Journal of Advanced Sport Technology
DOI: 10.22098/jast.2025.16862.1408
Received: 24 February 2025 Accepted: 13 May 2025

ORIGINAL ARTICLE *Open Access*

Changes in Lumbar Curvature and Posture Control after Six Weeks of TRX Training in Men with Lumbar Hyperlordosis: A Randomized Control Trial

Mohammad Seyedahmadi*[1], Karim Khalaghi[2], Samad Khosh Shekan[3], Yasaman khalaghi[4]

1. Associate professor, Department of Sport Sciences, Faculty of Humanities,Velayat University, Iranshahr, Iran.
2. Ph.D., Department of Sport Sciences, Hakim Nizami Qochan Institute of Higher Education, Quchan, Iran.
3. Department of Sport Sciences, Hakim Nizami Qochan Institute of Higher Education, Quchan, Iran.
4. Department of Sport Sciences, Allameh Tabatabai University, Tehran, Iran

Correspondence: Mohammad Seyedahmadi-Mseyedahmadi@Velayat.ac.ir
How to cite: Seyedahmadi, M., Khalaghi, K., Khosh Shekan, S., Khalaghi, Y. Changes in Lumbar Curvature and Posture Control after Six Weeks of TRX Training in Men with Lumbar Hyperlordosis: A Randomized Control Trial. *Journal of Advanced Sport Technology*, 2026; 10(1): 31-41. doi: 10.22098/jast.2025.16862.1408

A B S T R A C T

Background: Lumbar hyperlordosis is a common spinal abnormality that can negatively affect balance and physical performance. This study investigated the effect of six weeks of TRX exercises on lumbar curvature and postural control changes in men with lumbar hyperlordosis.

Methods: This study was a randomized controlled trial (RCT). The population consisted of non-athlete male employees aged 18 to 30 with lumbar hyperlordosis in Quchan city. From this population, a sample of 34 participants was selected through an initial screening process using a grid board and was randomly assigned to two groups: an experimental group (n=17) and a control group (n=17). The experimental group performed TRX exercises for six weeks, three sessions per week, each lasting 60 minutes. Lumbar lordosis was measured with a flexible ruler, while the static and dynamic balance were assessed using the Y-Balance and static balance tests. Data analysis was performed using paired t-tests and ANCOVA in SPSS version 22.

Results: The findings revealed that TRX exercises significantly reduced lumbar curvature in the experimental group compared to the control group (p=0.012). Additionally, the experimental group showed a significant improvement in static balance (p=0.007) and dynamic balance (p=0.020) compared to the control group. These improvements indicate the positive impact of TRX exercises on postural control and balance in individuals with lumbar hyperlordosis.

Conclusions: The results of this study demonstrated that TRX exercises can effectively reduce lumbar curvature and improve static and dynamic balance in men with lumbar hyperlordosis. Due to the instability created during these exercises, stabilizing muscles are activated, making them beneficial in addressing musculoskeletal issues.

K E Y W O R D S: Lumbar hyperlordosis, balance, TRX exercises, postural control, spinal abnormalities.

Introduction

The human spine plays a critical role in maintaining balance, transmitting forces, and protecting the central nervous system (1). The natural curvature of the spine includes lordosis (inward curve in the lumbar region), kyphosis (outward curve in the thoracic region), and scoliosis (lateral curvature). Lumbar lordosis is essential for proper mechanical stress distribution and maintaining body balance (2). However, changes in this curvature, particularly the excessive increase known as "lumbar hyperlordosis," can lead to chronic back pain, motor dysfunctions, and postural abnormalities (3). In this condition, over activity of lumbar extensor muscles and weakness of flexor muscles increase stress on intervertebral discs and facet joints (4). These changes, in addition to pain and discomfort, can cause movement restrictions and elevate the risk of injury (5). Lumbar hyperlordosis is a common abnormality, especially among individuals with low physical activity or those working long hours seated, such as office workers (6). Factors like weight gain, weak abdominal muscles, and overextension of lumbar extensor muscles increase the likelihood of this condition (7). Moreover, hormonal changes during pregnancy and structural defects can also contribute to the development of hyperlordosis (8).

Research has shown that exercise can effectively correct postural abnormalities, including lumbar hyperlordosis (9, 10). Strengthening and stretching exercises, which focus on strengthening the abdominal muscles and stretching the lumbar muscles, can help improve spinal curvature (11). The TRX training system, designed using suspension straps and body weight, aims to strengthen muscles (12). These exercises enhance core muscle strength and improve balance and muscular coordination (10, 13).

