An integrated motivational interviewing and cognitive-behavioural intervention promoting physical activity maintenance for adults with chronic health conditions: A feasibility study

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Abstract

Objectives: Physical activity (PA) is recommended for managing chronic health conditions but is rarely maintained. This feasibility study aimed to evaluate the preliminary efficacy of a Motivational Interviewing and Cognitive Behavioral (MI-CB) intervention for long-term PA for adults with chronic health conditions.

Methods: Participants (*N*=37) with stable conditions (e.g. diabetes) were randomized into a three-month MI-CB group (*N*=20) or usual care (*N*=17) after completing a Physical Activity Referral Scheme. Participants completed PA (e.g. average steps per day and kcal expenditure), psychological (e.g. self-efficacy) and epidemiological (e.g. BMI) standardized measures at baseline, three and six-months follow-up. Treatment fidelity and feasibility were assessed.

Results: Thirty-five participants completed the study (96% retention). The MI-CB group maintained kcal expenditure at three (p=0.009) and six months (p=0.009). Exercise barrier self-efficacy (p = 0.03), physical (p = 0.02) and psychological (p = 0.01) PA experiences were increased at three months only. No difference was found for average steps/day, social support, coping skills and epidemiological factors.

Discussion: This is the first study to demonstrate the feasibility and preliminary efficacy of MI-CB interventions for promoting PA maintenance in a clinical population. A large-scale trial with a longer follow-up (≥ 6 months) is warranted with treatment fidelity assessment.

Keywords

Chronic health conditions, health behavior change, motivational interviewing, self-efficacy, physical activity maintenance

Life expectancy is expected to rise worldwide with an increase in the number of adults living with multiple chronic health conditions from 44 million to 135 million by 2050, placing increasing pressure on healthcare systems.[1] Research has suggested that interventions need to target the commonalities of treatment for multiple health conditions, rather than single-disease interventions to increase cost-effectiveness.[2] Physical activity (PA) is one such treatment component that supports patient's self-management or prevention of cardiovascular disease, Type II diabetes and associated risk factors (e.g. hypertension).[2] A systematic review evaluated the effectiveness of interventions promoting PA in sedentary adults and found limited evidence of long-term effectiveness, which could limit health benefits.[3] Interventions often over-emphasize PA initiation and neglect long-term behavior change.[4] Therefore, effective intervention components and strategies for PA maintenance are required.[4,5]

Psychotherapeutic approaches are promising interventions that promote PA in adults with chronic health conditions.[2] One such approach is motivational interviewing (MI).[6] MI is a person-centered, goal-orientated approach that enhances motivation for behavior change by eliciting client change talk (e.g. desire, ability, reasons, and need) and commitment to action and change.[6] A systematic review demonstrated that MI interventions produce a small effect in increasing initial PA in adults with chronic health conditions but the evidence for long-term effectiveness is lacking.[7] One reason could be that MI was originally developed to establish a therapeutic relationship and increase motivation for *initial* behavior change.[6] Alternatively, action-oriented approaches, such as cognitive-behavioral (CB) techniques (e.g. action planning and problem solving), can help support the translation of motivational intentions into volition and maintenance of behavior change, and could be a promising adjunct to MI.[8,9.]

Currently, the methods and benefits for MI-CB integration remain largely theoretical within a PA setting and examples of implementation for adults with chronic health conditions have not been empirically tested. Studies that have integrated MI-CB were conducted in adolescent obesity or mental health fields but were methodologically flawed (e.g. equipment malfunction, non-compliance of measures, and unblinding of condition allocation).[10,11] Furthermore, PA counselling interventions lack assessment of psychological outcomes and treatment fidelity assessments.[12] Assessing fidelity of intervention delivery can optimize intervention effectiveness by identifying and correcting protocol deviations early and help sustain practitioner's skills.[12] Robust research is needed to evaluate whether MI-CB is effective for sustained PA behavior change. If such an intervention is effective, it will provide practitioners with the tools to reduce patient's risk of relapse and enhance adherence to services.[9]

The aim of this study was to test the feasibility and preliminary efficacy of an MI-CB intervention, with treatment fidelity assessment, for promoting PA maintenance (e.g. kcal expenditure and average steps per day), psychological outcomes (e.g. self-efficacy) and weight across six-months post-completion of a physical activity referral scheme (PARS) compared to usual care.

Method

Participants

PARS has been described elsewhere.[13] Briefly, patients are referred to a 12-week tailored exercise program by a health professional. After PARS completion, individuals with at least one cardiovascular risk factor (e.g. hypertension) or health condition (e.g. diabetes) were invited to the study by a referral officer or postal invitation from six leisure centers in South Yorkshire, UK. Participants were eligible if they had: (1) completed ≥75% of sessions (i.e.18-24 one-hour sessions) to ensure PA levels had sufficiently increased from sedentary;

(2) had a stable health condition; and (3) were aged 18 or older. Exclusion criteria included: a hearing impairment or a major operation scheduled during the study. A computer generator (NQUERY Version 7.0) produced a randomization sequence which allocated participants to the MI-CB intervention or usual care (UC) group on a case-by-case (1:1) basis. Ethical approval was obtained from Sheffield Hallam University's Local Research Ethics Committee (HWB-2011/12-S&E-07).

