

Positive Effects of Yoga on Physical and Respiratory Functions in Healthy Inactive Middle-Aged People

Abstract

Context: Yoga improves physical and respiratory functions in healthy inactive middle-aged people.

Aim: This study aimed to assess the effects of 8 weeks of *asana* and *asana* with *pranayama* lessons in order to clarify the influence of two different combinations of yoga practice on physical and respiratory functions in healthy inactive middle-aged people. **Subjects and Methods:** A total of 28 participants (mean age: 52.7 years) were divided into a yoga *asana* (YA) group and YA with *pranayama* (YAP) group. Participants attended a 70-min session once a week for 8 weeks. The YA group practiced basic *asana* without specific breathing instructions, while the YAP group practiced basic *asana* with specific breathing instructions (*pranayama*). Respiratory function was measured with an autspirometer. Physical function assessments included the 30-s chair stand test and upper and lower extremity flexibility. All tests were assessed at baseline and after 8 weeks of intervention.

Statistical Analysis: Changes in scores were analyzed with the paired *t*-test for each group. Pre-post results were compared for all the measured values. $P < 0.05$ was considered statistically significant.

Results: Both groups showed significant improvements in physical and overall respiratory functions after the 8-week yoga intervention. However, the maximal inspiratory pressure and lower extremity flexibility improved only in the YAP group. **Conclusions:** The 8-week yoga intervention for healthy inactive middle-aged people improved the overall respiratory and physical functions, and the inclusion of *pranayama* had the added benefit of improving inspiratory muscle strength and global body flexibility.

Keywords: *Asana*, *asana* with *pranayama*, *diaphragm stretching*, *flexibility*, *healthy inactive middle-aged people*, *physical function*, Pi_{max} , *respiratory function*, *respiratory muscle strength*, *trunk circumference*

Introduction

Yoga is an ancient Indian practice for bodily, mental, and spiritual communion. It was introduced by Swami Vivekananda in the United States in 1893, and from then on, yoga practice shifted toward the aims of attaining health, beauty, and body therapy, thus initiating the modern yoga age.^[1] As modern yoga increased in popularity, its use shifted to mind and body practices. Standard yoga usually combines *asana* (posture), *pranayama* (breathing), and meditation, with 89.9% of yogis using *pranayama* and about half (54.9%) using meditation combined with *asana*.^[2] *Asana* involves whole body movement, which consists of multi-joint stretching and strength-building motions of varying degrees of difficulty and other fitness-based exercises.^[3] *Pranayama* requires voluntary control of respiratory muscles and

involves different breathing speeds, shortening and elongation of breathing, and breath holding via three phases: *Puraka* (inhalation), *Kumbhaka* (retention), and *Rechaka* (exhalation).^[2]

According to McCall,^[4] yoga research has been conducted in the context of various health conditions, such as stress/anxiety, pain, depression, cardiovascular disease, blood pressure/hypertension, respiratory conditions, cancer, and diabetes. Moreover, the role of yoga has slowly expanded from complementary and alternative medicine to performance enhancement.^[5] Yoga is used to improve physical function (e.g., flexibility) and body coordination through *asana*, which has similar components such as stretching and strengthening exercises.^[6,7] Given its familiarity and similarities with traditional stretching movements, *asana* is used more often in general exercise

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Table 1: Basic Asana for both groups

Mountain Pose (Tadasana)	Chair pose (Utkatasana)	Standing forward bend (Uttanasana)	Eagle (Garudana)
Warrior I (Virabhadrasana I)	Warrior II (Virabhadrasana II)	Tree pose (Vrksasana)	Upward salute (Urdhva Hastasana)
Standing half forward bend (Ardha Uttanasana)	Spread leg forward fold (Prasarita Padottanasana A)	Leg lock pose (Supta Pawanmuktasana)	Crescent Pose (Parsva Urdhva Hastasana)
Staff pose (Virasana)	High lunge pose (Ashta Chandrasana)	Rabbit Pose (Sasangasana)	Extended child's pose (Utthita Balasana)
Hero Pose (Virasana)	Child's pose (Balasana)	Side sitting with spine twist (Bharadvajasana)	Corpus pose (Savasana)
Cat and cow (Bidalasana)	Plank pose (Phalakasana)	Seated forward bend (Pashimothanasana)	Supine knees to chest (Apanasana)
Downdog pose (Adho Mukha Svanasana)	Upward facing dog (Urdhva Mukha Svanasana)	Rocking and rolling (Jhulana Lurhakanasana)	Bridge pose (Setu Bandha Sarvangasana)
Supine twist (Supta Parivartanasana)	Plow pose (Halasana)	Prayer pose (Pranamasana)	Seated head to knee (Janu Sirasana)

