

Positive effect of yoga on cardiorespiratory fitness: A pilot study

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ABSTRACT

Introduction: Cardiovascular disease (CVD) is the leading cause of death in developed countries. An integral part of primary prevention is physical activity. One form of physical activity to be potentially used is yoga, but this activity is associated with lower energy expenditure than that recommended for prevention. The study aimed at assessing the effect of regular yoga sessions on the aerobic capacity of the practitioners and comparing it with the normal population performing physical activity recommended by guidelines.

Materials and Methods: Fifty-eight persons (16 males) with a mean age of 50.0 ± 11.06 years comprising the yoga group practiced yoga for at least 1 h a day for over 2 years. They underwent spiroergometry under maximal exercise testing to assess basic performance parameters. Their results were compared with those in 54 age-matched controls (16 males mean age of 48 ± 11.86 years performing a regular aerobic physical activity for at least 7 h a week).

Results: The yoga group had statistically significantly higher maximum performance per kilogram ($P = 0.007$) and maximum oxygen consumption per kilogram per minute ($P = 0.028$).

Conclusions: Despite low energy expenditure, yoga practices are better in some cardiorespiratory fitness parameters than other aerobic activities recommended by current guidelines for CVD prevention.


Key words: Cardiorespiratory fitness; prevention; yoga.

INTRODUCTION

Cardiovascular disease (CVD) is the leading cause of death and disability in all developed countries. An integral part of primary prevention mainly focusing on modifiable risk factors is physical activity.^[1] One form of physical activity to be potentially used is yoga, a system of physical practices and breathing techniques aimed at achieving better health and inner balance. These activities are recommended, for instance, in guidance provided by the American College of Sports Medicine.^[2]

Worldwide, studies have been published that document the beneficial effect of regular yoga exercises on human health. Innes *et al.*^[3,4] repeatedly carried out a meta-analysis of literature regarding the effects of yoga on indices of CVD risk associated with insulin resistance and suggested beneficial changes in blood pressure, abdominal obesity, lipid and coagulation profiles, oxidative stress, sympathetic activation, improved risk profiles in adults with type 2 diabetes mellitus, and several clinical endpoints. These findings were confirmed by other authors as well.^[5]

On the other hand, Lau *et al.*^[6] conducted a meta-analysis of studies in 2012 that would confirm the effectiveness of yoga for secondary prevention of CVD. In the main databases, they found no eligible randomized controlled trials meeting the inclusion criteria (at least a 6-month follow-up period, patients diagnosed with CVD, studies comparing a group practicing yoga and controls receiving no intervention or interventions other than yoga).

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Ray *et al.*^[7] studied 20 males during Hatha Yoga practices (asanas/postures and breathing maneuvers) and found that their metabolic rate was in the range of 1–2 metabolic equivalents (MET) except in three asanas (>2 MET). Similarly, Hagins *et al.*^[8] concluded that yoga sessions represent low levels of physical activity (a mean MET value across a session of 2.5) and do not meet recommendations for levels of physical activity for improving cardiovascular fitness. Thus, the question is whether mere practicing of yoga with low energy expenditure could be recommended for disease prevention.

The study aimed at assessing the effect of regular yoga sessions based on the system Yoga in Daily Life on aerobic capacity (cardiorespiratory fitness) of the practitioners and comparing it with the normal population performing physical activity as recommended.

MATERIALS AND METHODS

Participants

A total of 58 persons comprising the yoga group (16 males and 42 females) with a mean age of 50.0 ± 11.06 years (range, 31–70 years;) were examined. The inclusion criterion was to practice yoga in accordance with the system Yoga in Daily Life for at least 1 h a day for over 2 years (it response with Guidelines given by American Heart Association). Yoga in Daily Life is built on the principles of traditional Indian yoga and adapted to the modern lifestyle (relaxation, asanas...).

The control group comprised of 54 individuals (16 males and 38 females) with a mean age of 48 ± 11.86 years (range, 25–70 years). The controls were selected from patients registered at our department and randomly matched. The inclusion criterion was a regular aerobic physical activity performed for at least 7 h a week (brisk walking, jogging, cycling, dancing). The two groups were matched for age ($P = 1.0$) and gender ($P = 0.837$).

