Effects of Combining Physical Activity with Psychotherapy on Mental Health and Well-being: A Systematic Review

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Abstract

Objective: Despite a vast evidence-base advocating the psychological benefits of physical activity, relatively little is understood about how combining physical activity with psychological therapies may influence these positive effects. The aim of this paper is to systematically analyse evidence from studies adopting a combined approach, and identify potential mechanisms of action on clinical outcomes. **Methods:** The Embase, PsycINFO and Medline (PubMed and OVID) databases were searched for applicable trials published up to December 2018. Relevant data was extracted from eligible studies, and the Effective Public Health Practice Project (EPHPP) tool was utilised to objectively assess the quality of each study. **Results:** Twenty-two studies met the inclusion criteria, seven of which were rated as methodologically 'strong'. Combining physical activity with psychological therapy consistently engendered positive effects on outcomes compared with treatment as usual. Similar improvements in psychological outcomes were observed in most (7/8) groups receiving physical activity alone. Increased levels of physical activity were observed in psychologically-informed interventions, however this effect was unrelated to changes in psychological outcomes. **Limitations:** Clinical and methodological heterogeneity precluded meta-analyses of results, while risk of bias detected in the studies may compromise overall validity of the findings. **Conclusions:** Physical activity interventions may be a viable alternative to psychological therapies, provided psychological approaches are incorporated into the implementation design (i.e. behavioural activation). Improved psychological outcomes may be observed regardless of 'dose' received, however further research is required to ascertain whether psychosocial mechanisms of change mediate positive effects.

Keywords: physical activity; psychological therapy; behavioural activation; mental health; well-being

Introduction

The implementation of 'exercise as medicine' has been recommended as an effective treatment across a spectrum of psychiatric diseases (Pedersen & Saltin, 2015), and as an evidence-based alternative to current recommendations, may simultaneously address co-morbid physical conditions frequently associated with mental health issues (World Health Organisation, 2013). Indeed, evidence derived from previous reviews provides consistent support for physical activity (PA) interventions in reducing symptoms of depression (Cooney et al., 2013), anxiety (Stubbs et al., 2017), and post-traumatic stress disorder (PTSD) (Rosenbaum et al., 2015), when compared with non-active controls. Given the considerable heterogeneity between these reviews' populations, severity of disorder, and intervention 'dose' provided and received (frequency, intensity, time, type), the collective evidence strongly suggests that strategies to encourage PA could should be implemented for such individuals; particularly those who may be resistant to 'traditional' pharmacological or psychotherapeutic approaches.

When comparing the effects of PA with first-line treatments such as cognitive behavioural therapy (CBT), reviews have consistently reported similar reductions in symptoms of common mental health disorders (Bailey et al., 2018; Stonerock et al., 2015). Whilst this indicates that exercise may be equally effective as currently recommended psychological approaches, there is a lack of consensus on which 'mechanisms of action' underpin the psychological benefits observed (Michie et al., 2017). This has led to in increase in comprehensive reviews of the evidence-base pertaining to multifactorial pathways through which PA can effectuate change (e.g. Lubans et al., 2016; Teixeira et al., 2012); and justifies its consideration as a credible adjunct treatment for mental health disorders. Given that the effects of PA may be mediated by numerous biopsychosocial factors (Pedersen & Saltin,

2015), it can be argued that the benefits attained may extend beyond those reported by studies assessing psychological symptoms.

The concept that PA may offer additive benefits to psychotherapeutic approaches, has led to a rise in research trials examining whether a *combined* approach may augment the effects compared with either component alone; yet the diversity between designs, methodologies, and sample characteristics hinders interpretation of contrasting results-particularly in identification of which mechanisms may mediate observed effects. Randomised control trials (RCT's) which have demonstrated efficacy of combined interventions over non-active controls (Euteneur et al., 2017; Gourgouvelis et al., 2018), have objectively attributed changes in neurobiological markers to improvements in self-reported depressive symptoms. While this insinuates that increased PA levels *directly* engender positive effects via biological pathways, further trials of combined interventions have speculated that significant effects may also be induced via behavioural or psychosocial processes, such as: greater perceptions of social support (Van der Waerden et al., 2013); increased sense of mastery and self-efficacy (Merom et al., 2008); or a general 'behavioural activation' effect derived from scheduling activities and positive reinforcement (Parker et al., 2016; Veale, 2008). It is plausible that all of these hypothesised mechanisms may contribute to combined intervention effects, however without further analysing the 'dose' of PA/psychotherapy received by relative comparator groups, it is not possible to accurately establish what works for whom, and under what conditions (Michie et al., 2017).

One recent review and meta-analysis evidenced partial support for combined approaches in improving various psychological outcomes, however limited its inclusion criteria to adults with chronic diseases (Bernard et al., 2018). Moreover, the complex interactions which exist between physical health, motivation for PA, and prevalence of mental illness (Everson-Hock et al., 2015; Machaczek et al. 2018), somewhat preclude

delineation of the 'moderators of efficacy' proposed within the review. Given that the diverse potential mechanisms of change (i.e. self-efficacy, self-esteem, behavioural activation, increased PA, sense of autonomy, social connections) are commonly underpinned by concepts related to motivation, utilisation of existing research and theory may prove useful when drawing conclusions as to how these may relate to subsequent well-being outcomes (Cooney et al., 2013; Hagger & Chatzisarantis, 2014; Sancassiani et al., 2018).

The purpose of the present review is to expand on the results of previous research, through evaluating the efficacy of interventions which combine psychotherapy with PA, on improving participants' psychological symptoms (i.e. depression, anxiety), and—where reported—increasing overall levels of PA. Through including a broader range of populations (i.e. adolescents), and intervention component designs (i.e. PA as an adjunct to psychotherapy, or integrating psychotherapy into PA content and delivery), findings will be interpreted in respect to content and dose, to subsequently identify and explicate the potential mechanisms of action associated with each approach.

Methods

Inclusion and Exclusion Criteria

Based on relevant "PICO" elements (population, interventions, comparators, outcomes), a predetermined selection criteria was formulated to provide transparency and objectivity throughout the process (Centre for Reviews and Dissemination; CRD, 2009). To expand on previously published reviews and identify potential subgroup disparities, there were no restrictions on included populations- provided the sample used in the study was considered adolescent age or above (> 13 years). Any trials employing interventions which delivered psychological therapy in conjunction with physical activity were considered for inclusion in the final review, regardless of whether these were implemented as an alternative, or 'adjunct' to treatment as usual (TAU; i.e. providing PA to patients receiving CBT). Studies

comparing the effects of psychological therapy versus physical activity were excluded from the review, as were those which delivered components (PA and psychotherapy) as separate interventions, rather than simultaneously. Included studies required at least one between-groups comparator (i.e. PA alone, therapy alone, or TAU), and therefore those adopting a pre-post design were excluded from the review. Studies were considered for inclusion provided they utilised at least one psychometrically validated screening tool for mental health/well-being, either as a primary or secondary outcome measure.

Search Strategy

Following guidance specific to reviews of health interventions (CRD, 2009), a systematic search of the Medline (via OVID and PubMed), Embase and PsycINFO databases was conducted in November 2018. Key words and synonyms relating to the inclusion criteria (PICO) were identified to structure the search strategy (Supplemental Appendix 1). A manual citation scan of relevant papers was also conducted for completeness and breadth.

After removal of duplicates and limiting the search to articles published in English language, titles and abstracts were reviewed for eligibility, and consequently full texts were obtained for 113 studies. Individual scrutiny of each remaining paper ensured only those which adhered to the inclusion criteria were included in the final review. At each stage of the searching process, the reasons for exclusion of papers were categorised and recorded accordingly.

Data Extraction

A data extraction template was used to record key characteristics of the selected studies, including: Authors, date and location of the study; sample size and participant information; intervention details (frequency, intensity, time and type of each component); details of the comparator/control(s); outcomes measured with corresponding tools. Given the clinical diversity of the samples, a meta-analysis was deemed unsuitable (Higgins & Green,

2011), however findings in relation to outcomes of interest were extracted to identify any within group (pre-post test), or between-group (interaction) intervention effects.

Quality Assessment

The 'Effective Public Health Practice Project' (EPHPP, 2007) tool was used to assess the methodological integrity of each intervention, on the basis of six distinct components (selection bias; study design; confounders; blinding; data collection; withdrawals/dropouts). Informed by the tool's standardised dictionary, a rating for each component was derived from the information provided in each paper. Where information was not provided or unclear, protocols were checked for accuracy of the scoring. These ratings subsequently determined whether the quality of each study was considered to be strong (no weak ratings), moderate (one weak rating), or weak (> one weak rating) overall. All assessments and overall scoring were verified by a second reviewer (KT).

