

Efecto de la mejora de la movilidad lumbar, la estabilidad de la columna vertebral; con entrenamiento de estabilidad central para lograr el mejor corredor personal

Effect of improving lumbar mobility, spinal stability; with core stability training to achieve personal best runner

*Zulhasniati Zulhasniati, *Yudik Prasetyo, **Nugroho Susanto, **Andre Igoresky, **Yogi Arnaldo Putra, ***Gema Fitriady, ***Khoiril Anam, ****Zhanneta Kozina, ****Ratko Pavlovic, PhD, , ****Özgür Eken, ****Francesca Latino, ****Francesco Tafuri, ****Pradicta Nurhuda
 *Yogyakarta State University (Indonesia), **Padang State University (Indonesia), ***Malang State University (Indonesia), ***Semarang State University (Indonesia), ****H.S. Skovoroda Kharkiv National Pedagogical University (Ukraina), ****University of East Sarajevo (Bosnia and Herzegovina), ****Inonu University (Turkey), ****Pegaso University (Italy), ****Niccolò Cusano University (Italy), ****Research Center for Language, Literature, and Community, National Research and Innovation Agency (Indonesia)

Abstract. Running consists of simple basic movements, and to achieve these simple basic movements requires good mobility and stability, because the weakening of mobility and stability of the body causes misalignment or weakness of the legs so as to interfere with the absorption or propulsion phase in leg movement while running. Apply appropriate exercise methods to improve lumbar mobility and spinal stability. One training method that can be used is the core stability training method. Core stability is an exercise model to improve the ability to control the position of trunk movement through the pelvis and legs to allow optimal motion production. This study aims to ascertain whether core stability training can improve lumbar mobility and spinal stability in running athletes. The study used an experimental method with a research pattern using a group pretest-posttest design. 10 running athletes were sampled according to the criteria to be treated in the form of core stability training for 6 weeks. The athletes were assessed before and after training using the Functional Reach Test and Unilateral Hip Bridge Endurance. This study showed that there was a significant effect between core stability training and lumbar mobility ($P = 0.000$) and spinal stability ($P = 0.000$) in athletes. The results of this study show that the application of core stability exercises can increase the ability of lumbar mobility and spinal stability, so if the core stability exercises are done properly, they can increase stability in the spine and mobility in the lumbar, which causes dynamic limb movement to be more efficient.

Key Words: athletics; Core Stability; Lumbar Mobility; spine stability

Resumen. Correr consiste en movimientos básicos simples, y para lograr estos movimientos básicos simples se requiere una buena movilidad y estabilidad, porque el debilitamiento de la movilidad y la estabilidad del cuerpo provoca una desalineación o debilidad de las piernas que interfiere con la fase de absorción o propulsión en el movimiento de las piernas mientras se corre. Aplicar métodos de ejercicio apropiados para mejorar la movilidad lumbar y la estabilidad de la columna vertebral. Un método de entrenamiento que se puede utilizar es el método de entrenamiento de estabilidad central. La estabilidad del tronco es un modelo de ejercicio para mejorar la capacidad de controlar la posición del movimiento del tronco a través de la pelvis y las piernas para permitir una producción óptima de movimiento. Este estudio tiene como objetivo determinar si el entrenamiento de la estabilidad del tronco puede mejorar la movilidad lumbar y la estabilidad de la columna vertebral en atletas que corren. El estudio utilizó un método experimental con un patrón de investigación utilizando un diseño grupal pretest-posttest. Se tomaron muestras de 10 atletas de running de acuerdo con los criterios para ser tratados en forma de entrenamiento de estabilidad central durante 6 semanas. Los atletas fueron evaluados antes y después del entrenamiento mediante el Test de Alcance Funcional y la Resistencia Unilateral del Puente de la Cadera. Este estudio mostró que hubo un efecto significativo entre el entrenamiento de la estabilidad del tronco y la movilidad lumbar ($P = 0,000$) y la estabilidad de la columna vertebral ($P = 0,000$) en los atletas. Los resultados de este estudio muestran que la aplicación de ejercicios de estabilidad del core puede aumentar la capacidad de movilidad lumbar y la estabilidad de la columna vertebral, por lo que si los ejercicios de estabilidad del core se realizan correctamente, pueden aumentar la estabilidad en la columna vertebral y la movilidad en la lumbar, lo que hace que el movimiento dinámico de las extremidades sea más eficiente.

