Original paper

Body posture and postural stability of people practicing qigong

Postawa ciała a stabilność posturalna osób uprawiających qigong

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Key words: body posture, postural stability, qigong exercises.

Słowa kluczowe: postawa ciała, stabilność posturalna, ćwiczenia qigong.

Abstract

Introduction: Correct and stable posture is essential for the implementation of the majority of voluntary movements and locomotion. The study of postural stability is an element of clinical trials evaluating physical activity in order to determine the optimal therapeutic procedures. Qigong exercises are not only a form of prevention, helpful in maintaining wellbeing, but also a means of therapy in many diseases, including disorders of postural stability.
Aim of the research: To analyse the association between the quality of posture and postural stability of people practicing qigong.
Material and methods: The study involved 32 people. The mean age of those tested was 54 years. Posture study used optoelectronic method Diers formetric III 4D. Postural stability was tested on the platform Biodex Balance System. The studies were performed at the Posture Laboratory of the Institute of Physiotherapy at Jan Kochanowski University in Kielce.
Results and conclusions: Spearman rank order correlation showed a positive correlation of relative rotation of the spine area with a general indicator of stability ($p = 0.0206$) at an average level ($R = 0.4075$) and with the index of the stability A/P ($p = 0.0310$), although at a lower level ($R = 0.3819$). With the increase in the relative rotation of the spine area the overall stability indicator and stability indicator A/P also increased. Significant positive correlations were also seen for the surface rotation (+max) and a general indication of the stability and the stability index A/P. With the increase of surface rotation (+max) of the spine the overall stability indicator and stability indicator A/P also increased.

Streszczenie

Wprowadzenie: Prawidłowa i stabilna postawa ciała jest niezbędna do wykonania większości ruchów dowolnych i lokomocji. Badanie stabilności posturalnej stanowi element testów klinicznych oceniających aktywność ruchową w celu wyznaczenia optymalnych procedur terapeutycznych. Ćwiczenia qigong stanowią nie tylko formę profilaktyki, pomocną w utrzymaniu dobrego samopoczucia, lecz także środek terapii w wielu schorzeniach, m.in. w zaburzeniach stabilności ciała.
Cel pracy: Analiza związku między jakością postawy ciała a stabilnością posturalną osób uprawiających qigong.
Materiał i metody: Badaniami objęto 32 osoby, w tym 26 kobiet (81,25%) i 6 mężczyzn (18,75%). Średni wiek badanych wynosił 54 lata. W badaniach dotyczących postawy zastosowano optoelektroniczną metodę Diers formetric III 4D. Stabilność posturalną badano na platformie Biodex Balance System. Badania wykonano w Laboratorium Posturologii w Instytucie Fizjoterapii na Uniwersytecie Jana Kochanowskiego w Kielcach.
Wyniki i wnioski: Korelacja porządku rang Spearmana wykazała dodatni związek względnej rotacji powierzchni kręgosłupa z ogólnym wskaźnikiem stabilności ($p = 0{,}0206$) na przeciętnym poziomie ($R = 0{,}4075$) oraz ze wskaźnikiem stabilności A/P ($p = 0{,}0310$), choć na niższym poziomie ($R = 0{,}3819$). Wraz ze wzrostem względnej rotacji powierzchni kręgosłupa wzrastał również ogólny wskaźnik stabilności i wskaźnik stabilności A/P. Istotne dodatnie korelacje stwierdzono także dla rotacji powierzchni (+max) i ogólnego wskaźnika stabilności oraz wskaźnika stabilności A/P. Wraz ze wzrostem rotacji powierzchni (+max) kręgosłupa wzrastał ogólny wskaźnik stabilności i wskaźnik stabilności A/P.

Introduction

Correct and stable posture is essential for the implementation of the majority of voluntary movements and locomotion. The study of postural stability is an element of clinical trials evaluating physical activity in order to determine the optimal therapeutic procedures [1–9]. Qigong exercises are not only a form of prevention, helpful in maintaining wellbeing, but also a means of therapy in many diseases, including disorders of postural stability. There is extensive use of exercises developed in medical circles, closely related to the theories of traditional Chinese medicine. The health effects of qigong have been officially recognised as a therapeutic technique in Chinese hospitals since 1989. Qigong is a study subject at major medical universities. After years of debate, in 1996 the Chinese government announced qigong as an official part of the National Health Plan.