By activating deep abdominal and lumbar muscles, TRX helps maintain spinal alignment and reduces pressure on intervertebral discs (9). Additionally, these exercises promote flexibility, reduce back pain, and prevent injuries (9). For optimal results, TRX exercises should be done with proper form and ideally under the supervision of a trainer. For individuals with hyperlordosis, corrective exercises can aid in adjusting lumbar curvature and reducing pain (14). Research indicates that TRX effectively increases abdominal muscle strength and improves lumbar stability, facilitating the correction of postural abnormalities through greater activation of spinal stabilizing muscles (10).

Given the importance of natural spinal curvature for proper body function and the negative impact of hyperlordosis on quality of life, it is essential to find effective methods for correcting this abnormality. As TRX training is recognized as a novel and practical approach to strengthening core muscles and improving balance, this study aims to examine the effects of six weeks of TRX exercises on lumbar curvature and postural control in men with lumbar hyperlordosis. While previous research has mainly focused on the general effects of exercise on spinal curvature, this study specifically investigates the impact of TRX training on hyperlordosis and postural control.

Material and Methods

Ethical Approval and Trial Registration

This research was conducted under the approval of the Institute of Physical Education Ethics Committee, with the ethical code IR.SSRC.REC.1403.063. All methods were performed in accordance with the relevant guidelines and regulations as outlined by the committee. Additionally, this study has been registered in the Iranian Registry of Clinical Trials (IRCT) on 31/12/2024, under the code IRCT20110803007211N4. This protocol was developed and reported following the CONSORT 2010 guidelines to ensure transparency, reproducibility, and completeness in presenting the trial design and results.

Study Design and Participant Allocation

This randomized controlled trial (RCT) was conducted on non-athlete male employees aged 18 to 30 in Quchan. The sample size was estimated to be 111 individuals using G Power software, based on an effect size of 0.3, an alpha level of 0.05, and a power of 0.95. Initially, male employees were screened based on inclusion and exclusion criteria using a grid chart. After screening, 41 individuals

with hyperlordosis were identified, and 34 were randomly selected. These participants were randomly assigned to two groups: experimental and control groups, each consisting of 17 members. Out of the 34 participants, eight dropped out due to personal reasons or excessive absence.

Inclusion and Exclusion Criteria

The inclusion criteria were as follows: being male, providing written consent, being aged between 18 and 30 years, having lumbar lordosis with a curvature angle of 51 degrees or more (15), no signs of joint disorders in the spine, shoulder, or pelvis (16), no musculoskeletal deficiencies (17)or knee abnormalities, no musculoskeletal injuries or surgeries in the past six months (18), and no regular physical activity or history of athletic championships (17). The exclusion criteria included failure to complete the training program, excessive absence, or lack of interest in continuing.

Tools and Instruments Used in the Research

Various tools were used in this study to collect data. An informed consent form and a personal information sheet were employed to obtain participants' informed consent and gather their demographic information. Participants were fully informed about the purpose of the study, its potential risks, and benefits before providing their consent. A tape measure was used to determine height, while a digital scale measured weight accurately. A tape measure was used to determine height, while a digital scale measured weight accurately. Tools such as a foam cube for static balance measurement, a flexible and calibrated ruler for spinal curvature angle measurements, and TRX bands for stability exercises were employed (19). Markers, labels, and masking tape were also used for marking during the tests.

Measurement Procedure

All measurements in this study were conducted at the Corrective Exercise Clinic in Quchan. Initially, individuals suspected of having lumbar lordosis abnormalities were identified through posture observation. Participants completed the personal information form after explaining the research process and obtaining consent. The examiner measured thoracic kyphosis and lumbar lordosis using a flexible ruler. Participants' height and weight were also measured, and their body mass index (BMI) was calculated. Individuals with thoracic kyphosis exceeding 51 degrees (15) or vertebral rotation greater than 5 degrees were excluded from the study. Lower limb performance was then assessed using various tests, and participants were randomly assigned to either the experimental or control group. The experimental group underwent TRX training for six weeks, three sessions per week, each lasting 60 minutes, while the control group continued their usual daily activities. At the end of the intervention, measurements were repeated, and the data were analyzed.

Measurement of Lumbar Lordosis

This study used a 50 cm flexible ruler to measure lumbar lordosis (20). To evaluate the lumbar curve, two bony landmarks are needed according to the Yudas method (21-23), the spinous process of T12 was used as the starting point of the curve, and the spinous process of the second sacral vertebra (S2) was used as the endpoint (6, 21, 23, 24). The twelfth thoracic vertebra was used instead of the first lumbar vertebra to measure the entire lumbar curve (6). Therefore, three key bony landmarks—T2, T12, and S2—were needed. To calculate the lordosis angle, a line was drawn between T12 and S2, and a perpendicular line was drawn from the deepest point of the curve. The values of L and H were obtained and entered into the relevant formula to compute the angle. Individuals with kyphosis exceeding 51 degrees were excluded from the study (15).

