RELATIONSHIP OF BREATHING EXERCISES WITH IMPROVEMENT OF POSTURAL STABILITY IN HEALTHY ADULTS

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Abstract

The aim of this research was to explore if breathing exercises performed three times a week for 10 minutes increase intra-abdominal pressure and a postural balance improvement. During the last 20 years, core exercises have been an important part of most recreational fitness programs, with the intent that's focused on injury-prevention and postural stability improvement. In the principles of kinesiology and physiology, positions and movements are subordinated to processes of breathing. To test whether increased intra-abdominal pressure can be achieved using breathing exercises as a part of recreational exercising program, sample of 16 subjects divided into experimental group of 8, and control group of 8 people have taken posturo cybernetic test. For this experiment we used DNS breathing exercises, DNS intra-abdominal pressure test and a Posturomed machine. Tested participants have shown an improvement in balance, although the experimental group has shown significant improvement in balance. Thereby, this confirms that simple breathing exercises improve postural stability in 15 days, if performed three times a week for 10 minutes.

Key words: *diaphragm, posture, intra-abdominal pressure, DNS, GFM.*

Introduction

The role of abdominal muscles in maintaining postural stability remains undefined, causing researchers to experiment with intra-abdominal pressure, transverse abdominis concentric activation (hollowing) and eccentric contractions of other muscles of abdominal wall (Hodges et al., 2003). Groundforce method is recreational exercise system that relies its basis at bodyweight, mobility drills and metabolic outcome. This exercising program does not refer to any of the exercises on breathing, more than it is already usual in common physical recreation.DNS (Dynamic neuromuscular stabilisation) is based on developmental kinesiology, a science of maturation of the human movement system during the time of early development from birth and the first breath, until the child starts walking. Breathing exercises, as a part of DNS, are composed of conscious and volitional breathing, accompanied with movement of the body parts. With every contraction, the diaphragm increases the intra-abdominal pressure, causing the eccentric contraction of abdominal muscles which influence postural stability. Every static position of the body (standing, sitting…) does not include any changing of the bodily position in space. However, successful resisting to the change must contain dynamic processes. The ability to keep a posture which does not allow uncontrolled falling is known as postural stability (Kolář, 2013).

It is being recognized that the stabilization of the body in sport activities is conceived in core, which is situated in the center of the human body. There is not enough clarity about what anatomically „the core", is (Kibler, Press, & Sciascia, 2006). Diaphragm, a breathing muscle, is a main link that by its contraction initiates proper intra-abdominal pressure; IAP (Willson, Dougherty, Ireland & Davis, 2005), which is responsible for spinal stabilization and postural balance via eccentric contraction of abdominal muscles. And vice versa, challenges to posture can indirectly change breathing pattern. Depression of the diaphragm together with other abdominal muscles increases the intra-abdominal pressure (Kolář, 2013), in other literature also called - brace. But, its function and importance is not being mentioned in most of the studies that concern stabilization and core. Martial arts also refer to the solar plexus as a center of balance, power and strength. Also, some initiators of popular systems of exercise, such as pilates, do not include diaphragm into their definition of the "core". The aim of research is to determine the existence between the breathing quality and quality of stabilization. Articles and studies written about postural stability issue, aim to explore activation of the lower limbs muscles (Dohm-Acker, Spitzenpfeil & Hartmann, 2008; Wolburg, Rapp, Rieger & Horstmann, 2016) and also the improvements of the bodily balance created on the basis of proprioceptive training (Pfusterschmied et al., 2013). Researches that have been addressing postural stability and core imbalances, use different platforms or proprioceptive training equipment for collecting data (Stanton, Reaburn & Humphries, 2004), but often with no further attention to details that can affect test results such as: fists gripping, jaw clenching, pelvic floor muscles contracting and, for this work most importantly - holding breath. This, quantitative designed experiment is aiming to be a good start in narrowing the circle of unseen contractions during stability testing which can affect, actually increase the results of any stability testing. Choosing the experimental method, on 16 people sample, this research measured and collected data which gives us a clear insight of how practice of breathing exercises affect postural stability in just 15 days. Furthermore, there is a great will to improve balance and core stability in

elderly persons with osteoporosis, as a prevention of falls and fractures. Breathing exercises that affect intra-abdominal pressure are cheap and low impact method to be infiltrated into medicinal fitness. Education of elderly people about breathing is a lot cheaper procedure than medical expenses caused by treating osteoporosis consequences. The aim of this research was to explore if breathing exercises performed three times a week for 10 minutes as a part of recreational Ground force method training of healthy adults affect reflex engagement of the muscles involved in intra-abdominal pressure creation and therefore, a balance improvement.

