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Changes in physiological and biomechanical variables in women practicing the Power Yoga system

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Summary

Study aim: To investigate changes in selected indices of anaerobic capacity, the ability to maintain body balance and the height of elevating body's centre of mass, and maximum power output in lower limbs during countermovement jump (CMJ) after 6 months of participation in yoga classes in Ashtanga Vinyasa system (Power Yoga).
Material and methods: The study included 24 untrained women who volunteered to participate in a half-year experiment. The analysis focused on 12 women who participated in the classes until the experiment ended. The Wingate test was used to evaluate anaerobic capacity. In order to measure the functional state of vestibular organ the authors used a stabilographic method. Measurements of power output in the lower limbs and the height of elevation of the centre of mass in CMJ jumps were carried out using a dynamometric platform.
Results: The 6 months of training in the Power Yoga system considerably improved the height of CMJ jumps from 0.276 ± 0.048 m to 0.308 ± 0.038 m ($p<0.05$). These changes were not accompanied by significant increases in maximum power output (1286 ± 200 W and 1327 ± 2134 W before and after, respectively; $p>0.05$).
Conclusions: Practicing Power Yoga does not induce changes in the anaerobic capacity and the functional state of the vestibular organ in women.

Key words: Anaerobic capacity – Body balance – Power Yoga – Women

Introduction

There is a growing popularity of different types of recreational activity today. Decisions concerning the choice of a particular form of activity are usually made intuitively, without consideration of actual results for the body. The decision is often driven by current fashion. One of the most fashionable forms of physical activity today is Ashtanga Vinyasa (Power Yoga).

Power Yoga was popularized by American author Beryl Bender Birch [3]. She developed a methodology that allows almost everybody to perform vigorous series of exercise. The exercises in the Power Yoga system are of a more dynamic character compared to classical yoga [9]. They are practiced in attractive, spectacular systems. There are also dynamic transitions between the sequences of exercises performed to the rhythm of respiration. A specific type of respiration is used during the whole Power Yoga training session. It consists of performing a strong, profound inhalation through the nose and a strong extended expiration through the mouth. This method of respiration results in increased respiratory volume, more efficient respiratory cycle, and increased oxygen uptake [19]. Moreover, when performing individual exercises during a training session, the practitioner frequently changes the body position with respect to the ground. The person adopts 'reversed positions', i.e. vertical position with the head down.

The literature abounds in studies that have discussed the effects of practicing different yoga styles. Practicing yoga systems has been shown to improve muscle and joint elasticity, to strengthen muscle strength (with particular focus on static strength) [6,13,18], to cause body mass reduction [15], and to change body composition [2,15]. Yoga training has also been shown to increase aerobic power [1,16,17] and to decrease anaerobic power [1]. However, only the work of Buśko and Rychlik [6] concerned Power Yoga .

The aim of the present study was to investigate the changes in selected indices of anaerobic capacity, ability to maintain body balance and the height of elevation of the centre of mass, and maximum power output of lower limbs in counter movement jump (CMJ) after 6 months of participation in yoga classes in Ashtanga Vinyasa system (Power Yoga).

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Material and Methods

24 untrained women volunteered to participate in a half-year experiment of Power Yoga training, the analysis focused on the results obtained from the 12 women (mean age 24.2 ± 5.8 years) who participated in the classes until the experiment ended. At the beginning of the experiment their body height and body mass were 168.4 ± 6.3 cm and 60.0 ± 6.9 kg, respectively, and did not change significantly after 6 months of training. The Power Yoga classes were scheduled for 1 to 1.5 hours, 3 times a week, for 6 months. Throughout the experiment, the women did not participate in other classes of recreational and physical exercise nature and they had never practiced yoga before. The women were informed about the aim of the experiment and expressed their written consent to participate in the measurements; the study was approved by the Bioethical Commission of Scientific Research at the Institute of Sport in Warsaw, Poland.

The subjects followed a training regime based on the Power Yoga system. The classes were guided by a professional Power Yoga coach. During the classes, the participants performed a standard set of exercises at their own speed, controlled by the number of breaths. A training session was divided into several stages that differed in the body positions adopted for individual *asanas*. In terms of difficulty, the exercise sets were dedicated to beginner yoga practitioners. Mean values of heart rate throughout the duration of the whole training session ranged from 110 to 140 bpm. The following Power Yoga exercises were performed:

Initial Exercises: Two dynamic cycles of exercises with a duration of approximately 12 minutes, performed according to the individual rate of respiration, changing consecutively from one position to another. In each cycle, in one head-down position, the movement was stopped for a period of 5 deep breaths. The whole procedure was repeated 5 times. The aim of this procedure was to warm-up the body and to prepare it for the next exercises.

Standing Positions: A series of static stretching exercises aimed at strengthening in particular the muscles of the lower limbs took approximately 15 minutes. In all the exercises, the body weight was supported on the feet. The subjects remained in each position for a period of 5 deep breaths (10 to 20 s). The transitions between the positions occurred by means of dynamic but short movements and jumps. Each exercise, including the elements of entry and exit from the position, began and ended in a basic stance. The character of exercise was static. The intensity of exercise was increased gradually.

