

REVIEW PAPER

**THE APPLICATION AND EFFECTIVENESS OF YOGA IN
PREVENTION AND REHABILITATION OF SPORT
INJURIES IN ATHLETES PARTICIPATING IN
COMPETITIVE SPORT****Sunitha Ravi^{1,2}**¹Latvian Academy of Sport Education, Latvia²Dev Sanskriti Vishwavidyalaya, India

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Email: sunitha.ravi@lspa.lv**Abstract**

The purpose of the study is to review literature for scientific studies about application and effectiveness of yoga in rehabilitation & prevention of sports injuries in athletes participating in competitive sports. The author conducted a comprehensive search of open access articles of major scientific databases including PubMed, SCIEDIRECT, EBSCO, SCOPUS, Web of Science, etc.. No significant scientific studies were found relating to the application of yoga in rehabilitation and prevention of sport injury. Four studies were selected based on inclusion criteria. One pilot study has included yoga as part of sport conditioning and has investigated use of yoga for flexibility and incidence of non-contact injuries in baseball athletes. The other studies include a clinical example that has used yoga as part of the seven point program in injury treatment of elite football players, an intervention that has included yoga in high-volume training program and a randomised control trial that has evaluated effect of yoga in flexibility and balance among athletes. Conclusions: There is scope for further studies to examine the effect of yoga as an adjunct intervention in rehabilitation of select sports injuries for athletes in competitive sport. There is potential to include sport-specific yoga programs in athletic training for prevention of non-contact injuries.

Key words: *yoga, sport, injury, pain, prevention, flexibility***Introduction**

Global participation in organized and competitive sport is increasing. As per combined epidemiological studies from the United States (Powell &

Barber Foss, 1999), Europe (2008-2010, *EU IDB*), almost 10 million Sports injuries are reported among people in the kids and youth (6 to 24 years). While sport injuries cause direct and indirect physical and psychological effect on self and/or team, it poses economic burden on the health ecosystem in the community. Sprains and strains, fractures, contusions, abrasions and concussions top the list of sport-related ER diagnoses for kids in United States ages 6 to 19 — at a cost of more than \$935 million each year, according to the Safe Kids Worldwide report. Similarly in Europe, estimated cost of player injuries in top 4 soccer leagues was USD 12.4\$ million per team in 2015 (Forbes 2015). Approximately 4,500 people in Victoria (Australia) drop out from participation in five of the top team sport due to sport injuries and the number could increase to about 20,000 in the absence of effective sport injury prevention strategies and plans (Sport Injury Prevention Taskforce Final Report, Australia, 2013).

With the available evidence, Yoga (specifically yoga postures and pranayama) maybe associated with improvement in cardio-vascular fitness (KVV Prasad, et al., 2001; Tran, et al., 2001) and scientifically proven to positively effect on a person's physical and psychological conditions (Birch, 1995; Lidell, et al., 1983), bringing a better mind-body equilibrium. There are also studies that practice of yoga postures and pranayama have improved sports performance (Snehal, et al., 2014; Polsgrove, et al., 2016; Brynzak, et al., 2013; Powell, et al., 1999; Goodman, et al., 2014). However, there are no evidence based scientific studies about effectiveness of yoga in treatment of sport injuries.

The research questions of the study were,

1. how can yoga be used for rehabilitation & prevention of sport injuries?
2. how effective is yoga in rehabilitation & prevention of sport injuries?

Materials and Methods

The study incorporated varied search methods for relevant content including scientific substantiation. A comprehensive systematic search was conducted of open access articles of major complementary medicine and yoga databases including PubMed, SCIEDIRECT, EBSCO, SCOPUS, Web of Science etc and relevant literature was identified. *Inclusion Criteria:* The review included research studies documented in English from 1985 to 2015.

- Randomised control trials, clinical example / case report, pilot study
- Studies that included injury, rehabilitation, flexibility etc as one of the outcome variables (Fig. 1).

