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## ORIGINAL RESEARCH

# Embedded motivational interviewing combined with a smartphone application to increase physical activity in people with sub-acute low back pain: a cluster randomised controlled trial

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### KEYWORDS

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interviewing;  
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trolled trial;  
Smartphone applica-  
tion, app

### Abstract

**Background:** Moderately vigorous physical activity (PA) may be beneficial for people with sub-acute low back pain (LBP), but may initially be painful for patients and challenging for physical therapists to facilitate.

**Objectives:** This study investigated motivational interviewing (MI) delivered by physical therapists and a smartphone app for increasing PA in people with LBP.

**Methods:** A mixed methods cluster randomised controlled trial involving 46 adults with LBP in Melbourne, Australia. Participants attended weekly 30-min physical therapy consultations for 6 weeks. Experimental group physical therapists were taught to embed MI into consultations and patients were provided with a self-directed app. The primary outcome was accelerometer-derived moderately vigorous PA. Secondary outcomes were LBP disability (Oswestry Disability Index), functional capacity (Patient Specific Functional Scale), and self-efficacy (Pain Self-Efficacy Questionnaire). Between-group differences were analysed by ANCOVA post-intervention.

**Results:** There was no statistically significant difference between the experimental group and control group for PA. Between-group differences in LBP disability (MD= 19.4 units, 95% CI: 8.5, 30.3), functional capacity (primary MD= -4.1 units, 95% CI: -6.9, -1.3; average MD= -3.1, 95% CI: -4.9, -1.2) and self-efficacy (MD -11.3 units, 95%CI -20.2 to -2.5) favoured the control

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group with small to moderate effect sizes. There were low levels of overall engagement with the app.

**Conclusion:** The embedded MI intervention was no more beneficial than physical therapy alone for PA and was associated with poorer LBP disability, function, and self-efficacy. The effectiveness of embedding MI and a smartphone app into usual care for LBP was not supported.

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## 1 Introduction

2 Low back pain (LBP) is a common health complaint and a  
3 leading cause of disability worldwide.<sup>1–3</sup> Ten to 15% of peo-  
4 ple with LBP have experienced chronic LBP lasting for longer  
5 than 3 months. Chronic LBP is a burdensome condition and is  
6 associated with social isolation, early retirement, and pro-  
7 longed work absenteeism.<sup>4,5</sup> Physical activity may reduce  
8 the risk of someone developing chronic LBP by improving  
9 physical condition, mood, and motivation.<sup>6</sup> There is moder-  
10 ate certainty evidence from meta-analysis that physical  
11 activity improves absenteeism outcomes in people with sub-  
12 acute LBP (4–12 weeks), suggesting this phase may be an  
13 important time to target interventions.<sup>7</sup> Moderate to vigor-  
14 ous physical activity reduces long-term disability in people  
15 with chronic LBP,<sup>8</sup> but physical therapists have reported this  
16 can be challenging to facilitate.<sup>9</sup>

17 Motivational interviewing is an evidence-based counsel-  
18 ing technique to address ambivalence towards healthy  
19 behaviour change, through relational components (the spirit  
20 of motivational interviewing) and technical components  
21 (referred to as micro-skills).<sup>10</sup> Collaboration, autonomy, and  
22 evocation of ideas from the patient about behaviour change  
23 are facilitated through micro-skills, including open-ended  
24 questions, affirmations, reflective listening, and summa-  
25 ries.<sup>10</sup> Adding face-to-face and telephone-based motiva-  
26 tional interviewing to usual physical therapy care improves  
27 functional capacity in people with acute to sub-acute  
28 LBP.<sup>11,12</sup> However, dedicated 1:1 consultations require addi-  
29 tional funding and this may not be accessible to all patients.  
30 Training physical therapists to allocate a portion of usual  
31 treatment time to motivational interviewing may be more  
32 time efficient, but in isolation is unlikely to be enough to  
33 influence sustained changes in physical activity.

34 Smartphone applications (apps) have been used as a  
35 convenient way to deliver behaviour change interventions in  
36 healthcare settings.<sup>13</sup> Apps incorporating the principles of  
37 motivational interviewing have increased self-efficacy and  
38 physical activity in sedentary adults.<sup>14</sup> However, while some  
39 components of a motivational interviewing intervention for  
40 increasing physical activity are conducive to being delivered  
41 by an app (e.g. questions can be phrased to elicit patient  
42 change talk), others (e.g. accurately responding to open ended  
43 questions) require face-to-face interactions.<sup>15</sup> An intervention  
44 combining an app-based component with an in-person compo-  
45 nent that does not significantly detract from other physical  
46 therapy treatment modalities, may be one way to address this.

