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Many people come to yoga for quite simple reasons. They feel it might help them to cope with stress and become more relaxed, perhaps, or a physician has recommended it... But lying behind these superficial reasons is almost always a desire for a more fulfilled life. With time, commitment, and effort from the student, yoga can meet [these] goals. Anyone who tries the path of yoga will find, if they are serious about it, that their intentions, change along the way. Yoga has its own objectives, which every student must embrace in order to benefit fully.

Howard Kent: The Complete Illustrated Guide to Yoga. Element Books Ltd., Dorset, UK. 1999.

1. INTRODUCTION

Yoga is a philosophical system of exercise and meditation originating in what is now India 2000-4000 years ago. There are many forms of yoga which differ in specific practices, while maintaining the purpose of directing the mind and body (1). Common elements of many forms include postures (asanas), which are held for a certain period of time, controlled breathing exercises (pranayama) and meditation. Yoga practice has the general aim of facilitating the development and integration of the body, mind and breath to produce structural, physiological and psychological effects (2). Specifically, the development of a strong and flexible body which is free of pain, a balanced autonomic nervous system enabling all physiological systems to function optimally and a calm, clear and tranquil mind (3).

Hatha yoga is the most common form of yoga practiced in Western societies. It involves asanas to develop strength, flexibility, balance and the co-ordination of the mind, body and breath, in combination with pranayama and meditation exercise to calm the mind and develop self awareness (4). The different styles of hatha yoga that have developed are characterised by the rate at which asanas are performed, the physical intensity and level of difficulty, the relative emphasis on body alignment and relaxation and the ambient temperature in which it is practiced (5). Bikram yoga is a style that was synthesized from traditional yoga methods by Bikram Choudhury. It is performed in a warm/hot environment (~105^{o} F, at least 40% humidity) for 90 minutes and comprises a set series of 26 postures as well as breathing exercises. 'Hot yoga' is a style that is based on Bikram yoga but with subtle differences. Although many of the asanas may be common to both systems, others have been modified or omitted according to different schools of thought and which asanas are considered to be manageable and safe to perform.

2. AIM OF THIS REVIEW

Yoga is now practised widely for fitness and wellbeing in health clubs, community centres, yoga studios and schools. This popularity has created a need for well controlled research and clinical trials to evaluate its efficacy for improving general health and preventing disease, and to evaluate its role as an adjunctive or complementary therapy for the management of pain or chronic diseases. The majority of available yoga studies in the published literature have been conducted with adults, although studies of children and young adults have also been undertaken. The aim of

this review was to search the scientific literature, primarily seeking out systematic reviews, critical reviews and narrative reviews that have included studies with a focus on the health benefits of yoga in healthy individuals and clinical populations. Only one study of hot yoga (Bikram) was found and this is discussed in section 4.3. Hence, the review was focused on yoga more generally, and provides an overview of studies that investigated the health impacts of different yoga styles performed at normal ambient temperatures.

3. LEVELS OF EVIDENCE

Systematic reviews are regarded as the strongest form of evidence synthesis but are only as strong as the quality of the studies that are included. In systematic reviews, the methodological quality of the included studies is rated using a numerical scoring system for key aspects such as randomisation of participants, blinding, withdrawal and attrition. Where systematic reviews are not available, narrative or critical reviews of the literature can be useful for gaining a broad overview of knowledge in a given area. However, these reviews are generally not as rigorous in their inclusion criteria for studies, usually including lower quality studies and may take the claims or conclusions of study authors at face value. This section provides an overview of the different types of studies that have been used to investigate the effects of yoga practice on health outcomes that are relevant to different populations. Systematic reviews tend to focus more on high quality studies, whereas narrative and critical reviews generally contain more of a mixture of different quality studies.

Randomised controlled trials (RCTs) represent the 'gold standard' study design for establishing a cause and effect relationship between an intervention and an outcome. In their simplest form, RCTs involve the random allocation of participants to an intervention or control group. In clinical populations, the control group could be receiving standard medical treatment (e.g. usual medical care with or without placebo). Multiple experimental groups can also be compared with each other and the control group. This is the case where yoga is being compared with some other treatment, such as a drug or herbal treatment or another form of exercise. RCTs allow the rigorous evaluation of a single variable in a defined sample population, as the assumption is that all confounding variables (known or unknown) are distributed randomly and equally between the intervention and controls.

In some RCTs, the yoga group is compared with a waiting list control group. Here, volunteers are randomly assigned to the yoga 'treatment' condition or the waiting list control group. Then at the end of the treatment phase and the post-test assessment of outcomes, the yoga 'treatment' is made available to participants in the waiting list control group. The treatment given to the waiting list controls is not part of the study design but can be used to check the reliability of the intervention group results. Limitations of this design include an inability to assess long-term follow up data in the control group because they also receive the treatment. An additional disadvantage is that the treatment is withheld for a period of time in the controls, which might discourage potential volunteers from participating in the study.