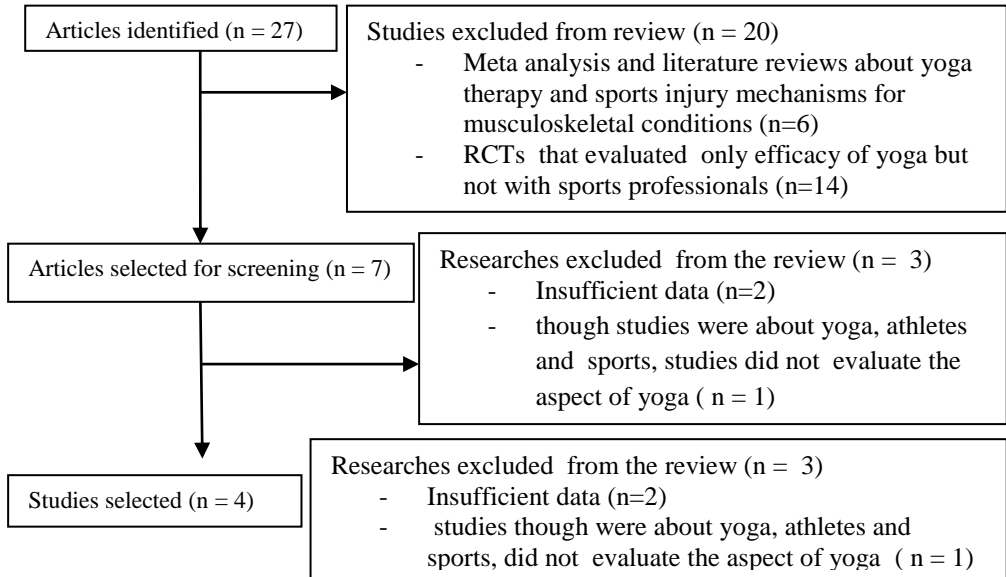


Figure 1. Results of the Review

Results

There were no significant studies for application of yoga in rehabilitation of sport injuries or prevention of sport injuries. However, one study attempted to investigate using yoga for flexibility and incidence of non-contact injuries in baseball athletes. None of the studies in the review are blinded trials. Among the other three studies selected for review, there is an individual clinical example with yoga as part of the injury treatment, a pilot study that examines the impact of a sport-specific yoga program on the enhancement of segment range of motion (ROM) and the effect upon non-contact injuries among athletes. The fourth study is about examining impact of yoga on flexibility and balance in athletes.

Table 1

Demographics of subjects and sport

<i>Study Reference</i>	<i>Sample Size</i>	<i>Gender (M/F) and Age (years) and Condition</i>	<i>Sport</i>	<i>Key focus</i>
Brukner et al. 2012	1	M = 1 Age – 26 years	Football	Rehabilitation for Grade 2 Femoris musculotendinous junction strain
McLean, 2009	30	M = 30	Base Ball	Flexibility and injury incidence
Brunelle et al. 2015	15	F= 7 ; M = 8 Age – 21 to 25 years	Skating	Postural skills in speed skating
Polsgrove et al. 2016	26	M = 26 Age – 19 to 21 years	Soccer and basket ball	Flexibility and balance in college athletes

Researchers have established that musculoskeletal or any other physical injury, depending on the grade of injury, have the potential to impact ROM, flexibility and endurance (in-case of long inactivity). There are studies that indicate yoga to enhance strength, flexibility and range of motion as part of injury rehabilitation or as prevention of injury. Studies are available about effect of yoga as a non-invasive, non-drug method of treating several musculo-skeletal, neurological conditions of the human. For example, Kirkwood et al. (2005) have found positive effect of yoga for arthritis, anxiety, depression, eating disorder etc., and suggest the need for further research. Ross et al. (2012), in their national survey of yoga practitioners have found that yoga might be beneficial for a number of populations including elderly women and those with chronic health conditions.