Palabras clave: atletismo; Estabilidad del núcleo; Movilidad lumbar; estabilidad espina dorsal

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Nugroho Susanto
 nugrohosusanto@fik.unp.ac.id

Introduction

Currently, running sports training is not only done by professional athletes but has become popular in Indonesian society because now people have developed very much in thinking about the importance of sports. Even those who initially just had fun now have a commitment to practice, and the results have become podiums in competitions. Running activists now consider running not just physical activity to make the body fit. Running is now developing into part of the style. In people's lives, some people also have

different goals when participating in running sports, one of which is competition in the field of running, which can be used as a recreational event for self-actualization. As stated by (Barmak et al., 2021; D. chul Lee et al., 2017; Nazik et al., 2015) healthy lifestyle behavior is an expression of self-actualization, health responsibility, and interpersonal support in managing stress. Community physical activity programs can increase awareness of physical activity (Weraman et al., 2023).

Running is not that simple because athletes and runners who train with the aim of achieving their personal best and

avoiding injury are influenced by various aspects such as technical aspects, physical aspects, and mental aspects (Boullousa et al., 2020; Smith et al., 2016; Smyth & Cunningham, 2017; Trowell et al., 2021). Athletes and runners who have excellent physical abilities cannot bring out their maximum abilities throughout the race if they are not supported by good tactics and techniques (Burke, 2017; Ceci et al., 2016; Jabbar, 2015; van Oeveren et al., 2021). Optimal results hinge on the athlete's physical readiness and the nature of training (Zanada et al., 2023). Techniques in running are related to hand swing hoists, foot movements, and postures, so that movements in running consist of structured movements that require skills so that running movements are carried out compactly and harmoniously (Blickhan et al., 2021; Hyun et al., 2014; Preece et al., 2016). Skills can be defined as simple basic gestures. To achieve these simple basic movements in running requires good mobility and body stability. Because any leg misalignment or weakness that negatively impacts leg mobility can interfere with the absorption or propulsion phase in running partners while running (Cowley, 2019; Fourchet et al., 2015; Hoenig et al., 2019; Lacquaniti et al., 2017; Sulowska et al., 2019; Watari et al., 2021).

The importance of mobility and stability in running can be seen when the body position maintains the body to stay upright when running, the legs that always move with the knees slightly bent, and the soles of the feet as a fulcrum must remain stable, so it is important to have good stability in running on the spine, ankles, and knees (Angin & Demirbüken, 2020; Ogaya et al., 2021). The drive to run is caused by a strong extension of the hip joint, knees, and ankles, which causes the body to project forward and upward towards the next step (Davis, 2016; Ogaya et al., 2021; Pandy et al., 2021). So it takes good lumbar mobility strength in order to maintain posture so as not to fall. Have good lumbar mobility strength and spinal stability so that running movements are more efficient, avoid injury, and avoid low back pain (Bertelsen et al., 2017; Ceyskens et al., 2019; Smrcina et al., 2022).

In modern times, there have been many varied training methods to support each exercise in accordance with the purpose and imposition of the training session. One exercise method that can improve the strength of lumbar mobility and spinal stability is weight training. Weight training is an exercise that is carried out systematically using weights as a tool to increase the strength of muscle function to achieve goals such as increasing mobility and body stability, one of which uses core stability exercises. Core stability exercises are exercise programs that are performed through assistive devices or body weight alone and aim to develop central muscle strength that balances posture (Amini et al., 2016; Haruyama et al., 2017; Oliva-Lozano & Muyor, 2020). Core stability exercises have become a very popular and effective method for improving physical fitness parameters such as endurance, explosive power, strength, balance, and flexibility (Kalaycioglu et al., 2020; Kumar & Zemková, 2022; Özen et al., 2020). Core stability training

also serves to improve movement performance to prevent the risk of injury (Opoku-Antwi & Kwakye, 2023; Silfies et al., 2015). Having good central muscle strength or not can affect lumbar mobility ability and spinal stability, so the purpose of this study was to see if applying core stability exercises to running athletes could help improve lumbar mobility and spinal stability in these runners.