Postural Control Measurement Process

Y-Balance Test

This test, derived from the Star Excursion Balance Test and validated by Gribble as a reliable method for assessing dynamic balance (25), was performed in three directions: anterior, posterior-medial, and posterior-lateral, forming a Y-shape with angles of 135°, 135°, and 90°, respectively. To perform the test, the participant stood with their dominant foot at the center of the device. In contrast, the other foot moved the sliding component forward without errors (such as shifting the dominant foot or leaning on the reaching leg) and then returned to the starting position. The reach distance, measured as the distance from the center of the device to the sliding component, was recorded three times for each direction, and the average was calculated. These values were then divided by the participant's leg length and multiplied by 100 to express the result as a percentage. Finally, the composite score for each participant was calculated by averaging the three directional scores. The intra-rater and inter-rater reliability coefficients for the different directions ranged from 0.85 to 0.91, and the overall score reliability ranged from 0.91 to 0.99 (26).

Static Balance Test

Static balance was measured using the Balance Error Scoring System (BESS). This test was performed in six conditions: double-leg stance, single-leg stance, and tandem stance, each on two surfaces—ground and foam—for 20 seconds with eyes closed and hands placed on the iliac crests. In the double-leg stance, the participant stood with feet together; in the single-leg stance, they stood on their non-dominant foot, while the other leg was positioned with approximately 20 degrees of hip flexion and 45 degrees of knee flexion. In the tandem stance, the non-dominant foot was placed behind, with the toes touching the front foot's heel.

During these stances, errors such as removing hands from the waist, opening eyes, stepping, stumbling or falling, abduction or flexion of the hip beyond 30 degrees, lifting toes or heels off the surface, or remaining out of the test position for more than 5 seconds were recorded by the examiner. Each error received a score, with a maximum of 10 errors per condition. In the end, the errors for each position were recorded, and the total static balance error score was calculated by summing up the errors across all conditions (maximum error score: 60) (27). The inter-rater and intra-rater reliability coefficients for this test were reported as 0.57 and 0.74, respectively, by Finoff (28).

TRX Suspension Training

Participants in the TRX group followed a six-week training protocol, with three sessions per week, each lasting 60 minutes. Rest periods of 30 seconds between exercises and 15 seconds between sets were incorporated. The exercises were designed based on credible sources from books and articles related to TRX suspension training and the investigator's coaching experience (29, 30) (Table 1).

Table 1. TRX Exercises for Six Weeks

week	Practice	Set × repetition	week	Practice	Set × repetition
1	Squat (go to the toe and back)	3×10	2	squat + hip abduction	2×10
	forward lunge	3×10		Cross lunge	2×10
	Side lunge	3×10		Side lunge(steep)	2×10
	Plank (elbow)	45sec×3		Plank(hand)	30sec×3
	Omega	3×10		Side omega plank	2×10
	Plank(supine)	45sec×3		Hamstring curl (hip ground)	2×10
3	Single leg squat	3×10	4	single leg squat	3×10
	Suspended lunge	3×10		Suspended lunge	3×10
	Abduction lunge	3×10		Abduction lunge	3×10
	Single leg plank	30sec×3		Single leg plank	45sec×3
	Single leg omega	3×10		Single leg omega	3×10
	Hamstring curl (hip ground)	3×10		Hamstring curl (hip ground)	3×10
5	Squat + hip abduction + rotation	3×12	6	Goblet squat	3×12

Bulgarian split squat	3×10	Pistol squat	3×8
Suspended lunge with rotation	3×10	TRX row with rotation	3×12
Side lunge with reach	3×10	Renegade row	3×10
Plank with arm raise	3 sets per leg, Duration: 45 sec	Plank with leg raise	3 sets per leg, Duration: 45 sec
Single leg plank with reach	3 sets per leg, Duration: 30 sec	Single leg plank with reach and rotation	3 sets per leg, Duration: 30 sec
Turkish get-up	3×5	Burpee with TRX row	3×10
Hamstring curl with resistance band	3×12	Superman with rotation	3×15

Statistical Method

The raw data from measuring research variables were analyzed using SPSS version 22 through descriptive and inferential statistics. A paired t-test was used to compare within-group changes between the pre-test and post-test, and ANCOVA was employed to analyze the results. The significance level of the study was set at 95%, with an alpha level of ≤ 0.05.

Results

Descriptive information regarding the age, height, and weight of the participants is presented in Table 2.

