

Abstract

Background

The prevalence and burden of disease of depression and anxiety disorders in young people necessitates effective early intervention strategies. The aim of this study was to evaluate the effectiveness of low-intensity interventions (problem solving therapy (PST) and physical activity promotion) in young people (15-25 years) with mild-moderate depression and/or anxiety.

Method

A 2 x 2 factorial randomised controlled trial (RCT) with factors of PST *versus* supportive counselling (control) and behavioural activation physical activity *versus* lifestyle psychoeducation (control). Help-seeking participants (n=176) were randomised to receive up to 6 manualised intervention sessions. Primary outcomes were post-intervention depressive symptoms (Beck Depression Inventory-II (BDI-II)), anxiety symptoms (Beck Anxiety Inventory), and Montgomery-Åsberg Depression Rating Scale (MADRS)). Trial registration ACTRN12608000550303.

Results

Depression symptoms were significantly reduced in the physical activity group compared to psychoeducation (BDI-II: $d=0.41$ (95% CI: 0.07-0.76); MADRS: $d=0.48$ (95% CI: 0.13-0.82), but not post-intervention anxiety symptoms. PST was not superior to supportive counselling, nor were any interactions between interventions significant.

Limitations

As self-reported levels of physical activity did not significantly differ between baseline and end-point in those randomised to the physical activity intervention, it is unclear as to whether physical activity led to the difference in depression symptoms.

Conclusions

PST was not superior to supportive counselling in reducing depression and anxiety symptoms in young people. Participants who received the physical activity intervention reported the greatest reduction in depression symptoms, however further research is required to establish the mechanism of action and to determine its effectiveness as an adjunct intervention in routine clinical practice.

Conflict of interest

None. Funding detailed in Acknowledgements.

Key words

Physical activity, problem solving therapy, young people, depression, anxiety, early intervention

The high prevalence and significant burden of disease associated with common mental health problems such as depression and anxiety in young people (Australian Bureau of Statistics, 2010; Gore et al., 2011) has ongoing adverse consequences such as poor social and vocational functioning (Brent and Birmaher, 2002; Judd et al., 1996; McGorry et al., 2007) and increased risks of self-harm and suicide-related behaviours (Hetrick et al., 2012). These outcomes do not solely occur in people with full-threshold or severe forms of disorder; considerable impairment in functioning is associated with what are often referred to as 'sub-threshold' mental health problems, which are equally, if not more, prevalent than the diagnosable disorders (Judd et al., 1997; Judd et al., 1996; Rivas-Vazquez et al., 2004). Effective interventions provided in the early stages of illness, including sub-threshold presentations and the first or early episodes of full threshold depression or anxiety, have the potential to rapidly improve the mental health and functioning of young people and prevent the negative impacts of persistent depression on interpersonal, education, employment and health outcomes (Hetrick et al., 2008).

Low-cost, low-intensity psychological interventions that focus on skill-building and increasing opportunities for positive reinforcement may be effective and acceptable alternatives for young people in comparison to more complex interventions such as cognitive behavioural therapy (Hetrick et al., 2015), and may promote intervention engagement (Rickwood et al., 2014; Rickwood et al., 2007; Tylee et al., 2007). While there is emerging evidence to suggest that problem solving therapy (Eskin et al., 2008; Lerner and Clum, 1990) and increased physical activity (Brown et al., 2013;

Ekeland et al., 2004; Larun et al., 2006) may have benefits in reducing symptoms of mental distress, particularly depression, in younger populations, directly comparable evaluations in clinical samples are lacking. As the systematic reviews of physical activity interventions have included studies that were highly heterogeneous or recruited predominantly healthy individuals, evidence of the effect of physical activity for the treatment of depression in children and adolescents is limited. A notable exception is a recent study of preferred intensity circuit training added to treatment as usual in a clinical sample of adolescents with depression, finding improved depression outcomes in the intervention group at the 6-month follow-up assessment (Carter et al., 2015; Carter et al., 2016).

We conducted a fully crossed factorial randomised controlled trial of PST and behavioural activation of physical activity, each compared against appropriate control conditions of supportive counselling and lifestyle psychoeducation. This trial examined the effectiveness of these interventions separately, and in combination in reducing depression and anxiety symptoms in help-seeking young people (aged 15-25 years) attending youth mental health services.

