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ACUTE EFFECT OF INSPIRATORY MUSCLE WARM UP PROTOCOL ON DYNAMIC AND STATIC BALANCE PERFORMANCE[i]

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Abstract:
The aim of this study is to examine the acute effect of inspiratory muscle warm-up protocol on dynamic and static balance performance. For this purpose, 17 sedentary individuals participated whose ages were between 20-26 years old. On different days, right static, left static, right dynamic and left dynamic tests were applied to the subjects randomly after control, placebo and experimental protocol. PowerBreathe brand inspiratory training device was used for inspiratory warming and Biodex Balance SD isokinetic balance test mechanism was used for measurement. The data obtained as a result of the test were analyzed by using the SPSS package program version 22.0. The data obtained were analyzed separately for General balance, Anterior-Posterior (A-P) balance and Medial-Lateral (M-L) balance groups. According to the result obtained, while the inspiratory warming protocol created a significant positive effect in some balance groups, it did not create a significant effect in some balance groups. Therefore, it can be said that the inspiratory warming protocol affects some balance parameters but this effect is not a level that can directly benefit the performance.

Keywords: warm-up, inspiratory, balance, training, respiratory

1. Introduction

The first step before almost any sporting activity, competition or training session is to warm up (1). Generally, the warm-up is the work done to prepare the athletes physiologically and psychologically, to take precautions against possible injuries, to increase their competition or training performance or to get the maximum efficiency from

[i] The present study was produced from master of science thesis of Adem Bilgiç with the same title.
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the sportive activity (2,3). In addition, it has been stated that warming, stretching and massage before or after sports activity reduces the risk and effect of muscle damage, which is more common as a result of eccentric exercises (4).

More than one discourse has been made to describe warming. If we need to make a general statement and definition, warm-up is usually done before exercise to maximize the efficiency of the person's motoric features. It also minimizes potential injuries and disabilities.

The meaning of the word balance is explained as the ability of an entity with mass to stand without tipping over (5). Its use in the sense of sport has been generalized as the stability of the trunk (6).

Balance is of great importance for the sportive performance or success that the person desires, and it is also the element of the neuromuscular system that has the mission of transmission. In addition to these, having a good balance ability is a very valuable condition for developing motor skills and adapting to new ones quickly (7).

When the oxygen requirements of the tissues increase during sports performance, the amount of oxygen provided to the tissues by the respiratory system should also increase. Due to the increase in the amount of carbon dioxide and body temperature resulting from the oxygen requirement in the tissues, the circulatory and respiratory systems should work together to restore the metabolic balance (8,20). During physical activity, respiratory muscles help respiration take place. The muscles around the rib cage that pull it up are the main muscles that help with breathing. Intercostal muscles and abdominal muscles help with exhalation efficiency thanks to the pressure they create. The airflow reaches its highest levels with the especially help of these muscles (9, 21, 22).

Considering this information, it is critical to investigate whether the inspiratory warm-up method will affect or how will affect balance performance, and that research on this subject will be a source and benefit for both sports sciences and future research in this field. The physical and physiological effects of warm-up protocols on the body and sportive performance have been revealed by studies. Testing the warm-up with more specific protocols may reveal more significant effects on physical and physiological performance.

So that the aim of the study is to examine the acute effects of inspiratory muscle warming protocol on dynamic and static balance performance.

2. Methods

Table 1: Descriptive statistics of the participants

	Min.	**Max.**	**Mean**	**Std. D.**
Age (years)	20.00	26.00	22.35	1.69
Height (cm)	170.00	192.00	178.53	7.06
Body Weight (kg)	60.00	94.00	74.35	9.30
Body Mass Index (kg/m^2)	19.62	26.64	23.30	2.21

2.1. Experimental Design

Our study was designed according to a randomized placebo-controlled crossover experimental design. 17 sedentary male subjects (Table 1) in the 20-26 age group participated in the study. As inclusion criteria, it was sought that the subjects did not have any health problems, as well as not having any sports branch and a training program that they regularly participated in. Subjects visited the laboratory 4 times in total within the scope of the study.

