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ACUTE EFFECT OF RESPIRATORY MUSCLE WARM-UP ON EXPLOSIVE POWER AND FLEXIBILITY PERFORMANCE

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Abstract:
The aim of this study is to examine the acute effect of respiratory muscle warm-up on explosive power and flexibility performance. Eighteen sedentary male subjects aged (22.44±1.71) voluntarily participated in the study. The subjects were randomly divided into groups as control, placebo and experiment. Acute-hip hamstring, neck trunk, shoulder flexibility and explosive power were measured by applying placebo at 5% of the maximal inspiratory pressure (MIP) value, and respiratory muscle warm-up exercise at 40%, with 2×30 breaths and a 1-minute rest between sets. POWER®breathe, UK brand respiratory muscle training device was used to warm up the respiratory muscles. The vertical jump test was used for explosive power. SPSS package program was used for statistical analysis of the data. Shapiro-Wilk test was used for the normality test. One-way analysis of variance was performed in repeated measurements to analyze the difference between applications. According to the results obtained, a statistically significant difference was found between the applications in the explosive power and sit-reach, neck-trunk flexibility averages ($p<0.05$). It was determined that the significant differences between the control and experimental groups were in favor of the experimental group. On the other hand, there was no statistically significant difference between the applications in the shoulder flexibility averages ($p>0.05$). As a result, it can be said that the respiratory muscle warm-up applied to sedentary people positively affects explosive power and flexibility values.

Keywords: respiratory, explosive power, flexibility, warm-up

1. Introduction

The term warm-up in sports is defined as a preparatory work period to improve competition or training performance (1). Sedentaries and athletes can potentially benefit

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from warm-up exercises. Although the implementation of some of the suggested warm-up components has been widely undertaken, the importance of warm-up has become a research topic, as it is not known whether it is beneficial, potentially harmful, or has no effect on an individual's performance. Perhaps more importantly, different types and structures of the warm-up are compared in controlled studies to determine the effects of warm-up, if any (2). The respiratory system is accepted as the main indicator of an individual's aerobic capacity (3). Whether it is daily life or determination of performance and work capacity, respiratory system efficiency, which is among the important pillars, has an important place in terms of sportive performance (4). The adequate and regular performance of the respiratory system depends on the working capacity of the respiratory muscles mechanically. Due to the role of the respiratory system, it is very important to warm up the muscles before application and exercise to increase performance (5).

Strengthening the respiratory muscles will help to correct the length and tension relations of the respiratory muscles and increase the respiratory capacity. In the literature reviews, it has been determined that the relationship between muscle warm-ups, especially of the left, and explosive power and flexibility has been investigated very little. In the light of this information; In this study, it was aimed to investigate the acute effect of respiratory muscle warm-up on explosive power and flexibility. It is thought that the results to be obtained for this purpose will contribute to sedentary individuals, athletes, training practices and sports literature.

2. Methods

2.1. Subjects

Eighteen sedentary male subjects in the 20-26 age group participated in the study. Care was taken to ensure that the subjects did not have a chronic disease. The subjects were given general information about the study. Then, anthropometric measurements of the subjects were taken.

Table 1: Descriptive characteristics of the participants

	Min.	Maks.	Mean	Std. D.
Age (years)	20,00	26,00	22,44	1,71
Height (cm)	170,00	192,00	178,19	7,15
Body weight (kg)	60,00	94,00	74,38	9,60
Body Mass Index (kg/m$^{2)}$	19,62	26,64	23,39	2,25

Table 1 provides information on the descriptive characteristics of the subjects participating in the study.

2.2. Study Protocol

A randomized placebo-controlled crossover experimental model was used in this study. Respiratory muscle warm-up (40%) (RMW), placebo respiratory muscle warm-up (5%)

(RMWp) and general trunk-oriented warm-up (GW) groups were randomly divided into respiratory strengths. POWER breathe brand respiratory muscle training device was used for respiratory muscle warm-up. For GW, the subjects were given dynamic warm-up exercises for the trunk muscles for 10 minutes that would not cause fatigue (6).

2.2.1. Respiratory Muscle Strength Measurement

An electronic respiratory pressure gauge was used to obtain the maximal inspiratory pressure (MIP) value. All measurements were made in the sitting position using a nasal plug. For MIP measurement; The person was given maximum expiration and it was ensured that the person made maximum inspiration against the closed respiratory tract and continued it for 1-3 seconds. The measurement was repeated until there was a difference of 5 cmH_2O between the two best measurements, and the best result was recorded in cmH_2O (7).

