Effectiveness of Acceptance and Commitment Therapy (ACT) interventions for promoting physical activity: A systematic review and meta-analysis

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Physical inactivity is the fourth leading cause of death worldwide and is a key risk factor for non-communicable diseases (NCDs) such as cardiovascular disease, some cancers and type 2 diabetes (Lee et al. 2012). Worldwide, inactivity is estimated to cause 9% of premature mortality, and if inactivity were decreased by 10%, more than 533,000 deaths could be averted every year (Lee et al. 2012). The World Health Organisation (WHO) recommendations for adults aged 18–64 are for at least 150 minutes of at least moderate-intensity aerobic physical activity (such as brisk walking or cycling) per week (WHO, 2019). However, the majority of the world’s population does not meet these recommendations (Ding et al. 2016; Rhodes, Janssen, Bredin, Warburton, & Bauman, 2017), and globally physical inactivity is on the rise (Lee et al. 2012). Given the public health burden associated with physically inactive lifestyles, there is a critical need for interventions that are effective in promoting the adoption and maintenance of regular physical activity, and over the last two decades, a wide range of interventions have been developed and evaluated in efforts to improve population levels of physical activity (PA) (Howlett, Trivedi, Troop, & Chater, 2019).

Grounding health promotion interventions in theory is often viewed as ‘good practice’ (Glanz & Rimer, 2005; Taylor, Conner, & Lawton, 2012; Prestwich, Webb, & Conner, 2015), and in many cases the development and evaluation of physical activity interventions has been guided by theory. The most common theories that have been used in the development of physical activity interventions are intrapersonal and interpersonal theories, such as the Health Belief Model (HBM; Rosenstock, 1974), the Stages of Change (Transtheoretical) Model (TTM; Prochaska & Velicer, 1997), the Theory of Planned Behaviour (TPB; Ajzen, 1991), and Social Cognitive Theory (SCT; Bandura, 1986) (Glanz et al. 2005). All of these theories have in common that they attempt to promote behaviour
change by targeting factors such as an individual’s knowledge, attitudes, beliefs, motivation, and skills in order to increase their intention to engage in the target behaviour (Glanz & Rimer, 2005; Rhodes & Nigg, 2011), and all have been shown to be effective at inducing a small to medium effect size on physical activity behaviour (Gourlan et al. 2016). Recently, however, there has been interest in the potential for basing health behaviour change interventions on a relatively new contextual and acceptance-based approach known as Acceptance and Commitment Therapy (ACT) (Zhang et al. 2018; Hayes, Strosahl, & Wilson, 1999; Hayes, Luoma, Bond FW, & Masuda, 2006).

Acceptance and Commitment Therapy (ACT) and the Psychological Flexibility Model of Behaviour Change

Unlike many other behaviour change interventions, ACT doesn’t aim to directly change internal experiences (such as thoughts, beliefs about capability, memories, feelings, or bodily sensations etc.), but instead aims to foster acceptance and mindfulness skills to enable greater behavioural regulation in the presence of these internal experiences (Zhang et al., 2018). This increase in behavioural regulation has been called ‘psychological flexibility’, which is defined as “contacting the present moment fully as a conscious human being, and based on what the situation affords, changing or persisting in behaviour in the service of chosen values” (Biglan, Hayes, & Pistorello, 2008). In other words, fostering psychological flexibility encourages individuals to change their relationships with internal experiences (rather than changing the experiences themselves) in such a way that they can engage in desired behaviours (e.g. increasing physical activity), even in the presence of difficult thoughts (e.g. ‘I’m too tired’, ‘I don’t have time to exercise’) and feelings (e.g. the physical discomfort that comes with moderate-vigorous exercise).
To date, ACT is the most researched intervention model based on the psychological flexibility model of behaviour change (Zhang et al., 2018). According to this model, psychological flexibility is the ability to contact the present moment more fully as a conscious human being, and to change or persist in behaviour when doing so serves valued ends. To build psychological flexibility, ACT interventions target six core processes (Zhang et al., 2018; Hayes et al., 1999; Hayes et al., 2006; Biglan et al., 2008): 1) Acceptance (the willingness to have and accept private experiences); 2) Defusion (the ability to see thoughts as descriptions of one’s experience and not actual reality); 3) Contact with the Present Moment (the ability to fully open to and aware of what is happening in the present moment); 4) Self-As-Context (awareness of an ‘observing self’, as distinct from the experiences observed); 5) Values (directions in life that an individual can choose to guide their behaviour); and 6) Committed Action (Engaging in a pattern of behaviour, in pursuit of short- and medium-term health-related goals, that is consistent with identified values). More detailed definitions of the six core ACT processes can be found in Supplementary Document 1. In addition to these six key processes, ACT interventions often begin with Creative Hopelessness, the aim of which is to undermine the control agenda and promote a more workable, expansive behavioural repertoire. The control agenda is the belief that people often have that in order to engage in behaviours that are important or meaningful, they must first control how they think or feel – for instance, to feel motivated, to feel less tired, or to have more confidence. While not one of the six core processes targeted by ACT, Creative Hopelessness is often viewed as being critical to opening an individual up to a new way of relating to their internal experiences and is thought to help pave the way for working with the
six core processes. A more detailed definition of Creative Hopelessness can be found in Supplementary Document 1.

**Acceptance and Commitment Therapy (ACT) for Physical Activity**

Generally, ACT-based interventions have shown promise for promoting a range of health behaviours, including smoking cessation (Gifford et al. 2004; Gifford et al. 2011; Hernández-López, Luciano, Bricker, Roales-Nieto, & Montesinos, 2009; Bricker et al., 2017; Bricker et al., 2014) and weight management (Forman & Butryn, 2015; Lillis, Hayes, Bunting, & Masuda, 2009; Lillis & Kendra, 2014), and evidence is emerging that ACT-based interventions may be effective for promoting physical activity (Zhang et al., 2018). Although physical activity confers many benefits, it is also inconvenient and requires considerable time and energy, it may not be intrinsically enjoyable, and the discomfort associated with physical activity initiation can be a strong contributor to premature termination (Ekkekakis, Hargreaves, & Parfitt, 2013). Acceptance and Commitment Therapy (ACT), therefore, is particularly suitable for physical activity because it encourages:

1. Experiential acceptance: ACT uses a variety of acceptance-based metaphors and experiential exercises to increase awareness and acceptance of unwanted thoughts, feelings, and sensations (such as the emotional and/or physical discomfort that may be experienced during physical activity) in order to foster the ability to make room for unpleasant internal experiences without trying to change or eliminate them (Hayes et al., 1999; Hayes et al., 2006; Biglan et al., 2008);

2. Behavioural commitment to valued life-directions: ACT emphasizes the necessity of identifying desired life directions (i.e. values) in domains related to health and fitness (e.g. maintaining physical independence) in order to motivate engagement in behaviours that are
consistent with those values. ACT also aims to foster the willingness and ability to forego a
behaviour that is perceived as more pleasurable or requires less effort (e.g. sitting on the
couch after dinner and watching TV) in order to engage in a behaviour that is more consistent
with one's health and fitness values (e.g. going for a walk after dinner) (Hayes et al., 1999;
Hayes et al., 2006; Biglan et al., 2008).

**Behaviour Change Techniques (BCTs) – the ‘Active Ingredients’ of Interventions**

Behaviour Change Techniques (BCTs) have been defined as the ‘active ingredients’
of behaviour change interventions in that they are “observable, replicable, and irreducible
component[s] of an intervention designed to alter or redirect causal processes that regulate
behaviour” (Michie et al., 2013, p4). In their development of a BCT taxonomy (the
Behaviour Change Technique Taxonomy version 1, BCTTv1), Michie et al. (2013) identified
93 individual BCTs, which cluster into 16 groups of BCTs.

Although it is considered best practice to develop behaviour change interventions
based on theory, some previous reviews have demonstrated that, on the whole, physical
activity interventions that are guided by a theory are no more effective that atheoretical
interventions (Conn, Hafdahl, & Mehr, 2011; Prestwich et al., 2014; McEwan et al., 2016;
Rhodes, Janssen, Bredin, Warburton, & Bauman, 2017). One explanation for this has been
that the main ‘driver’ of behaviour change is the specific BCTs used in interventions, rather
than the theory upon which the interventions are based (McEwan et al., 2019). If this were
the case, theory-based and atheoretical interventions could have similar effects if the same
BCTs were used in both types of intervention (McEwan et al., 2019). Consequently, it has
been recommended that the specific content of an intervention (in terms of the included
The main aim of this review was to examine the effectiveness of ACT-based interventions for physical activity. However, the review is also intended to aid the development of future ACT interventions for physical activity by describing the current state of the field and highlighting how ACT theory has been applied to physical activity. ACT interventions are typically defined by the theoretical processes of change that they target (namely, Acceptance; Defusion; Contact with the Present Moment; Self-As-Context; Values; and Committed Action), rather than being defined by the specific techniques used to target those processes (Zhang et al., 2018; Hayes et al., 1999; Hayes et al., 2006; Biglan et al., 2008; Hofmann & Hayes, 2019). Consequently, it is currently unclear how the constructs and content of ACT interventions relate to traditional BCTs (such as self-monitoring, action planning, etc.) - and hence a key aim of this paper was to identify which ACT processes are typically targeted by ACT-based interventions for physical activity, and also identify which BCTs of the BCTTv1 (Michie et al., 2013) are included in the content of ACT-based interventions.

To summarise, the aims of this review were to:

1. Determine the effectiveness of ACT interventions for physical activity through a meta-analysis.
2. Identify the ACT processes targeted by effective interventions through coding intervention descriptions and protocols (where available).
3. Identify the behaviour change techniques (BCTs) included in effective interventions through coding descriptions and protocols (where available) using the BCTTv1.
4. Identify other intervention characteristics associated with effective interventions.
Methods

This systematic review followed a protocol registered with PROSPERO (registration number: CRD42018115730) (Pears, Sutton, & Griffin, 2018) and used the PRISMA checklist (provided in Supplementary Document 2) for reporting systematic reviews (Moher, Liberati, Tetzlaff, & Altman, 2009).

Inclusion and Exclusion Criteria

Studies were required to meet the following criteria: (i) Randomized controlled trials (RCTs) or pre-post designs; (ii) the intervention was designed to increase physical activity (interventions targeting multiple health behaviours were excluded); (iii) the study must report a physical activity behaviour outcome (either objective or subjective/self-report); (iv) the study must include an intervention based on ACT (delivered individually or in a group; via single or multiple sessions; by any provider, including fully-digitized interventions; in any setting); (v) the study must target adult participants (≥18 years); (vi) the study must be available in English language.

Search Strategy

Seven electronic databases were searched from 1980 up to June 26th 2018: MEDLINE, EMBASE, PsycINFO, Web of Science, Scopus, CINAHL, and the Cochrane Library. Searches were restricted to 1980 or later, as acceptance and commitment therapy was not developed before 1982. The search strategy was designed and conducted with the help of a university librarian (IK). The search terms were “acceptance and commitment therapy” AND “physical activity”. Physical activity is defined as any bodily movement...
produced by skeletal muscles that results in energy expenditure. In daily life, physical activity can be categorized into work-related, sports, conditioning, household, or other activities (Caspersen, Powell & Christenson, 1985). Associated synonyms were identified and keyword and subject heading searches were performed. The strategy was adapted for each database. The full search strategy for each database can be found in Supplementary Document 3. To address the grey literature the list published on the ACBS (Association for Contextual Behavioural Science) website of ACT interventions for physical activity was searched. Reference lists of included studies were hand searched. The search was updated on May 29th, 2019.

