



## Review

## Exercise and the treatment of depression: A review of the exercise program variables

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## ARTICLE INFO

## Article history:

Received 3 January 2013

Received in revised form 10 March 2013

Accepted 21 March 2013

Available online 18 April 2013

## Keywords:

Depressive disorder

Clinical depression

Aerobic exercise

Randomized controlled trials

Exercise training

## ABSTRACT

**Objectives:** There is growing interest in the use of exercise in the treatment of depression. A number of randomized controlled trials (RCTs) have demonstrated a reduction in depressive symptoms with both aerobic and non-aerobic exercise interventions. This has been supported in a number of systematic reviews and meta-analyses. However, the heterogeneous nature of the exercise intervention trials makes determining the appropriate program variables (frequency, intensity, duration and type of exercise) difficult.

**Design:** A systematic review was undertaken on all RCTs reporting a significant treatment effect of exercise in the treatment of depression.

**Methods:** Studies were analyzed for exercise frequency, intensity, session duration, exercise type, exercise mode, intervention duration, delivery of exercise, level and quality of supervision and compliance. Study quality was assessed using the PEDro scale.

**Results:** Five RCTs published since 2007 met the inclusion criteria and were subsequently analyzed. Most programs were performed three times weekly and of moderate intensity. All included trials used aerobic exercise, either treadmill or outdoor walking, stationary cycle or elliptical cross trainer exercise. Intervention duration ranged from four to twelve weeks. Both group and individual programs were shown to be effective in lowering the symptoms of depression. Some level of supervision is recommended.

**Conclusions:** There is evidence for the use supervised aerobic exercise, undertaken three times weekly at moderate intensity for a minimum of nine weeks in the treatment of depression. Further research on the manipulation of program variables is warranted.

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## 1. Introduction

Depression is a debilitating condition exerting a significant negative effect on quality of life for millions of people worldwide.<sup>1</sup> Depression is typically managed in primary care using both pharmacotherapy and psychological interventions. However, the role of exercise as an adjunct to conventional therapies is gaining momentum with large number of recent studies having demonstrated exercise to be effective in reducing depression symptoms.<sup>2–6</sup> Indeed, a number of previous studies have found exercise to be as effective as medication<sup>3,7,8</sup> or psychological interventions<sup>9</sup> in the treatment of depression.

Whilst the effectiveness of exercise in the treatment of depression is clear, studies investigating the dose response to exercise in people with depression remains equivocal. For example, Singh and colleagues<sup>10</sup> randomized 60 older adults aged > 60 years with

minor or major depression, to a supervised high (80% of one repetition maximum) or low intensity (20% of one repetition maximum) progressive resistance training program for eight weeks. Results from this study showed that the high intensity resistance training program was deemed to be more effective compared to the low intensity program in the reduction of depressive symptoms. In contrast, using an aerobic exercise intervention, Dunn and colleagues<sup>11</sup> found that in adults with mild to moderate major depressive disorder aged 20–45 years, an exercise dose equivalent to that recommended for the general population (energy expenditure equivalent to 17.5 kcal/kg/week) was more effective than a low dose of exercise (energy expenditure equivalent to 7 kcal/kg/week for the reduction in the primary outcome measure of Hamilton Rating Scale for Depression. More recently Chu and co-workers<sup>5</sup> reported no difference between a high intensity aerobic exercise (65–75%MVO<sub>2reserve</sub>), low intensity aerobic exercise (40–55%MVO<sub>2reserve</sub>), or a stretching program in the reduction of depressive symptoms after 10 weeks of training in a group of sedentary women with mild to moderate depression. Despite their respective success at improving depressive symptoms, studies such

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as these fail to provide significant insight into the most effective exercise variables to be used for the treatment of depression. This is likely due to the heterogeneous nature of intervention type, differences in study duration, depression scores at baseline, and assessment methods used.

