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IN-DEPTH REVIEW

Do workplace physical activity interventions improve mental health outcomes?

A. H. Y. Chu[1,2], D. Koh[1,3], F. M. Moy[2], and F. Müller-Riemenschneider[1,4]

[1]Saw Swee Hock School of Public Health, National University of Singapore, Block MD3, 16 Medical Drive, Singapore 117597, Singapore, [2]Department of Social and Preventive Medicine, Faculty of Medicine, Julius Centre University of Malaya, University of Malaya, 50603 Kuala Lumpur, Malaysia, [3]PAPRSB Institute of Health Sciences, Universiti Brunei Darussalam, Jalan Tungku Link, Gadong, Brunei Darussalam BE 1410, [4]Institute for Social Medicine, Epidemiology and Health Economics, Charite University Medical Centre, 10098 Berlin, Germany

Correspondence to: D. Koh, Saw Swee Hock School of Public Health, National University of Singapore, Block MD3, 16 Medical Drive, Singapore 117597, Singapore. Tel: +673 246 3001, Ext 2291; fax: +673 246 1081; e-mail: david_koh@nuhs.edu.sg

Background	Mental health is an important issue in the working population. Interventions to improve mental health have included physical activity.
Aims	To review evidence for the effectiveness of workplace physical activity interventions on mental health outcomes.
Methods	A literature search was conducted for studies published between 1990 and August 2013. Inclusion criteria were physical activity trials, working populations and mental health outcomes. Study quality was assessed using the Jadad scale.
Results	Of 3684 unique articles identified, 17 met all selection criteria, including 13 randomized controlled trials, 2 comparison trials and 2 controlled trials. Studies were grouped into two key intervention areas: physical activity and yoga exercise. Of eight high-quality trials, two provided strong evidence for a reduction in anxiety, one reported moderate evidence for an improvement in depression symptoms and one provided limited evidence on relieving stress. The remaining trials did not provide evidence on improved mental well-being.
Conclusions	Workplace physical activity and yoga programmes are associated with a significant reduction in depressive symptoms and anxiety, respectively. Their impact on stress relief is less conclusive.
Key words	Muscle stretching exercises; occupational health; physical activity; psychological; stress.

Introduction

The work environment is recognized as an important source of psychological stress due to work demands and pressures. This may lead to adverse mental health outcomes and impaired psychological well-being. Many organizations have interventions to improve mental health such as cognitive behavioural therapy, meditation, relaxation and deep breathing. Physical activity may also be an effective intervention. Yoga is a form of physical activity that focuses not only on physical well-being but also on nurturing mental health and has attracted growing attention from researchers. Yoga combines physical activity/postures of low-to-moderate intensity which focus on muscle stretching exercises, meditation technique and regulation of respiration [1]. Participation in yoga as a

mind–body intervention has become increasingly popular in Western cultures over the past century [2].

Several hypotheses have been proposed to explain the connection between physical activity and improved mental health. The endorphin hypothesis postulates that elevation of endorphins (endogenous opioids) in the central nervous system (CNS) decreases cortisol levels, alters neurotransmitters, stimulates production of serotonin and norepinephrine, and increases levels of brain-derived neurotrophic factor [3–5]. Endorphins are elevated by exercise and released into the bloodstream from the pituitary, resulting in improved mood states, described as an 'endorphin high' or 'runner's high'. It is suggested that exercise increases the permeability of the blood–brain barrier and supports the safe passage of endorphins into the brain and CNS [6]. Inhibitory effects of endorphins

on the CNS tend to minimize the discomfort of exercise, causing a feeling of euphoria, positive mood state and sensation of calm after exercise [7]. An alternative hypothesis is based on monoamine neurotransmitters (e.g. serotonin and norepinephrine). This suggests that physical exercise stimulates the sympathetic nervous system, triggering the synaptic transmission of monoamines. Increasing concentrations of these neurotransmitters has the same effect as antidepressant drugs [3].

Past reviews of the effectiveness of physical activity trials on mental well-being included studies on subjects with clinical depression [8] or diagnosed anxiety disorders [9], children/adolescents [10], older populations [11] or the general adult population [12]. Other reviews reported interventions that included psychological treatments and physical activity trials in the workplace setting [13,14]. A previous meta-analytic review explored workplace physical activity interventions on worksite and health outcomes [15]. A review published in 2011 included studies published through 2009 on physical activity and workers' presenteeism, productivity, job satisfaction and emotional well-being.

While such information can be used to support the positive roles of physical activity, it falls short of suggesting practical guidelines on which forms of physical activity prescription in the workplace are likely to be most beneficial for specific health outcomes. This review updates the evidence from trials on the effectiveness of physical activity interventions specifically on workplace mental health outcomes (stress, anxiety and depression). Because yoga is considered to be an alternative to traditional aerobic exercise training programmes, our focus will be on exploring the effectiveness based on separate categorization of physical activity and yoga interventions.

Methods

A systematic literature review was conducted of peer-reviewed articles published between 1990 and August 2013 in the following databases: EMBASE, PubMed and the Cochrane Central Register of Controlled Trials (CENTRAL). The following search terms were entered: 'occupational or employee or organization or work' and 'stress or depression or anxiety or mental or psychological or well-being' and 'physical activity or exercise or muscle stretching exercise' and 'intervention or training or programme* or randomized controlled trial or controlled trial'. Reference lists within individual studies and review papers were screened to retrieve relevant studies.

The following general inclusion criteria were applied: (i) Types of study design: RCTs and other quasi-experimental studies. Comparison groups included no treatment or other interventions (i.e. various intensities or types of physical activity, stress management training, cognitive behavioural therapy, mindfulness training).

(ii) Study populations: working adults of different workforce sectors. (iii) Types of study interventions: interventions that involved evaluation of the effectiveness of physical activity interventions (i.e. interventions could be supervised or non-supervised physical activity, exercise and yoga programmes delivered either at the workplace or home based). (iv) Types of outcomes: mental health outcomes (including stress, anxiety and depression). (v) Written in the English language.

