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Treating Major Depression with Physical Activity: A Systematic Overview with Recommendations

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Abstract. The purpose of this systematic overview was to determine the most effective mode and dose of physical activity (PA) for treating major depressive disorder (MDD), and to suggest guidelines and recommendations for clinicians. The selection process consisted of a comprehensive search that was conducted up until April 2014 in the following databases: PsycINFO, Medline, PubMed and Scopus. The inclusion criteria were: (1) a randomized controlled trial (RCT) design, (2) complete description of intensity, duration and frequency of the PA, (3) the participants had to be diagnosed with MDD according to Diagnostic Statistical Manual 4 th edition (DSM-IV) or International Classification of Disease tenth Revision (ICD-10) criteria (4) if the controls received any treatment, it had to be specified, (5) published after 1990, (6) consist of aerobic or anaerobic treatment PA, and (7) not be a pilotor preliminary study. A quality assessment of each study was conducted independently by two reviewers; this stringent selection process resulted in 12 reviewed studies. Conclusion: individually customized PA, for at least 30 minutes, preferably performed under supervision and with a frequency of at least three times per week is recommended when treating MDD. These recommendations must be viewed in light of the relatively few studies matching the inclusion criteria. *Key words: depression; physical activity; treatment; major depression; RCT.*

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Depression is one of the most common forms of mental disorder and a major cause of ill health in society today affecting more than 340 million people worldwide (Dinas, Koutedakis, & Flouris, 2011). The prevalence of depression is estimated to be between 2% and 15% and is considered to be the fourth largest contributor to disease-generated disability in the world (disability adjusted life years, DALYs); it is expected to be the second-largest before 2020 (Moussavi et al., 2007). The cost for society and employers is significant because individuals affected by depression are in need of more than twice as much health benefits than their colleagues, and when at work, work tends to be less efficient due to difficulties in concentration (Adler et al., 2006; Birnbaum et al., 2010). Despite the suffering caused by depression, it is estimated that only 50% of those affected seek help (Angst et al., 2002). This can be explained by the characteristics of the disease (e.g. hopelessness, decreased interest, increased isolation, difficulty making decisions and inability to absorb information), possibly also by a prevailing negative attitude towards the use of anti-depressant drugs, which is the most commonly used treatment today (Johansson, Carlbring, Heedman, Paxling, & Andersson, 2013). Furthermore, groups not traditionally identified with depression are emerging (e.g. young people). This creates new challenges and a need for adjunctive treatments in addition to anti-depressant medication and psychotherapy. Physical activity (PA) is a treatment that has received great interest and generated ample research (Fetzner & Asmundson, 2014). It is well established that PA increases fitness, cognitive functioning and general well-being, and has a decreasing and/or preventive effect on several mental and physical conditions and disorders including anxiety (Jayakody, Gunadasa, & Hosker, 2014)

and depression (Abrantes et al., 2012; Hassmén, Koivula, & Uutela, 2000; Mammen & Faulkner, 2013; Rethorst, Wipfli, & Landers, 2009; Rizvi, Kaysen, Gutner, Griffin, & Resick, 2008). However, a problem with many studies is that they suffer from methodological weaknesses, such as the lack of control groups or comparing clinical with non-clinical groups (Cooney et al., 2013; Josefsson, Lindwall, & Archer, 2014). These methodological weaknesses, which also affect many reviews and meta-analyses, have severely limited possible conclusions based on the otherwise positive results. In turn, this has also restricted practical recommendations. For example, some studies conclude that high intensity activity is more effective than lower intensities, but the opposite is also mentioned in the literature (Birkeland, Torsheim, & Wold, 2009; Legrand & Heuze, 2007). There are also discrepancies in the literature between the suggested most effective doses of PA and the recommended types of activity (Dunn, Trivedi, Kampert, Clark, & Chambliss, 2005; Stella et al., 2005). In a general overview written specifically as primer for health-care providers, Stanton and Happell (2013) highlighted many of the discrepancies in the results regarding exercise and the treatment of depression but concluded nevertheless that this is sufficient evidence to support the benefits of both cardiovascular and resistance exercise in the treatment of depression.