A number of recent systematic reviews have identified methodological weakness in included studies such as lack of blinding to assessment (was the therapist or assessor aware of which group a participant was assigned to?), poor concealment (was the person responsible for determining eligibility for inclusion aware, at the time of the decision, of which group a participant would be assigned to?), lack of reporting of key program variables, low sample size, differences in the definition and assessment of depression, and lack of long term follow up.<sup>12–14</sup> In an attempt to close this knowledge gap, Teychene and colleagues<sup>15</sup> reviewed multiple studies including observational and interventional designs and concluded that there may not be an optimal loading parameter for people with depression since beneficial effects were noted from both low volume<sup>9</sup> and higher volume<sup>16</sup> programs. However a more recent meta-analysis<sup>17</sup> demonstrated that in a clinically depressed population, program durations of 10–14 weeks, with sessions lasting 45–59 min, performed five times weekly, showed the greatest effect sizes. Both aerobic and resistance exercise interventions were of similar benefit. High intensity exercise (>75% maximal heart rate) showed a larger effect size however the difference was not significantly different to lower intensity exercise (61–74% maximal heart rate). These recommendations have been used to formulate the UK National Institute for Health and Clinical Excellence (NICE) guidelines for the treatment and management of depression in adults<sup>18</sup> that remain the most widely used and quoted guidelines relating to exercise in the treatment of depression.

A recent Cochrane Review<sup>19</sup> concluded that exercise has a moderate effect compared to no treatment, is superior to bright light therapy, and is no different to pharmacotherapies or psychological interventions in the treatment of depression. This same review reported that both aerobic and resistance training interventions are effective with resistance training or combined interventions (resistance training and aerobic training) showing slightly larger effect sizes.<sup>19</sup> This finding may argue for the additive effect of resistance training in the treatment of depression. The Cochrane Review was unable to perform an analysis of exercise intensity due to the methodological differences between studies and lack of sufficient reporting of exercise intensity parameters.<sup>19</sup> The findings of the review by Rimer and colleagues<sup>19</sup> differs from both a previous Cochrane Review which failed to find a significant effect of exercise<sup>20</sup> and the findings of a recent review of RCTs which only included studies with a clinician diagnosis of depression.<sup>21</sup> An even more recent review and meta-analysis of studies relating to exercise and depression included only walking as the exercise intervention concluded that while walking demonstrates a statistically significant effect on depression symptoms, further RCTs are required to determine the appropriate combinations of program variables.<sup>22</sup> Moreover, the translation of clinical research into primary care requires further investigation.

To date, only one systematic review of RCTs has been performed specifically to establish recommendations for exercise program variables in the treatment of patients with depression. Perraton and colleagues<sup>23</sup> analyzed 15 papers meeting their strict inclusion criteria. Their review concluded that 30 min of supervised aerobic exercise performed three times weekly for at least eight weeks is likely to be effective in treating the symptoms of depression. Due to the limited available evidence, the authors concluded that further research is required before making recommendation related to non-aerobic exercise. The above recommendations for aerobic exercise are not dissimilar to those typically used for healthy populations<sup>24</sup> thus leading to the question, is exercise

for patients with depression necessarily any different from those without depression, or in fact other clinical populations such as type II diabetes mellitus? The above recommendations of Perraton and colleagues<sup>23</sup> differ from the National Institute for Health and Clinical Exercise (NICE) guidelines which recommend a program of three times weekly, for 45–60 min per session, performed for 10–14 weeks and this difference may reflect methodological differences between the studies reviewed. Similarly the recommendations from Perraton and colleagues<sup>23</sup> differ from the most recent recommendations for people with diabetes,<sup>25</sup> where a recommendation of both aerobic exercise and resistance exercise be performed for a minimum of 210 min per week with no more than two consecutive days without exercise.

From the RCTs conducted to date there is a wide variety of program variable combinations utilized making effective prescription of exercise in the treatment of patients with depression challenging for the practitioner. Thus, the purpose of this review is to build on the systematic review of Perraton and colleagues<sup>23</sup> by analyzing the studies published since 2007 which report a significant treatment effect of exercise for patients with depression and to examine the program variables which may lead to successful treatment. Recommendations will be developed which researchers and practitioners may draw upon for the design of exercise interventions for the treatment of patients with depression.

