

Review paper

HATHA YOGA AS A FORM OF PHYSICAL ACTIVITY IN THE CONTEXT OF LIFESTYLE DISEASE PREVENTION

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Abstract

Physical activity is interrelated with health, physical fitness, and quality of life. The role physical activity plays in the context of lifestyle disease prevention is indisputable. Physical exercises of yoga (hatha yoga) are a type of recreational physical activity classified as a form of body and mind fitness. Hatha yoga training consists of slow or fast and smooth entering into, holding, and exiting yoga postures called “asanas”. Besides asanas, a yoga class may also include breathing exercises (pranayama) and relaxation exercises.

The aim of this paper is to analyse the benefits of regular hatha yoga training in the light of scientific studies in regard to primary and secondary prevention of lifestyle diseases (cardiovascular diseases, respiratory system diseases, type 2 diabetes, obesity, and diseases of the musculoskeletal system in particular).

The results of the analysis revealed that regular hatha yoga training including pranayama (breathing exercises) produced a reduction in blood pressure and heart rate, improved respiratory functions, decreased blood glucose levels and body mass, as well as improving functional fitness and self-perceived quality of life. Therefore, hatha yoga as a form of physical activity can be a useful intervention for primary and secondary prevention of cardiovascular diseases, respiratory system diseases, metabolic diseases, and diseases of the musculoskeletal system, including back pain.

Key words: prevention, lifestyle diseases, back pain, physical exercises of yoga, breathing exercises

Introduction

Physical activity (PA) is interrelated with health, fitness, and quality of life. Previous studies clearly proved the importance of PA in primary and secondary prevention of civilisation diseases [1].

Civilisation diseases (lifestyle diseases) are widespread in contemporary society and are associated with the negative effects of the development of civilisation. The aetiology of civilisation diseases is connected with lifestyle risk factors [1, 2]. Lifestyle diseases consist of, among others, hypokinetic diseases, whose aetiology is mainly related to a deficiency of PA. Hypokinetic diseases include cardiovascular diseases, metabolic diseases (diabetes, obesity, etc.) and locomotor diseases (such as osteoporosis, back pain, or degenerative joint diseases). The importance of PA in the primary and secondary prevention of these diseases is unquestionable [3, 4, 5, 6, 7, 8].

Physical exercises of yoga (hatha yoga) are types of PA. Hatha yoga includes several dozen different poses and their varieties called “asanas”. An adequately adopted hatha yoga pose (asana) is a stable pose which allows for a correct and symmetric alignment of body parts. The adoption of a pose requires concentration and appropriate alignment of the body in order to

avoid deviating from the correct structure of movement and overloading the passive elements of the locomotor system. Physical exercises of yoga require participants to hold and move between a series of static postures (asanas). Respective poses can be merged into sequences by transitioning from one pose to another combined with breathing. The breath is important and should be calm and deep, whereas inhalation and exhalation should be adapted to the alignment of the body during the transition from one pose to another.

A hatha yoga class, besides asanas, also includes relaxation exercises, aimed for example at stress reduction, breathing exercises (pranayama), and meditation. Nowadays hatha yoga is identified as a fitness form called body & mind [9]. Regular hatha yoga training has many health benefits.

The objective of this paper is to analyse the benefits of regular hatha yoga practice in the context of primary and secondary civilisation diseases.

Methods

This paper discusses research findings published in peer-reviewed scientific papers and includes empirical studies conducted using objective research tools.

Results and discussion

Effects of hatha yoga on primary and secondary prevention of cardiovascular and pulmonary diseases

Cardiovascular diseases are the most common cause of death in the world, Europe, and also in Poland [10]. Research has found that yoga exercises improve cardiovascular system function, reduce systolic and diastolic blood pressure [11, 12, 13, 14, 15], and improve respiratory system function [16, 17].

