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A feasibility study of a physiotherapy-led motivational programme to increase physical activity and improve cardiometabolic risk in people with major mental illness

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1. Introduction

People with major mental illness (MMI) such as schizophrenia, bipolar disease and major depression have a reduced life expectancy [1–3]. This is predominantly due to natural causes [4–8], such as cardiovascular disease and metabolic syndrome (MetS) [2,6]. MetS, which is characterised by elevated fasting glucose, low high density lipoprotein (HDL) cholesterol, raised triglycerides, increased waist circumference (WC), and hypertension [9], is more common in people with schizophrenia and bipolar disorder than in the general population [10–12]. In addition, MetS is a risk factor for cardiovascular disease [13]. Pro-atherogenic 'health risk behaviours' associated with schizophrenia and bipolar disorder, such as smoking, poor nutrition and sedentary lifestyle [14,15] contribute to premature cardiovascular death in this population.

Increasing levels of physical activity may mitigate against the development of cardiovascular disease and a host of other chronic diseases among people with MMI [8,16,17]. Among the general population, achieving sufficient levels of physical activity for health benefits can be difficult. A recent systematic review and meta-analysis [18] showed that people with MMI are significantly less likely than matched healthy controls to meet physical activity guidelines (odds ratio = 1.5; 95% CI: 1.1–2.0, $p < 0.001$, $I^2 = 95.8$). Additional barriers to achieving optimal physical activity levels [14,19] are experienced in people with MMI, the most prevalent of which have been identified as low mood, stress, lack of support and tiredness [20]. High dropout rates seen in exercise interventions may be related to poor motivation [21–24]. Behavioural change strategies, such as motivational interviewing (MI), have proved to be successful for various interventions, such as smoking cessation and adherence, in both healthy and clinical populations [25,26]. MI is a 'collaborative, person-centred form of guiding to elicit and strengthen motivation for change' [27]. MI as a behavioural change framework [28] may also hold promise in mental health settings as a tool to increase levels of physical activity [24].

Within a cohort of individuals with MMI, the primary objective of this study was to explore the feasibility of implementing an innovative physical activity intervention, based on the framework of MI. Secondary outcomes included investigation of preliminary efficacy of the intervention on objectively measured physical activity and cardiometabolic risk, and exploration of its effect on factors which are linked to these variables such as body mass index (BMI) and aerobic fitness levels.

2. Material and methods

2.1. Experimental design

This was a prospective single-arm trial. Ethical approval was obtained from the Tallaght Hospital/St. James's Hospital, Dublin, Ireland, Joint Research Ethics Committee. Written informed consent was obtained from participants prior to enrollment into the programme.

2.2. Setting

A convenience sample of adults (aged 18 to 64 years) was recruited from the general adult psychiatry outpatient services in St. James's Hospital, Dublin, over a period of nine months from September 2013 to May 2014.

2.3. Inclusion/exclusion criteria

A pragmatic approach was taken to the named clinical diagnoses considered for inclusion in this study. This was due to a number of different psychiatry teams referring into this study and the clinical reality of both the Diagnostic and Statistical Manual of Mental Disorders, 5th edition (DSM-5) and the International Classification of Diseases,10th revision, Clinical Modification (ICD-10) used in this practice setting. Inclusion criteria therefore included a clinical

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diagnosis (made by a consultant psychiatrist) of schizophrenia, other psychotic disorders, bipolar disorder/bipolar affective disorder, or depressive disorder (major depressive disorder or recurrent depressive disorder). Additional inclusion criteria were the presence of at least one established cardiometabolic risk factor or MetS, adequate physical health as judged by the treating psychiatrist and defined by absence of the following; acute orthopaedic limitation to mobility, acute cardiac arrhythmias or other cardiovascular, respiratory or medical instability which precluded ability to partake safely in the physical health element of the intervention, and with the capacity to give informed consent. Participants were excluded if they were an inpatient at the time of recruitment, if they had a known moderate to severe intellectual disability, which would have significantly impacted the ability to follow instruction and partake in individualised sessions in this study, or were deemed medically unfit to participate. This was defined by absence of adequate physical health detailed above in inclusion criteria and satisfactory medical screening conducted by a medical research fellow which included a resting electrocardiogram (ECG) prior to the intervention.