## 2. Methods

Our methodology is similar to that of Perraton and colleagues.<sup>23</sup> Our review initially considered all RCTs published since 1960 fulfilling the following criteria:

1. **Population:** All adults aged 18–65 years with a diagnosis of depression as defined by the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM IV), International Statistical Classification of Diseases and Related Health Problems 10th Revision (ICD-10) criteria or a validated depression scale.
2. **Intervention:** Aerobic or resistance training program, or a combination of both, of any duration.
3. **Comparison group:** Any other intervention including pharmacotherapy, education, psychotherapy, other exercise program, or no intervention including wait list controls.
4. **Outcome measures:** Validated depression rating scales.

The following databases were searched: Pubmed, CINAHL, SPORTDiscus, psychARTICLES, and psychINFO. In addition, the authors' personal library was reviewed for additional relevant peer-reviewed and published articles. The reference lists of relevant articles were also examined and followed-up. The search terms used were: depression, 'major depression', 'major depressive disorder', 'exercise', 'exercise therapy', 'exercise programming'. The search was limited to English language RCTs published since 1960, with human subjects aged 18–65 of either gender. All references were imported into Endnote bibliographic software.

All RCTs from peer reviewed journals where exercise was demonstrated to be beneficial in the treatment of depression were included in the final review. Where no statistically significant effect compared to other treatments was found, the trial was only included if a significant treatment effect of exercise was present.

RCTs were excluded where a diagnosis of depressive disorders or depression was not made using DSM-IV, ICD-10 or validated instruments. Trials investigating a mental illness other than depression such as seasonal affective disorder, bipolar disorder, postnatal depression, schizophrenia, psychotic depression or post-traumatic stress disorder (PTSD) were excluded. Exercise interventions other

than standard aerobic or non-aerobic exercise such as Tai Chi, Yoga or dancing were also excluded.

After removal of duplicate studies and scanning of titles and abstracts for studies which failed to meet the inclusion criteria, the remaining studies were analyzed for the following data; exercise frequency (days per week), exercise intensity (heart rate or perceived exertion scale), exercise session duration (number of minutes), exercise type (aerobic or non-aerobic), mode of exercise (walking, running, machine weights, etc.), duration of intervention (number of weeks), delivery (group or individual), level of supervision (was it supervised and by whom) and compliance (number or percentage of completers).

All included trials were evaluated using the Physiotherapy Evidence Database Scale (PEDro).<sup>26</sup> This 10 point scale is commonly used in the evaluation of physical therapy RCTs and demonstrates good inter-rater reliability.<sup>27</sup> Papers are rated on the following criteria: random allocation; allocation concealment; similar between-group prognostic indicators at baseline; blinding of participants; blinding of therapists; blinding of assessors; key outcome measures obtained from at least 85% of participants initially assigned to groups; intention to treat analysis performed; between group statistical analysis performed on at least one key outcome and finally, both point measures and measures of variability were performed for at least one key outcome. External validity of this instrument is addressed by criteria one of the scale and internal validity is address by criteria two to nine of the scale.<sup>26</sup> This scale is limited since blinding participants and therapists or observers to an exercise intervention is not possible. Thus the highest possible score using the PEDro scale is eight out of 10 for the present review. Included studies were independently review by both authors. Where any discrepancy in PEDro scores existed this was resolved by discussion.

For the purpose of this review, interventions are defined as an aerobic exercise intervention where the intervention included walking, running or similar continuous activities; non-aerobic interventions where the intervention included free weight training, machine resistance exercise, body weight or similar forms of exercise; or combined interventions where both aerobic and non-aerobic exercise were performed.

### 3. Results

Our search revealed 2696 potential studies. After removal of duplicates, the remaining titles and abstracts were scanned for relevance, leaving 102 potential studies. Full text versions were obtained for the remaining papers and further screened for inclusion. A further 90 were subsequently excluded, leaving 12 papers for inclusion in this review. The principle reasons for exclusion included studies which included participants with multiple diagnoses (41 papers), were not structured exercise interventions (26 papers), or showed no significant or treatment effect of exercise (23 papers). To avoid conflict with the review of Perraton and colleagues,<sup>23</sup> the publication date inclusion criteria was narrowed to papers published since 2007, leaving five papers for inclusion in this review.