RCTs can also involve the blinding of experimenters and/or participants to group allocation, to prevent such knowledge from influencing the assessment of outcomes. Double-blind designs (both experimenter and participants) are considered the most robust method for reducing the risk of study bias but this is not possible in yoga intervention studies as both the participants and experimenters are aware of group allocation. The blind assessment of outcomes (by a trained person not directly involved in the day-to-day running of the study) can however, provide some level of control for this limitation.

Low numbers of study volunteers, absence of longer-term follow-up measures and imperfect randomisation are frequently cited as the major limitations of RCTs. Another potential limitation is that it might not be appropriate to generalize the results to the wider population due to the strict eligibility criteria employed, volunteer bias or the way that the data were analysed. Hence, for clear interpretation of an intervention's value to a defined population, all these factors need to be taken into account.

Non-randomised controlled trials are parallel-arm controlled trials, in which study volunteers are not allocated to a 'treatment' or control group at random. These are subject to considerably more bias. This is because confounding variables are unlikely to be equally distributed between groups and the participants who volunteer for a particular intervention (or who are assigned to the intervention by an experimenter) may have certain characteristics which differ from the wider population (known as selection or allocation bias).

Uncontrolled trials have no control group to compare against and typically compare pre-test and post-test scores on a variety of outcome in a single group of volunteers before and after the yoga intervention. These are subject to learning (practice, order)

effects. Additionally, it is difficult to know whether any effect of yoga practice in rehabilitating individuals is due to the yoga 'treatment' or natural recovery of health outcomes over time.

4. RELATIVE HEALTH BENEFITS OF EXERCISE AND YOGA

4.1 Health benefits of exercise

Evidence for the use of exercise in the maintenance of optimal health and rehabilitation can be traced back to ancient cultures. As early as the ninth century B.C., the ancient Indian system of medicine (*Ayurveda*) recommended exercise and massage for the treatment of rheumatism and the Greek philosopher Hippocrates ('the father of medicine') acknowledged the virtues of exercise for physical and mental health in the 4th century B.C. (6). In more recent times, a body of epidemiologic research has demonstrated inverse associations of varying strength between habitual exercise and the risk of several chronic diseases, including coronary heart disease, thromboembolic stroke, hypertension, Type 2 diabetes mellitus, osteoporosis, obesity, anxiety and depression (7-9). Additionally, a growing body of research during the last 20 years has provided 'convincing' evidence of an inverse association between physical activity and risk of colon cancer (10). There is also evidence of a 'probable' inverse association between physical activity and risk of other cancers, including post-menopausal breast and endometrial cancer and limited 'suggestive' evidence of a similar association between physical activity and lung, pancreatic and pre-menopausal breast cancer (10).

Aside from the important role it plays in the *primary prevention* of a range of chronic diseases, a physically active lifestyle can bring manifold health benefits to individuals who are carrying the burden of chronic disease. There is evidence that regular exercise is associated with physical and psychosocial health benefits in many chronic disease conditions (11) and hence, keeping fit and healthy is now promoted by Government health departments as an essential element of self-care for boosting general wellbeing, improving mobility and easing of symptoms. A physically active lifestyle can have an important role in controlling or reducing the impact of a chronic disease, prolonging survival and enhancing overall health-related quality of life (*secondary* and *tertiary* prevention). In this respect, 'exercise rehabilitation' is increasingly being recognised amongst healthcare professionals as an effective adjuvant or adjunctive treatment for a growing number of chronic conditions.

4.2 Health benefits of yoga

The relative health benefits of yoga in relation to disease risk and its role in the management of chronic diseases is less clearly established. Studies have investigated physiological responses evoked by yoga practice in comparison to those evoked by more conventional forms of exercise. The heart rate response to typical yoga sessions in healthy adults at normal ambient temperatures has been shown to be equivalent to low intensity walking exercise in some studies (12,13). Exercise at this intensity does not meet the currently recommended level of physical activity needed to promote health and cardiovascular fitness. However, other studies have provided conflicting evidence for healthy adults, with higher levels of cardiopulmonary stress being recorded during yoga sessions (14). Additionally, improvements in indices of cardiometabolic health have been observed in some (but not all) studies in healthy adults following programmes of yoga practice. A number of single group (uncontrolled) studies have reported improvements in maximum oxygen capacity (15-18), muscular strength (17,19), flexibility (18) and blood cholesterol profile (15), as well as reduced physiological effort at sub-maximal exercise intensities (20) and a lower level of perceived exertion at maximal exercise capacity (17). Such cardiometabolic adaptations suggest that yoga can provide a level of cardiopulmonary stress that is sufficient to achieve health benefits. Other benefits from yoga practice in healthy participants have been reported to be improved respiratory inspiratory and expiratory pressures and visual and auditory reaction times (19) and attenuated weight gain in overweight individuals (21). While some studies have found no improvement in cardiopulmonary variables after programmes of yoga practice (e.g. Blumenthal *and others* (22)), the actual level of physical exertion experienced during a session, and thus the stimulus for cardiometabolic adaptations, is likely to be strongly influenced by the type of yoga, the level of experience of the practitioner and the ambient temperature during the session. Yoga practice also involves a spiritual dimension and specific breathing exercises, not common to conventional forms of exercise, which may evoke other health benefits.

