

Comparison of Eight Weeks of Training in the Water and Land on Changes in Lumbar Lordosis of Girl Students of Yazd City

Hamidreza Fallah Yakhdani^{a*}, Samira Kamran^b, Hamid Abasi^a, Mohammad Hasan Kordi^c, Saeid Abedinzadeh^a

^a Department of Physical Education and Sport Science, Yazd University, Iran; ^b Department of Physical Education and Sport Science, Islamic Azad University of Yazd, Iran; ^c Student in Athletic Training, Shahid Bahonar University, Kerman, Iran

***Corresponding Author:** Hamidreza Fallah Yakhdani, Department of Physical Education and Sport Science, Yazd University, Iran. **Tel:** +98-913 3503717; **E-mail:** hamidreza.fallah@gmail.com

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Abstract

Introduction: Injuries related to lordosis 30 to 40 percent of spinal disorders have been allocated that the economic aspects of health care has also attracted attention. The aim of the present study was comparison of effect of eight weeks training in dry and water on change in lordosis of female students in Yazd. **Materials and Methods:** In this research 42 girls with lordosis in 9 to 12 years old were randomly selected from schools in Yazd and randomly divided into three groups of training in water (14 cases), land (n=14) and control group (14 people). Training program participants for eight weeks was carried out. Subject's lordosis was measured by flexible ruler as a noninvasive and reliable method of exercise before and after eight weeks. Repeated measures method was used for data analysis of pre-test and post-test. **Results:** The findings show that training on land and water had a positive effect on improving participant's lordosis ($P \leq 0.05$), but there was no significant difference in lordosis correction between two study groups ($P \geq 0.05$). **Conclusion:** According to the results, both on land and water corrective exercise program for girls with lumbar lordosis is useful and there was no difference between the two programs in the reduction of lumbar lordosis. It is recommended that the land and water exercises for people with lumbar lordosis given, and each of these methods has its own specific characteristics which, according to experts identify the persons recommended.

Keywords: Lordosis, Exercise on Land and Water, Corrective Exercises

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Introduction

Although the current modern life has brought and provide many technological advances and valuable services to the world and people, it has also caused many problems affecting the individuals' physical and psychological health. The problems that are mainly due to the factors such as poor mobility, wrong habits, lack of familiarity with proper body mechanics, and the wrong and poor posture exercises in everyday life (1).

The normal alignment of the spinal column depends on the function of its muscles, bones and joints. Therefore, the weakness of the spinal column muscles can harm the static and dynamic balance of individual, which is generally referred to as postural abnormality. Skeletal abnormalities may be due to lack of mobility and reception of environmental stimuli as well as inappropriate motor patterns (2) that contributes to undesirable effects on the psychological, social and

physiological functions of the people (3). In this regard, physiological disorders due to the poor physical condition are of great importance.

Increased lumbar arch, lordosis, is associated with shortness and inflexibility of the pectoral muscles and weakness of the respiratory muscles that adversely affect the respiratory system, i.e., reduces the volume of the chest cavity and subsequently the lung volume (4). Therefore, correction of the musculoskeletal structure of the chest and spine and in other words the correction of lordosis through corrective protocols, including strengthening the back muscles of the chest and stretching the pectoral muscles, can be useful in improving the angle of lordosis and respiratory capacity.

There is much research on the improvement of flexibility in water indicating good results for water exercises. Floating in water along with hydrostatic pressure reduces the pressure on the joints, which helps improve flexibility (5).

