participants, of whom
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44 53% participated in A+ and 47% in AiC.
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49 *Participation in PA: baseline – 12 weeks (SISEM measure).*

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51 At 12-weeks, all pathways saw PA increase, with greatest changes on the A+
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53 pathway (69.3%) and the lowest for TAU (22.6%). A statistically significant and
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3 strong main effect of time ($n=596$; $F(1, 593)=183.747$, $p<0.001$, $\eta p^2= 0.24$) indicated
4 a general increase in activity at 12 weeks compared to baseline levels.
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8 A significant interaction (see Figure 1) was found between time and pathway type,
9 though this was a small effect ($n=596$; $F(2, 594)=9.03$, $p<0.001$, $\eta p^2 = 0.03$). Simple
10 effects analyses showed that activity increased in all pathways: TAU ($F(1,$
11 $593)=11.58$, $p=.001$, $\eta p^2=.02$), AiC ($F(1, 593)=126.93$, $p<.001$, $\eta p^2=.18$) and A+ ($F(1,$
12 $593)=306.79$, $p<.001$, $\eta p^2=.34$), but Bonferroni post-hoc tests comparing post-minus-
13 pre difference scores indicated that in the A+ pathway ($p=.001$) but not in the AiC
14 pathway ($p=.247$) activity increased significantly more than for TAU.
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28 *Total duration (MET-mins) of PA: baseline – 12 weeks (IPAQ-S measure) comparing*
29 *AiC with A+ pathway.*
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33 A statistically significant and strong main effect of time indicated a general increase
34 in the total duration of PA (MET-minutes) from 0-12 weeks ($F(1, 487) = 225.20$;
35 $p<.001$; $\eta p^2 = 0.32$). There was also a significant main effect of pathway ($F(1,$
36 $487)=54.23$, $p<.001$, $\eta p^2=.10$) and a medium-sized interaction (see Table 3)
37 between pathway and time, with A+ participants experiencing a higher average
38 increase in amount of weekly activity (MET-minutes) than those following the AiC
39 pathway ($F(1, 487) = 25.05$, $p<.001$, $\eta p^2 = 0.05$). Simple effects showed that there
40 was significantly improved total MET-mins scores in both AiC ($F(1, 487) = 44.63$,
41 $p<.001$, $\eta p^2 = 0.08$) and A+ ($F(1, 487) = 227.71$, $p<.001$, $\eta p^2 = 0.32$) pathways, but
42 the effect was stronger in the A+ pathway.
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3 *Level of light-intensity PA: baseline – 12 weeks (IPAQ-S) comparing AiC with A+*
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5 *pathway.*

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8 A significant, moderate strength main effect of time was found. Levels of light-
9 intensity activity at 12 weeks were higher than compared to baseline ($F(1,488) =$
10 $55.54, p < .001, \eta p^2 = 0.10$). There was a main effect of pathway ($F(1, 487) = 54.99,$
11 $p < .001, \eta p^2 = .10$) and a significant but small interaction was found (see Table 3):
12 simple effects showed that those on the A+ pathway significantly increased light
13 activity ($F(1, 487) = 83.08, p < .001, \eta p^2 = .15$) those on AiC did not ($F(1,487) = 3.54,$
14 $p = .060, \eta p^2 = 0.006$).
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28 *Levels of moderate-intensity PA: baseline – 12 weeks (IPAQ-S) comparing AiC with*
29 *A+ pathway.*

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32 Moderate level PA increased from baseline to 12-weeks and this was a strong main
33 effect of time ($F(1,487) = 187.24, p < .001, \eta p^2 = .278$). There was no main effect of
34 pathway ($F(1,487) = 2.62, p = .106, \eta p^2 = .005$) and no significant interaction ($F(1,487)$
35 $= 1.86, p = .173, \eta p^2 = .004$), thus both A+ and AiC pathways saw increases in
36 moderate exercise at 12 weeks (see Table 3).
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48 *Outcome for levels of vigorous-intensity PA - baseline – 12 weeks comparing AiC*
49 *with A+ pathway.*