2.2.2. Respiratory Muscle Warm-up (RMW) Method

For RMW, 2 sets of 30 repetitions of 40% of the maximal inspiratory intraoral pressure (MIP) of the subjects participating in the study were performed as normal inspiration and expiration. 1-minute rest was given between sets (7). POWER breathe breathing muscle training device was used for the RMW method.

2.2.3. Placebo Respiratory Muscle Warm-up (RMWp) Method

Using the POWER breathe respiratory muscle training device, 2 sets of 30 repetitions of 5% of the maximal inspiratory intraoral pressure (MIP) of the subjects participating in the study were inhaled and exhaled normally. 1-minute rest was given between sets (7).

2.2.4. Explosive Power-Vertical Jump Test

The subject tried to jump to the maximum height in the side position next to the wall on a flat, smooth surface. Initially, the initial height was measured by raising the subject's one hand against the wall. With the legs bent from the knees, feet shoulder-width apart, the middle finger touching the highest point it can reach with a chalky way, taking maximum strength from the ground, was determined as the point reached by jumping. The distance between the starting point and the end point was noted and the jump power was determined. The test was performed by each subject 3 times and the best measurement was recorded (8).

2.2.5. Static Hip Hamstring Flexibility Measurement

Hip hamstring flexibility was determined by sit-reach test. The subject is in a sitting position with the head upright, the legs fully stretched and the point where the fingertips touch by fully contacting the sit-and-reach bench and extending the arms forward is accepted as the starting point. Then, with the knees tense, the arms are brought forward as far as they can reach towards the coffee table. The starting point and the end point are measured. The best measurement was obtained after the test was repeated 3 times (9).

2.2.6. Static Shoulder Flexibility Measurement

The subject is lying in the inverted sit-up position, holding the stick with the hands tensely forward, and the arms are lifted as high as possible without breaking the contact of the nose with the ground. The vertical distance from which the bar rose from the ground to the nearest point was measured and recorded. The test was repeated 3 times and the best score was obtained (9).

2.2.7. Static Neck-Trunk Flexibility Measurement

The distance between the ground and the nose was measured by laying face down on the ground with the hands clasped next to the head, and lifting the head as high as possible with the hip attached to the ground. After the test was repeated 3 times, the best grade was determined (9).

2.3. Statistical Analysis

SPSS package program (SPSS for Windows, version 22.0, SPSS Inc., Chicago, Illinois, USA) was used for statistical analysis of the data. Values were evaluated as mean and standard deviation. Shapiro-Wilk test was used for the normality test. Skewness and kurtosis values were checked for data that did not show normal distribution. One-way analysis of variance was performed in repeated measurements to determine the difference between applications. LSD correction test was used to control the significant difference between applications. Statistical analyzes were evaluated at the 0.05 significance level.

3. Results

Table 2: Vertical jump analysis results of the participants

	Mean	Std. D.	F	p	Difference
T1	41,94	5,80	5,515	0,014	T3-T1
T2	43,19	5,50			
T3	44,44	6,07			

Table 2 shows the analysis of the change in the vertical jump values of the participants between the control (T1), placebo (T2) and experimental (T3) applications. As a result of the statistical analysis, a significant difference was found between the applications in the vertical jump averages (p<0.05). The significant difference detected between the control and experimental application was in favor of the experimental group.

Table 3: Sit-reach flexibility analysis results of the participants

	Mean	Std. D.	F	p	Difference
T1	23,81	11,65	4,664	0,027	T3-T1
T2	24,56	11,28			
T3	25,56	11,40			

Table 3 shows the analysis of the change in the sit-reach flexibility averages of the participants between the control (T1), placebo (T2) and experimental (T3) applications. As a result of the evaluation, a significant difference was found between the applications in sit-reach flexibility averages (p<0.05). The significant difference detected between the control and experimental application was in favor of the experimental group.

Table 4: Neck-trunk flexibility analysis results of the participants

	Mean	Std. D.	F	p	Difference
T1	38,25	10,23	4,573	0,020	T3-T1
T2	39,38	10,38			
T3	41,31	8,92			

Table 4 shows the analysis of the change in the average neck-trunk flexibility of the participants between the control (T1), placebo (T2) and experimental (T3) applications. As a result of the evaluation, a significant difference was found between the applications in the average of neck-trunk flexibility (p<0.05). The significant difference detected between the control and the experimental application emerged in favor of the experimental group.