Method

Study design

In a 2 x 2 single-blind factorial RCT comparing the two active interventions to their matched control conditions, participants were randomised to one of four intervention combinations: (i) behavioural activation physical activity ('physical activity') and problem solving therapy (PST); (ii) physical activity and supportive

counselling; (iii) psychoeducation and PST; and (iv) psychoeducation and supportive counselling (e.g., see (Montgomery et al., 2003) for a description of the design). All interventions were manualised. The trial was registered with the Australian New Zealand Clinical Trials Registry (ACTRN12608000550303). The study was research was conducted in accordance with the Declaration of Helsinki (1989) and was approved by Melbourne Health Human Research Ethics Committee (HREC 2008.205). Full details of the study method are described in the trial protocol (Parker et al., 2011). Outcomes at 6 weeks (post-intervention) are reported here.

Setting

The trial was based in two *headspace* centres located in the western and northern suburbs of Melbourne, Australia. *headspace* centres are Australian government funded, youth mental health services that provide assessment and psychological and psychiatric interventions to people aged 12-25 years. These services are delivered in a “one-stop shop”, youth-friendly service environment staffed by general practitioners, psychologists, psychiatrists and other allied health professionals (occupational therapists, social workers, and mental health nurses). The centres also provide primary health care, vocational and educational assistance and specialist substance use services (Rickwood et al., 2014). The two *headspace* centres that were the recruitment sites for this study are managed by Orygen, The National Centre of Excellence in Youth Mental Health.

Participants

Reflecting the inclusion criteria, participants were aged 15-25 years and had

experienced elevated symptom levels as assessed by the K10 with scores of 20 or greater (“likely to have a mild mental disorder”(Andrews and Slade, 2001)) for more than one week; *or* a decline in functioning over the past month (20% drop in Social and Occupational Functioning Scale score (Goldman et al., 1992)); *and* no prior formal intervention (e.g., psychological intervention provided by a registered psychologist or pharmacological intervention greater than 4 weeks). Those with psychotic symptoms, a specific suicidal plan or intent; already exercising according to Australian government guidelines (i.e., for those under 18 years, 60 minutes of moderate to vigorous activity everyday; for those over 18, 30 minutes of moderate activity at least 4 times for week (Department of Health and Ageing, 2004, 2005)), evidence of an organic mental disorder or intellectual/learning disability were excluded from the study. As the trial was set in clinical services, participants were also excluded if the interventions in the trial were determined to be not suited to their clinical needs during routine clinical review meetings (e.g., presenting with eating disorder symptoms). All participants provided written informed consent.

Procedure

Participants were allocated to their intervention combination following their baseline assessment and prior to the first intervention session with one of the study’s psychologists. At the first intervention session, participants were provided with the intervention materials and resources relevant to their allocation. At each intervention session, participants were monitored using the depression, anxiety, suicidality, and psychosis items of the expanded Brief Psychiatric Rating Scale version 4 (Lukoff et al., 1986). Those reaching pre-defined threshold levels (see (Parker et al.,

2011)) were withdrawn from the study, as were those for whom antidepressant or anxiolytic medication became clinically warranted. At the end of the 6 sessions (post intervention), participants who had not responded or were in need of additional or ongoing intervention were referred to intervention as usual within the *headspace* centre, or to another appropriate service. The post-treatment outcome assessment was conducted, on average, within a two-week period of the final treatment session.

Interventions

Manualised interventions (Parker et al., 2008a; Parker et al., 2008b; Parker et al., 2008c) were delivered in 6 face-to-face sessions on a weekly basis by four research psychologists (BM, JS, AP, SH) with master or doctoral level qualifications. The duration was chosen based on the number of sessions in problem solving therapy trials for young people (see (Eskin et al., 2008)) and 6 sessions were within the available funding for psychological therapies (Medicare Benefits Schedule, Australia). The research psychologists were supervised on a fortnightly basis (AY, AP and additional clinical psychologists (see acknowledgements)). No concurrent therapy, either psychological or pharmacological, was permitted during the course of the interventions.

