



Engaging youth with major depression in an exercise intervention with motivational interviewing

Yasmina Nasstasia^{a,*}, Amanda L. Baker^b, Terry J. Lewin^b, Sean A. Halpin^a, Leanne Hides^d, Brian J. Kelly^b, Robin Callister^c

^a School of Psychology, University of Newcastle, Callaghan, NSW, 2308, Australia

^b School of Medicine and Public Health, Faculty of Health and Medicine, University of Newcastle, Callaghan, NSW, 2308, Australia

^c School of Biomedical Sciences and Pharmacy, and Priority Research Centre for Physical Activity and Nutrition, University of Newcastle, Callaghan, NSW, 2308, Australia

^d School of Psychology, University of Queensland, St Lucia, QLD, 4072, Australia

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ABSTRACT

Background: Exercise has beneficial effects on depression; however, research is constrained by low program adherence. This paper investigates: 1) whether there are improvements in stage of change (exercise readiness) and exercise self-efficacy from before to after a brief motivational interviewing (MI) intervention designed to enhance program engagement among youth with major depressive disorder (MDD); and 2) any prospective association between baseline stage of change (exercise readiness) category and exercise program participation, retention and treatment outcomes.

Methods: Selected pre- versus post-intervention and related secondary analyses based on pooled data from an initial pilot (n = 14) and subsequent two-armed RCT (n = 68). Participants were aged 15–25 years and met diagnostic criteria for MDD. Following psychological and physical fitness assessments, participants in the active treatment condition received a brief MI intervention followed by a supervised 12-week multi-modal exercise intervention.

Results: Higher initial exercise readiness was significantly related to baseline weekly exercise participation and self-efficacy, with trend-level associations with behavioural activation. There was a trend level differential improvement in exercise readiness post MI, and a significant increase in self-efficacy among the intervention group. Post MI self-efficacy was also correlated with increased exercise participation. Clear post-intervention benefits were detected for most outcome measures; however, these were not differential by baseline stage of change category.

Conclusion: Early MI based interventions increase exercise readiness and enhance self-efficacy, which may promote increased engagement and exercise adherence. Integrating MI as a prelude to exercise intervention shows promise as an effective engagement and treatment strategy among youth with MDD.

1. Introduction

1.1. Background

Major depressive disorder (MDD) is a highly prevalent condition with deleterious effects on psychological and physical functioning (Cooney et al., 2013). Exercise as treatment for MDD shows promising antidepressant effects either as a stand-alone or adjunctive treatment with adults (Cooney et al., 2013; Kvam, Kleppe, Nordhus, & Hovland, 2016) and more recently, youth populations (Hughes et al., 2013; Larun, Nordheim, Ekeland, Hagen, & Heian, 2006; Nasstasia et al., 2017; Parker et al., 2016). However, methodological issues, such as

lack of a clinical diagnosis of MDD and small samples without control groups, have constrained findings, warranting further investigation (Bailey, Hetrick, Rosenbaum, Purcell, & Parker, 2018). Exercise offers an accessible, non-stigmatising and well tolerated treatment alternative or adjunct that may appeal to youth in particular (Merrill, Warren, Garcia, & Hardy, 2017). Not all participants with MDD will engage and adhere to exercise programs, limiting potential benefits and constraining research seeking to establish the therapeutic efficacy of exercise (Helgadóttir, Hallgren, Kullberg, & Forsell, 2018; Herman et al., 2002; Krämer, Helmes, Seelig, Fuchs, & Bengel, 2014). Moreover, little research has examined how to increase exercise engagement among individuals with depression participating in exercise studies (Glowacki,

* Corresponding author. School of Psychology, Behavioural Sciences Building, University of Newcastle, Callaghan, NSW, 2308, Australia.
E-mail address: yasmina.nasstasia@newcastle.edu.au (Y. Nasstasia).

Duncan, Gainforth, & Faulkner, 2017).

Individuals with MDD report lower rates of exercise compared with non-depressed controls (Carter, Callaghan, Khalil, & Morres, 2012; Krämer et al., 2014), with a recent meta-analysis by Schuch et al. (2017) showing 67.8% of individuals with MDD do not meet physical activity recommendations and engage in higher rates of sedentary behaviour. They are also more likely to drop out of regular exercise programs (Kangas, Baldwin, Rosenfield, Smits, & Rethorst, 2015). Multiple barriers to exercise engagement are reported by individuals with MDD including: symptom barriers (hopelessness, pessimism, procrastination, anhedonia, fatigue, sleep and appetite disturbances); higher body mass index (BMI) or physical co-morbidities; an increased perception of situational barriers; and reduced exercise related self-efficacy (Schuch et al., 2017; Vancampfort et al., 2015). Younger people may be even more likely to drop out of exercise programs (Krogh, Lorentzen, Subhi, & Nordentoft, 2014). Moreover, a recent meta-analysis showed higher baseline depressive symptoms predicted increased rates of participant dropout (Stubbs et al., 2016). The Cochrane review by Cooney et al. (2013) found that exercise appeared to perform no better or worse compared with antidepressants or psychological therapies, although this finding was limited in part by the variable attendance rates for exercise treatments (Knapien, Vancampfort, Morien, & Marchal, 2015).

Exercise programs do not intrinsically focus on addressing issues relating to motivation and/or ambivalence. Motivational elements need to be built into the program; for example, by adopting supervised approaches (Stubbs et al., 2016) with motivational support, or customizing mode of exercise based on participants preferences (Nystrom, Neely, Hassmen, & Carlbring, 2015). One potential method for increasing engagement is by integrating exercise programs with motivational interviewing (MI) approaches. It has been suggested that MI 'fits the symptoms' of depression that revolve around motivational deficits (Burke, 2011). MI is a collaborative, person centred, therapeutic style designed to strengthen individuals' motivation and commitment to change (Miller & Rollnick, 2013). MI has been successfully applied as a pre-treatment strategy to increase patient engagement in a range of psychological and behavioural treatments (Hettinga, Steele, & Miller, 2005; Kertes, Westra, Angus, & Marcus, 2011). Research across varied populations and providers also confirms the effectiveness of MI in helping facilitate behaviour change, and even single sessions can trigger significant change (Hettinga et al., 2005; Strong et al., 2012).