A review of the literature by Ross and Thomas (23) identified 12 studies that had compared the effects of yoga with more conventional forms of exercise in adults and older adults. A total of 597 of the 873 volunteers who participated in the studies were women and most of the studies compared yoga practice with aerobic exercise, such as walking, running, dancing, stationary cycling, etc. Three of the studies involved stretching and/or range of motion exercises. Four of the studies were in clinical

populations (type 2 diabetes, multiple sclerosis, haemodialysis patients, and schizophrenics). Eight of the 12 studies were RCTs and study durations ranged from a single session to 6 months. These studies assessed a wide range of physical and psychosocial outcomes, with evidence that conventional forms of exercise are more beneficial for increasing energy expenditure and improving in maximum aerobic capacity in the healthy volunteers. However, there was evidence that many other health outcomes were improved more by yoga practice than by conventional exercise in the healthy volunteers. These included indices of autonomic nervous system, perceptions of fatigue, flexibility, menopausal symptoms, psychological stress and metabolic markers.

In the clinical populations, one study showed that in patients with multiple sclerosis, yoga and conventional forms of exercise had a similar impact on perceptions of fatigue and quality of life. However, another study showed that yoga was more beneficial for schizophrenic patients in relation to control of psychotic symptoms, social and occupational functioning and improvements in quality of life. For haemodialysis patients, one of the trials showed that yoga was more beneficial than conventional exercise for promoting improvements in kidney function (urea, creatinine excretion), perceptions of fatigue, pain, sleep disturbance, grip strength and total cholesterol levels. Finally, for patients with type 2 diabetes, one of the included studies showed similar benefits for yoga practice in comparison with conventional exercise on fasting blood glucose, total cholesterol and other metabolic markers.

4.3 Hot yoga

Hot yoga is performed in a room that is preheated to approximately 105^{o} F. This is likely to increase the stimulus for cardiovascular adaptations, as the need for blood to supply oxygen to the exercising muscles is challenged by the need to supply blood to the peripheral vessels of the skin for thermoregulation. This means that for any given exercise intensity in warm/hot environments, heart rate and cardiac output must be higher to satisfy the competing metabolic demands of exercising muscles and body heat dissipation demands of the skin. The greater increase in body temperature encountered during a hot yoga class may have an effect on other physiological processes, including increased dissociation of oxygen from haemoglobin and myoglobin to the exercising muscles, a lowering of the activation energy rates for metabolic reactions, improved skeletal muscle blood flow (allowing improved

oxygenation and removal of waste products) and an increase in the speed of nervous impulses (24). Additionally, the muscle-tendon unit is a visco-elastic structure, having both viscous and elastic properties and is capable of both plastic and elastic changes. The viscous properties of muscle connective tissue enable it undergo a permanent change in structure and the amount of viscous and elastic deformation is strongly influenced by the tissue temperature (25). Warm or hot ambient temperatures in combination with active muscular contractions could promote a greater reduction in the viscosity of muscle connective tissues, thereby enabling greater extensibility, and allowing deeper stretches to be achieved and potentially reducing the risk of injuries. Despite these potential physiological advantages over yoga practiced at normal ambient temperatures, higher sweat rates in warm or hot conditions necessitates proper attention to fluid replacement to prevent heat stress and a decline in physiological function.