Sitting Positions: A series of varied static exercises that took approximately 30 minutes started from a sitting position on the floor with legs stretched, which represented a counterpart to the basic standing position. The subjects remained in each position for a period of 5 deep breaths (10 to 20 s, depending on their respiratory rate). The elements of initial exercises were cyclically repeated between the exercises in order to maintain body warm-up. During a cycle of sitting positions, the exercise intensity was maintained at a relatively constant, thought higher, level compared to standing exercises.

Head-Down Exercises: These exercises were included in a cycle of static positions maintained for a longer time (from 10 to 25 breaths) in order to gently end the exercises. They began with a deep front bend, followed by a shoulder stand, headstand, and a cycle of positions with legs crossed. These exercises took approximately 15 minutes.

Final Exercises: They were the last position of the final sequence. In this position, the subjects lifted their hips up off the ground with legs crossed and remained supported with their hands only. They tried to perform this intensive exercise for as long as possible, performing from 25 to 100 deep breaths. This was the last intensive exercise before final relaxation.

Rest: A deep relaxation ended each session. It consisted in lying on the back. Relaxation time was approximately 10 minutes.

The Wingate test was used for evaluation of anaerobic capacity [20]. It consisted of performing a standard warm-up on a cycle ergometer followed by a 5-minute rest, maximum 30-second exercise with individual load in consideration of body weight of a subject. The load amounted to 7.5% of body weight (BW). Monark 824 E cycle ergometer (Sweden) connected with IBM PC Pentium computer with MCE v. 4.0 ("JBA" Zb. Staniak, Poland). The sensors were fixed on a flywheel that covered the distance of 6 m during one pedal rotation. The subjects, after adjustment of the appropriate height of the saddle and handlebar, performed the sitting tests without standing on pedals, starting the exercise from an immobilized position, with the feet attached to pedals with belts. Standard conditions were met during the exercise and the subjects received verbal encouragement to achieve a maximum pedalling frequency and maintain it as long as possible. MCE v. 4.0 software was used for measuring and computation of: mean power output (P_m), maximum power output (P_{max}), and fatigue index (FI) [7].

Stabilographic method was used for evaluation of the functional state of vestibular organ. The authors used for the purpose a 400×400×55 mm platform with strain gauge sensors that recorded the forces applied on the ground. The subjects stood on the platform and were asked to maintain a stable upright position for the duration of the measurement. The point of pressure of the feet on the ground was recorded as a dynamic parameter that changed its position in time. Posturo software was used for determining the following indices:

– mean radius [mm]: mean value obtained from the sum of consecutive distances from the centre of the system,

– sway area [mm^2]: the sum of triangles formed by 2 consecutive deviations ,

– total length [mm]: total length of the feet pressure point pathway in the test.

The experiment was repeated for 3 times for 30 s each time. The first measurement was performed when a subject stood on the platform with eyes open; the second one was performed with eyes closed and the third with the feedback. In the latter case, the subject stood on the measurement platform in front of a screen located at the distance of 5 m. The central area of the screen displayed a square (0.5×0.5 cm) and the point of pressure of the person studied. The subjects were asked to control the point so that it remained within the square's boundaries (feedback) on the screen.

Measurements of the power output in lower limbs and the height of elevation of the centre of body mass during CMJ were carried out using a dynamometric platform with Kistler amplifier. The amplifier was connected by means of an analogue-digital converter with an IBM PC computer and MVJ v. 1.0 software ("JBA" Zb. Staniak, Poland). The use of a physical model, where the whole body mass of a person who jumped vertically from the dynamometric platform, was reduced to a point to which vertical components of external forces are applied (body's force of gravity and vertical component of platform reaction forces). Based on the recorded ground reaction forces, the authors obtained the following parameters of the jump: maximum power output (P_{max}), mean power output (P_m), maximum height of elevation (h) and lowering (k) of the centre of mass before the jump [5]. Each person performed 2 maximum vertical jumps from a standing position, which was preceded by the body's premovement towards the ground (CMJ). The analysis was based on the jump with the greatest value of height of elevation of the centre of body mass.

The paired t-test or repeated measures analysis of variance (ANOVA) followed by Scheffé's test (*post hoc*) were used in data analysis. All the calculations were carried with the use of STATISTICA package (StatSoft, USA); the level of significance was set at α=0.05.

Results

Table 1 presents mean values of indices obtained in the Wingate test. Maximum power output, mean power output, and fatigue index did not change significantly after a 6-month Power Yoga programme. The results obtained during the measurements that encompassed changes in basic stabilographic indices (mean radius, sway area, and total length) did not show statistical difference after the period of 6 months of practicing Power Yoga (Table 2).