Although still in its infancy, MI as a prelude treatment to exercise interventions offers an innovative approach to promoting behaviour change (Karnes, Meyer, Berger, & Brondino, 2015; Miller & Rollnick, 2013). MI potentially enhances motivation or exercise readiness (stage of change) and perceived ability to engage in a particular behaviour (self-efficacy) (Krämer et al., 2014). Both stage of change and self-efficacy represent two key elements of the trans-theoretical (TTM) and health behaviour change models (Bulley, Donaghy, Payne, & Mutrie, 2007). The stage of change model describes specific phases individuals move through when seeking to make behaviour change. These stages include: pre-contemplation (not intending to change); contemplation (thinking about making changes); preparation (planning to or making small changes); action (actual changes have been made); and maintenance (changes have been sustained) (Berry, Naylor, & Wharf-Higgins, 2005). These stages are dynamic and individuals can transition in and out of stages, or return to and/or remain in lower stages (Haas & Nigg, 2009). The stage of change model can also be helpful in predicting who will disengage with treatment, identifying individuals at risk and tailoring stage matched interventions to individuals (Callaghan et al., 2005). Although the model is not without criticism, research suggests stage of change represents an important predictor of adherence to exercise interventions (Kirk, MacMillan, & Webster, 2010), with lower stages of change being more impacted by barriers to exercise (Lutz, Stults-Kolehmainen, & Bartholomew, 2010).

Self-efficacy, another potentially important predictor of exercise

behaviour, holds the notion that actual ability to perform a particular behaviour is a function of one's confidence to do so (Kangas et al., 2015). Self-efficacy is a crucial determinant of exercise behaviour and a key predictor of physical activity, particularly in the adoption stage of exercise (Bray, Gyurcsik, Culos-Reed, Dawson, & Martin, 2001; Lee, Arthur, & Avis, 2008). The belief one can exercise in the face of a range of constraints and barriers is associated with increased exercise participation (Farris et al., 2016; Lee et al., 2008). Increased self-efficacy may act as a mediator between exercise and improvement in depression by increasing positive health behaviour. Higher initial self-efficacy has been shown to predict better post-treatment outcomes across a variety of psychological and pharmacological treatments and disorders among adults and adolescents (Brown et al., 2014; Gordon, Tonge, & Melvin, 2011). Pre- to post-treatment changes in self-efficacy have also been shown to precede symptom reduction or predict symptom improvement (Brown et al., 2014).

Although the mechanisms underpinning a therapeutic benefit of exercise on MDD are not well understood, improvement in self-efficacy is theorised to be a mechanism for helping explain the antidepressant effects of exercise (Kangas et al., 2015; Lee et al., 2008). Individuals experiencing depressive symptoms frequently report lower self-efficacy than their non-depressed counterparts with respect to a range of behaviours (Kangas et al., 2015). Consequently, enhancing exercise self-efficacy may help reduce attrition from exercise programs and increase exercise behaviour over the longer term (Lee et al., 2008). Although it is not yet clear how MI exerts its effects across physical and mental health realms (Romano & Peters, 2016), theoretical principles underpinning MI are based on the notion that self-efficacy is an important determinant of behaviour change (Miller & Rollnick, 2013) and improvement in self-efficacy is purported to be one of the mechanisms by which MI changes exercise behaviour (Hardcastle & Hagger, 2011).

A small number of studies designed to increase exercise participation among adults have demonstrated that MI interventions can significantly increase exercise readiness and self-efficacy (Jeong & Jeong, 2017; Karnes et al., 2015). Although research investigating the use of MI among adolescents in treatment is limited (Callaghan et al., 2005), a number of studies have demonstrated the benefits of MI as a priming technique to facilitate engagement and motivation for mental health treatments (Dean, Britt, Bell, Stanley, & Collings, 2016; Dennis et al., 2004). To the best of our knowledge, there have been no published studies investigating effects of MI integrated with an exercise intervention on treatment engagement, exercise readiness (stage of change) and self-efficacy among youth with MDD.

There is also a paucity of research examining factors associated with exercise readiness and self-efficacy among youth with MDD. Youth may differ in their levels of motivation and exercise self-efficacy when volunteering for exercise interventions and this may impact on participation, retention and treatment outcomes. The contribution of an individual's motivation to change has been investigated among an adolescent population receiving inpatient treatment for substance abuse. Those in the pre-contemplation stage of change were significantly more likely to drop out of treatment (Callaghan et al., 2005). Similarly, research by Lewis et al. (2009) examined the effects of readiness to change on treatment outcome in a subsample of adolescents with MDD from the Treatment for Adolescents with Depression Study (TADS), comparing fluoxetine, cognitive-behavioural therapy (CBT), fluoxetine and CBT, and pill placebo. Their results showed that adolescents who were more action orientated at baseline responded best to treatment irrespective of treatment approach, with the researchers recommending addition of MI to depression interventions to support low action adolescents who may be ambivalent about change.

Other studies have reported that a higher stage of change at baseline is associated with increased, self-reported exercise behaviours (Berry et al., 2005) and exercise self-efficacy (Gorczyński, Faulkner, Greening, & Cohn, 2010). These factors may also play a role in influencing treatment efficacy and participation. Understanding the factors that

contribute to exercise behaviour among individuals with depression may help guide the development of interventions and target individuals more appropriately (Krämer et al., 2014).