A study of American adolescents practising yoga ($n = 14$) and a control group ($n = 14$) revealed a significant reduction of blood pressure (systolic by 34% and diastolic by 16%) in participants practising yoga compared with the control individuals [15]. Yoga practices were performed for 3 months, 2-3 times a week, for 90 minutes, and they aimed at improving strength and flexibility. A yoga class included breathing exercises (pranayama) performed for 5-7 minutes, a warm-up performed for 5-7 minutes, and the following asanas: Mountain Pose (*Tadāsana*), Chair Pose (*Utkatāsana*), Half Moon (*Ardha Chandrāsana*), Downward Facing Dog (*Adho Mukha Svanāsana*), Tree (*Vrikshāsana*), Warrior (*Virabhadrāsana*) I, II, and III, Upward Bow Pose (*Urdhva Dhanurāsana*), Cobra (*Bhujangāsana*), and Corpse pose (*Śavāsana*) at the end of the session [15]. The yoga postures listed above are mostly standing and prone poses which engage the cardiovascular and respiratory systems in intensive work and contribute to an improvement of cardiorespiratory fitness, flexibility, as well as muscle strength and endurance.

An Indian study enrolling 33 subjects between the ages of 35 and 65 years diagnosed with hypertension (mean systolic blood pressure above 155 mmHg and diastolic pressure above 106 mmHg) showed a significant reduction of systolic and diastolic blood pressure. The yoga exercises were performed in the morning and in the evening, 60 minutes per day, 6 days a week, during the period of 11 weeks. The authors also stated that both yoga exercises and medicine treatment helped hypertensives, but the yoga intervention was more effective [12]. The yoga training included Shavasana (*Śavāsana*), Pavanamuktasana (*Pavanamuktāsana*), Ardhalasana (*Ardhalāsana*), Viparitarani, Ardhamatsyasana (*Ardhamatsyāsana*), Crocodile Pose (*Makarāsana*), Cobra (*Bhujangāsana*), Ardhashalabhasana (*Ardhashalabhāsana*), Vakrasana (*Vakrāsana*), Vajrasana (*Vajrāsana*), Wheel Pose (*Chakrāsana*), and Mountain Pose (*Tadāsana*), as well as yoga mudra, breathing exercises (*Nadi-sodhana*), Om recitation, and meditation [12]. The yoga asanas applied were mainly sitting or lying poses that did not cause excessive changes of blood pressure or heart rate during the exercises.

The results of a study involving 50 healthy volunteers from India (20 women and 30 men) aged over 40 years revealed a significant reduction of heart rate and systolic and diastolic blood pressure as a result of yoga training [18]. Hatha yoga was practised for 60 minutes daily for a period of 6 months and included standing poses (*Suryanamaskar*, *Vrikshāsana*, and *Trikonāsana*), sitting poses (*Vajrāsana*, *Baddhakonāsana*, and *Parvatāsana*, among others), prone poses (*Bhujangāsana*, *Dhanurāsana*, and *Makarāsana*), supine poses (*Matyāsana*, *Chakrāsana*, *Sarvangāsana*, *Halāsana*, and *Pavanamuktāsana*), a relaxation pose (*Śavāsana*), pranayama, and meditation. The authors noted a significant reduction of heart rate and systolic and diastolic blood pressure after 2 months of yoga training [18].

The following poses (asanas) are recommended for hypertension: *Padmāsana*, *Vajrāsana*, *Halāsana*, *Paschimottanāsana*, and *Śavāsana*; and the following ones are proposed for coro-

nary artery diseases: *Padmāsana*, *Matyāsana*, *Sarvangāsana*, *Bhujangāsana*, *Paschimottanāsana*, and *Śavāsana* [18, 19, 20].

A study involving 83 adult patients (aged 20-80) from Sweden diagnosed with hypertension ($120/179/\leq 109$) showed a significant reduction of diastolic blood pressure in participants who performed yoga exercises at home for 15 minutes a day for a period of 12 weeks. Participants were divided into three intervention groups: yoga class with an instructor, yoga at home, and a control group. The authors did not observe any significant differences in systolic blood pressure from baseline between the yoga groups and the control group [21].

In another study from Sweden involving 12 women and men aged 25-60 years with slightly elevated blood pressure (not higher than 145/95) who were new to yoga, the authors did not observe any significant reduction in blood pressure after an 8-week hatha yoga programme with classes lasting 60 minutes [22]. This was probably due to the fact that the participants' blood pressure was low or already normal at baseline; therefore, changes in blood pressure were not to be expected. However, the study showed that yoga had an effect on heart rate variability (HRV), causing a significant increase of HRV [22]. Consequently, the findings showed the beneficial effects of yoga exercises on regulating blood pressure.