Results

Search Results

Database searches yielded 2153 citations in total, which reduced to 1144 following deduplication and application of limits. From reviewing the remaining titles and abstracts, a further 1031 papers were removed, as they failed to meet the full inclusion criteria. Of the 113 full texts screened, a total of 21 were eligible for inclusion in the review, which increased to 22 after identification of one further study through manual screening of relevant papers. A PRISMA flow diagram (Liberati et al., 2009) detailing the search process is presented in Figure 1.

Characteristics of Included Studies

A summary of each studies' sample, design, intervention, comparator(s) and outcomes can be found in Table 1. Sample sizes ranged from 19 - 779 participants, whose mean ages were between 14.7 - 79.3 years. Most of the studies included mixed sex samples, for which

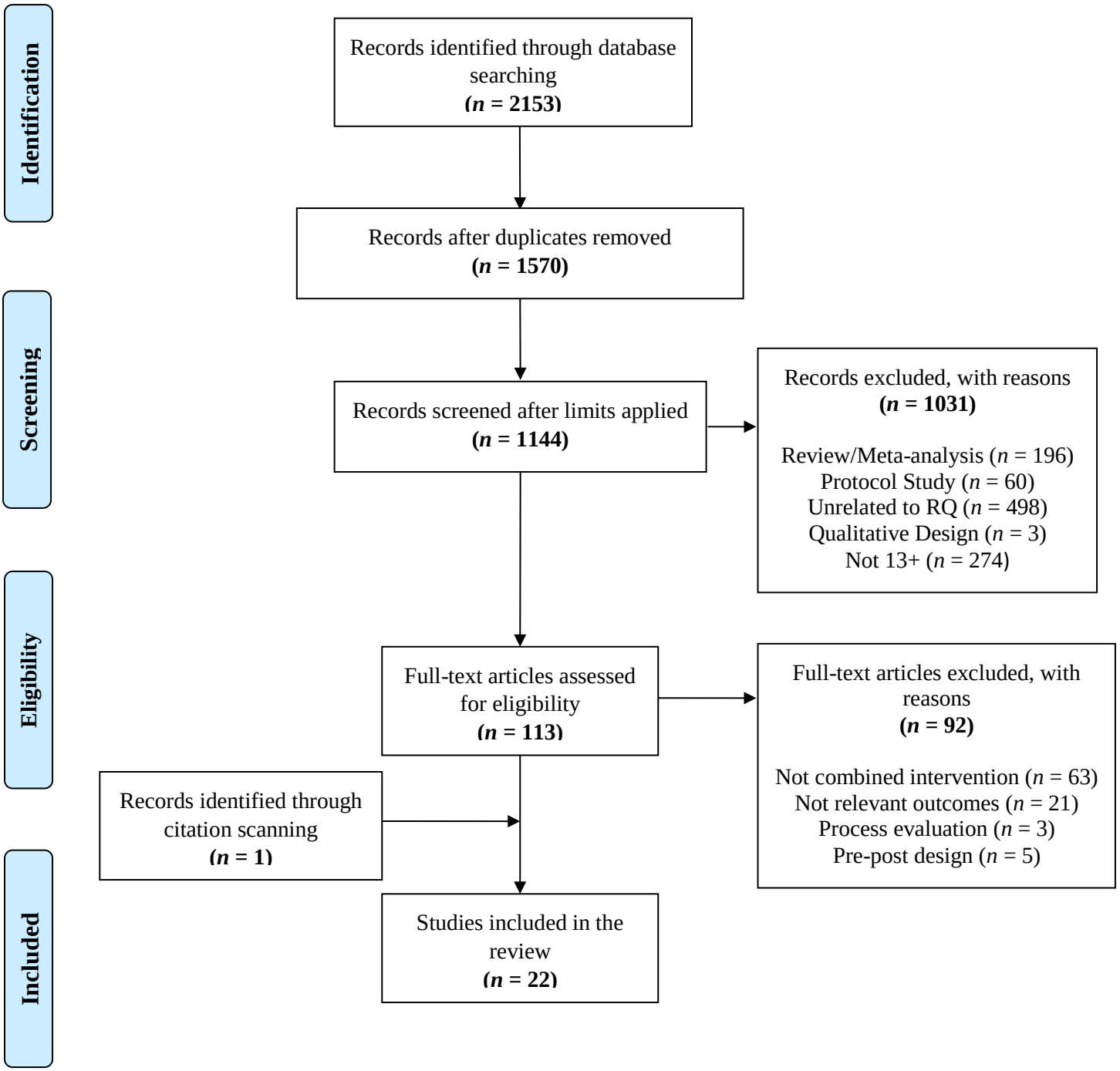

Figure 1. PRISMA flow diagram of study selection process. *Note:* RQ = Research Question.

the ratio female participants varied from 45.9 - 90%. Two studies were conducted with male participants only (Engberg et al., 2017; McGale et al., 2011); three recruited an exclusively female sample (Duijts et al., 2012; Lera et al., 2009; Van der Waerden et al., 2013).

Table 1
Characteristics of the Included Studies

Authors	Sample	Design	Intervention Details		Comparator(s)	Outcome Measures	Recommendations
			PA	PSYC			
Abdollahia et al., (2017) (Iran)	*n* = 54 54.3% female *M* age = 48.4 Moderate depression	RCT	F: 3 x p/w I: Moderate Ti: 40mins. T: Group aerobic **12 weeks**	F: 1 x p/w Ti: 90 mins. T: Group CBT **12 weeks**	1. Group CBT	Depression (BDI) Daily activity (BIADL)	- Control group (PA only) - Follow-up data - Social influence on outcomes
Brovold et al., (2012) (Norway)	*n* = 108 65.7% female *M* age = 79.3 Day hospital patients	RCT	F: 2 x p/w I: Moderate Ti: 45 mins. T: Balance exercises + prescribed resistance training **3 months**	F: 1 x p/w Ti: 30 mins. T: Group counselling on benefits of exercise **2-3 weeks**	1. Group counselling + balance exercises	- QOL (SF-36) - PA levels (SR)	- Control group - LT effects - Effect of varied resistance / intensity exercise
Duijts et al., (2012) (Holland)	*n* = 422 100% female Breast cancer patients	RCT	F: Self-directed I: 60-80% MHR Ti: 150-80 mpw T: Tailored PE programme **12 weeks**	F: 1 x p/w Ti: 90 mins. T: Group CBT **6 weeks**	1. Group CBT 2. PE programme 3. WL control	- Distress (HADS) - QOL (SF-36)	- Strategies to improve adherence
Engberg et al., (2017) (Finland)	*n* = 168 100% male *M* age = 40 CVD risk	RCT	F: 1 x p/w I: Moderate Ti: 60 mins. T: Group aerobic + resistance **3 months**	F: Once Ti: 90 mins. T: 1:1 'Health Counselling' **1 session**	1. 1:1 HC 2. WL control	- Self-rated Health - SWB (single item) - Depression (PHQ-2)	- HC addressing well-being - Other psychometric measures - Objective PA measures

Euteneur et al., (2017) (Germany)	*n* = 98 48% female *M* age = 37.3 Major depression	RCT	F: 4 x p/w I: Moderate Ti: 40 mins. T: Prescribed aerobic **16 weeks**	F: 1 x p/w Ti: 50 mins. T: 1:1 Behavioural Activation with exercise + CBT **16 weeks**	1. 1:1 Behaviour Activation without exercise + CBT 2. WL control	- Depression (BDI) - PA (IPAQ) - Inflammation (blood)	- Objective PA measures - Long-term follow-up
Fremont & Craighead (1987) (USA)	*n* = 49 73.4% female Age 19-62 Moderate depression	RCT	F: 3 x p/w I: Moderate Ti: 20 mins. T: Group running **10 weeks**	F: 1 x p/w Ti: 60 mins. T: 1:1 CBT **10 weeks**	1. 1:1 CBT 2. Group running	- Depression (BDI) - Anxiety (STAI) - Mood (POMS)	- Role of social support - Objective physiological measures
Gary et al., (2010) (USA)	*n* = 74 57.1% female *M* age = 65.8 Heart failure + depression	RCT	F: 3 x p/w I: Moderate Ti: <60 mins. T: Tailored walking prescription **12 weeks**	F: 1 x p/w Ti: 60 mins. T: 1:1 CBT **12 weeks**	1. 1:1 CBT 2. Prescribed walking program 3. TAU (Heart failure medication)	- Depression (HAM-D) - PA (6MWT) - HRQOL (MLHFQ)	- Control for/measure effect of social interaction - Objective PA measures (pedometer/accelerometer)
Gourgouvelis et al., (2018) (Canada)	*n* = 38 60.5% female *M* age = 30.1 Major depression	CT	F: 3 x p/w I: 60-80% MHR Ti: <60 mins. T: Prescribed aerobic + resistance **8 weeks**	'Cognitive behavioural group therapy' (details NR)	1. Cognitive behavioural group therapy	- Depression (BDI/ HADS) - Anxiety (HADS-A) - VO2 Max.	- Effect of baseline fitness - Larger sample
Jacobsen et al., (2013) (USA)	*n* = 286 67.8 % female *M* age = 57.8 Cancer patients	RCT	F: 3-5 x p/w I: 50-75% MHR Ti: 20-30 mins. T: Prescribed walking program	F: Once Ti: 15 mins. 1:1 + 20 min. video T: Self-directed	1. Stress Management 2. Prescribed walking program 3. TAU (Access to psychosocial services)	- QOL (SF-36) - Depression (CES-D) - Anxiety (BAI) - PA (LTEQ)	- Dose-response measures - Effect of different types of PA - Internet delivery/monitoring