Physical activity intervention arm

Behavioural activation. This intervention was based on behavioural activation principles (e.g., see Veale, 2008) including creating opportunities for the participant to engage in physical activity and monitoring the connection between their mood, anxiety and activity levels. Participants were provided with psychoeducation on the

relationship between exercise and mood/anxiety symptoms, government guidelines for physical activity (Department of Health and Ageing, 2004, 2005), a costs and benefits worksheet about engaging in physical activity, physical activity diaries and pedometers for motivational purposes. The type of physical activity was not prescribed; rather physical activities were tailored and chosen based on the individual participant's interests, prior activities that were enjoyable or offered a sense of achievement, current activity or perceived fitness levels, resources and social supports. The intervention included weekly goal setting, focusing on incremental changes and including incidental activities, and was designed to induce a sense of mastery or achievement in order for participants' to increase positive interactions with their environment and increase opportunities for positive reinforcement (Veale, 2008).

Lifestyle psychoeducation. This intervention provided the same psychoeducation and resources as the behavioural activation intervention, as well as weekly resources focusing on sleep, substance use, and other lifestyle information. This was designed to match weekly session time spent on the intervention in the active group. The resources were discussed in terms of general utility of the content of each, but the therapists did not specifically engage with participants on how to act on the information provided. The importance of physical activity was addressed in the first session but was not included in ongoing intervention.

Psychological intervention arm

Problem solving therapy. The intervention progressively worked through the seven

steps of PST, namely: (1) identifying the young person's problem/s; (2) selecting one or two key problems; (3) identifying and operationalising goals; (4) brainstorming and generating solutions; (5) exploring the risks and benefits of solutions and choosing a solution; (6) creating a SMART (specific, measurable, achievable, relevant, time-limited) plan, and (7) reviewing progress/evaluating the plan (Mynors-Wallis, 2005). Materials included a decisional balance worksheet and SMART plan template.

Supportive counselling. The intervention was based on general counselling principles (Geldard and Geldard, 2004) and was informed by the NICE guidelines for young people with mild to moderate depression (National Institute for Health and Clinical Excellence (NICE), 2005). The main goals of the intervention were to engage and build rapport so that the young person felt as though their concerns had been heard, that someone appreciated their experience and to work together on addressing current difficulties.

Outcomes

The primary outcomes were depression and anxiety symptom severity at post-intervention, assessed with the self-report measure of the Beck Depression Inventory-II (BDI-II (Beck et al., 1996)), the observer-rated measure of the Montgomery-Åsberg Depression Rating Scale (MADRS (Montgomery and Asberg, 1979)), and the self-report measure of the Beck Anxiety Inventory (BAI (Beck and Steer, 1990)). The test-retest reliability of the self-report measures are medium to high (BDI-II $>.90$; BAI $=.75$), with good to very good internal consistency (Cronbach's α : BDI-II $=.06$; BAI $=.60$) (Beck and Steer, 1990; Beck et al., 1996). The MADRS has high

inter-rater reliability at the end of treatment (ICC=0.82) and very good internal consistency (Cronbach's $\alpha = .86$) (Brooks and Kutcher, 2003). Higher scores on these measures indicate greater symptom severity. For the BDI-II, scores range from 0 to 63 and cut-points of 14, 20 and 29 represent mild, moderate and severe levels of depression (Beck et al., 1996). For the MADRS, scores range from 0 to 60 and cut-points of 7, 20 and 35 represent mild, moderate and severe levels of depression (Montgomery and Asberg, 1979). For the BAI, scores range from 0 to 63 and cut-points of 8, 16 and 26 represent mild, moderate and severe levels of anxiety (Beck and Steer, 1990).

Secondary outcomes were: clinical caseness, measured using the clinical range on scale scores of BDI-II>14, MADRS>7 and BAI>8; substance use, measured using the Substance and Choices Scale (Christie et al., 2007); functioning, measured using the Social and Occupational Functional Scale (Goldman et al., 1992); physical activity frequency and duration, based on the Active Australia Survey (Australian Institute of Health and Welfare, 2003), which adapted Items 4 and 5 from the International Physical Activity Survey (IPAQ) (Booth, 2000); and the type and frequency of interventions (psychological, pharmacological, or complementary) received by the young person between the post-treatment and follow-up assessments, measured by a questionnaire.

Sample size

Assuming a correlation of 0.7 between baseline and post-intervention observations, and allowing for 30% attrition, a sample size of 160 (40 participants in each cell) was

determined sufficient to maintain power above 80% to detect effects of 0.5 standard deviation change between active and comparison interventions. Beyond the detection of substantial non-additivity of effects of the interventions, it was recognised that power to differentiate the effectiveness of specific combinations of interventions would not be high.