We excluded abstracts, dissertations, studies involving trials with post-test only design, trials including physical activity intervention as a small component of health promotion programmes, animal studies, studies lacking outcomes related to the objectives of this review as well as non-English articles. The following characteristics were extracted and summarized from each study: study design, treatment and control (or reference) group, sample size and source of the study groups, treatment components, duration, outcome measures and main results. We evaluated the methodological quality of each study by the modified Jadad [16] (or the Oxford quality) rating systems (Table 1). The Jadad scale was developed and validated to gauge the quality of RCT-based methods relevant to random assignment. A point of 1 is given when adequate description and performance of each item are met. As double blinding is less applicable for behavioural interventions, the scale was modified to give a point of 1 when blinding of the outcome assessor was reported [17]. A total score between 0 (weakest) and 4 (strongest) was assigned to appraise the level of evidence of each study. A study was considered to be of high quality for those with a Jadad score ≥3 and low quality for those with a Jadad score <3. For assessment of the overall strength of the evidence, the modified Royal College of General Practitioners (RCGP) three-star system was adopted [18]. To determine a trial's effectiveness, we defined the outcome measure with '+' which denotes positive effects, '↔' no effects.

The modified RCGP three-star system:

***Strong evidence—provided by generally consistent findings in multiple, high-quality scientific studies.
**Moderate evidence—provided by generally consistent findings in fewer, smaller or lower quality scientific studies.
*Limited or contradictory evidence—provided by one scientific study or inconsistent findings in multiple scientific studies.
−No scientific evidence—based on clinical studies, theoretical considerations and/or clinical consensus.

Results

The literature search yielded 3684 unique titles from the databases. A total of 3650 articles were excluded after removing duplicates and applying inclusion and exclusion

Table 1. Jadad methodological quality system

Studies		1	2	3	4	Result of modified Jadad score
		Was the study described as randomized (this includes words such as randomly, random and randomization)?	Was the method used to generate the sequence of randomization described and appropriate (table of random numbers, computer-generated, etc)?	Single blinding for the outcome measures	Was there a description of withdrawals and dropouts?	
Randomized controlled trial						
1	Atlantis *et al.* [19]	1	1	0	1	3
2	Cheema *et al.* [20]	1	1	1	1	4
3	de Zeeuw *et al.* [21]	1	1	0	1	3
4	Eriksen *et al.* [22]	1	1	0	1	3
5	Grønningæter *et al.* [23]	1	0	0	1	2
6	Hartfiel *et al.* [24]	1	0	0	1	2
7	Hinman *et al.* [25]	1	0	0	1	2
8	Kerr and Vos [26]	1	1	1	1	4
9	Nurminen *et al.* [27]	1	1	0	1	3
10	Sakuma *et al.* [28]	1	1	0	1	3
11	Sjogren *et al.* [29]	1	0	0	1	2
12	Tveito and Eriksen [30]	1	1	0	1	3
13	Wolever *et al.* [31]	1	0	0	1	2
Comparison trial						
14	Granath *et al.* [32]	1	0	0	1	2
15	Van Rhenen *et al.* [33]	1	0	0	1	2
Controlled trial						
16	Mastura *et al.* [34]	0	0	0	1	1
17	Norris *et al.* [35]	0	0	0	1	1

criteria. Thirty-four full-text articles were obtained from potentially eligible titles for further evaluation, of which 17 were excluded. Figure 1 depicts a study flow diagram of the selection process. The detailed characteristics of the selected studies are shown in Table 2. Thirteen RCTs [19–31], two comparison trials [32,33] and two non-RCTs [34,35] were selected, comprising a total of 2025 subjects (post-intervention). Of these 17 studies, 3 were conducted each in the Netherlands, Norway, 2 studies each in Australia, Finland, UK, USA and 1 each in Japan, Malaysia and Sweden published between 1990 and August 2013. The sample size of the participants ranged from $n = 27$ to $n = 628$. Included trials consisted of working participants involved in a diverse range of sectors: telecommunications industry, casino, university, insurance company, postal service, local government authorities, laundry workers, household items manufacturer, childcare, elderly care, financial service and police officers. The age range of the study populations was 23–67 years, with the exception of one trial that failed to report the age of their study participants [32].

Studies were grouped into two key intervention areas: physical activity (aerobic dance/exercise, weight-training exercise, strength or resistance training) and yoga exercise. Within these groups, synthesis of evidence is provided using a narrative approach. Of the 13 RCTs, nine