Study quality was evaluated using the PEDro scale. Fig. 1 shows the range of PEDro scores for the five included RCTs.

All participants in the included studies were evaluated according to DSM-IV, ICD-10 or validated instruments. Two studies used the Beck Depression Inventory,<sup>5,6</sup> two studies reported diagnosis according to DSM-IV criteria<sup>28,29</sup> and one study used multiple criteria.<sup>30</sup> Three studies included participants with a diagnosis of MDD,<sup>28–30</sup> one study reported participants with mild to moderate depression<sup>5</sup> and one study failed to report the severity of depression.<sup>6</sup>

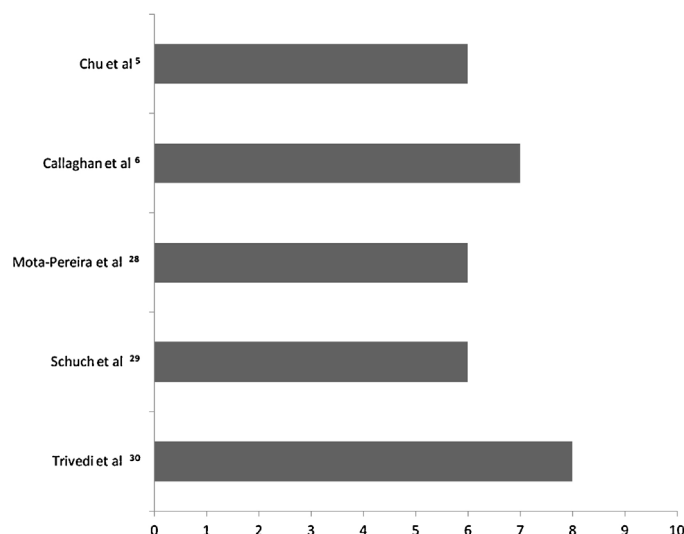


Fig. 1. PEDro scores.

The program characteristics of aerobic exercise interventions meeting the inclusion criteria are shown in Table 1. All trials used walking as the principle mode of exercise.

Since 2007 there were no non-aerobic or resistance training studies identified meeting the inclusion criteria.

Since 2007 there were no combined studies identified meeting the inclusion criteria.

All studies except one<sup>5</sup> included co-interventions. A summary of these is shown in Table 2.

Training frequency was adequately reported in all trials. Training intensity was adequately reported in two trials,<sup>5,6</sup> defined as moderate intensity in one<sup>28</sup> and two studies combined intensity and duration to report energy expenditure.<sup>29,30</sup> All studies except one,<sup>6</sup> reported training session duration. All studies utilized treadmill walking either alone, or combined with other forms of aerobic exercise such as stationary cycling,<sup>29,30</sup> cross trainer,<sup>30</sup> outdoor walking<sup>28</sup> or the participants personal preference.<sup>5</sup> Intervention duration was adequately reported in four out of five studies with one study reporting a variable length as it was conducted in a hospital setting.<sup>30</sup> Two studies reported exercise undertaken on an individual basis<sup>5,30</sup> with one study reporting a group intervention.<sup>6</sup> Both group and individual sessions were used in one study<sup>28</sup> with the mode of delivery being unclear in the final study.<sup>29</sup> All studies reported some level of supervision. However, one study failed to report the completion rate.<sup>30</sup> None of the five RCTs reported the use of recovery strategies or dietary co-interventions or instructions to maintain usual daily activities.

### 4. Discussion

The aim of this review was to identify the exercise program variables which may lead to successful treatment of patients with depression and provide recommendations which future studies may draw upon.

The present review observed a mean frequency of aerobic exercise in the included RCTs of 3.8 sessions per week. However, there was considerable variability in the frequency of exercise training in the studies reviewed, ranging from twice weekly<sup>29</sup> to five times weekly.<sup>5</sup> Three times weekly is the most commonly reported frequency and this is consistent with the review of Perraton and colleagues,<sup>23</sup> the NICE guidelines<sup>18</sup> and with recommendation for clinical<sup>25</sup> and non-clinical<sup>24</sup> populations.