47 The aim of this trial was to evaluate a new motivational  
48 interviewing intervention comprising a physical therapist-  
49 delivered component and a self-directed patient app, for  
50 increasing physical activity in people with sub-acute LBP.

## Methods

51  
52 The trial protocol has been published.<sup>16</sup> A mixed-methods,  
53 cluster randomised controlled trial was conducted in the  
54 physical therapy outpatient departments of 4 public hospi-  
55 tals in (Melbourne, Australia). Hospital sites (clusters) were  
56 allocated by single block pragmatic randomisation to deliver  
57 6 weeks of usual physical therapy or 6 weeks of the newly  
58 designed motivational interviewing intervention (Table 1).  
59 Concealed allocation was completed by an independent  
60 researcher using a random number generator ([www.random-  
61 ization.com](http://www.randomization.com)). The study received ethics approval from the  
62 Alfred Hospital Ethics Committee (47/15), Eastern Health  
63 Human Research and Ethics Committee (E12-2014), La Trobe  
64 University Human Ethics Committee (E12-2014) and Monash  
65 Health Human Research Ethics Committee (15067X). The  
66 study protocol was listed on the Australian New Zealand  
67 Clinical Trials Registry before the trial commenced  
68 (12615000724572). All participants provided written,  
69 informed consent prior to the trial commencing. The trial is  
70 reported in accordance with the Consolidated Standards of  
71 Reporting Trials (CONSORT) statement for cluster random-  
72 ised controlled trials<sup>17,18</sup> and the Consolidated Criteria for  
73 Reporting Qualitative Research (COREQ)<sup>19</sup>

## Participants

74  
75 Outpatient physical therapists at participating sites were  
76 eligible to take part in the study and recruit patients to the  
77 study from their caseloads if they met the following criteria:  
78 3–12 weeks of LBP between the inferior border of the 12th  
79 rib and the gluteal fold<sup>20</sup> preceded by 30 days of no/usual  
80 pain,<sup>21</sup> access to an Apple or Android smartphone and compe-  
81 tency using apps requiring text input. Patients were  
82 excluded if they had medical red flags (signs or symptoms  
83 that may indicate serious pathology),<sup>22</sup> were waitlisted for  
84 surgery, did not speak English, or lived greater than 40 km  
85 from the hospital site. Patients who scored in the severe  
86 range for depression and/or anxiety on the 21-item Depres-  
87 sion, Anxiety and Stress Scale (DASS-21) were also excluded  
88 from participating<sup>23</sup> and follow-up referral with a general  
89 practitioner or psychologist was initiated.<sup>16</sup> Depression and  
90 anxiety are associated with an increased risk for developing  
91 chronic LBP and may have introduced confounding factors in  
92 a trial of this size.<sup>24</sup>

## Interventions

93  
94 All patients attended a 30-min individualised, face-to-face  
95 consultation with their physical therapist once a week for 6  
96 consecutive weeks (Table 1). Physical therapy treatments

**Table 1** Description of interventions.

	Usual Care	Usual Care plus Motivational interviewing
Brief name	Physical therapy for sub-acute low back pain.	Motivational interviewing to increase physical activity in people with sub-acute low back pain.
Why	Reduce symptoms and activity limitations.	Reduce symptoms and activity limitations Build importance and increase physical activity.
What materials	Regular physical therapy treatment modalities.	Motivational interviewing embedded into regular physical therapy sessions. Self-directed motivational interviewing smartphone application for patients.
Who provided	Physical therapists.	Physical therapists who received 8 h of motivational interviewing training over 2 days.
How provided	In person.	In person (physical therapy component). Smartphone app.
Where (setting)	Outpatient physical therapy department.	Outpatient physical therapy department. A time and place convenient to patients (app component).
When/how much (dose)	6 sessions, each 30 min in duration, over 6 weeks (3 h total).	6 sessions, each 30 min in duration, over 6 weeks (3 h total). Motivational interviewing embedded at the discretion of the physical therapist. Patients prompted to use the smartphone app every 1 to 3 days.
Tailoring	Physical therapy treatment tailored to the patient's requirements and progress.	Motivational interviewing tailored to a patient's levels of importance and confidence. Smartphone app content tailored to patient's level of readiness for change.
Fidelity checking measures	Attendance at physical therapy consultations.	Attendance at physical therapy consultations. Physical therapists' level of proficiency in delivering motivational interviewing assessed by audio-taped real plays with the study coordinators on the Motivational Interviewing Treatment Integrity Scale.