A study conducted in India indicated that individuals who took part in yoga exercises had lower systolic and diastolic blood pressure and lower heart rate at rest (HR_{rest}) than those who did not. This study recruited 50 adults aged over 40 years practising yoga for more than 5 years and non-practising ones; the study did not have an experimental design [23].

The study mentioned above has documented the evidence of hatha yoga-associated blood pressure regulation and a hatha yoga-induced decrease in resting heart rate. Although exercise intensity was relatively low (that is low to moderate), these effects could be accounted for by the specificity of yoga training. Yoga instructors, especially those running classes for individuals with low levels of physical fitness or health problems, emphasise the need of assuming each pose calmly, maintaining a static posture for longer periods of time, breathing slowly, and avoiding excessive muscle tone as this could result in blood pressure elevation. Breathing and relaxation exercises are highly recommended as components of a hatha yoga session.

Santaella et al. noted an increase in forced vital capacity (FVC), forced expiratory volume in 1 s (FEV_1), and maximal expiratory (Pe_{max}) and inspiratory (Pi_{max}) pressures after 4 months of yoga training with breathing exercises in an elderly group of individuals (aged 68 ± 6 years) from Brazil. Yoga training (2 classes per week for 30 minutes plus home exercises) consisted of yoga postures and yoga respiratory exercises (*Bhastrika*). The control group was asked to do yoga exercises and stretching instead of *Bhastrika* exercises. The authors did not find any significant changes in any parameters in the control group. In conclusion, the respiratory yoga training in *Bhastrika* pranayama can be beneficial for the healthy elderly population as it improves their respiratory function [24].

Birkel found a statistically significant improvement in vital capacity in North American college students ($n = 287$) who practised yoga for approximately 2 hours per week for 15 weeks. A yoga class consisted of yoga postures, basic pranayama, and relaxation techniques. The author did not use a control group in the study [25].

A study involving 20 Hindu sedentary boys and girls aged 12-15 years who were given yoga training showed a statistically significant increase in forced expiratory volume (FEV), peak expiratory flow rate (PEFR), and FEV_1 . In a control group consist-

ing of 20 girls and boys, the increase in those parameters was insignificant. Hatha yoga training was performed for 6 months, 6 days a week, with each session lasting 45 minutes, and it also included breathing exercises [26].

Gupta and Sawane compared the effects of a yoga programme and a swimming programme. The authors indicated that both yoga and swimming can improve FVC, PEFR, and maximal ventilator volume (MVV). The improvement of FVC and MVV was better in the swimmer group than in the yoga group, while the improvement of PEFR was similar in both groups. The study comprised 81 healthy women and men aged 18-40 years who were assigned to the swimmer group or to the yoga group. Participants practised yoga (asanas for 40 minutes and pranayama for 20 minutes) or swimming (60 minutes) 6 days per week for a period of 12 weeks. The authors believe the improvement of breathing parameters after yoga training is due to the strengthening of the respiratory muscles [27].

Other research indicated that yoga exercises produced a reduction of blood pressure and heart rate at rest (HRR), contributed to the improvement in the HRV level, and lowered the stress level. High HRV indicates greater parasympathetic control [22, 24, 28, 29, 30]. Regular yoga training can improve breathing parameters; however, it should include breathing exercises (pranayama) and should be performed for at least 10 weeks. Respiratory efficiency is highly important in the prevention of pulmonary diseases, such as chronic obstructive pulmonary disease or bronchial asthma.

Bidwell et al. observed an improvement of quality of life and HRV as a result of yoga training. Their study included 19 women with mild-to-moderate asthma assigned to a yoga group or a control group for a 10-week intervention. No changes were found in the control group [31].

The magnitude of the improvement of breathing parameters is often related to the subjects' fitness level; greater improvements in pulmonary function are more likely to be seen in less fit individuals. It can also depend on the length of time the subjects spend practicing breathing exercises [24, 32]. The duration of the yoga training and its intensity (low or moderate) is also of importance. Most studies carried out so far included individuals who were sedentary; therefore, the efficiency of their cardiovascular and pulmonary systems was low or average, and the improvement of those parameters after the yoga intervention can be significant. Several studies indicated that yoga training improved cardiorespiratory fitness [13, 33, 34].

Effects of hatha yoga on primary and secondary prevention of metabolic diseases

Hatha yoga exercises are also an important intervention for primary and secondary prevention of metabolic diseases, particularly for the management of type 2 diabetes and obesity.