Study Selection
Two reviewers (SP/SS) independently screened titles and abstracts retrieved by the search strategy. Full-text articles were then reviewed for eligibility by the same two reviewers. The first instance where studies did not meet eligibility was recorded, and the study was not assessed for further criteria. The selection of studies was recorded according to the PRISMA guidelines. Conflicts between reviewers were resolved through discussion between the two independent reviewers. Cohen's kappa (κ) was calculated as a measure inter-rater reliability (Landis & Koch, 1977). Figure 1 shows the study search results and selection process.

Data Extraction
One reviewer (SP) extracted the data into a standardized data extraction form developed specifically for this review. Data extraction was verified by a second reviewer (SS). Disagreements between reviewers were resolved through discussion.
Data were extracted on:

**Study characteristics:** number of participants randomized; total number allocated to each trial arm; setting; design; trial arms; measurement times; physical activity outcome measures (objective or self-report); retention (calculated as a percentage of those randomized to the intervention and completed follow-up assessment).

**Participant characteristics:** age (mean and range); gender (% female); population.

**Effectiveness of intervention:** mean and standard deviation at baseline, postintervention, and follow-up for all physical activity outcomes (objective and self-report); effect size at post assessment and follow up. Where not reported, effect sizes were calculated based on postintervention and follow-up means, standard deviations, and sample sizes for each condition to produce standardized mean differences (SMD), with 95% confidence intervals (CIs).

**Intervention and Comparator characteristics:** Description of trial arms; Delivery provider; Format; Duration; Intensity (e.g. number of intervention contacts, duration of contacts, number of modules); Materials; ACT processes; BCTs.

**Risk of Bias**

Two reviewers (SP and SS) independently assessed risk of bias using the revised Cochrane Risk of Bias Tool 2.0 (Higgins et al. 2016). Studies were coded as *low, high or some concerns* of bias in the following five domains: 1) Risk of bias arising from the randomization process; 2) Risk of bias due to deviations from the intended interventions (effect of assignment to intervention); 3) Risk of bias in missing outcome data; 4) Risk of bias in measurement of the outcome; 5) Risk of bias in selection of the reported result. An overall risk of bias rating of *low, high or some concerns* was given to each study based on the
following criteria: *Low risk:* Low risk of bias across all domains; *High risk:* High risk of bias in at least one domain OR some concerns for multiple domains in a way that substantially lowers confidence in the result; *Some concerns:* Some concerns in at least one domain, but not to be at high risk of bias for any domain.

**ACT Processes**

Two reviewers (SP/SS) independently coded the ACT processes targeted in the intervention conditions of the included studies using a fixed-choice format to specify whether ACT processes were *explicitly named* (when ACT processes were explicitly named in the manuscript), *identifiable* (when processes could be identified from the intervention description, protocol or supplementary material, but were not explicitly named) or *absent*. Cohen's kappa ($\kappa$) was calculated as a measure inter-rater reliability (Landis & Koch, 1977). Disagreements between reviewers were resolved through discussion.

**BCTs**

Two reviewers (SP/SS) trained in the use of the Behaviour Change Technique Taxonomy v1 (Michie et al. 2013) coded the BCTs in the intervention and comparator conditions of the included studies. Coders independently coded the intervention and comparator condition using a fixed-choice format to specify if BCTs were definitely *present*, *probably present* (when techniques may have been used but this was uncertain) or *definitely absent*. Only BCTs targeting physical activity behaviour of intervention participants were coded. Cohen's kappa ($\kappa$) was calculated as a measure inter-rater reliability (Landis & Koch, 1977). Disagreements between reviewers were resolved through discussion.
Statistical analysis

For each study, we included the effect size for a physical outcome measure at the longest follow-up time-point available, choosing where possible a continuous, objective measure that best reflected overall physical activity.

A random effects meta-analysis calculated the pooled effect size, using the Chi-Squared test (Q-Statistic) to test for heterogeneity between studies and the I² statistic to estimate the proportion of variance due to real difference across studies rather than random error, using the widely used cut offs of 25%, 50% and 75% to represent low, moderate and high heterogeneity respectively (Higgins, Thompson, Deeks, & Altman, 2003). A random effects meta-regression was planned to examine whether intervention components were associated with intervention effect. We intended to assess publication bias using funnel plot techniques, Begg’s rank test and Egger’s regression test, as appropriate given the known limitations of these methods (Ruszni Nik Idris, 2012).

Results

A total of 1686 references were returned from the search strategy after removal of duplicates (Figure 1). Fourteen articles were identified as potentially relevant, with seven studies fulfilling all review criteria (Butryn, Forman, Hoffman, Shaw, & Juarascio, 2011; Ivanova, Yaakoba-Zohar, Jensen, Cassoff, & Knäuper 2016; Kangasniemi, Lappalainen, Kankaanpää, Tolvanen, & Tammelin, 2015; Martin, Galloway-Williams, Cox, & Winett, 2016; Moffitt & Mohr, 2015; Fletcher, 2011; Stevens, 2017). Cohen's kappa (κ) was 0.61 for title selection, 0.62 for abstract selection and 1 for full-text selection, representing substantial to perfect agreement. All seven included studies focused on physical activity interventions. None reported on sedentary behaviour.
Study characteristics

Table 1 summarises study characteristics. The seven included papers reported seven studies, including seven ACT-based interventions. Four studies were conducted in the USA (Butryn et al., 2011; Fletcher, 2011; Martin et al., 2016; Stevens, 2017), one in Canada (Ivanova et al., 2016), one in Australia (Moffitt and Mohr, 2015), and one in Finland (Kangasniemi et al., 2015). One study was set in a university campus (Butryn et al., 2011), one was set in the community (Martin et al., 2016), one was set in a centre for nutrition and metabolism (Fletcher, 2011), and for four studies the setting was not specified (Ivanova et al., 2016; Kangasniemi et al., 2015; Stevens, 2017; Moffitt and Mohr, 2015). There were six randomized controlled trials (RCTs), and one pre-post study (Martin et al., 2016). Four studies compared an ACT intervention with another intervention (Butryn et al., 2011; Ivanova et al., 2016; Kangasniemi et al., 2015; Moffitt and Mohr, 2015), one study compared an ACT intervention with two other interventions (Stevens, 2017), one study compared an ACT intervention with a no-treatment (wait-list) control group (Fletcher, 2011), and one study used a single-arm (pre-post) design (Martin et al., 2016).

In total, 526 participants were randomized. Sample size ranged from 28 to 138 (median = 72). Four of the studies (Ivanova et al., 2016; Kangasniemi et al., 2015; Martin et al., 2016; Stevens, 2017) recruited healthy adult participants who were ‘low active’ / ‘inactive’ / ‘sedentary’ / ‘insufficiently active’ (all defined as not currently meeting physical activity recommendations), one study recruited participants who were low-moderately active and also in the contemplation or preparation stage of the transtheoretical model (Moffitt and Mohr, 2015), one recruited adult participants who had been or were currently enrolled in a weight loss programme and were interested in increasing their physical activity (Fletcher,
and one study recruited healthy college students (Butryn et al., 2011). Mean age of participants ranged from 22.4yrs to 52.6yrs (median = 43.5yrs). Three studies recruited only female participants (Butryn et al., 2011; Ivanova et al., 2016; Stevens, 2017), in the remaining four studies ≥79% of participants were female. Time to final follow-up, measured from randomisation or baseline measurement, varied from 8 weeks to 6 months (median = 3 months).

Measurement of physical activity behaviour varied greatly. Physical activity behaviour was objectively measured in five studies (one study measured number of visits to an athletic centre (Butryn et al., 2011); one used an Actigraph to measure minutes of physical activity per day (Kangasniemi et al., 2015); one estimated cardio-respiratory fitness as a proxy measure of physical activity (Martin et al., 2016); one used a pedometer to measure step count (Moffitt and Mohr, 2015); and one used a heart-rate monitor to measure total minutes of physical activity over 30 days (Stevens, 2017)). Physical activity behaviour was estimated by self-report in five studies (one study assessed hours per week of exercise using the Godin Leisure-Time Exercise Questionnaire(Ivanova et al., 2016); two assessed MET-minutes using the International Physical Activity Questionnaire (Fletcher, 2011; Moffitt and Mohr, 2015); two assessed minutes of physical activity with 7-day recall (Kangasniemi et al., 2015; Stevens, 2017); and one used The Voluntary Exercise Questionnaire to assess voluntary exercise behaviour over the past month (Stevens, 2017)). Retention at follow-up ranged from 68%-100% (mean =82.6%) in the intervention trial arms; and from 71-95% (mean = 84.7%) in the comparator trial arms.

Overall risk of bias (Figure 2) was high for all seven studies. Five of the six RCTs were coded as being at high risk of bias in missing outcome data (Fletcher, 2011; Ivanova et al., 2016; Kangasniemi et al., 2015; Moffitt and Mohr, 2015; Stevens, 2017). All six RCTs
were coded as having some concerns in the domain of selection of the reported result. Risk of bias could not be coded for the pre-post study (Martin et al., 2016), but overall risk was judged to be high, given the lack of a control.

**Intervention Characteristics**

Table 2 shows the intervention characteristics, ACT Processes and BCTs present in the intervention and comparator trial arms for each of the seven studies. The ACT-based intervention was delivered by the lead author (an ACT interventionist) in one study (Ivanova et al., 2016), by clinicians or students trained in the delivery of ACT in four studies (Butryn et al., 2011; Kangasniemi et al., 2015; Fletcher, 2011; Stevens, 2017), and two studies (Martin et al., 2016; Moffitt and Mohr, 2015) did not specify who delivered the intervention.

ACT intervention delivery had a face-to-face component in six studies (Butryn et al., 2011; Ivanova et al., 2016; Kangasniemi et al., 2015; Martin et al., 2016; Fletcher, 2011; Stevens, 2017) and was delivered via a self-managed DVD in one study (Moffitt and Mohr, 2015). Two of the studies with a face-to-face component delivered the ACT intervention in a single, individual session lasting 40-60 minutes (Ivanova et al., 2016; Stevens, 2017). The remaining four studies with a face-to-face component delivered the ACT intervention in a group setting, with durations ranging from a single six-hour session (Fletcher, 2011) to eight 90-minute sessions over 10 weeks (Martin et al., 2016). In three studies, the intervention condition was an ACT intervention focusing on physical activity (Butryn et al., 2011; Ivanova et al., 2016; Fletcher, 2011). In the four remaining studies, an ACT intervention was combined with additional intervention components – self-monitoring with a pedometer plus feedback on current physical activity (Kangasniemi et al., 2015), a walking programme (Martin et al., 2016), and exercise prescription (Stevens, 2017).
Comparator conditions varied, including education on physical activity (Butryn et al., 2011; Stevens, 2017), mailed feedback on physical activity (Kangasniemi et al., 2015), implementation intentions (Ivanova et al., 2016), a pedometer-based walking programme (Moffitt and Mohr, 2015), exercise prescription (Stevens, 2017), and wait-list control (Fletcher, 2011).