97 included, but were not limited to, manual therapy, exercise  
98 prescription, advice, and education. Physical therapists in  
99 the experimental group attended an 8-hour training program  
100 over 2 × 4-h sessions. The program, designed and delivered  
101 by a motivational interviewing trainer and physical therapist,  
102 aimed to teach physical therapists how to embed components  
103 of motivational interviewing into their regular consultations.  
104 The content of the program was based on similar motivational  
105 interviewing training programs for physical therapists.<sup>11,25,26</sup> Between  
106 physical therapy consultations, patients in the experimental  
107 group were also instructed to use a new motivational interviewing-  
108 based app (MiMate) on their smartphone device. The self-directed  
109 app contained 10 sequential modules and comprised a series of  
110 specific multiple choice and open-ended questions designed to  
111 elicit answers that facilitated change towards increasing levels  
112 of physical activity. Additional components were a diary for  
113 recording physical activity and a flare up module that offered  
114 education/suggestions for managing exacerbations of pain.  
115 Physical therapists could review patient completed app material  
116 in preparation for consultations and patients were informed of  
117 this. The app was piloted with a convenience sample of users  
118 ( $n = 5$ ), and minor amendments were made to improve  
119 usability prior to the trial commencing. The intervention has  
120 been described in detail elsewhere.<sup>16</sup>

## 122 Outcomes

123 Patients were assessed at baseline and at the end of the 6-  
124 week intervention by a blinded assessor. The outpatient

physical therapy departments were open plan, and to maintain  
125 blinding, it was necessary for assessments to be conducted  
126 at patients' residences. 127

## Primary outcome 128

Physical activity was assessed as the mean number of daily  
129 minutes of moderately vigorous physical activity (MVPA),  
130 measured using the activPAL 3 tri-axial accelerometer. The  
131 device is a valid and reliable measure of MVPA<sup>27</sup> and was  
132 worn continuously for 7 consecutive days on the antero-lateral  
133 thigh.<sup>16</sup> Data were downloaded using proprietary software.<sup>28</sup>  
134 A daily average was calculated by dividing total weekly  
135 MVPA minutes by the number of days the device was worn  
136 for 10 or more hours.<sup>29</sup> 137

## Secondary outcomes 138

The modified Oswestry Disability Index (ODI) is a 10-item  
139 self-report questionnaire that assesses LBP disability as a  
140 percentage from 0 (no disability) to 100 (severe disability).<sup>30</sup>  
141 Functional capacity was assessed with the Patient Specific  
142 Functional Scale (PSFS).<sup>31</sup> Patients were asked to rate their  
143 ability to perform 1 primary and up to 4 secondary self-  
144 selected activities on an ordered scale from 0 (unable to  
145 perform) to 10 (perform at pre-injury level). Pain self-  
146 efficacy was measured using the Pain Self-Efficacy Question-  
147 naire (PSEQ), a 10-item self-report questionnaire to assess a  
148 person's confidence in performing a series of tasks, despite  
149 pain.<sup>32</sup> Each task (item) is scored from 0 (not at all 150

151 confident) to 6 (completely confident) to yield a total score  
152 out of 60.<sup>33</sup>

153 Physical therapists in the experimental group were  
154 assessed for proficiency with the Motivational Interviewing  
155 Treatment Integrity (MITI, version 4.2.1) code. The tool  
156 assesses the degree to which a recorded interaction is con-  
157 sistent with the technical and relational aspects of motiva-  
158 tional interviewing.<sup>34</sup> Each aspect is rated on an ordinal  
159 scale from 1 to 5 with higher scores indicating higher levels  
160 of motivational interviewing consistent behaviours. After  
161 motivational interviewing training, physical therapists par-  
162 ticipated in a recorded 20-min session with one of the study  
163 coordinators (JH and POH). During the interaction, the study  
164 coordinators spoke about a personal health-related behav-  
165 iour they wanted to change. The audio recording was  
166 reviewed by an independent researcher who had completed  
167 training in administering the MITI, and the process was  
168 repeated 6 weeks into patient recruitment. At the end of  
169 the 6-week intervention patients completed the Client Eval-  
170 uation of Motivational Interviewing (CEMI) questionnaire, a  
171 16-item self-report questionnaire.<sup>35</sup> Items are scored from 1  
172 (never) to 4 (a great deal) to yield a score out of 64. Higher  
173 scores indicate a perceived counselling style that is consis-  
174 tent with motivational interviewing.