- On the first visit; after general information about the study will be given to the subjects, in addition to age, height and weight measurements, static and dynamic balance measurements were taken and these measurements were called the control application.
- In the other 3 visits (2nd, 3rd and 4th visits), the following applications were made randomly and immediately after that, dynamic and static balance measurements were made;
- Inspiratory muscle warm-up (%40 intensity), (IMW)
  - Placebo inspiratory muscle warm-up (%5 intensity) (IMWp)
  - General warm-up (GW)

2.2. Procedures

2.2.1. Inspiratory Muscle Warm-up (IMW) Procedure

With the Powerbreathe brand inspiratory muscle training device, the subjects were asked to do normal inspiration and expiration with 2 sets x 30 breathing devices at 40% of the maximal inspiratory intraoral pressure (MIP). Also, 1-minute rest period was given between 2 sets. (10). An electronic respiratory pressure gauge was used to determine the maximal intraoral pressure. Measurements were made in the sitting position using a nasal plug. For MIP; The person was given a maximal expiration and the person was asked to make maximum inspiration against the closed respiratory tract and continue it for 1-3 seconds. The measurement was repeated until there was a difference of 5 cmH2O between the two best measurements and the best result was recorded in cmH2O (10).

2.2.2. Placebo Inspiratory Muscle Warm-up (IMWp) Procedure

With the Powerbreathe brand (Picture 1) inspiratory muscle training device, the subjects were asked to do normal inspiration and expiration with the device in the form of 2 sets x 30 breaths at 5% of the maximal inspiratory intraoral pressure (MIP). Also, a 1-minute rest period was given between 2 sets (10).

2.2.3 General Warm-up Protocol

The subjects applied dynamic warm-up exercises consisting of 5 different movements for the trunk muscles. The warm-up lasted for an average of 10 minutes and consisted of the following movements in a way that did not cause fatigue; 10 sit-ups, 10 reverse sit-ups, 20 trunk flips, 20 trunk abduction/adduction, 30sec pocketknife position. 30-second rest was given between each movement (11).

2.3. Obtaining Data

2.3.1. Dynamic Balance Test

A single leg dynamic balance test was applied in Biodex Balance SD isokinetic balance test mechanism (Picture 2.). The subject placed the dominant foot on the balance beam platform at an angle of 5 degrees and when it was ready, the servo motors that kept the platform stable were activated and the test was started and the platform was loosened. He kept his balance in this position for 3x20 seconds (10 seconds rest) and the test was terminated. At the end of the test, general balance, anterior/posterior balance, and medial/lateral balance scores were obtained. The obtained balance score showed that as it approaches 0, posture preservation is achieved, and as it moves away from 0, posture preservation deteriorates (12).

2.3.2. Static Balance Test

Single-leg static balance test was applied in the Biodex Balance SD isokinetic balance test mechanism. The subject placed his dominant foot on the balance beam platform at an angle of 5 degrees and when he was ready, the test started on the fixed platform. In this position, he maintained his balance in the form of 3x20 seconds (10 seconds rest) and the test was terminated. At the end of the test, general balance, anterior/posterior balance, and medial/lateral balance scores were obtained. The obtained balance score showed that as it approaches 0, posture preservation is achieved, and as it moves away from 0, posture preservation deteriorates (12).

2.4. Statistical Analyses

The data obtained at the end of the research; Excel program (Microsoft Office, version 2013, Microsoft Corp., Redmond, WA, USA) for classification and calculation of percentage differences, SPSS package program (SPSS for Windows, version 22.0, SPSS Inc., Chicago, Illinois, USA) for statistical analysis. USA) was used. Data were presented as mean, and standard deviation. Shapiro-Wilk test was used for the normality test. Skewness and kurtosis values were checked for data sets that did not show normal distribution, and data sets within ±2 were considered to have a normal distribution. One-way analysis of variance was performed in repeated measurements to analyze the difference between applications. LSD correction test was applied to check between which applications there was a significant difference. Statistical results were evaluated at 0.05 significance levels.

