ORIGINAL ARTICLE e-ISSN: 2349-0659 p-ISSN; 2350-0964

Correlation between Spinal Instability and Ankle Injuries in Amateur Marathon Runners

Shinde Sandeep B.[1]*, Kadam Shivanjali S.[1], Berde Shreeya D.[1], Gaonkar Nishant K.[2], Shinde Ravindra V.[3], Patil Sanjaykumar[4]

Abstract

Background: Marathon running is becoming more popular among middle-aged people who have no prior running experience. Improper or incomplete knowledge increases the risk of injuries in amateur runners. Individuals with spinal instability experience alteration in balance control while walking as well as running which in turn results in asymmetrical bodyweight distribution throughout the lower extremity. This changes the pattern of running leading to injuries of hips, knees, and ankle. **Methods:** The objective of the study was to correlate spinal instability with ankle injuries in amateur marathon runners. In this study, both male and female amateur marathon runners between the age group of 20 and 45 years with normal body mass index (BMI) were chosen and individuals with the previous surgery as well as degenerative diseases of spine and ankle fractures were ruled out. Spinal instability tests were carried out on amateur marathon runners with symptoms of instability. Subjects were asked questions related to ankle injuries. Outcome measures used were Oswestry Disability Index (ODI) and tests for spinal instability. **Results:** About 57% of participants were tested positive for the passive lumbar extension test and 42% of participants were tested positive for the prone instability test. There was the presence of ankle pain (68%), ankle swelling (24%), heel pain (60%), blisters (42%), ankle sprain (28%), and strain (26%) in selected participants. There were 68% runners with minimal disability and 32% runners with moderate disability. **Conclusion:** Amateur marathon runners with spinal instability had the presence of ankle injuries like ankle pain, ankle swelling, heel pain, blisters, ankle sprain, and strain. Based on the test performed and interpretation of the ODI and after correlating spinal instability with ankle injuries, we concluded that spinal instability increases the risk of ankle injuries in amateur marathon runners.

Keywords: Amateur runners, Ankle injuries, Oswestry disability index, Running injuries, Spinal instability

Asian Pac. J. Health Sci., (2022); DOI: 10.21276/apjhs.2022.9.4.12

Introduction

Marathon running is a rapidly developing hobby among non-athletic middle-aged people.[1] Non-professional marathon runners and those with limited talent are referred to as amateur marathon runners. In amateur marathon runners, running is linked to a high rate of injuries. It is critical to understand proper running biomechanics to avoid injuries. In terms of the lower extremities, running gait can be separated into two phases: Stance phase and swing phase. Absorption, propulsion, starting swing, and terminal swing are the four categories. When a plantar foot makes initial contact with the ground, this is known as footstrike. Footstrike can be classified as forefoot, midfoot, or heel strike. The time when the lower extremity limb of focus is in knee flexion is known as mid stance. At this point, propulsion begins to take place. Running's propulsive phase begins at midstance and lasts until toe-off. When the foot is not bearing weight and is travelling forward, it is in the swing phase. The acceleration, mid-swing, and deceleration phases make up the swing phase. Acceleration happens when the foot is raised off the ground. When the swing leg is close to the weight-bearing leg, it is called mid-swing. The swinging leg slows down during deceleration (terminal swing) in preparation for initial contact with the floor (Orthopedic Physical Assessment by David J. Magee, Ph.D., BPT, C.M.).

Running can be a great form of exercise when done in the right form. There is evidence that heel striking is linked to a higher rate of injury due to ineffective shock absorption. For preventing running injuries especially of the ankle joint, one must land on his/her midfoot or forefoot while running as this helps in propulsion.[2] It is important to maintain a center of gravity during running as this can reduce the risk of falls or injuries.

By keeping the center of mass of runners on the front half of the foot, running with a slender body allows gravity to force the runner ahead. This prevents heel strike and places the foot in front of the center of mass. Upright posture is important equally. Use of core muscles should be done to maintain the posture upright and stable. This maintains the center of gravity of the runner in the same position as in standing. Landing midfoot below the center of mass is important because this allows gravity to pull down the runner's foot and leg allowing the runner's calf muscles and ankle joints to relax. Landing behind the center of mass puts the body out of balance increases the chances of injury. The most common errors while running are tilting the chin up and scrunching the shoulders.