Table 2. Mean and Standard Deviation of Age, Height, and Weight of Participants

Variable	Group	Number	Mean±SD	P value
Age	Experimental	13	21.30±1.97	5.782
	Control	13	20.38±2.50	
Height	Experimental	13	163.30±6.48	0.570
	Control	13	161.84±6.46	
Weight	Experimental	13	57.30±3.42	0.101
	Control	13	59.92±4.36	

The results of the Shapiro-Wilk test indicated that the distribution of all research variables was normal; therefore, parametric tests were used for data analysis. Additionally, Levene's test showed that the data variance across all variables was equal. The results of the one-way ANOVA also revealed no significant differences between the groups at the beginning of the research period ($P > 0.05$), indicating homogeneity of the groups regarding the main variables.

Initially, a paired t-test was used to examine the effect of TRX exercises on the degree of lordosis and performance (static and dynamic balance) from the pre-test to post-test phases. The results are presented in Table 3.

Table 3. Results of the paired t-test for within-group comparison of lordosis and performance variables (static and dynamic balance)

Group		SD ± Mean		df	T	Sig
		Pre- test	Post -test			
Lordosis	Experimental	59.23±2.35	55.38±2.90	12	4.21	0.001
	Control	58.53±2.81	58.84±3.26	12	-0.22	0.823
Static Balance	Experimental	12.53±3.47	8.92±2.72	12	2.80	0.016
	Control	13.53±4.13	12.53±3.47	12	0.63	0.536
Dynamic Balance	Experimental	89.41±4.92	96.96±8.49	12	-2.90	0.013
	Control	91.27±4.31	90.29±5.73	12	0.61	0.547

The results of the dependent t-test showed that TRX exercises significantly improved the degree of lordosis in individuals with increased lumbar lordosis from the pre-test to the post-test stage ($t = 3.66$, $p = 0.003$). Additionally, the results of the dependent t-test indicated a significant improvement in

static balance (t = 2.80, p = 0.016) and dynamic balance (t = -2.90, p = 0.013) in individuals with increased lumbar lordosis from the pre-test to the post-test stage.
Furthermore, an analysis of covariance (ANCOVA) was used for between-group comparisons, and the results are presented in Table 4.

Table 4. Results of the ANCOVA for comparing exercise groups in the variables of lordosis and performance (static and dynamic balance)

Source of Effect	Sum of Squares	Degrees of Freedom	Mean Squares	F Statistic	Significance (p-value)	Effect Size
Lordosis	74.33	1	74.33	7.49	0.012	0.246
Static Balance	87.30	1	87.30	8.66	0.007	0.274
Dynamic Balance	329.16	1	329.16	6.26	0.020	0.214

The results of the ANCOVA test indicated that the exercises had a significant effect on the variables of lordosis and performance (static and dynamic balance). A significant difference was observed between the groups in the lordosis variable (p = 0.012), with a notable reduction in lordosis in the experimental group. Additionally, a significant difference was found in static balance (p = 0.007), with the experimental group showing substantial improvement. In dynamic balance, the results also indicated a significant difference between the groups (p = 0.020), demonstrating an improvement in the dynamic balance of the experimental group compared to the control group (Table 4).
Figures 1, 2, and 3 illustrate the changes in the mean values of various parameters across the groups during the pre-test and post-test phases. Figure 1 represents the mean lordosis of the groups, while Figure 2 depicts the mean static balance, and Figure 3 demonstrates the mean dynamic balance, highlighting the variations observed during the respective testing phases.

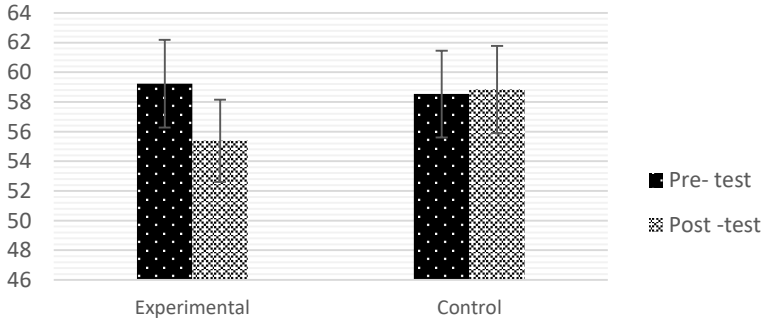

Fig 1. Mean lordosis of the groups during the pre-test and post-test phases

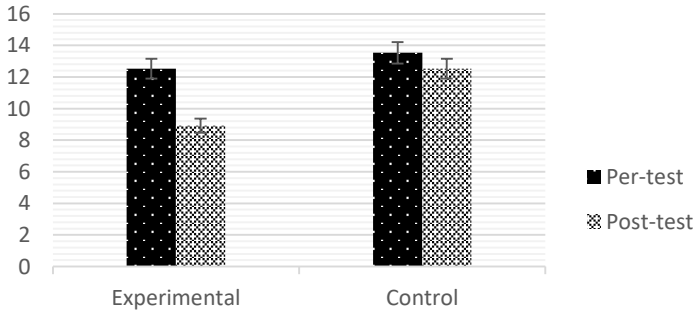

Fig 2. Mean static balance of the groups during the pre-test and post-test phases

