

Bond University  
Research Repository



## The feasibility and acceptability of high-intensity interval training for adults with mental illness: A pilot study

Chapman, Justin J.; Coombes, Jeff S.; Brown, Wendy J.; Khan, Asaduzzaman; Chamoli, Suneel; Pachana, Nancy A.; Burton, Nicola W.

*Published in:*  
Mental Health and Physical Activity

*DOI:*  
[10.1016/j.mhpa.2017.09.007](https://doi.org/10.1016/j.mhpa.2017.09.007)

*Licence:*  
CC BY-NC-ND

[Link to output in Bond University research repository.](#)

*Recommended citation(APA):*  
Chapman, J. J., Coombes, J. S., Brown, W. J., Khan, A., Chamoli, S., Pachana, N. A., & Burton, N. W. (2017). The feasibility and acceptability of high-intensity interval training for adults with mental illness: A pilot study. *Mental Health and Physical Activity*, 13, 40-48. <https://doi.org/10.1016/j.mhpa.2017.09.007>

### General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

For more information, or if you believe that this document breaches copyright, please contact the Bond University research repository coordinator.

**The feasibility and acceptability of high-intensity interval training for adults with mental illness: A pilot study**

Running title: HIIT for adults with mental illness

**Justin J Chapman**<sup>1,2</sup>

**Jeff S Coombes**<sup>2</sup>

**Wendy J Brown**\*<sup>2</sup>

**Asaduzzaman Khan**<sup>3</sup>

**Suneel Chamoli**<sup>4</sup>

**Nancy A Pachana**<sup>5</sup>

**Nicola W Burton**<sup>2</sup>

<sup>1</sup>The University of Queensland, School of Human Movement and Nutrition Sciences, Brisbane, Australia

<sup>2</sup>QIMR Berghofer Medical Research Institute, Brisbane, Australia

<sup>3</sup>The University of Queensland, School of Health and Rehabilitation Sciences, Brisbane, Australia

<sup>4</sup>The Princess Alexandra Hospital, Mood Academic Clinical Unit, Brisbane Australia

<sup>5</sup>The University of Queensland, School of Psychology, Brisbane, Australia

**Address for the institution at which this work was conducted:**

The University of Queensland, St Lucia, Brisbane, Queensland, Australia

**\*Correspondence to:**

*Name:* Dr Justin Chapman

*Present address:* QIMR Berghofer Medical Research Institute  
300 Herston rd  
Herston, Brisbane

*Email:* [justin.chapman@qimrberghofer.edu.au](mailto:justin.chapman@qimrberghofer.edu.au)

**Word count**

Abstract: 249; Main text: 4,140; Three (3) tables and two (2) figures are included.

**1 ABSTRACT**

2 **Introduction:** Adults with mental illness have increased risk of cardiovascular disease. High-  
3 intensity interval training (HIIT) is more efficacious than moderate-intensity continuous  
4 training (MICT) for improving cardiorespiratory fitness (CRF); however, the utility of HIIT  
5 for this group is unclear. The aim of this study was to compare the feasibility and  
6 acceptability of HIIT and MICT in adults with mental illness. A secondary aim was to  
7 compare the efficacy of HIIT and MICT on mental health and fitness. **Method:** Inactive  
8 adults with self-reported mental illness participated in aerobic exercise three times/week over  
9 12 weeks. Participants were randomised to HIIT (3x4-min bouts at 85–95% maximum heart  
10 rate [ $HR_{max}$ ] interspersed with 3-min recovery bouts) or MICT (1x30-min at 65–75%  $HR_{max}$ ).  
11 Feasibility was assessed using attendance and withdrawal rates. Acceptability and mental  
12 health was assessed using self-administered questionnaires. Fitness was measured using  
13 indirect calorimetry during a graded fitness test to exhaustion. **Results:** 24 participants  
14 consented and 16 participants began the intervention (HIIT, n=8; MICT, n=8). Completion  
15 rates (HIIT, n=4; MICT, n=5) and median attendances were similar (HIIT=81%,  
16 MICT=86%). Most participants were satisfied with their allocation (88% MICT; 100% HIIT),  
17 and found the exercise enjoyable (63% MICT; 100% HIIT). Equal numbers reported that they  
18 would like to continue the exercise (63%), and that they would feel confident doing so  
19 without supervision (75%). No significant differences were found between groups on mental  
20 health and fitness. **Conclusion:** This preliminary evidence suggests that HIIT was as  
21 acceptable and feasible as MICT for adults with mental illness.

22 **Key words:** HIIT; Aerobic exercise; Exercise intervention; Mental health; Pilot study;  
23 Randomised controlled trial

## 24 INTRODUCTION

25 Adults with mental illnesses have a mortality rate more than double that of the general  
26 population, and a 10-20 year lower life expectancy (Lawrence, Hancock, & Kisely, 2013).  
27 Evidence suggests that this mortality gap has increased in recent decades, and is largely  
28 attributable to preventable chronic conditions, such as cardiovascular disease (Lawrence et  
29 al., 2013). Exercise protects against chronic disease, decreases mortality risk (Barry et al.,  
30 2014), and can reduce symptoms of depression (Schuch et al., 2016), anxiety (Stonerock,  
31 Hoffman, Smith, & Blumenthal, 2015), and schizophrenia (Dauwan, Begemann, Heringa, &  
32 Sommer, 2015). Regular exercise also improves cardiorespiratory fitness (CRF), which is  
33 inversely related to cardiovascular and all-cause mortality (Blair et al., 1996).

34 High-intensity interval training (HIIT) involves alternating short bursts of high intensity  
35 exercise with recovery periods of rest or light exercise. HIIT can lead to greater  
36 improvements in CRF than moderate-intensity continuous training (MICT) in healthy  
37 individuals and cardiometabolic patients (Weston, Wisløff, & Coombes, 2013; Wisløff,  
38 Ellingsen, & Kemi, 2009). HIIT is also more effective than MICT at improving known  
39 cardiometabolic risk factors, such as insulin sensitivity, total and low-density lipoproteins,  
40 and endothelial function (Kilpatrick, Jung, & Little, 2014). In addition to the physical health  
41 benefits, HIIT may also improve mental health. Studies of HIIT in clinical groups with  
42 physical conditions (e.g. cardiac patients) have reported greater, or similar, improvements in  
43 quality of life compared with MICT (Fu et al., 2013; Moholdt et al., 2009; Molmen-Hansen et  
44 al., 2012; Wisløff et al., 2007), as well as similar reductions in symptoms of depression and  
45 anxiety (Freyssin et al., 2012).

46 Initial work has shown promise for the use of HIIT with adults with mental illness. Two  
47 controlled trials with inpatients with schizophrenia (Heggelund, Nilsberg, Hoff, Morken, &  
48 Helgerud, 2011), or substance use disorder (Flemmen, Unhjem, & Wang, 2014), reported that

49 8-weeks of HIIT for three sessions/week, using a 4x4 minute interval protocol, significantly  
50 improved fitness, but not mental illness symptoms. Another pre-post study used a 14-week  
51 HIIT protocol with 10x20-sec intervals and 90-sec recovery periods with patients with first  
52 episode psychosis; global functioning and severity, and social/occupational functioning  
53 remained similar, but waist circumference and VO<sub>2</sub>max significantly improved (Abdel-Baki,  
54 Brazzini-Poisson, Marois, Letendre, & Karelis, 2013). One study on the acute effects of HIIT,  
55 reported that adults with depression or schizophrenia experienced improved mental health for  
56 up to 3-hours after a single session of 4x4 minute interval training (Heggelund, Kleppe,  
57 Morken, & Vedul-Kjelsås, 2014). These studies used conventional aerobic equipment (e.g.  
58 treadmill) to achieve the desired heart rate training ranges. One pre-post study with  
59 outpatients with schizophrenia used “body weight exercises” to achieve age-predicted heart  
60 rate ranges, and found that an 8-week, three sessions/week intervention, involving 15 minute  
61 sessions (4 sets of 3.75-minute intervals which included 5x15-s circuit intervals) significantly  
62 improved depression, anxiety, and negative symptoms of schizophrenia (Wu, Lee, Hsu,  
63 Chang, & Chen, 2015).

64 Preliminary evidence suggests that HIIT is a feasible exercise protocol for adults with mental  
65 illness: Mean attendance rates in the aforementioned studies ranged from 68%-92%, and  
66 attrition ranged from 10%-36% (Abdel-Baki et al., 2013; Flemmen et al., 2014; Heggelund et  
67 al., 2011; Wu et al., 2015). However, no studies have specifically compared the feasibility or  
68 acceptability of HIIT and MICT for adults with mental illness across a range of diagnoses.  
69 From a patient perspective, HIIT may be more appealing than MICT, because a similar health  
70 benefit can be achieved in a shorter time. Additionally, the short bursts of activity involved in  
71 HIIT may be more enjoyable than traditional endurance training (Tjønnå et al., 2008).  
72 Conversely, some patients may find the higher intensity exercise uncomfortable (Blanchard,  
73 Rodgers, Spence, & Courneya, 2001).

74 The primary aim of this pilot study was to compare the feasibility and acceptability of HIIT  
75 with MICT, for adults with mental illness. The hypothesis was that HIIT would have better  
76 feasibility and acceptability than MICT, consistent with preliminary evidence from studies  
77 with other patient groups (Fu et al., 2013; Moholdt et al., 2009; Molmen-Hansen et al., 2012;  
78 Wisløff et al., 2007). The secondary aim was to compare the efficacy of HIIT and MICT on  
79 mental health and fitness.

## 80 **METHODS**

81 This was a two-group randomised study. Ethical approval was obtained from The University  
82 of Queensland Behavioural and Social Sciences Ethical Review Committee (2014000644),  
83 and the Princess Alexandra Hospital Metro South Human Ethical Review Committee  
84 (HREC/14/QPAH/202). Data were collected between October 2014 and July 2015 in  
85 Brisbane, Australia.