2.4. Enrollment procedures

Potentially eligible participants were provided with a patient information leaflet by their consultant at routine outpatient clinic appointments. A medical research fellow invited participants to enroll during an information session and conducted medical screening. Following this, eligible participants wishing to enroll in the study were given an appointment for a baseline physical assessment.

2.5. Intervention

The behavioural exercise intervention, conducted in an acute hospital setting over eight weeks, was based on the theoretical framework of MI [29] and was conducted in the following manner. Following baseline assessments, a 30-minute appointment was made to commence the intervention on an individual basis. Intervention sessions were conducted by the lead researcher, a physiotherapist, trained in MI. The face-to-face sessions were conducted weekly in a private room. The length of the sessions was flexible, lasting 20 to 40 min, and was led by the participant. The intervention was underpinned by the MI framework [27] and was flexible in its delivery to adapt to individual participants. The eight-week intervention focused on increasing physical activity through individualised sessions and the intervention protocol, included the following elements for all participants: the core skills of MI which are open ended questions, affirmations, reflections and summaries; the 'spirit' of MI which is collaboration, acceptance, evocation and compassion [27]; freely obtained education leaflets for information sharing (see Supplementary Material); Goal setting sheets and exercise diaries (see Supplementary Material).

2.6. Study outcome measures

Outcome measures were completed at three time points: at baseline prior to the intervention (T1), at the eight week time-point post completion of the intervention (T2) and three months post intervention (T3). Metabolic screening was measured at T1 and T2 only. The outcome assessment was not blinded. A research assistant, who was a qualified physiotherapist, helped with cardiorespiratory fitness testing and a medical research fellow conducted medical screening and assessments.

2.6.1. Sociodemographic and condition-related variables

Demographics were gathered to profile the cohort including employment status, educational achievement and diagnosis (Table 1).

Table 1
Baseline demographic characteristics, $n = 16$.

Variable	n (%)
Age, year	
Mean (SD)	46.3
Range	(10.5; 27–63)
Gender, M/F	5/11
Race/ethnicity	
Caucasian	16 (100)
Marital status	
Married	1 (6.25)
Separated/divorced	2 (12.5)
Single	13 (81.25)
Employment status on assessment	
Student/volunteer	3 (18.75)
Employed (part-time)	2 (12.5)
Retired	3 (18.75)
Unemployed/disability	8 (50)
Diagnosis	
Bipolar 1	5 (31.25)
Schizoaffective	4 (25)
Schizophrenia	6 (37.5)
Major depression	1 (6.25)
Time since diagnosis, years	
0–5	2 (12.5)
6–10	2 (12.5)
11–15	3 (18.75)
≥16	9 (56.25)
Medication[a]	
SGA	12 (75%)
FGA	2 (12.5)
ADT	8 (50%)
MS	9 (56.25%)
Educational achievement	
Primary level education	4 (25)
High school graduate	6 (37.5)
Bachelor's degree	5 (31.25)
Advanced degree	1 (6.25)
Smoker	
Smoker	9 (56.25)
Non-smoker	5 (31.25)
Ex-smoker	2 (12.5)
BMI, mean (SD) ($kg\,m^{-2}$)	35.34 (8.1)

n (%) unless otherwise stated.
Abbreviations: SGA - Second Generation Antipsychotic
FGA - First Generation Antipsychotic
ADT - Antidepressant therapy
MS – Mood Stabiliser
BMI – Body Mass Index.
[a] May add up to > 100% due to pharmacology.