1.2. Objectives and hypotheses

The purpose of this paper was two-fold: firstly, to investigate whether there are improvements in stage of change (exercise readiness) and exercise self-efficacy from before to after a brief MI intervention designed to enhance engagement among young people with MDD; and secondly, to investigate any prospective association between baseline stage of change (exercise readiness) category and exercise program participation, retention and key treatment outcomes. While MI integrated with an exercise intervention may work synergistically to increase the likelihood of treatment benefits by enhancing motivation, we were interested in exploring any early role MI may have played in influencing treatment engagement. We were also interested in exploring any treatment or participation effects of initial motivation (pre-MI and exercise intervention) as assessed by stage of change. It was hypothesised that: 1) the MI intervention would enhance treatment engagement and differentially increase exercise readiness and self-efficacy compared to the control condition; 2) the initial stage of change (exercise readiness) category would be associated with other concurrent key baseline characteristics, with individuals at more advanced stages reporting higher baseline rates of exercise self-efficacy and physical activity; 3) the initial stage of change (exercise readiness) category would be differentially associated with treatment engagement, retention and adherence to exercise programs, with lower stages relating to increased attrition and lower exercise participation rates; and 4) increased exercise self-efficacy would be associated with higher rates of exercise participation among those in the active treatment condition.

2. Methods

2.1. Design and relevant assessment time points

Data for the secondary analyses reported here were pooled from two studies: an initial pilot study (study 1) for a randomised controlled trial (RCT) (Nasstasia et al., 2017) and selected data from the subsequent RCT (study 2) (Nasstasia et al., 2018). In study 1, we investigated the feasibility of integrating a psychologist delivered MI intervention designed to increase engagement by young people with MDD in a 12-week exercise intervention, and explored patterns of change in the depression symptom profile. Although treatment effects and MI fidelity have been reported elsewhere, the effects of the MI intervention on exercise readiness and self-efficacy were not examined. In study 1, assessment of key outcome measures was conducted more frequently than in study 2, namely: pre-intervention (baseline) (T1); post-intervention (T3, Wk12); at follow-up (T5, Wk40); and every two weeks over the course of the 12-week exercise intervention (including mid-intervention; T2, Wk6). However, there was no control condition in study 1, with comparisons made against previous research utilising control groups.

Study 2 comprised a two-armed (treatment vs. control) RCT investigating the efficacy of an MI integrated multi-modal exercise intervention for treatment of depression in youth (Nasstasia et al., 2018). In part, study 2 was designed to exclude the possibility that the large observed treatment effects in study 1 were due to factors such as spontaneous remission of depressive symptoms. In Study 2, we adapted the MI intervention from study 1 for delivery by personal trainers (PT's). Details on the study 2 research protocol and associated power calculations have been reported previously (with no specific power calculations undertaken for the current paper) (Nasstasia et al., 2018). Longer-term treatment efficacy effects from this study and the impact of the intervention on depressive symptom profiles are reported elsewhere (Nasstasia, Baker, Lewin, Halpin, Hides, Kelly, & Callister, 2019). These studies were approved by ethics research committees from the

University of Newcastle (H2012-0114) and Hunter New England Local Health District (15/04/15/4.05) and the RCT was prospectively registered with the Australian New Zealand clinical trials registry (ANZCTR: ACTRN12613000638730). All participants provided written informed consent prior to participation.

Participants were stratified by gender and overall depression severity and randomised to an immediate (IM) (intervention) or a control/delayed (CTRL/DL) group, which subsequently received the intervention following the 12-week control period as part of a crossover design. Assessment of key outcome measures was conducted less frequently than in study 1, namely: pre-intervention (T1); mid-intervention (T2, Wk6); post-intervention (T3, Wk12); and at follow-up (T5, Wk24); with additional corresponding time points for the CTRL/DL group following the cross-over: at mid-intervention (T4, Wk18); and follow-up (T6, Wk36).

In both studies, a repeated measures design was used to evaluate any changes in exercise readiness and self-efficacy following participation in the MI intervention and prior to the exercise intervention. Exercise readiness (and related stage of change categories) and self-efficacy were assessed at: baseline (T1); post-MI intervention (T1a, Wk0); post-exercise intervention (T3, Wk12); and at follow-up (T5), across both studies. However, in study 2, the CTRL group also completed the same measures at the corresponding time points (e.g., T1a, Wk0) during the control period. Only data from the efficacy component of study 2 (T1 and T3 for IM and CTRL groups) were included in the pooled data set, to be more directly analogous to study 1. By aggregating data from both studies, we were able to augment our sample size to explore the questions of interest, facilitate comparisons with a control condition, and potentially increase the generalisability of findings by comparing MI delivered by a clinical psychologist versus personal trainers.

2.2. Participants, screening, assessment and procedures

As detailed methods have been published for both studies (Nasstasia et al., 2017, 2018), only a brief account is provided here. Participants in both studies were recruited from University and community populations. Individuals expressing interest in the study were screened by phone to determine their initial eligibility. Participants were within the 15–25 years age range and met current diagnostic criteria for MDD, as assessed by a clinical psychologist (Y.N.) at baseline utilising the Structured Clinical Interview for DSM-IV (SCID-1 Research Version) (First, Spitzer, Gibbon, & Williams, 2002). To increase generalisability, both studies included participants who were receiving other treatment for MDD, as well as those reporting that they already engaged in modest levels of physical activity. Demographic characteristics, treatment history related factors, and other baseline descriptive information about participants in each study are presented in [Supplementary Table S1](#). Psychological and physical fitness assessments for both studies were conducted at baseline, post-intervention and at follow-up. Post-intervention and follow-up psychological and physical fitness assessments were conducted by independent researchers in both studies, with blinding to treatment group occurring in study 2. At each time point, current depression diagnosis was assessed by the SCID and overall depression severity was assessed by the Beck Depression Inventory (BDI-II) (Beck, Steer, & Brown, 1996). Additional self-report psychological measures were administered at baseline, mid- and post-intervention and follow-up. Exercise readiness (stage of change) and exercise self-efficacy were additionally administered at T1a, post MI intervention for both studies, and at a comparable time during the control period for study 2.

2.2.1. Psychological self-report measures common to study 1 and 2

Beck Depression Inventory (BDI-II) (Beck et al., 1996). The BDI-II is a well-established 21-item self-report measure of depression symptom severity reflecting DSM-IV diagnostic criteria for MDD. Each item is

rated on a 4-point scale (0–3), with higher aggregate scores (ranging from 0 to 63) indicating greater severity of depression.