**ACT Processes**

The number and name of ACT processes present in each of the ACT interventions are reported in Table 2. On average, the number of ACT processes (including Creative Hopelessness) targeted by ACT interventions was 5.7 (range 5-7). Cohen's kappa (κ) was calculated for each ACT process and ranged from 0.59 (for Contact-with-the-Present-Moment) to 1 (for Acceptance, Self-As-Context, and Values), representing moderate to perfect agreement between raters. Table 3 shows the total number of studies targeting each of the ACT processes. Of the six core ACT processes, Defusion, Values and Committed Action were targeted by the ACT intervention in all seven studies, Acceptance was targeted in six studies (Butryn et al., 2011; Fletcher, 2011; Ivanova et al., 2016; 2015; Martin et al., 2016; Moffitt and Mohr, 2015; Stevens, 2017); Contact-with-the-Present-Moment was targeted in six studies (Butryn et al., 2011; Fletcher, 2011; Ivanova et al., 2016; Kangasniemi et al., 2015; Martin et al., 2016; Stevens, 2017), and Self-As-Context was targeted in three studies (Fletcher, 2011; Kangasniemi et al., 2015; Martin et al., 2016). Creative Hopelessness was targeted by the ACT intervention in four studies (Butryn et al., 2011; Fletcher, 2011; Ivanova et al., 2016; Moffitt and Mohr, 2015).

Three of the seven studies (Martin et al., 2016; Moffitt and Mohr, 2015; Stevens, 2017) explicitly named all processes targeted. In the remaining four studies, the number of
processes that were identifiable but not explicitly named ranged from one (two studies, Butryn et al., 2011; Fletcher, 2011) to four (one study, Ivanova et al., 2016) (Table 2). Self-as-Context (SAC) and Creative Hopelessness (CH) were more commonly identifiable but not explicitly named – SAC was targeted in three studies (Fletcher, 2011; Ivanova et al., 2016; Kangasniemi et al., 2015; Martin et al., 2016) but only explicitly named in one (Martin et al., 2016), and CH was targeted in four studies (Butryn et al., 2011; Fletcher, 2011; Ivanova et al., 2016; Moffitt and Mohr, 2015) but only explicitly named in two (Fletcher, 2011; Moffitt and Mohr, 2015). No ACT processes were targeted in the comparator interventions.

BCTs (Behaviour change techniques) Applied in Intervention and Comparator groups

The number and name of BCTs present in each of the intervention and comparator conditions are reported in Table 2. On average, the number of BCTs was greater in the intervention condition (mean of 7.0; range 0-11) than in the comparator condition (mean of 4.5; range 2-7) (Table 2). In four of the six studies with a comparator group (Fletcher, 2011; Kangasniemi et al., 2015; Moffitt and Mohr, 2015; Stevens, 2017), the number of BCTs was greater in the intervention condition than in the comparator condition and was equivalent in both conditions in one study (Ivanova et al., 2016). The number of BCTs was greater in the comparator condition than in the intervention condition in the one study in which the ACT intervention was identified as very promising (Butryn et al., 2011).

Table 4 shows the total number of studies with BCTs present (and probably present) in the intervention and comparator conditions. Overall, there were 22 different BCTs (out of a possible 93) identified in the seven studies – 20 different BCTs were identified across the intervention conditions (ACT intervention plus Additional Components) and 17 different BCTs were identified across the comparator conditions. Cohen's kappa (κ) could not be
calculated for 61 BCTs as both raters agreed that these were not included in any of the studies. For the 20 BCTs identified across the intervention conditions (ACT intervention plus Additional Components), Cohen’s kappa ($\kappa$) ranged from 0.7 to 1 representing substantial to perfect agreement between raters. For the 17 BCTs identified across the comparator conditions, Cohen's kappa ($\kappa$) ranged from 0.46 to 1 representing moderate to perfect agreement between raters.

**BCTs in the intervention condition: ACT intervention.**

There were ten different BCTs across all ACT interventions (excluding any additional components) (Table 4) with a mean of 2.6 (range 0-4) BCTs per intervention. The most common BCTs were 1.2 Problem solving, 1.3 Goal Setting (outcome) and 1.9 Commitment (all of which were identified in 3 of the 7 ACT interventions). The BCTs 1.4 Action Planning, and 5.4 Monitoring of emotional consequences were identified in 2 of the 7 ACT interventions. The remaining five BCTs were identified in only one of the seven ACT interventions.

In all six studies with a comparator, the comparator intervention contained more BCTs (mean = mean of 4.5; range 2-7) than the ACT intervention (mean = 2.8; range 0-4). Five BCTs were unique to the ACT intervention (not present in the additional components or comparator intervention): 1.7 Review outcome goal(s) (probably present in one intervention, Kangasniemi et al., 2015), 1.9 Commitment (present in two interventions (Fletcher, 2011; Stevens, 2017), probably present in one intervention (Moffitt and Mohr, 2015)), 5.4 Monitoring of emotional consequences (present in two interventions (Martin et al., 2016; Stevens, 2017)), 5.6 Information about emotional consequences (present in one intervention (Fletcher, 2011)), 15.4 Self-talk (probably present in one intervention (Ivanova et al., 2016)).
BCTs in the intervention condition: additional components.

There were 14 different BCTs across the additional components (that were combined with the ACT intervention) (Table 4) with a mean of 6.2 (range 4-8) BCTs per intervention - this included one study (Fletcher, 2011) in which additional BCTs were identifiable as probably present in the weight loss programme from which participants were recruited. The most common BCTs were 1.1 Goal Setting (behaviour), 1.4 Action Planning, 2.3 Self-monitoring of behaviour and 12.5 Adding objects to the environment (all of which were identified in 4 of the 4 interventions that combined ACT with additional components (Kangasniemi et al., 2015; Martin et al., 2016; Moffitt and Mohr, 2015; Stevens, 2017)). The remaining ten BCTs were identified as additional components in only 1-2 of the seven studies. No BCTs were unique to the additional components (not present in the ACT intervention or comparator intervention).

BCTs in comparator condition.

Seventeen different BCTs were present or probably present across the comparator interventions (Table 4) with a mean of 4.5 (range 2-7) BCTs per intervention - again this included one study (Fletcher, 2011) in which BCTs were identifiable as probably present in the weight loss programme from which participants were recruited. The most common BCTs were 1.1 Goal Setting (behaviour), 1.4 Action Planning, and 2.3 Self-monitoring of behaviour (all of which were identified in 4 of 7 studies). The remaining fourteen BCTs were identified in the comparator intervention of only 1-2 of the seven studies. Two BCTs were unique to the comparator intervention (not present in the ACT intervention or additional components): 1.5 Review behaviour goal(s) (probably present in one intervention, (Stevens, 2017)), 10.9. Self-reward (probably present in one intervention, (Stevens, 2017)).
Table 5 reports the physical activity outcomes for each study (outcomes included in the meta-analysis are underlined). Six studies were included in the random effects meta-analysis, four studies reported an objective measure of physical activity (Butryn et al., 2011; Kangasniemi et al., 2015; Martin et al., 2016; Stevens, 2017), two studies reported only self-report measures of physical activity (Fletcher, 2011; Ivanova et al., 2016). One study (Martin, 2015) was excluded from the statistical analysis because it was a pre-post study with no control group.

The ACT-based physical activity interventions had a large, statistically significant effect on physical activity behaviour, (SMD=1.21, 95% CI (0.16, 2.26), p=0.02). (Figure 3). The Chi-square test indicates that statistically significant heterogeneity is present among studies ($x^2=104.39$, $p<0.00001$) to a high degree ($I^2=95\%$). After removing 1 outlier (Fletcher, 2011), there was no significant heterogeneity present among the remaining five studies ($x^2=4.79$, $p=0.31$; $I^2=17\%$), and ACT-based physical activity interventions had a small-to-moderate, statistically significant effect on physical activity behaviour, (SMD=0.32, 95% CI (0.07, 0.57), $p=0.01$). (Figure 4). There were an insufficient number of studies to run the planned meta-regression. Publication bias was not assessed as there were inadequate numbers of included trials to properly assess a funnel plot or more advanced regression-based assessments.

**Discussion**

**The Effectiveness of ACT Interventions for Physical Activity**

The main aim of this review was to examine the effectiveness of ACT-based interventions for physical activity. Seven studies, including six RCTs, reporting seven ACT-
based interventions were identified. After the removal of one outlier, the meta-analysis showed a significant, small-to-moderate effect of ACT-based interventions on physical activity. Given the high risk of bias across all seven studies, the heterogeneity in physical activity outcome measures, as well as intervention and comparator characteristics, this finding should be interpreted with caution. Nevertheless, the results of this meta-analysis show promising results for ACT-based physical activity interventions.

**ACT Processes Targeted by ACT-interventions for Physical Activity**

Three ACT processes *Defusion, Values* and *Committed Action* were targeted by ACT-based interventions in all seven of the identified studies, while *Acceptance* and *Contact-with-the-Present-Moment* were targeted in six studies. Despite not being one of the six core ACT processes, *Creative Hopelessness* was targeted by the ACT intervention in four studies, whereas *Self-As-Context* (which is a core ACT process) was targeted in only three studies. Given the low number of ACT-based intervention studies, that all studies targeted at least five of the seven ACT processes, and that in four studies the ACT intervention was combined with additional intervention components, it is not possible to speculate about which ACT processes might be associated with effective interventions.

However, the following points are worth noting: (1) Only three of the seven studies explicitly named all processes targeted; in the remaining four studies some processes were identifiable but not explicitly named. For transparency, ease of replication and interpretation of findings, future studies should explicitly name processes targeted; (2) No reasons were given for why certain processes were targeted and others were not. Given the synergistic nature of the ACT processes (inter-related and over-lapping processes) (Hayes et al. 1999; Hayes et al. 2006) future studies should report the theoretical rationale for targeting some
ACT processes and not others; (3) It is interesting that the least commonly targeted process, 
*Self-As-Context*, is also the process that is notoriously difficult to understand conceptually, 
and one that practitioners often report that they struggle to address in practice (Westrup and 
Wright 2017). This raises the question of whether a process that is considered to be central to 
the ACT model is often left out of interventions because intervention developers find it too 
tricky to incorporate, or whether the process is difficult to identify when it is not explicitly 
named as a targeted process; (4) As already mentioned, in four of the seven studies, the ACT 
intervention was combined with additional intervention components such as feedback on 
current physical activity (Kangasniemi et al., 2015), a walking programme (Martin et al., 
2016; Moffitt and Mohr, 2015), and exercise prescription (Stevens, 2017). To appropriately 
examine the effectiveness of ACT-based interventions for physical activity, we would 
recommend that future studies include an ‘ACT-only’ intervention condition that includes no 
additional intervention components.