## 175 Semi-structured interviews

176 At the end of patient recruitment, a qualitative process  
177 analysis was conducted, to investigate patients' and physical  
178 therapists' experiences with the intervention. Physical  
179 therapists and 12 patients (selected at random) from the  
180 experimental group participated in a 30-min recorded semi-  
181 structured telephone interview with an independent male  
182 researcher, who used an interview guide designed by the  
183 research team. De-identified interviews were transcribed by  
184 a medical transcription service and downloaded into the  
185 NVIVO software package for analysis (Version 12.6.1.970,  
186 QSR International, Burlington, Massachusetts). Interviewees  
187 received a \$50 retail voucher as an acknowledgement of  
188 their time.

189 Adverse events were recorded and followed up according  
190 to the policies of the treating healthcare site.

## 191 Analysis

192 To achieve 80% power at a 0.05 significance level assuming a  
193 large effect size for the primary outcome and an intraclass  
194 cluster coefficient of 0.05, 14 participants per cluster were  
195 required.<sup>36,37</sup> The Final recruitment target was 15 per clus-  
196 ter (60 in total), allowing for loss to follow-up. Intention to  
197 treat principles were applied to all analyses.<sup>38</sup> Further  
198 details regarding the sample size calculation can be found in  
199 the trial protocol.<sup>16</sup>

200 Between-group differences at the end of the 6-week  
201 intervention for the primary and secondary outcomes were  
202 tested with analysis of covariance (ANCOVA), entering mean  
203 group and cluster baseline scores as covariates.<sup>39</sup> Age and  
204 symptom duration (at the time of the first physical therapy  
205 consultation in the study) are known predictors of LBP  
206 chronicity and were entered as additional co-variables.<sup>40</sup>  
207 Between-group differences in physical therapy attendance  
208 and accelerometer wear days were analysed by independent

*t*-tests. Changes in motivational interviewing proficiency  
209 across time were assessed by paired *t*-tests. 210

## 211 Qualitative analysis

212 Interview transcripts were analysed inductively by interpre-  
213 tive description.<sup>41</sup> A random selection of 4 patient and 2  
214 physical therapist transcripts were reviewed by two authors  
215 for common excerpts of interest, grouped together to form  
216 sub-themes. This process continued until no additional pat-  
217 terns were identified (data saturation). Common physical  
218 therapist and patient sub-themes were combined under a  
219 series of major themes and presented narratively. 219

## 220 Results

221 Patient recruitment commenced on 27 March 2017, and the  
222 final assessment was completed on 23 August 2018. The trial  
223 was finalised before meeting the recruitment target because  
224 of resourcing constraints. The flow of patient participants  
225 through the study is shown in Fig. 1. Of 58 patients screened  
226 for eligibility, 2 declined because their symptoms improved,  
227 10 were excluded because they scored in the severe range  
228 for depression and/or anxiety on the DASS-21, and 46 were  
229 enrolled (20 in the control group and 26 in the experimental  
230 group). One patient in the control group and 5 patients in  
231 the experimental group did not complete a follow-up assess-  
232 ment. Two patients in the experimental group experienced a  
233 mild skin reaction to the accelerometer film and did not  
234 complete this component of the reassessment and 1 patient  
235 was unavailable for the follow-up accelerometer assess-  
236 ment. These data were omitted from the follow-up assess-  
237 ment of the primary outcome. All available data were  
238 included in the analysis. 238

239 There were 78 physical therapy consultations in the con-  
240 trol group (mean = 4.6, standard deviation [SD] 1.6) and 72  
241 consultations in the experimental group (mean = 3.2, SD  
242 1.80), a mean difference of 1.3 consultations (95% CI: 0.3,  
243 2.4). Nine participants in the experimental group (35%) did  
244 not use the MiMate app at all. The average number of core  
245 modules completed over the 6-week intervention was 4.8  
246 (SD 3.9). The average number of activity diary entries was  
247 25.4 (SD 34.7) and the flare up module was used an average  
248 of 2.0 (SD 2.9) times. 248

249 The mean age of participants was 43.7 (SD 14.3), and the  
250 mean symptom duration at the time of the first treatment  
251 session was 30.2 (SD 14.6) days (Table 2 and supplementary  
252 material). 252

## 253 Effect of the intervention

254 At the end of the 6-week intervention there was no statisti-  
255 cally significant difference between the control group and  
256 experimental group for the primary outcome measure,  
257 mean daily minutes of MVPA (mean difference = 0.9 min, 95%  
258 CI: -6.7, 8.6) (Table 3). 258