The results of a study enrolling 22 participants aged 45-65 years from North America assigned to a yoga intervention group or to an educational group (control group) showed a reduction of body weight and blood pressure as well as an improvement in insulin and triglyceride levels in the yoga group compared with the control group. Participants in both the intervention group and the control group had to be non-exercisers, have a family history of type 2 diabetes, and have at least one of the following cardiometabolic risk factors: impaired fasting glucose (110-125 mg/dl), prehypertension (120-139/80-89 mmHg), overweight/obesity (BMI: 25-45 kg/m²), or an abnormal level of total cholesterol (>200). The authors stated that yoga exercises might be a possible risk reduction option for adults at high risk of type 2 diabetes. The participants were highly satisfied with

the programme and reported that they had gained strength, flexibility, and balance through the yoga exercises. The yoga group participated in a 3-month-long Vinyasa style yoga programme 2 days per week, with each session lasting 60 minutes. The yoga sessions began with a warm-up (5-7 minutes), ended with relaxation, and included asanas such as sun-salutation (10-12 minutes), standing poses (12-15 minutes), sitting/kneeling poses, and counter-poses (12-15 minutes) with spinal extension, a hip-opener, as well as spinal rotation and flexion [35].

The results of a study conducted in the diabetes clinic of Kasturba in India showed that yoga exercises decreased BMI, improved glycaemic control, increased vitamin C levels, and could be used as therapy in reducing oxidative stress in diabetes patients. The 123 participants included in the study comprised type 2 diabetes patients aged between 40 and 75 years assigned to a yoga group (n = 60) or a control group (n = 63). The yoga group participated in a 3-month-long yoga programme with sessions held at least 3 days per week. The authors noted significant improvements in BMI, fasting plasma glucose, and postprandial plasma glucose, but they did not find any significant reduction in systolic and diastolic blood pressure in the yoga group compared with the control group [36].

Singh et al., based on a study which included 24 type 2 diabetes patients aged 30-60 years, reported a reduction of fasting blood glucose, 2-hour postprandial blood glucose, systolic and diastolic blood pressure, and heart rate at rest. The patients were assessed before and after a 40-day yoga programme [37]. There was no control group.

A study assessing the efficacy of a 12-week hatha yoga intervention to improve metabolic risk profiles in 173 Chinese adults assigned to a yoga group or a control group showed that yoga training was effective in improving the MetS (metabolic syndrome) z score, in both MetS and non-MetS yoga participants. Based on an analysis involving the entire study population, the authors found a greater decrease in waist circumference, fasting glucose, triglycerides, and MetS z scores in the yoga group than in the control group. The study also revealed a significant reduction in systolic blood pressure in the non-MetS subgroup after the yoga intervention. The yoga group participants attended 12 weekly 60-minute yoga training sessions. They were taught the breathing technique and 57 yogic poses including their variations, among others Mountain Pose (*Tadāsana*), Chair Pose (*Utkatāsana*), Extended Side Angle Pose (*Utthita Parsvakonāsana*), Half Moon (*Ardha Chandrāsana*), Intense Side Stretch (*Parsvottanāsana*), Revolved Side Angle Pose (*Parivrtta Parsvakonāsana*), Revolved Triangle Pose (*Parivrtta Trikonāsana*), Squat-Sitting-Down Pose (*Malāsana*), Tree Pose (*Vrkshāsana*), Warrior I, II, and III (*Virabhadrāsana I, II, III*), Wide-Stance Forward Bend (*Prasarita Padottānsana*), Boat Pose (*Navāsana*), Bound Angle Pose (*Baddha Konāsana*), Cow-Face Pose (*Gomukhāsana*), Pigeon Pose (*Raja Kapotāsana*), Camel Pose (*Ushtrāsana*), Bow (*Dhanurāsana*), Cobra (*Bhujangāsana*), Locust (*Shalabhāsana*), Seated Forward Bend (*Paschimottānāsana*), Side Plank (*Vasishthāsana*), Upward Plank (*Purvottāsana*), Supported Shoulder Stand (*Salamba Sarvangāsana*), Plow Pose (*Halāsana*), and Corpse Pose (*Śavāsana*) [38].