2.6.2. Primary outcomes: feasibility outcomes

The primary outcome of this study was the feasibility of an individualised behavioural intervention based on theoretical framework of MI. Feasibility was evaluated following recommended outcomes including acceptability, demand, implementation, practicality, and limited-efficacy testing [30,31]. Acceptability of the programme was evaluated in two ways: participant feedback using a purposed-devised 7-item questionnaire on completion of the intervention, and adherence to the programme. The exit questionnaire (see Supplemental Material) gathered qualitative information on the intervention such as aspects of the programme participants found most beneficial, what they would change or include, and what changes in lifestyle or physical activity had occurred as a result of the intervention. Adherence was recorded by the number of participants who completed T1 and T2 assessments signifying completion of the programme, and by the number of weekly sessions attended. Eight sessions were offered to each participant. The number of participants referred to and entered into the study evaluated recruitment capability and demand respectively. The implementation of the programme, such as the number of sessions attended and goals set, was recorded by the investigator for later reflection on suitability and

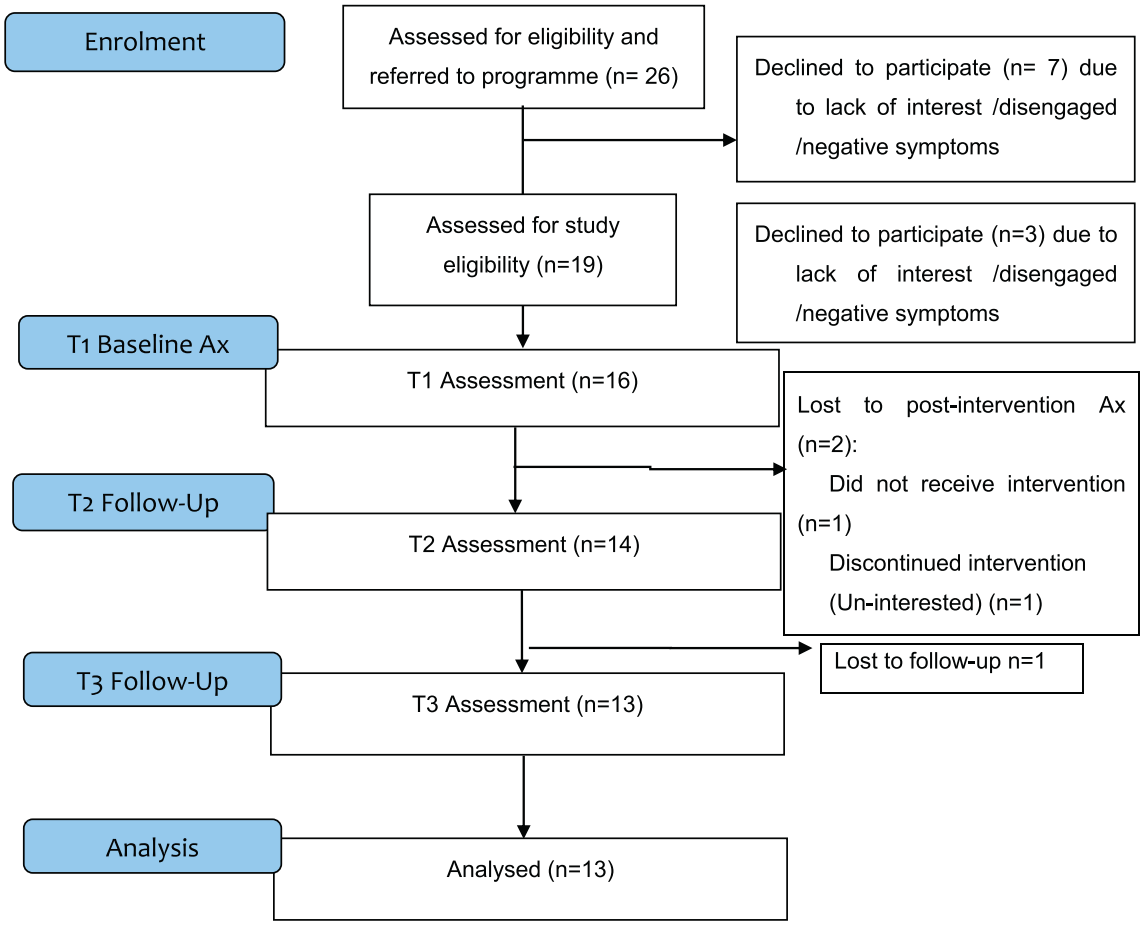

Fig. 1. Flow of participants through the study.

practicality of the intervention. This included the participants' engagement in the programme, and goals and barriers to attendance. A number of outcome measures were used to assess the suitability and acceptability of this population for this feasibility study.