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52 Just one participant engaged in vigorous PA at baseline, though this did not exceed
53 the exclusion threshold of 30 minutes per week. At 12-weeks, some 23 participants
54 (4.5%) were undertaking vigorous weekly activity. Despite vigorous intensity activity
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3 only being undertaken by 1 out of every 20 participants, there was a strong main
4 effect of time ($F(1,487) = 13.30, p < .001, \eta p^2 = .27$). There was no main effect of
5 pathway ($F(1,487) < 1$) and no significant interaction ($F(1,487) < 1$), thus both A+ and
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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 ($F(3, 234) = 11.81, p < .001; \eta p^2 = .13$), 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 ($F(1, 78) = 48.64, p < .001; \eta p^2 = .384$), 26 weeks ($F(1, 78) = 14.00, p < .001; \eta p^2 = .15$) and 52 weeks ($F(1, 78) = 14.86, p < .001; \eta p^2 = .16$).

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 ($\chi^2(df = 2) = 25.01; p < .05$).

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 ($\chi^2(df = 1) = 20.993; p < .001$). This was a moderate effect size (Cramer's $V = 0.303$).

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3 There was no significant association between pathway type and completion rate for
4 middle-aged participants (46-60 years), who were more likely to complete than not
5 complete both the A+ and AiC pathways, (χ^2 (df = 1) = 3.399, $p > .05$, Cramer's V =
6 0.194).
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16 Subgroup differences for outcomes

17 18 *Outcome for well-being (WHO-5): baseline - 12 weeks, comparing TAU with the A+* 19 20 21 *group* 22

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24 Baseline well-being scores for A+ and TAU were broadly equivalent, and indicated
25 clinically significant distress (Psychiatric Research Unit, 1998). There was a main
26 effect of time ($F(1, 240) = 53.69$, $p < .001$, $\eta p^2 = .183$) with a general improvement in
27 well-being at 12-weeks. There was a main effect of pathway ($F(1, 240) = 3.87$,
28 $p = .050$, $\eta p^2 = .02$) and also a significant interaction ($F(1, 240) = 7.95$; $p = .005$; $\eta p^2 = .03$),
29 with simple effects showing that although well-being had improved significantly in the
30 TAU group ($F(1, 240) = 6.44$, $p = .012$, $\eta p^2 = .003$) the improvement was even greater in
31 the A+ group ($F(1, 240) = 122.13$, $p < .001$, $\eta p^2 = .34$) (see Table 5). At 12-weeks, mean
32 scores for those following A+ were now significantly elevated above the cut-off for
33 clinically significant distress (Psychiatric Research Unit, 1998).
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50 *Outcome for self-efficacy (NGSE): baseline - 12 weeks, comparing TAU with the A+* 51 52 *group* 53