Design

The study was a multi-center randomized controlled feasibility study with a three-month active intervention period that assessed PA, weight and psychological measures at baseline, post-intervention (3 months) and follow-up (6 months).

Procedure

Interested participants were provided with further information about the study and a consent form. Participants were invited to an assessment and randomized into the study after baseline measures were completed.

MI-CB intervention. The 12-week MI-CB intervention was developed using intervention mapping[14] and included seven sessions: two one-hour face-to-face sessions delivered at the initial assessment (week 1) and exit interview (week 12) and five telephone sessions lasting 15-30 minutes in weeks 2-4, 6 and 8. Table 1 displays the intervention schedule, theories and techniques. Multiple theoretical components found to influence PA maintenance informed the intervention: theory of behavioral maintenance,[5] social cognitive theory,[15] relapse-prevention,[16] and expectancy-value theory.[17] Eight theory-derived determinants were targeted: PA outcome expectations, PA outcome experiences, PA outcome expectations-

experiences discrepancy, values, exercise barrier self-efficacy, social support, and coping skills. MI was the underpinning counselling approach used to influence motivation, self-efficacy and discrepancies/ambivalence.[6] A toolkit of 36 CB techniques derived from a taxonomy[18] and a previous study[19] were tailored to the individual.

******INSERT TABLE 1 HERE******

Usual care group. Individuals completing PARS are usually offered discounted gym membership or exercise classes by the leisure center. All individuals invited to take part in the study had signed-up to the offer. No additional PA support was offered throughout this study for those randomized into the UC group. For ethical consideration, all UC group participants received a one-hour feedback session on questionnaire results after the study ended and was delivered using components consistent with MI-CB.

Treatment Fidelity

The intervention was delivered by the primary researcher who completed six MI workshops facilitated by a trainer from the Motivational Interviewing Network of Trainers (MINT). Training included theory and audio-recorded supervised roleplays. Competence was assessed using the Motivational Interviewing Treatment Integrity (MITI) form (v 3.1.1)[20] by the trainer. Six supervisions post-training were received where feedback was provided on audio-recorded sessions.

Measures

Information on age, gender, ethnicity, employment status, and self-reported health condition(s) was collected at baseline.

Primary outcomes. The Silva ex[3] Plus triaxial pedometer measured average daily steps. The pedometer has been validated in an older adult clinical population.[21] The Community Healthy

Activities Model Programme for Seniors Scale (CHAMPS) consists of 41 items and measures total weekly kilocalorie (kcal) expenditure from all intensities (kcal-All/week) and moderate-vigorous PA (MVPA; kcal-MVPA/week).[22] The scale correlates well with doubly-labelled water tests: the gold-standard for measuring energy expenditure (r = 0.28).[23]

Secondary outcomes. The Barrier Self-efficacy for Exercise Scale (BARSE)[24] is a 13-item scale, 100-point percentage scale and measures participant's perceived capabilities to exercise three times a week if barriers are present (e.g. fatigue). The scale demonstrates excellent internal consistency (α = 0.92).

The Outcome Expectations and Realizations for Physical Activity Scale (OERS) is a 14-item scale which measures PA outcome expectations at baseline and PA outcome realizations/experiences at follow-up.[17] Factors are categorized into physical (e.g. weight loss) and psychological expectations and experiences (e.g. stress reduction). The OERS scale demonstrates good internal consistency (α = 0.87).

The COPE scale is a 60-item multi-dimensional measure, which assesses adaptive (e.g. planning) and maladaptive coping (e.g. denial) as outlined in the manual[25] Maximum scores for adaptive and maladaptive coping strategies are 112 and 48 respectively. Two adaptive coping subscales were used to measure seeking instrumental and emotional social support. The maximum score for each subscale is 16. The scale demonstrates excellent internal consistency (α = 0.87).

Epidemiological measures. Weight (kg) was measured using calibrated scales in each center. Clinical significance for weight was $\geq$ 5% loss from baseline weight.[26] Body Mass Index (kg/m^2) was calculated using height and weight.

Feasibility measures. Retention and adherence were assessed using attendance figures and session duration from the audio-tapes. Recruitment was assessed using response rates.

Treatment Fidelity. Three 10-minute segments were analyzed from separate audio-tapes by an independent coder using the MITI[20] and assessed proficiency to deliver open questions (≥50%), complex reflections (≥40%), MI adherent behaviors (≥90%) and global ratings of MI (≥3.5). Frequencies and the mean number of CB techniques delivered during the intervention were calculated after the study by listening to each audio-tape.