2.6.3. Efficacy outcomes

2.6.3.1. Physical activity. Physical activity levels were measured using the ActiGraph (Pensacola, FL, USA) GT3X+ triaxial accelerometer. ActiGraph accelerometry is an established method of measuring physical activity objectively and has been used successfully in this population [32], and in obese populations [33]. Participants were instructed to wear the accelerometer for 7 days on an elasticated waistband over their hip for all waking hours. Participants were asked to record a diary of their wear-time for future analysis. Wear time was calculated and validated using an algorithm in build in the Actilife software, and periods with zero counts of 90 min or more, were defined as non-wear time [34]. A lack of standardisation of accelerometer cut-points specific to mental health populations has been identified [35]. To avoid major data loss, a wear time of more than six hours/day [35] for at least two days [36] was used as the criterion for a valid measurement. Data was processed using ActiLife Software 6.9.2. Participants also completed the International Physical Activity Questionnaire (IPAQ – Long form), a 27 item self-administered questionnaire of physical activity and sitting time. It has been shown to be valid and reliable measure in assessment of physical activity in healthy people [37], and people with Schizophrenia [38].

2.6.3.2. Cardiometabolic risk/metabolic syndrome. Cardiometabolic risk, recorded pre and post intervention only, was conducted by a research fellow and included measures of blood pressure, waist circumference and the following blood samples: HDL cholesterol, fasting glucose and triglycerides. Cardiometabolic risk factors were measured according to the National Cholesterol Education Program (NCEP) Adult Treatment Programme 111 (ATP3) criteria [39]: low HDL (<1.03 mmol/l for males, <1.29 mmol/l for females), elevated triglycerides (≥ 1.7 mmol/l), elevated fasting glucose (≥ 6.1 mmol/l), hypertension ($\geq 130/85$) (electronic machine), and increased waist circumference (≥ 88 cm for women, ≥ 102 cm for men). MetS was defined as any 3 out of the 5 aforementioned risk factors.

2.6.4. Exploratory outcomes

2.6.4.1. Cardiorespiratory fitness. Aerobic capacity was determined using indirect gas calorimetry and the Modified Bruce Protocol submaximal treadmill test. Due to the low fitness levels identified in this population, the test was stopped when the participant reached a submaximal heart rate of 75% of their predicted maximum heart rate (220-age (0.75) = HRmax) [40], when the participant was unable to continue, or it became unsafe to continue due to adverse signs [41].

2.6.4.2. BMI. BMI was calculated using the formula: weight (kg)/[height (m^2)] [42].

2.7. Data analysis

Data was analysed using IBM® SPSS® Statistics v 22 (Chicago, IL, USA). Descriptive statistics of participant demographics were reported as number and percentage. Missing data was identified and managed using multiple imputations. Data was tested for normality and homogeneity of variances using the Shapiro-Wilk test and Maulchly's Test of Sphericity. For all analyses, p-value < 0.05 (two-tailed) was

considered statistically significant. Friedman's test was used to compare non-normally distributed data, and ANOVA repeated measures parametric tests were used to compare normally distributed data at multiple time points. The Wilcoxon signed rank test was used to compare cardiometabolic risk parameters.

3. Results

3.1. Participant recruitment

The flow of participants through the study is shown in Fig. 1. Twenty-six individuals were referred to the study programme. Nineteen participants were assessed for study eligibility. Sixteen participants met inclusion criteria, entered the trial and completed T1 assessments. Fourteen participants completed the intervention and T2 assessments. Of the two participants who did not complete the programme, one completed the baseline assessment only and decided to pursue a private weight loss programme, and the second dropped out after two sessions due to lack of interest. A further participant was lost-to follow-up, therefore thirteen participants (81.3%) completed T3 assessments.