studies investigated physical activity interventions and four investigated yoga. Among the comparison trials, one focused on physical activity, while the other involved yoga practice. Two of the non-RCTs investigated the effects of aerobic dance and aerobic/anaerobic programmes aimed at muscle strength training. The intervention trials differed in terms of the comparison group including wait-list control, psychological education, cognitive behaviour intervention, intensity of exercise and anaerobic training. The intervention period varied from 2 weeks to 12 months. The frequency of training sessions ranged from twice per week to once in every 4 weeks. Training duration ranged from 5 to 60 min per session. The regimens of the physical activity interventions varied from 5 min/working day (i.e. 25 min/week) to 55 min per session twice a day on 3 days per week. Nine studies examined the effectiveness of moderate- to high-intensity aerobic exercise; five studies evaluated yoga exercise, and one of each assessed low-intensity aerobic exercise, light resistance training and body muscle stretching/relaxation exercise. Multi-component programmes were identified in two trials: one trial involved aerobic/weight-training exercise accompanied by behaviour modification [19] and one trial investigated physical activity session coupled with stress management training [30], whereas the remaining 15 trials focused primarily on physical
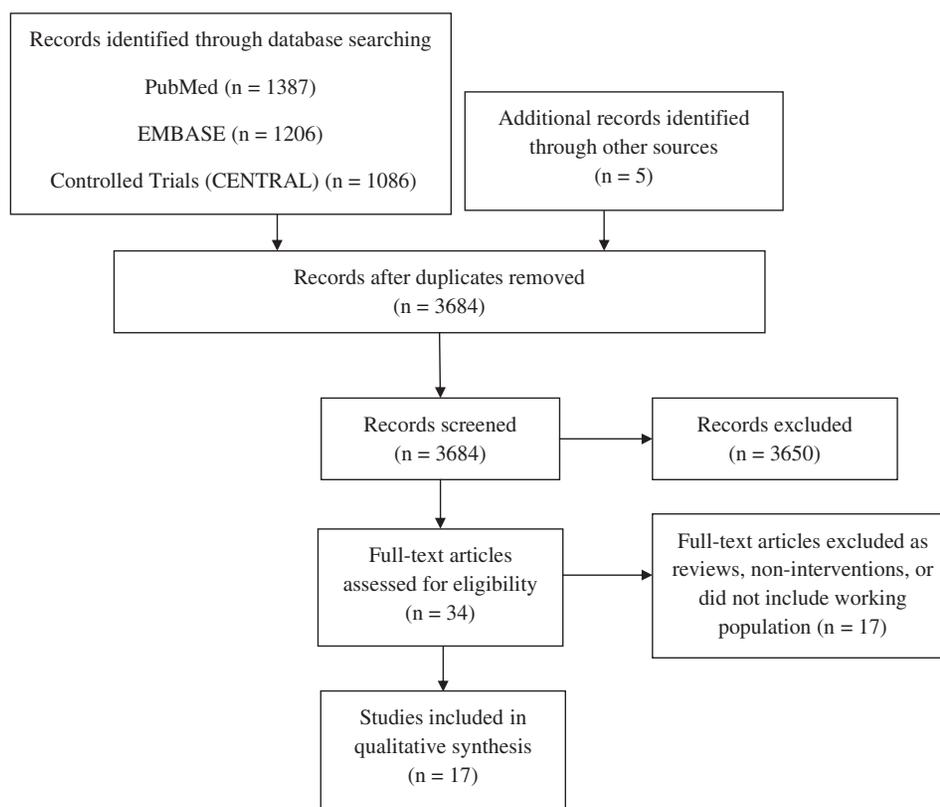
Figure 1. Flow diagram of study selection.

activity component. Adherence rate in these studies was calculated: compared with the start of the physical activity interventions, an average of 84% (range: 58–100%) of the participants were examined at the end of the trials.

Study outcomes included stress, anxiety and depression that were assessed using a number of self-report measures. Two studies assessed the level of depression using the Depression Anxiety Stress Scales (DASS) and the Patient Health Questionnaire (PHQ-9). Six studies included a measure of anxiety using the DASS, State-Trait Anxiety Inventory (STAI), General Well-Being Questionnaire and General Health Questionnaire (GHQ30). Twelve studies measured stress using DASS, Cooper job stress questionnaire, Personal Strain Questionnaire (PSQ), Nordic questionnaire, Perceived Stress Scale (PSS), Four-Dimensional Symptom Questionnaire (4DSQ), Derogatis Stress Profile (DSP) and Job stress questionnaire (JSQ). None of the studies reported negative effects derived from physical activity intervention on mental health outcomes.

The quality scores ranged from '2' to '4' for the RCTs, '2' for both comparison trials and '1' for both non-RCTs for the eligible studies on the Jadad scale (Table 1). Eight of the 13 RCTs that reported the procedure of random sequence generation were classified as high-quality studies. The most common loss of points in the rating system was due to lack of blinding procedure and unclear description of random sequence generation.

Effects of interventions

Physical activity and stress

Seven RCTs that compared physical activity with control groups receiving no treatment on workplace stress were identified [19,22,23,25,27,29,30]. Only one study of high quality showed a significant improvement in stress scores [19]. Atlantis *et al.* conducted an exercise intervention programme combined with behaviour modification in 44 employees from a casino over a 24-week period and showed significant improvement in stress score among the treatment group by −37% (effect size, $d = 0.56$, $P = 0.036$). The remaining RCTs—three each of high quality [22,27,30] and low quality [23,25,29]—reported no effects of physical activity on stress.

Physical activity and anxiety

Two RCTs of high quality [19,26] and two RCTs of low quality [23,29] investigated the effects of physical activity on anxiety. None found any significant difference between the treatment and control groups on anxiety disorders. Of note, Kerr and Vos [26] demonstrated a reduction in anxiety score among participants who received exercise training over a 12-month period; however, the differences between the groups did not reach statistical significance.