[1]Department of Musculoskeletal Sciences, Krishna college of Physiotherapy, Krishna Institute of Medical Sciences "Deemed to be University", Karad, Maharashtra, India

[2]Department of Orthopedics, Krishna Institute of Medical Sciences "Deemed to be University", Karad, Maharashtra, India

[3]Department of Microbiology, Krishna Institute of Medical Sciences "Deemed to be University", Karad, Maharashtra, India

[4]Department of Obstetrics and Gynaecology, Krishna Institute of Medical Sciences "Deemed to be University", Karad, Maharashtra, India

Corresponding Author: B. Shinde Sandeep, Department of Musculoskeletal Sciences Faculty of Physiotherapy, Krishna Institute of Medical Sciences "Deemed to be University", Karad, Maharashtra, India. E-mail: drsandeepshinde24@gmail.com

How to cite this article: Sandeep BS, Shivanjali SK, Shreeya DB, Nishant KG, Ravindra VS, Sanjaykumar P. Correlation between Spinal Instability and Ankle Injuries in Amateur Marathon Runners. Asian Pac. J. Health Sci., 2022;9(4):56-60.

Source of support: Krishna Institute of Medical Sciences "Deemed to be University", Karad, Maharashtra, India

Conflicts of interest: None.

Received: 03/02/2022 **Revised:** 17/03/2022 **Accepted:** 15/04/2022

©2022 The Author(s). This is an open access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Spinal instability is used to describe abnormal movement between one vertebra and the other. It can be due to weakening muscles that give support to the spine, for example, the multifidus or the transverse abdominal or erector spinae. Increased aberrant motion at the injured joint and physical alterations that occur at an injured joint are two variables that contribute to instability. Marathon runners must have proper preparation to minimize the risks of injury. Amateur marathon running has effects on the musculoskeletal system. Running may give rise to knee, ankle, and foot injuries. Higher body mass index (BMI), incorrect running shoes, poor form of running, overworking your muscles, not warming up, and cooling down are associated with amateur running injuries. Ankle sprain and strain are common injuries.[3]

The spine is considered as a pillar of the body, it is very important to maintain the spine in proper condition as it keeps the body in correct alignment during sitting, standing, walking, running, etc. The lower extremity balances the lumbar spine and pelvis during walking, running, etc. When the spine is unstable, this balance gets impaired due to which there is the change in the running technique as a result of which there will be an increased risk of injuries of the lower extremity. Running has a repetitive impact on the spine which can damage the spinal column resulting in instability and also putting stress on the discs leading to disc compression and herniation. The impact load generated on foot strike during running travels up the lower kinetic chain and converges on the spine. As there are spinal problems and the ankle joint is the only peripheral joint that is in contact with the ground during running and also carries the body's weight while running, it is important to study the relationship between spinal instability and ankle injuries in amateur marathons runners.

Spinal instability is characterized as a situation in which a patient's clinical status is unstable or there is a lack of spinal stiffness. Symptoms of spinal instability often occur during movements and are prominent in the middle range of movements. When the spine is unstable, an individual experiences symptoms of low back pain, decreased postural control, feeling of giving away, pain during change of position, etc. The centre of gravity lies anterior to the second sacral vertebra of the spine. When there is low back pain, an individual adopts forward flexion posture (increased postural sway) due to which the center of gravity lies in front of the foot instead of on the foot. This can increase the risk of injuries to the knees and ankle. This increased sway indicates the decreased ability of the spine to provide stability during walking and running.[4] Thus, it is necessary to find whether instability of the spine has any relation with ankle injuries while running in amateur runners.

The upper body's weight is transferred to the pelvic and lower extremities through the lumbar spine.[5] Maintaining lumbar spine stability during motions necessitates coordinated movements of many motion segments, and lack of stability can occur in any lumbar section. Changes of spine alter the biomechanical loading from back muscles, ligaments, and joints which can indirectly affect the joints of the lower extremity (hips, knees, and ankle) increasing the risk of injuries while running. Impaired balance control will have an impact on hips, knees, and ankle while running contributing to injuries of the joints, especially of the ankle and knee. There will also be unequal weight distribution while running, resulting in higher postural sway, which can contribute to ankle and other lower extremity joint issues.

Methods

Research Design

This was a cross-sectional study conducted at Karad, Maharashtra. Amateur marathon runners with spinal instability were selected. Various tests for spinal instability and the lumbar functional disability scale were used.

Participants

In total, 150 (n = 150) subjects including (n = 36 females and n = 114 males).

Inclusion Criteria

Age 20–45 years and BMI (18–24.9 kg/m^2) were included in the study.

Exclusion Criteria

Subjects who are elite runners/athletes, subjects with previous spinal surgeries, spinal fractures, degenerative diseases of the spine, ankle fractures, and conditions affecting balance, and subjects who practice marathons were excluded from the study. All participants were given a thorough explanation of the study's purpose and methodology before giving their informed consent. This research was carried out in accordance with ethical guidelines.