Perraton, Kumar, and Machotka (2010) reviewed the exercise parameters used in the studies employing randomized controlled trials (RCTs) that reported significant treatment effects for depression. They found evidence that supports a prescription of three 30-minute sessions per week of aerobic exercise at 60–80% of maximum heart rate (HR) for at least eight weeks. Stanton and Reaburn (2014) followed up the results of Perraton et al. (2010) by reviewing RCTs reporting a significant treatment effect of depression published after 2007. Their recommendations, while similar to the previous review, include more frequent, longer duration exercise sessions over a greater duration and with appropriately qualified supervision.

The aim of this systematic overview is therefore to examine the existing literature with the purpose of identifying what activity and dose of PA that have demonstrated the best effect in reducing depressive symptoms in clinically depressed individuals in RCT studies. However, in contrast to the previous reviews, the present overview will even consider studies that did not find significant treatment effects. As has been previously reported there are many discrepancies in the results reported on in the literature and by excluding studies that have not found an effect of exercise some of this variation could be missed. Based on our systematic overview of only high-quality research papers, specific recommendations will be made in order to help health professionals advising patients in regard to the optimal PA dose for depression, i.e. frequency, time and intensity.

Methods

Search strategy and inclusion criteria
To identify eligible studies for this review, an information specialist at Umeå university library was consulted; the following databases were then searched for peer-reviewed journal articles: PsycINFO, Medline, PubMed and Scopus. Reference lists of considered studies were also searched as well as relevant meta-analysis and systematic reviews.

The specific search terms used are presented in Table 1. The MeSH terms were used when searching for articles on PubMed and the other terms were used when searching on Medline, PsycINFO and Scopus. The literature searches were conducted between 24 March and 1 April 2014. When searching Scopus the following search terms were used: major depression or depression and PA or exercise with the limitations, treatment and randomized control trial.

Screening criteria
Only experimental, RCT studies that specifically addressed the treatment of depression in otherwise healthy individuals from English-language peer-reviewed journals after 1990 were considered. Furthermore, the experimental groups must have been diagnosed using validated diagnostic criteria, e.g. DSM-IV, ICD-10 (American Psychiatric Association, 1994; ICD-10, 2010). Treatment had to consist of either aerobic or anaerobic activities or a combination of both. Studies also had to have a detailed description of the activity, intensity, duration and frequency of the PA; a thorough description of the control group was also a

Table 1. *Specification of search terms used for this systematic overview*

Concept	MeSH terms	Other terms
Physical activity	Motor activity	Physical activity
	Exercise	Weightlifting
	Physical activity	Exercise
		Aerobic exercise
		Anaerobic exercise
Depression	Depressive disorder	Major depression or depression
Study design	Randomized controlled trials	
Associations	Treatment	Treatment

requirement. All studies that did not comply with these criteria were excluded, as well as all studies that explicitly identified themselves as being pilot or preliminary results.

To identify possible studies for inclusion, two independent reviewers matched all studies from the initial search against the pre-established inclusion criteria. When a discrepancy was detected, the reviewers discussed the study and decided if it should be included or not.

Definitions

Aerobic PA was defined as any activity that predominantly depends on the aerobic generating process; an activity triggering lactic acid formation was considered anaerobic. All PA that was performed by two or more participants together was deemed a group activity. An activity was considered supervised when at least one person was leading the activity. Duration was defined as minutes per session, and frequency as bouts per week. The intensity was defined by the Borg scale (Borg, 1982) or by an approximation of percentage of maximum HR. Activity mode referred to the kind of activity that was performed. Information about ongoing treatments included anti-depressants and psychotherapy.

Results

The database search resulted in 365 initial hits. The titles and abstracts of these were then screened which resulted in an exclusion of 321 articles. The remaining 44 full-text articles were assessed independently by the two reviewers resulting in an exclusion of 32 articles. The most common reason for exclusion was that all participants did not fulfil the diagnostic criteria for depression. Twelve articles met all inclusion criteria (Figure 1).

Quality of included studies

As noted earlier, methodological shortcomings are relatively common among published studies, which potentially increase the risk of bias. To minimize the risk of including inferior studies, we used a quality index created by the Cochrane Back Review Group (Furlan, Pennick, Bombardier, & van Tulder, 2009). This index consists of 12 defined and operationalized questions that each study was checked against. For each fulfilled criterion, the study obtained one point, which meant that the maximum number of points a study could receive was 12. If the information was not available or incomplete the study received no points on that question, the points were then added to a total score. The studies with a total score of 0–6 points were classified as being of low quality, which meant that they were at relatively high risk of bias, while those who received 7–12 points classified as being of high quality, and thus at low risk of being affected by bias. All 12 included studies met the required points tally, i.e. 7–12, to be graded as being of high quality and consequently be at low risk of bias. For a more detailed description of the quality index and the specific questions, see Furlan et al. (2009).

