Effects of High-Intensity Hatha Yoga on Cardiovascular Fitness, Adipocytokines, and Apolipoproteins in Healthy Students: A Randomized Controlled Study

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Abstract

Background: Yoga exercises are often used as a form of body and mind exercise to increase performance. However, knowledge about the physiologic effects of performing high-intensity Hatha yoga exercises over a longer time period remains limited.

Objective: To investigate the effects of high-intensity yoga (HIY) on cardiovascular fitness (maximal oxygen consumption, estimated from the Cooper running test), ratings of perceived exertion (RPE), heart rate (HR), heart rate recovery (HRR), blood pressure (BP), adipocytokines, apolipoprotein A1 (ApoA1), apolipoprotein B (ApoB), and glycosylated hemoglobin (HbA1c) in healthy students.

Methods: The 44 participants (38 women and 6 men; median age, 25 years [range, 20–39 years]) were randomly assigned to an HIY or a control group. The HIY program was held for 6 weeks (60 minutes once a week). Cardiovascular fitness, RPE, HR, HRR, BP, adipocytokines, HbA1c, ApoA1, and ApoB were measured at baseline and after 6 weeks in both groups.

Results: HIY had no significant effects on cardiovascular fitness (mean dose: 390 minutes [range, 210–800 minutes]), HR, HRR, BP, or any of the blood parameters. However, ApoA1 (1.47 ± 0.17 to 1.55 ± 0.16 g/L; $p = 0.03$) and adiponectin (8.32 ± 3.32 to 9.68 ± 3.83 mg/L; $p = 0.003$) levels increased significantly in the HIY group after 6 weeks.

Conclusions: Six weeks of HIY did not significantly improve cardiovascular fitness. However, ApoA1 and adiponectin levels increased significantly in the HIY group. This finding suggests that HIY may have positive effects on blood lipids and an anti-inflammatory effect.

Introduction

PHYSICAL ACTIVITY IS FREQUENTLY PRESCRIBED by medical professionals in countries such as Sweden and New Zealand to tackle a range of diseases. To avoid the trend of increasing inactivity,¹ Hatha yoga (HY) has been suggested as an additional form of physical activity.^{2,3} HY is also considered a body awareness and body–mind (mindfulness) activity⁴ and is the basis of most yoga styles. HY originates from India, is mainly based on the ancient text *Hatha Yoga Pradipika* (“light on the forceful yoga”), and aims to strengthen the body and mind and prepare for self-realization.⁵ HY is used as complementary treatment in traditional Western medicine⁶ and as a form of exercise to reduce stress and restore autonomic nervous system imbalance.^{7–9}

HY is a form of multifaceted neuromotor exercise training¹⁰ that uses psychophysical exercises, such as the body (*asana*), breathing (*pranayama*), locks (*bandha*), seals (*mudras*), and mind concentration (*dharana*).^{5,11} Many HY movements, such as the sun salutations (SS), are among the most common sequences in HY programs.¹²

Systematic reviews of HY research have shown significant and decreasing effects on blood pressure (BP), blood lipids, and metabolic measures, such as glycosylated hemoglobin (HbA1c).^{3,13} Additionally, HY studies have shown effects, including increased oxygen consumption and uptake;^{14,15} increased heart rate variability;^{8,12,16,17} decreased cortisol levels; and decreasing levels of fatigue, stress, and pain.²

Both physical exercise and HY increase levels of the anti-inflammatory protein adiponectin and decrease levels of the

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proinflammatory marker leptin.^{18–20} Importantly, these markers have been associated with metabolic abnormalities and cardiovascular risk. A recent meta-analysis showed positive effects after HY on blood lipids, including increases in high-density lipoprotein (HDL) cholesterol and reductions in low-density lipoprotein cholesterol,³ but research on the effects of HY on apolipoproteins is lacking.