Statistical analyses

Primary analyses were conducted on an intention-to-treat basis, including all participants randomised regardless of intervention actually received or withdrawal from the study. Continuous primary and secondary outcomes were analysed using linear mixed models repeated measures analysis of variance. An unstructured covariance matrix accounted for within-participant effects. Completely crossed Time by Psychological intervention by Physical activity intervention effects were fitted to the data with hypotheses about the effectiveness of each type of intervention being tested as planned contrasts comparing change from baseline to post-intervention in those who received the active intervention and those who received the comparator intervention. Residuals were examined for deviations from normality and, where necessary, robustness of conclusions to deviations from normality were established by repeating analyses using power transformed scores (Box and Cox, 1964). For analyses of binary, ordinal and categorical outcomes, non-linear mixed models were used incorporating participant-specific random intercepts and an appropriate link function and distribution family (Rabe-Hesketh and Skrondal, 2012). Analyses were undertaken using SPSS v21 and Stata v12.

Randomisation and intervention allocation

A stratified randomisation schedule was devised by an independent statistician (AM) to incorporate strata of sex and symptom severity at baseline (2 level factor: BDI-II cut-off points; ≤ 28 mild/ moderate or ≥ 29 severe). Allocation to intervention was concealed from the outcome assessors and those providing the interventions and carried out by research colleagues who were not involved in the study, in accordance with ICH Guideline E9 (International Conference on Harmonisation, 1999). The research psychologists were contacted after the baseline assessment and prior to the first intervention session, to inform them of each participant's intervention allocation.

Blinding

It was not possible to blind the research psychologists and participants to the intervention allocation due to the nature of the interventions. However, all assessments were conducted by research assistants blind to participant allocation.

Research assessments

Assessments were conducted independently by three psychology graduate research assistants (FS, SB, AS), trained by the principal investigator (AP) and supervised by the senior investigator (RP). To check the success of blinding the outcome assessors, research assistants were asked to guess a random selection of participants' intervention allocations at the end of the study. Overall, the accuracy rate did not differ from chance (psychological intervention, 41%; $\chi^2_1=.161$, $p=.688$; physical

activity intervention, 49%; $\chi^2_1=.010$, $p=.921$), therefore the blinding appeared to be successful. Inter-rater reliability of the observer-rated primary outcome measure of the MADRS was moderate, using Cohen's kappa ($k=0.41$, $p<.001$), indicating acceptable agreement between the blind outcome assessors (Landis and Koch, 1977).

Results

Demographic characteristics and drop out

Of the 176 consenting participants who were randomised in the study, 106 (60.2%) completed all 6 intervention sessions, 17 (9.7%) completed fewer than 6 sessions due to symptom improvement, 16 (9.1%) did not commence the intervention, 2 (1.1%) met exclusion criteria that were not detected at baseline (IQ<70 and prior intervention) and were excluded from the analyses, 7 (4.0%) were withdrawn due to clinical reasons, and 28 (15.9%) dropped out of the trial (see CONSORT diagram Figure 1 for the flow of participants through the trial).

As shown in Table 1, the groups, as randomised, were highly comparable with respect to sociodemographic and symptom variables as well as number and type of diagnoses, apart from relationship status at baseline. Participants in the psychoeducation condition were significantly more likely to report being in a relationship. Participants ranged in age from 15 to 25, with a mean age of 17.6 years ($SD=2.4$) and 61% were female. Recruitment into the study was not dependent on reaching threshold for a DSM-IV diagnosis, however, 71% of participants recorded an average of 1.16 ($SD=1.09$) diagnoses at baseline, with Major Depressive Disorder as

the most common diagnosis (30%, n=52). Of the 29% of participants without a DSM-IV diagnosis, sub-threshold depression was most commonly reported (24%, n=42), followed by sub-threshold anxiety (3.4%, n=6) and sub-threshold eating disorders (0.6%, n=1).

----- Insert Figure 1 here -----

Seventy-five percent of participants (n=130) completed the primary outcome post-intervention assessment. There were no significant differences at baseline on the primary outcomes between the participants who completed the post-intervention assessment and those who did not (BDI-II: $t(171)=1.31$, $p=.19$; MADRS: $t(172)=1.26$, $p=.21$; BAI: $t(171)=1.38$, $p=.17$).