Type of interventions

Table 2 shows details of all included studies, relating to study population, activity, if the intervention was supervised or not, if the intervention was performed individually or in groups and what type of treatment, if any, the controls received. There is also a description of the variables of the intervention, i.e. frequency, intensity and duration.
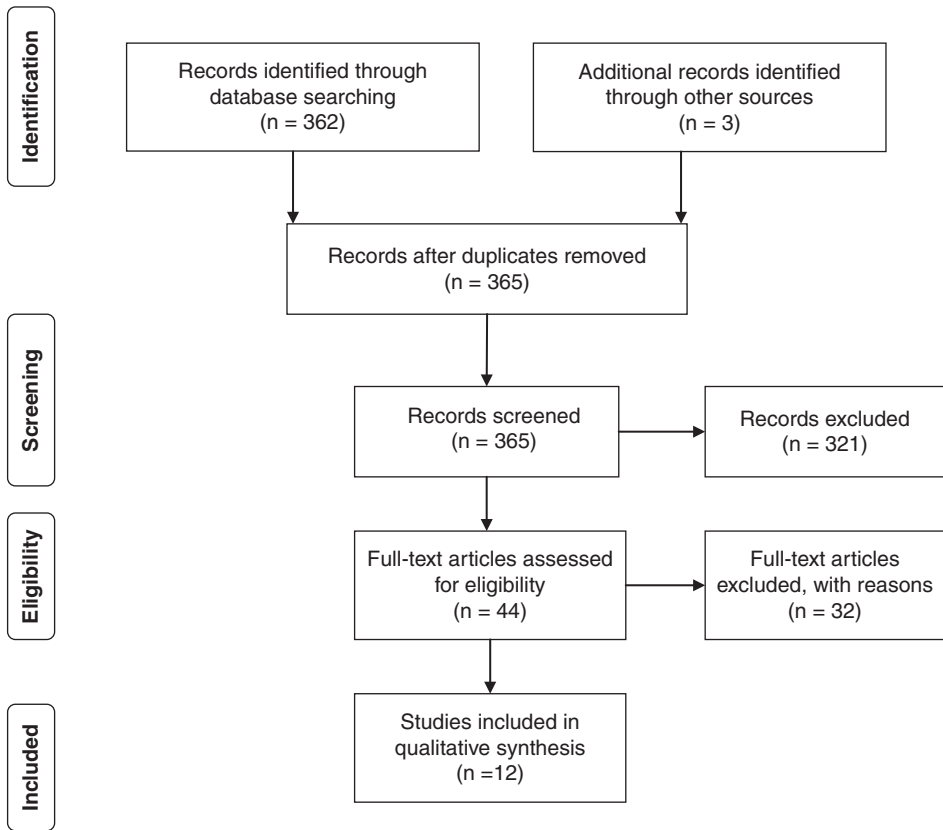
Figure 1. Flow chart of the inclusion process.

Participants

In 11 out of the 12 included studies, participants were diagnosed by DSM-IV; ICD-10 was used as the diagnostic in one (Study 7). Both sexes were represented with ages ranging between 12 and 84 years. The majority of studies (10/12) compared two or more treatments and therefore did not have a pure control group (a group that did not receive any treatment). One study (Study 4) described a one-year follow-up study, which included the same participants as another included study (Study 2). In two other studies (Studies 11 and 12), the same participants were described, but studied over 10 and 20 weeks, respectively. Two of the studies (Studies 6 and 10) consisted of inpatients, the rest of either outpatients or a mix of outpatients and inpatients. All but two studies had major depression diagnose (MDD) as inclusion criteria, the other two (Studies 11 and 12)

also included participants diagnosed with either Dysthymia, or mild depression. In all included studies, persons who already exercised regularly were excluded. In seven of the studies (Studies 1, 2, 4, 7, 8, 11 and 12), medication (or a recent change in dose) resulted in exclusion.