Table 2

Results from studies selected for Review

<i>Study Reference</i>	<i>Type of intervention</i>	<i>Yoga intervention / practice duration and Intensity</i>
Brukner et al. 2012	Yoga as part of 7 point rehabilitation program	12 weeks 60 minutes per session, twice per week
<i>Findings:</i> The injury was managed successfully with a seven-point programme-biomechanical assessment and correction, neurodynamics, core stability, eccentric strengthening, an overload running programme, injection therapies and stretching/relaxation. The evidence for each of these treatment options is reviewed.		
McLean, 2009	Yoga as sport conditioning	12 weeks 45 minutes per session, twice per week
<i>Findings:</i> Significant improvements in shoulder flexibility (SH) and Hamstring (HS) ($p < 0.05$). improvement in average mean of 5 cm was observed from pre-intervention ($M = 29.7\text{cm}$, $SD \pm 7.9$) to post-intervention, ($M = 34.9\text{cm}$, $SD \pm 9.9$). 14.49% improvement during the course of the intervention. Hamstring flexibility – an improvement with a mean value of 7cm was seen from pre-intervention ($M = 9.01\text{cm}$, $SD \pm 7.41$) to post-intervention ($M = 36.0\text{cm}$, $SD \pm 5.16$). 24% improvement in the mean. Decline in lower and upper extremity injuries (may be due to yoga).		
Brunelle et al. 2015	Yoga as motor time-on-task	36 yoga session during 8 weeks
<i>Findings:</i> The 36 yoga sessions totalized 986 minutes of motor time-on-task, registering a proportion of 30% of the global motor time-on-task of the training cycle. Improvements were found in eleven of the 14 angles measured when comparing pre- and post-postural tests (P -value from 0.01 to 0.005). During the 8 weeks, excepting traumatic injuries due to short track speed skating accidents, no skaters suffered injuries linked to the high volume of training.		
Polsgrove et al. 2016	Yoga with regular athlete training	10 weeks 2 times a week (intensity not specified)
<i>Findings:</i> Significant gains were observed in the yoga group for flexibility (SR, $P = 0.01$; SF, $P = 0.03$), and balance (SS, $P = 0.05$). Significantly, greater joint action were observed in the yoga group for: RFL (dorsiflexion, l-ankle; $P = 0.04$), DD (extension, r-knee, $P = 0.04$; r-hip; $P = 0.01$; flexion, r-shoulder; $P = 0.01$) and C (flexion, r-knee; $P = 0.01$). Significant JA differences were observed in the NYG for: DD (flexion, r-knee, $P = 0.01$; r-hip, $P = 0.05$; r-shoulder, $P = 0.03$) and C (flexion r-knee, $P = 0.01$; extension, r-shoulder; $P = 0.05$). A between group comparison revealed the significant differences for: RFL (l-ankle; $P = 0.01$), DD (r-knee, $P = 0.01$; r-hip; $P = 0.01$), and C (r-shoulder, $P = 0.02$).		

*RFL – right foot lunge; DD – downward dog; NYG – non-yoga group

* content of the table is from the selected studies for review

Discussion

The studies selected in this review (Table 2.) are discussed herewith to understand and explore possibilities of effectiveness of yoga in athletes.

1. *Yoga as part of Seven point program*

Brunker et al. (2012) have described treatment of hamstring injury in an elite football player. They have made a detailed investigation of aetiological and pathological factors of the injury and designed a seven point program to address the clinical challenge and have been successful.

Biomechanical assessment and correction was possibly a significant aspect as the asymmetry in ankle dorsi-flexion was identified and remedial actions were implemented with specific orthotic and manual therapies.

The example does not detail the cause of asymmetry in the athlete. Though we cannot assume that asymmetry could be one of the causes for the player's injury, researchers like Monro et al. (2014) have noted that there are possibilities including incomplete recovery from initial injury, incomplete rehabilitation, uncorrected biomechanical problems, et al. The athlete should be assessed not only for the acutely injured tissue but also for the underlying biomechanical problems along the kinetic chain and subclinical adaptations.