Procedures

This study was conducted out at Karad after receiving consent from the Institutional Ethical Committee. Participants who met the inclusion criteria gave their informed consent. Amateur marathon runners with spinal instability, both males and females, were chosen for this investigation. Subjects' demographic data were filled. Subjects with symptoms of spine instability (feeling of giving away, pain in the back, pain during movements, decreased postural control, etc.) were included in the study. Then Oswestry Disability Index (ODI) for low back pain was used to measure the functional independence of the subjects with instability symptoms. This scale addresses ten daily tasks that can be impacted by low back pain: The first item provides for a detailed description of pain intensity, while additional items such as (personal care, lifting, walking, sitting, standing, sleeping, social life, and traveling). Six statements on the type of activity are included in each point. In light of the present scenario, the subject must choose among six options on a 6-point scale, equating to a score ranging from 0 to 5, with 5 denoting higher disability. The maximum possible score, reported as a percentage, is 45. This disability index is calculated by dividing the total score (each section is worth from 1 to 6 points) by the number of sections answered and multiplying by 100. The Passive Lumbar Extension test and the Prone Segmental Instability test were used to confirm spinal instability. The participant was prone throughout the passive lumbar extension test, and both lower extremities were simultaneously lifted to a height of roughly 30 cm from the bed while keeping the knees extended. Pulling the legs gently. When the participant complained of severe lumbar pain ("low back ache," "extremely heavy feeling on the low back") while elevating both legs, the test was positive, and the pain went away when they returned to the starting position. The test was negative when the patient reported an atypical sensation (mild

numbness or prickling sensation). The individual was in a prone position with the body on the examining table and the legs over the side lying on the floor for the prone segmental instability test. The patient was then placed in this posture and pressure was given to the posterior portion of the lumbar spine. After that, the individual lifts his legs off the floor, and posterior compression is administered to the lumbar spine once more. The test was positive if the discomfort was only induced in the resting position, because the muscle movement covers the instability. After the subjects' spinal instability had been confirmed, they were asked one question about ankle injuries they had sustained during or after marathon running.

Statistical Analysis

Statistical analysis of age, gender, BMI, spinal instability tests, and all the findings of ankle injuries was done and the data are presented in the below tables. One-way analysis of variance (ANOVA) test presented a *P*-value <0.0001 of passive lumbar extension and prone instability test which is extremely significant. Ankle pain, ankle swelling, heel pain, blisters, ankle sprain, and strain were also analyzed by ANOVA test where the *P*-value is < 0.0001 which is also extremely significant. ODI also has *P*-value < 0.0001. A correlation (Pearson r) test was used to correlate the two variables (spinal instability and injuries of ankle).

Results

The study was carried out on 150 amateur marathon runners with spinal instability. There were 114 males and 36 females out of which 50 runners were below 30 years of age and 100 runners above 30 years [Table 1]. Eighty participants were under graduated and 70 were graduated. Out of 150, 28% were of the rural population and 72% of the urban population including manual labor (58.6%) and desk workers (41.3%) [Table 1]. The passive lumbar extension test was found to be positive in 57% of individuals, while the prone instability test was found to be positive in 42%. [Table 2]. Out of 150 chosen runners, 68% were having a minimal disability, and 32% had a moderate disability according to the ODI [Table 3].

Ankle fracture and dislocation were absent in all 150 participants chosen but ankle pain (68%), ankle swelling (24%), heel pain (55%), blisters (12%), ankle sprain (28%), and strain (26%) were present [Table 4]. Among 150 selected participants, correlation of passive lumbar extension test and prone instability test with ankle injuries has a significant result [Tables 5 and 6] except for strain. Correlation between ODI and ankle injuries was significant except strain which was not quite significant [Table 7].