3.1.1. Participant characteristics

Baseline demographics and condition-related features are presented in Table 1. The mean (SD) age of participants was 46.3 (10.5) years. The majority (81.3%, $n = 13$) of participants were single. Two (12.5%) participants were engaged in paid employment, while half of the participants ($n = 8$) were claiming disability benefit. Over half (56.3%, $n = 9$) of the participants were smokers.

3.2. Primary outcomes: feasibility outcomes

3.2.1. Acceptability

Acceptability to the programme was high, measured by feedback obtained at T2 via a 7-item questionnaire with a 92% response rate ($n = 12$). All respondents found the intervention to be beneficial. The majority ($n = 10$, 83.4%) reported increasing their daily physical activity, and 91.7% ($n = 11$) reported making positive lifestyle changes since completing the programme including increased walking, increased awareness of diet and reduction of smoking. The reported benefits included the opportunity to receive positive feedback, enthusiasm, encouragement and support. Goal setting, recording of physical activity, and advice and education about exercise were also perceived as beneficial by participants. The challenges to participation in physical activity encountered by participants included musculoskeletal pain ($n = 3$). Twenty five percent (n = 3) of participants suggested increased nutritional input and regular measurements of weight for future programmes. One participant suggested more group work and one participant requested more frequent sessions.

3.2.2. Demand

Recruitment capacity was ample with referrals sourced from six general adult psychiatry teams in St. James's Hospital none of which had a physiotherapy service. Adherence to the programme as measured by completion of T2 assessment, was high with 87.5% ($n = 14$) completing the intervention and T2 assessments. The number of sessions attended was also high at 83.9%. Reasons for having missed sessions were varied and included illness. Further details can be found in the Supplemental Information. One participant did not attend two sessions but with telephone follow up, returned after two weeks. One participant had to leave to care for a sick family member, despite this the participant continued the intervention independently and completed the follow-up assessment on return.

3.2.3. Implementation and practicality

Resources required for the intervention to educate and record activity were free and easily accessed from the Internet. Staffing for this study included one doctor for medical assessments, a research assistant to aid with physical assessments and the study investigator. The intervention sessions were conducted in short periods (20–30 min), scheduled flexibly during the working day. Physical activity engaged in included walking, swimming, stair climbing and yoga.

3.3. Efficacy outcomes

3.3.1. Physical activity

Data from three participants were excluded from objective physical activity analysis due to insufficient wear-time. Percentage wear time was 47.4% per 24 h period. At baseline, participants spent a median (Interquartile range (IQR)) of 8.2 (2.6) hours daily sedentary, the median amount of time spent in light activity was 168.3 (62.9) minutes daily, moderate activity was 30.1 (43.2) minutes daily and a median of 0.0 (1.0) minutes daily spent in vigorous activity. The median amount of time spent in moderate to vigorous intensity activity was 30.1 (46.2) minutes per day at baseline. Participants did not achieve any time in very vigorous activity at any time over the 3 time points. Physical activity levels and sedentary time did not statistically significantly change over the duration of the study ($p > 0.05$).

Subjective and objective physical activity levels are reported in Table 2. IPAQs were poorly completed and two were excluded from analysis as they did not meet the data processing guidelines of the tool. Fourteen participants were included in the analysis. There were no changes in self-reported physical activity levels or sitting time over the duration of the study ($p > 0.05$).

3.3.2. Cardiometabolic risk

Cardiometabolic parameters were available for 14 participants who completed T2 assessments (Table 2). Of these, 71.4% ($n = 10$) met the criteria for MetS at baseline. Post intervention, 50% ($n = 7$) met the criteria for MetS. Three participants therefore who had MetS at T1 did not have MetS at T2. Overall 57.1% ($n = 8$) improved in at least one parameter of cardiometabolic risk.