Methods

The type of research used in this study is quantitative research using experimental design methods. The research pattern used in this study was one group pretest-posttest design. This design involves one group, namely one group to treat core stability exercises. Sampling in this study used purposive sampling. Sample criteria include: (1) athletes who are still actively participating in running training; (2) willing to participate in all training given; (3) not in a state of illness or injury; and (4) male and aged between 18 and 21 years. The total population of 20 athletes met the criteria and, at the same time, served as a sample for this study. The data collection techniques carried out in this study are tests and measurements. Before giving exercises, pretest, and after giving practice, do a posttest. Treatment or exercise is carried out following an exercise program that has been prepared. Before being used for research, the training program is first validated by expert lecturers, so that the exercise program is feasible for research. The core stability exercise program will focus on improving muscles in the hip, abdomen, and pelvic areas because these muscles are associated with the performance of lumbar mobility and spinal stability. The forms of movement that will be used in the core stability training program are plank movements, leg circles, horizontal balance, side-lying leg lifts, double leg power and lifts, bridges, and roll-backs. The research process was carried out for 18 meetings not including pretest and posttest. The length of training required is for 6 weeks or more, with training conducted 3 times a week regularly for 6 weeks may have shown a significant effect on improving skills and physical condition. The instruments used in this study are the Functional Reach Test method ($ICC = 0.786$; $P < 0.001$) to determine the ability of lumbar mobility and the Unilateral Hip Bridge Endurance ($p = -0.49$ and $p = -0.56$; $p < 0.05$) to determine the ability of spinal stability. In accordance with the hypothesis and type of research used in this study, the statistical analysis used is a preloaded test of normality and homogeneity data, then continued with the two-way ANOVA test at the level of significance $\alpha = 0.05$. The process will be implemented in SPSS 20.0.

Results

The data from this study is in the form of pretest and posttest data on lumbar mobility and spinal stability. The research process will take place in three stages. The first stage is to perform a pre-test to obtain preliminary data on the assessment of lumbar mobility and spinal stability. The

second stage of this research activity is to carry out treatment. This research lasts for 2 months. The third stage is to perform a posttest to obtain final data on the assessment of lumbar mobility and spinal stability.

Table 1.
Measurement results

No	Measurement results					
	Lumbar Mobility			Spinal stability		
	Pre-test	Pos-test	Difference	Pre-test	Pos-test	Difference
1	39	43	4	20	22	2
2	45	48	3	20,5	22,75	2
3	37	45	8	23	28	5
4	35	39	4	20,5	22	2
5	42	45	3	31	32,75	2
6	38	42	4	19,75	23	3
7	40	44	4	28,5	31	3
8	37	40	3	23	24	1
9	39	41	2	28,5	30,75	2
10	38	40	2	20,5	24	4
Average	39	43	3,7	24	26	3
Percentage (%)			9%			11%

Uji normalitas

The calculation results using the Shapiro-wilk test with the SPSS software program version 20.0 with a significant level of 5% or 0.05 to see whether the data is normal or not can be seen in table 2 below.

Table 2.
Test results normalize variable data

Variable	Test	Sig. (P)	Conclusion	Description
Mobilitas Lumbal	Pre-Test	0,068	P>0,05	Normal
	Post-Test	0,373	P>0,05	Normal
Stabilitas Tulang Belakang	Pre-Test	0,222	P>0,05	Normal
	Post-Test	0,720	P>0,05	Normal

Based on statistical analysis of normality tests that have been performed using the Shapiro-Wilk test in Table 10 above, it shows that all pretest and posttest data of lumbar mobility and spinal stability are obtained from the normality test results of $p > 0.05$ significance data, which means the data are normally distributed.