Table 2. Detailed descriptions of included trials

Author(s) and reference numbers	Treatment control	Sample size and description[a]	Treatment components	Length	Outcome measures	Main results[b]
Randomized controlled trial						
Physical activity						
Atlantis *et al.* [19]	(i) Aerobic and weight-training exercise, plus behaviour modification or (ii) control group	T = 20 (mean age: 30±6.8 years), C = 24 (mean age: 33±8 years); casino employees with low physical activity (Australia)	20-min, 3 days/week of moderate- to high-intensity aerobic exercise on fitness facilities (Supervised)	24 weeks	Depression, anxiety and stress (DASS)	Depression: + Anxiety: ↔ Stress: +
de Zeeuw *et al.* [21]	(i) In-company fitness programme with two supervised training sessions per week or (ii) control group	T = 14 (mean age: 41.3±6.5 years), C = 13 (mean age: 31.8±7.5 years); white-collar employees from an insurance company with minimal symptoms of depression (The Netherlands)	10~20 min of cycling on a bicycle ergometer, jogging on a treadmill, walking on a cross-trainer, or climbing stairs, on a pedal stepper, 2 days/week of supervised training sessions (Supervised)	10 weeks	Depression (Patient Health Questionnaire, PHQ-9)	Depression: ↔
Eriksen *et al.* [22]	4-arm trial: (i) Physical exercise (PE), (ii) stress management training (SMT), (iii) combined integrated health programme (IHP), (iv) control group	PE = 144 (mean age [95% CI]: 38.2±36.7−39.7 years), SMT = 123 (mean age [95% CI]: 38.9±37.2−40.6 years), IHP = 129 (mean age [95% CI]: 38.2±36.5−39.8 years), C = 232 (mean age [95% CI]: 37.0±35.8−38.1 years); postal service employees (Norway)	60-min, 2 sessions per week of the Norwegian aerobic dancing programme, 'Gymnastikkitiden'. A dynamic and rhythmical moderate-intensity level exercise (70–80% of maximum heart rate) (Supervised)	12 weeks	Job stress (Cooper job stress questionnaire)	Job stress: ↔
Grønningæter *et al.* [23]	(i) Aerobic physical exercise (EXT), (ii) stress management training (SMT), (iii) control group	EXT = 25, SMT = 23, control = 28 (age range: 25−67 years); physically inactive insurance workers (Norway)	55-min, 2 sessions per day, 3 times per week of aerobic exercise and relaxation programme (Supervised)	10-week intervention, 6-month follow-up	Job stress (Cooper job stress questionnaire), trait/state anxiety (State-Trait Anxiety Inventory, STAI)	Job stress: ↔ Trait anxiety: ↔
Hinman *et al.* [25]	(i) Exercise group, (ii) control	T = 26, C = 24 (Average age: 38.9 years); female office workers from nursing school (USA)	15-min, 2 sessions per day of computerized body muscle relaxation exercise regime (Supervised)	8 weeks	Job stress (Personal Strain Questionnaire, PSQ)	Job stress: ↔
Kerr and Vos [26]	4-arm trial: (i) Treatment groups (T): (a) Regular participants of an Employee Fitness Programme (EFP), (b) Irregular participants of EFP (ii) Control groups (C): (a) Regular exercisers, (b) Non-exercisers	T (i) = 34, T (ii) = 29; C (i) = 38, C (ii) = 38 (mean age: 39 years); white-collar bank employees (The Netherlands)	60-min, once per week of employee fitness programme with onsite fitness facility using professionally trained physical education staff to increase endurance, strength and flexibility (Supervised)	12 months	Anxiety (Measured by 'Uptight' factor using the General Well-Being Questionnaire)	Anxiety: ↔
Nurminen *et al.* [27]	(i) Exercise group, (ii) control group	T = 133; C = 127 (mean age: 40 years); women laundry workers (Finland)	60-min, once per week of moderate-intensity physical activity (26 sessions) (Supervised)	3-, 8-, 12- and 15-month follow-up	Stress (Modified-version of Nordic questionnaire)	Stress: ↔
Sjogren *et al.* [29]	(i) Exercise intervention, (ii) control group	T = 55, C = 35 (mean age: 45.7±8.5 years); office workers (Finland)	5-min/working day (i.e. 25-min/week), light resistance training (Supervised)	15 weeks	Stress, anxiety (Subjective well-being questionnaire)	Stress: ↔ Anxiety: ↔

Table 2. (*Continued*)

Author(s) and reference numbers	Treatment control	Sample size and description[a]	Treatment components	Length	Outcome measures	Main results[b]
Tveito and Eriksen [30]	(i) Exercise group, (ii) control group	T = 12, C = 17 (mean age: 45 years); employees in a nursing home for older people (Norway)	60-min, 3 times per week of aerobic dancing sessions, health information/stress management training (1 h once per week) and a practical examination of the workplace during working hours (Supervised)	9 months	Job stress (Swedish version of the Psychological Demands dimension from the Demand/Control Model, PD-DCM)	Job stress: ↔
Yoga						
Cheema *et al.* [20]	(i) Yoga group, (ii) control	T = 18, C = 19 (total mean age: 38 ± 12 years); employees in university-based office positions (Australia)	50-min, 3 times per week of yoga empha-sized on postures and exercises (Supervised)	10 weeks	State and trait anxiety (State-Trait Anxiety Inventory, STAI)	State anxiety: +
Hartfiel *et al.* [24]	(i) Yoga group, (ii) control	T = 16 (mean age: 46.1 ± 11.5 years), C = 17 (mean age: 43.6 ± 11.5 years); local government authorities (UK)	50-min, 2.6 times of yoga sessions per week (Supervised)	8 weeks	Perceived stress (PSS)	Stress: +
Sakuma *et al.* [28]	(i) Home-based yoga group, (ii) control group	T = 44; C = 24 (mean age: 33.6 years); female childcare workers (Japan)	7 min 30 s of a DVD yoga programme (Home based)	2-week intervention, 4-week follow-up	Anxiety (General Health Questionnaire, GHQ30)	Anxiety: +
Wolever *et al.* [31]	(i) Yoga group, (ii) mindfulness group, (iii) control group	Yoga = 76, mindfulness = 82, control = 47 (average age: 42.9 years); national insurance carrier (USA)	60 min per week of yoga session (Home based)	12 weeks	Perceived stress (PSS)	Stress: +
Comparison trial						
Van Rhenen *et al.* [33]	(i) Physical exercise and relaxation intervention, (ii) cognitive intervention	Exercise intervention = 71, cognitive intervention = 59 (mean age: 44.2 ± 7.4 years); employees in a telecommunications company (The Netherlands)	60 min per session, with four sessions distributed over 10 weeks (Supervised)	10-week intervention and 6-month follow-up	Distress (Four-Dimensional Symptom Questionnaire [4DSQ])	Distress:+ Depression: + Anxiety: +
Granath *et al.* [32]	(i) Yoga and (ii) cognitive behaviour therapy, in either an all-female group or a mixed group (making 4 groups in total) * No control group	Yoga = 16, CBT = 17 (mean age: N/A); employees from large a company in the financial sector (Sweden)	10 sessions of weekly yoga exercise (Supervised)	4 months	Psychological: General stress level (Perceived Stress Scale, PSS)	Stress: +
Controlled trial						
Mastura *et al.* [34]	(i) Low-impact aerobic dance exercise, (ii) control group: conventional high/low impact aerobics	T = 20, C = 20 (age range: 40–55 years); overweight and sedentary working women from government sectors (Malaysia)	50-min, 3 times per week of a new intervention low-impact aerobic dance exercise (Total 36 sessions) (Supervised)	12 weeks	Total stress scores (Derogatis Stress Profile, DSP)	Stress: +
Norris *et al.* [35]	(i) Aerobic, (ii) anaerobic training, (iii) control group	Aerobic group = 28, anaerobic group = 24, control = 25 (age range: 20−50 years); male police officers; (UK)	45 min, 3 times per week in sessions aimed at improving either cardiovascular endurance or muscle strength (Supervised)	10 weeks	Job stress (Job stress questionnaire, JSQ)	Job stress: +