**Behaviour Change Techniques (BCTs) Present in ACT Interventions for Physical Activity**

Given that ACT processes are theoretical constructs, not intervention techniques, no 
BCTs could be identified in an intervention based on the process name (e.g. *Acceptance*) 
alone. Instead, BCTs could only be identified from intervention descriptions (Butryn et al., 
2011; Ivanova et al., 2016; Kangasniemi et al., 2015; Martin et al., 2016; Moffitt and Mohr, 
2015; Fletcher, 2011; Stevens, 2017), protocols (Ivanova et al., 2016; Fletcher, 2011) or 
fidelity checklists (Stevens, 2017). However, much of the intervention content did not fall 
into the existing BCTTv1 categories – on average over the seven studies, ACT-based 
interventions for physical activity included only 2.6 BCTs per intervention. This number is 
surprisingly low for a physical activity intervention, especially one that is theory-based; a
recent meta-analysis of physical activity interventions for healthy inactive adults (Howlett et al. 2019) found that the 26 included interventions contained an average of 8.4 BCTs. One explanation for the finding of the low number of BCTs in ACT interventions for physical activity is that four of the seven ACT interventions in this review were combined with additional components, and that when considered together, the overall intervention (ACT + additional components), the average number of BCTs was much higher at 7.0 BCTs per intervention. Alternatively, it is possible that, as five of the seven studies did not include an intervention protocol or fidelity checklist, BCT content could only be coded from intervention descriptions in the main text, and these descriptions may have been insufficient to identify the full number of BCTs in these interventions. This explanation is potentially unlikely, however, as the average number of BCTs identified in the comparator conditions of the current review (mean = 4.5 BCTs) is very similar to that of Howlett et al. (2019), who identified an average of 5.1 BCTs in comparator conditions. Furthermore, only 2-4 BCTs were identified in the ACT interventions for which full protocols (Ivanova et al., 2016; Fletcher, 2011) or a comprehensive fidelity checklist (Stevens, 2017) were published.

An alternative explanation for these findings is that ACT interventions contain very little in the way of ‘active ingredients’ as currently recognised and defined by the BCTTv1. This explanation may be plausible given that the model of behaviour change (psychological flexibility) and the behaviour change processes (acceptance, defusion, contact-with-the-present-moment, self-as-context, values, and committed action) that underlie ACT are relatively new in the field of behaviour change, having only been around for the last two-three decades (Hayes et al., 1999; Hayes et al., 2006).

Interestingly, three of the five BCTs identified in this current review as being unique to the ACT intervention (1.9 Commitment, 5.4 Monitoring of emotional consequences, 5.6...
Information about emotional consequences were not implemented in any of the 26 physical activity interventions included in Howlett et al.’s review. Furthermore, Howlett et al. (2019) found that the most frequently used BCTs in physical activity interventions were 1.1 Goal setting (behaviour) (22 studies) and 3.1 Social support (unspecified) (20 studies) – neither of which were included in any of the ACT interventions in the current review. Together, these findings again could be seen to point to the possibility that interventions based on ACT (and the psychological flexibility model) may include atypical BCTs (perhaps even some not currently included in the BCTTv1) because they target unique behaviour change processes not present in other models of behaviour change. However, it is important to note that goal-setting as a technique can be (and often is) used to target the Committed Action process of the psychological flexibility model (Hayes et al., 2006). Given that ACT interventions are often defined in terms of the behaviour change processes they target, rather than the individual techniques used to target those processes, it is possible that the ACT interventions included in this review may have included goal-setting, but that this BCT could not be identified from intervention descriptions, protocols, or fidelity checklists.

If ACT interventions do indeed contain ‘active ingredients’, and many of these are not currently included in the BCTTv1, we would recommend that future work focus on identifying what techniques are typically employed by ACT interventions, and ultimately aim to determine whether these techniques meet the criteria for inclusion in the BCTTv1 – namely that they:

(a) aim to change behaviour, (b) are proposed “active ingredients” of interventions, (c) are the smallest components compatible with retaining the proposed active ingredients, (d) can be used alone or in combination with other BCTs, (e) are observable and replicable, (f) can have a measurable effect on a
specified behaviour/s, and (g) may or may not have an established empirical
evidence base. (Michie et al., 2013, p84).

Steven Hayes, who developed ACT, has often highlighted that although many of the
techniques in ACT are relatively distinct, many are also shared with other approaches,
particularly cognitive-behavioural approaches, and he has emphasised that it is important not
to view ACT simply as a collection of techniques, but instead as “a perspective into which a
wide variety of [techniques], some identified with ACT and some not, can be deployed in a
coherent fashion linked to basic principles” (Hayes et al., 2013, p9). ACT is a ‘process-based
therapy’ (Hofmann & Hayes, 2019) and the goal of any ACT intervention (whether it’s
applied to health behaviour, mental health, or any other area) is to effect change the six core
processes (i.e. to increase psychological flexibility) in order to ultimately bring about a
change in behaviour (Hayes et al., 2013, p9). Furthermore, Hayes et al. (2013) have
speculated that understanding what techniques are effective is impossible without first
understanding behaviour change processes (Hayes et al., 2013), and Michie and Johnston
(2012) have highlighted the need for “linking active ingredients to an understanding of the
processes involved, that is, to the theoretical basis of behaviour change” (Michie & Johnston,
2012, p4). Consequently, in order to link the active ingredients of ACT interventions with the
underlying psychological flexibility model of behaviour change, we would also recommend
that researchers aim to clearly identify which specific techniques they have included in ACT
interventions (whether these BCTs are included in the BCTTv1 or not) and link these
techniques to the behaviour change processes they are intended to change.

Other Intervention Characteristics
It is well known that intervention effectiveness may depend not only the specific content of the intervention, but also on other intervention characteristics such as how it is delivered, by whom, to whom, in that format, with what intensity, and for how long (Davidson et al., 2003). Again, there was an insufficient number of studies in the current review to draw any conclusions about which of these characteristics may or may not be associated with the effectiveness of ACT interventions for physical activity. Nonetheless, it is perhaps useful to note that ACT interventions for physical activity: (i) have mostly been delivered by trained clinicians or researchers (Butryn et al., 2011; Ivanova et al., 2016; Kangasniemi et al., 2015; Martin et al., 2016; Fletcher, 2011; Stevens, 2017); (ii) can be delivered in self-managed DVD format as well as face-to-face individual or group format; (iii) can be delivered with a wide range of intensities and durations from as little as a single 40 minute session to eight 90-minute sessions.

**Strengths and Limitations**

A robust methodological approach and adherence to a published protocol and PRISMA are strengths of this review. The use of the BCTTv1 (Michie et al., 2013) allowed a thorough analysis of intervention components included in ACT interventions, and to the authors’ knowledge this is the first time ACT intervention content in any field has been coded using the BCTTv1.

Several of the limitations of this review are a consequence of methodological weaknesses of the included studies, but also represent opportunities for future research. First, measurement of physical activity behaviour varied greatly, and only four of the six RCTs included an objective measure of physical activity. We echo previous calls for future research to standardize measurement of physical activity so that data can be pooled more meaningfully (Autier & Pizot, 2016; Howlett et al., 2019).
A second limitation was that included studies were limited by small sample sizes (with all but one study having fewer than 100 participants), and a predominance of female participants. Given that the findings of this review add to the growing body of evidence that ACT-based interventions have shown promise for promoting a range of health behaviours including physical activity, we would recommend that future research focuses on exploring the effectiveness of ACT for physical activity in large-scale, randomized controlled trials. Although the predominance of female participants is typical of health behaviour research samples, with males comprising about 20% of samples (Ryan et al., 2019), future research should attempt to explore ways to increase recruitment of male participants, either in mixed- or single-gender studies.

Finally, in all four studies where additional components were added to the ACT interventions, the additional components contained more BCTs (identified using the BCTTv1) than the ACT intervention itself. Additionally, in all six studies with a comparator, the comparator intervention contained more BCTs (as identifiable using the BCTTv1) than the ACT intervention. The addition of ‘active ingredients’ to many of the ACT intervention, along with the high number of ‘active ingredients’ in the comparator conditions consequently reduces the ability to draw conclusions about the effectiveness of ACT interventions for increasing physical activity. We would recommend that future research: (i) minimise (ideally to zero) the number of active ingredients in a control comparator condition; (ii) explore the effectiveness of ACT interventions delivered with and without additional intervention components (such as the addition of a pedometer, a walking programme, implementation intentions, etc); (iii) clearly describe and name the behaviour change processes and techniques used in ACT interventions, where possible using the standardised terminology of the Behaviour Change Technique Taxonomy v1 (Michie et al., 2013), and highlighting where
necessary when the ‘active ingredients’/behaviour change techniques used are not part of the existing taxonomy.

Conclusions

ACT interventions show promise for increasing physical activity behaviour, but as yet no definitive conclusions can be drawn regarding the most effective intervention components or characteristics. Future development of ACT interventions for physical activity should attempt to describe and name the ACT processes targeted by the intervention, and the behaviour change techniques used to target those processes. Future trials should employ more high-quality study designs, with larger sample sizes, longer-term follow-ups, and use a standardised, objective measure of physical activity.
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## Tables