Analysis

Descriptive statistics (e.g. mean (M) and standard deviation (SD)) were calculated for each group at each time point to enable a comparison between groups. Statistical significance was set at $p \leq .05$. Intention-to-treat analysis was used for missing data using the last-observation-carried forward approach.[27] Data were analyzed using SPSS 19 for Windows. Between-group baseline differences were performed using chi-square tests on categorical variables and *t*-tests for continuous variables. Repeated-measures ANCOVA ($_{rm}$ANCOVA) was used for Time x Group comparisons consisting of 2 (time: 3 and 6 months) x 2 (group: intervention and control) with baseline data as the covariate. Square root log transformations were performed when two or more test assumptions were violated. Effect sizes and 95% confidence intervals were calculated using Hedges' (adjusted) g to correct for small samples. The magnitude of effect was assessed as large (0.8), medium (0.5), and small (0.2).[28] The study aimed to recruit 60 participants based on pilot study guidelines.[29]

Results

Sample characteristics

Thirty-seven participants were randomized and 35 participants successfully completed the study (Figure 1). Table 2 shows the descriptive statistics of the overall sample, MI-CB

intervention and UC group. The mean age of participants was 59.34 years (S.D. = 10.86) and 57% were male. Two participants dropped out of the MI-CB intervention before the intervention started (their baseline data were excluded from analyses). Reasons for drop-out were bereavement and a scheduled major operation.

*****INSERT FIGURE 1 HERE*****

*****INSERT TABLE 2 HERE*****

Intervention effects for PA outcomes

Table 3 displays the significance levels, effect sizes, and confidence intervals for kcals expended from MVPA per week (kcal-MVPA/wk), all PA intensities (kcal-All/wk) per week, and average steps/day between groups across six months. Controlling for baseline scores, the $_{rm}$ANCOVA models showed that the MI-CB group expended more kcal-MVPA/wk than the UC group at 3 months (F (1, 32) = 7.83, p =.009, g = 0.90) and this difference was maintained at 6 months (F (1, 32) = 5.34, p =.027, g = 1.05). The MI-CB group also expended more kcal-All/wk than the UC group at 3 months (F (1, 32) = 7.71, p = .009, g = 0.92) and this difference was maintained at 6 months (F (1, 32) = 4.95, p = .033, g = 0.78). There were no main effects between groups for average steps/day at 3 months (F (1, 32) = 0.29, p = .592, g = 0.13), and 6 months (F (1, 32) = 0.79, p = .382, g = 0.21).

*****INSERT TABLE 3 HERE*****

Intervention effects for psychological outcomes

Table 4a and 4b display the significance levels, effect sizes and confidence intervals for the psychological outcomes. Controlling for baseline scores, the $_{rm}$ANCOVA models showed that the MI-CB group reported higher self-efficacy for overcoming barriers to exercise (F (1, 32) = 5.50, p = .025, g = 0.56), experienced more physical PA outcomes (e.g. weight loss) (F (1, 32) = 6.11, p = .019, g = 1.23), and psychological PA outcomes (e.g. stress reduction) (F (1, 32) = 7.09, p = .012, g = 0.63) than the UC group at 3 months. No main effects between

groups were found for adaptive coping strategies (F (1, 32) = 1.21, p = .279, g = 0.27), maladaptive coping strategies (F (1, 32) = 0.50, p = .485, g = -0.17), instrumental social support (F (1, 32) = 0.18, p = .673, g = 0.14) and emotional social support (F (1, 32) = 0.54, p = .470, g = 0.23) at 3 months. At 6 months, no main effects between groups were found for any psychological outcomes although the effect sizes were small to medium for exercise barrier self-efficacy (F (1, 32) = 3.44, p = .073, g =0.45), instrumental social support (F (1, 32) = 1.55, p =.222, g = -0.43), physical PA experiences (e.g. weight loss) (F (1, 32) = 1.25, p =.273, g = 0.55), and psychological PA experiences (e.g. stress reduction) (F (1, 32) = 0.86, p = .360, g = 0.22). The confidence intervals around the effect sizes spanned both negative and positive values (Table 4a and 4b).

*****INSERT TABLE 4A AND TABLE 4B HERE*****

Intervention effects for epidemiological outcomes

Table 4b displays the adjusted for baseline mean scores, significance levels, and Hedges adjusted *g* for weight and BMI between groups. Controlling for baseline values, the $_{rm}$ANCOVA revealed no significant difference between groups for weight (F (1, 32) = 1.87, p = .181, g = -0.32) and BMI (F (1, 32) = 2.56, p = .119, g = -0.37) at three months, although the effect size was small indicating that a small reduction in weight (1.9kg) and BMI occurred. The majority did not achieve clinically significant (≥ 5%) weight loss in the MI-CB group (17.6%) and UC group (0%). At 6 months, there was no significant difference between groups for weight (F (1, 32) = 0.01, p = .925, g = 0.02) or BMI (F (1, 32) = 0.01, p = .961, g = 0.02) as both groups regained to baseline weight.

Feasibility

A total of 175 individuals were invited to take part in the study during a six months recruitment phase and 41 (24.34% response rate) expressed interest (see Figure 1). Thirty-five participants completed the study demonstrating high retention rates (96%). Participants attended an average of 6 sessions (S.D. = 1.10). The average total minutes received was approximately half of the 270 minutes available (M = 142.57, S.D. = 198 35.93) and 47% of participants did not receive the full intervention.