### 86 **Procedure**

87 Participants were recruited via general community advertisements (radio, local paper, online  
88 social media news articles), and clinician referral from private practice psychology clinics,  
89 and a local mental health outpatient unit. Individuals were eligible for the study if they: i)  
90 self-reported having a psychiatric diagnosis (any diagnosis not specified in the exclusion  
91 criteria), or were experiencing high psychological distress defined as a score >15 on the  
92 Kessler-6 scale (Kessler et al., 2002); ii) were currently receiving mental health treatment  
93 from a psychologist or psychiatrist; iii) were ambulatory; iv) were able to understand English,  
94 and v) were over 18 years of age. Exclusion criteria were: i) currently pregnant; ii) having  
95 acute symptoms of psychosis and considered insufficiently stable to participate (determined  
96 by the referring clinician); iii) having an eating disorder (e.g. anorexia nervosa, bulimia  
97 nervosa) characterised by excessive exercise; iv) having a mental illness secondary to a

98 diagnosed medical condition, and v) participating in more than 30 minutes per week of self-  
99 reported exercise. Participant information is shown in Table 1.

100 The lead researcher (JJC) met eligible individuals in person at an agreed location (often at  
101 their residence) to: i) obtain written informed consent for study participation; ii) obtain  
102 consent to contact their medical doctor for information related to their suitability to exercise;  
103 iii) administer the Adult Pre-exercise Screening System (APSS) (Norton et al., 2012); iv)  
104 administer a sociodemographic questionnaire (e.g. self-reported psychiatric diagnosis,  
105 education, employment; shown in Table 1); and v) provide accelerometers to measure  
106 baseline physical activity levels. Participants were asked to wear the accelerometer on a waist  
107 belt on the right hip, 24 hours/day (except when in water) for seven consecutive days, and  
108 note times to bed and out of bed each day in a log book.

109 After the initial meeting, participants were assigned a unique code that was sent to a  
110 biostatistician (AK) for randomisation. Participants were randomised in 1:1 ratio to HIIT or  
111 MICT conditions using block randomisation (block size of four). Participants were notified of  
112 their allocation at their first intervention exercise session, which was after completing all  
113 assessments.

114 After completing the accelerometry, participants were asked to attend an individualised  
115 baseline testing session. Participants were asked to refrain from vigorous activity and  
116 consuming alcohol for 24 hours, and from smoking for 2 hours, prior to the testing session. At  
117 the testing, participants completed self-administered mental health questionnaires, followed  
118 by anthropometric measures and a maximal fitness test. The lead researcher assisted an  
119 Exercise Physiologist with the assessments.

120 Assessments were completed at baseline and post-intervention (12 weeks). Participants were  
121 offered an AUD\$20 gift card at completion of the baseline assessments, and an AUD\$100 gift

122 card at completion of the post-intervention assessments. Participants were asked to complete  
123 the post-intervention assessments even if they withdrew from the study; however, those who  
124 withdrew because of exercise-related pain were not asked to complete the post-intervention  
125 fitness test.

## 126 **Outcomes**

127 Feasibility was assessed using recruitment numbers, attendance, completion rates, and  
128 reasons for withdrawal; completion of unsupervised sessions were assessed via self-report.  
129 Acceptability was assessed at post-intervention using ten questionnaire items developed for  
130 this study; responses were on a 5-point Likert scale (*strongly disagree, disagree, neither*  
131 *agree nor disagree, agree, and strongly agree*). Questionnaire items are shown in Table 2.

132 Symptoms of poor mental health were assessed using the Depression Anxiety Stress Scale  
133 (DASS21) (Lovibond & Lovibond, 1995), and the Psychological General Wellbeing Index  
134 (PGWBI) (Chassany, Dimenas, Dubois, & Wu, 2004). The DASS21 is a 21-item  
135 questionnaire to assess depression, anxiety and stress. Each subscale includes seven  
136 questions, with possible scores ranging from 0 to 21; the subscales have high internal  
137 reliability in adults across a range of mental illnesses (Cronbach's  $\alpha = 0.94, 0.87$  and  $0.91$  for  
138 depression, anxiety, and stress respectively) (Antony, Bieling, Cox, Enns, & Swinson, 1998).  
139 The PGWBI consists of 22 items to assess six dimensions of wellbeing: anxiety, depressed  
140 mood, positive wellbeing, self-control, general health and vitality; possible scores range from  
141 0 to 110 to form an overall index of general wellbeing (Chassany et al., 2004). The PGWBI  
142 has been shown to have satisfactory internal construct validity for patients with exhaustion  
143 related disorders (Lundgren-Nilsson, Jonsdottir, Ahlborg, & Tennant, 2013).

144 Body composition (percent fat mass, and fat free mass) was measured using bioelectric  
145 impedance. Height was measured to the nearest 0.1 cm using a stadiometer and waist was  
146 measured to the nearest 0.1 cm using a tape measure. Each was measured twice, and the



147 average taken as the point estimate. If there was more than a 1-cm difference between the two  
148 measurements, a third measurement was taken, and the average of the two closest values  
149 reported. Weight was measured to the nearest 0.01 kg using electronic scales.

150 Cardiorespiratory fitness (CRF) was assessed using a graded exercise test to exhaustion.  
151 Participants chose either treadmill or stationary bike; the modified Bruce protocol was used  
152 for the treadmill, and a ramping protocol was used for the stationary bike (Bruce, Kusumi, &  
153 Hosmer, 1973). Expired air was analysed using a standard metabolic system (Vmax,  
154 SensorMedics, Yorba Linda, CA), and electrocardiogram (ECG) was measured with a 12-  
155 lead ECG (GE Healthcare Case Machine, V6.51). Rate of perceived exertion was measured  
156 using the Borg scale, and blood pressure was manually measured using a stethoscope, every  
157 three minutes. The 20-second averaged rate of oxygen consumption during the final minute  
158 was used to calculate  $VO_{2max}$ . The maximum heart rate ( $HR_{max}$ ) achieved during the test was  
159 used to calculate the HR training range.

#### 160 **Intervention protocol**

161 Both HIIT and MICT conditions involved three sessions per week for 12 weeks (36 sessions  
162 total). Supervision was provided by the lead researcher (JJC), who is a qualified personal  
163 trainer. During supervised sessions, participants could use a treadmill or stationary bike, and  
164 were encouraged to use the same machine they used for the fitness test. Supervised exercise  
165 sessions were scheduled per participant availability, and were conducted in groups of up to  
166 five at the School of Human Movement and Nutrition Sciences Exercise Physiology research  
167 laboratory. Supervision was tapered over the program: three sessions/week were supervised  
168 for the first eight weeks; two sessions/week were supervised in the final four weeks, and  
169 participants were asked to complete one self-directed session/week at home. Exercise type for  
170 self-directed sessions was jogging or cycling.

171 *HIIT*: Three 4-minute (3x4-minute) intervals at 85-95% of  $HR_{max}$ , interspersed by 3-minute  
172 recovery periods at 60-70%  $HR_{max}$ . Training ranges had to be achieved within the first two  
173 minutes of each interval. Each session began with a 4-minute warm-up, and finished with a 3-  
174 minute warm-down at 60-70% of  $HR_{max}$ . The total session duration was 25 minutes.

175 *MICT*: 30 minutes at 65-75% of the  $HR_{max}$ . Each session began with a 3-minute warm-up,  
176 and finished with a 2-minute warm-down at 60-70% of  $HR_{max}$ . The total session duration was  
177 35 minutes.

178 HR ranges during supervised sessions were achieved by adjusting ergometer resistance, and  
179 treadmill speed and/or incline. Polar FT1 heart rate monitors (Polar Electro, Finland) were  
180 used to monitor compliance with target heart rates. HR was recorded at the end of each  
181 interval for HIIT participants, and at 20 minutes and 30 minutes for MICT participants. Blood  
182 pressure was measured before and after each session; participants with hypertension (140/90  
183 mm Hg) were required to rest until blood pressure returned to baseline. Participants were  
184 given a HR monitor to use for self-directed sessions, and the researcher met with participants  
185 at their residence to assist with planning an exercise route. There were no restrictions from  
186 engaging in additional exercise outside the study requirements.

### 187 **Data management**

188 Responses to the acceptability questionnaire were collapsed into three categories (*disagree*,  
189 *neutral*, *agree*) to generate summary statistics. These were then collapsed to two categories  
190 (*disagree/neutral*, *agree*) for analysis. Accelerometer data recorded during participants'  
191 waking hours defined by their self-reported time to bed and out of bed, were analysed to  
192 determine baseline activity levels. Consecutive zero counts of 60 minutes or longer were  
193 defined as non-wear and removed; data were considered valid if the accelerometer was worn  
194 for at least 80% of waking hours (J. J. Chapman, Brown, W.J., and Burton, N.W., 2015) on at  
195 least three days. Data from the accelerometer's vertical axis were converted to counts per

196 minute (cpm) and used to define sedentary behaviour (SB;  $\leq 100$  cpm), light activity (101–  
197 2,019 cpm), and moderate-to-vigorous activity (MVPA;  $> 2,019$  cpm).

## 198 **Analysis**

199 As an indicator of feasibility, attendance for all participants who did not withdraw were  
200 compared between HIIT and MICT conditions using Mann-Whitney U tests. Acceptability  
201 questionnaire items were compared for all HIIT and MICT participants who completed at  
202 least one exercise session, using Chi-square Fisher's exact tests. Participants were asked to  
203 complete the post-intervention outcome assessments even if they withdrew from the study; all  
204 participants who provided post-intervention data were included in the analyses of outcome  
205 variables (depression, anxiety, stress, wellbeing,  $VO_2\max$ ). *Per protocol* analyses included  
206 participants who completed at least 70% of the exercise sessions. Wilcoxon sign rank tests  
207 were used to compare within-group pre-post scores for HIIT and MICT groups, and Mann-  
208 Whitney U tests were used to compare the *percent change* in between groups. Participant  
209 baseline characteristics for HIIT and MICT conditions were compared using Mann-Whitney  
210 U tests for continuous variables (age, BMI, scores of depression, anxiety, stress and  
211 wellbeing, and time spent in SB, light activity, and MVPA), and Fisher's exact test for  
212 categorical variables (sex). Analyses were performed using SPSS version 23. Statistical  
213 significance was set at  $p < 0.05$ .

## 214 **RESULTS**

### 215 **Participants**

216 A participant flow diagram is shown in Figure 1. Fifty-four individuals were screened for  
217 study entry: 32 (59%) made contact after finding out about the study from community  
218 advertisements, 21 (39%) were referred from the outpatient clinic, and one (2%) was referred  
219 by a psychologist in private practice. Of those screened, 24 (44%) met the eligibility criteria.  
220 The most common reasons for ineligibility were already doing more than 30 minutes per

221 week of self-reported exercise (43%), and not receiving mental health treatment from a  
222 psychologist or psychiatrist (20%). Participant health and demographic characteristics at  
223 baseline are presented in Table 1.