[a]T indicates treatment group; C indicates control group.
[b]'+': positive effects, '↔': no effects.

Physical activity and depression

Two RCTs of high quality were identified that assessed the effects of physical activity on depressive symptoms [19,21]. Atlantis *et al.* [19] found that participants receiving an exercise training plus behaviour modification programme significantly reduced depression scores by −26% ($P < 0.05$) compared with participants who did not receive the programme. On the other hand, although de Zeeuw *et al.* [21] found an improvement ($d = -0.90$) in depression scores among participants who received the exercise training compared with the control group after the 10-week programme, the difference between the two groups was not significant.

Yoga and stress

Two RCTs of low quality evaluated the effectiveness of workplace yoga programmes [24,31]. Both reported a significant improvement in stress. In Hartfiel *et al.*'s study [24], short-term adherence to yoga practice over an 8-week period was found to significantly reduce stress scores (F ratio = 7.64, $P = 0.001$) when compared with the control group which received no treatment. Similarly, Wolever *et al.* [31] found a significant improvement (F ratio = 8.79, $P < 0.01$) in perceived stress among the yoga group after receiving a training over 12 weeks for home practice.

Yoga and anxiety

Two high quality RCTs evaluating yoga practice [20,28] showed significant reductions in anxiety. Cheema *et al.* [20] found that although the improvement in anxiety was not pronounced in the yoga group compared with the control group, those with higher adherence to the yoga intervention showed a significant improvement in anxiety symptoms ($P < 0.05$). Sakuma *et al.* [28] also found a significant reduction in anxiety ($P < 0.01$) among participants in a brief home-based yoga programme which lasted for 4 weeks.

Physical activity versus cognitive behavioural therapy on mental well-being

One comparison trial of low quality compared the effectiveness of two preventive stress management programmes for mental health scores: (i) physical activity combined with relaxation technique and (ii) cognitive behavioural therapy intervention [33]. Compared with baseline mental health scores, Van Rhenen *et al.* found significant improvements in stress, anxiety and depressive disorders among participants from both programmes; however, the differences between both groups post-treatment and at 6-month follow-up were not significant.

Yoga versus cognitive behavioural therapy on stress

One comparison trial of low quality examined the effectiveness of yoga and cognitive behavioural therapy programmes on perceived stress among a group of employees without a no-intervention control group design. The 10 sessions in each programme were conducted over a 4-month period. Whilst the effect size for reduction in stress scores was medium to large in each yoga and cognitive behaviour therapy group (effect sizes, $d = 0.82$ [Yoga] to $d = 1.42$ [Cognitive behaviour therapy]), the authors reported no statistically significant difference between the two programmes [32].

Two low-quality non-RCTs were identified that examined the effects of physical activity on perceived stress among employees [34,35]. Results demonstrated a significant positive effect on stress associated with physical activity programmes. Mastura *et al.* [34] showed a large effect size from low-impact aerobic dance ($d = 0.17$) in improving stress scores compared with a control group that undertook conventional aerobic exercise. The mean difference between treatment and control groups was 2.433 (standard error = 0.85, $P < 0.001$), suggesting a beneficial effect in the treatment group. Norris *et al.* [35] found a substantial improvement in stress scores for those performing aerobic and anaerobic exercise compared with controls; moreover, those performing aerobic exercise reported significantly larger treatment effects on stress than the anaerobic group (F ratio = 8.69, $P < 0.01$).

Discussion

This review identified 17 trials that examined the effectiveness of physical activity and yoga practice interventions on mental health outcomes in working populations. Besides RCTs, comparison trials and controlled (quasi-experimental) trials were included in this review. There was no adverse effect reported from any of the physical activity or yoga programs. However, there was a lack of consensus on the effectiveness of physical activity interventions.

There is limited evidence for the effectiveness of physical activity on stress (★). Differences in study subjects or procedural variation may explain these results. The number of subjects recruited in these studies may be too small, or subjects may not be sufficiently stressed to show improvement, and this might explain why stress and mood were unaffected by physical activity in most of the RCTs. For example, despite being a high-quality study with a supervised intensive physical exercise regime, the results obtained in Tveito and Eriksen's [30] study were probably influenced by its small sample size ($n = 29$). Another example is Sjogren *et al.*'s [29] study, where the authors speculated that the dose of light resistance training was not adequately high or prolonged to bestow beneficial effects.

In 2004, Atlantis *et al.* [19] provided suggestive evidence for the effect of supervised aerobic and weight-training exercise combined with behaviour modification

on stress level. The detection of such an effect was attributed to an 80% compliance rate in their treatment group, and this may be related to the supervised exercise and behaviour modification components that are effective in promoting exercise adherence among the participants. However, an approximately 40% dropout was noted at the end of the study. 'Lack of time' was believed to be a predominant reason for not complying with the regimen of three 20-min exercise sessions per week. Promotion of exercise adherence may be an important consideration for future studies to improve external validity of the results. Strategies to facilitate adherence may include recognizing participant's psychological determinants or barriers to exercise and providing strategies to deal with these. Specific goals can be set to achieve the prescribed amount of physical activity, regular follow-up regarding progress, providing financial incentives or rewarding with praise.