Intervention

Activity. The majority of studies (10/12) described an aerobic intervention, whereas one (Study 11) described an anaerobic intervention and one (Study 12) a mixed intervention. Walking or jogging was the choice in 8 of the 12 studies. The second most commonly used activity was cycling (7/12). In the two studies that included anaerobic activity, weightlifting was the choice.
Supervised. All experimental groups had at least partly supervised PA; in 9 of the studies

Table 2. *Participant characteristics, intervention characteristics, parameters of the intervention and effect of treatment*

| | Participants | Intervention | | | | Parameters | | Duration | | |
Articles	Population	Activity	Supervised	Group/ Individually	Controls	Frequency	Intensity	No. of weeks	Min/session	Remission rate
1. Blumenthal et al. (1999)	DSM-IV diagnosed, age: M = 57.0, SD = 6.5, N = 156	Walking/jogging	Both exercise groups	Group	Sertraline, sertraline + exercise	Three times/week	70–85% of max HR	16	45 min/session	60% no longer clinically depressed[b]
2. Blumenthal et al. (2007)	DSM-IV diagnosed, age: M = 53, SD = 8, N = 202	Walking/jogging/cycling	Only for one of the exercise groups	Supervised group, home individual	Non-supervised, individual, sertraline, placebo pill	Three times/week	70–85% of max HR	16	45 min/session	46% remission rate[b]
3. Dunn et al. (2005)	DSM-IV diagnosed, age: M = 35.9, SD = 6.4, N = 80	Walking/jogging/cycling	For all participants	Individual	Exercise placebo = stretching and flexibility exercise	Three or five times/week	High = 17.5 KKW, low = 7.0 KKW	12	In accordance with prescription guidelines established by the ACSM	41%/31% remission rate[a] for three/five times/week, respectively
4. Hoffman et al. (2011) Follow-up of Blumenthal et al. (2007)	DSM-IV diagnosed, age: M = 51.7, SD = 7.7, N = 172 (82% of the original cohort)	Walking/jogging/cycling	Only for one of the exercise groups	Supervised group, home individual	Non-supervised, individual, sertraline, placebo pill	Three times/week	70–85% of max HR	One-year follow-up	See Blumenthal et al. (2007)	Remission rate increased from 46% from 66% at 12-month follow-up
5. Hughes et al. (2013)	DSM-IV diagnosed 12–18 years old, age: M = 17.0, SD = 1.8, N = 30	Treadmill/stationary cycles first two then preferred mood	First two weeks, then all but one session/week individual	Group first two weeks, then all but one session/week individual	Same as experimental group, but at a lower energy expenditure	Three times/week	Energy expenditure of minimum 12 KKW	12	The time it took to reach 1/3 or 1/4 of the weekly caloric expenditure, about 30–40 min	86% remission rate[b] rate, sustained at 12-month follow-up
6. Knubben et al. (2007)	DSM-IV diagnosed inpatients, age: M = 49.5, SD = 13, N = 38	Walking	Through all sessions	Individual	Low-intensity stretching and relaxation exercise	Daily	80% of max HR	10 days	30 min/session	36% remission rate[b]
7. Krogh et al. (2009)	ICD-10 diagnosed, referred by general practitioner or psychiatrists, age: M = 38.9, SD = 9.5, N = 115	Fitness machines and aerobic exercise	For all participants	Group	Relaxation training	Two times/week	Strength group 50–75 RM, aerobic group 70–89% of max HR, relaxation group, no activity, higher than 12 on the Borg scale	16 weeks (4 moths)	90 min/session	34.8% remission rate after four month and 36.5 after 12 month
8. Krogh, Videbech, Thomsen, Gluud, and Nordentoft (2012)	DSM-IV diagnosed outpatients referred by physician or psychologist, age: M = 41.6, SD = 11.3, N = 165	Aerobic exercise, stationary cycling	For all participants	Group	Stretching exercise	Three times/week	65–80% of max capacity	12 weeks	45 min/session	29% remission rate

(Continued)