Aim of the research

The aim of this study was to analyse the association between the quality of posture and postural stability of people practicing qigong [10–14].

Material and methods

The study involved 32 people, including 26 (81.25%) women and 6 (18.75%) men. The posture study used the optoelectronic method – Diers formetric III 4D. The resulting image of the subject's posture was received by the optical system of the camera and then transferred to the computer. With the correct card and program, the computer made a proper analysis of postures. The test subject, stripped to just shorts, barefoot, stood at a distance of about 2 m in front of the device that is adjustable for height and takes several 4D pictures. Calculation of the results and printing analysis protocols took place after completion of the measurements. The following parameters of posture were assessed: kyphotic angle ICT-ITL (max), lordotic angle ICT-ITL (max), scoliotic angle, trunk length VP-DM mm, pelvic tilt DL-DR, pelvic tilt DL-DR mm, surface rotation (°), surface rotation (+max).

The Diers formetric III 4D optoelectronic method provides quick, free of harmful radiation, and large-optical measurement of posture and spine. The use of this system allows us to present various clinical issues relating to the objective analysis of body posture and scoliosis. It is currently the most advanced non-invasive system for evaluating posture [15–18].

Postural stability was tested on the Biodex Balance System platform. Three trials for 20 s with eyes open were made. The subjects had insight into their own postural system based on the centre of pressure (COP) on the screen. The test was done by maintaining the COP in the middle of the coordinate system. The change of the maximum pressure on the soles of the feet when the body tilts was received on a transducer consisting of a sensor installed in the base of the platform. The registered signal was converted from analogue information to digital and then elaborated by the computer software. The general indicator of stability (GIS), stability indicator A/P (IA/P), and the stability indicator M/L (IM/L) were calculated [19–23].

Statistical analysis

The analysis of the results was performed using the statistical package PQStat ver. 1.4.2.324. The results are shown in cardinality tables, tables of descriptive statistics, and correlation matrices and graphs. Normality of scales distributions was analysed using the Shapiro-Wilk test. Differences between men and women were assessed using the *U* Mann-Whitney test. Relations between the angle of kyphosis, lordosis and scoliosis, pelvic tilt and surface rotation and the overall stability indicator, and the stability indicator A/P and stability indicator M/L were analysed by estimating correlation coefficients of Spearman's rank order. The level of significance was set at $p < 0.05$ [24]. The study was performed in March 2014 in the Posture Laboratory of the Institute of Physiotherapy at Jan Kochanowski University in Kielce.

Results

Women constituted the majority (81.25%) of the study group and men only 18.75%. The average age in the study group was 54.28 years with a standard deviation of 12.24 years. The median of the distribution of the results of this scale is 55 years and the range of results was from 32 to 85 years. The average body height was 165.47 cm with a standard deviation of 8.1 cm. The median of the distribution of the results of this scale was 164.5 cm and the range of results from 150 to 184 cm. The average body weight was 66.14 kg with a standard deviation of 11.05 kg. The median of the distribution of the results of this scale as 65.6 kg and the range of results was from 48.3 to 89 kg. The average body mass index (BMI) score was 24.12 kg/m^2 with a standard deviation of 3.49 kg/m^2. The median of the distribution of the results of this scale was 23.1 and the range of results was from 17.5 to 32.3. The average angle of kyphosis was 52.47 with standard deviation of 9.45. The median of distribution of the results of this scale was 54 and the range of results was from 30 to 69. The lordotic angle was on average 42.75 with standard deviation of 10.44. The median of distribution of the results of this scale was 41.5 and the range of results was from 17 to 63. On the other hand, the angle of scoliosis was 18.16° with average standard deviation of 9.76°. The median of the distribution of the results of this scale was 16 and the range of results was from 3 to 48. The trunk length (VP-DM) was on average 445 mm with a standard deviation of