3. Results

Table 2 shows the analysis of the participants' right foot static balance scores between control, placebo and experimental application. As a result of the analysis, significance was determined between control, placebo and experimental applications in the A-P balance measurements of the participants ($p<0.05$). The significant difference detected between the control and the experimental application emerged in favor of the experimental application. No significant difference was found between other balance measurements and applications (p>0.05).

Table 2. Cross-application analysis of right static balance scores

		Mean	**Std. D.**	**F**	**p**	**Difference**
General balance	T1	0.98	0.79	2.382	0.12	-
	T2	0.70	0.42			
	T3	0.57	0.32			
A-P balance	T1	0.66	0.58	3.511	0.04	T3-T1
	T2	0.45	0.27			
	T3	0.33	0.11			
M-L balance	T1	0.59	0.58	1.163	0.32	-
	T2	0.42	0.30			
	T3	0.37	0.32			

A-P: Anterior-Posterior. **M-L**: Medial-Lateral; **T1**: Control Application. **T2**: Placebo Application. **T3**: Experiment Application.

Table 3 shows the analysis of the participants' right foot dynamic balance scores between control, placebo and experimental application. As a result of the analysis, significance was determined between control, placebo and experimental applications in the A-P balance measurements of the participants (p<0.05). The significant difference detected between the control and the experimental application emerged in favor of the experimental application. No significant difference was found between other balance measurements and applications (p>0.05).

Table 3: Cross-application analysis of right dynamic balance scores

		Average	**Std. Deviation**	**F**	**p**	**Difference**
General balance	T1	1.49	0.55	1.795	0.191	-
	T2	1.24	0.67			
	T3	1.12	0.52			
A-P balance	T1	1.12	0.33	2.874	0.048	T3-T1
	T2	0.94	0.57			
	T3	0.78	0.28			
M-L balance	T1	0.89	0.47	1.061	0.358	-
	T2	0.69	0.33			
	T3	0.76	0.48			

A-P: Anterior-Posterior. **M-L**: Medial-Lateral; **T1**: Control Application. **T2**: Placebo Application. **T3**: Experiment Application.

Table 4 shows the analysis of the participants' left foot static balance scores between control, placebo and experimental application. As a result of the evaluations, no significant difference was found between control, placebo and experimental applications in terms of left static balance scores (p>0.05).

Table 4: Cross-application analysis of left static balance scores

		Mean	Std. D.	F	p	Difference
General balance	T1	0.74	0.36	2.739	0.080	-
	T2	0.55	0.26			
	T3	0.56	0.23			
A-P balance	T1	0.51	0.29	2.174	0.141	-
	T2	0.38	0.20			
	T3	0.38	0.18			
M-L balance	T1	0.39	0.19	2.291	0.123	-
	T2	0.29	0.13			
	T3	0.31	0.14			
A-P: Anterior-Posterior. **M-L**: Medial-Lateral; **T1**: Control Application. **T2**: Placebo Application. **T3**: Experiment Application.						

Table 5 shows the analysis of the participants' left foot dynamic balance scores between control, placebo and experimental application. As a result of the analysis, significance was determined between control, placebo and experimental applications in the A-P balance measurements of the participants ($p<0.05$). The significant difference detected between the control and the experimental application emerged in favor of the experimental application. No significant difference was found between other balance measurements and applications ($p>0.05$).

Table 5: Cross-application analysis of left dynamic balance scores

		Average	Std. Deviation	F	p	Difference
General balance	T1	1.50	0.64	1.799	0.192	-
	T2	1.27	0.70			
	T3	1.16	0.35			
A-P balance	T1	1.11	0.45	2.842	0.050	T3-T1
	T2	0.90	0.51			
	T3	0.83	0.28			
M-L balance	T1	0.86	0.51	0.625	0.509	-
	T2	0.82	0.46			
	T3	0.71	0.27			
A-P: Anterior-Posterior. **M-L**: Medial-Lateral; **T1**: Control Application. **T2**: Placebo Application. **T3**: Experiment Application.						