There is considerable variation in the intensity of exercise ranging from patient-preferred<sup>6</sup> to 75%VO<sub>2reserve</sub>.<sup>5</sup> Given this range

**Table 1**  
Program variables of aerobic interventions.

Author	Frequency (per week)	Intensity	Session duration	Mode of exercise	Intervention duration	Individual or group	Level of supervision	Compliance
Chu et al. <sup>5</sup>	4–5	High (65–75%VO <sub>2reserve</sub> )	30–40 min	Treadmill (supervised), personal preference when unsupervised	10 weeks	Individual	Once weekly by investigator	80–100% (supervised session)
Callaghan et al. <sup>6</sup>	3	Low (40–55%VO <sub>2reserve</sub> ) Patient preferred	NR	Treadmill	4 weeks	Group	Qualified exercise therapist	66%
		Prescribed (RPE = 12) Moderate	NR					50%
Mota-Pereira et al. <sup>28</sup>	5 (1 supervised, 4 unsupervised)	Moderate	30–45 min	Treadmill (supervised), outdoor walking (unsupervised)	12 weeks	Both	Physical training teacher	91%
Schuch et al. <sup>30</sup>	3	Variable – duration and intensity aimed to expend 16 kcal/kg/week		Stationary cycle, treadmill or cross trainer	Variable – final assessment at hospital discharge	Individual	Trained researcher	NR
Trivedi et al. <sup>29</sup>	3 (median)	Variable – High dose (16 kcal/kg/week)		Treadmill and/or cycle ergometer	12 weeks	NR	Cooper Institute staff	63.8%
	2 (median)	Variable – Low dose (4 kcal/kg/week)						99.4%

NR – not reported.

of intensities and the differing methods used to measure intensity it makes any attempt to conclude an optimal exercise intensity difficult from the present review.

Training session duration was reported as variable in two studies included in this review<sup>29,30</sup> and not reported in another.<sup>6</sup> The remaining two studies<sup>5,28</sup> reported session durations of 30–40 min. This is less than that suggested in the NICE guidelines,<sup>18</sup> but consistent with the normal healthy population recommendation.<sup>24</sup>

Two studies since 2007 have employed aerobic exercise dosages based on public health recommendations. Schuch and colleagues<sup>30</sup> used an exercise dose of 16 kcal/kg/week where the participant was able to self-select the duration and intensity of exercise in order to achieve the required energy expenditure. Trivedi and coworkers<sup>29</sup> used two differing dosages, one at the upper limit of public health recommendations (16 kcal/kg/week) and compared this to a dosage at the lower end of the public health recommendations (4 kcal/kg/week) and found that although exit remission rates were identical for both groups (29.5%), median adherence rates for the lower dose was significantly better than with the higher dose. Whilst not explicitly identified, participants randomized to the higher dose group may have exercised at a higher intensity resulting in a more negative affect response to the exercise bout. This may support the observed adherence rates which were significantly lower in the high dose group (63.8%) compared to the low dose group (99.4%).<sup>29</sup>

The present review did not identify any non-aerobic or mixed interventions meeting the inclusion criteria. This may be because resistance training interventions typically require more physical space, financial investment and adequately qualified supervision,

whereas a walking program is easier to develop and implement. However, two interventions used stationary cycles<sup>29,30</sup> or elliptical cross trainers<sup>30</sup> and all studies used a treadmill for some component of the intervention which reflects both a capital investment and dedication of physical space. One study<sup>30</sup> used an in-patient setting. There is a paucity of literature investigating the effect of exercise in this population; however, recent studies demonstrate a positive effect across a range of conditions<sup>31–33</sup> with only one retrospective study showing no effect.<sup>34</sup>

The present review showed that intervention durations between four and twelve weeks are effective in reducing depressive symptoms. However, the mean duration, excluding the study of Schuch and colleagues<sup>30</sup> (duration not reported) was 9.3 weeks. This figure is in line with the recommendations from the previous systematic review of Perraton and colleagues<sup>23</sup> and with the NICE guidelines.<sup>18</sup> Twelve weeks was the most commonly reported duration for the five RCTs used in the present review.<sup>29,28</sup>

It would appear both group and individual exercise programs may be used successfully by people with depression. Interestingly, in the small number of studies which report both the mode of delivery and the compliance,<sup>5,6,28</sup> it would appear programs delivered either individually<sup>5</sup> or with both an individual and group component<sup>28</sup> have higher compliance, suggesting a possible additive effect of individual exercise sessions.