			12 weeks	Stress Management' **12 weeks**			
Jacquart et al., (2014) (USA)	*n* = 78 61.5% female *M* age = 59.7 Major depression	RCT	F: Daily I: Moderate Ti: 30 mins. T: 1:1 walking **2 weeks**	F: Daily Ti: 30 mins. T: Integrated 1:1 'Validation therapy' **2 weeks**	1. Validation therapy 2. TAU (Medication and group therapy)	- Psychiatric + social functioning (BASIS-32) - Depression (GDS)	- LT follow-up - Effect of various therapeutic approaches - Ex only group
Kashikar-Zuck et al., (2018) (USA)	*n* = 40 90% female *M* age = 15.4 Fibromyalgia	RCT	F: 2 x p/w I: Moderate Ti: 45 mins. T: Group strength + resistance **8 weeks**	F: 2 x p/w Ti: 45 mins. T: Group CBT **8 weeks**	1. Group CBT	- Depression (CDI) - Pain (VAS)	- Group-based 'booster' sessions - Longer-term follow-up - Ex only arm
Lera et al., (2009) (Spain)	*n* = 83 100% female *M* age = 50.2 Fibromyalgia	RCT	F: 1 x p/w I: Moderate Ti: 40 mins. T: Group CV exercise + stretching **10 weeks**	F: 1 x p/w Ti: 90 mins. T: Group CBT **15 weeks**	1. Group CV exercise + stretching	- QOL (SF-36) - Mental health (SCL-90-R)	- STAI/BDI measures - Long-term FU - Include males
McBeth et al., (2012) (UK)	*n* = 442 65.5% female *M* age = 56.2 Chronic pain	RCT	F: 3-5 x p/w I: 40-85% MHR Ti: 20-60 mins. T: Tailored exercise program **6 months**	F: 1 x p/w Ti: 30-45 mins. T: Telephone CBT **8 weeks** (Extra session at 3 and 6 months)	1. Telephone CBT 2. Tailored exercise program 3. TAU (Usual care from physician)	- QOL (SF-36) - Psychological distress (GHQ)	- Longer-term FU

McGale et al., (2011) (Ireland)	*n* = 104 100% male *M* age = 28 Sedentary	RCT (pilot)	F: 2 x p/w I: Moderate Ti: 55 mins. T: Group football **10 weeks**	F: 2 x p/w Ti: 55 mins. T: Integrated group CBT **10 weeks**	1. Individual exercise 2. WL control	Depression (BDI) Social Support (SPS)	- CBT only comparator - LT follow-up (12months) - Cost effectiveness
Melnyk et al., (2009) (USA)	*n* = 19 72% female *M* age = 15.5 Hispanic	Cluster RCT (Pilot)	F: 2-3 x p/w I: NR Ti: 15-20 mins. T: Group activities **15 sessions**	F: 2-3 x p/w Ti: 30 mins. T: Group psychoeducation **15 sessions**	1. 'Attentional control' ('healthy teens' education)	- Dep/Anx (BYI)	- Strategies to encourage 'homework' - Long-term FU
Melnyk et al., (2013) (USA)	*n* = 779 51.6% female *M* age = 14.7 Students	Cluster RCT	F: 1 x p/w I: NR Ti: 15-20 mins. T: Group activities (i.e. dancing, kick-boxing) **15 weeks**	F: 1 x p/w Ti: 30 mins. T: Group psychoeducation + homework **15 weeks**	1. 'Attentional control' ('healthy teens' education)	- Dep/Anx (BYI) - Social Skills (SSRS) - Substances (YRBS) - PA (pedometer)	- Measure fidelity - Wider sample - Fidelity measures - Mediating variables (PA/CBT?)
Melnyk et al., (2015) (USA)	*n* = 625	Cluster RCT **(F/U)**	As above (F/U)	As above (F/U)	1. 'Attentional control' ('healthy teens' education)	- Depression (BYI)	- Monitoring of intervention fidelity and quality of delivery

Merom et al., (2008) (Australia)	*n* = 74 78.5% female *M* age = 39.1 GAD/PD/SP	Cluster RCT	F: 1 x p/w I: Moderate Ti: 30 mins. T: Prescribed self-directed walking (goal= <150 mpw) **8 weeks**	F: 1 x p/w Ti: 90 mins. T: Group CBT **8 weeks**	1. Group CBT + dietary advice	- Depression, Anxiety, Stress (DASS-21) - PA levels (SR)	- Longer program duration - Measures of mechanisms i.e. self-efficacy - Social exercise effects - Objective PA measures
Parker et al., (2016) (Australia)	*n* = 176 61% female *M* age = 17.6 Moderate depression/ anxiety	RCT	F: 1 x p/w I: Self-directed Ti: Self-directed T: 1:1 'Behavioural activation' **6 weeks**	F: 1 x p/w Ti: NR T: 1:1 'Problem solving therapy' **6 weeks**	1. Psychoeducation control 2. Supportive counselling control	- Depression (BDI/MADRS) - Anxiety (BAI) - PA levels (IPAQ)	- Objective PA measures - Measure mediators: self-efficacy/social support
Pentecost et al., (2015) (England)	*n* = 60 48.4% female M age = 44.4 Severe depression	RCT	F: 1 x p/w I: Self-directed Ti: Self-directed T: Behavioural activation for PA **13 weeks**	F: 1 x p/w Ti: 35 mins. T: Integrated 1:1 low-intensity CBT **12 weeks**	1. Behavioural activation (TAU)	- Depression (CIS-R/ PHQ-9) - QOL (SF-36) - PA levels (7-day recall/ accelerometer)	- Record fidelity to intervention - Establish methods to improve recruitment/retention - Report variance (between-group) differences in outcomes
Smeets et al., (2008) (Holland)	*n* = 172 45.9% female *M* age = 42 Back pain	Cluster RCT	F: 3 x p/w I: 60-80% MHR Ti: 105 mins. T: Group aerobic (30mins)+strength (75mins) training **10 weeks**	F: 1 x p/w Ti: 90 mins. T: Group 'Problem solving therapy' **10 weeks**	1. Group problem solving therapy 2. Group aerobic training 3. WL control	- Depression (BDI) - Pain (PRI-T) - PA tasks	- Sub-group analyses of different treatment effects - Identify mechanisms of change - Compare individually tailored treatment effects

Van der Waerden et al., (2013) (Holland)	*n* = 161 100% female *M* age = 43.9 Depression + Low SES	RCT	F: 1 x p/w I: Low-moderate Ti: 60 mins. T: Group strength + resistance, stretching and relaxation **8 weeks**	F: 1 x p/w Ti: 60 mins. T: Group psycho education on coping with depression **8 weeks**	1. Group stretching and relaxation 2. WL control	- Depression (CES-D) - Stress (PSS)	- Objective dose-response measures - Effect of social exercise - P only group - Longer duration **- Initial motivation strategies to increase adherence**

Notes: PA: Physical Activity; PSYC: Psychotherapy; RCT: Randomised Controlled Trial; CT: Controlled Trial; *n:* Sample size; *M*: Mean; F: Frequency; I: Intensity; Ti: Time; T: Type; p/w: per week; mpw: Minutes per week; mins.: Minutes; MHR: Maximum heart rate; TAU: Treatment as usual; WL: Wait-list; NR: Not reported; CBT: Cognitive-behavioural therapy; SES: Socioeconomic status; F/U: Follow-up