To date, only one study in the published scientific literature has investigated the potential health benefits of hot yoga practice (26). This study investigated the effects of Bikram yoga on skeletal muscle strength and neuromuscular control in young adults. Individuals assigned to the yoga group participated in a 90 minute Bikram yoga class, three times a week for eight weeks (24 sessions in total). Sessions were performed in a heated (95-105^{o} F) and humidified (60% relative humidity) studio. Participants in the yoga group were compared with a control group who were instructed to maintain their usual level of activity for the same time period. Knee extensor (thigh) strength was improved after the yoga intervention but there was no change in elbow flexor (biceps) strength. An improvement in knee extensor steadiness (indicating better lower-limb neuromuscular control) and timed one-leg balance was also observed in the yoga group after eight weeks. Interesting, an improvement in knee extensor steadiness was also observed in the control group which might indicated a learning (practice) effect. The modest strength improvements observed for the knee extensors were attributed to the greater focus of the exercise training stimulus on the lower limbs. The improvements in lower-limb force and balance evoked by the Bikram yoga programme could have significant impact on individuals with impaired leg steadiness and balance, suggesting that further research in elderly populations is warranted.

5. YOGA AND CHRONIC DISEASE RISK FACTORS

Two systematic reviews of the literature on the 'protective' effects of yoga in relation to insulin resistance, type 2 diabetes and cardiovascular disease were undertaken by Innes *and others* (27,28). These two systematic reviews identified many of the same studies. The first review (27), which was much broader in scope, identified 70 studies, including 22 RCTs, 21 non-randomised controlled trials, 26 uncontrolled trials and one observational study. The broad conclusion from this review was that considered together, yoga practice was associated with beneficial changes in a range of outcomes that are indicative of insulin resistance and predictive of cardiovascular disease, including glucose tolerance, insulin sensitivity, lipid lipoprotein levels, anthropometric markers, blood pressure, oxidative stress and blood coagulation markers, autonomic function and clinical end-points. The majority of reviewed studies were conducted in healthy young to middle-aged adults (50%) or adults with or at risk of cardiovascular disease (30%). The second review (28) was more focused on adults with type 2 diabetes and identified 25 studies, including four RCTs, six non-randomised RCTs and 15 uncontrolled trials. The conclusion from this review was almost identical to the first review (27) and the evidence suggested that yoga practice can improve cardiovascular risk profiles in patients with type 2 diabetes, and could have a role in the prevention and management of cardiovascular complications in this clinical group. However, severe methodological limitations was a feature of many studies included in both these systematic reviews (e.g. non-randomised or uncontrolled designs, small participant numbers, poor description of the yoga intervention, etc.), which prevents firm conclusions from being drawn.

A systematic review conducted by Yang *and others* (29) identified 32 studies that had investigated the impact of yoga practise on four well established biological markers and risk factors for chronic disease, namely excess body weight, hypertension, elevated fasting glucose level and high cholesterol. Poor methodological quality was not a reason for exclusion of studies from the review, but studies were excluded if they were primarily focused on meditation or relaxation or if they were case studies. As well as intervention studies, observational studies were also included. The reviewed studies revealed evidence of beneficial effects of regular yoga exercise in relation to reductions in body weight in overweight participants and in patients with coronary heart disease, fasting blood glucose levels in patients with type 2 diabetes and coronary heart disease and blood pressure in healthy individuals and clinical populations, such as those with hypertension, cardiovascular disease and type 2 diabetes. In addition to the impact of

yoga on these biological markers, these studies show that yoga is a feasible exercise intervention for these clinical populations to engage in.

A more rigorous systematic review of studies that had investigated yoga practice for the management of type 2 diabetes undertaken by Aljasir *and others* (30) yielded only five studies that had recruited a total of 363 participants. The methodological quality of these studies was moderate to low. Yoga practice alone was studied in three of these studies, and in combination with other lifestyle modifications in the other two. All studies compared the effects of yoga practice with those of a control group receiving standard medical treatment only. Three of the included trials reported a beneficial effect of yoga practice on circulating levels of total and "good" (HDL) cholesterol and triglycerides. Inconsistent results were observed for circulating levels of "harmful" LDL cholesterol. An improvement in nerve conduction velocity was also observed in one of the studies but this was not statistically significant. The results of these studies suggest favourable effects of yoga practice on clinical diabetes outcomes, but only in the short-term as results for long-term outcomes were generally not significant. Methodological limitations prevented a definitive recommendation for physicians to encourage their patients to engage in yoga practice.

6. YOGA DURING CANCER REHABILITATION

There is a growing interest in the role of yoga and other exercise interventions for ameliorating the physical and psychological side-effects of cancer and its treatments. This has resulted from increasing rates of cancer survivorship and the well-documented lingering symptoms such as fatigue, sleep disturbances and joint pain that are frequently encountered but often inadequately treated with conventional approaches (31).