Table 2. *Continued*

	Participants		Intervention				Parameters				
									Duration		
Articles	Population	Activity	Supervised	Group/Individually	Controls	Frequency	Intensity	No. of weeks	Min/session	Remission rate
9. Mota-Pereira et al. (2011)	DSM-IV diagnosed treatment resistant outpatients, age: M = 47.0, SD = 2.7, N = 33	Walking at a speed of 5 km/hour	One session each week was supervised	Individual four times/week and in a group one session/week	Pharmacological therapy + one meeting/week with teachers technicians and other participants	Five times/week	>3 METs which is equivalent to moderate exercise	12 weeks	30–45 min/session	26% remission rate[a]
10. Schuch, Vasconcelos-Moreno, Borowsky, and Fleck (2011)	DSM-IV diagnosed inpatients, age: M = 42.7, SD = 13, N = 26	Aerobic, stationary cycle, treadmill or an elliptic	Every session	Individual	Treatment as usual (pharmacological and/or, ECT)	Three times/week	16.5 KKW	Two weeks	NR	No remission rates reported[a]
11. Singh, Clements, and Fiatarone (1997)	DSM-IV diagnosed volunteers, age: M = 71.3, SD = 1.8, N = 32	Anaerobic, resistant training, weightlifting	Every session	Individual	Interactive health education	Three times/week	80% of max capacity	10 weeks	45 min/session	59% remission rate[b]
12. Singh, Clements, and Singh (2001)	DSM-IV diagnosed volunteers, age: M = 71.3, SD = 1.8, N = 32	Anaerobic, resistant training, weightlifting	First 10 weeks, last 10 weeks unsupervised	Individual	Interactive health education the first 10 weeks	Three times/week	80% of max capacity	20 weeks	45 min/session	73% remission rate[a] sustained at 26-month follow-up

Notes. HR = heart rate, KKW = Kcal/Kg/Week, RM = repetition maximum, NR = not reported, ECT = electroconvulsive therapy, MET = metabolic equivalents of tasks, ACSM = American College of Sports Medicine.

[a] Statistically significant reduction in depressive symptoms.

[b] Statistically and clinically significant reduction in depressive symptoms.

the control group also had some supervised alternative treatments.

Group/individually. In five of the studies the intervention was performed individually, and in three the interventions were performed in a group setting. In four studies, part of the intervention was a mix between individual and group settings.

Controls. In seven of the studies, the control groups also performed some type of PA, with stretching as the most commonly used form. In five of the studies, the control group received treatment as usual, i.e. pharmacotherapy or psychotherapy, and in two the control group was offered health education.

Variables

Frequency. The most commonly used frequency was three times/week (9/12). The highest frequency was daily, used in one study (Study 6), followed by five times/week used in two studies (Studies 3 and 9) and the lowest frequency was two times/week which was used in one study (Study 7).

Intensity. In eight of the studies (Studies 1, 2, 4, 6, 7, 8, 11 and 12) intensity was expressed as a percentage of maximum HR, in three of the studies (Studies 3, 5 and 10) the intensity was expressed as energy expenditure and in one study (Study 9) intensity was reported in Metabolic Equivalents of Tasks (MET)-minutes. The most frequently used HR intensity in the studies was 65–85%, which was used in eight of the studies.

Length of intervention. Four of the studies (Studies 3, 5, 8 and 9) used 12-week interventions, three (Studies 1, 2 and 7) 16-week interventions. The longest intervention (Study 12) was 20 weeks and the shortest (Study 6) 10 days. The duration per session was reported in 10 of the studies, with a range between 30 and 90 minutes per session.

Effect of intervention. Ten of the studies reported a positive outcome of treatment, i.e. statistical decrease in depressive symptoms; two studies (Studies 7 and 8) reported that the treatment did not result in a symptom reduction (treatment vs. control). All but one study (Study 10) reported remission rates for the treatment groups, and those ranged between 86% (Study 5) and 26% remission (Study 9). In the studies that had a follow-up period (Studies 4, 5, 7 and 12), the remission rate increased in one study (Study

4) and remained the same in the other studies. For the seven studies that reported enough data to calculate effect size, six studies (Studies 3, 6, 9, 10, 11 and 12) had a large effect and one (Study 2) had a small effect size of treatment on depressive symptoms.

Discussion

The primary aim of this systematic overview was to identify the most effective type and dose of PA for treating clinically depressed populations. A secondary aim was to use the findings to offer health professionals specific recommendations when using PA to treat depressed patients.

Activity

There is a preference for using aerobic PA for treating depression, but the mode of activity (e.g. walking, jogging or cycling) does not seem to have any discernible effect on the outcome. Both of the studies using aerobic and anaerobic PA in the treatment of depression showed reduced depressive symptoms, although more data on anaerobic modes of activity are needed to draw any firm conclusions. Nevertheless, this concurs with the suggestion that the mode of the activity is of less importance than just becoming physically active (Danielsson, Noras, Waern, & Carlsson, 2013). However, it may not be the physical fitness element of the PA that has the greatest effect on depression, but rather other consequences of the PA (Krogh, Saltin, Gluud, & Nordentoft, 2009; Veale et al., 1992). Among the explanations offered are enhanced self-esteem, increased self-efficacy, improved coping skills and stronger social support (Foley et al., 2008; Knapen et al., 2005).