----- Insert Table 1 here -----

Implementation and uptake of the interventions

Four research therapists delivered the interventions, with allocation to each therapist based on workload and availability. A mean of 4.3 sessions (SD=2.2) were completed overall, with no significant difference between intervention groups. Over 60% of participants received at least 3 sessions. Between 5.8% and 10.2% of participants failed to attend any of their intervention sessions (see Table 2).

----- Insert Table 2 here ----

Primary outcomes: depression and anxiety symptoms

For the physical activity comparison (behavioural activation *versus* psychoeducation), the overall interaction of time and intervention arm was significant for the BDI-II, $F(2,122)=6.37$, $p=.002$. Planned contrasts showed that the physical activity group improved significantly more than the psychoeducation group from baseline, $t(136.6)=2.30$, $p=.023$ (see Figure 2). The mean difference in improvement on the BDI-II was 3.76 (95% CI: 0.53 to 6.99). The effect size post intervention was $d=0.41$ (95% CI: 0.07 – 0.76). Although the overall time-by-group interaction for the MADRS was not statistically significant, $F(2, 128)=2.30$, $p=.104$, post intervention there was a significant difference between groups in improvement from baseline, $t(143,2)=2.12$, $p=.036$. The physical activity group showed a mean improvement of 3.17 points (95% CI: 0.22 to 6.12) more than the psychoeducation group on the MADRS, $d=0.48$ (95% CI: 0.13 – 0.82). The overall time-by-intervention-arm interaction was not significant for the BAI, $F(2,119)=0.88$, $p=.417$, and there were no significant differences between groups on the change from baseline, $t(139.4)=0.55$, $p=.584$. Table 3 shows the means and standard errors of the primary outcomes at baseline and post-intervention for each comparison (see Montgomery et al., 2003).

No effects for the comparison between PST and supportive counselling were significant or near significant at any time for any of the primary outcomes (see Table 3). Consequently, comparisons between these conditions on other variables are not reported here.

---- Insert Figure 2 here ----

----- Insert Table 3 here -----

Secondary outcomes

Overall, depression scores on the MADRS and BDI-II reduced over the course of the trial (MADRS: $F(2,125.4)=79.52$, $p<.001$; BDI-II: $F(2,122)=97.22$, $p<.001$). A similar reduction was observed with anxiety scores on the BAI ($F(2,121)=109.43$, $p<.001$).

Clinical caseness

At baseline, 160 (92%) of 174 participants met caseness criteria on the MADRS (≥ 7). For cases available post-intervention, likelihood of remission was significantly higher for those receiving the physical activity intervention (in combination with either PST or supportive counselling) (56%), compared with those receiving the psychoeducation intervention (40%), relative risk (RR) = 1.67 (95% CI: 1.10 to 2.55). The number needed to treat (NNT) was 4.46 (95% CI: 2.52 to 19.41). Comparable results were found for the BDI-II self-report measure. At baseline, 140 (80.9%) of 173 participants met caseness criteria on the BDI-II (≥ 14). For those in this group available post-intervention, likelihood of remission was significantly higher for those receiving the physical activity intervention (63%), compared with those receiving the psychoeducation intervention (41%), relative risk (RR) = 1.55 (95% CI: 1.05 to 2.29). The number needed to treat (NNT) was 4.48 (95% CI: 2.44 to 26.77).

Substance use and functioning

There were no significant interactions of time and intervention arm for alcohol use, tobacco use or the overall Difficulties score of the Substance and Choices Scale (Christie et al., 2007). The interaction of intervention arm with time was significant for cannabis use, with those who received the two comparator interventions (supportive counselling and psychoeducation) increasing consumption over time compared to all other conditions ($z=2.52$, $p=0.012$). However, reported rates of all current substance use, including cannabis, were low at baseline and post-intervention, corresponding to very small numbers (range 1 to 9) of young people using cannabis. Therefore, although the difference in cannabis use was statistically significant, the change is small and unlikely to be clinically significant. Similarly, there were no significant interactions of time and intervention arm for social and occupational functioning, as measured by the SOFAS (Goldman et al., 1992) ($F(1,132.5)=3.12$, $p=.080$ and $F(1,132.5)=0.80$, $p=.374$ for physical activity and PST respectively).