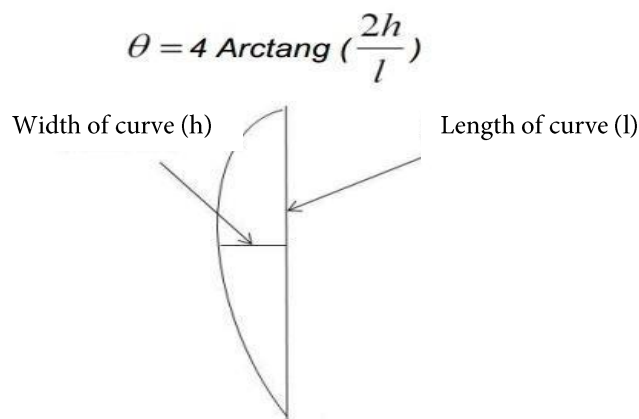


Figure 1. Calculation of lumbar lordosis

Since the lordosis is a common anomaly among people, and this abnormal condition can have severe and sometimes irreversible effects on the function of the cardiovascular system, respiratory system, digestive system, biomechanical function of muscles, and the quality of life (6), researchers should study different therapeutic programs. Numerous studies have been carried out on lordosis correction, including Siahtan *et al.* research that examined the effects of selected Pilates and corrective exercises in female teens aged 15-18 years. Their results showed that 8 weeks of regular training lacked significant effect in reducing the lordosis angle (7). In another study, Ostrowska examined the effect of stretching exercises on anterior-posterior spinal curvature in 52-84 years old post-menopausal women with osteoporosis. The research was conducted on two spine curvature disorders; kyphosis, and lordosis. The results showed that the correction of lordosis and kyphosis angles did not change significantly following the exercises (8). Rezvankhah *et al.* investigated the effect of 4 months immobility (no exercise) after 8 weeks of corrective exercises on lumbar lordosis in female students. Their results showed that 4 months immobility after 8 weeks of corrective exercises increased the mean lumbar lordosis angle in the experimental group compared with the control group (9). Hematfar *et al.* also compared the effects of Williams exercises and hydrotherapy program on the severity of pain and lumbar lordosis in female students. Their results indicated that Williams and hydrotherapy exercises were effective in the reduction and relief of backache and lumbar lordosis, and there was no significant difference between the results of these two methods (10). Mashhadi *et al.* investigated the effect of combined exercises on lumbar lordosis in mentally disabled adolescents. Their results showed that these exercises significantly reduced lumbar lordosis (11). Therefore, a review of the research on the effects of exercises on lumbar lordosis shows their contradictory results, which can be due to various reasons, such as different samples or various exercises. In addition, few studies conducted

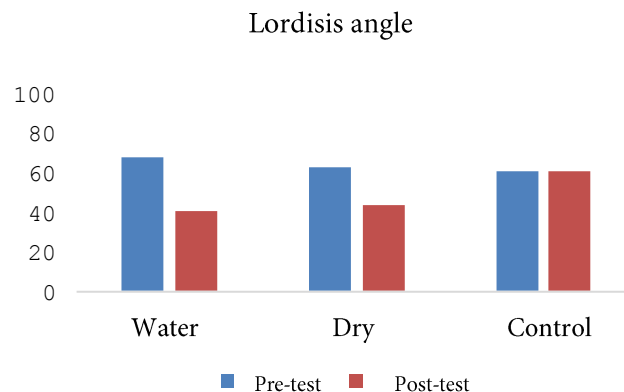


Figure 2. Changes in the lordosis angle for research groups

on the effect of hydrotherapy on lumbar lordosis has provided us with limited information. Thus, due to the lack of explicit literature on the comparison of exercises on land and in water on lumbar lordosis, the present study aimed to compare the effects of 8 weeks of selected water and land exercises on lordosis of female students in Yazd City, Iran.

Materials and Methods

In this quasi-experimental study, 680 primary school girls aged between 9 and 12 years were screened. Then a total of 112 students with lumbar lordosis were identified. After measuring the lumbar lordosis angle, 42 patients with the most severe lordosis were recruited. The range of their lordosis was determined by a flexible ruler, and the subjects were randomly divided into experimental group 1 (exercises in water) and experimental group 2 (exercises on land). It should be noted that the subjects had no physical problems and no specific disease other than lumbar lordosis.

For measuring the lordosis angle, the subjects were asked to be in a normal standing position, with bare feet on the board where the footprint was specified. Then, they were asked to open their feet as wide as the shoulder width and look straight forward completely normal and relaxed. Afterwards, the researcher stood behind the subject to find the reference point. A flexible ruler was used to measure the angle of lordosis. This ruler is a toolkit with a precision of 0.1 and a reliability factor of 97%. For this purpose, first the spinous processes of the vertebrae S2 and L1 were marked. Then, the lordosis angle was calculated by placing the flexible ruler on the arc and recording on the paper using the formula below (12) (Figure 1).