Application of the PA

Supervised versus unsupervised activity. All experimental groups were to some extent supervised, primarily to ensure that the PA was performed correctly, and so that the patients did not injure themselves. This could be interpreted to mean that supervision is crucial for the PA treatment to have an effect. However, even the studies not showing any significant treatment effect had supervised interventions. Thus, the importance of supervision needs to be further investigated. It is noteworthy that no systematic difference

could be detected between the studies that used full-time supervised interventions versus those only using part-time supervised interventions. The effect of the treatment appears to be unaffected by the extent of the supervision, which further highlights the need for extended research on the importance of the supervision. Some have argued that the most important aspect of the supervisor is to support motivation (Danielsson et al., 2013). An interesting question for future research is if supervision in form of electronic devices (e.g. FuelBand, Fitbit, pedometer, electronic diaries) can be as effective as the real-life supervision used in the studies reviewed here as these techniques have shown great potential in health monitoring and feedback (see reviews by Bassett, Rowlands, & Trost, 2012; Patel, Park, Bonato, Chan, & Rodgers, 2012). *Group versus individual activity*. Earlier meta-analyses and reviews have postulated that there is no difference in symptom reduction between individual and group performed PA (Eriksson & Gard, 2011; Perraton et al., 2010). The results of the studies included in this review suggest that both individual and group interventions can produce positive treatment outcomes. To reach a positive outcome, the PA needs to be performed over an extended period of time. This review, therefore, suggests that *both* individually and group performed PA can be effective in reducing depressive symptoms, but that group PA may be preferred for motivational reasons.

Frequency, intensity and duration. There seems to be a difference in the reduction of depressive symptoms on account of the frequency, but neither intensity nor duration made a difference in the studies included in this review. The most common frequency was three times/week, and in the only study with a lower frequency no significant effect of the PA intervention was detected. This indicates that the frequency should be at least three times/week to alleviate depressive symptoms, which agrees with a Position Stand from the American College of Sports Medicine describing what constitutes healthy exercise for developing cardiorespiratory, musculoskeletal and neuromotor fitness (Garber et al., 2011). Furthermore, there was a preference for using an intensity of 60–85% of max HR, but the two studies that did not describe any effect on

depression also used this intensity, which highlights the need to further study the relationship between PA intensity and depression.

The majority of included studies had sessions lasting between 30 and 45 minutes, and a treatment period lasting between 12 and 16 weeks. It is noteworthy that the study with 90-minute sessions did not produce any reduction in depression for the participants, suggesting that "more is better" is not true when it comes to reducing depressive symptoms in clinical populations. Shorter sessions, i.e. 30–45 minutes, thereby seem preferable. But because only a single study in this review used longer sessions, and those sessions included intermittent work, one should be careful in drawing too far-reaching conclusions regarding the importance of duration.

Perhaps the primary focus should be on encouraging the patient to do something physical – anything – rather than on the type, frequency and intensity of the PA. This suggestion is also supported by other researchers (e.g. Danielsson et al., 2013). There is a growing body of evidence supporting the notion that there is no direct relation between energy expenditure and a reduction in depressive symptoms and that it perhaps are other mechanisms (e.g. contextual factors, perceived intensity) that are responsible for the positive effects of PA on depression (King, Taylor & Haskell, 1993; Rethorst et al., 2009). Walking, Thai Chi and Qigong have, for instance, shown to be an effective treatment of depressive symptoms in a research setting (Robertson, Robertson, Jepson & Maxwell, 2012; Yin & Dishman, 2014). By giving continuous feedback on their progress, e.g. by wearable health devices or social media comments, the patient's motivation perhaps could be fuelled, previous studies have indicated that pedometers can achieve such a function (Baker et al., 2008; Bravata et al., 2007). Furthermore, it may be more important to be sensitive to what the patient prefers than on insisting on a certain mode of PA. Because inactivity is a large part of the illness, any type of physical activation may constitute a large enough step for this population. Indeed, researchers have warned that strict instructions regarding activity, duration, frequency and intensity may produce the opposite effect, i.e. building a mental resist-

ance against PA (Jack, McLean, Moffett, & Gardiner, 2010).