Automatic Thoughts Questionnaire (ATQ) (Hollon & Kendall, 1980). The ATQ consists of 30 self-report items assessing frequency of negative automatic thoughts. Scores range from 30 to 150, with higher scores reflecting increased negative cognitions. The ATQ is a widely used measure with strong psychometric properties reported (Hollon & Kendall, 1980).

Behavioural Activation for Depression Scale (BADSF) (Manos, Kanter, & Luo, 2011). The BADSF is a measure of behavioural activation (activation and avoidance). This nine-item measure has a total score ranging from 0 to 54, with higher scores representing increased activation (and less avoidance). The authors report that the scale has an internal consistency of 0.82, with demonstrated construct validity and predictive validity (Manos et al., 2011).

The Single Item Self-esteem Scale (SISE) (Robins, Hendin, & Trzesniewski, 2001). The single-item 'I have high self-esteem' is rated on a 5-point Likert scale ranging from 1 'strongly disagree' to 5 'strongly agree'. The SISE has demonstrated convergent validity with the Rosenberg Self-esteem Scale (Robins et al., 2001).

Exercise Readiness (stage of change measure) (Marcus, Selby, Niaura, & Rossi, 1992). For this single-item readiness to exercise measure participants are provided with a definition of regular exercise: "Regular exercise is any planned physical activity (e.g., brisk walking, aerobics, jogging, bicycling, swimming, rowing, etc.) performed to increase physical fitness. Such activity should be performed 3–5 times per week for 20–60 min per session. Exercise does not have to be painful to be effective but should be done at a level that increases your breathing rate and causes you to break a sweat". Respondents are asked to indicate how often they have been engaging in exercise in accordance with that criteria using a 5-point rating scale ranging from 1 '... no, and I do not intend to in the next 6 months' to 5 '... yes, I have been for more than 6 months'; these five options are typically characterised as a stage of change continuum (pre-contemplation, contemplation, preparation, action and maintenance). In the current study, we used this measure both as a continuous score (representing increasing exercise readiness) and as a basis for forming grouped stage of change categories.

Exercise Self-Efficacy scale (ESE) (Benisovich, Rossi, Norman, & Nigg, 1998). The ESE scale is an 18-item measure assessing confidence to exercise despite barriers, presented across six specific domains. These include negative affect, excuse making, must exercise alone, inconvenient to exercise, resistance from others, and bad weather. Items are rated on a 5-point scale ranging from 1 'not at all confident' to 5 'completely confident'. Higher aggregate scores (ranging from 18 to 90) indicate higher rates of exercise self-efficacy.

2.2.2. Physical activity and fitness assessments and exercise engagement

During baseline fitness assessments, exercise history and recent exercise participation were recorded. Regular exercise participation in study 2 was recorded as self-reported minutes of strength training and/or aerobic exercise per week.

Fitness assessments included: *Upper body muscular strength endurance* assessed by the number of repetitions on the YMCA Bench Press Test. Anthropometric measures included: *Height* in cm, measured without shoes on a Holtain stadiometer calibrated before each assessment session; *Weight* in kg, measured without shoes and in light clothing on a calibrated digital scale; *Body Mass Index (BMI)*, which was calculated using the formula: weight (kg)/ height (m²); and *Waist circumference* in cm, measured at the mid-point between the bottom rib and iliac crest at the end of a normal expiration.

Exercise engagement was assessed by recording initial commencement in the program and overall attendance at exercise sessions.

2.3. Integrated MI and exercise intervention

2.3.1. MI intervention and treatment fidelity

The MI intervention for study 1 comprised one session (90-min) and utilised a protocol 'Train your mood: Exercise as Treatment for Depression' developed as a pre-exercise engagement strategy for young people with MDD, which was delivered by a clinical psychologist (Y.N.). The MI protocol for study 2 "Exercise as Treatment for Depression: A guide for personal trainers" was revised and adapted for delivery by PTs to increase engagement effects. This MI intervention was shortened to 30-min based on participant feedback and to promote dissemination and real-world application. The PTs received a 6-h MI training workshop led by a clinical psychologist (Y.N.) trained and experienced in the delivery of MI, utilising specifically developed MI training modules to ensure standardisation. Personal trainers were also provided with a one-page prompt sheet outline of the MI protocol for use when facilitating MI sessions with participants. Following the training, PTs received two 1-h individualised coaching sessions with the psychologist who provided the training. Treatment fidelity for both studies was established utilising the Motivational Interviewing Treatment Integrity (MITI) code version 3.1 (Moyers, Martin, Manuel, Miller, & Ernst, 2010). Treatment fidelity for study 1 has been reported previously. Fidelity assessments were performed by two independent psychologists (coders) both trained in MI and in the use of the MITI. Coders only proceeded to rate the study sample after they had achieved adequate inter-rater reliability. Fortnightly face-to-face supervision was also provided to the coders to discuss questions and reach consensus when any difficulties emerged in coding.

2.3.2. Multi-modal exercise intervention

Following the MI intervention, participants in the active treatment condition commenced a 12-week multi-modal exercise intervention at the University gym. The PTs were qualified and experienced in the provision of individual and group-based exercise programs. Participants exercised in supervised small groups (3–5 people) three times per week for 1 h. The structured exercise training protocol included resistance training for the development of local muscular strength/endurance and aerobic exercise for the development of cardiorespiratory fitness (aerobic fitness) across four blocks of progressive intensity (A, B, C and D), and adhered to National Strength and Conditioning Association guidelines (Faigenbaum et al., 2009).

2.4. Statistical methods

All statistical analyses were performed using IBM SPSS software (Version 23: Armonk, NY, USA). As similar recruitment materials and inclusion/exclusion criteria were used in both studies, it was assumed that the selected samples would have comparable characteristics and expectations. A preliminary series of comparisons was conducted, utilising chi-squares for categorical data and analyses of variance (ANOVAs) for continuous variables, to help confirm the appropriateness of pooling participant data across studies. There was minimal within-subject missing data at each time point. In view of the secondary nature of the current analyses, complete pairs were used in all change-based analyses, with no imputation of missing data.