Methods

Samples of 16 (male and female) subjects were between 30 and 40 years old, with no recent proof of not being healthy. The subjects were divided into two sub-samples: control group (8 persons) and experimental group (8 persons). For minimal 6 months, all were included in the same recreational program (ground force method) of exercising three times a week. Exclusion criteria were: injuries, surgeries, ear diseases or deviations, respiratory problems, pregnancies and giving birth within 6 months. Prior to the tests, all the BA group participants were submitted to DNS diaphragm tests of intra-abdominal pressure quality, to ensure that their intra-abdominal pressure is properly activated. Paušić, Kuzmanić, Ivančić & Krželj (2016) examined the validation parameters of the Diaphragm Test (Dynamic Neuromuscular Stabilization) and the pattern of diaphragm activation in students of Faculty of Kinesiology University of Split. The ICC has been considered an acceptable level using it in assessing rater reliability of the Diaphragm Test.

Entities included in this testing were instructed to step barefoot with one leg to the platform, hold other leg up (heel in the height of the opposite knee, legs not touching) and keep the exact position for 10 seconds without leaning with their hands on the platform fence. They were obligated to breathe normally, not to hold breath, not to chew (a gum), not to clench their teeth or squeeze their fists. Eyes were directed straight forward to a certain spot drawn on a blackboard. If any of these criteria was not followed for more than 3 seconds, certain attempt was cancelled and a subject was encouraged to try again. Posturomed device is connected with PC and using Mycroswing software it allows a researcher to track the results during measurements. During balancing, the measurements are instantly being calculated in percentage. It uses variables: right leg shift by axis x and y, left leg shift by axis x and y.

The results are displayed in percentage for the right leg, for the left leg and for both legs, accurately, the average value of the result of both legs. This experiment had two main steps: 1) A sample of 16 subjects approached the posture-cybernetic test using the Posturomed machine, by manufacturer Micro swing. A platform is connected with computer and using the simple program it measures the balance in one leg stance position. All the tests were done individually, repeated once, randomly, for 10 times on both legs. Each test lasted 15+/- 5 minutes, and the participants were ready to approach after 5 minutes of warm-up exercises; which were the same for all. Then, the results were calculated to get the initial results; 2)The ETM group was divided in two sub-samples of 8 people, breathing exercises group (BA group) and control group (CON group). On the beginning of 25 days period, the first sample took a short (1 hour) „Functional breathing" workshop, in which they were introduced to a part of anatomy that concerns breathing. After awakening of their natural breathing pattern with Dynamic neuromuscular stabilization exercises (DNS), breathing exercises were given for a 10 minutes practice, during their regular ground force method classes three times a week (BE group). After 21-25 days, the same posture-cybernetic test took place. Prior to the tests, all the BE group participants were submitted to DNS tests of intra-abdominal pressure quality, to ensure that their intra-abdominal pressure is activated. All 8 subjects of the first sample were tested, for the second time. The control group of 8 people did not change anything in their daily physical practice and after 21-25 days, have repeated the posture-cybernetic test (CON group).

Therefore, after 21-25 days, the Posturomed machine, by manufacturer Bio swing was used for the exact same testing. The results were calculated via Excel to get the final scores. The data was analyzed in program Statistica 13,2. Descriptive statistics was calculated for all variables for initial and final measurements. Assessment of the normality of data was conducted with the Kolmogorov-Smirnov Test. ANOVA repeated measures was used to analyze results in which responses on multiple dependent variables (breathing exercises group and control group) correspond to measurements at different levels on two factors. Distribution is considered normal when significance level (p) is higher than 0,05.