All RCTs included in the present review were supervised to some degree. However, the qualifications of professionals providing supervision were varied. The influence of this variable is presently unknown however all supervisors were well trained in the provision of exercise.

**Table 2**  
Co-interventions for depression.

Author	Medication	Psychotherapy	Behavioral intervention	Electroconvulsive therapy
Chu et al. <sup>5</sup>	X	X	X	X
Callaghan et al. <sup>6</sup>	X	✓	✓	X
Mota-Pereira et al. <sup>28</sup>	✓	X	X	X
Schuch et al. <sup>30</sup>	✓	X	X	✓
Trivedi et al. <sup>29</sup>	✓	X	✓	X



**Table 3**

Summary of the aerobic exercise prescription guidelines for healthy and clinical populations and for those with depression.

Author	Frequency (per week)	Intensity	Session duration	Mode of exercise	Intervention duration	Individual or group	Level of supervision
Perraton et al. <sup>23</sup> (depression)	3	60–80%HR <sub>max</sub>	30 min	Individualized according to preference	8 weeks	Group or individual	Recommended. Qualifications and experience unspecified
NICE <sup>18</sup> (depression)	3	NR	45–60 min	NR	10–14 weeks	Group	Competent practitioner
Garber et al. <sup>24</sup> (healthy population)	≥5	Moderate	Min 30 min/session or ≥150 min/week	Individualized according to preference	Ongoing	NR	Experienced fitness instructor
	≥3	Vigorous	Min 20 min/session or ≥75 min/week Or a combination to achieve ≥500–1000 kcal/week				
Horden et al. <sup>23</sup> (type II diabetes and pre diabetes)	Min 3 with no more than 2 consecutive days without exercise	Moderate (55–69%HR <sub>max</sub> ) or Vigorous (70–89%HR <sub>max</sub> )	Min 210 min/week of moderate or 125 mins/week of vigorous exercise or a combination of both	Walking, running cycling or swimming	Ongoing	NR	Appropriately trained and qualified personnel
Stanton and Reaburn (current review) (depression)	3–4	Low – moderate or patient preferred	30–40 min	Any aerobic activity	9 weeks	Group or individual	Appropriately trained and qualified personnel

NR – not reported.

The present review of RCTs related to the effects of exercise interventions on symptoms of depression showed that compliance was highly variable ranging from 50%<sup>6</sup> to 100%.<sup>5</sup> This may be a reflection of the group versus individual participation, the exercise intensity, the exercise mode, or a combination of any of these variables. In the study of Trividi and colleagues,<sup>29</sup> participants randomized to the low dose group (4 kcal/kg/week) had a significantly higher compliance rate compared to participants in the high dose group (16 kcal/kg/week). Similarly, exercise undertaken at the individuals preferred intensity resulted in higher compliance rates compared to a prescribed intensity.<sup>6</sup> In contrast, no significant difference was noted in supervised session compliance between the high intensity or low intensity arms of the study of Chu and colleagues.<sup>5</sup> This finding highlights the complex interplay between program variables and needs further investigation.

## 5. Recommendations from this review

Taken together, it would seem that a program of supervised aerobic exercise comprising indoor or outdoor walking, stationary cycle or cross trainer exercise in either group, individual or combined formats, performed three to four times weekly, undertaken at low to moderate intensity or at the participants preferred intensity, with sessions lasting 30–40 min is beneficial in the treatment of depression. This appears to be effective for a range of co-interventions including medication use, psychotherapy, behavioral interventions to aid adherence and electroconvulsive therapy. Programs should be of at least nine weeks duration. These parameters are slightly increased over those proposed in the previous systematic review of Perraton and colleagues<sup>23</sup> with respect to frequency, session duration and length of intervention; but slightly less than the 45–60 min over 10–14 weeks recommended by the NICE guidelines.<sup>18</sup>

A recent systematic review and meta-analysis confirmed the efficacy of walking for the treatment of depression but was unable to provide recommendations as to the other most appropriate program variables to be used in the treatment of depression.<sup>22</sup> In contrast, the present review and the earlier review of Perraton and colleagues<sup>23</sup> confirm that an intervention using the program

variables similar to those recommended for the general population is beneficial for the treatment of depression.