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55 Baseline self-efficacy scores for the A+ and TAU were broadly equivalent. There was
56 a main effect of time ($F(1, 241) = 47.68$, $p < .001$, $\eta p^2 = .17$) and of pathway ($F(1,$
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3 241)=12.33, $p=.001$, $\eta p^2=.05$) and a significant interaction ($F(1, 241)=8.53$, $p=.004$,
4
5 $\eta p^2=.03$). Simple effects showed that at 12 weeks although self-efficacy had
6
7 improved significantly for the TAU group ($F(1, 241)=5.05$, $p=.026$, $\eta p^2=.02$) the
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9 improvement was even greater in the A+ group ($F(1, 241)=112.81$, $p<.001$, $\eta p^2=.32$)
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11 (see Table 5).
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18 *Predicting maintenance of PA over time (Total MET-minutes, IPAQ-S) with self-*
19 *efficacy and well-being*
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23 In participants who recorded PA (total MET-minutes) at all four time points ($n=74$),
24
25 we tested whether baseline self-efficacy and well-being respectively predicted total
26
27 MET mins at baseline, 12, 26 and 52 weeks.
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33 *Self-efficacy:*
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36 In those whose PA (total MET-minutes) was measured at all four time points ($n=74$),
37
38 baseline self-efficacy predicted PA most strongly at 52 weeks. A multivariate
39
40 regression using Pillai's trace found an overall significant relation between self-
41
42 efficacy and PA ($V=.15$, $F(4, 69)=3.04$, $p=.023$; $\eta p^2=.15$) with univariate analyses
43
44 showing that the relation between baseline self-efficacy and PA grew stronger at
45
46 each successive time point: baseline ($F(1, 72)<1$, $\eta p^2=.002$, $B=4.67$), 12 weeks, ($F(1,$
47
48 $72)=3.35$, $p=.071$, $\eta p^2=.04$, $B=32.14$), 26 weeks ($F(1, 72)=2.97$, $p=.084$, $\eta p^2=.04$,
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50 $B=37.28$) and 52 weeks ($F(1, 72)=9.23$, $p=.003$, $\eta p^2=.11$, $B=63.09$). Thus self-
51
52 efficacy at baseline best predicted PA at the final time point.
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58 An additional multivariate regression ($V=.14$, $F(4, 49)<1$, $\eta p^2=.03$) examined whether
59
60 *improvement* in self-efficacy from baseline to 12 weeks predicted PA over time (12,

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3 26 and 52 weeks). This was not the case: increase in self-efficacy did not predict
4 total MET-minutes at any of the time points ($p \geq .313$).
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10 *Well-being:*

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14 Again, in those whose PA (total MET-minutes) was measured at all four time points
15 (n=74), baseline well-being predicted PA best at 12 weeks, but the effect diminished
16 with successive time points. In a multivariate regression using Pillai's trace, well-
17 being significantly predicted PA overall ($V=.14$, $F(4, 69)=2.81$, $p=.032$; $\eta p^2=.14$) with
18 univariate analyses showing that the relation between baseline well-being and PA
19 was not significant at baseline ($F(1, 72)=3.24$, $p=.076$, $\eta p^2=.04$, $B=4.06$), was
20 significant at 12 weeks, ($F(1, 72)=10.70$, $p=.002$, $\eta p^2=.13$, $B=9.19$), but tailed off at
21 26 weeks ($F(1, 72)=2.90$, $p=.093$, $\eta p^2=.04$, $B=6.18$) and 52 weeks ($F(1, 72)=1.84$,
22 $p=.179$, $\eta p^2=.03$, $B=4.96$). Thus baseline self-efficacy was a more powerful predictor
23 than well-being of sustained PA (i.e. at 52 weeks).
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43 Cost of intervention

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46 Cost of establishing Active HERE included community-based recruitment, locating
47 and assessing community-based activities for quality and suitability, developing and
48 maintaining a comprehensive activity database, and marketing Active HERE to
49 public and local sports sectors. Following the set-up phase, ongoing costs lessened,
50 now primarily revolving around database maintenance, ongoing recruitment and core
51 intervention work. Therefore two programme costs are reported for each pathway:
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3 'programme lifetime' representing cost per participant over the full duration of the
4 programme (£230 per A+ participant and £115 per AiC participant) and 'established
5 phase' representing cost per participant from the second year of operation onwards
6 (£195 per A+ participant and £98 per AiC participant).
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15 ROI and cost-utility (≥61 years)

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18 QALY-ICER indicated a cost saving for both A+ and AiC pathways across short,
19 medium and long time horizons, for both 'lifetime' and 'established' phases, and for
20 the lowest levels of ongoing participation. Both intervention pathways were assessed
21 to be cost-effective @£20,000 per QALY, with >99% probability (Table 6; Table 7).
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28 A positive QALY-ROI was calculated across both A+ and AiC pathways and in all
29 instances. Modelled projections for QALY-ROI were higher for A+ than AiC, and in all
30 instances were strong, with >95% probability that a positive ROI would be realised.
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34 A positive NHS-ROI was calculated in all instances for the A+ pathway, with >95%
35 probability. The majority of the projected avoided cases requiring treatment were hip
36 fractures, dementia and heart disease. Modelled NHS-ROI was lower for the AiC
37 pathway, with the 'established' phase calculated to have >95% probability of cost
38 savings only in the medium and long term. The 'lifetime' phase was also calculated
39 to have >95% probability of cost savings at the medium and long time horizons, but
40 only for the longer duration (median 5 years) of ongoing participation.
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52 ROI and cost-utility (46-60 years)