When physical activity programmes were undertaken for the purpose of improving anxiety disorder, there was no significant difference between the intervention and control groups [19,23,26,29]. Based on these studies, it appears that there is no evidence to support the effectiveness of physical activity training programmes in reducing anxiety, among working populations (-). The absence of positive effects from the evidence of these intervention studies is in contrast to a recent systematic review which reported that both aerobic and anaerobic exercise treatments improved anxiety disorder [36]. In another review article examining treatment of anxiety symptoms in patients, Herring, O'Connor and Dishman [37] found that exercise training had a preventive effect on symptoms of anxiety disorder in sedentary adults with chronic illness. It is possible that differences in study population, i.e. working versus patient populations, are responsible for the discordance.

There was considerable heterogeneity in the exercise training doses between individual studies, thus interpreting findings of positive effects of exercise can be difficult. Grønningæter et al. [23] reported no significant effect of exercise on stress reduction. In this study, participants were grouped into treatment and control groups according to physical activity levels (i.e. physically active or inactive). The mental health scores of the participants at baseline were unclear and it is likely that the inclusion of 'stress-free' participants diluted the treatment effect of the physical activity interventions, contributing to non-significant findings. Thus, an intervention should be appropriately designed to target populations at higher risk for mental illness. Moreover, a small sample size of 25 participants in the exercise group may be another reason for the non-significant effects. Although no significant finding was observed, an effect of time on reduction of anxiety trait after 6-month follow-up was shown in the exercise group [23]. Likewise, Kerr and Vos [26] also suggested that exercise performed for a longer period of time may be beneficial. They found anxiety reduction

among those who exercise compared with non-exercisers, but it was not statistically significant. Taken together, these two studies imply that a longer exercise training period may provide more sustainable effects on mental health, and the issue of long-term follow-up treatment should be explored in future studies.

There is moderate evidence for the effectiveness of physical activity programmes to improve depression (★★). Although one high-quality RCT reported a significant improvement in depressive scores among casino workers [19]), another high-quality study of insurance company workers indicated a non-significant reduction [21]. This disparity may be partly due to differences in the physical activity programmes. When a supervised physical activity intervention and an additional behaviour modification strategy were utilized, Atlantis et al. [19] observed a reduction in depression scores. On the other hand, in a study by de Zeeuw et al. [21], even though the difference in depression scores between the treatment and control groups was not significant, the authors pointed out that 86% of their participants in the treatment group no longer suffered from minimal depressive symptoms compared with 31% in the controls. The common characteristics from these two high-quality randomized controlled studies are that they were carried out at the company's fitness centre, involving supervised 10–20 min of moderate- to high-intensity aerobic exercise training per session, and an intervention period of at least 10 weeks. These findings further support those previously described, suggesting that greater number of exercise sessions results in greater improvement in depression [38]. Under the supervision of a professional instructor, individuals in the exercise group had increased opportunities to contact motivational reinforcers, which helped to enhance the exercise compliance.

In contrast, results from a meta-analysis conducted by Lawlor and Hopker [39] yielded no supportive evidence for exercise intervention in the management of depression. This may be due to differences in the study populations. Participants diagnosed with depression aged 18 or above were included in the meta-analysis, whereas our review included those from the working population. The authors also suggested that their inconclusive findings were probably due to the low-quality studies with inadequate concealment of allocation, blinding and intention to treat analysis. However, trials of lower quality are usually associated with larger intervention effects [40]. These contradictory findings reinforce the need for better quality research in this area.

Two low-quality RCTs reported a significant reduction in perceived stress in the yoga group compared with control group ($P < 0.01$), indicating moderate evidence of the protective effect of yoga against stress (★★) [24,31]. Based on these two studies, it seems that yoga intervention practice for managing stress should be attempted for at least 50 min per week either in the workplace or at home. These

positive results are consistent with a systematic review of yoga practice on stress management among healthy adults [41]. Yoga programmes included in that review generally involved an intervention period of <4 months. Hence, the authors highlighted that more studies should be attempted to investigate the long-term effects of yoga on mental well-being. Apparently, yoga as a therapy may be better suited to address stress outcomes than the exercise intervention. Considerably more work and higher quality studies will be needed to confirm this hypothesis.

Although only two studies have been identified that support the protective effect of yoga against anxiety disorders [20,28], taken together these high-quality studies indicate strong evidence in this regard (★★★). In assessing the effectiveness of a 50-min yoga programme over 3 days per week on anxiety disorder, Cheema *et al.* [20] observed that higher adherers had significantly higher reduction in state anxiety than non-adherers. The small sample size (*n* = 37) of this study may limit its external validity. Therefore, while positive results were obtained, the interpretation of their findings must be done with caution. Sakuma *et al.* [28] evaluated a 4-week home-based yoga practice among childcare workers and found an improvement in anxiety. The yoga programme employed by Sakuma *et al.* was regarded as a brief one with simple poses and a short 7-min workout. Being different from conventional exercises, yoga as a mind–body practice that emphasizes on muscle stretching has the ability to yield beneficial health outcomes through various intermediate biological mechanisms.

Van Rhenen *et al.* [33] stated that the purpose of conducting their comparative study (between physical activity (combined with relaxation intervention) and cognitive therapy) was that cognitive-behavioural therapy has always been interpreted as a superior stress-reduction intervention programme to a physical activity intervention. They introduced four exercise training sessions (60 min/session) spread throughout 8 weeks. At the end of the study, no statistically different effect between the two interventions was reported, demonstrating that both were congruently effective in exerting a positive impact on mental well-being scores. The effect sizes were medium to large for distress, anxiety and depression in the exercise group and cognitive group (0.90, 0.57 and 0.39 versus 0.96, 0.25 and 0.37 in each group, respectively). Although positive outcomes were noted, the lack of a control group receiving no treatment is a weakness of this study. Thus, this evidence was graded as limited (★).