### Table 1: Selected characteristics of included studies

<table>
<thead>
<tr>
<th>Author; year; country</th>
<th>Participants</th>
<th>Setting</th>
<th>Population</th>
<th>Design</th>
<th>Trial arms</th>
<th>Measurement times</th>
<th>PA outcome measure(s)</th>
<th>Retention % (N at follow-up / N randomized)</th>
<th>Overall risk of bias</th>
</tr>
</thead>
<tbody>
<tr>
<td>Butryn et al.; 2011 USA</td>
<td>54 ACT: 35 ED: 19</td>
<td>University</td>
<td>College students</td>
<td>RCT</td>
<td>1. ACT 2. ED</td>
<td>Baseline 5 weeks 8 weeks</td>
<td>PA behaviour: 1. Number of days/week that participants entered the athletic centre [O]</td>
<td>ACT: 80% (28/35) ED: 95% (18/19)</td>
<td>High</td>
</tr>
<tr>
<td>Fletcher; 2011 USA</td>
<td>72 ACT: 36 Control: 36</td>
<td>Center for Nutrition and Metabolism (CNM) at University Medical School.</td>
<td>Adults Current or past enrolment on weight loss programme Interest in increasing PA</td>
<td>RCT</td>
<td>1. ACT 2. Control</td>
<td>Baseline 3 months</td>
<td>PA behaviour: 1. MET-minutes (International Physical Activity Questionnaire, IPAQ, long form) [SR] 2. Estimated Kcal Expended during past week (International Physical Activity Questionnaire, IPAQ, long form) [SR]</td>
<td>ACT: 81% (29/36) Control: 89% (32/36)</td>
<td>High</td>
</tr>
<tr>
<td>Ivanova et al.; 2016 Canada</td>
<td>39 ACT: 18 II: 21</td>
<td>Not specified</td>
<td>Adults Low active (not meeting minimum PA recs); Contemplation or Preparation Stages of Change</td>
<td>RCT</td>
<td>1. ACT 2. II</td>
<td>Baseline 6 months</td>
<td>PA behaviour: 1. Hours/week of at least moderate exercise expressed as an activity score (Godin Leisure-Time Exercise Questionnaire; GLTEQ) [SR]</td>
<td>ACT: 89% (16/18) II: 80% (16/20)</td>
<td>High</td>
</tr>
<tr>
<td>Kangasniemi et al.; 2015 Finland</td>
<td>138 ACT+SM+FB: 69 FB: 69</td>
<td>Not specified</td>
<td>Adults Inactive (not meeting minimum PA recs)</td>
<td>RCT</td>
<td>1. ACT+SM +FB 2. FB</td>
<td>Baseline 3 months 6 months</td>
<td>PA behaviour: 1. Health-enhancing physical activity (HEPA) time, min/day (Actigraph) [O] 2. Moderate-to-vigorous intensity physical activity (MVPA) time, min/day (Actigraph) [O] 3. Self-reported physical activity, min/day (7-day recall) [SR]</td>
<td>ACT+SM+FB: 78% (54/69) FB: 71% (49/69)</td>
<td>High</td>
</tr>
<tr>
<td>Martin et al.; 2015 USA</td>
<td>28</td>
<td>Community-based, university-affiliated mental health clinic</td>
<td>Adults ‘Sedentary’ (not meeting minimum PA recs)</td>
<td>Pre-post trial</td>
<td>1. ACT+WP</td>
<td>Baseline 10 weeks</td>
<td>Cardio-respiratory fitness (CRF): 1. 1-mile walk-test time in seconds (Rockport 1-mile walk test) [O] 2. Estimated aerobic capacity (VO2max), in ml/kg/min (Rockport 1-mile walk test) [O]</td>
<td>ACT+WP: 68% (19/28)</td>
<td>High</td>
</tr>
<tr>
<td>Moffitt and Mohr; 2015 Australia</td>
<td>76 ACT+WP: 39 WP: 37</td>
<td>Not specified</td>
<td>Adults Low or moderate PA in the contemplation or preparation stage of the transtheoretical model</td>
<td>RCT</td>
<td>1. ACT+WP 2. WP</td>
<td>Baseline 4 weeks* 8 weeks*</td>
<td>PA behaviour: 1. MET-minutes (International Physical Activity Questionnaire, IPAQ, long form) [SR] 2. Step count (in thousands), (G-Sensor 2026 Pedometer) [O] (during and post-intervention only - no baseline)</td>
<td>ACT+WP: 82% (32/39) WP: 73% (27/37)</td>
<td>High</td>
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<tr>
<td>Stevens; 2017</td>
<td>119</td>
<td>21-65yrs, 39.22yrs, 100% F</td>
<td>Adults</td>
<td>Not specified</td>
<td>RCT</td>
<td>Baseline</td>
<td>PA behaviour:</td>
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<tr>
<td>ACT+EP: 40</td>
<td>1. ACT+EP</td>
<td>1. Total mins of exercise over 30 days (Heart rate monitor, HRM, data) [O] (Month 1 only)</td>
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<tr>
<td>ED+EP:40</td>
<td>2. ED+EP</td>
<td>2. Total mins of exercise over 30 days (daily exercise journal) [SR] (Month 1 only)</td>
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<td>ACT+EP: 100% (40/40)</td>
<td>ACT+EP: High</td>
<td>ACT+EP: 100% (40/40)</td>
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<tr>
<td>ED+EP: 90% (36/40)</td>
<td>ED+EP: High</td>
<td>ED+EP: 90% (36/40)</td>
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</table>

ACT, Acceptance and Commitment Therapy; ED, education; EP, exercise prescription; F, female; FB, feedback; II, implementation intentions; N, number; O, objective; PA, physical activity; RCT, randomized controlled trial; SM, self-monitoring; SR, self-report; WP, walking programme.
Table 2: Intervention characteristics, ACT Processes and BCTs present in the Intervention and Comparator Trial Arms

<table>
<thead>
<tr>
<th>Author; year</th>
<th>Description of Trial Arms</th>
<th>Delivery Provider</th>
<th>Format / Duration/ Intensity/Materials</th>
<th>ACT Processes (N) Explicit (identifiable*)</th>
<th>BCTs (N) Present (probably present*)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Butryn et al.; 2011</td>
<td>ACT: ACT intervention focusing on PA. ED: Education intervention focusing on PA.</td>
<td>Advanced graduate student &amp; Clinical Psychologist</td>
<td>Face-to-face Group 2x 2-hr sessions (2 weeks apart)</td>
<td>ACT: (N=6) Acceptance Defusion Contact Present Moment Values Committed Action Creative Hopelessness*</td>
<td>ACT: (N=0) ED: (N=3) 2.3 Self-monitoring of behaviour* 4.1 Instruction on how to perform the behaviour* 5.3 Information about social and environmental consequences*</td>
</tr>
<tr>
<td>Fletcher; 2011</td>
<td>ACT: ACT intervention focusing on PA. Control: Wait-list control</td>
<td>Qualified, doctoral level graduates experienced in the delivery of ACT</td>
<td>ACT: Face-to-face Group 1x 6hr workshop</td>
<td>ACT: (N=7) Acceptance Defusion Contact Present Moment Self-As-Context* Values Committed Action Creative Hopelessness*</td>
<td>ACT: (N=4) 1.2 Problem solving* 1.9 Commitment 5.1 Information about health consequences 5.6 Information about emotional consequences 1.2 Problem solving* 1.3. Goal setting (outcome)* 2.4. Self-monitoring of outcome(s) of behaviour* 2.7. Feedback on outcome(s) of behaviour* Control: (N=4) 1.2 Problem solving* 1.3. Goal setting (outcome)* 2.4. Self-monitoring of outcome(s) of behaviour* 2.7. Feedback on outcome(s) of behaviour*</td>
</tr>
<tr>
<td>Ivanova et al.; 2016</td>
<td>ACT: ACT intervention focusing on PA. II: Implementation intentions (II) intervention focusing on PA</td>
<td>ACT Interventionist (lead author)</td>
<td>Face-to-face Individual 1x 40min session</td>
<td>ACT: (N=6) Acceptance Defusion Contact Present Moment* Values* Committed Action* Creative Hopelessness*</td>
<td>ACT: (N=2) 1.3. Goal setting (outcome)* 15.4 Self-talk* II: (N=2) 1.1 Goal-setting (behaviour) 1.4 Action Planning</td>
</tr>
<tr>
<td>Kangasniemi et al.; 2015</td>
<td>ACT+SM+FB: ACT intervention focusing on PA plus feedback (FB) on PA. FB: Feedback (FB) on PA.</td>
<td>ACT+SM+FB: Three-five group leaders trained in ACT and supervised by researcher</td>
<td>ACT+SM+FB: Face-to-face Group 6x 90min sessions (over 9 weeks) Pedometer Written feedback (via mail)</td>
<td>ACT: (N=5) Defusion* Contact Present Moment Self-As-Context* Values Committed Action</td>
<td>ACT+SM+FB: (N=4) 1.2 Problem solving* 1.3. Goal setting (outcome)* 1.4 Action Planning 1.7. Review outcome goal(s)* 1.1 Goal-setting (behaviour)* 1.4 Action Planning* 1.6. Discrepancy between current behaviour and goal* 2.2. Feedback on behaviour 2.3. Self-monitoring of behaviour 2.7. Feedback on outcome(s) of behaviour</td>
</tr>
<tr>
<td>Study</td>
<td>Type of Intervention</td>
<td>Duration/Details</td>
<td>ACT (N)</td>
<td>ACT+WP (N)</td>
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<tr>
<td>Martin et al., 2016</td>
<td>ACT+WP: ACT intervention focusing on PA plus based walking programme</td>
<td>Face-to-face Group 8 x 90min sessions (over 10 weeks)</td>
<td>(N=6)</td>
<td>(N=6)</td>
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<tr>
<td>Moffitt and Mohr, 2015</td>
<td>ACT+WP: ACT intervention focusing on PA plus pedometer-based walking programme</td>
<td>Face-to-face Individual 1 x information session Information booklet</td>
<td>(N=5)</td>
<td>(N=4+7)</td>
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<tr>
<td>Stevens, 2017</td>
<td>ACT + EP: ACT intervention focusing on PA plus exercise prescription</td>
<td>Research Assistant 3 clinical psychology doctoral students trained to deliver workshop protocols</td>
<td>(N=5)</td>
<td>(N=3+3)</td>
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</tbody>
</table>

1.2.5 Adding objects to the environment

FB: (N=6)
1.1 Goal setting (behaviour)*
1.4 Action Planning*
1.6. Discrepancy between current behaviour and goal*
2.2. Feedback on behaviour
2.3 Self-monitoring of behaviour
2.7. Feedback on outcome(s) of behaviour

5.4 Monitoring of emotional consequences
1.1 Goal setting (behaviour)
1.4 Action Planning
2.1. Monitoring of behaviour by others without feedback*
2.4. Self-monitoring of outcome(s) of behaviour
4.1 Instruction on how to perform the behaviour
8.7 Graded tasks
12.5 Adding objects to the environment

WP: (N=7)
1.1 Goal setting (behaviour)
1.4 Action Planning
2.1. Monitoring of behaviour by others without feedback*
2.3 Self-monitoring of behaviour
5.3 Information about social and environmental consequences
8.7 Graded tasks
12.5 Adding objects to the environment

WP: (N=0)
1.1 Goal setting (behaviour)
1.9 Commitment*
12.5 Adding objects to the environment
1.1 Goal setting (behaviour)
1.4 Action Planning
2.1. Monitoring of behaviour by others without feedback*
2.4. Self-monitoring of outcome(s) of behaviour
5.3 Information about social and environmental consequences
8.7 Graded tasks
12.5 Adding objects to the environment
<table>
<thead>
<tr>
<th>Exercise prescription</th>
<th>EP: (N=0)</th>
<th>EDUC+EP: (N=8+5)</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>1.1 Goal setting (behaviour)</td>
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<td>1.2 Problem solving</td>
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<td>1.3 Goal setting (outcome)*</td>
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<td>1.4 Action Planning</td>
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<td>1.5 Review behaviour goal(s)*</td>
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<td>4.1 Instruction on how to perform the behaviour</td>
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<td>5.1 Information about health consequences</td>
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<td>10.9. Self-reward*</td>
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<tr>
<td></td>
<td></td>
<td>1.1 Goal setting (behaviour)</td>
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<td>1.4 Action Planning</td>
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<td>2.3 Self-monitoring of behaviour</td>
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<td>4.1 Instruction on how to perform the behaviour*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>12.5 Adding objects to the environment</td>
</tr>
</tbody>
</table>

EP: (N=5)

1.1 Goal setting (behaviour)
1.4 Action Planning
2.3 Self-monitoring of behaviour
4.1 Instruction on how to perform the behaviour*
12.5 Adding objects to the environment

---

ACT, Acceptance and Commitment Therapy; BCTs, Behaviour Change Techniques; ED, education; EP, exercise prescription; F, female; FB, feedback; II, implementation intentions; N, number; O, objective; PA, physical activity; RCT, randomized controlled trial; SM, self-monitoring; WP, walking programme.