BDI: Beck Depression Inventory; SF-36: Short Form Health Survey (PCS: Physical Component Summary; MCS: Mental Component Summary; FS: Functional Status; EW: Emotional Well-being) HADS: Hospital Anxiety and Depression Scale; PHQ-2: Patient Health Questionnaire-2; HAM-D: Hamilton Rating Scale for Depression; CES-D: Centre for Epidemiological Studies for Depression Scale; BAI: Beck Anxiety Inventory; GDS: Geriatric Depression Scale; BASIS-32: Behavioural and Symptom Identification Scale; CDI: Children's Depression Inventory; SCL-90-R: Symptom Checklist-90-Revised; BYI: Beck Youth Inventory; DASS-21: Depression Anxiety and Stress Scale; MADRS: Montgommery-Asberg Depression Rating Scale; STAI: State Trait Anxiety Inventory; SRC: Stress Reduction Checklist; PRI: Pain Rating Index; PSS: Perceived Stress Scale; MLHFQ: Minnesota Living with Heart Failure Questionnaire; GHQ: General Health Questionnaire; BIADL: Barthel Index of Activities of Daily Living; 6MWT: 6-minute walk test; IPAQ: International Physical Activity Questionnaire; rec.HR: Recovery Heart Rate; VO2max: Maximal oxygen consumption test; LTEQ: Godin Leisure-Time Exercise Questionnaire; 5MWT: 5-minute walk test; SR: Self-reported

Participants with diagnosed depression were purposively recruited in nine of the studies, from settings including: outpatient clinics (Abdollahia et al., 2017; Euteneur et al., 2017; Gary et al., 2010; Gourgouvelis et al., 2018; Pentecost et al., 2015); inpatient psychiatric units (Jacquart et al., 2014); youth mental health centres (Parker et al., 2016); GP referral (Van der Waerden et al., 2013); or self-referral following public service announcements (Fremont & Craighead, 1987). In two of the trials, non-clinical samples were recruited via: inviting identified men with increased CVD risk (Engberg et al., 2017); or locally advertising for sedentary males (McGale et al., 2011). The three studies by Melnyk and colleagues (2009; 2013; 2015) were all based in a high school setting, and included any pupils enrolled in the schools' health education courses. One study included adults who had presented at a geriatric day hospital with various admission diagnoses (Brovold et al., 2012), while all other samples were recruited from selected outpatient clinics for: generalised anxiety and panic disorder (Merom et al., 2008); fibromyalgia (Kashikar-Zuck et al., 2018; Lera et al., 2009); cancer (Duijts et al., 2012; Jacobsen et al., 2013); pain (McBeth et al., 2012; Smeets et al., 2008); and heart failure (Gary et al., 2010).

Five of the studies were cluster RCT's- two of which had randomised groups at school-level (Melnyk et al., 2013; 2015), one at class-level (Melnyk et al., 2009), one based on patient diagnosis (Merom et al., 2008), and one in groups of four patients (Smeets et al., 2008). One controlled trial adopted a parallel group design, however failed to describe the method of group allocation (Gourgouvelis et al., 2018). The remaining 16 studies all randomised participants at the individual level. In addition to the intervention arms, comparator groups included PA alone in three studies (Lera et al., 2009; McGale et al., 2011; Van der Wearden et al., 2013), psychological therapy alone in thirteen studies (Abdollahia et al., 2017; Brovold et al., 2012; Engberg et al., 2017; Euteneur et al., 2017; Gourgouvelis et al., 2018; Jacquart et al., 2014; Kashikar-Zuck et al., 2018; Melnyk et al., 2009; Melnyk et al., 2013; Melnyk et al., 2015; Merom et al., 2008; Parker et al., 2016; Pentecost et al., 2015),

and both PA and psychological intervention arms in six of the studies (Duijts et al., 2012; Gary et al., 2010; Fremont & Craighead, 1987; Jacobsen et al., 2013; McBeth et al., 2012; Smeets et al., 2008). Nine studies also included a TAU/wait list control group.

Intervention Content

There was considerable heterogeneity between the 'dose' of PA and therapy provided (length, frequency and total duration) across the studies' intervention designs, as well as extensive variation across the type, content and mode of delivery. For the PA component, eight of the studies 'prescribed' individual tailored exercise to participants (Brovold et al., 2012; Duijts et al., 2012; Euteneur et al., 2017; Gary et al., 2010; Gourgouvelis et al., 2018; Jacobsen et al., 2013; McBeth et al., 2012; Merom et al., 2008), whereas eleven delivered activities in groups. Most studies implemented moderate intensity aerobic activities, including walking (Gary et al., 2010; Jacobsen et al., 2013; Jacquart et al., 2014; Merom et al., 2008), running (Fremont & Craighead, 1987), and football (McGale et al., 2011). Six studies also included a form of strength/resistance-based training in the sessions (Brovold et al., 2012; Engberg et al., 2017; Gourgouvelis et al., 2018; Kashikar-Zuck et al., 2018, Smeets et al., 2008; Van der Waerden et al., 2013). Three studies incorporated 'behavioural activation' with PA, whereby participants were provided with workbooks and diaries for self-monitoring of activity and associated mood (Parker et al., 2016; Pentecost et al., 2015; Euteneur et al., 2017). Design of the PA component of the 'BAcPAc' intervention (Parker et al., 2016) was further underpinned by principles derived from self-determination theory (SDT; Deci & Ryan, 2008).

For the psychological component, most (n = 17) studies adopted a CBT-based approach, which was delivered in groups for eleven of the trials. Individual CBT was provided in six interventions, either face-to-face (Euteuner et al., 2017; Fremont & Craighead, 1987; Gary et al., 2010; Jacquart et al., 2014; Pentecost et al., 2015), or via the telephone (McBeth et al., 2012). Of the remaining studies, two offered 'counselling' support

programmes with a focus on PA (Brovold et al., 2012; Engberg et al., 2017), two delivered 'problem-solving therapy', either individually (Parker et al., 2016) or to a group (Smeets et al., 2008), and one provided materials to participants containing instructions for self-directed 'stress management' techniques (Jacobsen et al., 2013). Design of the combined interventions also varied substantially between the RCT's, with five describing a simultaneous approach, in which PA was integrated with the psychological therapy (Jacquart et al., 2014; McGale et al., 2011), or incorporated as a part of the 'skills-building' session (Melnyk et al., 2009; 2013; 2015). Most studies (n = 15) provided PA separately to psychological therapy, delivering sessions for each concurrently throughout the intervention period. The therapeutic component for one intervention (Engberg et al., 2017) consisted of one 90-minute motivational talk regarding the benefits of PA, with Brovold et al., (2012) implementing a similar approach and providing participants with exercise diaries.

Outcomes

Statistical findings relating to the research question are presented in Table 2, which displays reported intervention effects for studies' psychological and physical outcomes. Studies' variability in measures of key variables, and statistical heterogeneity precluded calculation of standardised effect sizes for cross-study comparison of results. Therefore, a visual summary was deemed most suitable for interpretation of within-group (pre-post) effects, with any relevant between-group (intervention) effects presented according to the published data (Thomson & Thomas, 2012).

Psychological effects.

For the psychological outcomes of interest, scores generally improved for participants within the PA, therapy, and combined intervention arms. Where reported, this contrasted with a negative trend for corresponding scores in the TAU/control groups, with the exception of one

Table 2

Visual and Narrative Summary of Intervention Effects

Authors	Outcomes	Within-group effects				Between-group effects
		INT	PSYC	PA	TAU	
Abdollahia et al., (2017)	Dep (BDI-II)	+	+			Group x time interaction for INT (b = 3.30; p < .05)
	PA (BIADL)	+	+			Group x time interaction for INT (b = 3.21; p < .001)
Brovold et al., (2012)	QOL (SF-36)	+	+			3-month INT. effect for 'vitality' (MD= 9.5; p= .01) and 'bodily pain' (MD=10; p= .04)
	PA (6MWT)	+	+			NSF
Duijts et al., (2012)	Dep (HADS)	NR	NR	NR	NR	NSF
	Anx (HADS)	NR	NR	NR	NR	NSF
	QOL (SF-36-PF)	+++	+++	++++	-	6-month PA effect for 'physical functioning' (d= .41; p= .002)
Engberg et al., (2017)	Dep (PHQ-2)	++	++		-	INT. group overall greatest decrease in diagnosed depression (-16%; p= .078)
	QOL (SR)	++	++		++	NSF
Euteneur et al., (2017)	Dep (BDI-II)	+	+		-	Group x time interaction INT v TAU only (t= 2.90; p= .005). NSF for INT v PSYC
	PA (IPAQ)	+	-		-	INT effect for vigorous activity v PSYC (t= 2.74; p= .008) and TAU (t= 2.0; p= .049)
Fremont & Craighead (1987)	Dep (BDI)	++++	++++	++++		NSF
	Anx (STAI)	++++	++++	++++		NSF
	Fitness (rec. HR)	NR	NR	NR		Moderate correlation between change in BDI score and rec. HR for PA group (r = .37)
Gary et al., (2010)	Dep (HAM-D)	+	+	+	+	INT effect for moderate-major depression at 12 (p= .001) and 24-weeks (p= .014)
	QOL (MLHFQ)	+	+	+	-	NSF
	PA (6MWT)	++++	-	-	-	Group x time interaction for INT at 24-weeks (F= 6.9; p= .001)
Gourgouvelis et al., (2018)	Dep (BDI-II)	++++	++			Group x time interaction for INT (d= 2.38; p= .007)
	Dep (HADS)	++++	++			Group x time interaction for INT (d= 1.63; p= .0004)
	Anx (HADS)	+++	++			NSF
	PA (VO2max.)	++	+			31% increase for INT group (t= 2.17; p= .073) (vs 17% increase for PSYC group)