259 Between-group differences in pain disability, function,  
260 and self-efficacy favoured the control group at the end of  
261 the 6-week intervention. The mean differences were 19.4  
262 units for the ODI score (95% CI: 8.5, 30.3), 4.1 units for the  
263 PSFS primary item (95% CI: 1.3, 6.9), 3.1 units for the PSFS  
263 263

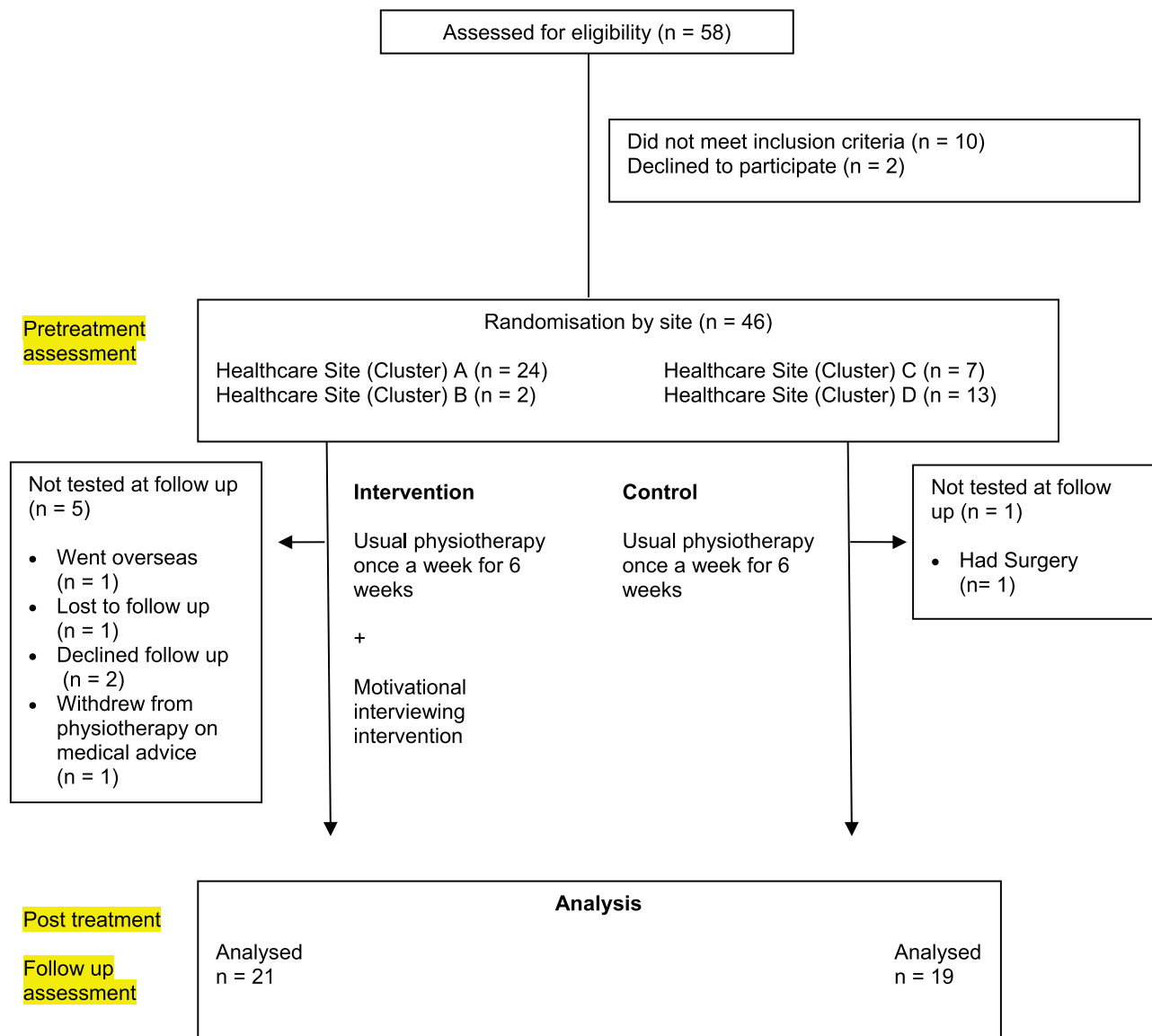


Fig. 1 Trial design and flow of participants through the study.