Text in grey shows the characteristics and BCTs of the additional intervention components that were added to the ACT intervention.
### Table 3: Total number of studies targeting ACT processes

<table>
<thead>
<tr>
<th>ACT Process</th>
<th>N studies targeting ACT process (identifiable)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acceptance / Willingness</td>
<td>6</td>
</tr>
<tr>
<td>Defusion</td>
<td>7 (1)</td>
</tr>
<tr>
<td>Contact with the Present Moment</td>
<td>6 (1)</td>
</tr>
<tr>
<td>Self-as-Context</td>
<td>3 (2)</td>
</tr>
<tr>
<td>Values</td>
<td>7 (1)</td>
</tr>
<tr>
<td>Committed Action</td>
<td>7 (1)</td>
</tr>
<tr>
<td>Creative Hopelessness</td>
<td>4 (2)</td>
</tr>
</tbody>
</table>

ACT, Acceptance and Commitment Therapy; N, number
### Table 4: Total number of studies with BCTs present (probably present) in the intervention and comparator conditions

<table>
<thead>
<tr>
<th>BCT Grouping (BCTTv1)</th>
<th>BCT Number and Name (BCTTv1)</th>
<th>N studies with BCT in Intervention condition</th>
<th>N studies with BCT in Comparator condition</th>
<th>N studies with BCT in either condition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>ACT Intervention</td>
<td>Additional Components</td>
<td></td>
</tr>
<tr>
<td>1. Goals and planning</td>
<td>1.1 Goal setting (behaviour)</td>
<td>0</td>
<td>4 (1)</td>
<td>4 (1)</td>
</tr>
<tr>
<td></td>
<td>1.2 Problem solving</td>
<td>3 (2)</td>
<td>1 (1)</td>
<td>2 (1)</td>
</tr>
<tr>
<td></td>
<td>1.3 Goal setting (outcome)</td>
<td>3 (3)</td>
<td>1 (1)</td>
<td>2 (2)</td>
</tr>
<tr>
<td></td>
<td>1.4 Action Planning</td>
<td>2 (1)</td>
<td>4 (1)</td>
<td>4 (1)</td>
</tr>
<tr>
<td></td>
<td>1.5 Review behaviour goal(s)</td>
<td>0</td>
<td>0</td>
<td>1 (1)</td>
</tr>
<tr>
<td></td>
<td>1.6. Discrepancy between current behaviour and goal</td>
<td>0</td>
<td>1 (1)</td>
<td>1 (1)</td>
</tr>
<tr>
<td></td>
<td>1.7. Review outcome goal(s)</td>
<td>1 (1)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>1.9 Commitment</td>
<td>3 (1)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2. Feedback and monitoring</td>
<td>2.1. Monitoring of behaviour by others without feedback</td>
<td>0</td>
<td>2 (2)</td>
<td>1 (1)</td>
</tr>
<tr>
<td></td>
<td>2.2. Feedback on behaviour</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>2.3 Self-monitoring of behaviour</td>
<td>0</td>
<td>4</td>
<td>4 (1)</td>
</tr>
<tr>
<td></td>
<td>2.4. Self-monitoring of outcome(s) of behaviour</td>
<td>0</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>2.7. Feedback on outcome(s) of behaviour</td>
<td>0</td>
<td>2 (1)</td>
<td>2 (1)</td>
</tr>
<tr>
<td>4. Shaping knowledge</td>
<td>4.1 Instruction on how to perform the behaviour</td>
<td>0</td>
<td>2 (1)</td>
<td>2 (1)</td>
</tr>
<tr>
<td>5. Natural consequences</td>
<td>5.1 Information about health consequences</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>5.3 Information about social and environmental</td>
<td>0</td>
<td>1</td>
<td>2 (1)</td>
</tr>
<tr>
<td></td>
<td>5.4 Monitoring of emotional consequences</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>5.6 Information about emotional consequences</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>8. Repetition and substitution</td>
<td>8.7 Graded tasks</td>
<td>0</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>10. Reward and threat</td>
<td>10.9. Self-reward</td>
<td>0</td>
<td>0</td>
<td>1 (1)</td>
</tr>
<tr>
<td>12. Antecedents</td>
<td>12.5 Adding objects to the environment</td>
<td>1</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>15. Self-belief</td>
<td>15.4 Self-talk</td>
<td>1 (1)</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

ACT, Acceptance and Commitment Therapy; BCTs, Behaviour Change Techniques; BCTTv1 Behaviour Change Technique Taxonomy version 1; N, number
### Table 5: Physical activity outcomes

<table>
<thead>
<tr>
<th>Author; year</th>
<th>Physical activity (PA) outcome measure(s)</th>
<th>Timepoint</th>
<th>Mean (SD)</th>
<th>SMD (95%CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Butryn et al.; 2011</td>
<td>1. Number of days/week that participants entered the athletic centre [O]</td>
<td>Baseline</td>
<td>ACT= 1.15 (1.43); ED= 1.17 (1.36)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>5 weeks</td>
<td>ACT= 1.89 (1.43); ED = 1.00 (1.15)</td>
<td>0.66 (0.05 to 1.27)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8 weeks</td>
<td>ACT= 1.50 (15.56); ED= 0.89 (1.48)</td>
<td>0.05 (-0.54 to 0.64)</td>
</tr>
<tr>
<td>Fletcher; 2011</td>
<td>1. MET-minutes (International Physical Activity Questionnaire, IPAQ, long form) [SR]</td>
<td>Baseline</td>
<td>ACT= 2862.3 (144.00); Ctrl= 2180.9 (150.00)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 months</td>
<td>ACT= 3956.4 (261.60); Ctrl = 2332.9 (246.00)</td>
<td>6.33 (5.17 to 7.48)</td>
</tr>
<tr>
<td></td>
<td>2. Estimated Kcal Expended during past week (International Physical Activity Questionnaire, IPAQ, long form) [SR]</td>
<td>Baseline</td>
<td>ACT = 1958.3 (1243.20); Ctrl = 1878.6 (1239.00)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 months</td>
<td>ACT= 1572.8 (1594.20); Control = 1851.4 (1395.00)</td>
<td>-0.18 (-0.65 to 0.28)</td>
</tr>
<tr>
<td>Ivanova et al.; 2016</td>
<td>1. Hours/week of at least moderate exercise expressed as an activity score (GLTEQ) [O]</td>
<td>Baseline</td>
<td>ACT =9.81 (11.98); II =14.53 (12.37)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6 months</td>
<td>ACT =23.59 (21.42); II=18.18 (12.71)</td>
<td>0.30 (-0.40 to 1.00)</td>
</tr>
<tr>
<td>Kangasniemi et al.; 2015</td>
<td>1. Health-enhancing physical activity (HEPA) time, min/day (Actigraph) [O]</td>
<td>Baseline</td>
<td>ACT+FB = 6.4 (7.4); FB=5.8 (6.1)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 months</td>
<td>ACT+FB =10.1 (9.9); FB =9.0 (11.8)</td>
<td>0.10 (-0.27 to 0.47)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6 months</td>
<td>ACT+FB =11.9 (14.0); FB =10.3 (13.4)</td>
<td>0.12 (-0.27 to 0.50)</td>
</tr>
<tr>
<td></td>
<td>2. Moderate-to-vigorous intensity physical activity (MVPA) time, min/day (Actigraph) [O]</td>
<td>Baseline</td>
<td>ACT+FB =26.2 (12.4); FB =22.8 (12.5)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 months</td>
<td>ACT+FB =27.4 (14.5); FB =24.3 (14.9)</td>
<td>0.21 (-0.17 to 0.58)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6 months</td>
<td>ACT+FB =29.5 (17.6); FB =26.6 (16.8)</td>
<td>0.17 (-0.22 to 0.55)</td>
</tr>
<tr>
<td></td>
<td>3. Self-reported physical activity, min/day (7-day recall) [SR]</td>
<td>Baseline</td>
<td>ACT+FB =15.4 (14.6); FB =11.6 (11.4)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 months</td>
<td>ACT+FB = 17.4 (14.3); FB =15.6 (15.7)</td>
<td>0.12 (-0.26 to 0.49)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6 months</td>
<td>ACT+FB =25.1 (18.0); FB =18.9 (14.5)</td>
<td>0.37 (-0.02 to 0.76)</td>
</tr>
</tbody>
</table>
### Martin et al., 2016

1. **CRF** 1-mile walk-test time in seconds (Rockport 1-mile walk test) [O]
   - Baseline: ACT = 980.95 (99.34)
   - 10 weeks: ACT = 916.26 (102.54)
   - Significance: \( p = 0.65 \) (0.01 to 1.29)

2. **CRF** Estimated aerobic capacity (VO2max), in ml/kg/min (Rockport 1-mile walk test) [O]
   - Baseline: ACT = 24.43 (6.71)
   - 10 weeks: ACT = 27.34 (6.83)
   - Significance: \( p = 0.43 \) (1.07 to 0.21)

### Moffitt and Mohr, 2015

1. **MET** minutes (International Physical Activity Questionnaire, IPAQ, long form) [SR]
   - Baseline: ACT+WP = 540.09 (608.82); WP = 466.13 (419.68)
   - 12 weeks: ACT+WP = 1892.72 (2840.93); WP = 776.72 (731.63)
   - Significance: \( p = 0.51 \) (0.01 to 1.03)

2. Step count (in thousands), (G-Sensor 2026 Pedometer) [O]
   - 4 weeks: ACT+WP = 35.48 (21.27); WP = 23.16 (14.28)
   - 8 weeks: ACT+WP = 34.04 (24.44); WP = 27.41 (25.63)
   - Significance: \( p = 0.26 \) (0.25 to 0.78)

   - 12 weeks: ACT+WP = 42.68 (33.28); WP = 20.04 (17.23)
   - Significance: \( p = 0.82 \) (0.29 to 1.36)

### Stevens, 2017

1. Total mins of exercise over 30 days (Heart rate monitor, HRM, data) [O]
   - 1 month: ACT+EP = 659.64 (496.85); EP = 517.15 (361.75)
   - Significance: \( p = 0.32 \) (0.13 to 0.77)

2. Total mins of exercise over 30 days, daily exercise journal [SR]
   - 1 month: ACT+EP = 886.45 (575.70); EP = 679.47 (442.44)
   - Significance: \( p = 0.40 \) (0.05 to 0.85)

3. Total mins of exercise over 30 days (daily exercise journal) [SR]
   - Baseline: ACT+EP = 70.83; EP = 92.39
   - 1 month: ACT+EP = 192.93; EP = 182.96
   - 3 months: ACT+EP = 179.17; EP = 121.32

4. PAR exercise min/week in past week (Stanford 7-day physical activity recall. PAR) [SR]
   - Baseline: ACT+EP = 50.45; EP = 54.41
   - 1 month: ACT+EP = 179.74; EP = 125.06

5. Voluntary exercise behaviour over the past month, score from 1-21 (The Voluntary Exercise Questionnaire, VEQ) [SR]
   - Baseline: ACT+EP = 6.33; EP = 6.25
   - 1 month: ACT+EP = 12.67; EP = 11.71