Jacobsen et al., (2013)	Dep (CES-D)	++	NR	NR	-	Group x time interaction INT v TAU (*t*= 2.38; *p*= .019)
	Anx (BAI)	+	NR	NR	-	Group x time interaction INT v TAU (*t*= 1.99; *p*= .049)
	QOL (SF-36)	NR	NR	NR	NR	NSF
	PA (LTEQ)	++	NR	NR	-	Group x time interaction INT v TAU (*t*= 2.75; *p*= .007)
Jacquart et al., (2014)	Dep (GDS)	NR	NR		NR	Post-test INT effect v PSYC (MD= 7.09) and TAU (MD= 10.60) (*p*< .001)
	QOL (BASIS-32)	NR	NR		NR	Post-test INT effect v PSYC (MD= .43) and TAU (MD= .87) (*p*< .001)
Kashikar-Zuck et al., (2018)	Dep (CDI)	+	+			NSF
	Pain (VAS)	++	+			3-month INT effect for pain (MD= 1.62; *p*= .11)
Lera et al., (2009)	Distress (SCL-90-R)	-		+		NSF
	QOL (SF-36 FS)	+		-		NSF
	QOL (SF-36 EW)	++		+		NSF
McBeth et al., (2012)	Distress (GHQ)	+	+	+	+	NSF
	QOL (SF-36 MCS)	+	+	+	+	NSF
	QOL (SF-36 PCS)	+	+	+	+	Group x time interaction INT v TAU at 6 (*b*= 3.5; *p*< .05) and 9-months (*b*=3.6; *p*<.01)
McGale et al., (2011)	Dep (BDI-II)	+++		+++	-	Group x time interaction INT v TAU (*d*= .66; *p*< .05) and PA v TAU (*d*= .81; *p* <.01)
Melnyk et al., (2009)	Dep (BYI-II)	+	-			NR
	Anx (BYI-II)	++	+			NR
Melnyk et al., (2013)	Dep (BYI-II)	-	+			INT effect for major depression post-test v PSYC (*F*= 6.98; *p*= .02)
	Anx (BYI-II)	+	+			NSF
	PA (Pedometer)	++	-			Group x time interaction for INT (MD= 4062; *p*= .003)
Melnyk et al., (2015)	Dep (BYI-II)	-	+			INT effect for major depression sustained at 12-months v PSYC (*F*= 5.78; *p*= .03)
Merom et al., (2008)	Dep (DASS-21)	+	+			Group x time interaction for INT (*d*= 1.39; *p*= .001)
	Anx (DASS-21)	+	+			Group x time interaction for INT (*d*= 1.36; *p*= .002)

	PA (mins. per week)	NR	NR			INT effect for walking (MD= 21; *p*=. 02). NSF for overall PA
Parker et al., (2016)	Dep (BDI-II)	++	+		NR	Group x time interaction for INT (MD= 3.76; *d*= .41; *p*= .02)
	Dep (MADRS)	++	+		NR	INT effect pre-post change (MD= 3.17; *d*= .48; *p*= .04)
	Anx (BAI)	+	+		NR	NSF
	PA (IPAQ)	NR	NR		NR	NSF
Pentecost et al., (2015)	Dep (CIS-R)	+	+			NR
	Dep (PHQ-9)	+	+			NR
	QOL (SF-36 MCS)	+	+			NR
	QOL (SF-36 PCS)	+	+			NR
	PA (Accelerometer)	-	-			NR
Smeets et al., (2008)	Dep (BDI)	+	+	+	NR	PA effect pre-post change v INT (MD = 2.17; $p < .05$)
	Pain (PRI)	+	+	+	NR	NSF
	PA (5MWT)	+	+	+	NR	NSF
Van der Waerden et al., (2013)	Dep (CES-D)	++		++	+	Negative PA effect for major depression v TAU (*d*= .56; *p*= .009)
	Stress (PSS)	+++		+++	+	INT effect for participants with low education v TAU (*d*= .53; *p*= .02)

Notes: + positive effect (non-significant); ++ ($p < .01$); +++ ($p < .01$); ++++ ($p < .001$); - negative effect
INT: Combined PA+PSYC; PSYC: Psychological therapy only; PA: Physical activity only; TAU: Treatment as usual/control
NR: Not reported; NSF: No significant findings ($p > .05$); MD: Mean difference

BDI: Beck Depression Inventory; SF-36: Short Form Health Survey (PCS: Physical Component Summary; MCS: Mental Component Summary; FS: Functional Status; EW: Emotional Well-being) HADS: Hospital Anxiety and Depression Scale; PHQ-2: Patient Health Questionnaire-2; HAM-D: Hamilton Rating Scale for Depression; CES-D: Centre for Epidemiological Studies for Depression Scale; BAI: Beck Anxiety Inventory; GDS: Geriatric Depression Scale; BASIS-32: Behavioural and Symptom Identification Scale; CDI: Children's Depression Inventory; SCL-90-R: Symptom Checklist-90-Revised; BYI: Beck Youth Inventory; DASS-21: Depression Anxiety and Stress Scale; MADRS: Montgommery-Asberg Depression Rating Scale; STAI: State Trait Anxiety Inventory; SRC: Stress Reduction Checklist; PRI: Pain Rating Index; PSS: Perceived Stress Scale; MLHFQ: Minnesota Living with Heart Failure Questionnaire; GHQ: General Health Questionnaire; BIADL: Barthel Index of Activities of Daily Living; 6MWT: 6-minute walk test; IPAQ: International Physical Activity Questionnaire; rec.HR: Recovery Heart Rate; VO2max: Maximal oxygen consumption test; LTEQ: Godin Leisure-Time Exercise Questionnaire; 5MWT: 5-minute walk test; SR: Self-reported

study (Engberg et al., 2017) which reported a significant pre-post difference in single-item ratings of health and well-being. In the 'COPE Healthy Lifestyle TEEN programme', overall depressive symptoms increased for the combined group post-intervention (Melnyk et al., 2013), and at 12-month follow-up (Melnyk et al., 2015), however this difference was not clinically significant or meaningful, as scores were still within the normal range.

Analyses of post-intervention effects for combined interventions versus therapy alone was performed in most of the studies, apart from a preliminary small-scale pilot study (Melnyk et al., 2009), and a feasibility trial conducted to identify methodological issues (Pentecost et al., 2015). Of the studies which assessed depression, nine reported a significant intervention effect, whereby the combined treatment engendered a greater reduction in symptoms compared with psychological therapy alone (*n* = 6/14: Abdollahia et al., 2017; Engberg et al., 2017; Gourgouvelis et al., 2018; Jacquart et al., 2014; Merom et al., 2008; Parker et al., 2016), and/or TAU (*n* = 5/10: Engberg et al., 2017; Euteneur et al., 2017; Jacobsen et al., 2013; Jacquart et al., 2014; McGale et al., 2011). For two studies, significant intervention effects were only observed in subgroup analyses of participants with major depression; both post-intervention (Gary et al., 2010; Melnyk et al., 2013), and at long-term follow-up (Melnyk et al., 2015). For the studies comparing combined intervention effects with PA alone, most (*n* = 6/7) found no significant differences between the change in depression scores, apart from one study (Smeets et al., 2008) which reported a significantly greater mean reduction in participants' scores, which favoured the PA-only group. Conversely, sub-group analyses in one study (Van der Waerden et al., 2013) showed that any combined intervention effects were confined to participants *without* depression, whereas those scoring within the mild-moderate range, reported significantly *more* depressive symptoms when assigned to receive PA alone.

There were mixed findings for studies which measured anxiety (n = 8), with only two reporting a significant combined intervention effect when compared with CBT alone (Merom et al., 2008), or TAU (Jacobsen et al., 2013). Group differences for QOL measures were also equivocal, however reported effects of the combined intervention appeared to be greatest for sub-scales related to physical measures, (Brovold et al., 2012; Jacquart et al., 2014), which—compared with TAU—were sustained in one study at 6, and 9-months (McBeth et al., 2012).

Physical effects.