40.72 mm. The median of distribution of the results of this scale was 445.5 mm and the range of results was from 327 to 542 mm. The mean trunk length was 500.88 mm with a standard deviation of 40.51 mm. The median distribution of the results of this scale was 501.5 mm and the range of results was from 377 to 592 mm. The average relative pelvic tilt was 0.31° with a standard deviation of 4.17°. The median of distribution of the results of this scale was 0° and the range of results from –9° to 11°. In contrast, the mean relative pelvic tilt was 0.38 mm with a standard deviation of 5.89 mm. The median of distribution of results was –0.34 mm with a standard deviation of 9.72 mm. The median of distribution of the results of this scale was 0 mm and the range of results from –12 mm to 15 mm. The mean relative surface rotation of the scale was –4° and the range of results was from –13° to 16°. In contrast, the mean relative rotation of the surface (+max) was 5.59° with a standard deviation of 5.2°. The median of distribution of the results of this scale was 4° and the results ranged from 0 to 16°. The average overall stability indicator was 0.5 with a standard deviation of 0.35. The median distribution of the results of this scale was 0.4 and the range of results was from 0.2 to 1.9. The average index of the stability A/P was 0.35 with a standard deviation of 0.24. The median of distribution of the results of this scale was 0.3 and the range of results was from 0.1 to 1.3. In contrast, the average score of the stability indicator M/L was 0.27 with a standard deviation of 0.25. The median of distribution of the results of this scale was 0.2 and the range of results was from 0.1 to 1.1 (Table 1).

Discussion

The age of women was on average 54.58 years and the median was 55 years. However, among men the average age was 53 years and the median of the distribution was 57.5 years. A higher mean was found in the group of women, and a higher median was reported in men. There was no significant difference between the sexes ($p = 0.7906$). Body height of women was on average 162.62 cm and the median was 164 cm. However, among the men the mean was 177.83 cm and the median of distribution was 177 cm. There was also a highly significant difference between the sexes ($p = 0.0002$). Weight among women was on average 62.74 kg and the median was 59.4 kg. However, among the men the average was 80.85 kg and the median of distribution was 81.2 kg. Higher means and median were found in the group of men. There was a highly significant difference between the sexes ($p = 0.0011$). Body mass index among women averaged 23.78 kg/m^2 and the median was 22.4 kg/m^2. However, among men the average was 25.57 kg/m^2 and the median of distribution was 25.4 kg/m^2. Although higher means and median were found in the group of men, there was no significant difference between the sexes ($p = 0.1409$) (Table 2). Kyphosis angle among women averaged 51.42° and the

Table 1. Descriptive statistics of the analysed scales

Analysed scales	Descriptive statistics of the analysed scales						
	Mean	Standard deviation	Minimum	Lower quartile	Median	Upper quartile	Maximum
Age [years]	54.28	12.24	32.00	46.50	55.00	63.50	85.00
Height [cm]	165.47	8.10	150.00	159.00	164.50	170.50	184.00
Weight [kg]	66.14	11.05	48.30	57.90	65.60	74.10	89.00
BMI [kg/m^2]	24.12	3.49	17.50	21.60	23.10	26.10	32.30
Kyphotic angle [°]	52.47	9.45	30.00	44.50	54.00	59.50	69.00
Lordotic angle [°]	42.75	10.44	17.00	36.50	41.50	49.50	63.00
Scoliotic angle [°]	18.16	9.76	3.00	12.00	16.00	20.50	48.00
Trunk length (VP-DM) [mm]	445.00	40.72	327.00	424.50	445.50	468.00	542.00
Trunk length [mm]	500.88	40.51	377.00	477.50	501.50	522.00	592.00
Relative pelvic tilt [°]	0.31	4.17	–9.00	–2.00	0.00	2.00	11.00
Relative pelvic tilt [mm]	0.38	5.89	–12.00	–3.00	0.00	3.00	15.00
Relative surface rotation [°]	–0.34	9.72	–13.00	–8.00	–4.00	9.00	16.00
Surface rotation (+max) [°]	5.59	5.20	0.00	1.00	4.00	9.50	16.00
General stability indicator	0.50	0.35	0.20	0.30	0.40	0.60	1.90
Stability indicator A/P	0.35	0.24	0.10	0.20	0.30	0.40	1.30
Stability indicator M/L	0.27	0.25	0.10	0.10	0.20	0.30	1.10