When a study of low quality was conducted to compare yoga intervention with cognitive behavioural therapy, both programmes significantly reduced the employees' perceived stress scores [32]. On closer inspection, cognitive behavioural therapy yielded a higher effect size (*d* = 1.42) than yoga exercise (*d* = 0.82). The authors suggested that the results may be attributable to similarities between the two interventions—cognitive behavioural

therapy usually includes a component on physical intervention (applied relaxation), whereas the yoga group in this study examined stress-related issues as well as focusing on physical activity. The findings are also limited by the small study group sizes (*n* = 33). Hence, there is limited evidence provided by this study in this regard (★). A larger study and possibly a long-term follow-up would be beneficial to enable a more definitive conclusion.

Two physical activity interventions investigated in a non-RCT design provided limited evidence on stress improvement [34,35] (★). Comparing low-impact aerobic dance with a control group that undertook conventional aerobic dance, Mastura *et al.* reported a favourable effect on stress in the treatment group and pointed out that music played in the background during aerobic exercise sessions encouraged study participation. Norris *et al.* [35] evaluated the job stress of male police officers assigned to either an aerobic or anaerobic strategy, or to a control group receiving no treatment. They found a significant improvement in perceived job stress in the aerobic group but not in the anaerobic group. The anaerobic programme was implemented at a lightweight level (with a higher number of repetitions) because most workers in this group took up the exercise for the first time, and this regimen may not be intense enough to produce an effect. Nonetheless, the most important limitation of these studies was the absence of randomization, which would result in lower internal validity.

Studies using rigorous research methodologies tend to show more positive results. Based on the qualitative summary of high-quality studies, supervised physical activity training conducted for at least 10 weeks at worksite fitness centres appears to be associated with a significant reduction in depression. The literature also showed strong evidence for the effect of yoga practice towards reducing anxiety at the workplace. The evidence supporting the effectiveness of physical activity interventions on stress reduction is currently inconclusive. While the working environment may be stressful, how workers cope may be buffered by their ability to manage stressors and changing lifestyle factors. The efficacy of physical activity interventions depend on factors such as quality of the intervention implemented, mode of delivery, length and intensity of the programme and tailoring of the physical activity regimen. Employees' baseline characteristics such as mental health status, age, gender and socioeconomic status should be taken into account before physical activity is incorporated into the worksite health and wellness programmes.

As only published studies were included in this review, publication bias may be present, thus introducing the possibility of positive results bias. The outcome measurements of mental well-being, study design and quality of study methodology were inconsistent across studies. A variety of instruments for assessing mental well-being were used by different researchers to define outcome of stress, anxiety and depression. This might lead to incomparable and varying results between papers. As most of the studies

could not be double blinded due to the nature of the interventions, the observed improvement of stress scores may be influenced by the Hawthorne and/or placebo effect. There were also differences in study population characteristics, and inadequate sample size was noted in many studies.

There is a need for high quality RCTs targeting populations at risk of mental disorders. Future trials should address methodological limitations, including sample size, recruitment and adherence as well as detailed characterization of physical activity with respect to duration, frequency, intensity and compliance rate. The use of objective measurement devices such as accelerometers and validated measures of mental health outcomes is recommended. Long-term sustainability of the effectiveness of an intervention should also be studied.

Key points

- This review indicates that physical activity programmes with a personalized supervision approach are effective in achieving beneficial mental health outcomes [22,23].
- Yoga programmes led by experienced trainers conducted at the worksite have been shown to improve state anxiety among workers [30,32].
- There was no adverse effect reported from any of the physical activity interventions or yoga programmes.
- Employers should take into account employees' baseline characteristics such as mental health status, age, gender, socioeconomic status before incorporating physical activity or yoga into the worksite health and wellness programmes.

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None declared.