This provides a significant input to adopt an injury prevention mechanism in elite athletes by treating signals and symptoms of imbalances in the physical structure of the body.

Neurodynamics clinical tests were normal, but the player had complaints about numbness, aching and restriction in movement of right leg. The authors of the study suggested that the proximity of the sciatic nerve to the hamstrings implicates scarring potentially compromising the normal mobility and nutrition of the sciatic nerve. The rehabilitation included sliding techniques and single leg raising (SLR) biased technique sensitized with hip rotation, adduction and dorsiflexion.

The example considers an input from an earlier study by Orchard et al. (2004) that L5 nerve root may be associated with the increasing age predisposition trend of hamstring and calf injuries in Australian Football players although injury rates of muscle groups supplied by nerve roots. This aspect of correlating age with possibilities of injuries, is significant as it implies the importance of considering age related factors in rehabilitation and prevention of athlete injuries.

Nee et al. (2006) have detailed about the mechanism of clinical manifestation of peripheral neuropathic pain and have proposed that conservative management incorporating neurodynamic and neurobiology education, non-neural tissue interventions, and neurodynamic mobilization

techniques can be effective in addressing musculoskeletal peripheral neuropathic pain states.

Earlier studies refer that the nerves may respond to mobilization procedures and techniques similar to those for the musculoskeletal system, with purpose to correct such abnormal neural tensions and re-establish the proper movement of the neural tissue (Monro, et al., 2014). This will result in a pain free state with subsequent improvement in the patient's functional ability level which is most of times the final goal. The basis of the ability of the nervous system for gliding and for transmission of tension has been thoroughly researched. The studies refer to the median nerve slides longitudinally in its bed when the limb is moved.

There are studies that illustrate the impact of yoga as therapy in conditions with low back pain. An exploratory study by Garfinkel et al. (1998) has tested effects of yoga therapy on pain and disability associated with lumbar disc extrusions and bulges. 62% of the 61 adults treated in the group had sciatica. The subjects underwent a 3 month yoga course and home practice. The Roland Morris Disability Questionnaire (RMDQ) score of the yoga group was 3.29 points lower than the control group. The researchers have recommended that yoga therapy can be a safe and beneficial for people with nonspecific low back pain or with sciatica, accompanied by disc extrusions and bulges.

A randomized control trial by Richard et al. (2007) for carpal tunnel syndrome observes that a yoga-based regimen was more effective than wrist splinting or no treatment in relieving some symptoms and signs of carpal tunnel syndrome.

The study has found significant improvement in hand grip strength (increased from 162 to 187mm/Hg; $P = .009$) and pain reduction (decreased from 5.0 to 2.9mm; $P = .02$).

The athlete's core stability programme was redesigned during the treatment. Sessions comprised a circuit of proprioceptive, neuromuscular control, core stability/strength and a varied lower limb strength exercise.

Core strengthening was supplemented using document based care (DBC), where core strengthening machines were designed to isolate the specific muscles involved in trunk core stability through a series of specific loaded exercises incorporating the main global lumbar movements (extension, rotation, flexion and side flexion) while limiting movement and activity in the muscles around the hips and thoracic spine.

Earlier study by Arnason et. al. (2008) has highlighted importance of core stability program for prevention of athletic injuries and to enhance sport performance.

Eccentric strengthening was applied to strengthen hamstrings. Arnason et al. (2008), have earlier used this program and have found that the eccentric training with Nordic lowers combined with warm-up stretching appears to reduce the risk of hamstring injuries in elite soccer players.

The programme comprised eight sets of 3 day cycles with consecutive days of running followed by a day off. This improved not only the player's aerobic running power but also served as aerobic fitness. In conjunction with video-based tracking of matches, the programme provides an objective measure of each player's 'standard week' in terms of training and match loads.