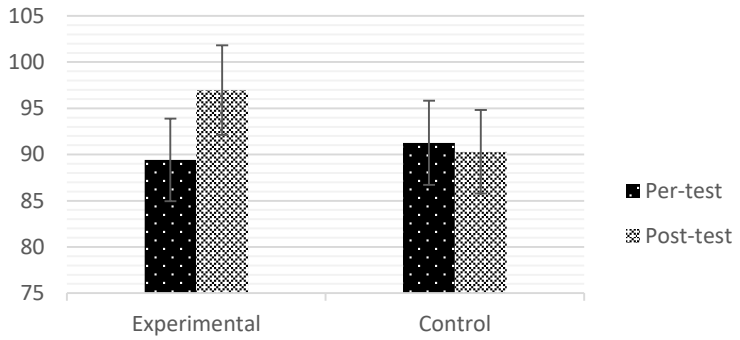

Fig 3. Mean dynamic balance of the groups during the pre-test and post-test phases

Discussion

This study aimed to examine the effects of six weeks of TRX exercises on lumbar hyperlordosis and postural control in individuals with increased lumbar lordosis. The findings revealed that TRX exercises significantly reduced lumbar lordosis and improved static and dynamic balance in these individuals. These results highlight the effectiveness of this training method in enhancing physical posture and motor control, aligning with previous research in many respects.

Specifically, the reduction in lumbar lordosis following TRX exercises indicates the positive impact of this training on improving body posture. This outcome is consistent with the findings of Aslani et al. (2018), who investigated the effects of TRX exercises on static and dynamic balance. Their study also demonstrated that TRX exercises can improve balance and body posture in athletes (29). Considering that balance and postural control are influenced by spinal alignment, these findings appear logical. Both studies emphasize that TRX exercises activate deep core muscles by utilizing unstable surfaces and contribute to better posture and balance.

The results of this study are also consistent with Sajedinia (2018), who explored the positive effects of TRX exercises on balance and proprioception in football players (31). Both studies found that TRX exercises enhance static and dynamic balance. These exercises improve physical performance in complex motor scenarios by engaging central stabilizing muscles and increasing body awareness.

Furthermore, the study by Saadatian et al. (2019), which examined the effects of TRX exercises on proprioception in athletes with shoulder impingement syndrome, reported findings similar to those of the present research. This study demonstrated that TRX exercises could enhance joint and muscle function, even if the primary focus of the exercises is on the spine or lumbar region (32). This indicates that TRX exercises can enhance musculoskeletal health by emphasizing core stabilization and suspension resistance.

On the other hand, some differences were observed when compared to the study by Gattke et al. (2016), which investigated the effects of TRX and elastic band exercises on balance and strength in older adults (33). In Gattke's study, both exercises showed similar effects on balance and strength in the elderly, whereas the present research focused solely on TRX exercises. These differences may be attributed to the characteristics of the study population (individuals with lordosis) and the variables assessed. Additionally, differences in measurement methods may have contributed to the varied results, especially since both elastic bands and TRX exercises are recognized as effective methods for improving balance.

The study by Miller et al. (2015), which compared traditional resistance training with TRX exercises, also supports the present findings. Miller's research revealed that TRX exercises, due to their instability, engage a higher number of muscle motor units (34). This aligns with the current study's results, which indicate improved balance and reduced lordosis. Miller also highlighted that TRX exercises enhance core stabilizer muscle activity, improving posture control and balance(34).

Harris et al. (2017) also demonstrated that TRX exercises increase the activity of selected muscles compared to exercises performed on stable surfaces (35). These findings align with the present study's results in improving dynamic balance, as increased muscle activity can enhance motor control and

balance during complex movements. TRX exercises improve postural control and balance by creating an unstable environment that demands greater muscle activation to maintain equilibrium.
Additionally, this study's findings are consistent with those of Son et al. (2017), which showed that core stability exercises can improve posture and balance in individuals with cerebral palsy (36). Both studies emphasize that unstable and suspension-based exercises, such as TRX, can lead to greater core muscle activation and improved balance.
One limitation of this study was the small sample size and its focus solely on non-athletic males with hyperlordosis, which may limit the generalizability of the results to other populations. Furthermore, the relatively short intervention period (six weeks) might not fully capture long-term changes. The study also did not investigate the effects of TRX exercises on other parameters related to spinal health and motor performance.
The practical applications of this research include utilizing TRX exercises as a low-cost and accessible method to improve lumbar curvature and postural control in individuals with hyperlordosis. Future studies are recommended to explore more extended training periods, assess impacts on women and various age groups, and compare TRX exercises with other therapeutic methods.