References

1. Lehrer PM, Woolfolk RL, Sime WE *et al. Principles and Practice of Stress Management*. 3rd edn. New York: Guilford Publications, 2007.
2. Saper RB, Eisenberg DM, Davis RB *et al.* Prevalence and patterns of adult yoga use in the United States: results of a national survey. *Altern Ther Health Med* 2004;**10:**44–49.
3. Kreme JMD, Scully D. *Psychology in Sport*. East Sussex, London: Taylor & Francis, 2012.
4. Young SN. How to increase serotonin in the human brain without drugs. *J Psychiatry Neurosci* 2007;**32:**394–399.
5. Peluso MAM, Andrade LHSGd. Physical activity and mental health: the association between exercise and mood. *Clinics* 2005;**60:**61–70.
6. McArthur JW. Endorphins and exercise in females: possible connection with reproductive dysfunction. *Med Sci Sports Exerc* 1985;**17:**82–88.
7. Allen M. The psychobiology of athletic training. In: Begel D, Burton RW, eds. *Sport Psychiatry: Theory and Practice*. New York: W. W. Norton & Company, 2000.
8. Krogh J, Nordentoft M, Sterne JA *et al.* The effect of exercise in clinically depressed adults: systematic review and meta-analysis of randomized controlled trials. *The J Clin Psychiatry* 2011;**72:**529–538.
9. Bartley CA, Hay M, Bloch MH. Meta-analysis: aerobic exercise for the treatment of anxiety disorders. *Prog Neuropsychopharmacol Biol Psychiatry* 2013;**45:**34–39.
10. Brown HE, Pearson N, Braithwaite RE *et al.* Physical activity interventions and depression in children and adolescents. *Sports Med* 2013;**43:**195–206.
11. Bridle C, Spanjers K, Patel S *et al.* Effect of exercise on depression severity in older people: systematic review and meta-analysis of randomised controlled trials. *Br J Psychiatry* 2012;**201:**180–185.
12. Conn VS, Hafdahl AR, Cooper PS *et al.* Meta-analysis of workplace physical activity interventions. *Am J Prev Med* 2009;**37:**330–339.
13. Richardson KM, Rothstein HR. Effects of occupational stress management intervention programs: a meta-analysis. *J Occup Health Psychol* 2008;**13:**69–93.
14. Bhui KS, Dinos S, Stansfeld SA, White PD. A synthesis of the evidence for managing stress at work: a review of the reviews reporting on anxiety, depression, and absenteeism. *J Environ Public Health* 2012;**2012:**515874.
15. Conn VS, Hafdahl AR, Cooper PS *et al.* Meta-analysis of workplace physical activity interventions. *Am J Prev Med* 2009;**37:**330–339.
16. Jadad AR, Moore RA, Carroll D *et al.* Assessing the quality of reports of randomized clinical trials: is blinding necessary? *Control Clin Trials* 1996;**17:**1–12.
17. Chiesa A, Serretti A. Mindfulness based cognitive therapy for psychiatric disorders: a systematic review and meta-analysis. *Psychiatry Res* 2011;**187:**441–453.
18. Waddell G, Burton AK. Occupational health guidelines for the management of low back pain at work: evidence review. *Occ Med (Lond)* 2001;**51:**124–135.
19. Atlantis E, Chow CM, Kirby A, Singh MF. An effective exercise-based intervention for improving mental health and quality of life measures: a randomized controlled trial. *Prev Med* 2004;**39:**424–434.
20. Cheema BS, Houridis A, Busch L *et al.* Effect of an office worksite-based yoga program on heart rate variability: outcomes of a randomized controlled trial. *BMC Complement Altern Med* 2013;**13:**82.
21. de Zeeuw ELEJ, Tak ECPM, Dusseldorp E *et al.* Workplace exercise intervention to prevent depression: a pilot randomized controlled trial. *Ment Health Phys Activ* 2010;**3:**72–77.
22. Eriksen HR, Ihlebaek C, Mikkelsen A *et al.* Improving subjective health at the worksite: a randomized controlled trial of stress management training, physical exercise

and an integrated health programme. *Occup Med (Lond)* 2002;**52:**383–391.

23. Grønningæter H, Hytten K, Skauli G *et al.* Improved health and coping by physical exercise or cognitive behavioral stress management training in a work environment. *Psychol Health* 1992;**7:**147–163.

24. Hartfiel N, Burton C, Rycroft-Malone J *et al.* Yoga for reducing perceived stress and back pain at work. *Occup Med (Lond)* 2012;**62:**606–612.

25. Hinman M, Ezzo L, Hunt D *et al.* Computerized exercise program does not affect stress levels of asymptomatic VDT users. *J Occup Rehabil* 1997;**7:**45–51.

26. Kerr JH, Vos MCH. Employee fitness programmes, absenteeism and general well-being. *Work Stress* 1993;**7:**179–190.

27. Nurminen E, Malmivaara A, Ilmarinen J *et al.* Effectiveness of a worksite exercise program with respect to perceived work ability and sick leaves among women with physical work. *Scand J Work Env Hea* 2002:85–93.

28. Sakuma Y, Sasaki-Otomaru A, Ishida S *et al.* Effect of a home-based simple yoga program in child-care workers: a randomized controlled trial. *J Altern Complement Med* 2012;**18:**769–776.

29. Sjogren T, Nissinen KJ, Jarvenpaa SK *et al.* Effects of a physical exercise intervention on subjective physical well-being, psychosocial functioning and general well-being among office workers: a cluster randomized-controlled cross-over design. *Scand J Med Sci Sports* 2006;**16:**381–390.

30. Tveito TH, Eriksen HR. Integrated health programme: a workplace randomized controlled trial. *J Adv Nurs* 2009;**65:**110–119.

31. Wolever RQ, Bobinet KJ, McCabe K *et al.* Effective and viable mind-body stress reduction in the workplace: a randomized controlled trial. *J Occup Health Psychol* 2012;**17:**246–258.

32. Granath J, Ingvarsson S, von Thiele U *et al.* Stress management: a randomized study of cognitive behavioural therapy and yoga. *Cogn Behav Ther* 2006;**35:**3–10.

33. Van Rhenen W, Blonk RW, van der Klink JJ *et al.* The effect of a cognitive and a physical stress-reducing programme on psychological complaints. *Int Arch Occup Environ Health* 2005;**78:**139–148.

34. Mastura J, Fauzee O, Bahaman AS *et al.* Effect of low-impact aerobic dance exercise on psychological health (stress) among sedentary women in Malaysia. *Biol Sport* 2012;**29:**63–69.

35. Norris R, Carroll D, Cochrane R. The effects of aerobic and anaerobic training on fitness, blood pressure, and psychological stress and well-being. *J Psychosom Res* 1990;**34:**367–375.

36. Jayakody K, Gunadasa S, Hosker C. Exercise for anxiety disorders: systematic review. *Br J Sports Med* 2014;**48:**187–196.

37. Herring MP, O'Connor PJ, Dishman RK. The effect of exercise training on anxiety symptoms among patients: a systematic review. *Arch Intern Med* 2010;**170:**321–331.

38. Scully D, Kremer J, Meade M *et al.* Physical exercise and psychological well being: a critical review. *Br J Sports Med* 1998;**32:**111–120.

39. Lawlor DA, Hopker SW. The effectiveness of exercise as an intervention in the management of depression: systematic review and meta-regression analysis of randomised controlled trials. *Br Med J* 2001;**322:**763–767.

40. Schulz KF, Chalmers I, Hayes RJ *et al.* Empirical evidence of bias. Dimensions of methodological quality associated with estimates of treatment effects in controlled trials. *J Am Med Assoc* 1995;**273:**408–412.

41. Chong CS, Tsunaka M, Tsang HW *et al.* Effects of yoga on stress management in healthy adults: a systematic review. *Altern Ther Health Med* 2011;**17:**32–38.