224 Of the 24 participants who received accelerometers at baseline, 21 completed the  
225 accelerometer protocol, and of those 19 (90%) provided valid accelerometry data (HIIT=9,  
226 MICT=10). Participants in each group had similar accelerometer-derived SB ( $U=61.0$ ,  
227  $p=0.211$ ), light activity ( $U=44.0$ ,  $p=0.968$ ), and MVPA ( $U=38.0$ ,  $p=0.604$ ), and were of  
228 similar age ( $U=68.5$ ,  $p=0.880$ ), BMI ( $U=32$ ,  $p=0.069$ ), and gender (Fisher's exact test,  
229  $p=0.414$ ). Participants also had similar scores for baseline depression ( $U=59.5$ ,  $p=0.974$ ),  
230 anxiety ( $U=66.0$ ,  $p=0.722$ ), stress ( $U=74.5$ ,  $p=0.346$ ), and wellbeing ( $U=35.0$ ,  $p=0.107$ ).  
231 Participants who withdrew but still provided post-intervention data were similar to those who  
232 completed the exercise program on all baseline measures ( $p>0.05$ ).

### 233 **Feasibility**

#### 234 *Withdrawals*

235 Two participants withdrew after completing the baseline accelerometry, but prior to  
236 completing the fitness test, or being told their group allocation. These participants had  
237 schizophrenia ( $n=1$ ) and bipolar disorder ( $n=1$ ), and withdrew due to personal concerns about  
238 inability to attend due to poor mental health (e.g. disorganisation, or having regular "bad  
239 days"). Twenty-two participants (92% of those randomised) completed all baseline  
240 assessments, six of whom (27%) withdrew prior to being told their group allocation. Reasons  
241 for withdrawal were: "Too much going on in their life" ( $n=1$ ), recent surgery ( $n=1$ ),  
242 psychiatric admission ( $n=1$ ), and self-consciousness ( $n=1$ ). Two people did not provide  
243 reasons for withdrawal.

244 Of the 16 participants who began the exercise program, equal numbers were allocated to HIIT  
245 (n=8) and MICT (n=8). Seven participants (44% of total) withdrew before completing the 12-  
246 week program (HIIT=4; MICT=3), after a median of three weeks (range=2-7). The most  
247 common reason for withdrawal was exacerbation of a pre-existing musculoskeletal condition  
248 (n=4): back/hip pain (HIIT=2) and shin/ankle pain (MICT=2). Two participants withdrew due  
249 to transport difficulties (HIIT=1, MICT=1): one because of fuel costs, and one because of an  
250 inability to organise public transport. One HIIT participant withdrew because the exercise  
251 was perceived as too difficult.

### 252 *Completion and attendance*

253 Median attendance for the five participants who completed the MICT program was 86%  
254 (IQR=59-90%), or 31 of 36 sessions (IQR=20-33). Median attendance for the four  
255 participants who completed the HIIT program was 81% (IQR=43-95%), or 29 of 36 sessions  
256 (IQR=16-34). Attendance was similar in the two groups ( $U=10.0$ ,  $p=1.0$ ). Nine participants  
257 (50% of those who began the program) completed the exercise program (HIIT=4, MICT=5).  
258 Three HIIT participants, and four MICT participants completed at least 70% of sessions (78%  
259 of those who completed). The numbers of participants who completed each assessment are  
260 shown in

### 261 **FIGURE CAPTIONS**

#### 262 **Figure 1: Participant flow diagram**

263 HIIT: high-intensity interval training; MICT: moderate-intensity continuous training.

264 <sup>a</sup> Withdrew before completing mental and physical health baseline assessments, but after  
265 providing written informed consent, completing a demographics questionnaire, and wearing  
266 an accelerometer for 7 days.

267 <sup>b</sup> Withdrew after completing the baseline assessments (including the fitness test) but before  
268 receiving their group allocation.

269 <sup>c</sup> Participants who withdrew were invited to complete the post-intervention assessments; those  
270 who withdrew to exercise-related pain were not asked to complete the post-intervention  
271 fitness test.

272 **Figure 2: Baseline and post-intervention mental health scores of participants completing**  
273 **at least 70% of the program**

274 Median pre-intervention (black bars) and post-intervention (shaded bars) scores on mental  
275 health outcomes are shown for participants who completed at least 70% of exercise sessions;  
276 individual data are plotted as solid lines. Possible depression, anxiety and stress scores range  
277 from 0 to 21, higher scores represent higher severity. Possible wellbeing scores range from 0  
278 to 110, higher scores represent better wellbeing. HIIT: High intensity interval training; MICT:  
279 Moderate intensity continuous training.

280

281 **Table 1: Health and demographic characteristics of participants at baseline**

	HIIT (n=12)	MICT (n=12)	All (n=24)
	Mean (SD)	Mean (SD)	Mean (SD)
Age (years)	37.4 (10.4)	38.6 (11.7)	38.0 (10.8)
Female n (%)	7 (58%)	4 (33%)	11 (92%)
Psychological distress <sup>a</sup>	15.3 (6.6)	17.5 (3.6)	16.3 (5.4)
<u>Self-reported diagnosis</u>	<b>n (%)</b>	<b>n (%)</b>	<b>n (%)</b>
Psychoses	3 (25%)	3 (25%)	6 (25%)
Depression	1 (8%)	3 (25%)	4 (17%)
Bipolar disorder	3 (25%)	1 (8%)	4 (17%)
Anxiety	0 (0%)	1 (8%)	1 (4%)
Delusional disorder	1 (8%)	0 (0%)	1 (%)
Depression and anxiety <sup>b</sup>	2 (17%)	1 (8%)	3 (12%)
Depression, anxiety and <i>other</i> <sup>c</sup>	1 (8%)	2 (17%)	3 (12%)
Depression and BPD	1 (8%)	0 (0%)	1 (4%)
Bipolar and BPD	0 (0%)	1 (8%)	1 (4%)
<u>Education</u>			
Did not finish high school	1 (8%)	4 (33%)	5 (21%)
High school	2 (17%)	5 (42%)	7 (29%)
Certificate/diploma (college)	6 (50%)	2 (17%)	8 (33%)
Tertiary degree (university)	3 (25%)	1 (8%)	4 (17%)
<u>Employment</u>			
Full-time/part-time	1 (8%)	1 (8%)	2 (8%)
Student	2 (17%)	0 (0%)	2 (8%)
Unemployed / looking for work	3 (25%)	7 (58%)	10 (42%)
Unable to work	6 (50%)	4 (33%)	10 (42%)
<u>Smoker status</u>			
Never/ex-smoker	6 (50%)	4 (33%)	10 (42%)
Daily/occasionally	6 (50%)	8 (67%)	14 (58%)
<u>BMI (kg/m<sup>2</sup>) <sup>d</sup></u>			
<18.5	0 (0%)	1 (10%)	1 (4%)
18.5 – 24.9	1 (8%)	1 (10%)	2 (8%)
25 – 29.9	4 (33%)	6 (60%)	10 (42%)

>30	7 (58%)	2 (20%)	9 (38%)
-----	---------	---------	---------

282 HIIT: high-intensity interval training; MICT: moderate-intensity continuous training; BPD:  
283 borderline personality disorder; BMI: Body Mass Index.

284 <sup>a</sup> Psychological distress was measured using the Kessler-6 scale; scores range from 6 to 30,  
285 scores over 15 indicate high distress.

286 <sup>b</sup> The participant allocated to MICT had a diagnosis of postnatal depression.

287 <sup>c</sup> *Other* here refers to i) alcohol dependence, ii) binge-eating disorder, and iii) borderline  
288 personality disorder.

289 <sup>d</sup> BMI calculated as weight (kg) / height (m)<sup>2</sup>. Height and weight were measured for  
290 participants who completed the baseline fitness test, BMI was therefore available for 22  
291 participants (HIIT, n=12; MICT, n=10).

292



293 **Table 2: Acceptability of the exercise condition (n=16)**

Questionnaire item	Group	Disagree	Neutral	Agree
		n (%)	n (%)	n (%)
I feel satisfied with the exercise condition that I was allocated to	HIIT	0 (0%)	1 (13%)	7 (88%)
	MICT	0 (0%)	0 (0%)	8 (100%)
I would have preferred to be in the other exercise condition	HIIT	4 (50%)	3 (38%)	1 (13%)
	MICT	6 (75%)	2 (25%)	0 (0%)
I found the exercise enjoyable	HIIT	0 (0%)	0 (0%)	8 (100%)
	MICT	1 (13%)	2 (25%)	5 (63%)
I found the exercise too hard	HIIT	4 (50%)	2 (25%)	2 (25%)
	MICT	6 (75%)	2 (25%)	0 (0%)
I found the exercise boring	HIIT	4 (50%)	4 (50%)	0 (0%)
	MICT	4 (50%)	3 (38%)	1 (13%)
I would have preferred group-based exercise	HIIT	4 (50%)	2 (25%)	2 (25%)
	MICT	6 (75%)	0 (0%)	2 (25%)
I looked forward to the exercise sessions	HIIT	2 (25%)	3 (38%)	3 (38%)
	MICT	2 (25%)	2 (25%)	4 (50%)
I would like to continue doing this kind of exercise outside of the study	HIIT	2 (25%)	1 (13%)	5 (63%)
	MICT	1 (13%)	2 (25%)	5 (63%)
I would feel confident doing this kind of exercise without assistance	HIIT	1 (13%)	1 (13%)	6 (75%)
	MICT	0 (0%)	2 (25%)	6 (75%)
I would feel confident being able to do this kind of exercise when having a bad day	HIIT	4 (50%)	2 (25%)	2 (25%)
	MICT	3 (38%)	5 (63%)	0 (0%)

294 HIIT: High-intensity interval training; MICT: Moderate intensity continuous training.

295

296 **Table 3: Study outcomes for all participants who completed post-intervention**  
 297 **assessment**

	HIIT		MICT	
	Baseline	12-weeks	Baseline	12-weeks
<b>Mental health</b>		(n=9)		(n=10)
<u>DASS21</u> <sup>a</sup>				
Depression	14 (5, 16)	9 (3, 13)	7 (9, 10)	9 (4, 13)
% change		-25 (-50, 29)		-20 (-50, 50)
Anxiety	7 (2, 12)	1 (0, 7)	6 (4, 9)	6 (3, 7)
% change		-43 (-100, 0)		5 (-50, 4)
Stress	12 (3, 14)	6 (3, 10)	12 (10, 14)	8 (5, 12)
% change		0 (-45, 29)		-22 (-58, 0)
<u>PGWBI</u> total score <sup>b</sup>	61 (43, 76)	68 (54, 75)	50 (45, 58)	52 (47, 73)
% change		13 (-9, 22)		20 (-5, 44)
<b>Physical health</b>		(n=7)		(n=9)
Weight (kg)	85 (79, 106)	83 (81, 105)	87 (72, 96)	84 (73, 93)
BMI (kg/m <sup>2</sup> )	31 (27, 33)	31 (27, 32)	27 (24, 29)	28 (25, 28)
Waist circumference (cm)	100 (93, 110)	103 (89, 119)	90 (81, 101)	92 (85, 101)
% fat mass	30 (25, 41)	32 (24, 35)	28 (24, 40)	27 (16, 32)
VO <sub>2</sub> max (ml/kg/min) <sup>c</sup>	21 (20, 28)	23 (18, 29)	24 (21, 32)	22 (21, 33)

298  
 299 DASS21=Depression Anxiety Stress Scale; PGWBI=Psychological General Wellbeing Index.