Reported engagement in physical activity

Self-reported rates of physical activity were measured by the Active Australia Survey (Australian Institute of Health and Welfare, 2003) and calculated as the number of days spent engaged in levels of activity that met the guideline recommendations for intensity and duration (i.e., 60 minutes of moderate to vigorous activity for <18 years; 30 minutes of moderate activity, for >18 years). The mean number of days participants met guideline levels of intensity and duration rose from .73 (SD=1.21) at baseline to 1.47 (SD=1.81) post-intervention. However, there was no significant difference between groups on the change from baseline ($z= -0.90$, $p=0.367$ and $z= -$

1.31, $p=0.190$ for the physical activity and psychological intervention arms, respectively). Other indices of activity and sedentariness were explored, including calculating Metabolic Equivalent of Task (MET) minutes (Ainsworth et al., 2000) and time spent engaged in computer-based activities, none of which showed any significant difference in change between conditions.

Discussion

Main findings

This RCT demonstrated that a physical activity intervention using a behavioural activation approach significantly reduced symptoms of depression in young people at post-intervention (six weeks), compared to a lifestyle psychoeducation intervention. There was a medium effect size for both self-report and clinician-rated variables. At post-intervention, the physical activity intervention group was in the 'minimal depression' range whilst the psychoeducation group was in the 'mild' range on the BDI-II, representing a clinically meaningful reduction. This is further highlighted by the significantly greater number of young people in the physical activity intervention who experienced changes in scores that reflected remission of clinical levels of symptomatology by the end of the intervention compared with those in the psychoeducation group. The results showed that those in the physical activity group reported the greatest improvement regardless of the type of psychological intervention received (either PST or supportive counselling). However, there were no differences in anxiety symptoms post-intervention between the intervention arms.

The effect size of the physical activity intervention, on the background of a psychological intervention, on the BDI-II ($d=0.41$) was of a similar magnitude to that found in trials of psychological interventions for adolescents and young people with depression (e.g., $d=0.34$ (Weisz et al., 2006)). The intervention used a behavioural activation approach, which is a component of a more complex intervention, namely cognitive behavioural therapy, which forms a core part of the standard training that a range of allied health professionals receive in Australia. As such, the overarching approach is likely to be familiar to these professionals and has the potential to be integrated into routine clinical care as an effective, low-cost, low-intensity adjunctive intervention for depression in young people with basic training to support the emphasis on physical activity.

Unlike the physical activity intervention, those receiving PST did not experience significantly greater reductions in depression or anxiety symptoms compared to those receiving a nondirective supportive counselling intervention. There was no evidence for synergistic effects in those who received both active interventions (PST and physical activity) compared to those who received both control interventions (supportive counselling and psychoeducation). Observed group differences were due to the effect of the physical activity intervention. These results are inconsistent with two smaller prior studies which found that depression outcomes were superior for PST compared to a wait-list control group (Eskin et al., 2008) and group-based PST compared to group-based supportive counselling for young people (Lerner and Clum, 1990) with elevated depression symptoms and suicidal ideation. Additionally, there were no group differences in anxiety outcomes, with all participants improving

across the course of the study regardless of intervention allocation. Whilst the current study found that PST and supportive counselling were equally beneficial in reducing depression and anxiety symptoms, the PST intervention is structured and easily manualised, and therefore has the advantage of ease of dissemination by a range of allied health professionals. The lack of group differences was unexpected and may be due to our pragmatic inclusion criteria that differed from prior studies that tested PST in predominantly depressed young people, in that we included participants with a broader range of presenting issues. By actively recruiting young people at earlier stages of mental ill-health, we may also have recruited a sample for whom the generic nature of a supportive counselling approach was a beneficial intervention.

Strengths and limitations

This is one of the largest and adequately powered trials, to examine the effectiveness of a physical activity intervention and problem solving therapy in young people, particularly including those aged 18-25 years, and one of the few studies using clinical samples to include young males (e.g., see (Carter et al., 2015)). The study was conducted in a manner that allowed reporting according to the CONSORT statement and the randomisation process and allocation concealment had a low risk of bias. However, given the nature of the interventions, neither the intervention providers nor the participants were blinded, which may impact on the primary outcomes that used self-report measures. The interventions were chosen as simple approaches to address the unique needs of young people with emerging or mild-to-moderate presentations of high prevalence mental disorders. Unlike many studies in