Table 2: Description of asana and pranayama practice for each group

	YA (n=14)	YAP (n=14)
Asana	Basic Asana [Table 1]	Basic Asana [Table 1]
Pranayama	No Pranayama	1:1,1:2 breathing pattern
	No specific breathing exercise	Deeper and slower breathing
		Kumbhaka (Breath holding)
		Kapalabati [Figure 1]
		Uddiyana Bandha [Figure 2]
		Voice sound awareness
		Abdominal expansion
		Emphasis on lower rib movement awareness

regimens, but *pranayama*, which is typically used in standard yoga practice, is not widely used in fitness and sports. We hypothesized that, by adding *pranayama* to *asana*, respiratory function would improve and lead to enhanced physical function. However, no such studies have been conducted to date. Accordingly, this study aimed to assess the influence of *asana* and *pranayama* on physical function by targeting healthy inactive middle-aged people.

Subjects and Methods

Healthy nonsmoking volunteers were recruited through flyers, social networks, and family members and friends of current customers at Kyoto MBM Labo (Kyoto, Japan). Inclusion criteria were as follows: (1) age between 40 and 60 years and (2) able to take yoga lessons once a week for 8 weeks. Exclusion criteria were as follows: (1) previous extended period of practicing yoga, (2) a history of surgery of lower extremities, and (3) a history of being diagnosed with or treated for cardiovascular and respiratory disorders. A total of 28 volunteers (2 males and 26 females; mean age: 52.7 years) formed the final study population. This study was performed in accordance with the Declaration of Helsinki and was approved by

the Ethics Committee of the School of Comprehensive Rehabilitation, Osaka Prefecture University. We explained the objectives and significance of the study to participants and obtained oral and written informed consent prior to enrollment.

Participants were listed alphabetically and assigned numbers. Participants with odd numbers were allocated to the yoga *asana* (YA) group (mean age: 51.9 years \pm 7.2 years; $n = 14$, 1 male and 13 females), and participants with even numbers were allocated to the YA with *pranayama* (YAP) group (mean age: 53.4 years \pm 7 years; $n = 14$, 1 male and 13 females). Participants were further divided into two different time groups each ($n = 7$) to accommodate the studio size. All participants attended a 70-min session once a week for 8 weeks and were also recommended to complete home exercises at least twice a week by following instructions in the provided DVD during the study period. They were told to continue with their normal lifestyle during the study. Lessons were taught by an instructor who studied and trained in Iyengar Hatha Yoga for 20 years in the United States and Japan with professional credentials as an athletic trainer. The instructor is recognized by the American Medical Association as a health-care professional in the United States. The YA group only practiced *asana*, which was broken down to simple movements in the first session and increased in complexity, difficulty, and holding time as lessons progressed [Table 1]. In contrast, contents for the YAP group consisted of basic *asana* with a similar sequence to the YA group, but with additional specific breathing instructions (1:1 and 1:2 breathing pattern, deeper and slower breathing, and breath holding, referred to as *Kumbhaka*). Breathing practice was conducted using participants' own voice and sounds to increase the awareness of their own breath length, strength, and speed [Table 2].

In addition to breathing awareness instructions, *pranayama* practice (either *Kapalabhati* or preparation of *Uddiyana Bandha*) was included in the YAP lesson. *Kapalabhati* is a

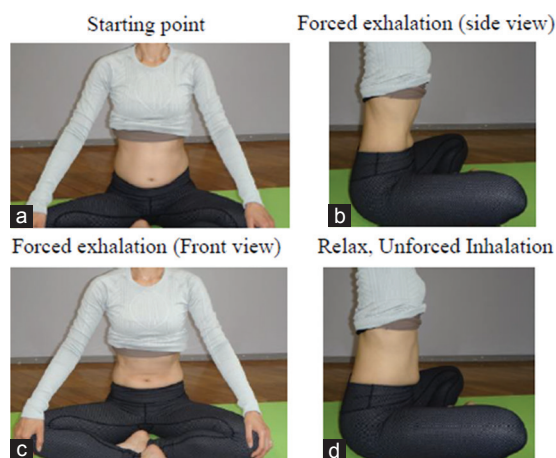


Figure 1: Kapalabhati (seated) while keeping the spine straight with knees crossed, with hands on knees and abdomen relaxed, exhale completely (a). Inhale completely from nose to expand the abdomen, and then quickly press the abdomen in to force air out of the lungs (b and c). Then, relax the abdomen to inhale (d). Start with one breath per second and repeat 8–10 times