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3 QALY-ICER calculations for AiC indicated cost savings from the medium time
4 horizon onwards. Cost savings were also indicated for A+, but only for the longer
5 duration (median 5 years) of ongoing participation. AiC was assessed to be cost-
6 effective @£20,000 per QALY in the short, medium and long term, with >95%
7 probability (Table 7). A+ was assessed to be cost-effective @£20,000 per QALY at
8 the medium and long time horizons, with >99% probability (Table 6).
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18 Modelled projections for QALY-ROI were higher for AiC than for A+. A positive
19 QALY-ROI was calculated across both A+ and AiC pathways at the medium and
20 long time horizons, with >95% probability that a positive ROI would be realised.
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23 Short time horizon QALY-ROI projections were positive, but lower probability, for
24 AiC, and negative for A+.

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30 NHS-ROI was calculated to be negative for both pathways at the short time horizon.
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32
33 Modelled projections showed higher NHS-ROI for AiC than A+. Cost savings were
34 projected from the medium time horizon, but there was not a >95% probability of cost
35 savings until the long time horizon, and only then for the longer duration of ongoing
36 participation.
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45 **Discussion**

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48 Active HERE engaged mainly mid-older aged inactive adults in weekly PA through
49 an open-access, personalised signposting intervention based in the local community,
50 and resulted in maintenance of this behaviour for significant numbers of participants.
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53 The addition of MI increased the effectiveness of personalised signposting.
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57 Maintaining weekly PA over time is a key challenge for adults in mid-older age, and
58 risk of relapsing back to inactivity is significant at the end of targeted PA
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3 interventions (Amireault et al., 2013). Yet, maintenance is necessary in order that the
4
5 benefits of exercise to adults' physical and mental health are achieved.
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8 Discontinuation of gains in PA reverses the improvements to physical conditioning
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10 achieved during periods of activity (Amireault et al., 2013; Karinkanta et al., 2009).
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12 Cost-effective, brief and open-access interventions such as Active HERE provide a
13
14 valuable addition to public health programmes by creating lasting change in target
15
16 communities.
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20 Inactive adults are at increased risk of reduced psychological well-being (Galper et
21
22 al., 2006; Hamer et al., 2014). Active HERE significantly increased psychological
23
24 well-being in an inactive cohort who on average were found to have clinically
25
26 significant low well-being at baseline. PA has been widely found to enhance
27
28 psychological well-being and increase effectiveness of clinical treatments for
29
30 depression in middle-older age adults (World Health Organisation, 2018). Elevated
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32 mood is also likely to create a positive 'feedback loop' increasing intrinsic motivation
33
34 to maintain regular PA. Interestingly, the current study found that psychological well-
35
36 being at baseline most strongly predicted PA at 12 weeks, but did not predict PA
37
38 long-term. A possible explanation for this is that participants experienced a boost in
39
40 well-being as they engaged in the regular exercise throughout the intervention, which
41
42 is in line with other research citing the positive association of psychological well-
43
44 being with PA (Galper et al., 2006; Hamer et al., 2014). This increase in well-being is
45
46 an important outcome of exercise and is likely to have provided some motivation to
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48 continue with the intervention. However, an implication of the present study is that
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50 increased psychological well-being does not significantly contribute to maintenance
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52 of regular PA long term.
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3 Active HERE was based around the health psychology models underpinning the
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5 HTS programme. Self-efficacy broadly refers to an individual's confidence in their
6
7 autonomous ability to accomplish significant behaviours. Experimental research has
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9 found that self-efficacy predicts health-related behaviours, including maintenance of
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11 exercise, and is a central component in Self-Determination Theory (SDT) (Deci &
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13 Ryan, 1985). SDT predicts that behaviour change is most likely to be maintained by
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15 those individuals who are intrinsically motivated and self-efficacious towards the
