

# Comparing the Effect of the Corrective Exercises of America's National Academy of Sports Medicine and Pilates on the Correction of Lordosis among Female High School Students in Golestan Province in 2018

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## Abstract

**Background:** Lordosis is a curvature in the posterior of vertebral column. Loss of normal lordotic alignment may induce pathologic changes in the spine from load bearing and accelerate degeneration of the functional motion units. The purpose of this study was to compare the effect of the corrective exercises of the National Academy of Sports Medicine (NASM) and Pilates on the correction of lumbar lordosis among female high school students.

**Methods:** In this experimental study, conducted in 2018, 45 female high school students suffering from lumbar lordosis were randomly selected from Golestan Province and divided into three groups of NASM corrective exercises, Pilates exercises and control. The two intervention groups received corrective exercises for eight weeks, the angle of lordosis was measured prior to and following the intervention, and the analysis of variance was used at a significant level of  $P < 0.05$ .

**Results:** The results showed that both 8-week corrective NASM ( $P = 0.03$ ) and 8-week Pilates exercises ( $P = 0.01$ ) had a significant effect on the angle of lumbar lordosis. However, no significant differences were observed in the control group in this regard ( $P = 0.7$ ). Moreover, according to ANOVA test, there were no significant differences among the three groups regarding lordosis angle prior to the intervention ( $P = 0.13$  and  $F = 2.14$ ).

**Conclusion:** Based on the results of the present study, the lumbar lordosis angle decreased in both NASM and Pilates exercises groups following the intervention, with NASM exercises resulting in more reduction in the lumbar curvature compared with Pilates exercises. Therefore, therapists and experts of corrective movements can make use of these exercises as novel approaches to correcting lordosis.

**Keywords:** Lumbar lordosis, Corrective exercises of the National Academy of Sports Medicine (NASM), Pilates exercises

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## 1. Introduction

Lordosis or lumbar arch is a curvature in the posterior of vertebral column. This curvature is situated at the lowest part of vertebral column right above the sacrum (1). The presence of pathological conditions in the spine structure leads to pain, referred to as the lower back pain (2). The weakness in the muscle that holds the spine leads to the loss of static and dynamic balance, which is generally referred to as postural abnormalities. Approximately one third of the children 9-13 years and 43% of the adolescents in Iran suffer from lumbar hyperlordosis (3). In this regard, therapeutic exercises or corrective movements are among the most common methods for correcting abnormal spinal curvatures (4). In order to maintain a normal lumbar curvature, weakened muscles should be strengthened through corrective movements and exercises (5). Afroundeh and colleagues examined the effects of traditional corrective and Pilates exercises on the lumbar hyperlordosis of female students,

observing a significant reduction in lordosis and lower back pain (6). Exercise is conducive to strengthening the muscles and maintaining a normal lumbar hyperlordosis (7). Most of the studies in the past have examined the effects of traditional exercises on lumbar hyperlordosis improvement. However, parallel with the new scientific advances, new exercises have been developed for enhancing such abnormalities. Recently, the National Academy of Sports Medicine (NASM) in the United States has introduced a new corrective protocol comprising four stages of inhibition, stretch, activation and coherence (8) Another way that physiotherapists have been trained in recent years is Pilates exercises that improve the principles of static and dynamic balance through posture, flexibility and posture (9). On the other hand, Pilates exercise is a set of exercises that engage the body and the brain in a manner that strengthens the endurance of the entire body and targets the deepest muscles (10). Alizadeh and colleagues investigated the effect of 8 weeks of Pilates exercises on static and dynamic balance of athletes

with history of mechanical back pain; they showed that Pilates exercises were able to effectively treat the low back pain and ameliorate the balance of the subjects (11). Most studies conducted on abnormality correction methods have employed traditional exercises while the new exercise methods have not been properly explored. In this regard, Pilates exercise is a well-known approach in many countries, but it is not commonly used in Iran. The corrective exercises of NASM and Pilates exercises are two non-invasive methods for improving the rehabilitation, promoting the quality of life, and reducing health, economic and social costs. However, to our knowledge, no study has attempted to compare the effects of these two methods. Accordingly, in 2018, we decided to conduct a study to compare the effect of corrective exercises of NASM and Pilates on the correction of lumbar lordosis among high school girls in Golestan Province, Iran.

## 2. Objectives

The purpose of this study was to compare the effect of corrective exercises of the National Academy of Sports Medicine (NASM) and Pilates on the correction of lumbar lordosis among female high school students.

## 3. Methods

This experimental study was conducted in a number of high schools in the cities of Ali Abad Kotoul and Gorgan (Golestan Province) on 45 female students who were allocated in two intervention groups and a control group. Fifteen subjects were included in each group by use of Gpower statistical software and based on Afroudeh and colleagues study with an effect size of 1.5, a test power of 0.95 and a significance level of 0.05 (12). The inclusion criteria were female students suffering from lumbar hyperlordosis and the consent of the subjects' parents for their participation in the study. Those not able to perform the exercises and absent for more than two sessions were excluded from the study. Data collection tools were a flexible ruler (made in Iran) and a graphic paper. The validity of the ruler concerning lumbar lordosis measurement was 0.91. A very high correlation ( $r=0.92$ ) has been found between size of lumbar lordosis measured by a flexible ruler and from lumbar X-rays (13-15). The linear correlation of the chessboard with radiographic criteria was 92%, and its validity and reliability were 83% (3).