Table 2. Anthropometric parameters depending on gender

Anthropometric scales		Descriptive statistics							*U* Mann-Whitney test
		Mean	Standard deviation	Minimum	Lower quartile	Median	Upper quartile	Maximum	
Age [year]	Women	54.58	11.30	32.0	47.0	55.0	63.0	85.0	$U = 72.00$ $p = 0.7906$
	Men	53.00	16.97	32.0	34.0	57.5	67.0	70.0	
Height [cm]	Women	162.62	5.78	150.0	158.0	164.0	167.0	172.0	$U = 0.00$ $p = 0.0002$
	Men	177.83	3.71	174.0	175.0	177.0	180.0	184.0	
Weight [kg]	Women	62.74	8.79	48.3	57.3	59.4	72.2	78.2	$U = 10.00$ $p = 0.0011$
	Men	80.85	7.15	71.5	74.2	81.2	88.1	89.0	
BMI [kg/m^2]	Women	23.78	3.66	17.5	21.3	22.4	25.8	32.3	$U = 47.00$ $p = 0.1409$
	Men	25.57	2.41	22.9	23.3	25.4	27.8	28.7	

median was 52°. However, among men the average was 57° and the median of distribution was 58.5°. Although higher means and median were found in the group of men, there was no significant difference between the sexes ($p = 0.2094$). Lordosis angle among women averaged 44.27° and the median was 44.5°. However, among men the average was 36.17° and the median of distribution was 38°. Higher means and median were found in female group. There was a significant difference between sexes ($p = 0.0336$). Scoliosis angle among women was 19.35° and the median was 16.5°. However, among men the mean was 13° and the median distribution was 14°. Slightly higher means and median were found in the group of women. There was no significant difference between the sexes ($p = 0.1924$). Trunk length (VP-DM) among women averaged 435. mm and the median was 435 mm. However, among men the average was 486.17 mm and the median of distribution was 472.5 mm. Higher means and median were found in the group of men. There was a highly significant difference between the sexes ($p = 0.0028$). The trunk length among women averaged 492.12 mm and the median was 489 mm. However, among men the mean was 538.83 mm and the median was 528 mm. Higher means and median were found in the group of men. There was a highly significant difference between the sexes ($p = 0.0047$). The relative pelvic tilt among women averaged –0.19° and the median was 0°. Among men the average was 2.5° and the median of the distribution was 1°. There was no significant difference between the sexes ($p = 0.1764$). The relative pelvic tilt among women averaged –0.35 mm and median was 0. Among men the average was 3.5 mm and the median of distribution was 1.5 mm. Higher means and median were found in the group of men. There was no significant difference between the sexes ($p = 0.1764$). The relative surface rotation among women averaged 0.73° and the median was –4°. However, among men the average was –5° and the median of distribution was –6.5°. Higher means and median were found in women. There was no significant difference between the sexes ($p = 0.2565$). The relative surface rotation (+max) of women averaged 6.27° and the median was 6°. However, among men the average was 2.67° and the median of distribution was 1.5°. Higher means and median were found in women. There was no significant difference between the sexes ($p = 0.2668$) (Table 3). The overall stability indicator among women averaged 0.55 and the median was 0.5. Among men the average was 0.3 and the median of distribution was –0.3. Higher means and median were found in women. There was a significant difference between the sexes ($p = 0.0426$). The stability indicator A/P among women averaged 0.37 and the median was 0.3. However, among men the average was 0.23 and the median of distribution was 0.2. Higher means and median were found in the group of women. There was no significant difference between the sexes ($p = 0.1843$). The stability index M/L among women averaged 0.3 and the median was 0.2. However, among men the average was 0.13 and the median of distribution was 0.1. Higher means and median were found in the group of women. There was no significant difference between the sexes ($p = 0.0865$) (Table 4). Spearman rank order correlation showed a positive correlation of relative rotation of the spine area with general stability indicator ($p = 0.0206$) at an average level ($R = 0.4075$) and the stability indicator A/P ($p = 0.0310$), although at a lower level ($R = 0.3819$). With the increase in the relative rotation of the spine area the overall stability indicator and stability indicator A/P also increased. In the case of the stability indicator M/L, there was no significant correlation ($R = 0.2443$, $p = 0.1778$) withthe relative rotation of the surface of the spine. Significant positive correlations were also seen for the surface rotation (+max) and the overall stability indicator ($R = 0.3526$, $p = 0.0478$) and the indicator A/P ($R = 0.3873$, $p = 0.0285$). The increase in surface rotation (+max)