Repeated measures ANOVAs were used to examine the effects of the MI intervention on exercise readiness (continuum) and self-efficacy. ANOVAs were also used to explore differences in demographic, psychological, health and fitness characteristics by baseline stage of change category. The relationship between baseline stage of change and retention at 12 weeks was assessed utilising chi-square tests. Pearson correlations were conducted to investigate relationships between exercise self-efficacy, baseline stage of change (continuum) and exercise participation. The significance level for all tests was set at $p \leq 0.01$ to partially control for potential Type 1 errors associated with multiple comparisons, with statistical trends also noted at $p \leq 0.05$; this is the

equivalent of a Bonferroni-adjusted family-wise error rate with 5 members per family (e.g., physical health/activity measures).

3. Results

3.1. Sample characteristics

Supplementary Fig. S1 details participant recruitment and retention patterns for both studies. Supplementary Table S1 reports findings from a preliminary series of baseline comparisons between participants from the two studies. These groups were similar in almost all respects, except for differences in relationship status ($p = 0.006$) and waist circumference ($p = 0.022$), potentially reflective of the broader range of sampling sources for study 2. Additionally, there was no significant difference between these study groups in early change in depression scores, as assessed by changes between eligibility screening and baseline on the Beck Depression Inventory Fast Screen (BDI-FS) [$F_{(1, 80)} = 3.337, p = 0.07$; mean change (SD): study 1, -1.79 (2.15); study 2, -0.44 (2.57)]. Consequently, data from the two samples were pooled for the main analyses. Three-quarters (78.0%, $n = 64$) of participants were female, with an average age of 20.7 (SD 2.5) years. Participants were predominately single (71.6%, $n = 58$), with no children, and most were currently studying (84.2%, $n = 69$). Mean baseline depression (BDI-II) scores were in the severe range. Most participants (82.9%, $n = 68$) were currently receiving treatment for their depression, with over two-thirds (68.3%, $n = 56$) taking antidepressant medication. The majority (82.7%, $n = 67$) also reported a family history of depression. Life time use of tobacco was reported by 44.4% ($n = 36$) of the sample. As detailed in the left-hand columns of Table 1, for the pooled sample, mean BMI was in the overweight range, with participants averaging only 59.21 min per week of cardiovascular and/or strength-based exercise on a regular basis. On average, participants described themselves as having low self-esteem (SISE mean = 1.9). At baseline, 24.4% ($n = 20$) of participants were in the pre-contemplation or contemplation stage of exercise readiness, 41.5% ($n = 34$) were in the preparation stage, and 34.1% ($n = 28$) were in the action or maintenance stage.

3.2. MI fidelity assessment

Interviews were rated by two independent judges who were both psychologists trained in MI and in the MI treatment integrity (MITI) code, Version 3.1.1 (Moyers et al., 2010). Thirty-eight recordings from study 2 were double coded in their entirety, representing 65.0% of the retained study sample. Average coded session duration was 33.14 min

(SD 10.67), which was similar to study 1 fidelity assessments, where ratings were based on 21 interview segments. The MITI global ratings (evocation, collaboration, autonomy/support, direction and empathy), which were rated from 1 (low) to 5 (high), displayed adequate fidelity to MI principles, with 87.6% of the domains rated as 4 or 5. This was slightly lower than in study 1, in part due to the variability across different trainers (67.5%–99.3%).

3.3. MI intervention effects on increased exercise readiness and self-efficacy

Repeated measures ANOVAs were used to examine the effects of the MI intervention on exercise readiness (continuum). Mean baseline (T1) exercise readiness was 3.13 (SD 1.10) decreasing to 2.83 (SD 1.23) post control (T1a) for the control condition while mean baseline (T1) exercise readiness for the active condition was 3.26 (SD 0.94) increasing to 3.47 (SD 0.91) post MI (T1a) intervention. There was a trend-level interaction effect for exercise readiness [$F_{(1, 68)} = 6.28 (p = 0.015)$], with the active condition who received the MI intervention reporting an increased readiness compared with a decrease among the control group who did not receive the MI intervention.

A three-way 2 X 3 X (2) [treatment condition by baseline stage of change by time] analysis of variance (ANOVA) was also used to examine the effects of the MI intervention on exercise self-efficacy by baseline stage of change. There was a significant overall increase in scores from baseline to the post MI intervention [$F_{(1, 64)} = 19.80 (p < 0.001)$], which differed by treatment condition [$F_{(1, 64)} = 14.84 (p < 0.001)$] with the active condition reporting increased exercise self-efficacy compared with the control condition who did not receive the MI intervention (see Table 2 for relevant means).

As shown in Table 2, all of the exercise readiness sub-groups receiving the MI intervention displayed increases in exercise self-efficacy post MI, as did the pre-/contemplation group from the control condition. While the triple interaction (involving treatment condition) was not significant, there was a significant differential increase in exercise self-efficacy by stage of change category [$F_{(2, 64)} = 7.79, p = 0.001$], with the pre-/contemplation group displaying greater change between the two assessments.

3.4. Baseline measures by stage of change (exercise readiness) category

According to the trans-theoretical model, baseline stage of change (exercise readiness) category would be expected to be associated with a range of other measures assessed at a similar time point. The right-hand columns of Table 1 report baseline profiles for selected measures by

Table 1
Baseline measures by stage of change (exercise readiness) category for the pooled sample (N = 82).