Table 1. Mean values (±SD) of the relative mean power output (P_m), relative maximum power output (P_{max}) and fatigue index (FI) obtained before the experiment and after 6-month Power Yoga training (n = 12)

Variable	Before	After
P_m (W/kg)	5.70 ± 0.78	5.75 ± 0.61
P_{max} (W/kg)	6.84 ± 1.04	6.83 ± 0.82
FI (%)	14.00 ± 6.32	13.25 ± 5.58

Table 2. Mean values (±SD) of stabilographic indices in studied women (n = 12) obtained before the experiment and after 6 months of Power Yoga training

Variable	Before	After
Mean radius (mm)		
Eyes Closed	9.83 ± 3.39	9.03 ± 2.73
Eyes Open	9.43 ± 4.42	8.45 ± 2.98
Feedback	4.50 ± 0.97	4.23 ± 0.85
Sway Area (mm^2)		
Eyes Closed	714.6 ± 285.8	691.1 ± 225.3
Eyes Open	874.1 ± 467.3	760.6 ± 253.3
Feedback	574.8 ± 250.1	530.8 ± 348.6
Total Length (mm)		
Eyes Closed	242.0 ± 44.9	254.4 ± 33.8
Eyes Open	315.7 ± 70.2	311.8 ± 58.1
Feedback	386.2 ± 114.7	362.6 ± 117.4

Table 3. Mean values (±SD) of variables characterising countermovement jump performance in studied women (n = 12) obtained before the experiment and after 6 months of Power Yoga training

Variable	Before	After	R (%)
P_{max} (W)	1286.1 ± 200.1	1326.8 ± 213.6	3.4
P_{max}/BM (W/kg)	21.51 ± 4.29	21.96 ± 4.07	2.8
P_m (W)	720.0 ± 153.9	30.9 ± 133.0	3.7
P_m/BM (W/kg)	12.10 ± 3.16	12.12 ± 2.52	3.2
h (m)	0.276 ± 0.048	0.308 ± 0.038 *	13.0

Legend: P_{max} – Maximum power output; P_m – Mean power output; BM – Body mass; h – Height of elevation of the centre of body mass; R – percentage change with respect to before value; * Significantly (p<0.05) different from respective value recorded before the experiment.

Mean values obtained during counter-movement jumps (CMJ) among the women studied are presented in Table 3. Maximum power output developed in CMJ jumps did not change after the 6-month Power Yoga training (1286 ± 200 W and 1327 ± 2134 W before and after, respectively; $p>0.05$). Significant ($p<0.05$) changes were found only in height of elevation of the centre of body mass, which improved by 13%.

Discussion

The data concerning the effect of yoga exercise on physical capacity are ambiguous. Tran *et al.* [21] found that practicing yoga as the only form of physical activity did not result in changes in the level of physical capacity. Furthermore, Balasubramanian *et al*. [1] demonstrated an increase in maximum oxygen uptake and reduction in anaerobic capacity in a group of students after 6 weeks of yoga training. These authors suggested that participation in yoga classes caused a conversion of fast-twitch tissues into slow-twitch tissues. In our study, no significant changes in anaerobic capacity were found after a 6-month Power Yoga programme. These results are consistent with previous research discussed in a study by Balasubramanian *et al.* [1].

The effect of yoga training on changes in balance has not been widely researched in the literature yet. However, the authors who attempted to measure this effect found beneficial changes. Chen *et al.* [8], after a 4-week participation of women in Silver Yoga classes, demonstrated a significant improvement ($p<0.05$) in balance and mobility range in shoulder joints. The yoga training discussed in the present study did not cause significant changes in basic stabilographic indices. It is difficult to explain this fact since apart from the strength and flexibility components, performing asanas in standing or reversed positions contains a balance-related component. It was expected that the exercises should improve the ability to maintain balance.

There is also some inconsistency in the results obtained for changes in the height of elevation of the centre of body mass and power developed during counter-movement jump (CMJ), drop jump (DJ), and squat jump (SJ) that occurred after different types of training [4,11,14]. In a study by Harris *et al.* [12], strength training did not improve jumping ability measured in CMJ jumps, whereas power training (i.e. training with the load of 30% of maximum isometric force) improved jumping ability in CMJ jumps. Diallo *et al.* [10] demonstrated that 10 weeks of plyometric training caused a significant increase in maximum power output measured for CMJ, DJ, and SJ jumps in footballers. However, no reports are available in the literature concerning changes in the height of elevation of the centre of body mass and maximum power output measured for CMJ, DJ, or SJ after Hatha Yoga training. In our study, Power Yoga training did not affect maximum power output and mean power output during CMJ jumps; the respective improvements being 3.4% and 3.7%. A significant increase of 13.0% was observed for the height of elevation of the centre of body mass. Yoga exercises have a nature of isometric training combined with stretching and dynamic transitions between individual asanas. This is likely to have caused the improvement in jumping ability, which could have increased as a result of enhanced neuromuscular coordination.

Summing up, a 6-month training programme in the Power Yoga system significantly increased the height of elevation of the centre of body mass in CMJ jumps but, no significant changes in maximum power output were found. It also seems that practicing Power Yoga does not affect changes in anaerobic capacity in women and the functional state of the vestibular organ.

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