Taken together, existing research investigating the effects of HY covers many different body and breathing exercises, but little is known about the specific effects of high-intensity yoga exercises (HIY), which mainly consist of vigorous SS sequences performed at rapid speed with inversions at the end. To fill this gap, the present study aimed at investigating the effects of HIY on cardiovascular fitness, heart rate recovery (HRR), BP, apolipoproteins, and adipocytokines. The study hypothesis was that healthy individuals participating in a 6-week HIY program, mainly including SS, would show increased cardiovascular fitness in terms of estimated maximal oxygen consumption (VO_{2max}). In addition, improvements in ratings of perceived exertion (RPE), heart rate recovery (HRR), adipocytokines, and apolipoproteins were expected.

Materials and Methods

Participants

Participants ($n=260$, with 40 men) volunteered to participate and were recruited from university bulletin boards and websites (Fig. 1). Of these 206, were excluded and 54 were enrolled; 44 participants completed the study. The analyses were performed as per protocol. The study was presented via a question as to whether participation in a 6-week high-intensity hatha yoga was of interest. Participants responded by email and received detailed written and oral information about the study; they were also asked to return a form that elicited information on the inclusion/exclusion criteria regarding physical fitness, injuries, and chronic diseases. Those who fulfilled the inclusion criteria and were healthy (based on normal-range blood pressure levels, blood samples, HbA1c, apolipoprotein A1 [ApoA1], apolipoprotein B [ApoB], adiponectin, leptin, and subjective response) were randomly assigned to an HIY group (with home

training) or to a control group (no treatment, no yoga or home exercises, and no change in exercise behavior other than was allowed in the inclusion criteria).

Inclusion criteria involved being a healthy student aged 20–40 years performing physical exercise no more than 2 hours per week at a medium intensity or 1 hour a week at a high intensity. Exclusion criteria included chronic disease, injuries, recent operations, or taking medication that can affect performance. Participants who had headaches in the morning were also excluded. Medication for asthma and allergies was not an exclusion criterion and was used by some participants.

Randomization was performed by a person not involved in the research project. Blank papers were scattered on a table with participants' identification codes (face down). To prevent unequal group sizes, every other identification code was placed in the HIY or control group.

Participants were given information on the testing procedure and how to use the RPE-Borg scale. Suggestions on how to improve their technique and achieve their best and true performance during the Cooper test were also included. On the measurement day (performed at a 400-meter sport and track field arena), participants were instructed not to eat, drink coffee, or smoke 2–3 hours before the test and not to exercise. A total of five test leaders were involved, who measured the same participant during the intervention. The HIY program was carried out during the spring and late summer/fall of 2013. The present study used a randomized controlled design and was approved by the Regional Ethical Review Board in Stockholm, Sweden (reference number: 2011/248-31/1). All participants signed informed consent forms.

The study conformed to the Declaration of Helsinki concerning human rights and informed consent and followed correct procedures concerning treatment of humans.

Measures

Cardiorespiratory fitness (estimated VO_{2max}) was measured by using the Cooper walk/run test. Compared to the treadmill test, this test has a correlation and reliability of 0.9–0.92 with true VO_{2max} measurements.^{21,22} This distance- and time-dependent tool is based on the original

FIG. 1. Study flowchart.

Cooper calculation ($[(d_{12} - 505)/45]$, where d_{12} is the distance covered in 12 minutes). Before the measurement, participants were familiarized with the test. During the test, test leaders gave similar verbal encouragement and registered the time, RPE, and HRR for all participants. After the HIY program, the Cooper test and measurements were repeated. The test leaders were blinded to the group allocation of the participants.

The difference between maximal heart rate (HR) at the end of the Cooper test and 1 minute after was registered and called HRR. HR was measured with a Polar heart rate monitor (RCX5, Polar Electro Oy, Kempele, Finland). The Borg RPE 20 scale²³ was used to provide RPE to ensure maximal performance of the Cooper test and during the HIY exercises. Fatigue was measured for breathing (central) and for the legs (peripheral). All participants were asked to note their physical activity levels in a weekly activity diary.