Exclusion criterion was a rejection of participation in the study.

Design

The clinical evaluation consisted of taking histories and conducting physical examinations, including weight and height measurements with calculation of body mass index (BMI kg/m^2).

In both groups, maximal exercise testing was performed on the Oxycon Plus system-Jaeger, in a well-ventilated, temperature- and humidity-controlled room. The system was calibrated before each test. Exhaled gases

were analyzed using the breath-by-breath method (a facemask). The exercise tests were carried out on a bicycle ergometer (Ergoline 600).

All participants were fasting for 12 h overnight. The protocol started with a 3-min workload of 1 W/kg and was followed by an incremental ramp protocol to a subjective maximal effort (a test duration of up to 12 min).^[9] From all participants, a signed written informed consent was obtained.

Assessments

The following parameters were investigated: Resting heart rate (HR_{rest}), resting blood pressure (BP_{rest}), maximum heart rate (HR_{max}), blood pressure at maximum exertion, maximum performance (W_{max}/kg), maximum oxygen consumption per kilogram per minute ($\text{VO}_{2\text{max}}/\text{kg}/\text{min}$), maximum metabolic equivalent (MET_{max}), maximum minute ventilation (V_{Emax}), $\text{VCO}_{2\text{max}}$, maximum carbon dioxide production, and respiratory exchange ratio (RER).

Data analysis

Statistical analyses were done using software Statistica 12 (Dell Softwares, StatSoft, Inc.). The Mann–Whitney U-test was used to evaluate differences in all clinical variables between both groups. The logistic regression was applied in the case of adjustments for weight and BMI. The level of significance was set at $P = 0.05$.

RESULTS

Results for the entire cohort, males and females are shown in Tables 1 and 2.

The yoga group had statistically significantly higher HR_{max} , W_{max}/kg , $\text{VO}_{2\text{max}}/\text{kg}/\text{min}$, and MET_{max} and statistically significantly lower body weight, BMI, BP_{rest} , V_{Emax} , $\text{VO}_{2\text{max}}$ and $\text{VCO}_{2\text{max}}$.

After the cohort was divided into males and females, the statistically significant differences between the categories varied. In case of males, the yoga group had statistically significantly lower body weight, V_{Emax} and $\text{VO}_{2\text{max}}$ and in females statistically significantly lower body weight, HR_{rest} , systolic and diastolic BP_{rest} and $\text{VO}_{2\text{max}}$. The female yoga practitioners had statistically significantly higher HR_{max} , W_{max}/kg , $\text{VO}_{2\text{max}}/\text{kg}/\text{min}$, MET_{max} , and RER.

In both groups, the mean performance parameters (W_{max}/kg and $\text{VO}_{2\text{max}}/\text{kg}/\text{min}$) were normal when compared with charts for the general population.

Table 1: The studied parameters for the entire cohort

	Mean±SD			P
	Entire cohort (n=111)	Yoga group	Control group	
Weight (kg)	77.705±18.8551	67.281±11.4280	88.707±18.9648	<10 ⁻⁶
Height (cm)	171.181±9.3311	170.246±9.2182	172.169±9.4336	0.402
BMI	26.510±6.1865	23.172±3.1117	30.034±6.6757	<10 ⁻⁶
HR _{rest}	74.441±13.8194	70.982±12.2496	77.037±14.9817	0.065
HR _{max}	163.47±19.46	169.01±15.71	157.63±21.38	0.004
Systolic BP _{rest} (mm Hg)	125.405±14.8498	121.667±15.2460	129.352±13.4602	0.003
Diastolic BP _{rest} (mm Hg)	79.550±11.4127	76.842±10.5911	82.407±11.6449	0.024
Systolic BP _{max} (mm Hg)	182.836±26.0678	181.263±23.2275	184.528±28.9440	0.638
Diastolic BP _{max} (mm Hg)	81.972±14.4661	80.526±11.0067	83.558±17.4709	0.241
W _{max} /kg	2.471±0.9130	2.618±0.6392	2.317±1.1184	0.007
VO _{2max} /kg/min	27.454±8.2434	28.407±6.3432	26.448±9.8242	0.028
MET _{max}	7.793±2.2976	8.109±1.8037	7.439±2.6991	0.018
VE _{max} (l/min)	84.216±30.7407	74.982±23.0268	93.963±34.8219	0.008
RER	1.219±0.1229	1.240±0.1001	1.197±0.1404	0.078
VCO _{2max} (l/min)	2496.279±857.7041	2327.719±686.9208	2674.204±982.5749	0.094
VO _{2max} (l/min)	2113.532±681.2193	1943.070±586.9638	2293.463±731.3539	0.011