Table 3. Body posture depending on gender

Scales of body posture		Descriptive statistics							*U* Mann-Whitney test
		Mean	Standard deviation	Minimum	Lower quartile	Median	Upper quartile	Maximum	
Kyphotic angle [°]	Women	51.42	9.45	30.0	43.0	52.0	58.0	69.0	*U* = 51.50 *p* = 0.2094
	Men	57.00	8.72	43.0	52.0	58.5	64.0	66.0	
Lordotic angle [°]	Women	44.27	10.78	17.0	40.0	44.5	51.0	63.0	*U* = 33.50 *p* = 0.0336
	Men	36.17	5.56	26.0	34.0	38.0	40.0	41.0	
Scoliotic angle [°]	Women	19.35	10.19	5.0	12.0	16.5	23.0	48.0	*U* = 50.50 *p* = 0.1924
	Men	13.00	5.73	3.0	11.0	14.0	16.0	20.0	
Trunk length (VP-DM) [mm]	Women	435.50	37.11	327.0	423.0	435.0	461.0	491.0	*U* = 15.50 *p* = 0.0028
	Men	486.17	29.86	464.0	468.0	472.5	498.0	542.0	
Trunk length [mm]	Women	492.12	37.92	377.0	474.0	489.0	515.0	584.0	*U* = 19.00 *p* = 0.0047
	Men	538.83	29.25	514.0	519.0	528.0	552.0	592.0	
Relative pelvic tilt [°]	Women	–0.19	4.08	–9.0	–2.0	0.0	2.0	11.0	*U* = 49.50 *p* = 0.1764
	Men	2.50	4.18	–2.0	0.0	1.0	6.0	9.0	
Relative pelvic tilt [mm]	Women	–0.35	5.65	–12.0	–3.0	0.0	3.0	15.0	*U* = 49.50 *p* = 0.1764
	Men	3.50	6.41	–3.0	0.0	1.5	6.0	15.0	
Relative surface rotation [°]	Women	0.73	10.15	–13.0	–8.0	–4.0	10.0	16.0	*U* = 54.00 *p* = 0.2565
	Men	–5.00	6.23	–11.0	–8.0	–6.5	–5.0	7.0	
Surface rotation (+max) [°]	Women	6.27	5.46	0.0	1.0	6.0	12.0	16.0	*U* = 54.50 *p* = 0.1614
	Men	2.67	2.42	1.0	1.0	1.5	4.0	7.0	
	Men	3.16	2.00	0.00	9.00	0.00	6.00	3.60	

Table 4. Postural stability depending on gender

Scales of postural stability		Descriptive statistics							*U* Mann-Whitney test
		Mean	Standard deviation	Minimum	Lower quartile	Median	Upper quartile	Maximum	
General stability indicator	Women	0.55	0.37	0.2	0.3	0.5	0.6	1.9	*U* = 35.50 *p* = 0.0426
	Men	0.30	0.13	0.2	0.2	0.3	0.4	0.5	
Stability indicator A/P	Women	0.37	0.26	0.1	0.2	0.3	0.4	1.3	*U* = 50.00 *p* = 0.1843
	Men	0.23	0.10	0.1	0.2	0.2	0.3	0.4	
Stability indicator M/L	Women	0.30	0.26	0.1	0.1	0.2	0.3	1.1	*U* = 42.00 *p* = 0.0865
	Men	0.13	0.05	0.1	0.1	0.1	0.2	0.2	

was associated with the occurrence of higher values of the overall stability indicator and stability indicator A/P (Table 5). The relationship between the quality of posture and postural stability of the people practicing other Chinese gymnastic system, so-called tai-chi, was analysed by Kuczyński [25]. He examined 59 persons aged 34–70 years in the context of the impact of this activity on the dynamic properties of posture. Free postural stability was evaluated at the beginning, after 6 weeks, and at the end of the tai-chi course. There was a significant reduction in the dispersion of the COP (centere-of-foot pressure) in the frontal plane after