Table 5: Shoulder flexibility analysis results of the participants

	Mean	Std. D.	F	p	Difference
T1	43,63	11,60	2,004	0,152	-
T2	45,87	12,61			
T3	46,69	11,75			

Table 5 shows the analysis of the change in the mean shoulder flexibility of the participants between the control (T1), placebo (T2) and experimental (T3) applications. As a result of the analysis, it was determined that there was no significant difference between the applications in the shoulder flexibility averages of the participants (p>0.05).

4. Discussion

According to the results obtained, a statistically significant difference was found between the applications in the explosive power and sit-reach, neck-trunk flexibility averages (p<0.05). It was determined that the significant differences between the control and experimental groups were in favor of the experimental group. On the other hand, there was no statistically significant difference between the applications in the shoulder flexibility averages (p>0.05).

Vertical jumping increases the body's ability to use explosive power and helps to show power in sports. In the sports world, the vertical jump is a way of measuring what kind of athletes they have on their teams (10). The warm-up period prepares the cardiovascular system, respiratory system, nervous system and musculoskeletal system so that they can meet the demands of more strenuous activity by gradually increasing the demand for these systems (11).

In the study conducted by Comba, the effect of four-week respiratory muscle training on performance in female basketball players was investigated. When the results obtained from the vertical jump test were examined, an increase of 8.34% was observed in the pretest-posttest data, and a statistically significant difference was found (12).

Church et al. (2001) examined the extent to which warm-up affects flexibility in their research with 40 female participants, and in their study using the vertical jump parameter, they stated that general warm-up affects the flexibility and flexibility treatment positively (13).

Duncan and Woodfield (2006) examined the acute effects of the general warm-up protocol on children's flexibility and vertical jump performance. According to the data obtained as a result of the study, they found that general warm-up increased the flexibility performance. The findings obtained in this context revealed that warm-up has a significant effect on vertical jump, and in this sense, it is parallel to the literature (14).

O'Sullivan et al. (2009) found that dynamic warm-up increases flexibility (15).

Agiular et al. (2012), in their study, examined the effect of warm-up protocols on quadriceps and hamstring flexibility and emphasized their significant contribution (16).

De Weijer et al. (2003), in a study conducted by 56 volunteer subjects, showed that warm-up resulted in a significant increase in hamstring length (17).

Perrier et al. (2011), in their research, examined the effects of warm-up on flexibility along with other parameters, and as a result of their research, they found that warm-up creates a significant difference in flexibility performances (18).

Zakas et al. (2006), in their study, applied warm-up protocols to adolescent players and found that warm-up increases flexibility in the data they obtained (19).

Lomax and McConnel (2009), in their study with 8 participants who regularly do sports, stated that the MIP value increased significantly after warm-up the respiratory muscles (20).

Volianitis et al. (2001) examined the changes in the performance of participants by applying respiratory muscle warm-up in their study and found that respiratory warm-up reduced muscle fatigue (21).

Kantarson et al. (2010) made a total of 22 subjects, 11 women and 11 men, do warm-up exercises with 30%, 40%, 50% intensities. They achieved an increase in the MIP value in the warmed-up subjects (22).

Lin et al. (2007), in a study with 10 male badminton players, investigated the effect of respiratory muscle warm-up on aerobic performance and found a significant increase in the experimental group who did the exercise (23).

Ozdal et al. (2016) examined the effect of inspiratory muscle warm-up on anaerobic power. The research emphasized that effective results were obtained in reaching high levels of inspiratory muscle warm-up (24).

In our study, the explosive power and flexibility values obtained after the respiratory muscle warm-up are similar to the results in the literature. The general idea in the literature is that warm-up increases the athlete's performance. This situation supports our study. As a result of our study; It was observed that respiratory muscle warm-up had a positive effect on the explosive power and flexibility values of individuals. This increase was seen in the experimental group that applied respiratory muscle warm-up. According to these results, it can be said that respiratory muscle warm-up significantly strengthens explosive power and flexibility performance. This effect is thought to be due to the activity of the diaphragm muscles.

As a result, it can be said that the respiratory muscle warm-up applied to sedentary people positively affects explosive power and flexibility values. For this reason, regular and planned respiratory muscle warm-up exercises in different groups can be recommended in order to increase the quality of life in sedentary individuals and to increase the performance of athletes.

Conflict of Interest Statement

There are no potential conflicts of interest between the authors of this article.

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