Littman et al. reported a significant decrease of waist circumference in overweight and obese breast cancer survivors who were assigned to a 6-month yoga intervention compared with the control group [39]. The results of a study conducted in Korea enrolling 16 postmenopausal women with more than 36% body fat assigned to a yoga group (n = 8) or a control group (n = 8) revealed a significant decrease of waist circumference,

body weight, body fat percentage, BMI, visceral fat area, total cholesterol, triglycerides, low-density lipoprotein cholesterol, diastolic blood pressure, insulin, and glucose as well as a significant increase of high-density lipoprotein after 16-week yoga exercise [40]. The limitation of the study cited above was a small sample size.

The results of previous studies suggest that hatha yoga may improve indices of risk in adults with type 2 diabetes, including glucose tolerance and insulin sensitivity [41]. Studies have found a decrease of blood glucose level [42] and an improvement of metabolic parameters [43] as a result of regular yoga training.

Bera and Rajapurkar, in a study including 40 boys aged 12 to 15 years old assigned to a yoga group (with yoga exercises 3 days per week for 45 minutes for the period of one year) or a control group (sedentary), observed a significant decrease of fat mass and a considerable improvement of bone density in the yoga group compared with the control group [44].

The results of previous studies also confirmed that yoga exercises prevented obesity [11, 14, 43, 45]. Performing more difficult and more dynamic yoga poses during 90 minutes produces energy expenditure at a level of 250 kcal, which is beneficial for the management of body weight [46].

Effects of hatha yoga on primary and secondary prevention of musculoskeletal system disorders and diseases

Hatha yoga exercises can be used in primary and secondary prevention of musculoskeletal system disorders and diseases. Regular hatha yoga practice helps extend the spine and strengthen the muscles, in particular those responsible for good body posture. It also enhances ligament and joint flexibility. Participants develop good posture habits which reduce the load on the skeleton, especially spine components; it also helps relieve back pain. Carefully selected asanas promote optimal body alignment, minimise anatomic abnormalities and contribute to body posture correction. Hence, chronic back pain (especially in the lumbar area) that threatens functional independence becomes reduced. Contrary to exercises resulting in rapid muscle contraction, hatha yoga promotes muscle/ligament strengthening and relaxation. Muscle relaxation, in turn, improves contraction efficiency. Relaxation exercises boost relaxation skills; the benefits include a reduction of muscle tone and alleviation of muscle tension symptoms.

The results of research studies have indicated a reduction of back pain as a result of regular yoga training [47, 48, 49].

Based on a study evaluating the effect of Iyengar yoga therapy on chronic low back pain, Williams et al. reported significantly greater reductions in functional disability and pain intensity in a yoga group compared with a control group. The study included 90 American adults with a mean age of 48 years with chronic low back pain (CLBP) assigned to a yoga group or a control group. The yoga group participated in 24 weeks of Iyengar yoga consisting of 90-minute classes held twice a week [47]. The findings suggest that Iyengar yoga may be an effective therapy for chronic low back pain.

Galantino et al.'s study enrolling 22 participants from the USA with CLBP between the ages of 30 and 65 years assigned to a yoga group or a control group showed a significant improvement in joint flexibility, balance, and depression scores as well as a significant decrease of disability in participants who performed hatha yoga compared with those from the control group. The yoga group met twice weekly for a 6-week period for 60-minute formal sessions. The yoga programme consisted of

breathing poses; standing, sitting, and kneeling poses; as well as forward bending, backward bending, twisting, Sun Salutation, and relaxation [48].

A study determining the efficacy of Iyengar yoga therapy with regard to pain-related outcomes in American adults with non-specific chronic low back pain with symptoms persisting for >3 months assigned to a yoga group (n = 20) or a control group (n = 22) revealed a significant reduction in self-reported disability and pain and reduced use of pain medication in the yoga group compared with the control group. The yoga group participants were required to attend one 90-minute class each week for 16 weeks. They were also encouraged to practise yoga at home for 30 min, 5 days per week [49]. The intervention consisted of 29 poses which were performed using belts, blocks, chairs, wall ropes, benches, boxes, stools, and weights [49, 50].