Uji homogenitas

The homogeneity test is intended to test the similarity of variance between the pretest and posttest. The homogeneity test in this study is the Levene test. The homogeneity test results are presented in Table 3 below.

Table 3.
Hasil uji homogenitas

Variabel	Test	Sig. (P)	Keterangan	Kesimpulan
Mobilitas Lumbal	Pre-Test	0,283	P>0,05	Homogen
	Post-Test	0,152	P>0,05	Homogen
Stabilitas Tulang Belakang	Pre-Test	0,600	P>0,05	Homogen
	Post-Test	0,661	P>0,05	Homogen

Based on the statistical analysis of homogeneity tests that have been carried out using the Wilk Levene test in Table 3 above, The homogeneity test result of the data significance value is $p > 0.05$, which means that the data in the group has homogeneous variance. Thus, populations have common variants or are homogeneous.

Uji hipotesis

Testing of research hypotheses is carried out based on the results of data analysis and the interpretation of two-way ANAVA analysis.

Table 4.
Uji analisis paired samples test

Variabel	Pair	t-hitung	Sig. (2 tailed)	Status
Mobilitas Lumbal	Pretest-Posttest	8,330	0,000	Signifikan
Stabilitas Tulang Belakang	Pretest-Posttest	9,111	0,000	Signifikan

The paired sample test results obtained a significance of 0.000 less than the significant level (α) = 0.05, then H_a was accepted. This means that there is a significant effect of core stability training on the lumbar mobility and spinal stability of athletes. This means that there is a significant difference between the average value before treatment and the average value after treatment. This means that there is an effect of core stability training on increasing the ability of the car to increase the lumbar and spinal vitality.

Discussion

Providing core stability exercises over time will improve lumbar mobility and spinal stability because exercises performed systematically and repeatedly for an extended period of time will put stress on the muscles, causing physiological adaptations to occur. Providing core stability exercises over time will improve lumbar mobility and spinal stability because exercises performed systematically this can be seen from the results of giving core stability exercises for 18 meetings, the results of testing the hypothesis is known that there is a significant influence between core stability exercises on lumbar mobility ability, and spinal stability in athletes. In the core stability exercise group in lumbar mobility only increased ability 9%, and in spinal stability only increased 11%. ally and repeatedly for an extended period of time will put stress on the muscles, causing physiological adaptations to occur. Similarly, the results of research conducted (Smrcina et al., 2022) show that the provision of core stability exercises can strengthen the muscles that provide stability to the spine and show promising results. Not only that, research conducted by (Coulombe et al., 2017) on the comparison of the application of core stability exercise and general exercise in reducing low back pain shows that the application of core stability exercise in the short term is more effective than general exercise in increasing the strength of muscles in the lumbar region so as to reduce pain and increase lumbar mobility.

Doing core stability exercises can activate the work of the core muscle. The activation of this core muscle will increase spinal stability because the active core muscle will increase intra-abdominal pressure and form an abdominal brace that will increase the stability of the spine (Alrwaily et al., 2019; Nabavi et al., 2018). Core stability exercises can improve lumbar flexibility and mobility and reduce the risk of muscle strain (Gordon & Bloxham, 2016; Sandler et al., 2014). Similarly, the results of research conducted by

(Haruyama et al., 2017) that the application of core stability exercises increases the value of flexibility, thus affecting the level of mobility ability. Core stability exercise can activate harmonious movements between the four core muscle groups (diaphragm, pelvic muscles, trunk muscles, and abdominal muscles) so as to provide lumbar stability and increased mobility in the lumbar (K. Lee, 2021). Increased control in the lumbopelvic by stimulating coordination and control of the lum-bopelvic muscles so that they can maintain the position of the spine by increasing core stability. Muscle activity aims to activate the trunk (core), diaphragm, and pelvic floor muscles to be able to maintain the stability of the position of the spine (K. Lee, 2021; Vélez, 2019; Yilmaz et al., 2023). The three muscle groups contract simultaneously during this exercise.