At least two reviews of the published literature have been focused on yoga as a complementary therapy for cancer patients and/or survivors. A narrative review of mind-body therapies for cancer by Elkins *and others* (32) identified nine small-scale studies that had investigated the effects of yoga practice on clinically important outcomes in cancer patients. Patients with lymphoma who participated in a seven week Tibetan yoga intervention reported lower sleep disturbance than a waiting list control group but the yoga intervention had no effect on measures of anxiety, depression or fatigue (33). In contrast, short-term yoga interventions evoked improvements in psychosocial outcomes such as anxiety, depression (and mood), mental health, quality

of life, psychosocial functioning, cancer-related fatigue and spirituality (and spiritual wellbeing) and hot flashes in breast cancer patients (34-39). Another single group design study reported reduced levels of pain and fatigue in a sample of 13 metastatic breast cancer patients after participation in an eight week programme of gentle yoga (40). Two other studies involved larger samples: 128 breast cancer survivors and a large multi-centre randomised controlled trial involved 410 early-stage cancer survivors. In the breast cancer trial, women allocated to a 12-week Hatha yoga intervention experienced moderate improvements in fatigue, overall mood, spiritual wellbeing and quality of life in comparison to a waiting list control group (41). In the multicentre study (42), participants who were randomised to a twice-weekly 75 minute yoga class for 4 weeks experienced a 22% improvement in sleep quality compared with a 12% improvement in the control group. The yoga group showed these sleep improvements despite a 12% reduction in their sleep medication, in comparison to a 5% increase in sleep medication in the control group. In addition, the yoga group reported a 42% reduction in cancer-related fatigue and a 6% improvement in quality of life, versus a reduction of 12% in cancer-related fatigue and no change in quality of life in the controls. These results show some promising data for clinically important cancer outcomes but most studies to date have involved very small numbers of patients and more larger-scale, well controlled prospective intervention studies are needed in a broader spectrum of cancer patients and survivors.

An evidence-based review of studies that investigated the efficacy of yoga as a complementary intervention for patients for cancer by Smith and Pukall (43) identified a further four studies that were not considered by the previous review. Of these, two studies were RCTs (44,45) and two were uncontrolled trials (46,47). One of the RCTs reported improvements in emotional functioning and quality of life in breast cancer patients not currently engaged in any other form of treatment in comparison to a waiting list control group after a 7 week programme of yoga therapy (45). The other RCT reported a decrease in post-chemotherapy-induced nausea frequency and nausea intensity, intensity of anticipatory nausea and anticipatory vomiting in breast cancer patients who engaged in a yoga therapy programme compared with a supportive therapy control group (44). Outcomes were assessed before and after their fourth cycle of treatment. The two uncontrolled trials reported improvements in psychosocial variables, including feelings of peace, spiritual wellbeing, positive mind state and decreased stress levels in cancer patients following programmes of yoga therapy (46,47).

7. YOGA FOR STROKE REHABILITATION

There are very few studies on the efficacy of yoga for stroke rehabilitation. A systematic review of the literature undertaken by Lynton *and others* (48) revealed no controlled studies of yoga for stroke rehabilitation. Only one small-scale study involving an eight-week programme of Hatha yoga (2 x 1.5 hour sessions per week) in four stroke patients was identified. Statistical analysis of the data was not possible from such a small number of patients, but at the individual level, two patients experienced an improvement in balance and three of the patients achieved improvements on a timed battery of movement tests. As all patients were at least 9 months post-stroke and had reached a plateau of recovery, these results are promising and are perhaps unlikely to have resulted from natural recovery of function over time.

A small pilot study involved a 12-week course of twice-weekly 1.5 hour Kundalini yoga classes in three stroke patients (48). The patients were six-months post-stroke and all had a diagnosis of aphasia. The yoga postures were modified to accommodate the capabilities of the patients. All three patients showed an improvement in their speech impediment and dexterity after the yoga intervention. The authors felt that the results of this small scale study were very promising and justified further investigations of yoga for chronic stroke rehabilitation.

8. YOGA AND ASTHMA

A review of the literature by Steurer-Stey *and others* (49) identified four randomised controlled trials that had investigated the effects of yoga practice in asthmatics. One study (50) investigated the effects of yoga practice in 53 pairs of asthmatic patients that were matched for age, sex and severity of asthmatic symptoms. Patients were randomised to receive yoga therapy or standard treatment (no yoga therapy). Over 54 months of follow-up, the yoga group experienced an improvement in the number of weekly asthma attacks and peak flow rate, as well as a decrease in drug treatment score. Another smaller-scale study of asthmatic students reported non-significant improvements in medication use, lung function and symptom score in the group randomly assigned to yoga practice. The other two trials (51,52) compared the effects of yoga breathing exercises (Pranayama) with other breathing exercises or no intervention. These reported positive changes in mental state (coping with stress, subjective perception of symptoms, etc.) and at least trends for improvement in lung function parameters in the intervention groups. The latter three trials involved only 75

patients in total, and lack of statistical power most probably explains why changes in some of the outcomes were inconclusive.