Conclusion

Overall, this study's results indicate that TRX exercises can effectively reduce lumbar lordosis and improve static and dynamic balance. By inducing instability during training, these exercises activate the body's stabilizing muscles more effectively, leading to improved posture and physical performance. The alignment of these findings with previous research suggests that TRX exercises, as an effective training method, can be utilized to treat and improve various physical conditions, including lumbar musculoskeletal issues, and enhance balance and sports performance.

Ethical Considerations:

Compliance with ethical guidelines

This research was conducted under the approval of the Institute of Physical Education Ethics Committee, with the ethical code IR.SSRC.REC.1403.063, and registered in the Iranian Registry of Clinical Trials (IRCT) on 31/12/2024, under the code IRCT20110803007211N4.

Funding

This study was conducted without financial support from any institution.

Conflict of Interest

The authors declare that there are no conflicts of interest regarding the publication of this manuscript.

Acknowledgment

The authors would like to thank all the participants who contributed to this study sincerely.

References

1. Muto M, Muto G, Giurazza F, Tecame M, Fabio Z, Izzo R. Anatomy and Biomechanics of the Spine. Radiofrequency Treatments on the Spine. 2017:1-10. doi:10.1007/978-3-319-41462-1_1.
2. Shirazi-Adl A, Parnianpour M. Effect of changes in lordosis on mechanics of the lumbar spine-lumbar curvature in lifting. J Spinal Disord. 1999;12(5):436-47.
3. Adams MA, Dolan P. Spine biomechanics. J Biomech. 2005;38(10):1972-83. doi:10.1016/j.jbiomech.2005.03.028.
4. Jentzsch T, Geiger J, König MA, Werner CM. Hyperlordosis is Associated With Facet Joint Pathology at the Lower Lumbar Spine. Clin Spine Surg. 2017;30(3):129-35. doi:10.1097/BSD.0b013e3182aab266.

5. Madhuchandra P, Pawankumar K, Santhosh GS, Raju K. Predictability of degenerative disc disease by lumbar sagittal alignment on conventional radiograph in comparison with cross-sectional magnetic resonance imaging. J Orthopaedic Diseases and Traumatology. 2023;6(1):106-10. doi: 10.4103/jodp.jodp_79_22.
6. Nourbakhsh MR, Moussavi SJ, Salavati M. Effects of lifestyle and work-related physical activity on the degree of lumbar lordosis and chronic low back pain in a Middle East population. J Spinal Disord. 2001;14(4):283-92. doi:10.1097/00002517-200108000-00002.
7. Thangasheela G J, R. V, M. M, Saju MK F, A. A, Navamani J MA, et al. Different types of Corrective exercises on Correction of Hyper Lumbarlordosis in Females- A Narrative Review. J Adv Zool. 2023. doi:10.17762/jaz.v44iS-3.1663.
8. Casagrande D, Gugala Z, Clark SM, Lindsey RW. Low Back Pain and Pelvic Girdle Pain in Pregnancy. J Am Acad Orthop Surg. 2015;23(9):539-49. doi:10.5435/jaaos-d-14-00248.
9. Flores-León A, Soto V, Araneda OF, Guzmán-Venegas R, Berral de la Rosa FJ. Muscle activity of the Lumbo-pelvic-hip complex in three isometric exercises using TRX® rip trainer™. Retos. 2018.
10. Yalfani A, Bigdeli N, Gandomi F. Comparing the effects of suspension and isometric-isotonic training on postural stability, lumbopelvic control, and proprioception in women with diastasis recti abdominis: a randomized, single-blinded, controlled trial. Physiother Theory Pract. 2023;39(12):2596-608. doi:10.1080/09593985.2022.2100300.
11. Kendall FP, McCreary EK, Provance PG, Rodgers MM, Romani WA. Muscles: testing and function with posture and pain: Lippincott Williams & Wilkins Baltimore, MD; 2005.
12. Tinto A, Campanella M, Fasano M. Core strengthening and synchronized swimming: TRX® suspension training in young female athletes. J Sports Med Phys Fitness. 2017;57(6):744-51. doi:10.23736/s0022-4707.16.06338-6.
13. Aram S, Khodaei K, Zolfaghar Didani M. The effect of low-intensity suspension training with blood flow restriction on GH, IGF-1, and their association with physical fitness in young women. Physiol Rep. 2024;12(15):e16154. doi:10.14814/phy2.16154.
14. Kudchadkar GS, Gurudut P, Welling A. Comparative effect of mat pilates and egoscue exercises in asymptomatic individuals with lumbar hyperlordosis: A randomized controlled trial. Indian J Phys Ther Res. 2019;1(2):79-88. doi: 10.4103/ijptr.ijptr_38_19.
15. Rajabi R, Latifi S. the Norm of thoracic curves (kyphosis) and lumbar curve (lordosis) in men and women. Res Sports Sci. 2010(7).
16. Izadi Farhadi MH, Seidi F, Minoonejad H, Thomas AC. Differences in Gluteal and Quadriceps Muscle Activation Among Adults with and Without Lumbar Hyperlordosis. J Sport Rehabil. 2020;29(8):1100-5. doi:10.1123/jsr.2019-0112.
17. Mirzaie Z, Seidi F, Rajabi R, Khoshro F. The effectiveness of an eight-week exercise program on lumbopelvic stability of women with lumbar hyperlordosis deformity. J Res Sport Rehabil. 2019;6(12):1-10. doi:10.22084/rsr.2019.5141.1065.
18. Anderson BE, Neumann ML, Huxel Bliven KC. Functional movement screen differences between male and female secondary school athletes. J Strength Cond Res. 2015;29(4):1098-106. doi:10.1519/jsc.0000000000000733.
19. Snarr RL, Esco MR. Electromyographic comparison of traditional and suspension push-ups. J Hum Kinet. 2013; 39:75-83. doi:10.2478/hukin-2013-0070.
20. Seidi F, Rajabi R, Ebrahimi E, Alizadeh MH, Daneshmandi H. The Effect of a 10-Week Selected Corrective Exercise Program on Postural Thoracic Kyphosis Deformity. Sport Sci Health Res. 2013;5(1):5-22. doi:10.22059/jsmed.2013.32159.
21. Youdas JW, Garrett TR, Egan KS, Therneau TM. Lumbar lordosis and pelvic inclination in adults with chronic low back pain. Phys Ther. 2000;80(3):261-75.
22. Youdas JW, Garrett TR, Harmsen S, Suman VJ, Carey JR. Lumbar lordosis and pelvic inclination of asymptomatic adults. Phys Ther. 1996;76(10):1066-81. doi:10.1093/ptj/76.10.1066.