BP was measured by using a Welch Allyn Durashock 2-hose nonautomated aneroid sphygmomanometer (AJM-8001-001, 12 × 35 cm; AJ Medical, Lidingö, Sweden), with an inflatable cuff and a screw valve using a stethoscope (Panasonic Combination Stethoscope, Matsuo Meditech Corp., Tokyo, Japan) for auscultation. BP, MEAN, MID and pulse pressure BP were computed by using readings obtained from both arms. Machine error/accuracy of AJM-8001-001 was ± 3 mmHg (2%).

All blood samples were collected via a catheter and analyzed immediately. Adiponectin and leptin samples were frozen and analyzed after approximately 6 months. ApoA1/ApoB samples were analyzed with DXC/LX (Beckman-Coulter) with a measurement interval 0.21–3.2 g/L and 8% measurement uncertainty. Adiponectin was determined by using radioimmunoassay (EMD Millipore, [St. Charles, MO] by Electra-Box [Farsta, Sweden]); the measurement interval was 0.8–200 μ g/L, with 10% measurement uncertainty. Leptin was determined by using a radioimmunoassay (Millipore/Linco), with a measurement interval of 0.78–100 μ g/L and 10% measurement uncertainty. HbA1c was determined by using Variant II Turbo (Bio-Rad, Hercules, CA), with a measurement interval of 15–184 mmol/mol and 2.5% measurement uncertainty.

Intervention with HIY

Participants (who were naive to yoga) performed a standardized 60-minute HIY program once weekly for 6 weeks, with additional home training. The control group did not receive any intervention. See Appendix A for a description of the HIY program.

Statistical analysis

Sample size was calculated to show a difference in VO_{2max} . An improvement of 2.2 mL/kg per min (6%) with a power of 0.8 and a two-sided α value of 0.05 required at least 20 participants with a standard deviation of 2.5 in the HIY and a standard deviation of 1 in the control group.

Depending on skewness, Wilcoxon signed-rank tests or t tests were computed to analyze differences at baseline and follow-up within and between groups. Wilcoxon signed-rank tests were used to analyze differences in Borg RPE measurements. Confidence intervals (CIs) were included where applicable. Statistically significant skewness emerged for the following parameters: Cooper value, age, height, body-mass index, systolic BP, leptin, and adiponectin/leptin ratio. Depending on skewness, Spearman (rs) correlation coefficients or Pearson (rp) coefficients were computed. The significance level was set to $p < 0.05$. Analyses were performed by using Stata software (Stata Corp., College Station, TX)/Version 11.

Results

There were no significant group differences at baseline in any of the parameters (Tables 1 and 2). Both ApoA1 (change of 0.08 g/L; 95% CI, 0.0–0.1 g/L) and adiponectin (change of 1.35 mg/L; 95% CI, 0.5–2.2 mg/L) increased significantly in the HIY group; no other significant effect was seen between the HIY and the control groups. There were no significant HbA1c changes in the control group, but in the HIY group HbA1c was lowered and nearly significantly (Table 2).

Borg scale (ratings of perceived exertion) RPE

During the HIY program, the median central RPE was 14 (range, 9–17) after 25 minutes and 15 (range, 10–18) after 45 minutes. The median peripheral RPE was 13 (range, 9–16)