The physician's decision of injections, a mixture of Traumeel and Actovegin were performed in the lumbar regions centrally, over the facet joints and the iliolumbar ligaments bilaterally and the right sacroiliac joint (SIJ).

The treatment exclusively had 60 minutes of yoga sessions twice a week during the rehabilitation period and found Yoga to be effective. The fact of including yoga based breath training in the treatment the importance of mindfulness and relaxation in sport. However, the extent of yoga's efficacy in comparison to the other methods was not part of the study.

Overall, the clinical example has attempted to design a treatment that diagnoses the player's limitations and imbalances, and to address them at the physical, physiological and mind-body levels. One of the theoretical models, the integrated approach of yoga therapy (IAYT) considers correction of imbalances at the physical, mental and emotional levels. The duration of treatment, cooperation of the patient and the patient's awareness of his/her own situation are considered important aspects in accelerating the effect of IAYT. According to the theory of Pancha Kosha defined in the vedic texts (*Taittiriya Upanishad*), the human existence comprises of five layers or sheaths. The gross body is the annamaya kosha (food sheath), the subtler energy is the pranamaya kosha (vital sheath), the third layer is that of emotion and feelings and is called manomaya kosha (mental sheath), the layer of imagination, knowledge, insight and understanding forms the vignanamaya kosha (the intellectual sheath). The fifth is the anandamaya kosha (sheath of bliss). This conceptual of yoga explains the intervention for injury and prevention of physical, physiological, psychological conditions.

The inclusion of neurodynamics, core strengthening and hamstring strengthening suggest a possibility in prevention mechanism of injuries too. A research by Croisier (2004) has found that players with strength imbalances were more likely to sustain a hamstring injury than those

without imbalance. Another review of studies by Rachiwong et al. (2015) observes the effectiveness of an adapted and specific rehabilitative intervention in hamstring muscle re-injury prevention.

The breath training (increase in lung capacity, stamina and relaxation response) could specifically the hamstring freeing might have added to the effectiveness of overload running programme. However, correlation between muscle relaxation, strengthening on effective injury rehabilitation in competitive sport is an area to be further investigated.

Though sustained and continued practice of yoga is advocated in several texts of yoga, there are few evidenced researches about positive effects of yoga in physical and psychological fitness.

Williams et al. (2005), mention in their study about implementation of a 8 week (60 minutes per day thrice a week) modified hatha yoga program for male and female workers in the age group of 18 to 55 years as part of industrial rehabilitation for injured workers. The injuries included in the study were paraplegia acquired absence of limb as classified by International Classification of Diseases (ICD). The yoga group (9 people) practiced, a set of yogasanas and relaxation postures using suitable props. The combination of selected postures required lengthy contractions of all major muscle groups, including ROM of joints in the leg, spine and upper body. The researchers have found a 82% increase in ROM and also an improvement in flexibility in of lower back, hamstring and hand-grip.

The yoga group also showed significant increase in vital capacity, which the researchers attribute to pranayama (slow and deep breathing). Birkel et. al. (2000) observe that pranayama enhances vital capacity in healthy subjects. Hovsepian et al. (2013) study about pranayama's effect on pulmonary capacities in people with physical activity limitation.

A randomised control study was conducted by Bedekar et al. (2012) to evaluate the efficacy of iyengar yoga on chronic low back pain and results were assessed for 12 weeks (midway), 24 weeks (immediately after) and 48 weeks (6 months) after the therapy. There were significant reductions in functional disability, pain intensity and depression in the yoga group in both 12 and 24 weeks. There were also significant reductions of pain medication in yoga group in slightly less than 24 weeks compared to the group that received standard medical care.