3.4. Exploratory outcomes

Cardiorespiratory fitness levels were low at baseline but increased significantly ($p = 0.022$) over the 3 time points (Table 2). All participants in this study were overweight or obese at baseline with a mean (SD) BMI of 35.3 kg/m^2 (8.0) (Table 2). No significant change ($p = 0.14$) in BMI was observed over the course of the programme.

4. Discussion

4.1. Main findings

This study primarily demonstrated the preliminary feasibility and acceptability of the physical activity intervention outlined in this paper for a population with MMI. The intervention offered an innovative approach to health behaviour promotion in this cohort where motivation can be a barrier to exercise [20–24,43,44]. Changes were also shown for the secondary outcome of cardiovascular fitness, although this may have been due to a practice effect.

4.2. Primary outcome: feasibility

The adherence rate reflected a high level of acceptability and suitability of the programme to this population. This study implemented one-to-one sessions, which were well received. Although low adherence rates to programmes have been associated with MMI [16,45], other studies have also demonstrated improved adherence by including individualised or motivational components [46–48].

The intervention group engaged in non-specific physical activity twice a week. Self-selecting the mode and intensity of exercise tapped

Table 2
Results of participants at T1, T2 and T3 time points.

	T1 (baseline)	T2 (post intervention)	T3 (follow up)	P-value
Self-report physical activity (IPAQ) $n = 14$				
Median (IQR)				
Total physical activity (weekly MET-min)	1026.0 (1391.6)	1828.5 (3740.2)	2023.3 (2342.6)	0.64
Total sitting mins/week (including transport)	2682.5 (1990.0)	1895.1 (1052.5)	2417.6 (1035.5)	0.75
Objective physical activity (ActiGraph) n = 13 median (IQR)				
Sedentary time (min per day)	492.5 (156.8)	469.96(119.3)	433.7 (47.7)	0.15
Light activity (min per day)	168.3 (62.9)	148.3(60.9)	159.95 (32.4)	0.17
Moderate activity (min per day)	30.1 (43.2)	28.0 (21.0)	30.9(32.7)	0.93
Vigorous activity (min per day)	0.0 (1.0)	0.0 (0.6)	0.0 (0.1)	0.56
Mod/Vig activity (min per day)	30.1 (46.2)	28.0 (22.5)	29.2 (32.7)	0.93
Cardiometabolic risk factors n = 14				
Median (IQR)				
Triglycerides	1.81 (1.20)	1.41 (1.13)		0.101
HDL cholesterol	1.27 (0.26)	1.32 (0.25)		0.006[b]
Fasting BSL[c]	5.30 (1.45)	5.00 (1.15)		0.015
Obesity (waist circumference)	112.50 (36.15)	107.00 (32.87)		0.002[b]
Hypertension				
Systolic	123.50 (21.00)	125.00 (31.00)		0.421
Diastolic	80 (14)	81 (14.75)		0.850
Variable n = 16				
Median (IQR)				
Predicted VO_2max (ml kg min^{-1})	28.0 (13.0)	30.0 (8.9)	30.7 (8.5)	0.02[a]
Time on treadmill (mins)	6.8 (7.0)	8.0 (5.3)	8.7 (3.3)	0.31
Variable n = 16				
Mean (SD)				
BMI (kg m^{-2})	35.3 (± 8.1)	34.7 (± 8.6)	34.1 (± 8.9)	0.14

HDL – High Density Lipid.
BSL – blood sugar level.
[a] p-Value referrers to comparison between all the time points.
[b] Significant over the 3 time points with Bonferoni correction applied (Significance level $p < 0.008$). Wilcoxon Signed Ranks Test.
[c] $n = 13$.

into more autonomous forms of motivation, namely identified regulations (indicating that PA outcomes are personally important) and intrinsic motivation (that is being physically active for its own sake, due to the challenge, enjoyment and/or rewarding aspect) [49]. This resulted in a personalised sense of satisfaction on completion of individualised exercise, promoting self-efficacy and independence. Previous research [50] in people with schizophrenia has shown that autonomous motivation is consistent with behavioural change and adoption and maintenance of new lifestyle behaviours, which may be important in terms of initiation and adoption of behavioural change in this study.