Treatment Fidelity

Results from the independent coder revealed that the intervention provider almost reached beginner proficiency for global clinician rating (M = 3.44, S.D. = 0.19), was competent in delivering MI adherent behaviors (M = 90.67, S.D. = 5.77) and open questions (M = 86.46, S.D. = 13.64) but failed to meet beginner proficiency for complex reflections (M = 33.45, S.D. = 11.95). A total of 34 CB techniques were delivered (Table 5). Visualization and

distraction techniques were not delivered. Frequently delivered techniques were barrier identification (n=106), problem solving (n=97), review of behavioral goals (n=90) and behavioral self-monitoring (n=43). The least delivered techniques were prompting social comparison (n=1) and rewards (n=3).

*****INSERT TABLE 5 HERE*****

Discussion

Summary of main findings

This pilot study is the first to demonstrate the feasibility and preliminary efficacy of an integrated MI-CB intervention for promoting PA maintenance in adults with chronic health conditions. The MI-CB group expended more kcals from all intensities of activity (e.g. walking), including MVPA (e.g. cycling), compared to the UC group. This was maintained at six-months follow-up supporting the proposed theory that MI-CB can support PA maintenance.[9] In contrast, there was no difference between groups for average steps per day. The study included individuals with musculoskeletal disabilities who often choose non-weight bearing activities (e.g. cycling) or have slower walking speeds which pedometers cannot accurately detect.[30] Future studies should consider the use of piezoelectric accelerometers (e.g. ActiGraph) to accurately measure steps at slower speeds and different acitivities.[30]

The MI-CB intervention demonstrated efficacy in improving psychological determinants in the short-term, but not-long-term, including self-efficacy to overcome exercise barriers (e.g. inclement weather), and physical and psychological PA experiences, which is consistent with previous research[17, 24]. However, there was no improvement for coping skills, social support, or any psychological variable at six months. The treatment fidelity results could explain this. Fewer CB techniques were used for prompting social support (e.g. planning social support) and coping skills (e.g. if-then plans) but strategies to

promote exercise barrier self-efficacy (e.g. barrier identification) and PA outcome experiences (e.g. eliciting PA experiences) were delivered more frequently. CB strategies can influence the determinants associated with PA maintenance if implemented correctly but treatment fidelity measures should be utilized throughout interventions, not just on study completion, to ensure protocol deviations are identified and corrected early to achieve optimum efficacy.[12]

This calls into question 'what worked?' within the MI-CB intervention. The intervention provider demonstrated at least beginner proficiency for most MI technical components (e.g. open questions), except complex reflections. This might suggest that MI adherent behaviors, even at beginner level, can contribute to PA maintenance. However, additional training and on-going supervisions (greater than six supervisions) are needed to improve MI-CB technique proficiency and optimize intervention efficacy.[31] Intervention research and health professionals newly trained in MI-CB techniques could improve their outcomes from implementing these findings.

The MI-CB intervention did not affect weight or BMI. Although a small, non-significant, reduction in weight occurred at three-months, the majority of participants did not meet clinical significance (≥5% weight loss). This is consistent with previous research suggesting that PA interventions often produce weight reductions of <2kg[26] and additional calorie restriction techniques are needed to induce further weight loss. The MI-CB group also exercised more than the UC group but BMI measurements cannot detect body composition changes compared to bioimpedance analysis.[32] While weight loss/maintenance was not the original study aim, future PA research could benefit from considering these factors.

Feasibility

Previous research suggests that MI-CB can improve adherence to intensive interventions,[9] which this study demonstrated through the excellent retention and adherence

rates. In contradiction with this, the intervention group received approximately half of the total time and the UC group also experienced high study attendance rates, which included only three assessment points (and no intervention). A previous review found that brief and frequent follow-up contacts influenced PA maintenance.[33] This study adds that brief and frequent contacts are important for intervention/study adherence but it is the intervention content that leads to effective behavioral maintenance. This is supported by the MI-CB intervention that maintained PA at six-months compared to the UC group that declined over time. Future interventions would benefit from including brief MI-CB contacts over time to enhance PA maintenance.

Recruiting the desired sample size (i.e. ≥ 60)[28] during a six-month recruitment phase was not feasible. Recruitment barriers to research are often reported by adults with chronic health conditions (e.g. lack of time and health concerns).[34] Future research would need to increase the number of recruitment sites and recruitment duration (>6months) to achieve an adequate sample size.

Strengths and limitations

This is the first randomized controlled pilot study to provide evidence in support of the theory that MI-CB can influence PA maintenance.[9] The heterogeneous sample improves the generalizability of MI-CB interventions to services that treat adults with a range of chronic health conditions rather than being limited to single disease specific interventions. Treatment fidelity was assessed, including compliance to intervention delivery, which provides an overview of techniques that could be effective with on-going reflective supervision throughout an intervention.

Due to the small sample size, the study might be underpowered to find significant long-term effects for the psychological determinants but was sufficient to detect a promising

short-term effect. Although non-significant, the confidence intervals around the effect sizes ranged from positive to negative effects. This variance is likely due to the heterogeneity associated with the sample population, who often have complex healthcare needs, leading the MI-CB intervention to work for some participants more than others. A large-scale trial could identify the sub-groups that respond favorably (or not) to an MI-CB intervention.