9. YOGA FOR DEPRESSION AND ANXIETY

A critical review of the evidence by Uebelacker *and others* (53) identified seven randomised controlled trials and one non-randomised controlled trial that had investigated the effect of yoga practice on symptoms of depression in individuals with a diagnosis of depression or elevated depression symptoms (Uebelacker et al. 2010). Of the five studies that compared yoga to no treatment or a minimal-treatment control group, four showed evidence of improvement in depressive symptoms in comparison to the controls (54-57). In three of these trials, the participants had a clinical diagnosis of major depressive disorder and the fourth trial involved students with mild depressive symptoms but no psychiatric diagnosis. Of the other trials, one showed more favourable effects for electroconvulsive therapy over Sudarshan Kriya yoga (SKY) in clinically depressed patients (58), a second trial showed that SKY was not more effective than partial SKY (pranayama only) in alleviating depressive symptoms in clinically depressed patients (59), the third trial reported that yoga exercise was no more effective than aerobic exercise for reducing depressive symptoms in individuals with elevated depressive symptoms and the final trial involving students with severe depressive symptoms did not undertake a statistical comparison between groups randomised to Shavasana yoga or no treatment. There was considerable methodological heterogeneity between the studies which varied in duration (few days to 12 weeks), intensity (daily to once per week), yoga type (e.g. SKY, Iyengar and other meditation-based interventions) and control group. Furthermore, five trials had considerable methodological weaknesses and inconsistencies in results between the trials means that it is difficult to draw any generalised conclusions.

Anxiety disorders include phobias, panic disorder, obsessive compulsive disorder, post-traumatic stress disorder and generalised anxiety disorder. A few studies have reported positive effects of yoga practice on measures of anxiety in non-clinical populations (60-64). Two of these studies in particular are worth further consideration. In the first of these studies (57), the effects of twice weekly yoga classes for 2 months were investigated in women experiencing symptoms of depression and anxiety. In comparison to the waiting list control patients, women in the yoga group experienced a significant reduction in state and trait anxiety levels. In the second of these studies

(65), 130 volunteers with mild to moderate levels of stress were randomised to a weekly 1 hour session of hatha yoga or relaxation for 10 weeks. After 10 weeks, yoga and relaxation were found to be equally effective for reducing stress and anxiety but yoga was more effective for improving mental health status. However, at the longer-term follow-up time point of 16 weeks, more positive effects were observed in the relaxation group, which is likely to be a reflection of the higher proportion of participants in the relaxation group who continued to practice.

Kirkwood *and others* (66) undertook a systematic review of the research evidence on the effectiveness of yoga for the treatment of anxiety and anxiety disorders. Eight studies were identified, six RCTs and two non-randomised controlled trials. In five studies, the participants had been diagnosed with an anxiety disorder (anxiety neurosis, obsessive compulsive disorder and psychoneurosis), in two studies the volunteers were suffering from examination anxiety and snake phobia and in the remaining study, the participants were about to undergo an anxiety-provoking examination. One of the studies (67), which compared yoga with a meditative control group in patients with a diagnosis of OCD, showed significantly greater improvements on the Yale-Brown OCD Scale and other scales in the yoga group after 3 months. Two studies investigated the effects of yoga as a treatment for anxiety neurosis in hospital outpatients (68,69). One (68) reported a clinically significant reduction in Hamilton Anxiety Scale score in the yoga group versus controls after 3 weeks and the other (69) showed evidence of greater reductions in anxiety levels and overall improvement of symptoms in a yoga versus diazepam treatment group after 3 months. Both these trials were non-randomised designs. A further two studies undertaken by the same research group (70,71) investigated the effects of yoga in psychoneurosis (mixed anxiety and depression disorders) or psychosomatic disorder. In the first of these studies, significantly lower anxiety scores were recorded in a yoga versus a 'placebo yoga' group after 4 weeks. In the other study, patients who engaged in yoga practice experienced a greater reduction in the Taylor's Anxiety Scale score after 6 weeks than patients allocated to a drug treatment group. Other studies provided some evidence that relaxation techniques derived from yoga practice could be more effective than progressive relaxation and no intervention (control) for reducing pre-examination anxiety levels in university students (54,72).