cleansing technique [Figure 1]^[8,9] that aids in the clearing of air passages and reduces tension and blockage in the chest. The technique requires quick rapid pumping of breath muscles, especially the diaphragm, in order to achieve forced exhalation from the lungs, followed by rapid but passive inhalation. In this study, *Uddiyana Bandha*, an abdominal contraction method with external breath retention,^[9] was used to facilitate abdominal muscle contraction [Figure 2].

Home exercise DVDs consisted of four exercises of approximately 7 min in total for each group. Home exercises for the YA group included four basic *asana* exercises, while those for the YAP group included two basic *asanas* and two conscious breathing exercises. Each participant underwent pre- and post-measurements a week before the first lesson and a week after the last lesson.

Inbody 430 (InBody Japan Inc, Tokyo, Japan) was used to measure weight, muscle mass, body fat mass, and body mass index for basic body composition. For muscle endurance and balance, the 30-s chair stand (30CS) test was performed for three trials and the average value was taken. Resting heart rate was taken for 30 s before the test. Participants stood in front of a chair and were instructed to squat down to sit and then to stand back up as quickly as possible for as many times over the course of 30 s. Arms were folded across the chest during the test. There was a 1-min rest period between trials. After three trials of 30CS, heart rate was taken again for 30 s.^[10]

To test flexibility, the back scratch (BS) test for upper extremities and the chair sit and reach (CSR) test for lower extremities were used. For the BS test, participants were asked to bring one arm over the shoulder and the other arm from below behind their back to assess the distance between two hands.^[10] The distance between the two closest fingers of the two



Figure 2: Uddiyana Bandha (preparation) after complete exhalation in the lightly bent knee position, place hands on knees to press down (a). Hold breath and, without inhalation, relax abdomen, making the abdomen bulged (b). Repeat a few times. While holding breath after emptying the lungs and relaxing the abdomen, make a false inhalation, keeping the glottis closed and expanding the chest, bringing the abdomen in and upward. Hold the position for a comfortable length of time, i.e. about 1–2 s in this study (c). Slowly release the abdomen and inhale

hands was measured. The average of two trials for each direction, i.e., the right arm from the top and the left arm from the top, was used.

For the CSR test, participants sat on the edge of the chair. One foot remained flat on the floor, while the other leg was extended forward with the knee straight, heel on the floor, and ankle dorsiflexed at 90°. Participants placed two hands together with middle fingers aligned, and after inhalation, they bent forward smoothly with exhalation at the hip toward the toes with their back straight and head up. While participants held the reach for 2 s with knees straight, the distance between the tip of the middle finger and the closest toes was measured. When the fingertips just touched the toes, the score was 0. If the fingertips did not reach the toes, a negative score was assigned. If the fingertips went passed the toes, then a positive score was assigned.^[10] Two trials were performed for both sides, and the average score was used. For both the BS and CSR tests, the average score of two trials for each side was determined separately, followed by addition of the average scores from the left and right sides. This score was used to reflect upper and lower body extremity flexibility.

Respiratory function and respiratory muscle strength were measured using an aeromonitor (AE-300S, Minato Medical Science, Osaka, Japan) and autspirometer (AS-507, Minato Medical Science, Osaka, Japan) in the seated position. The testing was administered by a licensed physical therapist specialized in the respiratory rehabilitation field. Participants were first instructed to exhale maximally and then inhale maximally before forcefully exhaling into the autspirometer. To obtain accurate results, participants were instructed to pinch the nose with fingers and purse their lips to completely seal the mouthpiece.