Lack of confidence or knowledge around exercise modes and frequencies can be a barrier to participating in physical activity [51,52]. Feedback from participants from the current study confirmed that individualised sessions of information sharing at the start of the programme, and regular weekly follow-up to support and encourage the participants, were highly valued by participants. Notwithstanding this, feedback revealed that some participants would have enjoyed additional group sessions, highlighting the importance of offering flexibility within this cohort. Reasons for dropping out of the intervention were amotivation or dependence on others [53,54]. Lack of motivation and adherence to healthcare programmes are themes that have been documented in this population [55]. Major strengths of this study were precise method of measuring physical activity and involvement of a physiotherapist for the exercise element of this programme. Lower drop-out rates have been reported in PA arms of RCTs which included an exercise professional, such as a physiotherapist, highlighting the importance of professional support [56,57].

4.3. Secondary outcomes

4.3.1. Physical activity

This study found no significant change in objective physical activity over the course of the study. Objectively measured baseline physical activity levels demonstrated participants met the current daily guidelines of 30 min of moderate intensity exercise cumulatively [58], however it is unclear if these were in bouts greater or equal to 10 min. High levels of sedentary behaviour noted in this study were comparable to other research in people with schizophrenia, though these studies included hospitalised patients [35] or a non-specified mix of inpatients and outpatients [59], as opposed to the community dwelling cohort included in the present study. Few studies have investigated the effect of an intervention on physical activity levels in a purely community dwelling population with MMI using objective measures. Masa-Font et al. (2015) [60] demonstrated increased level of physical activity following a physical activity and diet programme using the IPAQ in patients with MMI. In contrast to our 8 week study, this was conducted over three months and consisted of group physical activity and education sessions.

We observed differences between subjective reports and objective measures, and this reflects findings in varying populations [61,62]. This can be explained either by overestimation of physical activity by the subjective measure, or inability of the accelerometer to capture all activity, such as swimming or activity undertaken without wearing the technology.

Although this study did not significantly influence physical activity levels, a trend towards reduced sedentary time over the course of the intervention was observed both subjectively and objectively. It is likely that a significant effect would be demonstrated through an adequately powered randomised controlled trial (RCT). Metabolic benefits have been documented of lowering the risk of developing Type 2 Diabetes Mellitus by reducing overall sedentary time [63]. Small changes in sedentary behaviour may have health benefits but as yet the effect of decreasing sedentary time on cardiometabolic risk and aerobic fitness is underexplored in this population.

4.3.2. Cardiometabolic risk

In agreement with existing evidence, this study found a high

baseline prevalence of metabolic risk parameters in an MMI cohort [64,65]. WC, a parameter of MetS, showed a significant improvement at T2 ($p = 0.002$).

The median percentage change of obesity measured by WC was 5.3% between T1 and T2. The International Organisation of Physical Therapists in Mental Health workgroup suggest a reduction of WC of 5% from the initial waist circumference should be a target in the short term, i.e. the first 6 months of an intervention, with a reduction of 5–10% of the initial WC being maintained in the long term [66].

Similar lifestyle interventions have been successful to reduce cardiometabolic in cohorts with MetS [67]. A 12-week weight management intervention ($n = 48$) demonstrated significant weight loss in participants with schizophrenia and schizoaffective disorder taking olanzapine, a second generation antipsychotic drug [68]. A small pilot in Canada ($n = 16$) demonstrated benefits to weight, lipid profile and aerobic fitness from a low-intensity exercise and nutrition intervention for participants taking second-generation antipsychotics [46]. Therefore the reduction seen in WC in this study is an import finding and clinically noteworthy.

4.4. Exploratory outcomes

4.4.1. Cardiovascular fitness

Baseline cardiovascular fitness levels were low. The low levels of fitness increased somewhat towards normal levels for age and gender comparisons [69,70]. These results are consistent with findings in research that show overall health performance and fitness levels of the MMI population are reduced compared to healthy controls [8,71].