10. YOGA FOR SLEEPING PROBLEMS

A systematic review of complementary medicine approaches for insomnia by Kozasa *and others* (73) identified only one study that had investigated the potential health benefits of yoga practice in this respect. This study was a RCT involving 120 older people with sleep complaints who were randomised to one of three groups: yoga, ayurvedic herbal medicine or waiting list control. After six months of practice, the yoga group showed a decrease in the time taken to fall asleep, an increase in the number of hours slept per night and an improved feeling of being rested in the morning in comparison to the other two groups. The sample of older people recruited for this study reported have sleeping problems and did not have a clinical diagnosis of chronic insomnia. A cross-sectional study published in 2009 provided some further support for the role of yoga in promoting sleep quality (74). In this study 16 volunteers with a minimum of 3 years of yoga practice were compared with a control group. Long-term yoga practice was associated with better sleep quality and a modulatory action on circulating levels of cortisol.

11. SPECIAL POPULATIONS

11.1 Children and young adults

A systematic review of the literature undertaken by Birdee *and others* (1) identified 19 randomised controlled trials and a further 15 non-randomised controlled trials involving children and young adults. A large majority of the studies reviewed reported positive effects of yoga practice on physical fitness and cardiorespiratory health. Two non-randomised studies suggested that yoga, as well as more conventional exercise such as swimming and dance, promoted mental health benefits in young adults older than 18 years of age. As a method of building discipline and self-awareness in children, intuitively, yoga has potential benefits for children with attention problems. Initial evidence also suggests that yoga has potential to reduce ADHD symptoms in children (3) but no conclusive studies exist at the present time. Studies that have investigated yoga as an intervention for reducing anxiety and stress and improvement in coping abilities/mood states have yielded mixed results (3). Although the large majority of reviewed studies reported health benefits for children and young adults who participate in yoga classes, methodological limitations prevent strong conclusions from being drawn and the evidence can only be considered preliminary. Further studies with improved experimental rigour are required before firm conclusions can be drawn.

11.2 Older adults

Interest in yoga is growing amongst older adults and could be an ideal exercise modality for promoting strength, flexibility and improved balance in elderly populations. A recent critical review of the literature by Roland *and others* (5) identified 10 studies (involving 544 participants) that had investigated the impact of yoga practice on physical fitness and function in older adults. Five of the studies were RCTs and the other five were uncontrolled trials. The length of the yoga intervention ranged from 4-24 weeks. The three larger-scale RCTs involving over 100 participants (22,75,76) reported improvements in lower-body flexibility, endurance, shoulder and hip range of motion, balance measures and diastolic blood pressure following 4-6 months of yoga practice. Two small-scale RCTs also reported improvements in lower body strength, postural control, steadiness and balance confidence following programmes of yoga practice (77,78) and these data were generally supported by the uncontrolled studies. The authors concluded that while the scientific evidence supporting yoga for improved fitness in older adults shows promise, methodological issues in the currently available literature means that further studies are needed.

11.3 Post-menopausal women

A large majority of postmenopausal women experience menopausal symptoms, including hot flashes and night sweats (vasomotor symptoms), excessive fatigue and impaired sleep, mood disturbances and headaches. Innes *and others* (79) undertook a systematic review of the literature on mind-body therapies for menopausal symptoms. The systematic review identified three randomised controlled trials and five uncontrolled trials, ranging from 7-16 weeks in duration, which had investigated the effects of yoga and/or yogic meditation alone or in combination with education or other co-interventions on menopausal symptoms. Four studies investigated breast cancer patients and/or survivors. The majority of these studies reported an attenuation of symptoms (including overall symptoms, vasomotor symptoms, musculoskeletal pain, psychological distress and sleep disturbance) in women who had engaged in yoga and yogic-meditation practice. There was an overall reduction in menopausal symptoms of 36-80%, depending on the study design, with improvements being maintained in many cases for at least 3 months after completion of the programme. One of the reviewed studies showed that yoga and walking were equally effective for enhancing positive affect and menopause-related quality of life, as well as for reducing negative affect in

middle-aged women (80). This RCT involved 164 women randomised to one of three groups, yoga, walking, or control group and the duration of the intervention was 4 months. The women who experienced improvements in menopausal symptoms also experienced improvements in all positive mental health and quality of life outcomes and reductions in negative mental health outcomes. Interestingly, the yoga intervention was less intensive (2 x 90 min classes per week) than the walking intervention (3 x 1 hour sessions per week, plus individualized home exercise prescription 1-2 days per week). Compliance to the sessions was also lower in the yoga group (63% versus 70%). Considered together, the weight of evidence from these reviewed studies suggests that yoga and yogic-meditation therapies can have a positive impact on menopausal symptoms in otherwise healthy women and breast cancer patients/survivors. However, the authors concluded that methodological limitations inherent in most of the studies hinder interpretation of the findings and mean that firm conclusions cannot be drawn until more rigorous RCTs with larger cohorts of women have been undertaken.