300 <sup>a</sup> Possible depression, anxiety and stress scores range from 0 to 21, higher scores represent  
 301 greater severity of symptoms (i.e. a negative change indicates improved mental health).

302 <sup>b</sup> Possible wellbeing scores range from 0 to 110, higher scores represent greater wellbeing.

303 <sup>c</sup> A total of 12 participants (HIIT n=6, MICT n=6) completed the post-intervention maximal  
 304 fitness tests. One HIIT participant's VO<sub>2</sub>max results were excluded due to a technical error.

305 .

**306 Acceptability**

307 Responses to acceptability items are presented in Table 2; only participants who began their  
308 first exercise session were included in the acceptability analyses (MICT=8, HIIT=8). Most  
309 participants were satisfied with their allocation (MICT=8, HIIT=7). Few reported that the  
310 exercise was boring (MICT=1, HIIT=0), or too hard (MICT=0, HIIT=2), and there was a  
311 suggestion that more HIIT than MICT participants found the exercise enjoyable (MICT=5,  
312 HIIT=8). Equal numbers reported that they'd like to continue that kind of exercise after the  
313 study (63%), and that they'd feel confident doing so without supervision (75%). Chi-square  
314 Fisher's exact tests did not reveal any significant differences between conditions for any of  
315 the acceptability items ( $p>0.1$ ).

**316 Mental and physical health outcomes**

317 Aggregated baseline and post-intervention scores are presented in Figure 2, and Table 3.  
318 There were no statistically significant within-group differences between pre- and post-  
319 intervention mental health outcomes or fitness, for either HIIT (depression:  $p=0.09$ , anxiety:  
320  $p=0.06$ , stress:  $p=0.27$ , wellbeing:  $p=0.48$ ,  $VO_2max$ :  $p=0.89$ ) or MICT (depression:  $p=0.77$ ,  
321 anxiety:  $p=0.12$ , stress:  $p=0.09$ , wellbeing:  $p=0.13$ ,  $VO_2max$ :  $p=0.92$ ). There were no  
322 statistically significant differences between HIIT and MICT participants in the percent change  
323 in mental health outcomes or fitness, for all who provided post-intervention data (MICT  
324  $n=10$ , HIIT  $n=9$ ; depression:  $p=0.83$ , anxiety:  $p=0.12$ , stress:  $p=0.52$ , wellbeing:  $p=0.50$ ,  
325  $VO_2max$ :  $p=1.0$ ) or the per protocol sample (depression:  $p=0.86$ , anxiety:  $p=0.06$ , stress:  
326  $p=0.63$ , wellbeing:  $p=0.40$ ,  $VO_2max$ :  $p=1.0$ ).

**327 Additional observations**

328 There was great diversity among participants and in their responses to the exercise program.  
329 For example, two participants had complex presentations of mental illness (e.g. multiple  
330 comorbidities, hospital admission during the program etc.), but still completed the program

331 with high attendance (>70%), and showed marked improvements in mental health. In  
332 contrast, three other participants cited poor mental health as the reason for low attendance,  
333 and reported poorer mental health at post-intervention; for example, one participant withdrew  
334 and re-enrolled three times before beginning the exercise, finally withdrawing due to  
335 disorganisation and antipsychotic medication side-effects. Some participants had strong  
336 support for attending the exercise sessions; for example, one participant's partner drove her to  
337 exercise sessions, bought an activity monitor (Fitbit) for her, and actively encouraged her to  
338 reach walking goals. Other participants had strong motivation to improve their health, and  
339 began additional exercise (e.g. began participating in fun runs). Two participants who  
340 withdrew before completing four weeks of the intervention reported better mental health at  
341 follow-up due to improvements in other life circumstances (e.g. housing situation resolved).

## 342 **DISCUSSION**

343 The primary aim of this study was to compare the feasibility and acceptability of HIIT with  
344 MICT for adults with mental illness. Contrary to our hypothesis, HIIT and MICT had similar  
345 feasibility and acceptability; attendance and withdrawal rates, and responses on acceptability  
346 questionnaire items were similar. Most HIIT and MICT participants found the exercise  
347 enjoyable, and said they would like to continue the exercise after the study. A secondary aim  
348 was to evaluate the efficacy of each exercise condition on mental health and fitness. Although  
349 there was some suggestion of a greater anxiolytic effect in HIIT, there were no significant  
350 differences in the outcomes because of limited statistical power.

351 In terms of feasibility, it is notable that study attrition was high *overall*: 63% (n=15) of  
352 randomised participants withdrew. This is higher than attrition rates reported in most previous  
353 exercise training studies with adults with mental illness: meta-analyses reported pooled  
354 attrition of 18% (95%CI=15–22%) for adults with major depression (Stubbs et al., 2016), and  
355 27% (95%CI=20%–35%) for adults with schizophrenia (Vancampfort et al., 2016). In this

356 study about half of those who withdrew (n=8; 53% of withdrawals) did so after completing  
357 the baseline assessments, but before receiving their group allocation. This may indicate that  
358 the context of the exercise (exercise laboratory at a university), rather than the type of  
359 exercise, negatively influenced participation for these individuals. Further, all participants  
360 stated that the VO<sub>2</sub>max test (which involved wearing a head piece and nose-clip, breathing  
361 through a mouthpiece, and being monitored with a 12-lead ECG) was an unpleasant  
362 experience, which may have influenced their decision to withdraw. Future research into the  
363 feasibility of exercise interventions for adults with mental illness could use less invasive  
364 approaches to assess cardiorespiratory fitness (e.g. submaximal testing) or an indirect  
365 measure of exercise capacity e.g. six-minute walk test (Vancampfort et al., 2015).

366 Attrition after commencing the exercise program was also high: 44% (n=7) of those who  
367 began the exercise program withdrew. Withdrawal rates were similar for HIIT and MICT  
368 conditions (HIIT=4; MICT=3), and may therefore have been independent of exercise  
369 intensity. The most common reason for withdrawal was the exacerbation of a pre-existing  
370 musculoskeletal injury. Although participants could switch to a different aerobic machine to  
371 minimise further exacerbation (e.g. stationary cycling instead of treadmill), this did not  
372 resolve the pain issues in some cases. As we only included inactive individuals in the study,  
373 low conditioning may have made them more susceptible to exercise-related pain. The  
374 feasibility of HIIT and MICT programs could be improved by incorporating a lower-intensity  
375 pre-conditioning phase, including rehabilitation exercises to minimise exacerbation or injury  
376 (e.g. core stability exercise for participants with low back pain), or including other aerobic  
377 machines to reduce impact (e.g. upper body ergometer). Other reasons for withdrawal  
378 included transport related issues (fuel costs, unable to organise regular attendance), and self-  
379 consciousness about attending a busy university. Accessibility could be improved by offering

380 transport assistance, or conducting exercise programs at community exercise facilities or  
381 within the local neighbourhood (e.g. outdoor walking groups).

382 Most (86%) participants who withdrew from the program did so in the first six weeks. This  
383 suggests that more focused support (e.g. transport assistance) during this initial period could  
384 assist participants to overcome PA barriers, and improve program feasibility. However,  
385 participants who completed the program did so with high attendance: median attendance was  
386 81% and 86% for HIIT and MICT groups, respectively. Anecdotally, those with strong social  
387 support or motivation had highest attendance. Facilitating social support and increasing  
388 motivation during the first six weeks may improve overall adherence to an exercise  
389 intervention (Gross, Vancampfort, Stubbs, Gorczynski, & Soundy, 2016). Social support  
390 could be increased by encouraging participants to exercise with a friend or someone they  
391 know, or by facilitating a ‘team’ environment among exercise participants, e.g. by providing  
392 team t-shirts, or setting group challenges (e.g. cumulatively walk a certain distance every  
393 week). Motivation could be increased by including exercise counselling or motivational  
394 interviewing.

395 No statistically significant between- or within-group differences in mental health were found  
396 at post-intervention. The greatest improvement was in anxiety scores for HIIT participants  
397 (median reduction of 43%): The three participants who completed at least 70% of HIIT  
398 sessions demonstrated a complete remission of anxiety symptoms. However, this was not  
399 statistically significant ( $p=0.06$ ), possibly due to small sample size. Anecdotally, participants  
400 with positive expectation and a commitment to the exercise benefitted the most. A diverse  
401 range of life circumstances (e.g. housing, medication etc.), however, may have influenced  
402 mental health outcomes, independent of potential exercise effects.

403 No significant between-group differences in fitness were found at post-intervention. Previous  
404 studies in patients with cardiometabolic disease have shown greater improvements in

405  $\text{VO}_2\text{max}$  following HIIT interventions (19%, compared with 10% for MICT; mean difference  
406  $\sim 3 \text{ mL}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$ ) (Weston et al., 2013), and that HIIT protocols using a 4x4-minute intervals  
407 were most efficacious (Weston et al., 2013). We used 3x4-minute intervals because we  
408 believed that 4x4-minute intervals would be too demanding for inactive, sedentary patients  
409 with a chronic mental illness, and this may have reduced potential fitness gains. Participants  
410 were given heart rate monitors to use during their four unsupervised sessions; however,  
411 compliance may have been lower in unsupervised settings (e.g. to the prescribed intensity,  
412 duration, number of sets), which may also have reduced potential improvements in mental  
413 health and fitness.