TABLE 1. ANTHROPOMETRIC MEASURES FOR HIGH-INTENSITY HATHA YOGA AND CONTROL GROUPS AT BASELINE AND AFTER 6 WEEKS

Variable	HIY group (n = 21)	HIY group after 6 wk	p-Value: HIY	Control group (n = 23)	Control group after 6 wk	p-Value: control	p-Value: HIY vs. control
Women/men (n/n)	18/3			20/3			
Age (y)	25 (20–37)			25 (20–39)			
Height (m)	1.66 (1.59–1.93)			1.68 (1.53–1.91)			
Weight (kg)	65.4 $\pm$ 12.8	65.5 $\pm$ 12.7	0.76	62.8 $\pm$ 8.5	62.4 $\pm$ 8.6	0.38	0.38
Body-mass index (kg/m ²)	22.2 (16.9–34.8)	22.0 (16.9–34.8)	0.74	21.9 (18.6–25.3)	22.2 (18.3–25.2)	0.31	0.34
Waist-to-hip ratio	0.76 $\pm$ 0.06	0.75 $\pm$ 0.07	0.44	0.75 $\pm$ 0.05	0.75 $\pm$ 0.04	0.75	0.63
Waist circumference (cm)	75.52 $\pm$ 9.34	75.0 $\pm$ 9.72	0.26	73.72 $\pm$ 6.42	74.22 $\pm$ 5.53	0.41	0.13

Medians and ranges are shown for skewed measures while means and standard deviation are presented for normally distributed measures. Wilcoxon signed-rank tests or t -tests were computed to analyze differences at baseline and follow-up within and between groups (depending on skewness).

HIY, high-intensity yoga.

TABLE 2. CARDIOVASCULAR FITNESS (MAXIMAL OXYGEN CONSUMPTION, COOPER TEST), BLOOD PRESSURE, APOLIPOPROTEINS, GLYCOSYLATED HEMOGLOBIN, AND ADIPOCYTOKINES AT BASELINE AND AFTER 6 WEEKS FOR THE HIGH-INTENSITY YOGA AND CONTROL GROUPS

Variable	HIY group (n=21)			Control group (n=23)			p-Value: HIY vs. control
	Baseline	6 wk	p-Value	Baseline	6 wk	p-Value	
Cooper test (maximal oxygen consumption) (mL/kg per min)	37.3±7.9	37.5±7.9	0.78	38.5±7.7	38.3±6.6	0.79	0.87
Central RPE	17 (15–20)	17 (14–19)	0.20	17 (12–19)	17 (7–19)	0.83	0.37
Peripheral RPE	15 (8–18)	15 (11–17)	0.45	14 (9–16)	14 (8–18)	0.15	0.14
HRR	39.9±13.1	36.8±15.5	0.39	40.8±11.8	39.2±12.7	0.56	0.82
Rest HR (beats/min)	81.6±18.9	79.6±8.2	0.47	81.3±13.7	78.5±14.5	0.32	0.97
Systolic BP (mmHg)	118.7±5.8	118.3±5.2	0.80	118.9±8.9	117.3±6.3	0.25	0.54
Diastolic BP (mmHg)	76.8±5.9	77.2±7.4	0.73	74.8±5.8	77.8±6.8	0.01 ^a	0.15
MID BP (mmHg)	97.7±4.7	97.8±5.8	0.66	96.8±6.5	97.5±5.9	0.45	0.45
Plasma ApoA1 (g/L)	1.47±0.17	1.55±0.16	0.03 ^a	1.59±0.22 ^c	1.62±0.22 ^c	0.37	0.28
Plasma ApoB (g/L)	0.80±0.14	0.81±0.15	0.65	0.78±0.16 ^c	0.81±0.18 ^c	0.12	0.46
ApoB/ApoA1	0.55±0.12	0.53±0.13	0.28	0.50±0.12	0.51±0.14	0.48	0.20
Blood glycosylated hemoglobin HbA1C (mmol/mol)	32.2±2.9	31.3±3.8	0.07	31.8±2.7	31.8±4.2	1.0	0.22
Serum adiponectin (mg/L)	8.32±3.32	9.68±3.83	0.003 ^a	9.07±3.29 ^b	9.53±3.78 ^b	0.18	0.37
Serum leptin (μg/L)	14.33±11.04	14.63±10.97	0.73	10.19±7.07 ^b	9.43±5.48 ^b	0.59	0.48
Adiponectin/leptin	1.24±1.46	1.33±1.52	0.24	1.39±0.95 ^b	1.51±1.35 ^b	0.59	0.78

Data are expressed as means ± standard deviations or medians (ranges). Confidence intervals are presented in text. Wilcoxon signed-rank tests or *t*-tests were computed to analyze differences at baseline and follow-up within and between groups (depending on skewness). Wilcoxon signed-rank tests were used to analyze differences in ratings of perceived exertion at the end of the Cooper test (RPE).