Means and standard deviations were calculated for all measurements for each group. Statistical analysis was performed with SPSS version 25.0 (IBM Corporation, New York, USA), and baseline data were analyzed using the unpaired *t*-test. Using all the available data from the

Table 3: Participants' baseline demographic data and outcome in all measures

Parameters	YA (n=14)	YAP (n=14)	P
Age	51.9±7.2	53.4±6.8	0.593
Height	159.0±5.3	157.9±6.7	0.648
Weight	55.4±7.4	53.3±6.4	0.423
Skeletal muscle mass	21.6±3.6	21.2±2.9	0.769
BMI	21.9±2.5	21.4±2.9	0.629
30CS, n	18.58±4.0	19.30±4.1	0.650
HR after 30CS	45.0±4.56	44.6±4.9	0.812
BS	2.7±13.2	-12.4±24.4	0.052
CSR	13.0±23.6	13.5±15.1	0.947
VC	3.0±0.13	2.8±0.12	0.324
FVC	2.9±0.14	2.7±0.11	0.347
FEV	2.3±0.10	2.3±0.10	0.628
PEFR	5.5±0.27	5.7±0.33	0.655
Pe _{max}	59.2±2.7	67.2±5.7	0.220
Pe _{peak}	64.5±2.9	73.0±6.1	0.222
Pi _{max}	49.8±4.6	50.3±3.6	0.939
Pi _{peak}	53.2±4.9	54.8±4.1	0.798

YA=Yoga *asana*, YAP=Yoga *asana* with *pranayama*, BMI=Body mass index, 30CS=30-s chair stand, BS=Back scratch, CSR=Chair sit and reach, VC=Vital capacity, FVC=Forced vital capacity, FEV=Forced expiratory volume, PEFR=Peak expiratory flow rate, Pe_{max}=Maximum expiratory pressure, Pe_{peak}=Peak expiratory pressure, Pi_{max}=Maximum inspiratory pressure, Pi_{peak}=Peak inspiratory pressure, HR=Heart rate

Table 4: 30-s chair stand test: number of chair stands completed

Group	Test					
	Number of 30CS completed			HR after 30CS		
	Pre	Post	P	Pre	Post	P
YA	18.6±4.0	22.9±5.3	0.001	45.0±4.6	52.6±6.9	0.001
YAP	19.3±4.1	22.2±5.7	0.010	44.6±4.9	50.6±7.0	0.009

30CS=30-s chair stand, HR=Heart rate, YA=Yoga *asana*, YAP=Yoga *asana* with *pranayama*

28 participants, changes in scores were analyzed with the paired *t*-test for each group. Pre-post results were compared for all the measured values. $P < 0.05$ was considered statistically significant.

Results

Baseline characteristics of both groups were similar, with no significant differences observed between groups in any of the primary variables ($P > 0.05$) [Table 3]. All the 28 participants attended all the eight lessons. For the 30CS test, the number of chair stands and heart rate after the test significantly increased in both groups [Table 4]. Both groups showed similar improvements in upper extremity flexibility with the BS test [Table 5]. On the other hand, significant improvements in lower extremity flexibility with the CSR test were observed only in the YAP group [Table 5].

For respiratory function, overall pulmonary function, which included vital capacity (VC), forced VC, forced expiratory volume, and peak expiratory flow rate, significantly improved in both groups. For respiratory muscle strength, maximum inspiratory pressure (Pi_{max}) significantly improved only in the YAP group and maximum expiratory pressure (Pe_{max}) did not improve in either group. Other respiratory parameters, including peak expiratory pressure (Pe_{peak}) and peak inspiratory pressure (Pi_{peak}), did not significantly improve in either group [Table 6].

Discussion

The important findings of this study were as follows: (1) an 8-week yoga intervention targeting healthy inactive middle-aged people significantly improved physical and overall respiratory functions with or without *pranayama* and (2) only the group that added *pranayama* showed improvements in maximum inspiratory pressure and lower extremity flexibility.

Consistent with several studies that have reported positive effects of *asanas* on physical function,^[11-13] healthy middle-aged participants in our study showed improved number of chair stands completed in 30 s and heart rate after the 30CS test. The completion of repetitive chair stand movements requires flexibility, as well as muscular strength and endurance of lower extremities. By practicing *asanas*, moving through different angles of joint movements contributes to the strengthening of muscles and flexibility.^[14] In addition, diaphragmatic stretching by yoga reportedly improves thoracic and abdominal cavity expansion, lumbar flexibility,^[15-17] body stability,^[18] balance,^[18] and expiratory muscle activity.^[19] Diaphragmatic breathing is facilitated by yoga, thereby influencing movement stability and overall respiratory function such that participants were able to withstand a higher activity load in the short term. In this study, merely practicing *asana* once a week was sufficient to alter the physical and respiratory status of healthy middle-aged people who had no exercise habits. Generally speaking, such people have reduced body mobility and flexibility, which can be reversed by physical exercise. This could explain why practicing even only *asanas* improved both respiratory and physical functions.