414 This is the first study to compare the feasibility and acceptability of HIIT and MICT for  
415 adults with mental illness. A strength of this study is that our sample had a diverse range of  
416 psychiatric diagnoses. Previous research into HIIT for adults with mental illness has focused  
417 on patients with one specific diagnosis (e.g. schizophrenia, depression, substance use)  
418 (Abdel-Baki et al., 2013; Flemmen et al., 2014; Heggelund et al., 2014; Heggelund et al.,  
419 2011; Wu et al., 2015). Understanding the feasibility and acceptability of different exercise  
420 approaches for heterogeneous patient groups may guide the implementation of exercise  
421 programs in mental health services, where patient groups are likely to be diverse. A limitation  
422 is that this study was underpowered due to the higher than expected attrition. Further, medical  
423 comorbidities, or the type, dose, or changes to conventional mental health treatments (e.g.  
424 medications, psychotherapy) were not assessed. Conventional treatments may confound  
425 mental health outcomes via associated changes in mental health; medical comorbidities may  
426 also influence mental health via pain and reduced mobility (Stubbs et al., 2015), and are  
427 commonly reported as a barrier to physical activity, which may influence program feasibility  
428 (J. J. Chapman, Fraser, Brown, & Burton, 2016).

429 In summary, this preliminary evidence suggests that both HIIT and MICT are acceptable and  
430 feasible forms of exercise for adults across a range of mental illnesses. Community-based  
431 exercise programs with tailoring of exercises to participant abilities, and support in the initial  
432 stages of training to overcome physical activity barriers and enhance motivation, may  
433 improve adherence and reduce withdrawal rates. Larger trials with more comprehensive  
434 assessment of potential confounders are necessary to compare the efficacy of HIIT and MICT  
435 on mental health and fitness for adults with mental illness.

436



437 **ACKNOWLEDGEMENTS**

438 This work was supported by an internal seeding grant scheme of The University of  
439 Queensland Faculty of Health and Behavioural Sciences. The authors would like to thank the  
440 Princess Alexandra Hospital for their role in referring participants to the trial.

441 **CONFLIST OF INTEREST**

442 The authors declare that there are no conflicts of interest.

443 **REFERENCES**

- 444 Abdel-Baki, A., Brazzini-Poisson, V., Marois, F., Letendre, É., & Karelis, A. D. (2013).  
445 Effects of aerobic interval training on metabolic complications and cardiorespiratory  
446 fitness in young adults with psychotic disorders: a pilot study. *Schizophrenia*  
447 *Research, 149*(1), 112-115.
- 448 Antony, M. M., Bieling, P. J., Cox, B. J., Enns, M. W., & Swinson, R. P. (1998).  
449 Psychometric properties of the 42-item and 21-item versions of the Depression  
450 Anxiety Stress Scales in clinical groups and a community sample. *Psychological*  
451 *assessment, 10*(2), 176-181.
- 452 Barry, V. W., Baruth, M., Beets, M. W., Durstine, J. L., Liu, J., & Blair, S. N. (2014). Fitness  
453 vs. fatness on all-cause mortality: a meta-analysis. *Progress in Cardiovascular*  
454 *Diseases, 56*(4), 382-390.
- 455 Blair, S. N., Kampert, J. B., Kohl, H. W., Barlow, C. E., Macera, C. A., Paffenbarger, R. S.,  
456 & Gibbons, L. W. (1996). Influences of cardiorespiratory fitness and other precursors  
457 on cardiovascular disease and all-cause mortality in men and women. *JAMA, 276*(3),  
458 205-210.
- 459 Blanchard, C. M., Rodgers, W. M., Spence, J. C., & Courneya, K. S. (2001). Feeling state  
460 responses to acute exercise of high and low intensity. *Journal of Science and*  
461 *Medicine in Sport, 4*(1), 30-38.

- 462 Bruce, R. A., Kusumi, F., & Hosmer, D. (1973). Maximal oxygen intake and nomographic  
463 assessment of functional aerobic impairment in cardiovascular disease. *American*  
464 *Heart Journal*, 85(4), 546-562.
- 465 Chapman, J. J., Brown, W.J., and Burton, N.W. (2015). Defining a valid day of accelerometer  
466 monitoring in adults with mental illness. *Mental Health and Physical Activity*, 9(25),  
467 48-54. doi: 10.1016/j.mhpa.2015.09.003
- 468 Chapman, J. J., Fraser, S. J., Brown, W. J., & Burton, N. W. (2016). Physical activity  
469 preferences, motivators, barriers and attitudes of adults with mental illness. *Journal of*  
470 *Mental Health*, 25(5), 448-454. doi: 10.3109/09638237.2016.1167847
- 471 Chassany, O., Dimenas, E., Dubois, D., & Wu, A. (2004). The psychological general well-  
472 being index (PGWBI) user manual. *MAPI Research Institute*.
- 473 Dauwan, M., Begemann, M. J., Heringa, S. M., & Sommer, I. E. (2015). Exercise Improves  
474 Clinical Symptoms, Quality of Life, Global Functioning, and Depression in  
475 Schizophrenia: A Systematic Review and Meta-analysis. *Schizophrenia Bulletin*,  
476 42(3), 588-599. doi: doi:10.1093/schbul/sbv164
- 477 Flemmen, G., Unhjem, R., & Wang, E. (2014). High-intensity interval training in patients  
478 with substance use disorder. *BioMed research international*, 2014(5), 1-8. doi:  
479 10.1155/2014/616935
- 480 Freyssin, C., Verkindt, C., Prieur, F., Benaich, P., Maunier, S., & Blanc, P. (2012). Cardiac  
481 rehabilitation in chronic heart failure: effect of an 8-week, high-intensity interval  
482 training versus continuous training. *Archives of Physical Medicine and Rehabilitation*,  
483 93(8), 1359-1364.
- 484 Fu, T.-c., Wang, C.-H., Lin, P.-S., Hsu, C.-C., Cherng, W.-J., Huang, S.-C., . . . Wang, J.-S.  
485 (2013). Aerobic interval training improves oxygen uptake efficiency by enhancing

- 486 cerebral and muscular hemodynamics in patients with heart failure. *International*  
487 *Journal of Cardiology*, 167(1), 41-50.
- 488 Gross, J., Vancampfort, D., Stubbs, B., Gorczynski, P., & Soundy, A. (2016). A narrative  
489 synthesis investigating the use and value of social support to promote physical activity  
490 among individuals with schizophrenia. *Disability and Rehabilitation*, 38(2), 123-150.
- 491 Heggelund, J., Kleppe, K. D., Morken, G., & Vedul-Kjelsås, E. (2014). High aerobic intensity  
492 training and psychological states in patients with depression or schizophrenia.  
493 *Frontiers in psychiatry*, 5, 1-8. doi: 10.3389/fpsy.2014.00148
- 494 Heggelund, J., Nilsberg, G. E., Hoff, J., Morken, G., & Helgerud, J. (2011). Effects of high  
495 aerobic intensity training in patients with schizophrenia-A controlled trial. *Nordic*  
496 *journal of psychiatry*, 65(4), 269-275.
- 497 Kessler, R. C., Andrews, G., Colpe, L. J., Hiripi, E., Mroczek, D. K., Normand, S. L. T., . . .  
498 Zaslavsky, A. M. (2002). Short screening scales to monitor population prevalences  
499 and trends in non-specific psychological distress. *Psychological Medicine*, 32(6), 959-  
500 976. doi: 10.1017/S0033291702006074
- 501 Kilpatrick, M. W., Jung, M. E., & Little, J. P. (2014). High-intensity interval training: a  
502 review of physiological and psychological responses. *ACSM's Health & Fitness*  
503 *Journal*, 18(5), 11-16.
- 504 Lawrence, D., Hancock, K. J., & Kisely, S. (2013). The gap in life expectancy from  
505 preventable physical illness in psychiatric patients in Western Australia: retrospective  
506 analysis of population based registers. *British Medical Journal*, 346:f2539.
- 507 Lovibond, S. H., & Lovibond, P. F. (1995). *Manual for the Depression Anxiety Stress Scales*  
508 (2nd ed.). Sydney: Psychology Foundation.
- 509 Lundgren-Nilsson, Å., Jonsdottir, I. H., Ahlborg, G., & Tennant, A. (2013). Construct validity  
510 of the psychological general well being index (PGWBI) in a sample of patients

- 511           undergoing treatment for stress-related exhaustion: a rasch analysis. *Health and*  
512           *quality of life outcomes*, 11(1), 2.
- 513 Moholdt, T. T., Amundsen, B. H., Rustad, L. A., Wahba, A., Løvø, K. T., Gullikstad, L. R., . .  
514           . Slørdahl, S. A. (2009). Aerobic interval training versus continuous moderate exercise  
515           after coronary artery bypass surgery: a randomized study of cardiovascular effects and  
516           quality of life. *American Heart Journal*, 158(6), 1031-1037.
- 517 Molmen-Hansen, H. E., Stolen, T., Tjonna, A. E., Aamot, I. L., Ekeberg, I. S., Tyldum, G. A.,  
518           . . . Stoylen, A. (2012). Aerobic interval training reduces blood pressure and improves  
519           myocardial function in hypertensive patients. *European journal of preventive*  
520           *cardiology*, 19(2), 151-160.
- 521 Norton, K., Coombes, J., Hobson-Powell, A., Johnson, R., Knox, C., Marino, N., . . . Piper,  
522           K. (2012). *Adult Pre-Exercise Screening System (APSS)*: Exercise and Sports Science  
523           Australia.
- 524 Schuch, F. B., Vancampfort, D., Richards, J., Rosenbaum, S., Ward, P. B., & Stubbs, B.  
525           (2016). Exercise as a treatment for depression: a meta-analysis adjusting for  
526           publication bias. *Journal of Psychiatric Research*, 77, 42-51.
- 527 Stonerock, G. L., Hoffman, B. M., Smith, P. J., & Blumenthal, J. A. (2015). Exercise as  
528           Treatment for Anxiety: Systematic Review and Analysis. *Annals of Behavioral*  
529           *Medicine*, 49, 542-556.
- 530 Stubbs, B., Gardner-Sood, P., Smith, S., Ismail, K., Greenwood, K., Patel, A., . . . Gaughran,  
531           F. (2015). Pain is independently associated with reduced health related quality of life  
532           in people with psychosis. *Psychiatry Research*, 230(2), 585-591.
- 533 Stubbs, B., Vancampfort, D., Rosenbaum, S., Ward, P. B., Richards, J., Soundy, A., . . .  
534           Schuch, F. B. (2016). Dropout from exercise randomized controlled trials among