**ACT**: Acceptance and Commitment Therapy; **Ctrl**: Control; **ED**: education; **EP**: exercise prescription; **FB**: feedback; **II**: implementation intentions; **N**: number; **M**: mean; **O**: objective; **PA**: physical activity; **RCT**: randomized controlled trial; **SD**: standard deviation; **SR**: self-report; **SM**: self-monitoring; **WP**: walking programme.
Where possible effect sizes were calculated based on postintervention and follow-up means, standard deviations, and sample sizes for each condition to produce standardized mean differences (SMD) with 95% confidence intervals (CIs). Positive effect sizes indicated favourable changes in the ACT intervention groups, compared to the comparator groups. Effect sizes of >0.2, >0.5 and >0.8 represent small, medium and large effects, respectively. X = unable to calculate effect size. Outcomes included in the meta-analysis are underlined. † pre-post effect sizes are given when there was no comparator group.
Figure 1. Flow diagram of systematic selection of papers in review. Total numbers are shown in **bold**. Results of the original search (conducted 26th June 2018) plus the results of the updated search (conducted 29th May 2019) are show in [square brackets].
<table>
<thead>
<tr>
<th>Study</th>
<th>Randomization process</th>
<th>Deviations from intended interventions</th>
<th>Missing outcome data</th>
<th>Measurement of the outcome</th>
<th>Selection of the reported result</th>
<th>Overall Bias</th>
</tr>
</thead>
<tbody>
<tr>
<td>Butryn et al.; 2011</td>
<td>?</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>?</td>
<td>-</td>
</tr>
<tr>
<td>Fletcher; 2011</td>
<td>?</td>
<td>+</td>
<td>-</td>
<td>?</td>
<td>?</td>
<td>-</td>
</tr>
<tr>
<td>Ivanova et al.; 2016</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>?</td>
<td>?</td>
<td>-</td>
</tr>
<tr>
<td>Kangasniemi et al.; 2015</td>
<td>?</td>
<td>+</td>
<td>-</td>
<td>?</td>
<td>?</td>
<td>-</td>
</tr>
<tr>
<td>Martin et al.; 2015</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>-</td>
</tr>
<tr>
<td>Moffitt and Mohr; 2015</td>
<td>?</td>
<td>+</td>
<td>-</td>
<td>?</td>
<td>?</td>
<td>-</td>
</tr>
<tr>
<td>Stevens; 2017</td>
<td>?</td>
<td>+</td>
<td>-</td>
<td>?</td>
<td>?</td>
<td>-</td>
</tr>
</tbody>
</table>

+ Low risk
? Some concerns
- High risk
na not assessed

*Figure 2.* Risk of bias assessment according to Version 2 of the Cochrane risk-of-bias tool for randomized trials (RoB 2.0).
Figure 3: Forest plot of the effect of ACT-based interventions versus Comparators on physical activity behaviour expressed as standardised mean difference.

Figure 4: Forest plot of the effect of ACT-based interventions versus Comparators on physical activity behaviour expressed as standardised mean difference, after removing one outlier.
Authors’ contributions

Both authors contributed to designing the review protocol, screening the identified studies, extracting data, and analysing and interpreting the findings. SP drafted the manuscript. Both authors read, contributed to and approved the final manuscript.

Acknowledgements

The authors thank Isla Kuhn for help with search strategies; and Kate Ellis and Joe Oliver for constructive criticism of the manuscript.

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Disclosure statement

The authors report no potential conflict of interest.

Data availability statement

The authors confirm that the data supporting the findings of this study are available within the article and its supplementary materials.
**Supplementary Document 1:** The Interacting Psychological Skills/Processes Identified in the ACT Transdiagnostic Model of Psychological Flexibility (Hayes et al. 1999)

<table>
<thead>
<tr>
<th>Process</th>
<th>Definition (Hayes et al. 2016)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acceptance / Willingness (A)</td>
<td>“Acceptance is taught as an alternative to experiential avoidance. Acceptance involves the active and aware embrace of those private events occasioned by one’s history without unnecessary attempts to change their frequency or form, especially when doing so would cause psychological harm. For example, anxiety patients are taught to feel anxiety, as a feeling, fully and without defense; pain patients are given methods that encourage them to let go of a struggle with pain, and so on.”</td>
</tr>
<tr>
<td>Defusion (D)</td>
<td>“Cognitive defusion techniques attempt to alter the undesirable functions of thoughts and other private events, rather than trying to alter their form, frequency or situational sensitivity. Said another way, ACT attempts to change the way one interacts with or relates to thoughts by creating contexts in which their unhelpful functions are diminished. For example, a negative thought could be watched dispassionately, a person could thank their mind for such an interesting thought, label the process of thinking (“I am having the thought that I am no good”), or examine the historical thoughts, feelings, and memories that occur while they experience that thought.”</td>
</tr>
<tr>
<td>Contact with the Present Moment (CPM)</td>
<td>“ACT promotes ongoing non-judgmental contact with psychological and environmental events as they occur. The goal is to have clients experience the world more directly so that their behavior is more flexible and thus their actions more consistent with the values that they hold. A sense of self called “self as process” is actively encouraged: the defused, non-judgmental ongoing description of thoughts, feelings, and other private events.”</td>
</tr>
<tr>
<td>Self-as-Context (SAC)</td>
<td>“I” emerges over large sets of exemplars of perspective-taking relations (what are termed in RFT “deictic relations”), but since this sense of self is a context for verbal knowing, not the content of that knowing, it’s limits cannot be consciously known. Self as context is important in part because from this standpoint, one can be aware of one’s own flow of experiences without attachment to them or an investment in which particular experiences occur: thus defusion and acceptance is fostered. Self as context is fostered in ACT by mindfulness exercises, metaphors, and experiential processes.”</td>
</tr>
<tr>
<td><strong>Values (V)</strong></td>
<td>“Values are chosen qualities of purposive action that can never be obtained as an object but can be instantiated moment by moment. ACT uses a variety of exercises to help a client choose life directions in various domains (e.g. family, career, spirituality) while undermining verbal processes that might lead to choices based on avoidance, social compliance, or fusion (e.g. “I should value X” or “A good person would value Y” or “My mother wants me to value Z”).”</td>
</tr>
<tr>
<td><strong>Committed Action (CA)</strong></td>
<td>“Finally, ACT encourages the development of larger and larger patterns of effective action linked to chosen values. In this regard, ACT looks very much like traditional behavior therapy, and almost any behaviorally coherent behavior change method can be fitted into an ACT protocol, including exposure, skills acquisition, shaping methods, goal setting, and the like. Unlike values, which are constantly instantiated but never achieved as an object, concrete goals that are values consistent can be achieved and ACT protocols almost always involve therapy work and homework linked to short, medium, and long-term behavior change goals.”</td>
</tr>
<tr>
<td><strong>Creative Hopelessness (CH)</strong></td>
<td>“Purpose: To notice that there is a control agenda in place and notice the basic unworkability of that system; to name the system as inappropriately applied control strategies; to examine why this does not work. Method: Draw out what things the client has tried to make things better, examine whether or not they have truly worked in the client’s experience, and create space for something new to happen. When to use: As a precursor to the rest of the work in order for new responses to emerge, especially when the client is really struggling.”</td>
</tr>
</tbody>
</table>

**References**

** definition taken from [https://contextualscience.org/facing_the_current_situation_creative_hopelessnesscontrol_is_a_problem](https://contextualscience.org/facing_the_current_situation_creative_hopelessnesscontrol_is_a_problem)
Supplementary Document 2: Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement

<table>
<thead>
<tr>
<th>Section/topic</th>
<th>#</th>
<th>Checklist item</th>
<th>Reported on page #</th>
</tr>
</thead>
<tbody>
<tr>
<td>TITLE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Title</td>
<td>1</td>
<td>Identify the report as a systematic review, meta-analysis, or both.</td>
<td>Title Page, page 1</td>
</tr>
<tr>
<td>ABSTRACT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Structured summary</td>
<td>2</td>
<td>Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.</td>
<td>2</td>
</tr>
<tr>
<td>INTRODUCTION</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rationale</td>
<td>3</td>
<td>Describe the rationale for the review in the context of what is already known.</td>
<td>2-7</td>
</tr>
<tr>
<td>Objectives</td>
<td>4</td>
<td>Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).</td>
<td>7</td>
</tr>
<tr>
<td>METHODS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protocol and registration</td>
<td>5</td>
<td>Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.</td>
<td>7</td>
</tr>
<tr>
<td>Eligibility criteria</td>
<td>6</td>
<td>Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.</td>
<td>7-8</td>
</tr>
<tr>
<td>Information sources</td>
<td>7</td>
<td>Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.</td>
<td>8-9</td>
</tr>
<tr>
<td>Search</td>
<td>8</td>
<td>Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.</td>
<td>Supplementary Document 3</td>
</tr>
<tr>
<td><strong>Section/topic</strong></td>
<td><strong>#</strong></td>
<td><strong>Checklist item</strong></td>
<td><strong>Reported on page #</strong></td>
</tr>
<tr>
<td>-------------------</td>
<td>-------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>------------------------</td>
</tr>
<tr>
<td>Study selection</td>
<td>9</td>
<td>State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).</td>
<td>9</td>
</tr>
<tr>
<td>Data collection</td>
<td>10</td>
<td>Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.</td>
<td>9-10</td>
</tr>
<tr>
<td>Data items</td>
<td>11</td>
<td>List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.</td>
<td>9-10</td>
</tr>
<tr>
<td>Risk of bias in</td>
<td>12</td>
<td>Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.</td>
<td>10-11</td>
</tr>
<tr>
<td>individual studies</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Summary measures</td>
<td>13</td>
<td>State the principal summary measures (e.g., risk ratio, difference in means).</td>
<td>11</td>
</tr>
<tr>
<td>Synthesis of results</td>
<td>14</td>
<td>Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., $I^2$) for each meta-analysis.</td>
<td>11</td>
</tr>
<tr>
<td>Risk of bias across studies</td>
<td>15</td>
<td>Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).</td>
<td>NA</td>
</tr>
<tr>
<td>Additional analyses</td>
<td>16</td>
<td>Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.</td>
<td>12</td>
</tr>
</tbody>
</table>

**RESULTS**

<table>
<thead>
<tr>
<th><strong>Study selection</strong></th>
<th>17</th>
<th>Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study characteristics</td>
<td>18</td>
<td>For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.</td>
<td>13-15</td>
</tr>
<tr>
<td>Section/topic</td>
<td>#</td>
<td>Checklist item</td>
<td>Reported on page #</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>----</td>
<td>--------------------------------------------------------------------------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>Risk of bias within studies</td>
<td>19</td>
<td>Present data on risk of bias of each study and, if available, any outcome-level assessment (see Item 12).</td>
<td>14-15, Figure 2</td>
</tr>
<tr>
<td>Results of individual studies</td>
<td>20</td>
<td>For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group and (b) effect estimates and confidence intervals, ideally with a forest plot.</td>
<td>14-18, Tables 1-5</td>
</tr>
<tr>
<td>Synthesis of results</td>
<td>21</td>
<td>Present results of each meta-analysis done, including confidence intervals and measures of consistency.</td>
<td>20, Figures 3-4</td>
</tr>
<tr>
<td>Risk of bias across studies</td>
<td>22</td>
<td>Present results of any assessment of risk of bias across studies (see Item 15).</td>
<td>NA</td>
</tr>
<tr>
<td>Additional analysis</td>
<td>23</td>
<td>Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).</td>
<td>20</td>
</tr>
</tbody>
</table>