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17 behaviour (Amireault et al., 2013; Deci & Ryan, 1985; Janssen et al., 2014; Selzler et
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19 al., 2016; Sheeran et al., 2016). In line with SDT, our longitudinal analysis found that
20
21 baseline levels of self-efficacy were the strongest predictor of whether a participant
22
23 sustained PA long-term when followed up one year post-baseline. Furthermore, it
24
25 was baseline self-efficacy, rather than improvement of self-efficacy in the first 12
26
27 weeks, which was the more powerful predictor of PA at 52 weeks. These findings
28
29 suggest the importance of public health messages that highlight the benefits of mid-
30
31 older aged adults undertaking PA. Provision of safe, entry-level exercise
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33 programmes for this age-group is vital to ensure these inactive individuals feel safe
34
35 and able to increase their PA levels. By focussing on MI and tailored
36
37 recommendations in the first intervention session, A+ participants' self-efficacy was
38
39 supported and developed from baseline. Distinct features of the Active HERE
40
41 delivery model may also have increased self-efficacy by tackling common barriers to
42
43 access and help-seeking. For example, Active HERE's non-clinical delivery format
44
45 and self-referral route may have reduced stigma, which has been found to prevent
46
47 people with mental health problems or obesity-related issues seeking support
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49 (Schnyder et al., 2017; Silveira et al., 2013). Subsequent A+ sessions celebrated
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51 success and tailored recommendations to overcome any emerging barriers, and this
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3 may be reflected in the finding that self-efficacy increased over time. The current
4
5 study therefore supports the assertion that interventions based around established
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7 behaviour change models, which include methods to overcome commonly reported
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9 practical and psychosocial barriers, are most likely to be effective in supporting
10
11 lasting behaviour change.
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14
15 Active HERE was assessed to be cost-effective. For participants ≥ 61 years, both
16
17 pathways were cost-saving, with A+ estimated to provide greater ROI than AiC. The
18
19 addition of MI was linked to improved outcomes, higher completion rate and
20
21 increased net cost savings from the short time horizon though, as participants self-
22
23 selected their pathway, other factors may be present. For participants aged 46-60,
24
25 addition of MI also improved outcomes, but did not significantly increase completion
26
27 rate or cost savings, with AiC estimated to provide greater ROI than A+. This may
28
29 indicate that older participants were more likely to experience barriers to
30
31 participation, which were addressed effectively by additional MI support. Another
32
33 consideration is that projected cases avoided were mainly hip fractures, dementia
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35 and heart disease, which are more prevalent in older people. This suggests that cost
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37 savings are likely to be realised more quickly with the older age group.
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43 ROI and cost-effectiveness were projected to increase over time for both pathways
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45 and both age groups. Projections were higher following the set-up phase, due to the
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47 reduced cost per participant once the programme was established. This indicates
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49 there are financial benefits to be derived from sustaining successful interventions,
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51 and in undertaking preventative projects to realise greater financial savings in the
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53 medium and long term.
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4 Practitioners working in both primary care and local communities are challenged by
5
6 the imperative to increase PA levels among inactive adults. Those working with mid-
7
8 older aged populations, and those in rural and semi-rural communities, face
9
10 increased challenge. Theoretically-based interventions, like Active HERE, offer
11
12 practitioners an evidence-based, time-limited, cost-effective model that can be
13
14 implemented across adult age ranges and health status. The community-based
15
16 nature of Active HERE, leveraging existing exercise practitioners and community
17
18 venues, increased cost-effectiveness by reducing delivery costs. Though beyond the
19
20 scope of this cost-effectiveness evaluation, it is likely that the project also added
21
22 value to the local sports and exercise economy, increasing promotion and
23
24 participation. The model is one of partnership and shared benefits to public health,
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26 primary care and community services.
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35 Limitations