BMI = Body mass index; HR_{rest} = Resting heart rate; BP_{rest} = Resting blood pressure; HR_{max} = Maximum heart rate; BP_{max} = Blood pressure at maximum exertion; W_{max}/kg = Maximum performance; VO_{2max}/kg/min = Maximum oxygen consumption per kilogram per minute; MET_{max} = Maximum metabolic equivalent; VE_{max} = Maximum minute ventilation; VO_{2max} = Maximum oxygen consumption; VCO_{2max} = Maximum carbon dioxide production; RER = Respiratory exchange ratio

Table 2: The studied parameters by gender

	Mean±SD		P	Mean±SD		P
	Yoga group males	Control group male		Yoga group females	Control group females	
	Weight (kg)	76.17±12.44		94.08±17.67	0.0665	
Height (cm)	180.35±7.28	181.40±7.88	0.536593	165.95±6.06	166.72±4.95	0.850363
BMI	23.31±2.51	28.79±6.58	0.0860	23.11±3.36	30.76±6.72	<10 ⁻⁶
HR _{rest}	71.88±14.69	73.70±13.40	0.497465	72.02±11.25	79.0±15.64	0.049849
HR _{max}	171.94±7.68	164.75±16.13	0.132609	167.75±18.02	153.44±23.14	0.006746
Systolic BP _{rest} (mm Hg)	125.58±9.98	130.00±15.13	0.597976	120.00±16.83	128.97±12.59	0.002761
Diastolic BP _{rest} (mm Hg)	79.41±5.55	81.75±12.80	0.844871	75.75±12.01	82.79±11.09	0.014719
Systolic BP _{max} (mm Hg)	188.23±22.28	201.31±28.12	0.196432	178.30±23.25	175.14±25.21	0.662299
Diastolic BP _{max} (mm Hg)	77.05±7.08	79.23±21.29	0.754297	82.0±12.07	86.06±14.61	0.165179
W _{max} /kg	3.17±0.59	3.01±0.11	0.706589	2.38±0.49	1.9±0.88	<10 ⁻⁴
VO _{2max} /kg/min	34.41±5.14	33.28±10.11	0.478473	25.85±4.99	22.42±7.1	0.001036
MET _{max}	9.81±1.45	9.04±2.72	0.356947	7.38±1.41	6.31±1.97	0.0601
VE _{max} (l/min)	95.47±25.32	127.45±27.42	0.0665	66.27±15.40	74.26±20.85	0.232228
RER	1.23±0.07	1.25±0.13	0.326062	1.24±0.10	1.16±0.13	0.005315
VCO _{2max} (l/min)	3183.41±496.99	3626.40±827.47	0.103507	1964.05±349.61	2114.08±532.54	0.361543
VO _{2max} (l/min)	2669.54±436.99	3037.75±510.26	0.035708	1634.27±297.39	1855.64±419.41	0.030730

BMI = Body mass index; HR_{rest} = Resting heart rate; BP_{rest} = Resting blood pressure; HR_{max} = Maximum heart rate; BP_{max} = Blood pressure at maximum exertion; W_{max}/kg = Maximum performance; VO_{2max}/kg/min = Maximum oxygen consumption per kilogram per minute; MET_{max} = Maximum metabolic equivalent; VE_{max} = Maximum minute ventilation; VO_{2max} = Maximum oxygen consumption; VCO_{2max} = Maximum carbon dioxide production; RER = Respiratory exchange ratio