A cohort study by Moriello et al. (2014), has compared effects of conventional physiotherapy and additional yoga asanas, on 51 patients undergoing total knee arthroplasty (TKR) due to osteoarthritis and has noted significant improvement on pain, stiffness and functional scores in the experimental group as compared to the conventional group at day 3 after

operation, 6 weeks and 3 months. Similarly, a case report by Engebretsen et al. (2008) has documented improvements in balance, flexibility; endurance; posture; muscle strength of the hip extensors, hip abductors and knee extensors; and in performance of functional goals in a 12 week program designed for an individual with spinal cord injury. Yoga was used along with conventional physiotherapy.

There is a potential for yoga to be included as adjunct intervention in sport physical therapy as well. Posadzki and Parekh (2009), mention that conceptually, both physiotherapy and yoga, each through its own procedures, improve muscle strength, increase joint mobility and soft tissue flexibility, mobilize the nervous system, improve body posture, improve proprioception and thereby encourage better awareness of the body, releasing trigger points and relieving pain. It may be worthwhile to explore further researchers that include yoga as an adjunct intervention in sport physical therapy.

2. *Sport-specific yoga program*

Mclean (2009) examines the longitudinal impact of sport-specific yoga program on ROM and effects on non-contact injuries among baseball athletes. The author details several evidenced research studies about shoulder injury mechanisms and considers the assumption that shoulder injuries could possibly be prevented by maintaining flexibility (through reducing strain mechanism on the anterior and posterior joint capsule).

It is useful to note that yoga training was sequenced after athletic conditioning and that the series of yoga postures varied each day in accordance with sport conditioning. This re-emphasises the athlete centric approach and importance of collaboration among key stake holders during sport training. The study mentions about all participants attending this 12 week training, signifying the importance of adherence to training for success of the program.

Observing a control group that did not adhere to the training schedule maybe another insightful study to make useful observations about the effect of the sport specific yoga training program. A randomized control trial by Sager et al. (2014) identified high-risk and low-risk injuries in Norwegian 1st, 2nd, or the top of the 3rd division teams, through a questionnaire, however the introduction of individual specific preventive training programs did not affect the injury risk in this intervention, most likely due to a low compliance with the training programs prescribed.

The study by Mclean does not detail the exercises used for conditioning and also accepts its limitation about considering only one pre-season cycle prior to the competitive sport. The study certainly extends

scope to conduct research studies with yoga interventions in specific sport training for prevention of non-contact sport injuries.

3. *Yoga in high-volume training*

Brunelle et al. (2015) have included yoga program into the pre-season high volume training and have found positive results. The study observes improvements in eleven of the 14 angles measured, and no injuries linked to the high volume of training thus signifying possibility to integrate yoga in high-volume athlete trainings.

This pilot study is significant as it uses yoga as a training stimulation to enhance postural skills and details importance of postural adjustments in short track speed skating. The intervention was successful in developing a new range of functional skills specific to the sport. The coaches were able to observe the efficiency in the skating strides of athletes which is correlated to the dissociation of the hip and torso (effect of yoga training). This is one of the very few researches about a sport specific yoga intervention.

A study by Pauline et al. (2011) has compared static stretching to yoga and found that yoga has a greater effect on range of motion at the shoulder and hip than static stretching in a healthy population. Another study by Schleip et al. (2011) has observed significant improvement in shoulder and hip flexion, hip extension and abduction range of motion following a 12 week yoga practice.

A study by Green et al. (2002) suggests that tissue loading procedures could eventually induce a period in which the tissue stiffness increases beyond the original state provided that the amount of tissue strain is high enough and that the duration of the subsequent resting period is sufficiently long. Another study by Goodman et al. (2014) has observed that a common sport injury prevention regime involves repetitive active stretching followed by periods of seated resting. They have demonstrated that this sequence of preparation tends to augment lumbar spine stiffness.

4. *Yoga in regular athlete training*

Polsgrove et al. (2016) have examined the effect of yoga in athletes. They have included yoga as an additional component in the regular athlete training and observed significant improvements in balance and flexibility. The researchers have considered 3 specific postures, the right foot lunge, downward dog and chair and hence makes it easier to comprehend the effects of these postures in sport and possibly help to create a standardised training schedule.