Results and discussion

The results of the K-S test (Table 1) show that all variables are normal distributed. Because of fact that all variables are normal distributed the parametric procedure of ANOVA was used to show us where are differences. Average values of all variables total moved from 512.975 to 1550.944 millimeters. In axis x and y average value in all initial and final measurements moved in range from 71.443 (axis y F_L) to 1516.622 (axis x I) millimeters. A recent study which used the same stability platform and subjects included in the same recreational program of exercises three times a week, have shown that their stability was among average and that it varies in positive direction by a small percentage from a control group composed of entities which have had the same predispositions, except exercising three times a week a Ground

force method training. Its hypothesis that regular recreational exercising of Ground force method positively refers to postural stability has been rejected (Mijić, 2017). It is clear that a usual recreational fitness program, even though it is based on mobility and stability background, does not affect postural stability in a way of statistical significance. Therefore it is of the great importance to consider parameters such as breathing in this equation and to move further in this direction while gaining the aim of postural balance improvement.

Table 1 Descriptive statistics of all variables in initial and final measurement.

Variable	AS	SD	Skewness	Kurtosis	max D	K-S p
axis x I	1516.622	470.360	1.069	1.627	0.187	p > .20
axis y I	157.443	31.869	0.106	-0.458	0.185	p > .20
total traveled way I	1550.944	471.933	1.099	1.720	0.192	p > .20
axis x I_R	749.811	259.512	0.808	1.242	0.113	p > .20
axis y I_R	81.800	17.066	-0.492	0.876	0.128	p > .20
total traveled way I_R	768.181	259.636	0.805	1.294	0.113	p > .20
axis x I_L	766.811	284.401	2.366	7.391	0.257	p > .20
axis y I_L	75.643	18.033	0.716	0.050	0.146	p > .20
total traveled way I_L	782.763	286.218	2.392	7.487	0.258	p < .20
axis x F	993.977	251.401	-0.050	-0.522	0.213	p > .20
axis y F	139.907	30.317	-1.006	0.835	0.199	p > .20
total traveled way F	1028.440	251.470	-0.120	-0.546	0.207	p > .20
axis x F_R	541.434	144.759	0.527	0.468	0.140	p > .20
axis y F_R	73.256	16.530	0.371	-0.657	0.109	p > .20
total traveled way F_R	557.818	145.035	0.496	0.363	0.127	p > .20
axis x F_L	493.661	113.919	-0.654	-0.650	0.200	p > .20
axis y F_L	71.443	11.837	-1.319	1.705	0.194	p > .20
total traveled way F_L	512.975	112.065	-0.731	-0.512	0.206	p > .20

Legend: I - initial test, F - final test, L - left, R - right, N - the number of participants, AS - mean, SD - standard deviation, max-D – maximum difference, K-S - Kolmogorov-Smirnov test, p - p value

Table 2 ANOVA for differences between groups in initial and final measurement.

variable	SD ba I-F	SD con I-F	df	F	p
axis x_T - groups	527.080 - 248.535	282.325 – 249.605	**1**	**7.874**	**0.014**
axis y_T – groups	23.021 - 34.007	16.868 – 26.647	**1**	**10.978**	**0.005**
total traveled way TOTAL - groups	524.410 - 247.311	280.463 – 250.081	**1**	**8.036**	**0.013**
axis x_R - groups	251.309 - 133.986	192.478 – 161.261	**1**	**16.779**	**0.001**
axis y_R - groups	10.937 - 14.317	12.501 – 19.506	**1**	**7.865**	**0.014**
total traveled way_R - groups	247.620 - 133.368	192.489 – 162.478	**1**	**17.080**	**0.001**
axis x_L - groups	367.716 - 120.103	144.378 – 114.881	1	2.556	0.132
axis y_L - groups	16.155 - 10.033	10.152 – 13.859	**1**	**10.039**	**0.007**
total traveled way_L - groups	368.798 - 117.087	144.204 – 113.941	1	2.738	0.120

Legend: T - total, L - left, R - right, groups – experimental and control group, df = degrees of freedom, F - F value, p - p value.