Baseline measure	Pooled (Overall) (n = 82) Mean (SD)	Stage of change (Exercise readiness) category			Statistical significance
		Pre-/Contemplation (n = 20) Mean (SD)	Preparation (n = 34) Mean (SD)	Action/Maintenance (n = 28) Mean (SD)	
Body Mass Index (BMI) (kg/m ²)	26.46 (7.02)	27.39 (9.21)	26.60 (6.45)	25.67 (6.11)	$F_{(2, 77)} = 0.34, p = 0.71$
Waist circumference (cm)	90.36 (18.92)	92.14 (25.44)	90.57 (17.27)	88.89 (16.04)	$F_{(2, 77)} = 0.17, p = 0.85$
Strength and aerobic (minutes per week) $n = 67^a$	59.21 (73.59)	20.00 (29.67)	35.00 (41.04)	115.96 (59.21)	$F_{(2, 64)} = 15.19,$ $p < 0.001^{**}$
Bench press repetitions	19.98 (10.59)	17.58 (12.65)	20.61 (10.52)	20.86 (9.22)	$F_{(2, 77)} = 0.64, p = 0.53$
Beck Depression Inventory fast screen (BDI-FS)	11.82 (3.42)	12.55 (3.32)	11.71 (3.52)	11.43 (3.34)	$F_{(2, 79)} = 0.65, p = 0.52$
Beck Depression Inventory (BDI-II Total)	33.06 (9.10)	33.85 (8.04)	33.11 (11.33)	32.43 (9.84)	$F_{(2, 79)} = 0.12, p = 0.89$
Automatic Thoughts Questionnaire (ATQ)	93.75 (28.43)	97.95 (27.72)	92.58 (30.84)	92.18 (26.63)	$F_{(2, 79)} = 0.29, p = 0.75$
Behavioural Activation Depression Scale (BADS)	18.23 (5.75)	15.96 (6.12)	17.96 (5.99)	20.19 (4.60)	$F_{(2, 79)} = 3.40, p = 0.04^{\#}$
Exercise Self-efficacy (ESE)	47.84 (13.58)	37.19 (15.46)	48.28 (10.68)	54.91 (10.48)	$F_{(2, 79)} = 12.88,$ $p < 0.001^{**}$
Single Item Self-Esteem Score (SISE)	1.90 (0.85)	1.63 (0.89)	1.97 (0.78)	2.00 (0.86)	$F_{(2, 78)} = 1.28, p = 0.28$

Note: ^a This measure was not assessed in the pilot study; [#] trend ($p \leq 0.05$); * $p \leq 0.01$; ** $p \leq 0.001$.

Table 2
Exercise self-efficacy at baseline and post MI intervention by stage of change (exercise readiness) category and treatment condition.

Treatment condition/Measure	Baseline stage of change (exercise readiness) category			
	Overall Mean (SD)	Pre/Contemplation Mean (SD)	Preparation (Mean (SD))	Action/Maintenance Mean (SD)
Control				
<i>Exercise Self-efficacy</i>	(n = 23)	(n = 8)	(n = 8)	(n = 7)
Baseline (T1)	49.57 (SD 13.70)	39.73 (11.14)	54.58 (12.58)	55.07 (12.71)
Post-MI control (T1a)	50.87 (SD 14.85)	54.63 (14.47)	46.50 (16.27)	51.57 (14.52)
Active				
<i>Exercise Self-efficacy</i>	(n = 47)	(n = 9)	(n = 21)	(n = 17)
Baseline (T1)	44.73 (SD 12.47)	29.53 (12.00)	45.47 (9.83)	51.87 (8.30)
Post-MI intervention (T1a)	58.51 (SD 15.79)	52.11 (15.64)	56.76 (16.74)	64.06 (13.57)

stage of change. There were trend-level differences observed in behavioural activation ($p = 0.038$), and a statistically significant difference in weekly participation in strength and aerobic exercise ($p < 0.001$) and exercise self-efficacy ($p = < 0.001$). Individuals at higher stages of change reported higher baseline self-efficacy, behavioural activation, and participation in weekly exercise. Baseline stage of change was also significantly correlated with baseline exercise self-efficacy ($r = 0.42$, $p < 0.001$).

3.5. Engagement and retention

3.5.1. Study engagement across conditions and stage of change (exercise readiness) categories

Of the 48 participants in the pooled active condition, 46 (95.8%) commenced the exercise program, with one person unexpectedly moving out of the area prior to the exercise intervention. Overall, 79.3% of participants ($n = 65/82$) completed 12-week assessments and this did not vary by treatment condition; among those who commenced the exercise intervention, 76.1% ($n = 35/46$) were retained at 12 weeks post-treatment, compared with 88.2% ($n = 30/34$) of the control group. Similarly, 73.5% ($n = 25/34$) of control group members went on to participate in the exercise intervention as part of the crossover design, amongst whom 96% ($n = 24/25$) completed the subsequent 12-week assessment.

Within the pooled active condition, 18.8% ($n = 9$) were in the pre-contemplation or contemplation category at baseline, 45.8% ($n = 22$) in the preparation category, and 35.4% ($n = 17$) in the action/maintenance category; for the control condition, the corresponding values were: 32.4% ($n = 11$); 35.3% ($n = 12$); and 32.4% ($n = 11$). An examination of baseline readiness to exercise (stages of change) and retention at 12 weeks utilising chi-square tests showed a trend towards significance within the pre/contemplation stage of change category (chi-square 5.09, $p = 0.050$). Specifically, in the active treatment group 55.6% ($n = 5$) of the pre/contemplators did not return for post 12-week assessments in comparison to only 9.1% ($n = 1$) of the pre/contemplators from the control condition. No other stages of change associations were significant.

3.5.2. Stage of change (exercise readiness) category, and attendance at exercise sessions

The pooled active condition attended a mean of 18.18 (SD 10.60) personal trainer supervised exercise sessions (or 50.5% of the potential 36 sessions per person). Within the baseline pre/contemplation group, attendance averaged 16.78 (SD 14.54) sessions (or 46.6%), compared with 17.91 (SD 9.91) sessions (49.7%) for those at the preparation stage, and 19.29 (SD 9.64) for the action/maintenance category (53.4%). Exercise self-efficacy as assessed following the MI intervention (and prior to commencement of the exercise intervention) was positively correlated at trend-levels with subsequent participation in PT supervised exercise sessions ($r = 0.35$, $p = 0.017$); however, baseline

exercise self-efficacy was not correlated with exercise participation ($r = 0.22$, $p = 0.131$). Participants retained at 12 weeks reported attending an average of 21.86 (SD 8.64) exercise sessions whereas those who dropped out attended an average of 8.3 (SD 9.1) sessions [$F_{(1, 46)} = 22.6$, $p < 0.001$].