The exercise on land consisted of six parts; first the subject was asked to perform general warm up activities for 5 minutes (walking, jogging and stretching). Then, two types of stretching

Table 1. Descriptive results

Factor	Group	Control (n=14)		Exercise in water (n=14)		Exercise on land (n=14)	
Variable	Statistic	Mean	SD	Mean	SD	Mean	SD
Age	-	11.14	0.864	11.14	0.864	11.07	0.829
Height (m)	-	152.64	8.83	148.64	9.02	147.36	9.76
Pretest weight (kg)	-	53.62	11.13	46.59	13.71	43.46	11.98
Posttest weight (kg)	-	55.17	11.69	47.95	13.98	44.29	12.19
Lordosis angle	Pretest	61.32	6.43	68.43	11.75	63.18	11.5
	Posttest	56.53	9.42	36.57	8.81	39.78	8.04

Table 2. ANOVA test results for comparison of changes in the lordosis angle after training on land

Effect	Sum of Squares	Degrees of Freedom	Mean Square	F	Significance	Effect Size
Test	3832.447	1	3832.447	129.12	0.001	0.909
Error	385.852	13	29.681	-	-	-

Table 3. ANOVA test results for comparison of changes in the lordosis angle after training in water

Effect	Sum of Squares	Degrees of Freedom	Mean Square	F	Significance	Effect Size
Period	7103.078	1	7103.078	105.61	0.001	0.89
Error	874.335	13	67.257	-	-	-

Table 4. Tukey post hoc test results for comparison of both the groups regarding the lordosis angle

Variable	Group	Group	Mean difference	Standard error	Significance
Lordosis angle	Water	Land	-3.209	3.317	0.601
		Control	-19.956	3.317	0.001
	Land	Control	-16.747	3.317	0.001

exercises (stretching of the pelvic psoas muscles and waist extensor muscles), followed by strengthening exercises of abdominal muscles and oblique abdominal muscles, and finally bridge pose (strengthening of gluteus maximus muscles) were performed.

The exercise in water also consisted of six parts; first the subject was asked to perform general warm up activities in the water for 5 minutes. The warm up included walking, sideways walking in water and so on. The other five exercises were related to stretching gluteus maximus muscles and strengthening gluteus maximus muscles, abdominal muscles, oblique abdominal muscles and quadriceps muscles.

Both exercises starts from low duration and intensity and followed the principle of progress. For this purpose, the stretching exercise started from 10 seconds in the first week and increased to 30 seconds in the last week; and the strengthening exercises started by ten repetitions in the first week to 30 repetitions in the last week.

After collecting the research data, the demographic data such as age, height, and weight as well as the research variables were analyzed with descriptive and inferential statistics using SPSS 18. In this way, after confirming the normal distribution of data by Kolmogorov-Smirnov test ($P \geq 0.05$), repeated measures ANOVA was performed to compare the means between experimental groups. Also, the significance level was considered at 95% throughout the research ($\alpha \leq 0.05$).

Results

Table 1 presents the information on the descriptive statistics of the study sample with respect to the variables in the pretest and posttest.

According to Table 2, the main effect of the intervention period (from pretest to posttest) of exercise on land is significant for the lordosis angle ($P=0.001$, $F_{1,13}=129.12$). Therefore, the results showed that the corrective land exercises had a positive effect on the girl students' lordosis angle.

According to Table 3, the main effect of the test period (from pretest to posttest) of exercise in water is significant for the lordosis angle ($P=0.001$, $F_{29,1}=105.61$). Therefore, the results showed that the corrective exercises in water had a positive effect on the girl students' lordosis angle.

Table 4 shows a significant difference between the water exercise group and the control group ($P=0.001$), and also between the land exercise group and the control group ($P=0.001$) with respect to the lordosis angle variable. On the other hand, the results showed no significant difference between the land and water exercise groups ($P=0.601$). In other words, although water and land exercises can both have a positive effect on the improvement of the lordosis angle of young female students, none of them is significantly better than the other. Figure 2 demonstrates the trend of changes for each group separately.

Discussion

The present study compares the effect of eight weeks of selected land and water exercises on the changes in lumbar lordosis in female students. The results supported the positive effect of corrective land and water exercises on reducing the lordosis angle of female students. Also, it was found that there was no significant difference between the land and water exercise groups in the lordosis angle.

Concerning the reduction of the lumbar lordosis angle with corrective exercises in water and on land, the results of the present study are consistent with Rahnema *et al.* (14), Carter (15), and Mashhadi (11) studies. These studies reported that the lumbar lordosis angle decreases with corrective exercises in water and on land.

To explain the possible reasons for decrease in lordosis after these corrective exercises, it can be stated that in lumbar lordosis, the pelvis is not in the correct direction. In this condition, the hip flexors and waist extensor muscles shorten and the abdominal and hamstring muscles stretch. The land exercises are stretching and strengthening exercises; the strengthening exercises affect the muscle tendons, alter various skeletal sections and stabilize the ligaments. On the other hand, the stretching exercises are used as the coordinator of the antagonist and agonist muscles (16). Therefore, these exercises elongate the waist muscles while strengthen the abdominal muscles and eventually reduce lumbar lordosis.