264 item average (95% CI: 1.2, 4.9), and 11.3 units for the PSEQ  
265 (95% CI: 2.5, 20.22).

## 266 Therapist proficiency

267 All 5 physical therapists in the experimental group were profi-  
268 cient in motivational interviewing after training. The mean  
269 score for the MITI was 3.4 (SD 0.2) for the technical subscale  
270 and 3.8 (SD 0.3) for the relational subscale. There was no signifi-  
271 cant change in either MITI sub-scale score at follow up assess-  
272 ment (technical sub-scale 3.4 (SD 0.2); relational sub-scale 3.7  
273 (SD 0.5). The mean score on the CEMI was 50.7 (SD 6.1) (n = 20).

## 274 Adherence to trial protocol

275 In a variation from the trial protocol<sup>16</sup> 26 of the 83 assess-  
276 ments were completed by a study coordinator (JH) due to  
277 resourcing challenges. These assessments were therefore  
278 unblinded.

## Qualitative findings

279

280 Twelve of 15 patients completed an interview. Four of the 5  
281 physical therapists in the experimental group were inter-  
282 viewed. Three major themes were identified from 7 thera-  
283 pist and 7 patient sub-themes (Table 4).

284 Major theme 1, therapeutic style: All physical therapists  
285 described motivational interviewing as a different way of  
286 communicating, requiring them to speak less and listen  
287 more. Three physical therapists felt using motivational  
288 interviewing helped them build greater rapport with their  
289 patients. This was mirrored in comments 11 patients made  
290 about feeling a strong sense of connection with their phys-  
291 ical therapist.

292 Major theme 2, therapeutic content and implementation:  
293 Seven patients discussed working collaboratively to set  
294 activity related goals. This was consistent with how 3 phys-  
295 ical therapists described using reflections and summaries to  
296 facilitate collaborative goal setting.

**Table 2** Baseline characteristics of patient participants by group.

Demographics	Exp n = 26	Con n = 20
Age (years)	39.2 (12.8)	49.5 (14.9)
Sex		
Male	8 (31 %)	10 (50 %)
Female	14 (69 %)	10 (50 %)
Symptom duration*		
Baseline	28.0 (16.1)	23 (8.7)
assessment	35.2 (16.5)	23.6 (8.1)
First treatment session		
DASS-21		
Anxiety subscale (0–42)...	4.2 (4.1)	4.60 (4.0)
Depression Subscale (0–42)	5.2 (5.2)	6.1 (6.3)
Employment status		
Full time hours	10 (39 %)	11 (55 %)
Part time hours	5 (19 %)	3 (15 %)
Casual hours	1 (4 %)	0 (0 %)
No paid employment	7 (27 %)	0 (0 %)
Missing	3 (12 %)	
Receiving sick leave entitlements		
Yes	6 (23 %)	4 (20 %)
No	12 (46 %)	6 (30 %)
N/A	7 (27 %)	7 (35 %)
Missing	1 (4 %)	3 (15 %)

Data are mean (standard deviation), frequency (proportion). Abbreviations: Exp, experimental group; Con, control group; DASS, Depression Anxiety and Stress Scale. \*Days since the onset of low back pain.

Four patients reported using the MiMate app regularly over the 6-week intervention, 6 intermittently and 2 did not use it at all. Barriers to app use included uncertainty of purpose, lack of perceived benefit over required effort and ambiguity regarding some open-ended questions. Three physical therapists reported asking about the app initially, but stopped if they perceived patients were not interested.

Major theme 3, impact/suggested improvements: Three physical therapists felt the training could have been more specific to outpatient physical therapy environments, through video examples of physical therapists embedding motivational interviewing. Three patients also suggested videos may be an efficient way to introduce the app.

## Discussion

This trial investigated a new way of delivering motivational interviewing that combined a face-to-face component (physical therapy embedded motivational interviewing) and a self-directed patient smartphone app, MiMate. There was no between-group difference in change in physical activity at the end of the 6-week intervention. The recruitment

target of 60 participants was not met and this likely contributed to the study being underpowered for the primary outcome measure (MVPA).