Leptin and adiponectin was calculated for women only (majority of the sample) showing significance in adiponectin in yoga group.

^aStatistically significant.

^b*n* = 17 in the control group.

^cApoA1, apolipoprotein A1; ApoB, apolipoprotein B (*n* = 21 in the control group).

RPE, ratings of perceived exertion immediately at the end of the Cooper test; HRR, heart rate recovery (differences in heart beats after 1 minute); rest HR, resting heart rate; BP, blood pressure; MID BP, systol + diastol/2.

after 25 minutes and 14 (range, 10–18) after 45 minutes. Positive correlations (differences) emerged between peripheral RPE and during the Cooper test in the HIY group (*rs* = 0.47; *p* = 0.03). After the intervention, positive correlations (Spearman) emerged between HR and central RPE (*rs* = 0.53; *p* = 0.02) in the HIY group. This finding verifies that the participants understood and used the RPE scale accurately.

Blood pressure

For BP, no significant differences emerged between baseline and follow-up between groups (Table 2). Diastolic BP increased significantly within the control group, with changes of 3.0 mmHg (95% CI, 0.9–5.0 mmHg). After 6 weeks, no significant effects emerged for pulse pressure or mean arterial pressure (not shown).

HIY dose

For findings related to HIY dose, see Appendix A.

Discussion

An intervention with a 6-week HIY program showed no significant effect on cardiovascular fitness as compared to a control group. However, for blood parameters within the HIY group, significant effects emerged for ApoA1 and adiponectin.

VO_{2max}

The present study found no differences between or within groups for VO_{2max}. This could relate to low intensity and

total time performing HIY but also to the fact that the participants were not untrained. However, no previous studies seem to have reported effects of 6 weeks of HIY on cardiovascular fitness. Previous findings have shown that acute effects include increased VO_{2max}¹⁴ and elevated HR²⁴ during HIY that are sufficient for cardiovascular fitness effects.

Some researchers^{14,15,24} have suggested that the practice of SS, as included in HIY, can be used to maintain or improve cardiovascular fitness. One study¹⁵ using a mixture of dynamic and static exercises on a group similar to that included in the present study measured oxygen uptake after 8 weeks of HY and showed a 6% increase. This effect on cardiorespiratory fitness could perhaps be related to the frog pose, dynamic lunges, and SS.¹⁵

Others have shown an intensity of 41% (19 mL/kg per min) of VO_{2max}²⁵ from the back-bending yogic exercises and inversions (included in the present study) and have shown high oxygen consumption. This is close to the minimum limit required to achieve cardiovascular training effects. However, this study also showed high heart rates using the “yoga push-up” (*chatturanga*) included in HIY. Clay et al.²⁶ have reported an intensity of 40% of VO_{2max} (13 mL/kg per min) from SS, while others²⁷ have noted an intensity of 9.9%–26.5% of VO_{2max} from HY postures (no SS). These lower figures are far from the minimum recommendations.

Apolipoproteins

While previous research has investigated HDL and shown increasing levels after HY,³ the present study seems to be

the first to measure apolipoproteins, the main component of HDL and LDL. Even though the HIY dose was relatively small and baseline levels of ApoA1 were low and within the normal range, a significant effect emerged for ApoA1. However, ApoA1 levels increased in the HIY group only. The mechanism relating to the ApoA1 findings in the HIY group perhaps relates to HIY being more of a mindful physical exercise, which is different from other types of regular exercise, while the control group continued with their regular exercise and did no systematic mindful physical training. However, the ApoA1 findings follow research showing that ApoA1 typically increases with physical exercise.²⁰ Yet, a higher yoga dose might have resulted in significant group effects. A possible limitation of the present study on ApoA1 levels is that the control group did not add a additional group activity to their regular physical activity schedule as the HIY group did.