Measures relating to physical outcomes were obtained in twelve of the studies, including: physical functioning tests conducted by research assistants (Brovold et al., 2012; Gary et al., 2010; Smeets et al., 2008); validated assessments of cardiovascular fitness (Fremont & Craighead, 1987; Gourgouvelis et al., 2018); self-reported questionnaires of weekly PA (Abdollahia et al., 2017; Euteneur et al., 2017; Jacobsen et al., 2013; Merom et al., 2008; Parker et al., 2016); and objectively recorded PA using pedometers (Melnyk et al., 2013) or accelerometers (Pentecost et al., 2015). Pre-post measures were not reported in three studies (Fremont & Craighead et al., 1987; Merom et al., 2008; Parker et al., 2016), however significant improvements were recorded in four studies' combined intervention groups (Gary et al., 2010; Gourgouvelis et al., 2018; Jacobsen et al., 2013; Melnyk et al., 2013), with either non-significant or negative changes reported in all comparator groups. This trend was observed in one study's PA-arm (Gary et al., 2010)- leading the authors to suggest that the addition of psychological therapy may have been integral to motivation and adherence to exercise.

One study did not conduct inferential analysis (Pentecost et. al., 2015), however post-intervention descriptive statistics showed that overall levels of PA were higher in the combined intervention group than those receiving 'behavioural activation for PA' alone. Most interventions yielded significant between-group differences in mean PA change, when

compared psychological therapy alone (Abdollahia et al., 2017; Euteneur et al., 2017; Gary et al., 2010; Gourgouvelis et al., 2018; Melnyk et al., 2013; Merom et al., 2008); and when compared with PA alone (Gary et al., 2010). In one multi-arm study, significant effects of the combined treatment were reported for comparisons with TAU (Jacobsen et al., 2013), however omission of any further between-group contrasts restricted identification of the component mechanisms of change. Of the remaining trials, three found no significant differences in PA-change when comparing combined treatment effects with: therapy alone (Brovold et al., 2012; Parker et al., 2016); or either therapy, PA, or TAU arms (Smeets et al., 2008). Finally, despite not reaching statistical significance, the trial combining running with CBT (Fremont & Craighead, 1987), found a stronger correlation between improvement of fitness levels and change in depression, for the group who received running alone (r = .37 v r = .11). Notwithstanding, as causality cannot be established, this result should be interpreted with caution.

Quality Assessment

A full breakdown of each trial's component ratings can be found in Supplemental Appendix 2. Eleven of the interventions were deemed methodologically weak overall, predominantly due to: evidence of selection bias (8/11); non-reporting/lack of participant or assessor blinding (8/11); and either failure to describe dropouts, or attrition rates falling below the acceptable level (< 60%). Other components which increased the risk of bias included failing to control for between-group confounders (i.e. gender; Melnyk et al., 2009), and non-reporting of the method of randomisation (Gourgouvelis et al., 2018). Four studies received a moderate global rating; two of which presented a high risk of selection bias, due to poor levels of participation (McBeth et al., 2012; Van der Waerden et al., 2013). Non-reporting of blinding (Abdollahia et al., 2017), or randomisation (Gary et al., 2010) techniques precluded these studies from receiving a strong global score. Seven studies met

criteria to be considered as methodologically strong, however all presented moderate risk of selection bias, due to referral of participants from a clinical source (i.e. medical specialist). Although four studies sufficiently evidenced blinding of outcome assessors, it was not possible to blind participants to the research question, resulting in moderate component ratings overall (Jacquart et 2014; Parker et al., 2016; Pentecost et al., 2015; Smeets et al., 2008). Finally, while withdrawals and drop-outs were adequately described in all of the 'strong' studies, three were ascribed moderate overall, due to <80% follow-up rate (Brovold et al., 2012; Lera et al., 2009; Pentecost et al., 2015).

Discussion

This systematic review provides up-to-date information pertaining to the effects of combined psychotherapeutic and PA interventions, on psychological and physical outcomes across clinically and demographically diverse populations.

It was apparent from the findings that combining psychological therapy with physical activity yielded positive results on psychological outcomes, in contrast to the negative trend observed for wait-list participants or TAU. Despite this generally positive effect, less than half (10/22) of the combined interventions *significantly* improved any psychological outcome (i.e. depression, anxiety, QOL, stress), and with the exception of one study (Parker et al., 2016), similar pre-post effects were observed within 'active comparator' groups. Between-group findings provided equivocal evidence for the efficacy of combined interventions over psychotherapy alone, with overall results suggesting that adjunctive PA engendered positive changes in just over half of the studies (9/15). Conversely, of the seven studies which included a PA group, none reported significant benefits to participants receiving the combined intervention, thus implying that PA-alone is at least equally effective as when combined with psychotherapeutic support. Nonetheless, considerable heterogeneity between studies' samples, methodologies, and overall quality impedes identifying the 'active

ingredients' of positive changes observed in the most effective interventions (Michie et al., 2013). Consequently, consistencies and differences between the salient results will be scrutinised in relation to these factors, in an attempt to draw inferences and explain findings in relation to the existing evidence-base.

Combined Interventions and Psychological Outcomes

Studies involving participants with mild-moderate levels of depression demonstrated efficacy for group-based interventions over one-to-one psychotherapy in reducing individuals' symptoms (Abdollahia et al., 2017; Fremont et al., 1987; Van der Wearden et al., 2013). In contrast, for participants with clinically major depression, the most effective interventions 'prescribed' PA, regardless of whether the psychological component was delivered individually (Gary et al., 2010; Jacquart et al., 2014), or as a group (Gourgouvelis et al., 2018); indicating that effective treatment for this population may necessitates a 'tailored' approach to PA, in accordance with individual needs. In exception, focusing on the 'behavioural activation' aspect of CBT engendered similar reductions in self-reported symptoms when combined with exercise, or euthymic activities (Euteneur et al., 2017), inferring that—for major depression—this technique can reduce symptom severity either with or without additional PA. Paradoxically, incorporating principles of 'behavioural activation' into the PA component of the intervention (Parker et al., 2016), significantly reduced symptoms of depression irrespective of the adjunctive psychological component (problem solving therapy or supportive counselling). Moreover, positive changes were unrelated to symptom severity at baseline, or self-reported change in levels of PA. The study's lack of objective and/or physiological measures precludes any definitive explanation, yet the evidence suggests that delivering combined interventions within a 'behavioural activation' framework may be an effective method of reducing depression, notwithstanding: individual differences, such as severity and age; and methodological variations, such as group-based or

one-to-one delivery. Nonetheless, as biological (Euteneur et al., 2017) and/or psychosocial (Parker et al., 2016) factors evidently mediate this relationship, further research is required to ascertain the optimal dose-response of intervention components, and delineate mechanisms of change according to psychological, physical and social needs (Bailey et al., 2018).

Combined Interventions and PA Levels

Twelve of the studies included in the review recorded at least one PA-related outcome measures, which indicated that participants receiving combined interventions were more likely to increase levels of PA, compared to those receiving psychotherapy alone or TAU/wait list controls. There was limited, yet consistent evidence that participants receiving combined interventions experienced significantly greater improvement in PA-outcomes than those allocated to individualised, 'prescribed' PA alone- the latter of which were comparable to reported levels for TAU/wait-list controls (Gary et al., 2010; Jacobsen et al., 2013). Taken together, this insinuates that—at least for the samples included in these studies—effective strategies to increase levels of PA necessitate incorporation of evidence-based psychological techniques, which may reflect synergies between the intervention targets (i.e. self-regulation, goal-setting), and the principles underpinning effective PA behaviour change techniques (i.e. autonomous motivation, self-efficacy) (Hagger & Chatzisarantis, 2014; Michie et al., 2017). In contrast, delivering 'physical treatment' (aerobic exercise and muscle strengthening) to *groups* of participants, rather than 'prescribing' PA individually, was found to be equally effective in increasing PA as the treatment incorporating psychological techniques (Smeets et al., 2008). Overall, this indicates that social interaction and reinforcement may have mediated observed effects, and highlights the need for social support measures in future studies, including direct comparisons between PA and psychotherapy groups.

Effects of PA on Psychological Outcomes

Despite the considerable heterogeneity between samples, intervention content and methodological quality, the effect on psychological outcomes for participants allocated to PA alone (n = 9), was generally at least equivalent to those receiving the adjunctive therapy; with some studies reporting *larger* effect sizes for 'physical functioning' (Duijts et al., 2012), and depression scores (McGale et al., 2011; Smeets et al., 2008), and a stronger association between changes in fitness and depression scores for these participants (Fremont & Craighead, 1987). While scarcity of objective PA measures hinders the ability to identify causative mechanisms, the tendency for combined interventions to effectuate the greatest increases in overall PA (see above), indicates that changes in psychophysiological markers associated with mental health (Euteuner et al., 2017; Gourgouvelis et al., 2018), may have been mediated by psychosocial factors, rather than changes in fitness/PA levels *per se*. Moreover, efficacy of both combined interventions and PA alone in improving psychological outcomes (i.e. depression, stress, QOL), implies that establishing commonalities between psychosocial processes underpinning each component, may enable identification of the 'active ingredients' associated with effective interventions (Michie et al., 2013).