Improvements in LBP disability, functional capacity, and pain self-efficacy favoured the control group, with small to moderate associated effect sizes. These findings are in contrast with a previous study that showed 6 × 30-min telephone motivational interviewing consultations plus physical therapy improved functional activity in patients with subacute LBP, compared with physical therapy alone.<sup>11</sup> In the current study motivational interviewing was embedded into usual physical therapy consultations and there were poor levels of compliance with the patient smartphone app. The amount of motivational interviewing delivered to patients is likely to have been less than in previous studies.<sup>11,12,42</sup> In the current trial, patients in the control group also received more physical therapy (on average 4.6 vs 3.2 consultations). This can make findings difficult to interpret. Therefore, patients in the experimental group received less physical therapy care, and the intensity of motivational interviewing delivered may not have been sufficient to influence a meaningful increase in MVPA. A previous systematic review and meta-analysis found that brief sessions of motivational interviewing of 15 or more minutes were potentially effective for facilitating health behaviour change in people with chronic health conditions.<sup>43</sup> However, the motivational interviewing interventions included for review were either dedicated face-to-face or group interactions. The findings of the current trial support the need for further randomised controlled trials to evaluate how to best integrate motivational interviewing into regular healthcare practice in non-counselling settings.

This study had several strengths. Physical therapists' proficiency in delivering motivational interviewing was confirmed using a validated outcome measure. The cluster design also meant that there was a small risk of contamination between experimental and control physical therapists. Despite not meeting the recruitment target, the study was likely sufficiently powered to detect a statistically significant difference for the secondary outcome measures.

There were also some limitations. The recruitment target of 60 participants was not met and one healthcare site only recruited two patient participants, because of an unexpected decline in patient referrals for LBP. There were low levels of engagement with and use of the MiMate, which was designed to increase the amount of motivational interviewing delivered to patients. The MiMate smartphone app and online therapist portal were delivered as intended (patients were able to download it and functionality of the therapist portal was confirmed). However, it appears likely that these components of the intervention were not used as intended by most patients and physical therapists. The main app modules were designed to be accessed every 1–3 days; however, patients used this section on average only 4.8 times over the 6-week intervention and 35% did not use it at all. None of the physical therapists reported using the therapist portal to review patient completed app content. The online portal was envisaged as the conduit between the two components of the intervention and designed to assist physical therapists in planning the motivational interviewing content of consultations. Future studies may consider using motivational interviewing as part of the physical therapy training program

**Table 3** Mean  $\pm$  standard deviation within groups and mean difference (95 %CI) difference between groups at the end of the 6-week intervention for the primary and secondary outcomes.

	Usual Care ( <i>n</i> = 26)	Usual Care plus Motivational Interviewing ( <i>n</i> = 20)	Between-group difference in change scores
	Mean $\pm$ SD	Mean $\pm$ SD	Mean (95% CI)
MVPA <sup>a</sup>			
Pretreatment	9.7 (9.6)	8.1 (10.6)	
Posttreatment	11.7 (16.1)	9.7 (9.6)	1.0 (−6.6, 8.6)
Oswestry Disability Index (0–100) <sup>b</sup>			
Pretreatment	34.8 (18.3)	38.1 (15.2)	
Posttreatment	15.8 (14.0)	26.7 (16.9)	19.4 (8.5, 30.3)**
PSFS: Primary Item (0–10)			
Pretreatment	3.1 (1.9)	3.7 (2.4)	
Posttreatment	8.0 (2.7)	5.6 (2.3)	−4.1 (−6.9, −1.35)**
PSFS: Item Average (0–10)			
Pretreatment	3.7 (1.2)	3.4 (1.5)	
Posttreatment	8.0 (2.1)	5.3 (1.9)	−3.1 (−4.9, −1.2)**
PSEQ (0–60)			
Pretreatment	38.3 (13.9)	34.1 (10.9)	
Posttreatment	51.1 (8.7)	41.8 (13.0)	−11.3 (−20.2, −2.5)*

Abbreviations: MVPA, Moderate to Vigorous Physical Activity; PSFS, Patient Specific Functional Scale; PSEQ, Pain Self Efficacy Questionnaire.

<sup>a</sup> Average daily minutes.

<sup>b</sup> Lower score signifies better function

<sup>i</sup> Adjusted scores from ANCOVA using group and cluster baseline scores, age and symptom duration at first consultation as covariates.

\*  $p < 0.05$ .

\*\*  $p < 0.01$ .