12. ADVERSE EFFECTS AND CONTRAINDICATIONS TO YOGA

There are some examples in the scientific and medical literature of adverse effects, when yoga practice has had injurious consequences. Fortunately, in situations where people are receiving proper tuition by a qualified and experienced yoga teacher, such occurrences are few and far between. Some forms of yoga involve difficult postures that might be unachievable for many young healthy and fit adults. Additionally, some of the postures, if not taught correctly by a qualified teacher, or if insufficient attention to safety has been heeded, could predispose the practitioner to serious injury. This being said, there are examples in the literature of vulnerable groups engaging in popular forms of yoga without any problems, including patients with chronic heart failure, knee osteoarthritis and pregnant women. It is feasible that a general lack of evidence for adverse effects could reflect under-reporting in the literature (rather than yoga being a low-risk activity) but the weight of available evidence suggests that with proper instruction, the popular forms of yoga are safe for most people, including those with chronic conditions. Many adverse events and injuries can be prevented by ensuring that selected exercises are matched to individual capabilities.

In the case of hot yoga, special precautions should be taken for some clinical groups, such as those with cardiovascular disease and multiple sclerosis. In individuals with compromised cardiac function (e.g. chronic heart failure, angina pectoris, etc.) the

competing metabolic and thermoregulatory demands of hot yoga could place exceptional burden on the cardiovascular system. This would make hot yoga unsafe by predisposing such individuals to a serious adverse event. Additionally, some clinical populations can have an adverse reaction to exercise in warm/hot environments (e.g. people with multiple sclerosis) and participation in hot yoga classes would be contra-indicated. Individuals with such conditions should always consult their general practitioner before engaging in hot yoga sessions. Finally, continuous fluid replacement during participation in hot yoga sessions is essential for all to help prevent heat stress and a decline in physiological function.

13. SUMMARY AND CONCLUSIONS

The weight of available evidence suggests that yoga practice is safe and can bring many health benefits to practitioners, whether they are young, old, healthy, recovering from illness or looking for a therapeutic option to help them to manage a chronic condition. It is important to be mindful of the fact that most positive evidence to date has emanated from studies that are considered to have only poor to moderate methodological quality, e.g. non-randomised controlled trials and uncontrolled, single group studies. In addition, many of the available studies in the scientific literature have been conducted in India and there is a relative shortage of good quality studies involving Western populations. However, these methodological weaknesses should be weighed against the inherent limitations in RCT design. Additionally, although RCTs offer the highest level of evidence, it is not always possible to discern the full range of health benefits that might be gleaned from this type of study. RCTs usually have a pre-selected set of outcome measures that are assessed before and after the intervention in both experimental and control groups. It is possible that this way of assessing efficacy might miss some important physiological or psychosocial variable that has a key impact on health or quality of life. The inclusion of qualitative outcomes in future studies, such as focus groups and structured interviews, and a greater involvement of yoga practitioners, teachers and patient groups in the design of studies, could help to overcome this.

For future research, a number of other issues need to be considered. Firstly, the studies that are currently available in the published literature involve a wide range of yoga ‘interventions’, in which the health benefits of different yoga styles have been investigated. For example, the yoga interventions in some studies have placed much

more emphasis on breathing exercises (pranayama), whereas others have focused more on the physical components (asanas). This means that it is very difficult to compare across different studies or to develop a clear evidence-base for a particular type of yoga in a specific population. This problem is compounded by the wide variety of yoga intervention 'doses' that have been investigated across different studies. For example, most reviews of the literature (including some systematic reviews) have attempted to make broad conclusions about the health benefits of yoga from intervention studies that have not only differed in style but also programme duration. More high quality controlled studies, with larger sample populations, and with the purpose of investigating the health benefits of balanced yoga systems (e.g. involving pranayama, asana and meditation delivered by qualified teachers), are urgently needed. Ideally, both quantitative and qualitative physiological/psychosocial outcomes should be assessed over short-term and longer-term periods of follow-up. For optimal impact, the inclusion of diverse populations at risk of lifestyle-related chronic diseases would also be highly desirable.

There are good physiological reasons why hot yoga could augment the health benefits of conventional forms of yoga that are performed at normal ambient temperature and humidity. These include an improved stimulus for cardiovascular adaptations, an enhanced blood flow and oxygen supply to working muscles and greater extensibility of the muscle-tendon unit. For some individuals and clinical populations, hot yoga should only be engaged in after seeking medical advice and adequate hydration during sessions is vital for all participants to prevent heat stress. To date, only one controlled study of the health benefits of hot yoga is available and no published studies have investigated the safety aspects of this yoga style. Considering the growing popularity of hot yoga amongst people of all ages, further studies are clearly warranted!

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