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

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53 Active HERE successfully engaged mid-older aged inactive adults, living in a largely
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55 rural area, with regular PA. Change was maintained over time for a significant
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57 number of participants. Supplementing personalised signposting with MI increased
58
59 the effectiveness of the intervention. Active HERE was shown to be cost effective,
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3 with net cost savings for older adults (≥ 61 years) in the short, medium and long term,
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5 with savings increasing over time. The model, based around health-psychology
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7 theories of behaviour change, increased participants' self-efficacy and psychological
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9 well-being, and created holistic impact that reached beyond increasing weekly levels
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11 of PA. Future work is needed to confirm causal relationships between variables,
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13 additional impacts on participants' lives, and socioeconomic impacts on rural health
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15 and sports sectors.
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Table 1 Measures taken and time points for each pathway

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

[†]Single Item Sport England Measure. Number of days of exercise \geq 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)	<i>p</i> -value (A+ vs. AiC)
Gender (%)			
<i>Female</i>	74%	76%	n.s.
<i>Male</i>	26%	24%	
Age (% bands)			
<i>18 – 34 years</i>	11%	12%	n.s.
<i>35 – 44 years</i>	9%	11%	
<i>45 – 59 years</i>	28%	22%	
<i>≥ 60 years</i>	43%	45%	
<i>No response</i>	9%	10%	
Long-term health condition(s) (%)			
<i>None</i>	39%	79%	<i>p</i> <.001
<i>One</i>	31%	15%	
<i>Two</i>	15%	4%	
<i>Three</i>	8%	2%	
<i>≥ 4</i>	7%	0%	
Employment status (%)			
<i>Retired</i>	38%	36%	<i>p</i> <.001
<i>Employed (full-time)</i>	12%	22%	
<i>Employed (part-time)</i>	11%	8%	
<i>Self-employed</i>	5%	4%	
<i>Unemployed</i>	12%	4%	
<i>Permanently sick/disabled</i>	8%	2%	
<i>Other</i>	11%	11%	
<i>No response</i>	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	
	<i>Baseline</i>	<i>12 weeks</i>	<i>Baseline</i>	<i>12 weeks</i>	<i>Baseline</i>	<i>12 weeks</i>	<i>Baseline</i>	<i>12 weeks</i>
<i>AiC</i>	189.07 (374.26)	444.69 (447.56)	172.14 (353.13)	235.76 (320.70)	11.35 (68.07)	179.35 (279.01)	5.58 (81.84)	29.58 (153.01)
<i>A+</i>	381.82 (545.08)	893.29 (729.30)	362.04 (534.00)	635.05 (658.84)	19.78 (134.36)	224.97 (342.07)	0.00 (0.00)	33.28 (170.78)
<i>Total</i>	297.07 (486.63)	696.05 (659.60)	278.54 (472.34)	459.49 (572.09)	16.07 (110.22)	204.91 (316.40)	2.45 (54.27)	31.66 (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 [†]			
	<i>Baseline</i>	<i>12 weeks</i>	<i>26 weeks</i>	<i>52 weeks</i>
<i>A+ (n=79)</i>	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.

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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 [‡]	
	<i>Baseline</i>	<i>12 weeks</i>	<i>Baseline</i>	<i>12 weeks</i>
<i>A+</i>	45.32 (21.94)	60.50 (20.91)	28.75 (4.04)	31.98 (4.07)
<i>Comparison</i>	43.76 (18.13)	50.51 (19.30)	27.58 (5.62)	28.88 (5.52)
<i>Total</i>	44.99 (21.17)	58.40 (20.95)	28.50 (4.44)	31.32 (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					
		<i>Programme Lifetime</i>			<i>Established Phase</i>			<i>Programme Lifetime</i>			<i>Established Phase</i>		
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

Age	Time horizon	3 years median ongoing participation						5 years median ongoing participation					
		<i>Programme Lifetime</i>			<i>Established Phase</i>			<i>Programme Lifetime</i>			<i>Established Phase</i>		
		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	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; 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^{††} >95%

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