Self-reported measures were largely used within this study and findings should be interpreted with caution due to potential over-reporting of PA.[7] To increase confidence in the maintenance effects of the intervention, future trials need to assess whether MI-CB is more effective than single therapy approaches (e.g. MI only) for maintaining PA with a longer post-intervention follow-up of ≥ 6 months.[4,33.]

Conclusion

This study demonstrates the feasibility and preliminary efficacy of MI-CB for PA maintenance in adults with chronic health conditions. The intervention had a short-term effect on some psychological determinants (e.g. exercise barrier self-efficacy and PA outcome experiences). Treatment fidelity measures should be implemented throughout MI-CB interventions to identify and correct protocol deviations to enhance intervention efficacy. A large-scale trial is warranted to demonstrate the effectiveness of integrated MI-CB compared to single therapies for PA maintenance with a longer follow-up (≥ 6 months).

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Declaration of conflicting interests

The Author(s) declare(s) that there is no conflict of interest.

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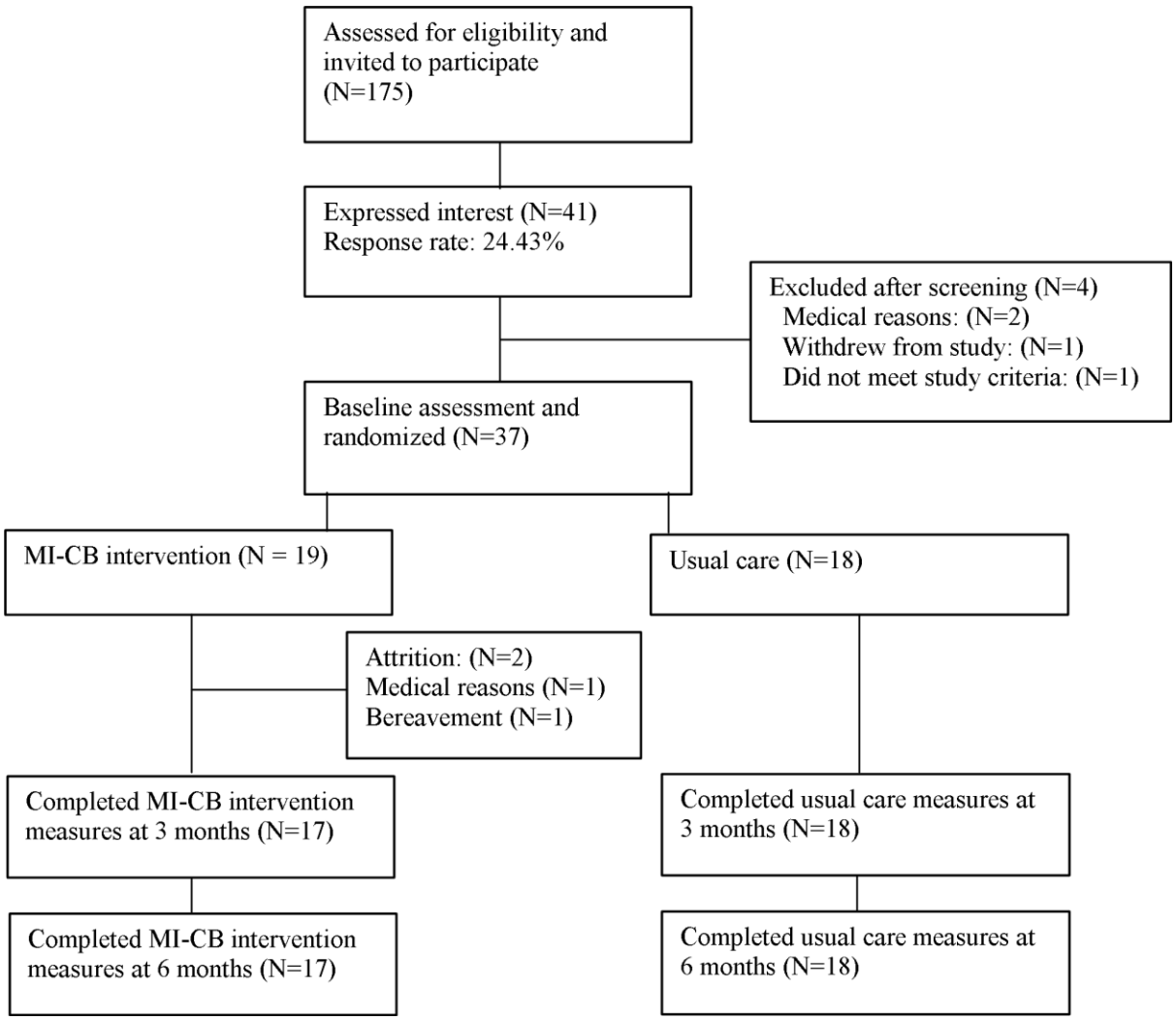

Figure 1. Participant recruitment and retention flow diagram

Table 1. Intervention schedule, content, theory, determinants and behavior change techniques.