- 535 people with depression: A meta-analysis and meta regression. *Journal of Affective*  
536 *Disorders, 190*, 457-466.
- 537 Tjønnna, A. E., Lee, S. J., Rognmo, Ø., Stølen, T. O., Bye, A., Haram, P. M., . . . Slørdahl, S.  
538 A. (2008). Aerobic interval training versus continuous moderate exercise as a  
539 treatment for the metabolic syndrome a pilot study. *Circulation, 118*(4), 346-354.
- 540 Vancampfort, D., Buys, R., Sienaert, P., Wyckaert, S., De Herdt, A., De Hert, M., & Probst,  
541 M. (2015). Validity of the 6min walk test in outpatients with bipolar disorder.  
542 *Psychiatry Research, 230*(2), 664-667.
- 543 Vancampfort, D., Rosenbaum, S., Schuch, F. B., Ward, P. B., Probst, M., & Stubbs, B.  
544 (2016). Prevalence and predictors of treatment dropout from physical activity  
545 interventions in schizophrenia: a meta-analysis. *General Hospital Psychiatry, 39*, 15-  
546 23.
- 547 Weston, K. S., Wisløff, U., & Coombes, J. S. (2013). High-intensity interval training in  
548 patients with lifestyle-induced cardiometabolic disease: a systematic review and meta-  
549 analysis. *British Journal of Sports Medicine, 48*(16), 1227-1234. doi:  
550 10.1136/bjsports-2013-092576
- 551 Wisløff, U., Ellingsen, Ø., & Kemi, O. J. (2009). High-intensity interval training to maximize  
552 cardiac benefits of exercise training? *Exercise and Sport Sciences Reviews, 37*(3),  
553 139-146.
- 554 Wisløff, U., Støylen, A., Loennechen, J. P., Bruvold, M., Rognmo, Ø., Haram, P. M., . . . Lee,  
555 S. J. (2007). Superior cardiovascular effect of aerobic interval training versus  
556 moderate continuous training in heart failure patients a randomized study. *Circulation,*  
557 *115*(24), 3086-3094.

558 Wu, M., Lee, C., Hsu, S., Chang, C., & Chen, C. (2015). Effectiveness of high-intensity  
559 interval training on the mental and physical health of people with chronic  
560 schizophrenia. *Neuropsychiatric Disease and Treatment*, *11*, 1255-1263.

561

## 562 **FIGURE CAPTIONS**

### 563 **Figure 1: Participant flow diagram**

564 HIIT: high-intensity interval training; MICT: moderate-intensity continuous training.

565 <sup>a</sup> Withdrew before completing mental and physical health baseline assessments, but after  
566 providing written informed consent, completing a demographics questionnaire, and wearing  
567 an accelerometer for 7 days.

568 <sup>b</sup> Withdrew after completing the baseline assessments (including the fitness test) but before  
569 receiving their group allocation.

570 <sup>c</sup> Participants who withdrew were invited to complete the post-intervention assessments; those  
571 who withdrew to exercise-related pain were not asked to complete the post-intervention  
572 fitness test.

### 573 **Figure 2: Baseline and post-intervention mental health scores of participants completing** 574 **at least 70% of the program**

575 Median pre-intervention (black bars) and post-intervention (shaded bars) scores on mental  
576 health outcomes are shown for participants who completed at least 70% of exercise sessions;  
577 individual data are plotted as solid lines. Possible depression, anxiety and stress scores range  
578 from 0 to 21, higher scores represent higher severity. Possible wellbeing scores range from 0  
579 to 110, higher scores represent better wellbeing. HIIT: High intensity interval training; MICT:  
580 Moderate intensity continuous training.

581

582 **Table 1: Health and demographic characteristics of participants at baseline**

	HIIT (n=12)	MICT (n=12)	All (n=24)
	Mean (SD)	Mean (SD)	Mean (SD)
Age (years)	37.4 (10.4)	38.6 (11.7)	38.0 (10.8)
Female n (%)	7 (58%)	4 (33%)	11 (92%)
Psychological distress <sup>a</sup>	15.3 (6.6)	17.5 (3.6)	16.3 (5.4)
<u>Self-reported diagnosis</u>	<b>n (%)</b>	<b>n (%)</b>	<b>n (%)</b>
Psychoses	3 (25%)	3 (25%)	6 (25%)
Depression	1 (8%)	3 (25%)	4 (17%)
Bipolar disorder	3 (25%)	1 (8%)	4 (17%)
Anxiety	0 (0%)	1 (8%)	1 (4%)
Delusional disorder	1 (8%)	0 (0%)	1 (%)
Depression and anxiety <sup>b</sup>	2 (17%)	1 (8%)	3 (12%)
Depression, anxiety and <i>other</i> <sup>c</sup>	1 (8%)	2 (17%)	3 (12%)
Depression and BPD	1 (8%)	0 (0%)	1 (4%)
Bipolar and BPD	0 (0%)	1 (8%)	1 (4%)
<u>Education</u>			
Did not finish high school	1 (8%)	4 (33%)	5 (21%)
High school	2 (17%)	5 (42%)	7 (29%)
Certificate/diploma (college)	6 (50%)	2 (17%)	8 (33%)
Tertiary degree (university)	3 (25%)	1 (8%)	4 (17%)
<u>Employment</u>			
Full-time/part-time	1 (8%)	1 (8%)	2 (8%)
Student	2 (17%)	0 (0%)	2 (8%)
Unemployed / looking for work	3 (25%)	7 (58%)	10 (42%)
Unable to work	6 (50%)	4 (33%)	10 (42%)
<u>Smoker status</u>			
Never/ex-smoker	6 (50%)	4 (33%)	10 (42%)
Daily/occasionally	6 (50%)	8 (67%)	14 (58%)
<u>BMI (kg/m<sup>2</sup>) <sup>d</sup></u>			
<18.5	0 (0%)	1 (10%)	1 (4%)
18.5 – 24.9	1 (8%)	1 (10%)	2 (8%)
25 – 29.9	4 (33%)	6 (60%)	10 (42%)

>30	7 (58%)	2 (20%)	9 (38%)
-----	---------	---------	---------

583 HIIT: high-intensity interval training; MICT: moderate-intensity continuous training; BPD:  
584 borderline personality disorder; BMI: Body Mass Index.

585 <sup>a</sup> Psychological distress was measured using the Kessler-6 scale; scores range from 6 to 30,  
586 scores over 15 indicate high distress.

587 <sup>b</sup> The participant allocated to MICT had a diagnosis of postnatal depression.

588 <sup>c</sup> *Other* here refers to i) alcohol dependence, ii) binge-eating disorder, and iii) borderline  
589 personality disorder.

590 <sup>d</sup> BMI calculated as weight (kg) / height (m)<sup>2</sup>. Height and weight were measured for  
591 participants who completed the baseline fitness test, BMI was therefore available for 22  
592 participants (HIIT, n=12; MICT, n=10).

593



594 **Table 2: Acceptability of the exercise condition (n=16)**

Questionnaire item	Group	Disagree	Neutral	Agree
		n (%)	n (%)	n (%)
I feel satisfied with the exercise condition that I was allocated to	HIIT	0 (0%)	1 (13%)	7 (88%)
	MICT	0 (0%)	0 (0%)	8 (100%)
I would have preferred to be in the other exercise condition	HIIT	4 (50%)	3 (38%)	1 (13%)
	MICT	6 (75%)	2 (25%)	0 (0%)
I found the exercise enjoyable	HIIT	0 (0%)	0 (0%)	8 (100%)
	MICT	1 (13%)	2 (25%)	5 (63%)
I found the exercise too hard	HIIT	4 (50%)	2 (25%)	2 (25%)
	MICT	6 (75%)	2 (25%)	0 (0%)
I found the exercise boring	HIIT	4 (50%)	4 (50%)	0 (0%)
	MICT	4 (50%)	3 (38%)	1 (13%)
I would have preferred group-based exercise	HIIT	4 (50%)	2 (25%)	2 (25%)
	MICT	6 (75%)	0 (0%)	2 (25%)
I looked forward to the exercise sessions	HIIT	2 (25%)	3 (38%)	3 (38%)
	MICT	2 (25%)	2 (25%)	4 (50%)
I would like to continue doing this kind of exercise outside of the study	HIIT	2 (25%)	1 (13%)	5 (63%)
	MICT	1 (13%)	2 (25%)	5 (63%)
I would feel confident doing this kind of exercise without assistance	HIIT	1 (13%)	1 (13%)	6 (75%)
	MICT	0 (0%)	2 (25%)	6 (75%)
I would feel confident being able to do this kind of exercise when having a bad day	HIIT	4 (50%)	2 (25%)	2 (25%)
	MICT	3 (38%)	5 (63%)	0 (0%)

595 HIIT: High-intensity interval training; MICT: Moderate intensity continuous training.

596

597 **Table 3: Study outcomes for all participants who completed post-intervention**  
 598 **assessment**

	HIIT		MICT	
	Baseline	12-weeks	Baseline	12-weeks
<b>Mental health</b>		(n=9)		(n=10)
<u>DASS21</u> <sup>a</sup>				
Depression	14 (5, 16)	9 (3, 13)	7 (9, 10)	9 (4, 13)
% change		-25 (-50, 29)		-20 (-50, 50)
Anxiety	7 (2, 12)	1 (0, 7)	6 (4, 9)	6 (3, 7)
% change		-43 (-100, 0)		5 (-50, 4)
Stress	12 (3, 14)	6 (3, 10)	12 (10, 14)	8 (5, 12)
% change		0 (-45, 29)		-22 (-58, 0)
<u>PGWBI</u> total score <sup>b</sup>	61 (43, 76)	68 (54, 75)	50 (45, 58)	52 (47, 73)
% change		13 (-9, 22)		20 (-5, 44)
<b>Physical health</b>		(n=7)		(n=9)
Weight (kg)	85 (79, 106)	83 (81, 105)	87 (72, 96)	84 (73, 93)
BMI (kg/m <sup>2</sup> )	31 (27, 33)	31 (27, 32)	27 (24, 29)	28 (25, 28)
Waist circumference (cm)	100 (93, 110)	103 (89, 119)	90 (81, 101)	92 (85, 101)
% fat mass	30 (25, 41)	32 (24, 35)	28 (24, 40)	27 (16, 32)
VO <sub>2</sub> max (ml/kg/min) <sup>c</sup>	21 (20, 28)	23 (18, 29)	24 (21, 32)	22 (21, 33)

599 **Note:** all values quoted as median (25<sup>th</sup> – 75<sup>th</sup> percentile).