Drawing on findings presented in this review, and research published elsewhere (Lubans et al., 2016), such mechanisms include changes related to: feelings of competence and self-efficacy; sense of mastery and autonomy; and perceived support and connectedness. This may additionally explain evidence for the efficacy of interventions which comprised of techniques know to moderate these processes (i.e. goal-setting, self-regulation and social contact), regardless of the studies' sample, methodology, or overall quality rating. Furthermore, heterogeneity between the content or 'dose' of psychotherapy or PA (frequency, intensity, time, type), reinforce the concept that individuals may respond better to theory-based interventions which incorporate effective behavioural change techniques, such as 'behavioural activation' (Michie et al., 2017).

Conclusions

Findings from the current review suggest that incorporating PA into psychotherapeutic approaches has a positive effect on psychological outcomes, however similar benefits may be attained by providing theory-based PA programmes alone. In accordance with evidence published elsewhere (Biddle et al., 2018), the efficacy of PA interventions may be unrelated to the 'dose' received, indicating that psychosocial mechanisms of change (i.e. self-efficacy and social support) may explain the association between PA and well-being. Despite this evidence for PA-alone, the finding that a combined approach produced greater increases in PA levels, reinforces the importance of basing such interventions on key psychological principles which underpin sustained behaviour change (i.e. goal-setting and self-regulation), and thus effectuate change to wider predictors of mental health and well-being (i.e. neuro-biological) (Lubans et al., 2016).

The overall findings derived from this review raises an interesting concept; that rather than regarding PA as an 'adjunct' to psychotherapeutic treatment, a theory-based PA programme may offer a viable, and effective alternative from which numerous biopsychosocial benefits may be attained. Specifically, current findings suggest that integrating 'behavioural activation' into the design and delivery may be a particularly effective technique, to instil positive and sustained changes across outcomes related to such factors. Although usually associated with CBT, the activity planning and use of goals highlights how and why this specific approach may be particularly compatible with PA for improving psychological outcomes, and substantiates existing research arguing for greater focus on behavioural changes, over challenging maladaptive cognitions and schemas (Veale, 2008).

Limitations and Future Recommendations

The results of this review provide a comprehensive assessment of studies which combine psychotherapy with PA, attained through: an exhaustive predetermined selection criteria; a broad and thorough search strategy; systematic extraction of key data; and use of a validated assessment tool to evaluate overall quality of the evidence-base. Despite the questionable quality ratings applied to half of the included studies, it is important to note that these reflected aggregated scores derived from constructs which largely reflect reporting methods (i.e. dropouts, blinding, randomisation etc.), and arguably prioritise efficacy over effectiveness under "real-world" conditions (Khorsan & Crawford, 2014). Nonetheless, it is acknowledged that findings must be interpreted within the context of the review's limitations. While the extensive inclusion criteria returned a wide variety of compliant studies, high levels of clinical and methodological heterogeneity rendered the data unsuitable for meta-analyses (Higgins & Green, 2011), and somewhat limits confidence in the generalisability of proposed 'mechanisms of action'. Assessment and synthesis of qualitative evidence is recommended for future reviews, to further understanding of what mechanisms are effective, for whom, and why (CRD, 2009).

Although the findings presented consistently suggest that the effects of PA on psychological outcomes are at least equivalent to combined interventions, this was based on a relatively small number of studies, due to the paucity of trials with an 'active' comparator (PA-alone). Furthermore, while between-group comparisons of combined and psychotherapy interventions insinuate that differences resulted from the adjunctive PA, it is possible that unintended contamination may have influenced these results- particularly given that most studies did not randomise at cluster-level, and employed an 'intention-to-treat' analysis (Sussman & Hayward, 2010). In addition to measures of fidelity and adherence to the intervention, future studies should ensure that reliable measures of PA are obtained from both intervention and comparison groups (Ehlers et al., 2016), to thereby control for PA within

analyses, and establish the influence of PA as a potential facilitator of any observed psychological effects.

References

Abdollahi, A., LeBouthillier, D. M., Najafi, M., Asmundson, G. J., Hosseinian, S., Shahidi, S., ... & Jalili, M. (2017). Effect of exercise augmentation of cognitive behavioural therapy for the treatment of suicidal ideation and depression. *Journal of affective disorders*, *219*, 58-63.

Bailey, A. P., Hetrick, S. E., Rosenbaum, S., Purcell, R., & Parker, A. G. (2018). Treating depression with physical activity in adolescents and young adults: a systematic review and meta-analysis of randomised controlled trials. *Psychological medicine*, *48*(7), 1068-1083.

Bernard, P., Romain, A. J., Caudroit, J., Chevance, G., Carayol, M., Gourlan, M., ... & Moullec, G. (2018). Cognitive behavior therapy combined with exercise for adults with chronic diseases: Systematic review and meta-analysis. *Health Psychology*, *37*(5), 433-450.

Biddle S. J. H., Ciaccioni S., Thomas G., Vergeer I. (2018). Physical activity and mental health in children and adolescents: an updated review of reviews and an analysis of causality. *Psychology of Sport & Exercise* doi:10.1016/j.psychsport.2018.08.011

Brovold, T., Skelton, D. A., & Bergland, A. (2012). The efficacy of counseling and progressive resistance home-exercises on adherence, health-related quality of life and function after discharge from a geriatric day-hospital. *Archives of gerontology and geriatrics*, *55*(2), 453-459.

Centre for Reviews and Dissemination (2009). *Systematic Reviews: CRD's guidance for undertaking reviews in health care.* Available from https://www.york.ac.uk/media/crd/Systematic_Reviews.pdf

Cooney, G. M., Dwan, K., Greig, C. A., Lawlor, D. A., Rimer, J., Waugh, F. R., ... & Mead, G. E. (2013). Exercise for depression. *Cochrane database of systematic reviews*, (9). Art. No.: CD004366. DOI: 10.1002/14651858.CD004366.pub6.

Deci, E. L., & Ryan, R. M. (2008). Self-determination theory: A macrotheory of human motivation, development, and health. *Canadian psychology/Psychologie Canadienne*, *49*(3), 182-185.

Duijts, S. F., van Beurden, M., Oldenburg, H. S., Hunter, M. S., Kieffer, J. M., Stuiver, M. M., ... & Lopes Cardozo, A. M. (2012). Efficacy of cognitive behavioral therapy and physical exercise in alleviating treatment-induced menopausal symptoms in patients with breast cancer: results of a randomized, controlled, multicenter trial. *J Clin Oncol*, *30*(33), 4124-4133.

Effective Public Health Practice Project (EPHPP) (2007). *Quality assessment tool for quantitative studies.* Retrieved from http://www.nccmt.ca/knowledge-repositories/search/14

Ehlers, D. K., Fanning, J., Awick, E. A., Kramer, A. F., & McAuley, E. (2016). Contamination by an active control condition in a randomized exercise trial. *PloS one*, *11*(10), e0164246. doi:10.1371/journal. pone.0164246

Engberg, E., Liira, H., Kukkonen-Harjula, K., From, S., Kautiainen, H., Pitkälä, K., & Tikkanen, H. O. (2017). The effects of health counseling and exercise training on self-rated health and well-being in middle-aged men: a randomized trial. *The Journal of sports medicine and physical fitness*, *57*(6), 916-922.

Euteneuer, F., Dannehl, K., Del Rey, A., Engler, H., Schedlowski, M., & Rief, W. (2017). Immunological effects of behavioral activation with exercise in major depression: an exploratory randomized controlled trial. *Translational psychiatry*, *7*(5), e1132.

Everson-Hock, E. S., Green, M. A., Goyder, E. C., Copeland, R. J., Till, S. H., Heller, B., & Hart, O. (2015). Reducing the impact of physical inactivity: evidence to support the case for targeting people with chronic mental and physical conditions. *Journal of public health*, *38*(2), 343-351.

Fremont, J., & Craighead, L. W. (1987). Aerobic exercise and cognitive therapy in the treatment of dysphoric moods. *Cognitive therapy and Research*, *11*(2), 241-251.

Gary, R. A., Dunbar, S. B., Higgins, M. K., Musselman, D. L., & Smith, A. L. (2010). Combined exercise and cognitive behavioral therapy improves outcomes in patients with heart failure. *Journal of psychosomatic research*, *69*(2), 119-131.

Gourgouvelis, J., Yielder, P., Clarke, S. T., Behbahani, H., & Murphy, B. A. (2018). Exercise leads to better clinical outcomes in those receiving medication plus cognitive behavioral therapy for major depressive disorder. *Frontiers in psychiatry*, *9*, (37), doi: 10.3389/fpsyt.2018.00037

Hagger, M. S., & Chatzisarantis, N. L. (2014). An integrated behavior change model for physical activity. *Exercise and Sport Sciences Reviews*, *42*(2), 62-69.