Session	Theory	Determinants	Content description	Behavior change techniques
Week 1: 1-hour initial assessment (Face-to-face)	Expectancy-value theory; Theory of behavioral maintenance; Relapse prevention; Social cognitive theory.	Core values; Exercise outcome expectations and experiences; Discrepancy between outcome expectations and experiences; Social support; Coping skills; Exercise barrier self-efficacy; Values.	• Explore historical and current exercise behavior; • Identify exercise outcome expectations (e.g. to lose weight), discrepancy and satisfaction between experience/expectations (e.g. I wanted to lose weight but I haven't lost as much and I'm unsatisfied); • Identify and change unrealistic expectations (e.g. I expected to lose 1 stone in two weeks); • Elicit priority of values and PA expectations, e.g., I expect to become fitter (expectation) to improve my independence (value) and this is important (priority); • Assess barriers/relapse triggers and plan coping techniques (e.g. If I do too much, I'm then too tired to do anything but I can cope by pacing myself);	Motivational interviewing skills are used throughout the session including: open-ended questions, affirmations, reflections, summaries. Cognitive behavioral techniques include: • Elicit PA outcome expectations and experiences • Explore satisfaction • Identify discrepancy between current behavior and goal/experiences • Elicit values and priorities • Identify barriers and problem solving • Graded tasks and activity pacing • Framing/reframing • Social support (general, practical and emotional) • Goal setting (behavior and outcome)

			• Assess and promote self-efficacy using affirmations; • Identify suitable social support networks; • Develop goals and action plans.	• Action planning
Week 2: 15-30 minutes (Telephone)	Social cognitive theory; Relapse prevention.	Exercise barrier self-efficacy.	• Review of goal progress; • Barrier identification and level of self-efficacy for overcoming barriers (e.g., How confident are you to overcome barrier X on a scale of 1-10? What will move you from a 3 to a 4?); • Emphasize experiential learning through trial and error for condition management; • Progress and amend action-plan and goals.	Motivational interviewing strategies. Cognitive behavioral techniques are tailored to change talk but can include: • Goal setting and Review of behavior goal(s) • Relapse prevention (barrier identification, problem solving, coping/action plans) • Feedback on behavior or outcomes • Focus on past success • Provide information about consequences (exercise, diet or condition management) • If-then plans • Prompt experiential learning through trial and error.
3. Week 3 15-30 minutes	Outcome-expectancy theory;	Outcome expectations and experiences in	• Review of goal and action plan/coping plan progress from previous session;	Motivational interviewing strategies. Cognitive behavioral techniques include:

(Telephone)	Social cognitive theory.	relation to goal progress.	• Identify current experiences of PA, discrepancy with expectations and satisfaction (e.g. I currently feel good when I exercise but I expected to lose more weight so I'm not satisfied); • Teach self-monitoring strategies to monitor goal (e.g. activity tracking).	• Goal setting and review of behavior and outcome goal(s) • Action plans and If-then plans • Self -monitoring of behavior or outcomes • Elicit current PA outcome experiences • Explore satisfaction with exercise outcomes • Match goals to values
4. Week 4: 15-30 minutes (Telephone)	Social cognitive theory; Relapse prevention.	Exercise barrier self-efficacy; Coping strategies; Social support.	• Review of goal progress from previous session; • Affirm current progress; • Prompt discussion of future barriers and strategies to overcome them; • Prompt assessment of current social support structures and prompt environmental restructuring where possible; • Reassess action plan for the next two weeks.	Motivational interviewing strategies. Cognitive behavioral techniques are tailored to level of change talk but can include: • Action planning and If-then plans • Relapse prevention (identify barriers, problem solving) • Coping strategies (e.g. activity pacing, planning) • Social support and Environmental restructuring
5. Week 6: 15-30 minutes	Social cognitive theory; Relapse	Exercise barrier self-efficacy;	• Review of progress from previous session; • Relapse prevention;	Motivational interviewing strategies. Cognitive behavioral techniques:

(Telephone)	prevention.	Coping strategies.	• Tailor strategies to individual	• Relapse prevention • Goal-setting/review of behavioral/outcome goals
6. Week 8: 15-30 minutes (Telephone)	Social cognitive theory; Relapse prevention	Exercise barrier self-efficacy; Coping strategies.	• Review of progress from previous session; • Barrier identification, strategies and level of self-efficacy for overcoming barriers; • Teach strategies to overcome barriers; • Tailored to individual.	Motivational interviewing strategies. Cognitive behavioral techniques: • Relapse prevention • Goal-setting/review of behavioral/outcome goals
7. Week 12: 1-hour Exit-Interview (Telephone)	Expectancy-value theory; Theory of behavioral maintenance; Relapse prevention; Social cognitive theory.	Intervention recap and planning for the future.	• Review of progress from previous session and intervention as a whole; • Identify what has and can help PA maintenance; • Identify future if-then scenarios for overcoming barriers (e.g. If I experience X, Then I will do Y); • Prompt reflection of trial and error process; • Refer to health services if required (e.g. GP).	Motivational interviewing strategies as outlined above. Cognitive behavioral techniques: • Action planning • Problem solving • If-then plans • Relapse prevention • Condition management (e.g., pacing)