**Table 4** Qualitative Findings: Major themes, sub-themes, and extracts from the semi structured interviews.

Major Theme	Participant sub-theme	Example interview extract	Physical therapist sub-themes	Example interview extract
Therapeutic style	Patient/therapist connection	“They just got me.” (Pt 07) “They (treating physical therapists) never made (me) feel like just a patient” (Pt 12)	Motivational interviewing is a different mindset that requires a different skillset	“Reflections were something new, so sort of making sure obviously you’re listening to what they’re saying and then almost repeating it back to them to show that – “Yeah, I hear what you said. (Tx02)
	Physical therapy consultations were different to previous experiences with healthcare providers	“I felt more taken care of by the staff and they explained things a lot more. They asked more about my lifestyle and how my back affected my everyday living and what I wanted out of the physio” (Pt05)	Motivational interviewing helps build rapport with patients	“You definitely build a lot more rapport with patients using motivational interviewing. They’re maybe more open to what you’re saying. A lot of patients maybe just feel they’re being told what to do all the time, as opposed to being listened to.” (Tx03)
Therapeutic content and implementation	Setting goals as a team	“They would always ask me how I think I would go-not just give me an activity and say – you’ve got to do this physical activity... It wasn’t just giving me things that I had to do; we’d have a discussion about it.” (Pt 11)	Emphasis on collaborative goal setting	“It was useful to try and find out where they were at in terms of how ready they were to change or increase (their activity levels)” (Tx 02)

**Table 4** (Continued)

Major Theme	Participant sub-theme	Example interview extract	Physical therapist sub-themes	Example interview extract
Impact and suggested improvements	Physical therapists were good communicators who wanted to understand	“They were very interested, engaged, and they wanted me to get better and were there to support that” (Pt10)	Embedding motivational interviewing was a helpful assessment tool	“They were just relaxed and chatting, but I was getting useful information and getting them to think about what they wanted to achieve and how confident they felt they were, without them really thinking I was questioning them.” (Tx02)
	Low levels of engagement with and use of the MiMate app	“It was just time consuming; we all have busy schedules.” (Pt 10) “I remember (the physical therapist) saying that she was on the other side of the app. But I don't really feel like I got a lot back from that.” (Pt03)	Checked app compliance initially, stopped asking if the patient seemed disinterested	“If consistently over a few sessions they weren't using it, and they didn't show interest in it, I stop asking them.” (Tx 04)
	Examples about how to use the MiMate app and how it may be used as a part of physical therapy treatment	“There just needed to be a bit more current explanation of what the app actually did. A video case study of how to use it would definitely be a good thing” (Pt07)	Training program could have been more physical therapy-specific	“It might have been helpful to see a physical therapist implementing it exactly how we would.” (Tx 02)
	Ongoing impact	“The treatment) helped me. Now, I'm regular with my exercise and that's helped me to get back and get rid of my back pain which is a very important thing for me” (Pt08)	Ongoing use of motivational interviewing	“I found it was really helpful to implement, not just with the patients that were involved with the trial, but also any of the outpatients that I was seeing.” (Tx02) “I think definitely the theme of motivational interviewing has been really good and has changed the way I approach patients” (Tx03)

Abbreviations: Pt, Patient; Tx, Physical therapist.

379 to improve patient compliance with the app, as well as  
380 therapists' use of the online portal. Some patients reported  
381 they were unsure about the relationship between the app  
382 and physical therapy consultations. Uncertainty of purpose  
383 is a barrier to patients engaging with digital interventions  
384 for LBP.<sup>44</sup> A series of introductory videos within the MiMate  
385 app that explain its purpose and provide examples of it being  
386 used in everyday situations may be a practical way of  
387 addressing this.

388 Finally, physical therapists were assessed for proficiency  
389 in delivering motivational interviewing by a 20-min face to  
390 face session with a study coordinator, who spoke about a  
391 personal health-related behaviour they wanted to change.  
392 This was not aligned with how physical therapists were  
393 taught to embed motivational interviewing into regular con-  
394 sultations for LBP and the extent to which physical thera-  
395 pists were able to achieve this remains uncertain. Audio-  
396 recording all physical therapy consultations and applying the  
397 MITI to a random selection of de-identified consultations  
398 would provide a more accurate assessment.<sup>45</sup>

## Conclusions

399

400 It remains uncertain if training physical therapists to  
401 embed motivational interviewing into consultations, and  
402 combining this with a self-directed patient app, is more  
403 beneficial than usual physical therapy care for increasing  
404 physical activity in sub-acute LBP. Despite this, physical  
405 therapists were positive about motivational interviewing.  
406 Given the accessibility and potential cost-effectiveness of  
407 evidence-based behaviour change apps, further studies  
408 are warranted to establish the feasibility and effective-  
409 ness of the intervention. These should ensure adequate  
410 steps to optimise patient adherence and engagement  
411 with the MiMate smartphone app.

## Conflicts of Interest

412

413 The author declares no conflicts of interest.



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423 ware for research assistance).

## 424 Supplementary materials

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