There was a statistically significant effect between initial and final measurement of two groups in all variables (p was lower of 0.05), except in standing on left foot in axis x and total travel way (Table 2). The F value shows use that there are big differences between initial and final measurements. All subjects from group that have breathing exercises have better results in final measurements in all variables except in axis y_T and axis y_R, while opposed to them control group have worse results in all axis y and similar results in other variables. Hodges et al. (1997) emphasizes that contraction of the diaphragm precedes the onset of movement of the limb and support the hypothesis that this preparatory action may aid truncal stability. The increase in spinal stiffness was positively correlated with the size of the intra-abdominal pressure - IAP increase. IAP increased stiffness at L2 and L4 level. The results of this study provide evidence that the stiffness of the lumbar spine is increased when IAP is elevated (Hodges et al., 2005). We can conclude that spinal stiffness contributes lumbar stability which affects postural balance. Using the exact same tests on Posturomed machine, Budimir has proven that the exercise that requires the great amount of mobility and a range of motion; specifically a squat performed repetitively until failure, has a negative impact on postural balance. (Budimir, 2017) The mechanical effectiveness of breathing is altered under pathological conditions, aka stress, which most probably occurred during squat repetitions.

In a resting state, it is around 1% and with more intensive demand it increases to 4/5%. One of the predispositions for that cause is an elevated position of the diaphragm, which means that its involvement in process of inspiration is insufficient (Kolář, 2013). Diaphragm is not able to contract in its full range of motion and according to that, intra-abdominal pressure creation and postural balance are decreased.

Conclusion

Tested participants have shown an improvement in balance, although the test group has shown significant improvement in balance. Thereby, this confirms that simple breathing exercises improve postural stability in 15 days, if performed three times a week for 10 minutes. Breathing exercises as a three times a week activity has increased postural balance in healthy adults, as a result of their intra-abdominal pressure improvement. This study is aiming to be among pioneers in narrowing the circle of unseen and uncoordinated or compensatory contractions during stability testing which can increase the results of any stability testing. Furthermore, rising the awareness of having properly engaged all abdominal muscles that create intra-abdominal pressure, compensatory patterns are presupposed to be reduced and postural balance achieved.

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POVEZANOST VJEŽBI DISANJA SA POBOLJŠANJEM POSTURALNE STABILNOSTI ZDRAVIH ODRASLIH OSOBA

Sažetak

Tijekom posljednjih 20 godina, core vježbe su važan dio većine rekreativnih fitness programa, s namjerom prevencije ozljeda i poboljšanja posturalne stabilnosti. Nema dovoljno jasnoće o tome što je "core". Dijafragma, mišić disanja, kontrakcijom inicira intraabdominalni tlak, odgovoran za stabilnost kralježnice i posturalnu ravnotežu preko ekscentrične kontrakcije trbušnih mišića. No, njezina funkcija i važnost se ne spominju u većini studija koje istražuju stabilizaciju. Cilj ovog istraživanja bio je istražiti je li vježbe disanja koje se izvode tri puta tjedno tijekom 10 minuta kao dio rekreativne vježbe za zdrave odrasle osobe, utječu na refleksno angažiranje mišića koji su uključeni u stvaranje intra-abdominalnog tlaka i time poboljšanje ravnoteže. Uzorak od 16 muških i ženskih ispitanika testiran je pomoću Posturomed stroja, tvrtke Bioswing. Ispitanici su imali između 30 i 40 godina, zdravi. Za minimalno 6 mjeseci svi su bili uključeni u isti rekreacijski program vježbi tri puta tjedno. Zatim je uzorak podijeljen u poduzorke. Prva polovica od 8 osoba dobila je kratki tečaj vježbi disanja, koji su se obvezali dvaput tjedno provoditi 10 minuta, neposredno prije njihove redovne rutinske vježbe (BE grupa). Nakon 21-25 dana provedeno je isto ispitivanje. Kontrolna skupina od 8 osoba nije ništa promijenila u svakodnevnoj praksi i nakon 21-25 dana ponovila je test (CON grupa). Vježbe za disanje kao aktivnost tri puta tjedno povećale su posturalnu ravnotežu kod zdravih odraslih osoba, kao rezultat njihovog poboljšanja tlaka unutar abdomena.

Ključne riječi: *dijafragma, tjelesna postura, intra-abdominalni tlak, DNS, GFM.*

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