The reason for the reduction in the lordosis angle after eight weeks of corrective exercises in water is clear. The specific gravity of water resists and reduces any movement in the water. When the body starts to move, the muscles contract to overcome the inertia and the resistance of water. Now, one must increase the force used to move with increasing speed and range of motion. As a result, the activity of the involved muscles increases, too. These factors can be attributed to the increased abdominal muscle strength. Also, by performing flexibility exercises in the area of lumbar muscles in the water, which are more convenient for water properties such as flotation, one tries to reverse the relative shortening of muscles. All of these factors can justify the significant reduction in lumbar lordosis angle (17). Moreover, according to the hydrotherapy method, body weight is reduced by up to 90% when it is in water. As a result, the pressure on joints and environmental forces such as gravity, which exerts pressure on the joints and the lumbar vertebrae, significantly reduces. Thus, the person can take advantage of the movements in the water by reducing the pressure on the joints and muscles. In addition, water, due to its unique physical properties, is an effective environment to relieve the pain in the back, waist and other musculoskeletal areas in sports. Therefore, hydrotherapy will

increase muscle strength, flexibility, and range of motion (18).

With an increase in the waist curvature, the center of gravity is transmitted from the middle to the back of the vertebrae, and the spinous processes become close to each other. Consequently, the intervertebral foramen through which the spinal nerves pass, will be reduced. The person in the water feels a slight stretching effect on the lumbar vertebra; this is mainly due to the neutralization of the gravity pressure by flotation. During this stretching, the lumbar intradiscal pressure decreases, the size of the spinal cord increases and a short distance may develop between the joints. Following the musculoskeletal contraction when exercising in water, there is a reflex and release response. The stronger the contraction, the greater would be the muscle release. It seems that the feeling of weight loss in water relieves or significantly reduces muscle cramp that decreases muscle spasm. Also, the research results indicate that hydrotherapy exercises were effective in reducing the lumbar lordosis.

Another objective of this study was to compare the effects of water and land exercises on the lumbar lordosis angle. The results showed no significant difference between the two exercise environments. In this regard, we face a shortage of research, but the closest research is Hematfar *et al.* (10) who compared the effects of Williams exercise and a certain hydrotherapy exercise on the severity of pain and lumbar lordosis in female students. The results of their research showed that Williams's exercises and hydrotherapy were effective in the reduction and relief of a backache and lumbar lordosis, and there was no significant difference between the results of these two methods. Exercises in water rapidly reduces lumbar lordosis followed with a slow process, but Williams's exercises had a gradual and effective trend. In this context, Sami *et al.* (18) investigated the effects of hydrotherapy, relaxation and Williams exercises on the improvement of chronic back pain in athletes. Their results showed that relaxation, hydrotherapy, and McKenzie exercise significantly relieved chronic back pain in athletes, but there was no significant difference between the effectiveness of these three methods.

Water, with a density about 700 times greater than air, increases the amount of energy used for an activity relative to the land. However, water also reduces the loading pressure on the joints and making it easier to do exercises. Also, the viscosity of water can increase the strength of the body. On the other hand, the exercises on the land can correct the motor pattern due to the direct effect on the lumbar spinal stabilization muscles (19).

It should be noted that this research is among the few studies that have compared the effects of the land and water exercise on lumbar lordosis. Despite the great advice of specialized therapists and physiotherapists for the use of

aquatic environments, very few studies have been conducted in this field. Therefore, it is necessary to carry out further research on the effect of water therapy exercises on the postural abnormalities and comparing it with exercises on land.

Conclusion

In sum, both the land and corrective water exercises are useful for girls with lumbar lordosis abnormality and there is no difference between these two exercises in reducing the lumbar lordosis angle. The similarity of both exercises indicates that the changes are not related to the specific exercise environment, and both environments (water and land) have a significant positive effect on the dependent variables. Therefore, we recommended that these exercises be prescribed for people with lumbar lordosis abnormality. Each of these exercises has its own characteristics (for example, children are enjoying water exercises) and should be recommended to people according to the experts' opinions.

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None

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Authors' contributions:

All authors made substantial contributions to conception, design, acquisition, analysis and interpretation of data.

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