Table 2 Means, standard deviations, and % of baseline characteristics for total sample and study groups[a]

	Intervention (*n*=17)	**Usual Care (*n*=18)**	**Sample (*N*=35*)***
Demographics			
Age (years), mean (S.D.)	60.70 (10.04)	58.05 (11.72)	59.34 (10.86)
Female (%)	41.0	44.0	43.0
Condition (%)			
Multiple	71.0	72.0	71.0
Musculoskeletal	12.0	11.0	11.0
Coronary Heart Disease	12.0	-	6.0
Cerebrovascular	-	6.0	3.0
Mental health	-	6.0	3.0
Endocrine and Metabolic diseases	6.0	6.0	6.0
Comorbidities, mean (S.D.)	3.05 (1.63)	4.05 (2.43)	3.57 (2.12)
Employment (%)			
Full-time	6.0	6.0	6.0
Part-time	6.0	28.0	17.0
Full-time Carer	6.0	6.0	6.0
Unemployed	18.0	6.0	11.0
Incapacity Benefit	12.0	17.0	14.0
Retired	53.0	39.0	46.0
Ethnicity (*n*)			
White British	16.0	18.0	34.0
Black Caribbean	1.0	-	1.0
Weight (Kg), mean (S.D.)	89.59 (12.13)	89.21(17.20)	89.40 (14.74)
Body Mass Index (kg/m^2; %)			
Normal weight	6.0	6.0	6.0

Pre-obesity	24.0	44.0	34.0
Obesity Class I	47.0	22.0	34.0
Obesity Class II	23.0	17.0	20.0
Obesity Class III	-	11.0	6.0
Primary Outcomes			
Average Steps/day, mean (S.D.)	5638.29 (3063.19)	5530.40 (3142.14)	5582.80 (3058.61)
Kcal-All/wk, mean (S.D.)	6495.13 (4302.78)	4479.36 (4000.61)	5458.45 (4214.23)
Kcal-MVPA/wk, mean (S.D.)	4799.73 (3450.16)	3287.62 (3379.06)	4022.08 (3449.45)
Secondary Outcomes			
Barrier Self-Efficacy, mean (S.D.) *	69.81 (21.54)	54.78 (20.80)	62.0 (22.0)
Adaptive Coping, mean (S.D.) **	74.58 (12.17)	61.22 (13.77)	68.0 (15.0)
Maladaptive Coping, mean (S.D.)	22.41 (7.00)	22.00 (7.51)	22.02 (7.16)
Emotional Social Support, mean (S.D.)	7.58 (3.00)	8.00 (3.98)	7.8 (3.49)
Instrumental Social Support, mean (S.D.) **	10.70 (3.11)	7.77 (2.94)	9.20 (3.33)
Outcome Expectations (Physical), mean (S.D.)	29.52 (8.28)	21.72 (10.78)	25.51 (10.29)
Outcome Expectations (Psychological), mean (*S.D.*)	65.94 (19.16)	54.22 (25.59)	61.0 (22.0)

Table 3. Descriptive statistics (mean, S.D.), significance levels[a] (between groups), and standardized mean differences (Hedges adjusted *g*) with 95% confidence intervals for physical activity at 3 and 6 months between groups.

		Average Steps/day	**Kcal-MVPA/wk[b]**	**Kcal-All/wk[b]**
3 Months (End-point)	MI-CB Mean (S.D)[d]	5567.71 (2594.68)	4792.25 (4335.93)	6584.48 (5170.88)
	UC Mean (S.D)[d]	5236.67 (2521.56)	2230.96 (4210.72)	3314.22 (5020.81)
	Hedges adjusted *g* (95% CI)[c]	0.13 (-0.54, 0.79)	0.90 (0.20, 1.59)	0.92 (0.22, 1.62)
	P	0.592	0.009**	0.009**
6 Months (Follow-up)	MI-CB Mean (S.D)[d]	5633.25 (2574.25)	4885.91 (4571.31)	6550.89 (5110.03)
	UC Mean (S.D)[d]	5095.81 (2501.73)	1972.85 (4439.29)	3083.54 (4961.7)
	Hedges Adjusted *g* (95% CI)[c]	0.21 (-0.46, 0.86)	1.05 (0.35, 1.76)	0.78 (0.09, 1.46)

P	0.382	0.027*	0.033*

Table 4a. Descriptive statistics (mean, SD), significance levels [a], and standardized mean differences (Hedges adjusted *g*) with 95% confidence intervals for psychological and epidemiological outcomes at 3 and 6 months between groups.