4. Discussion

According to the results obtained from these studies, the inspiratory warming protocol applied significantly affected the A-P balance parameters in the static balance of the right foot ($p<0.05$). However, there was no significant difference in general balance and M-L balance parameters. In the left foot static balance test, there was no significant difference between the none of applications in the general balance, A-P balance and M-L balance parameters ($p>0.05$). In our study, quadrant (quarter) values, another data obtained in static and dynamic balance measurements, were also examined, but no significant difference was found in terms of general balance, A-P balance and M-L balance in these data ($p>0.05$). In the right foot dynamic balance measurements, a significant difference was found in the A-P balance parameters between the applications ($p<0.05$), but there was no significant difference in the general balance and M-L balance parameters ($p>0.05$). Also in the left foot dynamic balance measurements, a significant difference was found in the A-P balance parameters between the applications ($p<0.05$), but there was no significant difference in the general balance and M-L balance parameters ($p>0.05$).

In a study conducted by Costa et al. in 2009, the acute effect of stretching movements trained at different duration on dynamic balance was examined. The subjects used a bicycle ergometer (70 rpm and 70 W) during the warm-up and then performed each protocol including passive stretching for the lower extremities for 3x15 sec and 3x45 sec. When the results of the study were examined, it was stated that stretching for 15 seconds significantly affected dynamic balance ($p<0.01$), while stretching for 45 seconds did not statistically affect dynamic balance performance. (13).

In 2011, Denerel investigated the acute effects of a warm-up protocol, which includes static and dynamic stretching movements, on dynamic balance. When the results of the research were examined, it was determined that all three protocols including static stretching, dynamic stretching and balance applications had a significant positive effect on dynamic balance performance ($p<0,01$) (14).

Köse investigated the effect of different warm-up methods on balance performance in 2014. In the study, the subjects were given static warm-up, dynamic warm-up and warm-up run, with an interval of 24 hours. After the warm-up protocols, static and dynamic balance measurements were made by using an isokinetic balance measuring device. When the results obtained from the dynamic balance test were examined, there was no statistically significant difference except for the average balance error figures of the three different warming protocols applied ($p>0.05$). When the data obtained from the static balance test were examined, it was seen that the static and dynamic warm-up protocol applied in the experiment was more effective than the warm-up run and gave positive results ($p<0.01$). As a result, it is thought that static and dynamic warm-up exercises in addition to the warm-up run will affect the static balance performance more positively. (15).

In a study conducted by Çelebi in 2001, the effect of stretching and warm-up + stretching exercises on dynamic balance was examined. According to the results obtained from the study, it is understood that stretching and warm-up + stretching exercises affect dynamic balance positively (16).

In the experiment Behm et al. conducted with 16 male university students with an average age of 24.1 years in 2004, they warmed up for 5 minutes with 70 rpm and 1 kg resistance using a bicycle ergometer, and then applied static stretching training. Then, when the balance performance results of the group which performed warm-up and static stretching were examined, a negative effect of 2.2% was detected, although there was no significant difference. It is predicted that the reason for the difference between the results here and the results obtained from the literature review of previous studies may be due to the long duration of the stretching exercise protocol applied by Behm et al. (17)

In a study conducted by Özdal in 2016, it was stated that the exercise performed for the core area for 8 weeks increased respiratory muscle strength and significantly reduced respiratory muscle fatigue (18). Therefore, in this study, the relation between the core region and respiratory muscles has been revealed. According to the results of Özdal's doctoral study in 2015, inspiratory warming has an acutely positive effect on balance performance as it improves the contraction-tension ratio and contractility skills of the core muscles, in addition to increasing blood circulation. Because the core muscles are located around the center of gravity and therefore affect the balance performance. However, it is thought that this result is not exactly at a rate that can positively affect sportive performance (19). As a matter of fact, this situation showed parallelism with our study because while some of the balance scores were positively affected in the results examined, there was no significant effect in some of them. It may be recommended to conduct a more detailed study by developing various inspiratory warming protocols with different sample groups of data that did not differ significantly.

Conflict of Interest Statement

The author declares no conflicts of interest.

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