Adiponectin and leptin (adipocytokines)

Although baseline levels were within the normal range, the present study replicated previous findings^{18,20} showing increased adiponectin levels after HIY. However, the present study showed no effect on leptin. This is possibly due to the short time period and the fact that the participants had levels within the normal range, but another possible reason is that this is not a sensitive enough biomarker. Previous research has shown higher adiponectin levels and lower leptin levels among yoga experts as compared to inexperienced participants, showing a better immunologic response and an anti-inflammatory effect.^{19,28,29} The physiologic mechanism relating to the increase in adiponectin, but not leptin, found in the present study is probably due to adiponectin levels changing faster than do leptin levels.

Heart rate

A lowered HR was observed in both groups investigated here, but this finding was not statistically significant. Generally, a high HR is seen during some HY exercises. But when oxygen consumption is measured, the intensity is not linear to HR (unpublished data). However, there seem to be no reports of HR and oxygen consumption during HIY and, consequently, the use of HR as a measure of HY intensity seems inappropriate.²⁶ Some studies measuring HR²⁴ have mentioned that yogic exercises put a low to moderate stress on the cardiovascular system and have noted that SS (included in HIY) may be intensive enough to improve cardiorespiratory fitness in unfit participants. Others have shown lowered resting HR^{8,30} after HY, thus indicating a vagal dominance.^{31–33} While the present study included no HR measurement during HIY, RPE was above 14 (HR, 140 beats/min) and thus within the cardiovascular training zone.

Duration and intensity

The total HIY training dose (both at home and during classes) was on average 390 minutes (6.5 hours [range, 210–800 minutes]) distributed over 6 weeks (Appendix A). This corresponds to a weekly average of 65 minutes. Effects on the cardiovascular system require at least 75 minutes at RPE of 14–16. The RPE rating (14–17) was at a sufficient exertion, but the total time was on the lower limit to show any improvements.¹⁰ After 45 minutes into the 60-minute

HIY, RPE during the HIY class was at the recommended ratings. This shows that the time (75 minutes at 14–16 or 150 minutes at 12–13) was on the verge of health effects on the cardiovascular system.³⁴ Yet, with HY being a form of mindful exercise training, no intensity standards have been determined.¹⁰ However, the dynamic intensity (1–3 seconds per exercise) using a longer intervention would have created difficulties with technique and motivation for unfit participants. In the present study, the total HIY time was likely to be an issue. The exercise dose did not differ between the groups at baseline. The control group did not report any changes in exercise behavior during the intervention period.

Blood pressure

The participants included in the present study were young and normotensive (i.e., their BP was already within the normal range at baseline), and consequently large BP changes were not detected. A larger HIY dose could perhaps show the lowered BP effect, which has been reported in previous research.¹³ This relates to HY exercises performed with the head below the heart, which lowers HR and induces baroreceptor firing.³⁵

Although a recent meta-analysis³ shows clinically important effects of HY on cardiovascular risk factors as compared to usual care, many people do HY as a form of exercise. There is further need to evaluate its effects and to introduce an additional form of exercise to avoid the trend of increasing inactivity. Others studies have shown strength benefits of SS.³⁶ and future research should evaluate these effects further.

Limitations

Considering the limitations of the present study, the large variation in home training and home exercises is an obvious issue. Even though RPE measurements showed that the home training was performed at a sufficient intensity, this was probably not the case. This is likely the result of unfamiliarity in using the RPE scale at home; whenever possible, electronic monitoring should probably be used alongside RPE ratings. Another issue relates to this study being a field study, which allowed limited control over some factors.