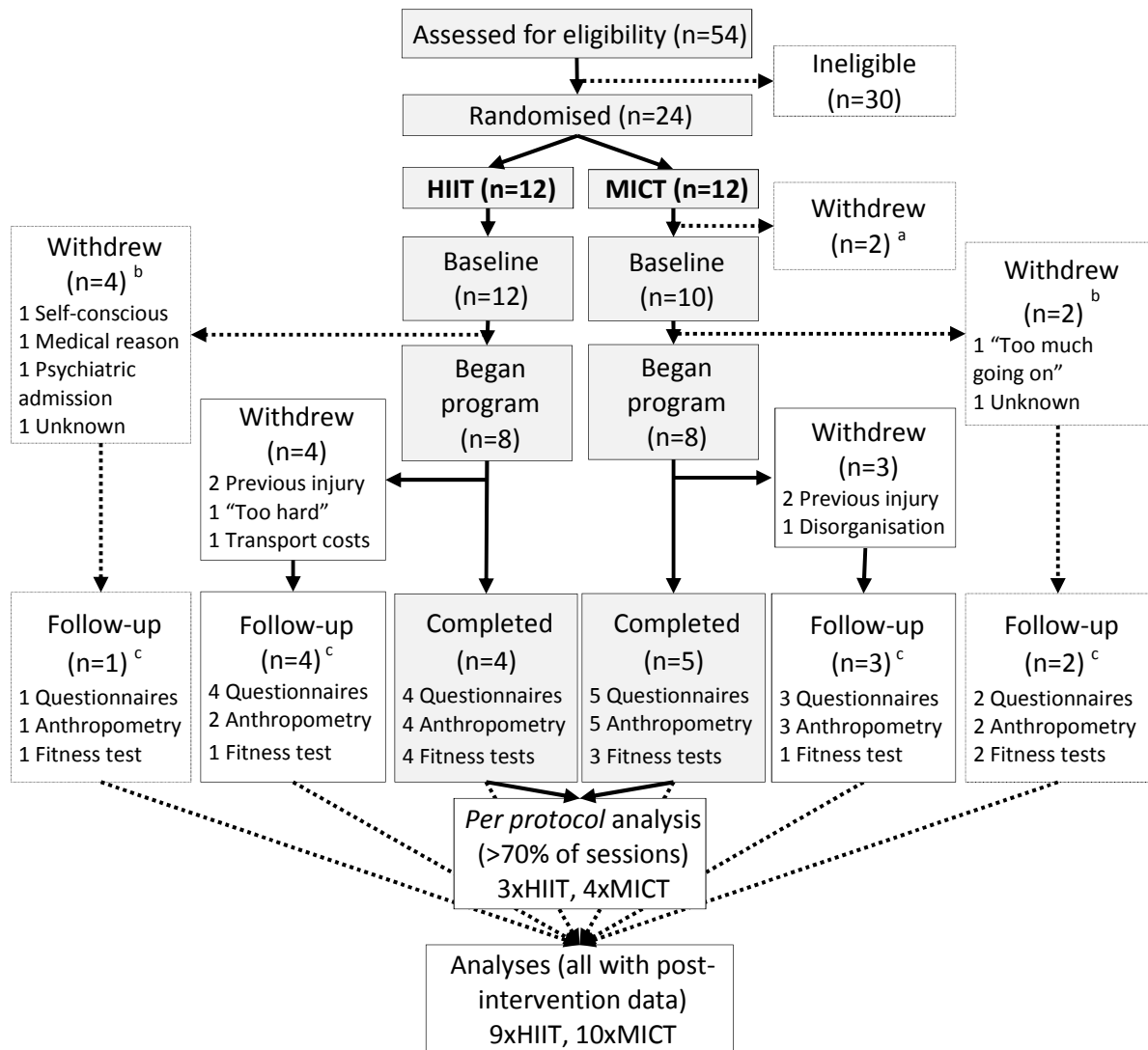
600 DASS21=Depression Anxiety Stress Scale; PGWBI=Psychological General Wellbeing Index.