3.6. Differential changes in treatment effects across readiness to exercise (stage of change)

Three-way [2 X 3 X (2), treatment condition by baseline stage of change (by time)] analyses of variance (ANOVAs) were conducted to explore differential effects of treatment by baseline stage of change (exercise readiness) category. Of the 65 participants across both pooled active and control conditions who completed baseline and 12-week post-treatment assessments, 14 participants were in the pre/contemplation category at baseline, 29 in the preparation category, and 22 in the action/maintenance category. Participant mean scores for key self-report measures at the pre and post 12-week assessments by baseline stage of change (exercise readiness) category, and associated ANOVAs, are presented in [Supplementary Table S2](#). There was an overall significant improvement in depression, negative automatic thoughts, behavioural activation, self-esteem, bench press, strength and aerobic exercise, and these were all differential by treatment condition (but only at trend levels for self-esteem and strength and aerobic exercise) with the pooled active group showing more improvement. There was a similar overall improvement in exercise self-efficacy; however, this did not differ by treatment condition ($p = 0.728$) with exercise self-efficacy significantly improving across both pooled active and control groups. There were no differential effects by baseline stage of change category observed for any of the key outcome measures; the strongest interaction was a stage of change by time effect for the BADS-SF ($p = 0.066$), which showed a similar pattern to the earlier MI analyses, with more marked improvements in behavioural activation for those at earlier stages of change (see [Supplementary Table S2](#)).

4. Discussion

To the best of our knowledge, this is the first study evaluating the effects of MI on stage of change (readiness to exercise) and exercise self-efficacy among youth with MDD enrolled in an exercise intervention. Our hypothesis that the MI intervention would enhance treatment engagement and differentially increase exercise readiness and self-efficacy compared to the control condition was supported. There was a trend level significant increase in exercise readiness (stage of change) following the MI intervention, with the control group showing no corresponding improvements. The MI intervention appears to have enhanced behaviour change among pre-contemplators and contemplators and reinforced those in the preparation, action and maintenance stages. This is consistent with the application of MI as a client-based intervention tailored to the individual, increasing readiness among lower

stages while reinforcing those at higher stages. Motivation is theorised by Miller as a state of readiness for change, as opposed to a personality trait, which may be guided to move in a specific direction (Britt, Hudson, & Blampied, 2004) and be potentially useful at any point in treatment (Callaghan et al., 2005).

There was also a significant increase in exercise self-efficacy following the MI intervention differential by treatment condition with intervention participants reporting significant increases in exercise self-efficacy. These promising results suggest MI supports the development of self-efficacy among youth with MDD. This is an important finding given the role self-efficacy plays in predicting exercise behaviour particularly in the early stages of exercise adoption (Bray et al., 2001), and the lower rates of exercise self-efficacy commonly reported among individuals with depressive symptoms (Kangas et al., 2015).

A closer examination of these results by initial stage of change showed a significant improvement in exercise self-efficacy among the pre-contemplation/contemplation group from both conditions. However, the increase in exercise self-efficacy at the corresponding time point among the control condition only applied to the pre-contemplation and contemplation group. On the other hand, mean improvements in exercise self-efficacy in the pooled active condition were observed across both higher and lower stages of change, suggesting MI can enhance exercise self-efficacy irrespective of exercise readiness. These findings are consistent with research supporting the notion that MI interventions may be beneficial to less motivated participants as well as individuals who are already prepared to act (Prochaska et al., 2008). It also suggests exercise self-efficacy improvements among pre-contemplators and contemplators among control participants may potentially be a function of agreeing to participate in a trial. Participants were aware that they were volunteering for an exercise intervention for depression and the control group were also aware that they would cross over to the exercise intervention following the waitlist period. Research suggests exercise self-efficacy can increase even among those who are just thinking about fitting exercise into their own lives (Buckley & Cameron, 2011). This may partly explain the corresponding increases in exercise self-efficacy among the pre-contemplators and contemplators both at early stages and post the 12-week control period. However, some research suggests limited prior experience with exercise may lead to overestimating exercise self-efficacy, with accurate estimates only occurring following experience with exercise (McAuley et al., 2011).

Consistent with other research (Berry et al., 2005), our hypothesis that initial stage of change (exercise readiness) category would be associated with other concurrent key baseline characteristics was also supported. Those at earlier stages reported significantly less exercise and lower levels of exercise self-efficacy than those in later stages, as the model would predict. There were similar trend level patterns with respect to behavioural activation. No other significant relationships were observed, although almost all of the means were in the expected direction and this may be partly due to the small sample sizes across respective stage groups, warranting further research. Our results also suggest personal trainers can learn how to apply MI based interviewing. Although this is consistent with other studies (Hettema et al., 2005), the variability across trainers with respect to the MITI global scores suggests that not all personal trainers can implement MI easily and some may have benefited from additional support.

4.1. Engagement, retention and treatment outcomes

Treatment engagement in the pooled active condition was high, with 95.8% (46/48) of participants commencing the exercise intervention. This contrasts with research by Carter et al. (2015) in which 18.1% (8/44) of adolescents did not attend any of the exercise sessions. Further, similar engagement and even stronger retention rates were observed among the control group both at week 12 (post control) and when they crossed over into the MI/exercise intervention. On average, the pooled active condition attended just over half of the possible

supervised exercise sessions, with those at higher stages recording the highest average, exercise participation rates. These findings are consistent with a growing body of research showing MI can improve treatment attendance, particularly within the substance use domain and more recently, for other mental health disorders (Dean et al., 2016; Seal et al., 2012; Westra & Dozois, 2006).