## 6. Comparison with healthy and clinical populations

The current review considers effective exercise interventions for people with depression. Compared to the previous review of Perraton and colleagues<sup>23</sup> our review recommends more frequent, longer duration exercise sessions over a greater duration and with appropriately qualified supervision. Compared to the most recent reviews for exercise prescription for healthy populations,<sup>24</sup> the current review recommends a similar total volume of exercise, however the recommendations from Garber and colleagues<sup>24</sup> highlight the additional value of more vigorous exercise. To date this has not been established in people with depression. Similarly, the review of Garber at colleagues<sup>24</sup> highlights the need for ongoing compliance for the maintenance of benefits. Whilst the current review agrees with this recommendation, the majority of studies have used a clinical endpoint such as remission, or fixed study duration without long term follow up. Further long term studies are needed to investigate the ongoing benefits for people with depression.

Compared to the common clinical condition, type II diabetes mellitus, for which there has been a significant body of research investigating the effects of exercise, the present review recommends a similar exercise frequency, however the total volume (160 min/week versus 210 min/week) and the inclusion of more vigorous exercise remain disparate recommendations.<sup>25</sup> As with the review of Garber and colleagues,<sup>24</sup> Horden and co-workers<sup>25</sup> emphasize the need for ongoing exercise compliance.

Considering the NICE recommendations for exercise in the treatment of depression,<sup>18</sup> those for healthy populations,<sup>24</sup> people with diabetes<sup>25</sup> and the outcomes of the present review collectively, there is a significant overlap in the recommended exercise prescription parameters. Based on this overlap, one could consider the prescription of a supervised, group based, individualized aerobic exercise program of ≥150 min/week to be a universal program across people without clinical contraindications, for those with depression or for those with type II diabetes. Table 3 shows a summary of the relevant recommendations from these reviews.

Therefore, health professionals should not be discouraged in recommending exercise in general and aerobic exercise specifically for people with depression. As with other clinical populations, pre-screening for co-morbid conditions, individually tailoring exercise to suit the client's preference, access to facilities and ensuring supervision and follow up are likely to enhance the long term outcomes.

## 7. Limitations

This review included trials which showed a positive effect of exercise in people with clinical depression only and excludes post-natal depression, bipolar disorder or depression with co-morbid illness such as diabetes or cancer. Similarly, this review only includes structured exercise interventions and not leisure time physical activity, sports participation, or other forms of exercise such as Yoga, Tai Chi, stretching or other lower intensity exercise. Finally, since no non-aerobic exercise interventions such as resistance training were examined, we cannot compare the loading parameters for each exercise modality.

As with previous reviews,<sup>13,19,20,35</sup> methodological inconsistencies exist in the literature. The heterogeneous nature of study design including outcome measures, depression score at baseline, co-interventions, exercise loading and blinding of assessors makes it difficult to develop strong conclusions.

## 8. Future recommendations

There is a need to develop a series of consecutive interventions in which just one exercise program variable is manipulated at one time. Thus, the effect of separately manipulating exercise frequency, intensity, session duration and length of intervention may be addressed. Alternatively, we may look to determine the minimum effective dose required to have an effect on symptoms of depression. People with depression may have less motivation initially<sup>36</sup> and thus prescribing the minimum amount of exercise known to be effective may encourage better initial compliance. There has also been keen interest in an affect-regulated approach to exercise prescription with one recent training study confirming the utility of such an approach in a non-clinical population.<sup>37</sup>

## 9. Summary

Exercise which is effective for the treatment of depression is not substantially different to that recommended for population health, nor for those with type II diabetes. Aerobic exercise which is supervised to some degree, performed three to four times weekly at a moderate or self-selected intensity for 30–40 min over a period of at least nine weeks appear effective in the treatment of depression. Further research is necessary to elucidate the full effect of manipulating the variables commonly used in exercise programs.

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