23. Youdas JW, Hollman JH, Krause DA. The effects of gender, age, and body mass index on standing lumbar curvature in persons without current low back pain. Physiother Theory Pract. 2006;22(5):229-37. doi:10.1080/09593980600927864.
24. Seydi F, Rajabi R, Ebrahimi Takamjani E. Relationship between Strength of Lumbopelvic Girdle Muscles with Lumbar Lordosis. Olympic J. 2008;16(3):73-82.
25. Gribble PA, Hertel J, Plisky P. Using the Star Excursion Balance Test to assess dynamic postural-control deficits and outcomes in lower extremity injury: a literature and systematic review. J Athl Train. 2012;47(3):339-57. doi:10.4085/1062-6050-47.3.08.
26. Plisky PJ, Gorman PP, Butler RJ, Kiesel KB, Underwood FB, Elkins B. The reliability of an instrumented device for measuring components of the star excursion balance test. N Am J Sports Phys Ther. 2009;4(2):92-9.
27. Bell DR, Guskiewicz KM, Clark MA, Padua DA. Systematic review of the balance error scoring system. Sports Health. 2011;3(3):287-95. doi:10.1177/1941738111403122.
28. Finnoff JT, Peterson VJ, Hollman JH, Smith J. Intrarater and interrater reliability of the Balance Error Scoring System (BESS). Pm r. 2009;1(1):50-4. doi: 10.1016/j.pmrj.2008.06.002.
29. Aslani M, Minoonejad H, Rajabi R. Comparing the Effect of TRX Exercise and Hoping on Balance in Male University Student Athletes. USWR. 2018;7(4):241-50. doi:10.32598/ptj.7.4.241.
30. Dawes J. Complete Guide to TRX® Suspension Training®: Human Kinetics; 2022.
31. Sajedi Nia M. The effect of 6 weeks of TRX training on functional strength, knee sense, and balance in soccer players. Gilan University, Rasht. 2018.
32. Saadatian A, Sahebozamani M, Karimi MT, Sadegi M, Amiri Khorasani MT. The Effect of 8-Week Total Body Resistant Suspension Exercises on Shoulder Joint Proprioception in Overhead Athletes with Impingement Syndrome: A Randomized Clinical Trial Study. J Rafsanjan Univ Med Sci. 2019;17(12):1095-1106.
33. Gaedtke A, Morat T. TRX Suspension Training: A New Functional Training Approach for Older Adults - Development, Training Control and Feasibility. Int J Exerc Sci. 2015;8(3):224-33. doi:10.70252/SWSX2936.
34. Miller W, Wagganer J, Barnes J, Sofo S, editors. Assessment of electromyographic activity during a TRX and traditional split-squat. Int J Exerc Sci: Conf Proc. 2015.
35. Harris S, Ruffin E, Brewer W, Ortiz A. Muscle Activation Patterns During Suspension Training Exercises. Int J Sports Phys Ther. 2017;12(1):42-52.
36. Son MS, Jung DH, You JSH, Yi CH, Jeon HS, Cha YJ. Effects of dynamic neuromuscular stabilization on diaphragm movement, postural control, balance and gait performance in cerebral palsy. NeuroRehabilitation. 2017;41(4):739-46. doi:10.3233/nre-172155.