Data were collected following the project approval by the Research Council of the Faculty of Medical

Sciences of Islamic Azad University of Aliabad Katool. The sampling method of this study was based on random selection from two schools located in Aliabad Katoul and two schools in Gorgan city. The simple random coin-throwing method divided the subjects into training groups (NASM), Pilates group and control group. The study method was explained to the participants and they were asked to complete the demographic form. Informed consent was obtained from the parents and the students and they were assured about the confidentiality of their information. The samples were also informed that they could withdraw from the study at any time with any reason. In this study, an educator with a doctoral degree in corrective movements carried out the intervention in the intervention groups for eight consecutive weeks (three one-hour sessions per week) at Takhti Club in Aliabad Katool city. In the first session, following introductions, the participants were instructed as to how to perform the exercises to measure the angle of lordosis with a Flexi curve ruler; the subjects primarily stood upright in a comfortable and relaxed standing position with bare foot placed on the cardboard where the foot position was marked. The participants then took a shoulder-width stance with a straight head posture. In this case, the twelfth thoracic vertebra (T12) and the frontal view of sacrum (S1) were touched and determined; the ruler was then placed on the lumbar vertebra (T12-S1) and formed the lumbar curvature on flexible ruler. Next, the ruler was carefully lifted and the curvature was drawn on a paper. The vertical line was then drawn from T12 to S1 in order to measure the maximum length (L) and depth (H) of the lumbar in centimeter. To ensure accuracy, the measurements were repeated three times and the means were further recorded. Using formula ( $\theta=4\text{Arctan}2H/L$ ) (13), the lumbar curvature of the subjects was then measured. In this formula, "L" refers to the distance between the two landmarks (lordosis distance from T12 to S1), "H" represents the distance between the deepest point of the curvature and line (L), which is drawn perpendicular to line (L), and " $\theta$ " shows the angle between the vertebrae (lordosis). Normal lordosis angle is  $30^\circ$  and angles  $>40^\circ$  indicate hyperlordosis (16). Afterwards, the subjects with naked upper shoulder stood upright naturally sideways behind the Graphic paper. NASM exercises were explained for the samples in NASM group based on Clark's book of Essential of Corrective Exercise Training (Table 1); simultaneously, the Pilates exercises were instructed to the samples in Pilates group (Table 2), (12). The control group received no exercise lessons. After the end of the 8 weeks, the lordosis angle of the three groups was once again measured.

**Table 1:** The stages of National Academy of Sports Medicine exercises to improve the lumbar lordosis of high school girls in Golestan Province, 2018

Techniques	Frequency (per week)	Sets	Repetitions	Duration of each repetition	Example
Warm up	3 days	1	5	For 5 minutes	breathing, waist twist , cat stretch, knee-to-chest exercise
Inhibitory techniques	3 days	1	n/a*	Hold the floor roller on the points for 30 to 90 seconds	Static Ball Latissimus Dorsi Stretch, Static Erector Spin Stretch, Static Flexor Stretch, Hip Flexor Complex
Muscle lengthening techniques	daily	1-4	n/a	20- to 30-second hold	Hip ball bridge
Activation technique	3 days	1-2	10-15	Hold 2 isometric seconds in long range and 4 unexpected seconds	Abdominal/intrinsic core stabilizer ball crunch, Prone iso abs
Coherence techniques	3 days	1-3	10-15	Slow and controlled	Ball squat to overhead press
Cooling down	daily	1	5	For 5 minutes	Lunge swing, side stretching , four stretches, no thigh or hip pulls

The exercises were repeated for 8 weeks and 3 one-hour sessions per week. \* n/a=not applicable

**Table 2:** The stages of Pilate's exercises to improve the lumbar lordosis of high school girls in Golestan Province, 2018

Techniques	Frequency (per week)	Sets	Repetitions	Duration of each repetition	Example
Warm up	3 days	1	5	For 5 minutes	Breathing, waist twist, cat stretch, knee-to-chest exercise
Strengthening	3 days	1	10-15	Ten enhancing movements including strengthening the abdominal muscles and rectus femoris muscle	Spine stretch, rolling back, spine twist, single leg stretch, double leg stretch, single leg kick
Stretching movements	3 days	1	10-15	Ten stretching movements, including stretching the hip flexor muscles and lumbar muscles	Leg pull back, swimming, leg circle, shoulder bridge
Cooling down	Daily	1	5	For 5 minutes	Lunge Swing, side stretching, four stretches, no thigh or hip pull

The exercises were repeated for 8 weeks and 3 one-hour sessions per week

**Table 3:** Demographic characteristics of the study samples

Demographic variables	NASM Group	Pilates training group	Control group	P value
Age (Year)	15.26±1.03	15.02±1.28	14.76±1.13	P=0.46
Height (cm)	159.9±82	158.2 ±2.3	158.3±3.11	P=0.87
Weight (Kg)	57.93±5.1	56.4±4.6	56.4±3.48	P=0.53

Following the collection, the data were entered into SPSS software version 22 and analyzed using descriptive statistics (table, mean, and standard deviation), inferential statistics and analysis of variance for duplicate data. The paired t-test was used to compare the intra-group changes (pre- and post-test).