Table 5. Correlation of Spearman rank order between the scales of posture and postural stability

A pair of variables		Spearman rank order correlation		
		R	*t*	*p*
Kyphotic angle [°]	GSI	–0.1171	–0.6457	0.5234
	IA/P	–0.0478	–0.2620	0.7951
	IM/L	0.0481	0.2638	0.7938
Lordotic angle [°]	GSI	0.0116	0.0637	0.9497
	IA/P	0.1384	0.7657	0.4498
	IM/L	0.2021	1.1304	0.2672
Scoliotic angle [°]	GSI	0.0521	0.2858	0.7770
	IA/P	0.0247	0.1352	0.8934
	IM/L	–0.0225	–0.1232	0.9028
Relative pelvic tilt [°]	GSI	0.1067	0.5880	0.5609
	IA/P	–0.0197	–0.1080	0.9147
	IM/L	–0.0240	–0.1314	0.8963
Relative surface rotation [°]	GSI	0.4075	2.4443	0.0206
	IA/P	0.3819	2.2633	0.0310
	IM/L	0.2443	1.3801	0.1778
Surface rotation (+max) [°]	GSI	0.3526	2.0640	0.0478
	IA/P	0.3873	2.3009	0.0285
	IM/L	0.1433	0.7932	0.4339

6 weeks, especially in the sample with eyes closed (CE), and in the second half of the course this tendency was already slower. Changes in the sagittal plane showed the same direction, but they were on the verge of significance. Slightly different phenomena were observed in postural stability in the light of visco-elastic parameters. After 6 weeks no statistically significant differences were noted. In contrast, at the end of the course (after 12 weeks) stability was improved. A closer analysis of the data shows, however, a completely different character of changes in both planes of motion. In the sagittal plane, they persisted in samples with eyes closed (CE), while in the frontal plane they persisted in the samples with open (OE). In the sagittal plane with eyes open (EO) the results before the start of tai-chi course did not differ from the results of young people, apart from reduced stiffness and viscosity, which resulted from a lower weight of those practicing tai-chi. Otherwise they changed the dynamics of posture with eyes closed (CE). It is known that one of the major features that distinguishes the quality of the equilibrium as a function of age is the significant difference in the use of sight [25, 26]. In this case, the results show an improvement in the stability of the body caused by the exercise of tai-chi. There was a reduction in the dispersion of the COP as a result of training, in addition to a significant increase observed in all parameters, again to a level significant for young people. According to Kuczyński, these trends may be permanent, as opposed to temporary phenomena observed in other examples where introduced restrictions resulted in the pattern of changes in visco-elastic parameters consistent with the theory [25]. The deterioration of these proportions in this group may indicate the occurrence, as a result of regular physical activity, of a new model of the same structure, but with changed dynamic properties, similar to young people. In the frontal plane during the first test there were significantly reduced values of the visco-elastic parameters compared to normative data. Despite this, the dispersion of the COP was very small. This proves the existence of compensatory mechanisms involving the mutual support of the sensory systems: visual, labyrinthine, and proprioceptive [27]. As found in poorer postural stability degeneration, of one of these systems could have been masked by the takeover of its functions by the other. After completing the tai-chi course, the stability of posture with eyes open (EO) returned to the data similar to standard, and the dispersion of the COP decreased, which confirms the beneficial effects of the exercise. Changes with eyes closed (CE) were not significant, although they proceeded in the right direction and also led to a significant reduction of the COP. There was a significant relationship between the practice of tai-chi and posture stability, which is confirmed by other authors [28–30].

Conclusions

There was a positive correlation of relative rotation of the spine area with a general stability indicator at the average level. There was a positive correlation of relative rotation of the surface with stability indicator A/P, although at a lower level. With the increase in the relative rotation of the spine area the overall stability indicator and stability indicator A/P also increased. Significant positive correlations also occurred for the surface rotation (+max) and general stability indicator and the stability indicator A/P. With the increase of the surface rotation (+max) of the spine the overall stability indicator and stability indicator A/P also increased.

Conflict of interest

The authors declare no conflict of interest.

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