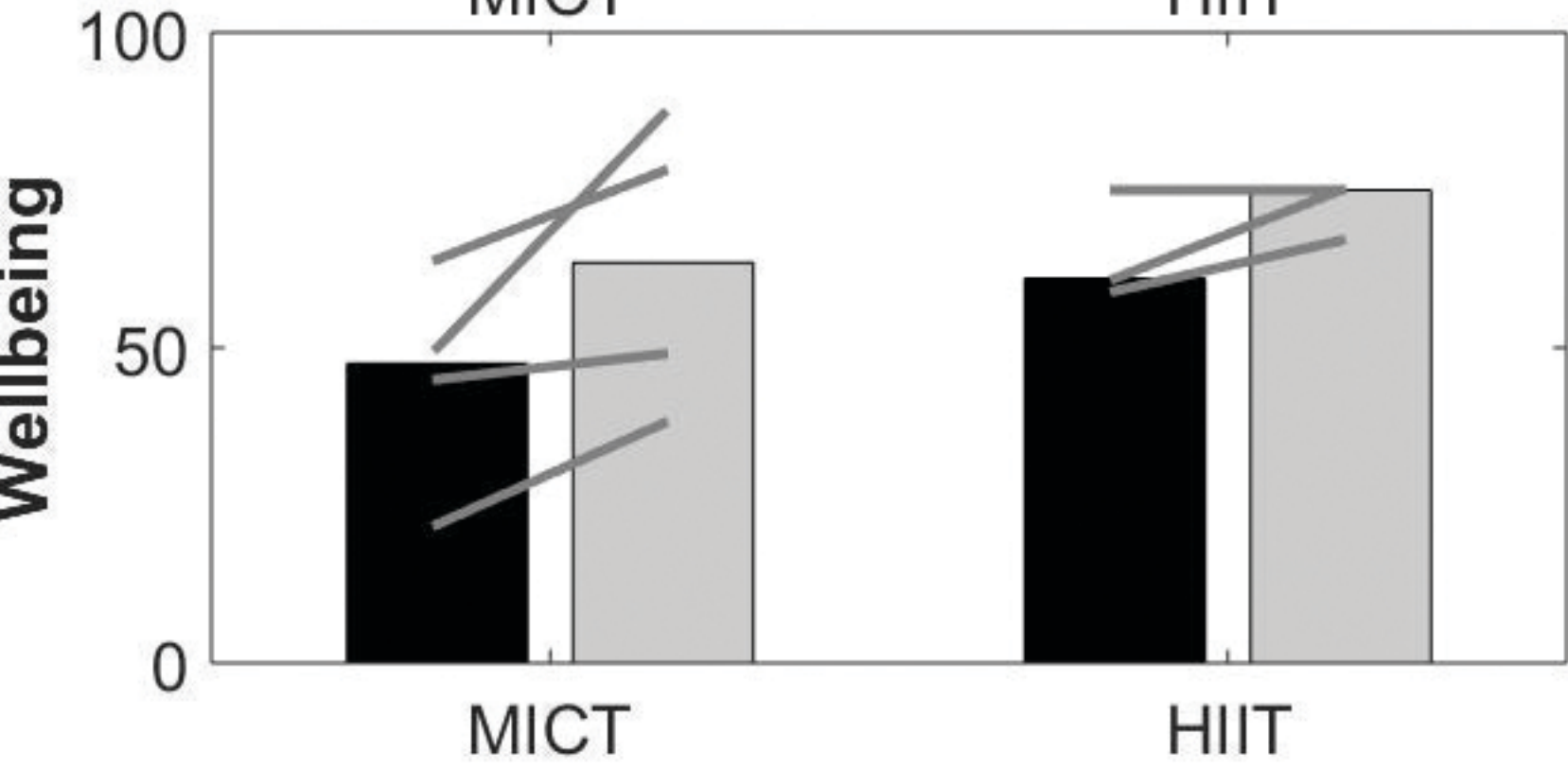
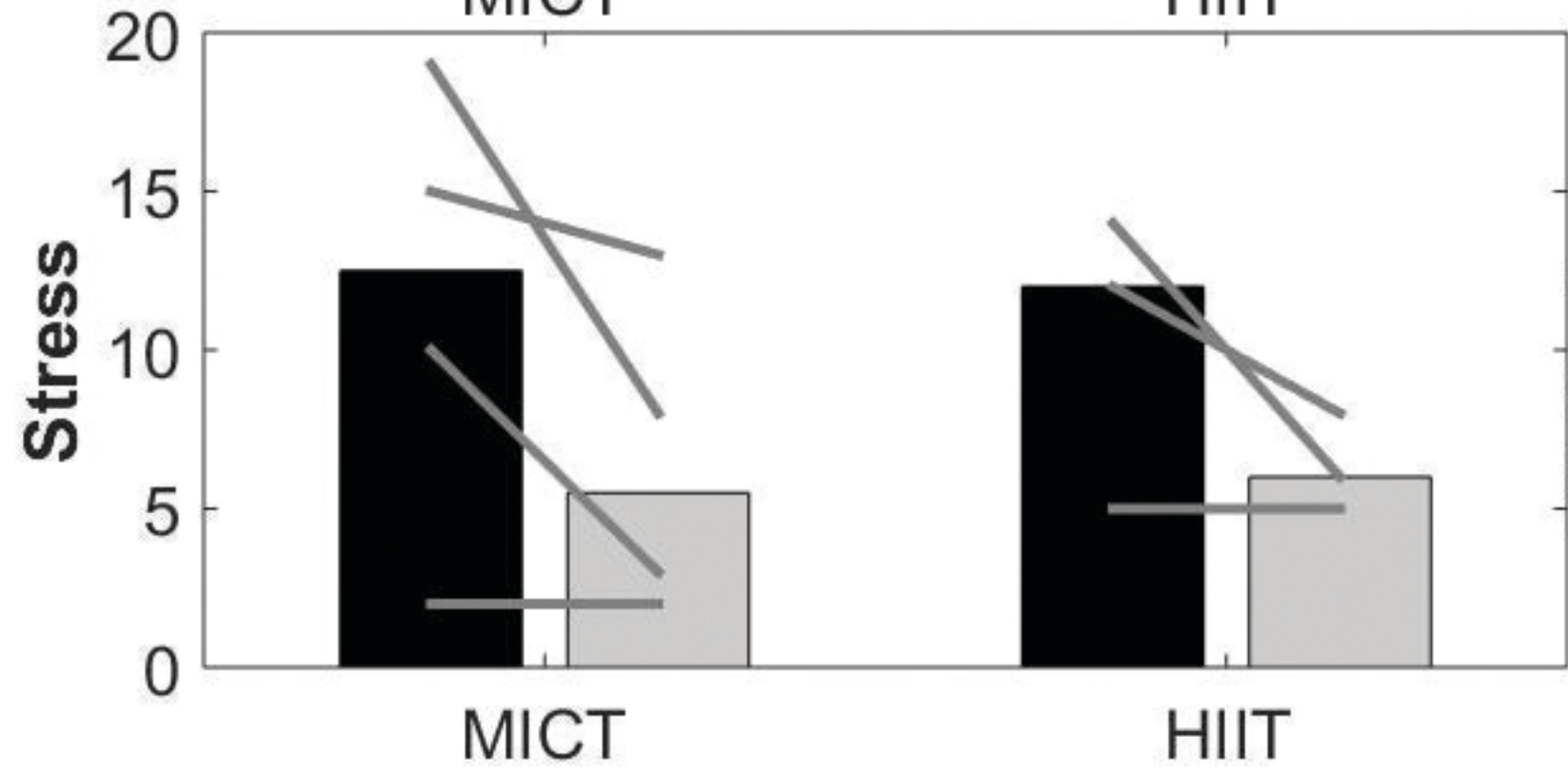
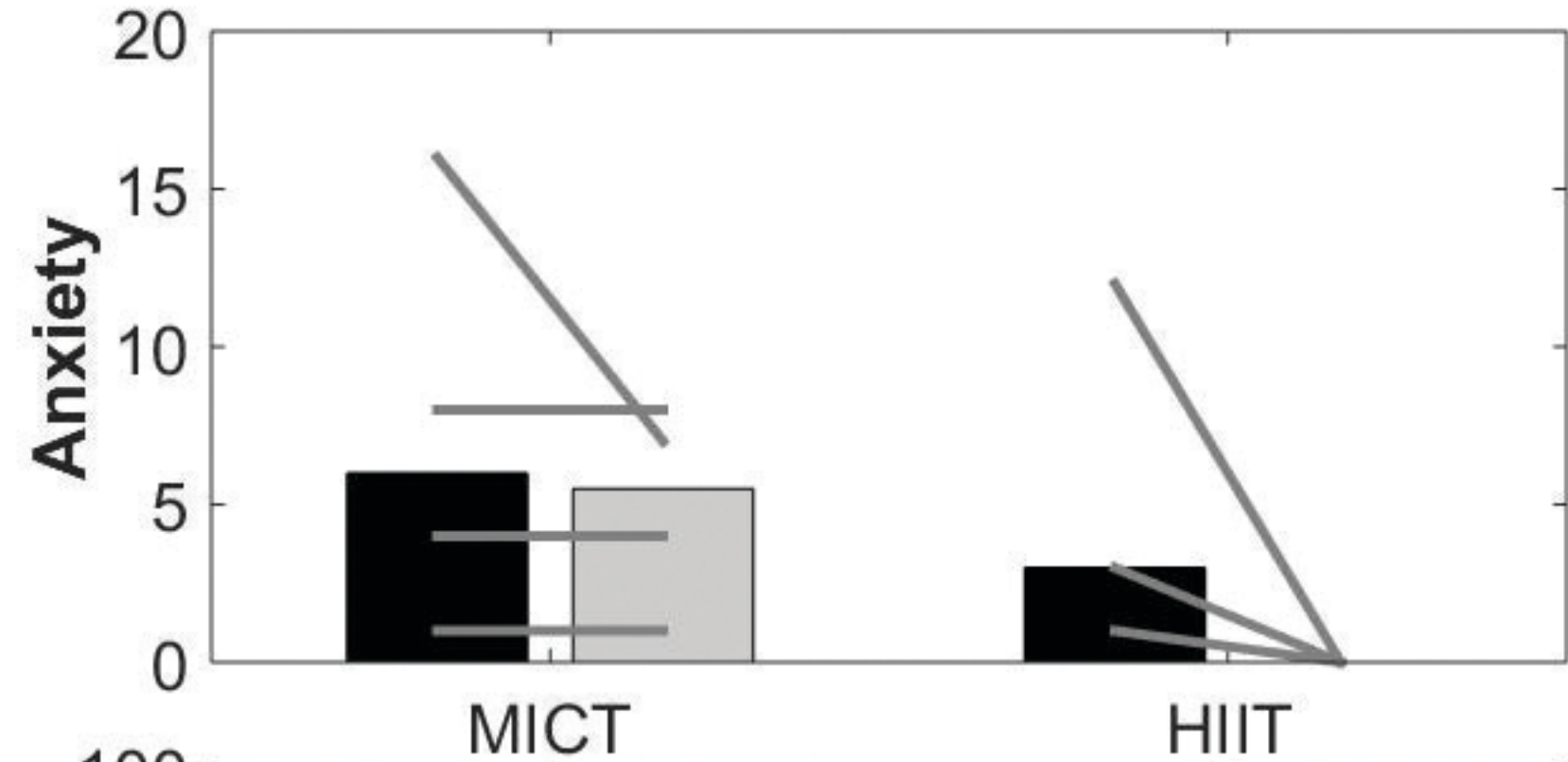
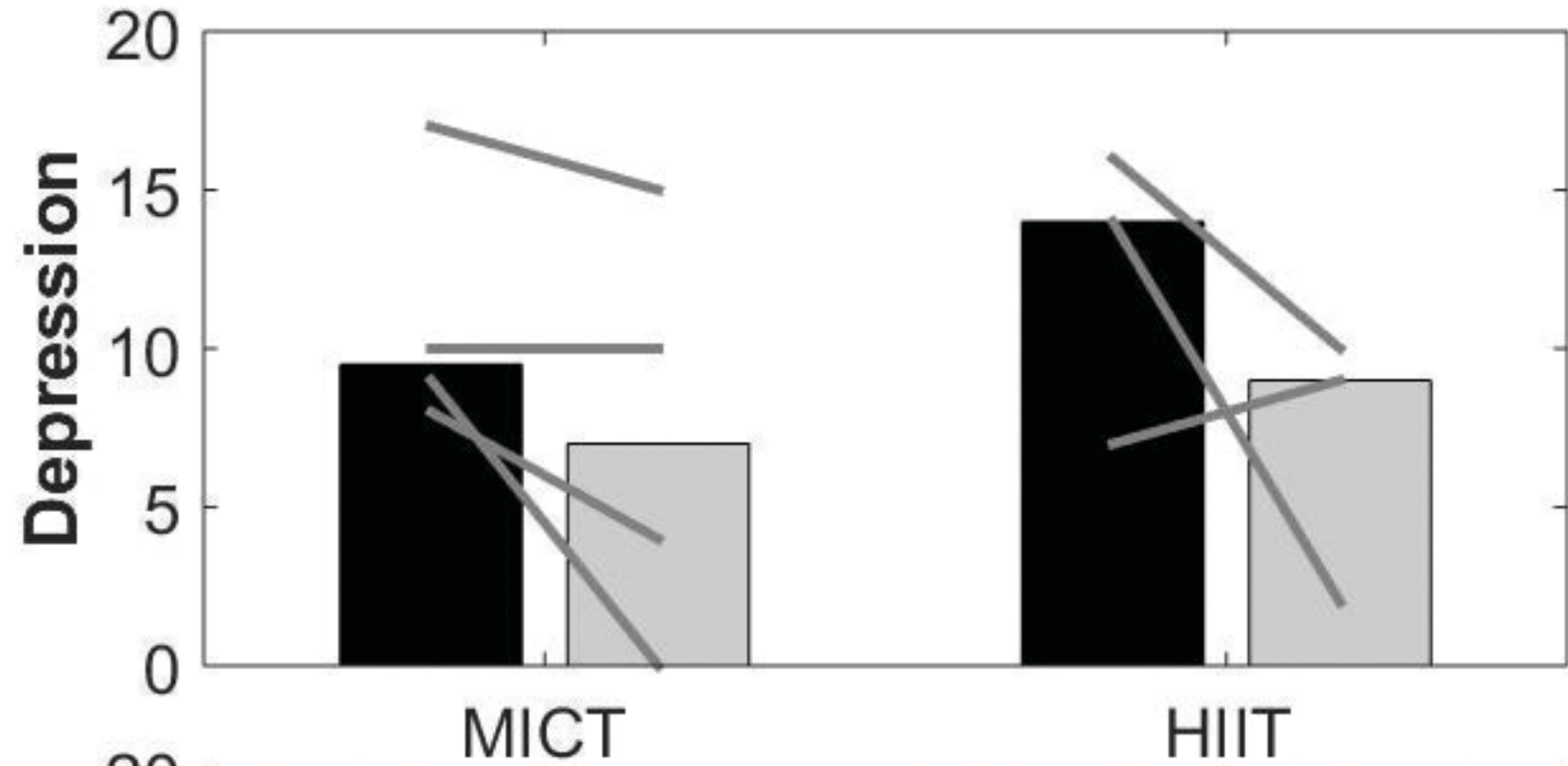
601 <sup>a</sup> Possible depression, anxiety and stress scores range from 0 to 21, higher scores represent  
 602 greater severity of symptoms (i.e. a negative change indicates improved mental health).

603 <sup>b</sup> Possible wellbeing scores range from 0 to 110, higher scores represent greater wellbeing.

604 <sup>c</sup> A total of 12 participants (HIIT n=6, MICT n=6) completed the post-intervention maximal  
 605 fitness tests. One HIIT participant's VO<sub>2</sub>max results were excluded due to a technical error.

606





High-intensity interval training (HIIT) and moderate-intensity continuous training (MICT) have similar acceptability and feasibility for adults with mental illness.

Larger trials are necessary to compare the efficacy of HIIT and MICT on mental health and fitness for adults with mental illness.

Community-based, individualised exercise programs with support to overcome physical activity barriers and enhance motivation may improve feasibility.