#### 4. Results

No significant differences were observed between the three groups in terms of demographic characteristics such as age (P=0.46), height (P=0.87)

and weight (P=0.53), (Table 3). Also, ANOVA test did not show any significant differences between the three groups (P=0.13) prior to the intervention. However, in contrast to the control group (T=0.38, P=0.7), paired t-test showed a significant difference in NASM (P=0.01, T=6.06) and Pilates (P=0.03, T=3.54) groups before and after the intervention (Table 4).

#### 5. Discussion

Findings of this study showed that the exercises of America's National Academy for Sport Medicine

**Table 4:** Comparison of the differences in the lumbar angle of lumbar lordosis among National Academy of Sports Medicine, Pilates and control groups prior to and following the intervention

Groups	Before intervention	After intervention	Changes between groups	Changes within groups
NASM corrective exercises	53.7±1.83	52.04±1.47	P=0.13 F=2.14	P=0.01 T=6.06
Pilates exercises	53.13±1.73	52.03±1.11		P=0.03 T=3.54

(NASM) and Pilate's corrective exercises were effective in correcting lumbar hyperlordosis of high school girls. Afroundeh and colleagues employed traditional and Pilates corrective exercises and showed that both methods positively influenced lordosis complications by increasing the flexibility of waist and quadriceps muscles and strengthening the abdominal and hamstring muscles. They also revealed that none of the exercise methods had superiority over the other (6), which could be attributed to the fewer training sessions compared to the present study. There is a positive relationship between abdominal muscle strength and angle of lumbar hyperlordosis (17). In line with the results of the present study, Kamali and colleagues showed a significant increase in the abdominal muscle strength, endurance, flexibility, and balance following 8 weeks of (NASM) training. They further referred to the advantages of NASM exercise compared to other corrective exercises in terms of weakened muscles, stating that instead of merely strengthening the muscles, it is better to make use of coherence exercises in the end (18). Abbaszadeh and colleagues, after 8 weeks of corrective exercises on the hyperlordosis angle of a sample of girls, showed that corrective movements significantly reduced the lumbar curvature of the girls and increased the strength and endurance of abdominal muscles and the flexibility of hamstring muscles (19). Elik and colleague observed that Pilates exercises improved the severity of pain and increased the endurance of abdominal and back muscles (20). Miyamoto and co-workers reported that Pilates exercises had a significant effect on the severity of pain and the range of spinal movements (21). Lower back pain in sitting position can be due to lumbar hyperlordosis (22). The results of the present study revealed that NASM exercise method was more effective than Pilate's exercises. Focusing on the ratio powers of the couple force of pelvic-lumbar girdle, Sahebozamani and colleagues showed that corrective exercises significantly decreased the lordosis angle (23). Rezvankhak Golsefidi and colleagues used corrective and stretching exercises to control the complications of hyperlordosis in adolescents and showed that strengthening and stretching exercises created a sort

of coordination between the contracted and stretched muscles, ultimately reducing the anterior pelvic tilt. On the other hand, through following appropriate programs, the flexibility and elasticity of the lumbar curvature are also reduced (24). Failure to correct these abnormalities before the age of 18 will lead to postural changes and pains in the musculoskeletal system, joint deformation, muscular fatigue, and biomechanical imbalances.

## 6. Conclusion

Results of this study showed that people with a lordosis angle of more than 30 degrees can reduce their angle of lumbar hyperlordosis through exercising NASM and Pilates. Furthermore, NASM exercise protocol was more effective in reducing the lordosis angle. These exercises are cost-friendly and effective and can be performed in schools; therefore, trainers of corrective exercises are recommended to use these exercises to correct hyperlordosis complications. To correct other spinal abnormalities and musculoskeletal disorders such as forward head posture and scoliosis, a combination of NASM and Pilates exercises is further recommended. Sometimes, lumbar hyperlordosis entails other musculoskeletal dysfunctions such as hyperkyphosis or forward shoulder, which was not addressed in this study, hence suggested for future studies.

## 7. Limitations of the Study

Participants' menstrual cycles affected the exercise performance. Lack of control over the participants' motivation level in performing the exercises and their inappropriate sitting, standing and sleeping behaviors were among the other limitations of the study.

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### Conflict of Interest

The authors declared no conflict of interest.

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