Although practicing *asanas* with *pranayama* was as effective as practicing *asanas* alone in improving physical function, maximum inspiratory pressure improved only in the YAP group. Respiratory muscles, especially inspiratory muscle strength, play a significant role in muscle endurance.^[20] Previous studies have suggested the effects of inspiratory muscle pressure on high-intensity exercises^[20-22] and its effect on the change of perception of respiratory exertion during exercise.^[20,23] Improving respiratory muscle strength delays muscle fatigue and improves blood flow to peripheral muscles, thereby decreasing the sense of breathlessness.^[24,25] Thus, practicing *pranayama* over an extended period could potentially enhance respiratory circulation and contribute

Table 5: Upper and lower extremity flexibility

Group	Test					
	BS test			CSR test		
	Pre	Post	P	Pre	Post	P
YA	2.7±13.2	6.9±10.8	0.008	13.0±23.6	15.3±21.9	0.189
YAP	-12.4±24.4	-6.2±19.3	0.015	13.5±15.1	21.6±13.9	0.011

BS=Back scratch, CSR=Chair sit and reach, YA=Yoga *asana*, YAP=Yoga *asana* with *pranayama*

Table 6: Respiratory measures for both groups

Parameter	Group					
	YA group			YAP group		
	Pre	Post	P	Pre	Post	P
VC	3.0±0.5	3.2±0.6	0.001	2.8±0.5	3.0±0.5	0.001
FVC	2.9±0.5	3.1±0.6	0.001	2.7±0.4	2.9±0.5	0.000
FEV	2.3±0.4	2.4±0.4	0.001	2.3±0.4	2.3±0.4	0.017
PEFR	5.5±1.0	6.1±1.4	0.015	5.7±1.2	6.5±1.4	0.010
Pe _{max}	59.2±10.3	63.9±9.7	0.116	67.2±21.3	67.1±20.1	0.983
Pe _{peak}	64.5±10.9	68.4±10.0	0.171	73.0±23.0	73.1±23.5	0.977
Pi _{max}	49.8±17.3	53.5±20.9	0.375	50.3±13.6	56.4±16.2	0.048
Pi _{peak}	53.2±18.2	57.1±22.2	0.346	54.8±15.3	60.2±15.9	0.104

YA=Yoga *asana*, YAP=Yoga *asana* with *pranayama*, VC=Vital capacity, FVC=Forced vital capacity, FEV=Forced expiratory volume, PEFR=Peak expiratory flow rate, Pe_{max}=Maximum expiratory pressure, Pe_{peak}=Peak expiratory pressure, Pi_{max}=Maximum inspiratory pressure, Pi_{peak}=Peak inspiratory pressure

to adequate motor control,^[26] as well as bring about further positive changes in physical function.

This study has several limitations. First, the study period was only 8 weeks, with yoga lessons being conducted only once a week. A previous literature review concluded that a minimum of 10 weeks, with *pranayama* practiced at least twice a week, was needed to observe changes in pulmonary function.^[16] Our participants were all new to yoga, including *pranayama*. The technique of *pranayama* and being conscious of one's own breathing take time to learn. Thus, the 8-week interventional period may not have been sufficient to examine the effects of *pranayama*. Nonetheless, improvements in various respiratory parameters were observed in both groups. A longer study period with more frequent lessons may have altered the outcome of this study. Second, the present study targeted inactive middle-aged people, so our findings may not apply to younger and more active people. Previous studies have reported that changes in respiratory function take longer in younger people than older people.^[19,27] Finally, we selected *Kapalabhati pranayama* in this study. Given that a different pace of *pranayama* might have different effects on physical function,^[28] studies involving a different kind of *pranayama* may be informative.

Conclusions

An 8-week yoga intervention targeting healthy inactive middle-aged people improved overall respiratory and physical functions, and the inclusion of *pranayama* had the added benefit of improving inspiratory muscle strength and global body flexibility.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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