Kim et al., who carried out their study evaluating the effects of a virtual reality-based yoga exercise programme (Wii Fit yoga) on 30 middle-aged female chronic low back pain patients, reported a significant decrease in self-reported disability and pain including low back pain in the yoga group compared with the control group. The yoga intervention consisted of a 30-minute virtual reality-based yoga programme using Wii Fit activities such as deep breathing and yoga poses which was performed in a total of 12 sessions for 4 weeks [51].

The results of a study enrolling 75 sedentary adults (96% of whom were women), with a mean age of 52 years, with rheumatoid arthritis (RA) or knee osteoarthritis assigned to a yoga group or a control group indicated an improvement of physical and psychological health, vitality, and general health and a decrease of pain in the yoga group compared with the control group. The yoga intervention consisted of 60-minute classes held twice a week for 8 weeks and one weekly home practice [52]. Therefore, yoga exercises may be an adequate form of physical activity for sedentary adults with arthritis.

Based on the results of a study evaluating the efficacy of integrating hatha yoga therapy with therapeutic exercises for osteoarthritis (OA) of the knee joints, Ebnezar et al. reported a significant improvement in terms of walking pain, disability, the range of knee flexion, as well as joint tenderness, swelling, and crepitus in the yoga group compared to the control group. The study included 235 participants from India with OA, between the ages of 35 and 80 years, who were assigned to receive hatha yoga therapy or therapeutic exercises after 20 minutes of physiotherapy (for both groups). The integrated yoga therapy consisted of 40-minute classes held daily for 2 weeks and included the following: standing poses, e.g. *Tadāsana*, *Ardha kati chakrāsana*, *Ardha chakrāsana*, *Prasarita padahastāsana*; lying poses, e.g. *Bhujangāsana*, *Shalabāsana*, and *Viparita karani*; exercises improving the range of motion in the hip, knee, and ankle joints; as well as breathing exercises and relaxation. The therapeutic exercises lasted as long as the yoga exercises [53].

The results of a study conducted in Turkey revealed the beneficial effects of regular yoga exercises in 9 women between the ages of 65 and 75 years with osteoporosis. Its authors observed a decrease of pain and an improvement of functional fitness and self-reported quality of life (QoL) [54]. The limitation of that study was a small sample size and the lack of control group.

Hatha yoga training also helps to develop correct posture. The results of a study conducted in Poland, enrolling 25 persons over 55 years old who attended 90-minute weekly yoga classes for 8 months revealed, based on a Rippstein pluriometer assessment, a significant decrease of thoracic kyphosis and lumbar lordosis and a higher percentage of normal angles of anterior-posterior curvatures after the yoga intervention compared to

baseline [55]. The limitation of this study was the lack of a control group. The beneficial effects of yoga exercises on posture were confirmed by a study involving 118 American adults with the angle of thoracic kyphosis above 40. The authors reported a decrease of thoracic kyphosis after the yoga intervention which consisted of 60-minute yoga classes held 3 times per week for 24 weeks [56].

The findings of the studies cited above suggest that hatha yoga may be an important therapy in treating locomotor diseases and disorders; therefore, yoga exercises can be applied in individuals suffering from a variety of diseases who are unable to perform other forms of physical activity. However, the expertise of a person running yoga classes tailored for persons with various diseases is essential.

Conclusion

Yoga exercises produce several benefits which may depend on age, the type of yoga intervention including the style of yoga, as well as the duration, frequency, and intensity of yoga exercises. In the studies cited above, the average time of yoga interventions was 3 months (from 2 weeks to one year), the frequency being 2-6 times per week and the duration of a single class being 40-90 minutes. Yoga classes were supplemented with breathing exercises, meditation, and relaxation.

The effects of regular hatha yoga practice may also depend on the level of physical fitness. People who have been sedentary might experience the benefits of hatha yoga exercises earlier than those who have previously been physically active.

Studies on the effects of hatha yoga conducted so far have been carried out in groups of different ages and with diverse health conditions, and the interventions have varied in terms of their duration as well as the volume and frequency of yoga sessions. Nevertheless, the results obtained have indicated the explicit benefits of hatha yoga with respect to primary and secondary prevention of civilisation diseases, especially cardiovascular and respiratory system diseases, disorders and diseases of the musculoskeletal system, as well as type 2 diabetes mellitus.

One more aspect of hatha yoga worth emphasising is that it can be practised almost everywhere – no special facilities or expensive equipment are required. Therefore, hatha yoga can become a habitual physical activity and hence an important lifestyle component.

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