For instance, weather conditions differed slightly during the Cooper tests, and obviously experimental testing (i.e., direct measurements of $\text{VO}_{2\text{max}}$) would have allowed for more precise measurement of various markers. With regard to the biomarkers, there was no correction for variations in plasma volume shifts, and details on nutritional status would have added information. In addition, it would have been ideal to include sagittal abdominal diameter measures. Although the sample size and power were sufficient, the use of pseudorandomization to obtain equal group sizes might be an issue. We chose to measure apolipoproteins instead of total cholesterol, HDL cholesterol, and triglycerides, meaning that the participants did not have to be in the fasting state.

Positive effects

The obvious strengths lie in participants being glucometabolically healthy (very low HbA1c), and a larger effect on

blood parameters was not detected after HIY. Perhaps research on older people or those with lower fitness levels or on patient groups is needed to detect such effects.

Both the ApoA1 and adiponectin levels increased in HIY, which suggests a positive metabolic effect on a somewhat active and healthy group. However, large positive effects were not expected. Yet, the increasing ApoA1 and adiponectin levels along with the lowered HbA1c in the HIY show a clear trend. The HIY dose-response was low for any cardiovascular fitness improvements, but this study still found positive effects on ApoA1 and adiponectin.

Conclusions

Contrary to the initial hypothesis, this 6-week HIY program had no significant effect on estimated $\text{VO}_{2\text{max}}$. This probably relates to insufficiencies and variations regarding both HIY dose and intensity. The weather conditions also varied slightly during the Cooper tests. An additional limitation involves the use of pseudo-randomization to obtain equal group sizes. However, apolipoprotein A1 and adiponectin levels increased significantly in the HIY group, which suggests that HIY can potentially be effective in low doses.

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Author Disclosure Statement

No competing financial interests exist.

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Appendix A: Intervention with High Intensity Yoga Program

HIY program

The high-intensity yoga (HIY) program included high-intensity dynamic yoga postures with 30–40 min of classical *surya namaskar*, that is, SS, and 15 min of other poses (*pincha mayurasana*); half hand stand toward the wall (*ardha adho mukha vrksasana*), *parivrtta parsvakonasana*, *gomukha-sana*, and *sarvangasana*. The SS involves a collection of 12 separate exercises forming a dynamic sequence using *tadasana*, *tadasana* with back bend, *uttanasana* (with bent knees), crescent pose (right leg back), *adho mukha svanasana*, modified *chatturanga dandasana* (with buttocks up and knees and chest on ground), *urdhva mukha svanasana* (knees on ground), *adho mukha svanasana*, crescent pose (right leg forward), *uttanasana*, *tadasana* with back bend and *tadasana*, SS sequence similar to that described elsewhere.¹⁴

The next round was repeated with the left leg back and forward during the crescent pose. The speed of the SS was somewhat increased during the 6-week period, with the goal of performing each pose for 1.5–2 seconds. Relaxation (5 minutes) used the waterfall pose (*viparita karani*) or lying on the back (*shavasana*).

All classes were run by three experienced certified yoga instructors on the same day of the week and at the same time in the afternoon. The instructors received a DVD with the HIY program and practiced it together for several months to get synchronized in their instruction of the program.

During the HIY classes and during home practice, the participants were encouraged to fill in their perceived exertion (central and peripheral), with the aim of working at an intensity of 14–17 using the RPE scale. The HIY group received a 55-minute DVD with the same content as the HIY class and was encouraged to participate in home training at least twice a week. The control group received the HIY DVD after the intervention.

HIY dose

The average HIY dose for the teacher-led classes was 240 minutes (range, 60–360 minutes) from a total of 360 minutes (1 class weekly for 6 weeks), including an average of four classes during the intervention. During the 6 weeks, the home training was an average of 135 minutes (range, 0–560 minutes) while the recommendation was 120 minutes a week. The average total HIY time (classes and home training) was 390 minutes (range, 210–800 minutes).