The study is important as it brings correlation between the kinetic chain and differences of usage of varied muscle groups for balance. This study furthers the insight that practice of yoga helps to reduce muscle

tightness caused during sport training and also enhance flexibility and balance required for the sport. A comparison for the right foot lunge (RFL) indicates that the yoga group athletes utilized more dorsiflexion of left ankle position while the non-yoga athletes adopted a more plantar flexed position. These variations are suggestive that yoga athletes are better able to balance their body weight and eccentrically stretch their posterior shank muscles than non-yoga athletes. During the downward dog, it was observed that the non-yoga group had tightness in hamstring and lower back muscles.

Ce et al. (2015) conducted a pilot study of a 5 week yoga intervention for mens' division 1 athletic team in the age group 17 to 20 and have found that participants after 5 weeks of yoga practice reported greater mindfulness, greater goal-directed energy, and less perceived stress than before the intervention. Boyle et al. (2004) have examined how a regular yoga practice delayed the onset of muscles soreness (DOMS), a form of muscle trauma and/or damage at the level of the connective tissue and cell. Brynzaket et al. (2013) have observed the effect of yoga exercises on preparedness of student basketball team and have found that 13 players of experimental group demonstrated more preparedness in their game after the 9 month yoga intervention. There was increase in the following level indicators, namely, vertical jump, speed endurance, speed, retention of equilibrium (balance), free throw, with the movement, three-point shots, free throws, tactical execution.

Singh et al. (2015) have found significant increase of muscular strength ($t=6.946^*$), muscular endurance ($t=9.863^*$), flexibility ($t=11.052^*$) and agility ($t=14.068^*$) among female hockey players (18 to 25 years of age). An earlier study by Brown et al. (2005) has observed that yoga group showed a high level of maximal anaerobic alactic power and maximal force and the group required low energy expenditure and cardiopulmonary effort to maintain the yoga postures. According to Ghiya et al. (2012), yoga also uses breath control to alter the autonomic state as well as the control of the attention. Yoga explicitly aims at establishing a more optimal overall psychophysical state (New York, North Point Press, 1999).

Gore (2004) in his book *Anatomy and Physiology of Yogic Practices* has detailed variations between yoga and exercise. He explains that during exercise, a specific movement is repeated to strengthen that group of muscles and there is a possibility of asymmetrical development.

Conclusions

With the paucity in the scientific research in application of yoga in sport injury rehabilitation and in prevention, there is potential for researchers to consider studies about application and maybe effectiveness of

yoga for specific sport injuries. It is more useful if studies can include mechanism of yoga in rehabilitation and prevention of sport injuries. Detailed studies about yoga as an intervention for prevention of sport injuries is an interesting area that will throw light on modification in sport training.

Further, it would certainly help fellow researchers if yoga is considered as a non-pharmacological, no-invasive intervention in treating specific sport injuries. There are evidence based studies about application of yoga as non-invasive and non-pharmacological intervention in treatment of musculoskeletal, psychosocial, neuromuscular conditions etc. It may be useful to extend these studies in symptomatic treatment in sport related injuries.

Only one study in the current review is a randomized control trial (RCT). This warrants for further blinded RCTs to understand validity of using yoga as an intervention in competitive sport.

The application of yoga as adjunct intervention in various conditions majorly observe pain management, functional mobility, muscular endurance, quality of life etc. Most of the studies have documented the physical therapy applications. It may be of significance to detail the pharmacological interventions as well, so it helps the sport researchers understand the correlation between physical therapy treatments and pharmacology in elite athletes.

The pilot studies that have included yoga in athlete training program have observed efficacy of yoga in flexibility and low incidence of injuries. This could be a potential area of research to address a pertinent issue with reference to prevention of sport injuries in elite and non-elite athletes.

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