**DISCUSSION**

| Summary of evidence           | 24 | Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., health care providers, users, and policy makers). | 20-26                       |
| Limitations                   | 25 | Discuss limitations at study and outcome level (e.g., risk of bias), and at review level (e.g., incomplete retrieval of identified research, reporting bias). | 26-27                       |
| Conclusions                   | 26 | Provide a general interpretation of the results in the context of other evidence, and implications for future research. | 28                          |

**FUNDING**
<table>
<thead>
<tr>
<th>Section/topic</th>
<th>#</th>
<th>Checklist item</th>
<th>Reported on page #</th>
</tr>
</thead>
<tbody>
<tr>
<td>Funding</td>
<td>27</td>
<td>Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.</td>
<td>65</td>
</tr>
</tbody>
</table>
### Supplementary Document 3: Search Strategy

**OVERVIEW**

<table>
<thead>
<tr>
<th>Databases Searched</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medline via OVID</td>
</tr>
<tr>
<td>Embase via OVID</td>
</tr>
<tr>
<td>CINAHL via Ebsco</td>
</tr>
<tr>
<td>PsycINFO via Ebsco</td>
</tr>
<tr>
<td>Cochrane Central Register of Controlled Trials</td>
</tr>
<tr>
<td>Web of Science</td>
</tr>
<tr>
<td>Scopus</td>
</tr>
</tbody>
</table>

**RCT FILTER:** SIGN filter for Medline, embase, cinahl, and adapted for remaining databases:

[http://www.sign.ac.uk/search-filters.html](http://www.sign.ac.uk/search-filters.html)

**Medline**

exp exercise/ or exp walking/ or exp physical fitness/ or exp running/ or exp physical exertion/ or exp bicycling/ or exp swimming/ or exp yoga/ or exp sports/ or exp dancing/ or exp leisure activities/ or exp activities of daily living/ or ((physic* adj3 activ*) or exercis* or walk* or run* or fitness* or (physical adj (fit* or exert*)) or swim* or yoga* or cycling* or bicyc* or pilates* or (energy expenditure) or sport* or danc* or (activ* adj lifestyle) or (leisure activ*) or (activities of daily living)).mp.

and

((accept* adj5 commit*) or (act)).mp. or exp “acceptance and commitment therapy”/

AND

(Randomized Controlled Trials as Topic/ or randomized controlled trial/ or Random Allocation/ or Double Blind Method/ or Single Blind Method/ or clinical trial/ or clinical trial, phase i.pt or clinical trial, phase ii.pt or clinical trial, phase iii.pt or clinical trial, phase iv.pt or controlled clinical trial.pt or randomized controlled trial.pt or multicenter study.pt or clinical trial.pt or exp Clinical Trials as topic/ or (clinical adj trial$).tw or ((singl$ or doubl$ or treb$ or tripl$) adj (blind$3 or mask$3)).tw or PLACEBOS/ or placebo$.tw or randomly allocated.tw or (allocated adj2 random$).tw) NOT (case report.tw or letter/ or historical article/)

Limits: 1980 to present

**Embase**

1. (Clinical Trial/ or Randomized Controlled Trial/ or controlled clinical trial/ or multicenter study/ or Phase 3 clinical trial/ or Phase 4 clinical trial/ or RANDOMIZATION/ or Single Blind Procedure/ or Double Blind Procedure/ or Crossover Procedure/ or PLACEBO/ or randomi?ed controlled trial$.tw. or rct.tw. or (random$ adj2 allocat$).tw. or single blind$.tw. or double blind$.tw. or ((treble or triple) adj blind$).tw. or placebo$.tw. or Prospective Study/) not (Case Study/ or case report.tw. or abstract
report/ or letter/ or Conference proceeding.pt. or Conference abstract.pt. or Editorial.pt. or Letter.pt. or Note.pt.) (1550528)

2  ((physic* adj3 activ*) or exercis* or walk* or run* or fitness* or (physical adj (fit* or exert*))) or swim* or yoga* or cycling* or bicyc* or pilates* or energy expenditure or sport* or danc* or (activ* adj lifestyle) or leisure activ* or activities of daily living).ti,ab. (1003036)

3  exp *exercise/ (131738)

4  exp *sport/ (65674)

5  exp *physical activity/ (107892)

6  exp *walking/ (31215)

7  exp *running/ (9236)

8  exp *fitness/ (15066)

9  exp *swimming/ (6667)

10 exp *yoga/ (2799)

11 exp *cycling/ (3068)

12 exp *dancing/ (1823)

13 exp *leisure/ (8585)

14 exp *daily life activity/ (12195)

15 or/2-14 (1092874)

16 ((accept* adj5 commit*) or act).ti,ab. (291098)

17 exp **"acceptance and commitment therapy"/ (444)

18 16 or 17 (291138)

19 1 and 15 and 18 (622)

20 limit 19 to yr="1980 -Current" (614)
# Query

S8  S1 AND S4 AND S7

S7  S5 OR S6

(MH "Physical Fitness+") OR (MH "Exercise+") OR (MH "Walking+") OR (MH "Running+") OR (MH "Exertion+") OR (MH "Cycling") OR (MH "Swimming") OR (MH "Yoga+") OR (MH "Dancing+") OR (MH "Leisure Activities+") OR (MH "Activities of Daily Living+") OR (MH "Sports+")

((physic* n3 activ*) or exercis* or walk* or run* or fitness* or (physical n1 (fit* or exert*))) or swim* or yoga* or cycling* or bicyc* or pilates* or (energy expenditure) or sport* or danc* or (activ* n1 lifestyle) or (leisure activ*) or (activities of daily living))

S5

S4  S2 OR S3

S3  (MH "Acceptance and Commitment Therapy")

S2  (accept* n5 commit*)

(MH "Clinical Trials+") OR PT Clinical trial OR ( TX ( (singl* n1 blind*) or (singl* n1 mask*) ) or TX ( (doubl* n1 blind*) or (doubl* n1 mask*) ) or TX ( (tripl* n1 blind*) or (tripl* n1 mask*) ) or TX ((trebl* n1 blind*) or (trebl* n1 mask*) ) ) OR TX randomi* control* trial* OR (MH "Random Assignment") OR TX random* allocat* OR TX placebo* OR (MH "Placebos") OR (MH "Quantitative Studies") OR TX allocat* random*

Limited to 1980 onwards

# Query

PsycINFO

S13  S3 AND S6 AND S12

S12  S7 OR S8 OR S9 OR S10 OR S11

S11  trial* or placebo* or random* or control* or quantitative*

((DE "Clinical Trials") OR (DE "Placebo") OR (DE "Quantitative Methods")] OR (DE "Random Sampling")

S10
TX allocat* random*

( TX ((singl* n1 blind*) or (singl* n1 mask*)) or TX ((doubl* n1 blind*) or (doubl* n1 mask*)) or TX ((tripl* n1 blind*) or (tripl* n1 mask*)) or TX ((trebl* n1 blind*) or (trebl* n1 mask*))) OR TX randomi* control* OR (MH "Random Assignment") OR TX random* allocat* OR TX placebo*

S7 (doubl* n1 blind*) or (doubl* n1 mask*) or (tripl* n1 blind*) or (tripl* n1 mask*)

S6 S4 OR S5

S5 DE "Acceptance and Commitment Therapy"

S4 (accept* n5 commit*)

S3 S1 OR S2

((((((DE "Exercise" OR DE "Aerobic Exercise" OR DE "Weightlifting" OR DE "Yoga") OR (DE "Physical Activity" OR DE "Actigraphy" OR DE "Exercise") OR (DE "Physical Fitness")) OR (DE "Walking")) OR (DE "Swimming")) OR (DE "Yoga")) OR (DE "Energy Expenditure")) OR (DE "Activities of Daily Living")

((physic* n3 activ*) or exercis* or walk* or run* or fitness* or (physical n1 (fit* or exert*)) or swim* or yoga* or cycling* or bicyc* or pilates* or (energy expenditure) or sport* or danc* or (activ* n1 lifestyle) or (leisure activ*) or (activities of daily living))

Limited to 1980 onwards

Cochrane Central Register of Controlled Trials

ID

#1 accept near/5 commit*:ti,ab,kw (Word variations have been searched)

#2 MeSH descriptor: [Acceptance and Commitment Therapy] explode all trees

#3 #1 or #2

#4 ((physic* near/3 activ*) or exercis* or walk* or run* or fitness* or (physical near/1 (fit* or exert*)) or swim* or yoga* or cycling* or bicyc* or pilates* or (energy expenditure) or sport* or danc* or (activ* near/1 lifestyle) or (leisure activ*) or (activities of daily living))

#5 MeSH descriptor: [Exercise] explode all trees

#6 MeSH descriptor: [Walking] explode all trees

#7 MeSH descriptor: [Physical Fitness] explode all trees

#8 MeSH descriptor: [Physical Exertion] explode all trees

#9 MeSH descriptor: [Bicycling] explode all trees
MeSH descriptor: [Swimming] explode all trees

MeSH descriptor: [Yoga] explode all trees

MeSH descriptor: [Sports] explode all trees

MeSH descriptor: [Dancing] explode all trees

MeSH descriptor: [Leisure Activities] explode all trees

MeSH descriptor: [Activities of Daily Living] explode all trees

#4 or #5 or #6 or #7 or #8 or #9 or #10 or #11 or #12 or #13 or #14 or #15

#3 and #16

Web of Science

((physic* NEAR/3 activ*) or exercis* or walk* or run* or fitness* or (physical NEAR/1 (fit* or exert*))) or swim* or yoga* or cycling* or bicyc* or pilates* or (energy expenditure) or sport* or danc* or (activ* NEAR/1 lifestyle) or (leisure activ*) or (activities of daily living))

AND

((accept* NEAR/5 commit*))

AND

Random* or trial* or placebo* or blind* or control*

Limited to 1980 to current

SCOPUS

TITLE-ABS-KEY ((( PHYSIC* W/3 ACTIV*) OR EXERCIS* OR WALK* OR RUN* OR FITNESS* OR ( PHYSICAL W/1 (FIT* OR EXERT*)) OR SWIM* OR YOGA* OR CYCLING* OR BICYC* OR PILATES* OR ( ENERGY W/1 EXPENDITURE ) OR SPORT* OR DANC* OR ( ACTIV* W/1 LIFESTYLE ) OR ( LEISURE W/1 ACTIV*) OR ( ACTIVITIES W/1 OF W/1 DAILY W/1 LIVING ))) AND TITLE-ABS-KEY (ACCEPT* W/5 COMMIT*) AND TITLE-ABS-KEY (RANDOM* OR TRIAL* OR PLACEBO* OR BLIND* OR CONTROL*)