نشریه فناوری ورزشی پیشرفته

DOI: 10.22098/jast.2025.16862.1408

تاریخ دریافت: ۱۴۰۳,۱۲,۰۶ تاریخ پذیرش: ۱۴۰۴,۰۲,۲۳

Journal of Advanced Sport Technology

«مقاله پژوهشی»

تغییرات در انحنای کمری و کنترل وضعیت بدن پس از شش هفته تمرین TRX در مردان مبتلا به هایپرلوردوز کمری: کارآزمایی تصادفی کنترل شده

یاسمن خلاقی۴، صمد خوش شکن۳، کریم خلاقی۲ **محمد سیداحمدی۱***

۱- دانشیار، گروه علوم ورزشی، دانشکده علوم انسانی، دانشگاه ولایت، ایرانشهر، ایران.

۲- گروه علوم ورزشی، مؤسسه آموزش عالی حکیم نظامی قوچان، قوچان، ایران.

۳- گروه علوم ورزشی، مؤسسه آموزش عالی حکیم نظامی قوچان، قوچان، ایران.

۴- گروه علوم ورزشی، دانشگاه علامه طباطبایی، تهران، ایران

نویسنده مسئول: **محمد سیداحمدی** Mseyedahmadi@Velayat.ac.ir

چکیده

هدف: هایپرلوردوز کمری یکی از ناهنجاری‌های شایع ستون فقرات است که می‌تواند تأثیرات منفی بر تعادل و عملکرد جسمانی داشته باشد. این مطالعه به بررسی اثر شش هفته تمرینات TRX بر تغییرات انحنای کمری و کنترل قامتی در مردان مبتلا به هایپرلوردوز کمری پرداخت.

روش شناسی: این مطالعه یک کارآزمایی بالینی تصادفی‌شده بود که بر روی ۳۴ مرد غیرورزشکار ۱۸ تا ۳۰ ساله مبتلا به هایپرلوردوز کمری در شهر قوچان انجام شد. افراد پس از غربالگری اولیه با استفاده از تخته شطرنجی به‌صورت تصادفی در دو گروه تجربی و کنترل (هر کدام ۱۷ نفر) تقسیم شدند. گروه تجربی به‌مدت شش هفته، سه جلسه در هفته و هر جلسه ۶۰ دقیقه، تمرینات TRX را انجام داد. انحنای کمری با خط‌کش انعطاف‌پذیر و تعادل ایستا و پویا به‌ترتیب با آزمون‌های تعادل ایستا و آزمون Y ارزیابی شد. تحلیل داده‌ها با استفاده از آزمون تی زوجی و تحلیل کوواریانس در نرم‌افزار SPSS نسخه ۲۲ انجام گرفت.

یافته ها : نتایج نشان داد که تمرینات TRX به‌طور معناداری انحنای کمری را در گروه تجربی در مقایسه با گروه کنترل کاهش داد(p=۰،۰۱۲) همچنین، گروه تجربی نسبت به گروه کنترل در تعادل ایستا (p= ۰/۰۰۷) و تعادل پویا (p= ۰/۰۲۰) بهبود معناداری داشتند.

نتیجه گیری: نتایج نشان داد که تمرینات TRX می‌توانند به‌طور مؤثری موجب کاهش انحنای کمری و بهبود تعادل ایستا و پویا در مردان مبتلا به هایپرلوردوز شوند. ناپایداری ایجادشده در حین این تمرینات منجر به فعال‌سازی عضلات تثبیت‌کننده می‌شود که این امر می‌تواند در اصلاح مشکلات اسکلتی–عضلانی مؤثر واقع گردد.

کلمات کلیدی: هایپرلوردوز کمری، تعادل، تمرینات TRX، کنترل قامت، ناهنجاری‌های ستون فقرات.