Higgins, J. P. T., & Green, S. (2011). *Cochrane Handbook for Systematic Reviews of Interventions, Version 5.1.0.* Retrieved from http://handbook-5-1.cochrane.org

Jacobsen, P. B., Phillips, K. M., Jim, H. S., Small, B. J., Faul, L. A., Meade, C. D., ... & Wilson, R. W. (2013). Effects of self-directed stress management training and home-based exercise on quality of life in cancer patients receiving chemotherapy: a randomized controlled trial. *Psycho-Oncology*, *22*(6), 1229-1235.

Jacquart, S. D., Marshak, H. H., Dos, H. S., Luu, S. M., Berk, L. S., McMahon, P. T., & Riggs, M. (2014). The effects of simultaneous exercise and psychotherapy on depressive symptoms in inpatient, psychiatric older adults. *Advances in mind-body medicine*, *28*(4), 8-17.

Kashikar-Zuck, S., Black, W. R., Pfeiffer, M., Peugh, J., Williams, S. E., Ting, T. V., ... & Myer, G. D. (2018). Pilot randomized trial of integrated cognitive-behavioral therapy and neuromuscular training for juvenile fibromyalgia: The FIT Teens Program. *The Journal of Pain*, *19*(9), 1049-1062.

Khorsan, R., & Crawford, C. (2014). External validity and model validity: a conceptual approach for systematic review methodology. *Evidence-Based Complementary and Alternative Medicine, Volume 2014, Article ID 694804* http://dx.doi.org/10.1155/2014/694804

Liberati, A., Altman, D. G., Tetzlaff, J., Mulrow, C., Gøtzsche, P. C., Ioannidis, J. P., ... & Moher, D. (2009). The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration. *PLoS medicine*, *6*(7), e1000100.

Lera, S., Gelman, S. M., López, M. J., Abenoza, M., Zorrilla, J. G., Castro-Fornieles, J., & Salamero, M. (2009). Multidisciplinary treatment of fibromyalgia: does cognitive behavior therapy increase the response to treatment?. *Journal of psychosomatic research*, *67*(5), 433-441.

Lubans, D., Richards, J., Hillman, C., Faulkner, G., Beauchamp, M., Nilsson, M., ... & Biddle, S. (2016). Physical activity for cognitive and mental health in youth: a systematic review of mechanisms. *Pediatrics*, *138*(3), e20161642.

Machaczek, K. K., Allmark, P., Goyder, E., Grant, G., Ricketts, T., Pollard, N., ... & Green, G. (2018). A scoping study of interventions to increase the uptake of physical activity (PA) amongst individuals with mild-to-moderate depression (MMD). *BMC public health*, *18*(392), doi: 10.1186/s12889-018-5270-7

McBeth, J., Prescott, G., Scotland, G., Lovell, K., Keeley, P., Hannaford, P., ... & Beasley, M. (2012). Cognitive behavior therapy, exercise, or both for treating chronic widespread pain. *Archives of internal medicine*, *172*(1), 48-57.

McGale, N., McArdle, S., & Gaffney, P. (2011). Exploring the effectiveness of an integrated exercise/CBT intervention for young men's mental health. *British journal of health psychology*, *16*(3), 457-471.

Melnyk, B. M., Jacobson, D., Kelly, S., O'Haver, J., Small, L., & Mays, M. Z. (2009). Improving the mental health, healthy lifestyle choices, and physical health of Hispanic adolescents: A randomized controlled pilot study. *Journal of School Health*, *79*(12), 575-584.

Melnyk, B. M., Jacobson, D., Kelly, S., Belyea, M., Shaibi, G., Small, L., ... & Marsiglia, F. F. (2013). Promoting healthy lifestyles in high school adolescents: A randomized controlled trial. *American Journal of Preventive Medicine*, *45*(4), 407-415.

Melnyk, B. M., Jacobson, D., Kelly, S. A., Belyea, M. J., Shaibi, G. Q., Small, L., ... & Marsiglia, F. F. (2015). Twelve-month effects of the COPE healthy lifestyles TEEN program on overweight and depressive symptoms in high school adolescents. *Journal of School Health*, *85*(12), 861-870.

Merom, D., Phongsavan, P., Wagner, R., Chey, T., Marnane, C., Steel, Z., ... & Bauman, A. (2008). Promoting walking as an adjunct intervention to group cognitive behavioral therapy for anxiety disorders—a pilot group randomized trial. *Journal of anxiety disorders*, *22*(6), 959-968.

Michie, S., Richardson, M., Johnston, M., Abraham, C., Francis, J., Hardeman, W., ... & Wood, C. E. (2013). The behavior change technique taxonomy (v1) of 93 hierarchically clustered techniques: building an international consensus for the reporting of behavior change interventions. *Annals of behavioral medicine*, *46*(1), 81-95. DOI:10.1007/s12160-013-9486-6

Michie, S., Carey, R. N., Johnston, M., Rothman, A. J., De Bruin, M., Kelly, M. P., & Connell, L. E. (2017). From theory-inspired to theory-based interventions: A protocol for developing and testing a methodology for linking behaviour change techniques to theoretical mechanisms of action. *Annals of behavioral medicine*, *52*(6), 501-512.

Parker, A. G., Hetrick, S. E., Jorm, A. F., Mackinnon, A. J., McGorry, P. D., Yung, A. R., ... & Purcell, R. (2016). The effectiveness of simple psychological and physical activity interventions for high prevalence mental health problems in young people: A factorial randomised controlled trial. *Journal of Affective Disorders*, *196*, 200-209.

Pentecost, C., Farrand, P., Greaves, C. J., Taylor, R. S., Warren, F. C., Hillsdon, M., ... & Taylor, A. H. (2015). Combining behavioural activation with physical activity promotion for adults with depression: findings of a parallel-group pilot randomised controlled trial (BAcPAc). *Trials*, *16*(367).

Pedersen, B. K., & Saltin, B. (2015). Exercise as medicine–evidence for prescribing exercise as therapy in 26 different chronic diseases. *Scandinavian journal of medicine & science in sports*, *25*, 1-72.

Rosenbaum, S., Vancampfort, D., Steel, Z., Newby, J., Ward, P. B., & Stubbs, B. (2015). Physical activity in the treatment of post-traumatic stress disorder: a systematic review and meta-analysis. *Psychiatry research*, *230*(2), 130-136.

Sancassiani, F., Machado, S., & Preti, A. (2018). Physical activity, exercise and sport programs as effective therapeutic tools in psychosocial rehabilitation. *Clinical practice and epidemiology in mental health*, *14*, 6-10.

Smeets, R. J., Vlaeyen, J. W., Hidding, A., Kester, A. D., van der Heijden, G. J., & Knottnerus, J. A. (2008). Chronic low back pain: physical training, graded activity with problem solving training, or both? The one-year post-treatment results of a randomized controlled trial. *Pain*, *134*(3), 263-276.

Stonerock, G. L., Hoffman, B. M., Smith, P. J., & Blumenthal, J. A. (2015). Exercise as treatment for anxiety: systematic review and analysis. *Annals of behavioral medicine*, *49*(4), 542-556.

Stubbs, B., Vancampfort, D., Rosenbaum, S., Firth, J., Cosco, T., Veronese, N., ... & Schuch, F. B. (2017). An examination of the anxiolytic effects of exercise for people with anxiety and stress-related disorders: A meta-analysis. *Psychiatry research*. 249, 102-108.

Sussman, J. B., & Hayward, R. A. (2010). An IV for the RCT: using instrumental variables to adjust for treatment contamination in randomised controlled trials. *Bmj*, *340*, c2073. doi:10.1136/bmj.c2073

Teixeira, P. J., Carraça, E. V., Markland, D., Silva, M. N., & Ryan, R. M. (2012). Exercise, physical activity, and self-determination theory: a systematic review. *International journal of behavioral nutrition and physical activity*, *9*(78). DOI:10.1186/1479-5868-9-78

Van der Waerden, J. E., Hoefnagels, C., Hosman, C. M., Souren, P. M., & Jansen, M. W. (2013). A randomized controlled trial of combined exercise and psycho-education for

low-SES women: short-and long-term outcomes in the reduction of stress and depressive symptoms. *Social science & medicine, 91*, 84-93.

Veale, D. (2008). Behavioural activation for depression. *Advances in Psychiatric Treatment, 14*(1), 29-36. doi:10.1192/apt.bp.107.004051

World Health Organization (2013) *Global action plan for the prevention and control of noncommunicable diseases 2013-2020*. Geneva. World Health Organization. https://apps.who.int/iris/bitstream/handle/10665/94384/9789241506236_eng.pdf?sequence=1