Having core muscle endurance is the most important component in core training because it supports core muscles in maintaining an efficient torso position (Hung et al., 2019; Wirth et al., 2017). Having core muscle endurance is important for spinal stability during long-term exercise (Toprak Çelenay & Özer Kaya, 2017). Maximum running with high intensity can cause core muscle fatigue. Therefore, increasing core muscle endurance can benefit running performance (Koblbauer et al., 2014). This is evident from the increased distance in the results of the 12-minute running test conducted by the study participants, because core muscle function is related to running kinematics and breathing work (Koblbauer et al., 2014; Toprak Çelenay & Özer Kaya, 2017). Core muscles allow optimal force production to control, support, and move extremes (Silfies et al., 2015) and also improve the ability to control the position of torso movement through the pelvis and legs to allow optimal motion production (Bagherian et al., 2019; Kalaycioglu et al., 2020; Sartori et al., 2022; Zemková & Zapletalová, 2022), because core stability also provides proximal stability for distal mobility (Bagherian et al., 2019; Myers & Kibler, 2018; Panchal et al., 2017).

Core muscle exercises include hip muscles, abdominal muscles, and pelvic muscles; these muscles play an important role in transferring power between the lower and upper extremities (Oliva-Lozano & Muyor, 2020; Zemková & Zapletalová, 2022). Also included are the multi-joint muscles, namely the latissimus dorsi and psoas, that pass through the core, connecting it to the pelvis, legs, shoulders, and arms (De Bruin et al., 2021). These muscles are responsible for supporting posture, creating movement, coordinating muscle action, allowing stability, absorbing force, generating force, and transmitting force throughout the body (Clayton, 2016; De Bruin et al., 2021). Strong core muscles improve force transmission and minimize force loss during transfer from the lower extremities of the body, torso, and then upper extremities; thus, running movements are positively affected by a strong core. The importance of having a strong core is that it can balance the relationship between muscle length and movement patterns, allow deeper muscle activity, increase core stability and strength, reduce the risk of injury, and increase

movement efficiency in the limbs (Luo et al., 2023), until the provision of appropriate core stability exercise can result in increased core muscle endurance, breathing, and movement efficiency (Cavaggioni et al., 2015). So if core stability exercises are done well, it can increase stability in the spine and mobility in the lumbar, which causes dynamic limb movement to be more efficient.

Conclusion

The application of core stability exercises can enhance the lumbar mobility and spinal stability of running athletes, according to the findings of a six-week study. The findings demonstrated how proper core stability workouts improve spine stability and lumbar mobility, which in turn affect running kinematics and respiratory effort. Furthermore, according to certain research, core stability training might help runners and sportsmen avoid injuries. Thus, properly executed core stability exercises can improve lumbar mobility and spine stability, resulting in more efficient dynamic limb motions and assisting runners and athletes in reaching their personal bests.

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Conflicts of interest

No conflicts of interest are disclosed by the writers.

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Datos de los/as autores/as y traductor/a:

Zulhasniati	zulhasniati0280fik.2022@student.uny.ac.id	Autor/a
Yudik Prasetyo	yudik@uny.ac.id	Autor/a
Nugroho Susanto	nugrohosusanto@fik.unp.ac.id	Autor/a
Andre Igoresky	andre.igo88@fik.unp.ac	Autor/a
Yogi Arnaldo Putra	yogi.ap@fik.unp.ac.id	Autor/a
Gema Fitriady	gema.fitriady.fik@um.ac.id	Autor/a
Khoiril Anam	khoiril.ikor@mail.unnes.ac.id	Autor/a
Zhanneta Kozina	zhanneta.kozina@gmail.com	Autor/a
Ratko Pavlovic, PhD	pavlovicratko@yahoo.com	Autor/a
Özgür Eken	ozgureken86@gmail.com	Autor/a
Francesca Latino	francesca.latino@unipegaso.it	Autor/a
Francesco Tafuri	francesco.tafuri@unicusano.it	Autor/a
Pradicta Nurhuda	prad009@brin.go.id	Autor/a
Mhs proofreading	mhsproofreading@gmail.com	Traductor/a