clinical settings, this study was based in youth mental health clinical services, highlighting the feasibility of delivering the interventions, which did not require access to specialised exercise equipment or off-site facilities, and included the use of appropriate control group interventions. The physical activity intervention in particular differed from prior studies in young people with prescribed, often group-based, physical activity programs (e.g., see Chu et al., 2009; McCann and Holmes, 1984; Nabkasorn et al., 2006) in that the focus was on developing individualised and tailored activity plans within face-to-face psychological treatment, focusing on incremental change and drawing on the young person's existing resources and supports, to increase the likelihood that any changes made could be maintained after the end of the intervention period. Although offering participants access to circuit training equipment, a recent study of depressed adolescents found that tailoring the intervention to the participants' preferred intensity of physical activity in addition to treatment as usual demonstrated greater reductions in depression scores when compared to treatment as usual (Carter et al., 2015). As this difference in depression outcomes was evident at the 6-month follow-up assessment rather than immediately post-treatment, the authors concluded that physical activity may provide a delayed treatment response, contrasting with our findings of short-term benefits despite a lack of self-reported changes in amounts of physical activity.

Study limitations include missing data for our primary outcomes, which ranged from 23.6% (MADRS) to 27.6% (BAI). However, our power calculation allowed for missing data rate of up to 30%, and there were no significant differences between those who did and did not complete post intervention assessments in terms of the primary

outcome measures. Failure to observe a significant effect of the physical activity intervention on the chosen indices of activity itself is a cause for some concern, although our study is not unique in this regard. For example, Strom and colleagues also recently reported that an online physical activity intervention in adults reduced depression without any differences in self-reported levels of physical activity (Strom et al., 2013). Self-report measures of physical activity are more susceptible to measurement error (Helmerhorst et al., 2012) compared to objective measures such as accelerometer data (Ekeland et al., 2005). The latter were not feasible in this study due to financial constraints and likely unacceptability. The measure used to assess physical activity allowed us to categorise activity levels by the number of days that met current physical activity guidelines. This categorisation may not have been sensitive to change, however, additional analyses exploring MET minutes and time spent engaged in sedentary activities also failed to show changes in engagement in activity. With 40% of participants not completing 6 sessions of treatment for a variety of reasons, including disengagement and symptom improvement, it is also possible that the 'dose' of the intervention received by participants was insufficient to lead to changes in levels of engagement in physical activity. Furthermore, since behavioural components have been found to be effective interventions for depression in young people (Hetrick et al., 2015), it is possible that the behavioural activation framework provided participants with opportunities for positive reinforcement and generally contributed to the improvement in depression symptoms, rather than changes in physical activity contributing to this outcome. We currently have two additional funded trials, one under way (ACTRN 12614000282684, see anzctr.org.au) and one in establishment, that will include

objective physical activity measures as well as a range of behavioural and social support measures, to examine the effective components of the intervention and the mechanisms of change.

Implications

Opportunities for future research fall into two broad areas: objective measures of physical activity and examining the essential components of the intervention. Research on objective measures could focus on developing a reliable and valid measure of physical activity for use in youth mental health and examining the feasibility of using objective measures of activity such as accelerometers, cardiovascular and strength assessments in youth mental health settings. Research examining the components of the intervention could attempt to measure the contribution of engagement in physical activity and general behavioural activation effects to intervention outcomes, and assess factors such as social support and self-efficacy to determine if these are mediating factors.

Our results demonstrated that depression and anxiety symptoms reduced in young people receiving all of the low-intensity interventions, however, the participants who received the physical activity intervention reported clinically significant improvement in depression outcomes. There is the potential to adapt the intervention for other service delivery models (e.g. primary care, tertiary mental health services) to enhance service provision by broadly disseminating a low-cost, low-intensity intervention for high prevalence disorders. With such low rates of engagement in physical activity, only 6% of the young people screened for inclusion were exercising

at guideline-recommended levels, there is a strong need for clinicians to include physical activity as part of a comprehensive biopsychosocial assessment and consider its inclusion in intervention plans. The findings suggest there may be a role for integrating brief, behavioural activation physical activity with intervention as usual to improve outcomes for depression in young people.

Contributors

AGP, SEH, AJF, AJM, ARY, PDMc and RP designed the study, developed the methodology, and wrote the manuscript. AJM and AGP conducted the analyses. FS, JS and SB collected the data and contributed to the manuscript. All authors have approved the final article.

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