Recommendations/implication for practice

Whether the PA is aerobic or anaerobic seems to be of secondary importance as both types effectively reduced depressive symptoms in the reviewed studies. In line with recent research, perhaps the focus should instead be on the preference of the patient (Burton, Khan, & Brown, 2012). Our recommendation is therefore that the clinician discusses various options of PA together with the patient, so that the treatment is "tailored" in accordance with the patient's preferences (e.g. confidence, autonomy, abilities) as much as possible.

Based on this review, PA at least three times a week can be recommended, and for at least 30 minutes per bout. The results also suggest that supervised PA increases the likelihood of a successful outcome; this may also apply to group exercise but then more for helping the patient maintain motivation than for reducing depressive symptoms per se.

Limitations/methodology of trials

First, it is worth mentioning that if a treatment shows high efficacy in reducing depressive symptoms in a scientific study with highly motivated participants, it does not automatically mean that this treatment will show high effectiveness when implemented in the intended environment or practice. Identifying "one solution" or a specific universal "dose" that fits all, when it comes to PA, is problematic. Rather, the more realistic position would be that it is several different aspects (practical, technical and psychosocial) that affect the outcome on reduction in depressive symptoms.

However, the fact that relatively few studies fulfilled the inclusion criteria somewhat limits the conclusions that are possible to draw from this review; at the same time this highlights the need for additional high-quality research. None of the included studies separates between sedentary behaviour and PA, which can affect the results, further, if a person combines bursts of high intensity PA with long bouts of physical inactivity, the potential for positive health effects may lessen (Grontved & Hu, 2011; Proper, Singh, van Mechelen,

& Chinapaw, 2011). A majority of the control groups in the reviewed studies were offered relaxation training, stretching, other forms of alternative PA or health education that has been shown to have a reducing effect on depressive symptoms (Fortney & Taylor, 2010; Murphy, Carney, Knesevich, Wetzel, & Whitworth, 1995). The extra attention and social support possibly reduce the difference between supervised PA and the control condition, which could mean that the observed effects underestimate the potential positive effects of PA on depression. Another limitation is that the duration of the interventions used span over a considerable period of time, i.e. 10 days to 20 weeks. This makes it difficult to compare between studies, but it is worth noting that nine of the included studies used a duration of 12–16 weeks, which in earlier reviews have been considered sufficient (Danielsson et al., 2013).

A further limitation is that the subjective experience of the PA has not been fully considered. Recent studies have postulated that there could be a difference in efficacy between leisure-time and non-leisure-time PA, were leisure-time PA tends to be more effective in reducing depressive symptoms that non-leisure-time PA (Chen, Stevinson, Ku, Chang, & Chu, 2012; Harvey, Hotopf, Overland, & Mykletun, 2010; Pickett, Yardley, & Kendrick, 2012). It should also be noted that all included studies had regular PA as an exclusion criterion, which could increase the effect of the treatment since the patients started off at a low PA level. Further research is needed to investigate if it is possible to generalize these results to more physically active populations. Finally, it should be mentioned that all but one study included participants from western societies (Europe and the USA), which could be a threat against the external validity since cultural differences possibly could affect the results.

Future research/implications for research

PA seems to be an effective stand-alone treatment for depression. However, more research is needed on the importance of customized PA for treating depression. It is also important to separate these recommendations from recommendations for general

health, because there is a growing body of evidence suggesting that there is no apparent association between general fitness (i.e. cardiovascular fitness) and reduction in depressive symptoms (Foley et al., 2008; Krogh et al., 2009; Veale et al., 1992). There is also a need for more studies with a longer follow-up period, to further investigate the long-term effects. Research in this field would also benefit from clearer inclusion/exclusion criteria as well as more controlled PA: this would make it possible for the researchers to further investigate the casual relationship between depressive symptoms and PA. A further aspect that studies in this field would benefit from is more control over the PA, not only in the allocated activity sessions, but also through all activity during the day. Through a more comprehensive measure of activity the possibilities would increase to comment on the effectiveness and not only the efficacy of the treatment, this could perhaps be done by time-series studies, even though that would perhaps be problematic with this specific population.

Disclosure statement

The authors have declared that no conflict of interest exists.

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