Notably, cardiovascular fitness levels improved significantly over the course of the intervention ($p = 0.02$). This mirrored results from other studies [16,47]. However, as physical activity did not increase, this increased aerobic capacity was somewhat unexpected. A likely explanation for this discrepancy may be the practice effects of the exercise testing procedures. There are several other hypotheses: the relationship of reduced sedentary time on cardiovascular fitness is underexplored in this population; swimming activity, a cardiovascular exercise engaged in by 7 participants was not captured by the accelerometer; exercise intensity was not recorded during activity such as walking. These uncaptured factors may have also contributed to the increased aerobic fitness observed.

Participants were also successful in maintaining cardiovascular fitness at follow up. Increased fitness with low intensity exercise is seen in other such studies using walking programmes [17]. Individualising the programme to allow participants self-select the mode of exercise may have aided adherence to the programme which led to changes in cardiorespiratory capacity which were maintained at 3 months.

4.4.2. BMI

Participants in the current study were overweight or obese, a finding similar to other studies [43,52,72]. BMI levels did not change significantly over the course of the study. There is evidence of interventions influencing BMI in research, however this is not consistent [46,58,73]. Decreased BMI was demonstrated in a study by Daumit et al. (2013) [43] at three months post intervention and continued to decrease at follow-up assessments at six months and 18 months post intervention. Masa-Font et al. (2015) [58], similar to this study, found no significant difference at three months. In contrast to the study by Masa-Font et al. (2015) [60], the current study did demonstrate a significant difference in waist circumference post intervention.

4.5. Clinical implications

The data from this feasibility study is encouraging and may hold clinical relevance. High levels of acceptability and compliance shown demonstrate that MI is a suitable intervention strategy in this population. Furthermore MI is a low cost intervention requiring minimal resources and is time efficient. Walking, a cost effective and functional activity was the main physical activity chosen by participants. It can therefore be argued that a MI based physical activity intervention such as that outlined in this study could easily be integrated into mental health services.

Positive changes were demonstrated in aerobic capacity, and aspects of cardiometabolic risk. Significant improvements were shown in waist circumference, and small but non-significant improvements were seen in time spent sedentary. As those with MMI are known to have increased mortality levels, even the modest improvements in cardiovascular risk and cardiovascular fitness may be clinically relevant.

4.6. Study limitations

Several limitations pertained to the study. This was a single arm trial which used a sample of convenience. The numbers involved were likely not powered adequately or of sufficient length to detect changes in physical activity levels.

Accelerometers have successfully been used in studies investigating physical activity in people with MMI [35,59]. In this study, however, a high level of non-wear time was noted; characteristics of disorganisation and lack of routine seen in this study's population, along with poor completion of activity logs, led to difficulty analysing wear time. We also noted limitations to using indirect gas calorimetry to assess cardiorespiratory fitness. For example, there was difficulty obtaining consistent heart rate data using telemetry during exercise in participants with severe central obesity and the use of a facemask added to the anxiety of the testing procedure.

4.7. Future directions

A future adequately powered RCT of a similarly designed PA intervention, underpinned by MI-based, supported by an exercise professional and including objective measurement of PA versus standard care should be performed to test true efficacy. Cut-points for accelerometer data suitable for this population should be established which may improve accuracy of accelerometer data and future studies may consider continuous PA monitoring. Poor completion levels of the self-report PA measure observed in this study suggest that future studies also should consider using an interview-administered approach [74]. Due to difficulties noted using indirect gas calorimetry, follow on studies could consider measuring aerobic capacity using the 6MWT, which has been validated in this population [51]. Future research should also include cost effectiveness analyses.

5. Conclusion

This study demonstrated that a MI-based physical activity intervention is acceptable and feasible in a population with MMI. Some small changes to cardiorespiratory fitness and cardiometabolic risk factors were noted. This study adds to the body of research aimed at designing effective interventions to increase physical activity in people with MMI by promoting self-efficacy, taking into account personal preference and autonomy.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.genhosppsych.2018.03.002.

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