		Psychological Outcomes				
		Barrier Self-Efficacy	**Adaptive Coping**	**Maladaptive Coping**	**Emotional Support[b]**	**Instrumental Support[b]**
3 Months (End-point)	MI-CB[d] Mean (SD)	72.78 (31.85)	72.49 (18.71)	20.53 (8.17)	8.69 (4.14)	9.58 (4.97)
	UC[d] Mean (SD)	54.68 (30.90)	67.37 (18.12)	21.89 (7.93)	8.02 (4.03)	8.95 (4.91)
	Hedges Adjusted *g* (95% CI)[c]	0.56 (-0.11, 1.24)	0.27 (-0.39, 0.94)	-0.17 (-0.83, 0.50)	0.23 (-0.44, 0.89)	0.14 (-0.52, 0.81)
	P	0.025*	0.279	0.485	0.470	0.673
6 Months (Follow-up)	MI-CB[d] Mean (SD)	61.38 (31.85)	68.67 (19.48)	19.37 (5.45)	8.89 (4.74)	8.31 (4.91)
	UC[d] Mean (SD)	47.03 (30.90)	70.37 (18.83)	20.10 (4.74)	8.44 (4.56)	9.88 (4.74)

Hedges Adjusted *g* (95% CI)[c]	0.45 (-0.22, 1.12)	-0.09 (-0.75, 0.58)	-0.14 (-0.80, 0.52)	0.14 (-0.52, 0.81)	-0.43 (-1.10, 0.24)
P	0.073	0.728	0.573	0.675	0.222

Table 4b. Descriptive statistics (mean, SD), significance levels [a], and standardized mean differences (Hedges adjusted *g*) with 95% confidence intervals for psychological and epidemiological outcomes at 3 and 6 months between groups.

		Psychological Outcomes		**Epidemiological Outcomes**	
		OERS Physical	**OERS Psychological**	**Weight** (kg)	**BMI**
3 Months (End-point)	MI-CB[c] Mean (SD)	23.35 (6.41)	59.70 (31.49)	87.69 (5.05)	31.09 (2.07)
	UC[c] Mean (SD)	15.40 (6.22)	39.62 (30.61)	89.32 (4.91)	31.86 (2.01)
	Hedges Adjusted *g* (95% CI)[b]	1.23 (0.51, 1.95)	0.63 (-0.05, 1.31)	-0.32 (-0.99, 0.35)	-0.37 (-1.04, 0.30)
	P	0.019 *	0.012*	0.181	0.119
6 Months (Follow-up)	MI-CB[c] Mean (SD)	19.71 (6.25)	51.87 (29.84)	89.59 (8.82)	31.79 (3.02)
	UC[c] Mean (SD)	16.22 (6.06)	45.24 (29.01)	89.39 (8.58)	31.72 (2.90)

Hedges Adjusted *g* (95% CI)[b]	0.55 (-0.12, 1.23)	0.22 (-0.44, 0.89)	0.02 (-0.64, 0.69)	0.02 (-0.64, 0.69)
P	0.273	0.360	0.925	0.961

Table 5. Mean, SD, and total amount of cognitive-behavioral techniques delivered during the intervention.

Cognitive behavioral techniques	Mean (SD)	Total (n)
Prompt barrier identification	6.23 (1.88)	106.00
Prompt problem solving	5.70 (1.82)	97.00
Prompt review of goals (behavioral)	5.29 (1.49)	90.00
Prompt action planning	2.58 (1.22)	44.00
Prompt self-monitoring (behavioral)	2.52 (1.32)	43.00
Prompt goal setting (behavioral)	2.29 (0.84)	39.00
Elicit PA[a] experiences	2.29 (0.84)	39.00
Provide information about health consequences (condition specific)	2.11 (1.65)	36.00
Prompt framing/reframing	1.94 (1.88)	33.00
Comparative imagining of future outcomes (when goal setting)	1.88 (1.11)	32.00
Prompt practical support (health professional)	1.58 (1.58)	27.00
Elicit satisfaction with PA outcomes	1.41 (0.71)	24.00
Provide information about health consequences of exercise	1.41 (0.93)	24.00
Prompt activity pacing	1.23 (1.64)	21.00
Elicit outcome expectations	1.17 (0.39)	20.00
Prompt time management techniques	1.17 (1.42)	20.00
Encourage environmental restructuring	1.11 (0.33)	19.00
Elicit values	1.11 (0.48)	19.00
Provide instruction on how to perform the behavior	1.11 (1.11)	19.00
Encourage acceptance of health condition	1.05 (1.08)	18.00
Elicit priority of PA outcome expectations	1.05 (0.24)	18.00
Prompt social support (general)	0.82 (1.13)	14.00
Prompt goal-setting (outcome)	0.70 (0.84)	12.00
Provide feedback on outcome of behavior	0.64 (1.27)	11.00
Prompt trial and error experiential learning	0.64 (0.78)	11.00
Provide information about health consequences (diet)	0.58 (1.00)	10.00
Set/encourage graded tasks	0.58 (1.12)	10.00
Prompt portion control	0.52 (1.06)	9.00

Provide information about health consequences (condition management)	0.35 (0.70)	6.00
Prompt if-then plans	0.35 (0.86)	6.00
Provide link between thoughts and behavior	0.29 (0.58)	5.00
Pros and cons of behavior change	0.29 (0.46)	5.00
Prompt food-diary	0.23 (0.43)	4.00
Prompt rewards (material, self-reward, outcome)	0.17 (0.39)	3.00
Prompt social comparison	0.05 (0.24)	1.00
Visualization/mental rehearsal	0.00 (0.00)	0.00
Distraction	0.00 (0.00)	0.00

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