Table 3: The studied parameters adjusted for BMI

	Entire group	Males	Females
W _{max} /kg	0.0010	0.0148	0.0237
VO _{2max} /kg/min	0.0026	0.0213	0.0533
MET _{max}	0.0063	0.0363	0.1056
VE _{max} (l/min)	0.08	0.0083	0.0453
RER	0.3564	0.1020	0.7357
VCO _{2max} (l/min)	0.0090	0.0479	0.0982
VO _{2max} (l/min)	0.0082	0.0390	0.0828

W_{max}/kg = Maximum performance; VO_{2max}/kg/min = Maximum oxygen consumption per kilogram per minute; MET_{max} = Maximum metabolic equivalent; VE_{max} = Maximum minute ventilation; VO_{2max} = Maximum oxygen consumption; VCO_{2max} = Maximum carbon dioxide production; RER = Respiratory exchange ratio

Given the differences in body weight and BMI between the two groups, the results were adjusted for BMI. Table 3 shows

that the yoga group has statistically significantly higher W_{max}/kg and VO_{2max}/kg/min despite lower V_{Emax}, VO_{2max}, and VCO_{2max}.

DISCUSSION

The present study showed that the group practicing the Yoga in Daily Life system had better aerobic performance than controls performing other aerobic physical activity for the same amount of time per week. Thus, it may be concluded that in spite of low energy expenditure during sessions, yoga has a positive effect on individuals' aerobic performance.

The results are consistent with data from Chen *et al.*^[10] reported a positive influence of Silver Yoga

exercises on physical fitness (e.g., body composition, cardiovascular-respiratory functions or body flexibility).

Not surprisingly, the yoga group had a statistically significantly lower body weight and BMI. This is associated not only with taking regular exercise (its duration was identical in both groups) but especially with dietary habits as most yoga practitioners prefer healthy, preferably vegetarian, foods.^[11]

Physical performance improvement is possible owing to both better economy of breathing and improvement in cardiovascular reserve, with other factors such as psycho-physiological and better relaxation possibly contributing.^[7]

In the present study, yoga was more beneficial for females, in whom it was also shown to influence HR_{rest} and/or BP_{rest} . The main mechanisms behind lower BP_{rest} are likely to be parasympathetic predominance, increased baroreflex sensitivity and decreased the arterial tone and peripheral resistance.^[12]

The present study failed to show an effect of yoga on exertional blood pressure. There is no study available on this issue.

After adjustment for BMI, the impact of yoga on the main cardiovascular performance parameters was confirmed in both males and females. The differences between males and females should be verified in future studies with more participants.

The mean age of participants in the present study was 48 years, similar to the mean age of females in a study by Ramos-Jiménez *et al.*^[13] reporting a positive effect of 11-week intensive Hatha Yoga program on V_{Emax} and VO_{2max} .

In the present study, the Yoga in Daily Life system was applied. This may not be expected to result in better performance. For instance, in a recent study by Akhtar *et al.*,^[14] 30 physiotherapy students volunteered to undergo a baseline 6-min walk test, followed by thirty 1-h yoga sessions (yogic asanas/postures for 30 min, pranayamas/breathing for 15 min, omkar chanting for 10 min, and shavasana/relaxation for 5 min) over 6 weeks. Another 6-min walk test after the yoga intervention showed statistically significant improvements in walk distance, rating of perceived exertion and recovery time.

Similarly, Parshad *et al.*^[15] investigated the impact of yoga on hemodynamic function in healthy medical students and found its improvement after 6 weeks of practice

comprising asanas/postures, pranayamas/breathing, and dhyana/meditation.

The present study is mainly limited by small subject numbers; however, other studies reported in the literature are of similar sizes. The second limitation is the wide range of age. The study was not prospective, mainly because of complicated methods associated with performing such studies affected by inadequate participants' compliance. Ideally, a large international multicenter study concerned with the topic should be organized.

CONCLUSION

Despite low energy expenditure, yoga practices are better in some cardiorespiratory fitness parameters than other aerobic activities recommended by current guidelines for CVD prevention.

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