Our hypothesis that initial stage of change (exercise readiness) category would be differentially associated with treatment engagement, retention and adherence to exercise programs, with lower stages experiencing increased attrition and lower exercise participation rates, was partially supported. Although almost everyone commenced the exercise program, pre-/contemplators in the pooled active condition were less likely to complete the exercise program and return for their post-exercise intervention assessments compared with those in the control condition. This is consistent with related research (Callaghan et al., 2005; Taylor, Zaitsoff, & Paterson, 2014) and highlights the importance of assessing exercise readiness from the outset and providing increased support to young people who report ambivalence. Unexpectedly, our results suggested that initial stage of change does not play a role in determining key psychological or fitness treatment outcomes for those who engaged with the program. Irrespective of their initial stage of change, participants in the pooled active condition benefited from the integrated MI/exercise intervention, with significant improvements in depression, negative automatic thoughts, self-esteem and behavioural activation recorded post-treatment. Similarly, they were physically fitter as assessed by a higher number of bench press repetitions post 12-week intervention and higher rates of ongoing exercise participation (see [Supplementary Table S2](#)). As illustrated in [Supplementary Table S3](#), the magnitude of the treatment effects observed here are consistent with previous pilot work (Nasstasia et al., 2017) and with the corresponding results from a detailed examination of change in depressive symptoms profiles (cognitive, affective, somatic) and associated cognitive and behavioural factors (Nasstasia et al., 2019).

Although these findings are inconsistent with predictions from the stage of change model, youth with MDD are potentially more impacted by their symptoms than those with less severe depressive symptoms and are therefore less ambivalent concerning behaviour change. At baseline, participants met current diagnostic criteria for MDD and most reported severe depressive symptoms. Although many also noted participation in some type of concurrent treatment, it is possible that participants may have been actively seeking a treatment alternative, in part driven by symptom severity, perceived medication side effects and/or therapy mismatch.

Participation in supervised exercise sessions was positively related to post MI exercise self-efficacy at trend levels, supporting our last hypothesis. This is consistent with research highlighting the importance of exercise self-efficacy for behaviour change (Brown et al., 2014). Confidence or self-efficacy appears to be positively related to exercise adherence, while self-efficacy is well established as a predictor of successful initiation and maintenance of regular exercise. In some cases, efficacy beliefs are better predictors of future behaviour (Kangas et al., 2015; Lee et al., 2008). This underscores the importance of assessing exercise self-efficacy early when working with youth experiencing MDD and employing other interventions to promote higher rates of exercise participation (Hardcastle & Hagger, 2011; Lee et al., 2008; Lutz et al., 2010).

4.2. Limitations

Although the individual studies were powered to detect larger treatment effects, and we pooled participants to facilitate comparisons with a control group, the current sample size may have been too small to detect differences among stage of change categories post 12 week-treatment. Secondly, as a prelude to other treatment, MI can provide a synergistic component that itself increases the likelihood of post-

treatment clinically significant improvements (Hettema et al., 2005). For more definitive evidence, a third exercise-only study group (who do not receive the MI intervention) is required. Such studies could also provide enhanced opportunities for a formal examination of mediation effects, to elucidate the mechanisms by which interventions such as MI impact on program engagement and subsequent changes in depression. Thirdly, although the manualised MI approach was designed to support trainers, trainers who were less skilled may have over relied on the protocol inadvertently leading to reduced intervention tailoring and MI spirit, potentially contributing to greater variability. Although our results are promising, and suggest personal trainers can deliver an MI intervention, future studies are required to elucidate how much training and supervision they require, how long before skills are developed and how well these skills are retained.

Although carefully monitored, participants who were already engaging in modest levels of exercise and/or concurrent treatment were not excluded from the studies. While reflective of 'real-world' clinical practice, and a positive design feature particularly within the youth psychotherapy literature (Merrill et al., 2017), we cannot rule out potential interaction effects of concurrent treatments on study outcomes. However, the treatment and control groups were just as likely to report participating in concurrent treatments at baseline and both reported depressive symptoms in the severe range. Moreover, improvements in depression post-treatment were only observed in the active treatment group, suggesting that exercise is a useful adjunctive treatment and may even benefit individuals who have responded poorly to medications (Trivedi, Greer, Grannemann, Chambless, & Jordan, 2006). Further research is also warranted which differentiates treatment responders versus non-responders to antidepressant medication to better delineate the respective roles of the different treatment components.

5. Conclusions

MI integrated with an exercise intervention shows promise as an innovative and effective treatment for Major Depressive Disorder among youth, addressing the problem of participant engagement and retention in exercise programs. MI may also help enhance exercise self-efficacy irrespective of initial stage of change. These findings are promising and support continued development of MI as a prelude intervention among youth with MDD enrolled in exercise programs. Moreover, these findings were generally applicable to PT delivered MI intervention, although PTs may have benefited from additional training. In conclusion, the findings suggest that there are a number of factors which warrant consideration by health professionals when determining who will drop out of exercise treatment, as well as adding to our understanding of factors that enhance exercise participation. Excluding potential participants from treatment programs based on low exercise readiness is not justified. Although initial stage of change does not determine treatment responsiveness, participants in the pre/contemplation group are more likely to drop out of active treatment and may require additional encouragement, monitoring and support, including the potential provision of booster MI sessions. Exercise self-efficacy plays an important role in promoting increased exercise participation. Consequently, assessing and augmenting self-efficacy prior to the commencement of the intervention, irrespective of initial efficacy scores may help promote increased participation. Our research suggests MI interventions can help support participant engagement, increase readiness to exercise, and enhance exercise self-efficacy across all stages of change. Finally, our findings suggest that there may be benefits to integrating psychological and physiological approaches and techniques, which together can help improve treatment engagement and participation outcomes among youth with MDD.

Declaration of interest

None.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.mhpa.2019.100295>.

Authors contributions

YN drafted the manuscript and contributed to project design, data collection, management, analysis and interpretation; RC, BK, AB and LH obtained funding to support the project and contributed to project design, data collection and management and manuscript revision. LH and SH contributed to project design, data collection, management and manuscript revision. TL contributed to data management, statistical analysis and interpretation and manuscript revision. All authors have read and approved the manuscript.

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