Discussion

The study aimed to study and find the correlation between spinal instability and ankle injuries in amateur marathon runners. The objective of the study was to correlate spinal instability with ankle injuries in amateur marathon runners. In this study, 150 amateur marathon runners based on inclusion and exclusion criteria were chosen. Two tests (active flexion test and prone instability test) were performed to find out the spinal instability among the chosen amateur marathon runners. Participants were asked a single question about the presence or absence of injuries of ankle they faced because of amateur marathon running. For the subjective study, Oswestry Low Back Disability Index was used to rate the pain in the low back. Participants were given the questionnaire and they were asked to mark the point which most closely describes their current situation. Based on their scoring,

Table 1: Distribution of demographic variables

Demographic variables	*Frequency (%)*	*Total*
Age group		
>30	50 (33.33)	150
≤30	100 (66.66)	
Gender		
Male	114 (76)	
Female	36 (24)	
BMI (kg/m^2)		
18.5–21	69 (46)	
22–24.9	81 (54)	
Education level		
Undergraduate	80 (58.3)	
Graduate	70 (46.6)	
Living area		
Rural	42 (28)	
Urban	108 (72)	
Occupation		
Manual labor (e.g., workers)	88 (58.6)	
Desk workers (e.g., teachers, bank employees, shop owners)	62 (41.3)	

BMI: Body mass index

Table 2: Distribution of tests

Test	*Positive*	*Negative*	*Percentage*	*P*
Passive lumbar extension test	86	64	57	<0.0001
Prone instability test	64	86	42	

Table 3: Distribution of Oswestry disability index

ODI	*Frequency (%)*	*P*
Minimal disable	102 (68)	<0.0001
Moderate disable	48 (32)	

ODI: Oswestry disability index

Table 4: Total number of presence and absence of ankle injuries

Ankle injuries	*Present*	*Absent*	*Total*	*Percentage*	*P*
Ankle pain	102	48	150	68	<0.0001
Ankle swelling	36	114		24	
Heel pain	83	67		55	
Blisters	18	132		12	
Ankle sprain	44	106		28	
Strain	40	110		26	
Ankle fracture	0	150		0	-
Ankle dislocation	0	150		0	

Table 5: Correlation of passive lumbar extension test with ankle injuries

Test	*Ankle injuries*	*R*	*P*
PLE test	Ankle pain	−0.1776	0.0297
	Ankle swelling	−0.2323	0.0042
	Heel pain	−0.1739	0.0333
	Ankle sprain	−0.2005	0.0139
	Blisters	0.1761	0.0311
	Strain	0.0284	0.7297
	Ankle fracture	-	-
	Ankle dislocation	-	-

PLE: Passive lumbar extension

Table 6: Correlation of prone instability test with ankle injuries

Test	*Ankle injuries*	*r*	*P*
PI test	Ankle pain	0.1776	0.0297
	Ankle swelling	0.2323	0.0042
	Heel pain	0.1739	0.0333
	Ankle sprain	0.2005	0.0139
	Blisters	−0.1761	0.0311
	Strain	−0.0284	0.7297
	Ankle fracture	-	-
	Ankle dislocation	-	-

PI: Prone instability

Table 7: Correlation of Oswestry disability index with ankle injuries

Outcome	*Ankle injuries*	*r*	*P*
ODI	Ankle pain	0.2208	0.0066
	Ankle swelling	0.0508	0.5365
	Heel pain	0.0126	0.8879
	Ankle sprain	0.1858	0.0228
	Blisters	0.2567	0.0015
	Strain	0.1551	0.0580
	Ankle fracture	-	-
	Ankle dislocation	-	-

ODI: Oswestry disability index

interpretation was done as minimal disabled, moderately disabled, severely disabled, and crippled.

Statistical analysis was done using the ANOVA test and correlation (Pearson r) test. The *P*-value for tests, ODI, and ankle injuries is <0.0001 which is extremely significant. The r-value for the correlation test between ODI and ankle injuries is also significant. There is also the significant result of spinal instability tests performed and injuries of the ankle.

According to a study by Wilson *et al*., there is a link between trunk muscles and lower extremity muscles; therefore, a decrease in core muscle strength may increase the risk of injuries while running.[6] According to a study by Sung *et al*., trunk muscular imbalance relates to uneven postural activity, which can result in a diminished, uncoordinated effect in those with low back pain. As a result, core muscle training may be beneficial in preventing postural instability.[7] As a result, core strengthening and spinal stability exercises are essential for maintaining spinal stability.

Subacute non-specific low back pain patients with lumbar instability demonstrated more disability than non-specific low back pain patients without lumbar instability, according to a study by Benca *et al*., this clinically suggested that low back pain treatment should include not only pain and disability, but also the correction of motor control changes.[8] Subjects with lumbar discomfort demonstrate unfavorable postural adaptation during running, according to Seay *et al*., (2011), due to impaired coordination between the lumbar spine and pelvis.[9]

When amateur runners were exhausted, Koblbauer *et al*. found that they had an overall increase in trunk inclination and greater ankle eversion peak angles.[10] As a result of the preceding research, activities such as bridging, prone planks, side planks, knee bent raises, and ball exercises should be used to develop core muscles to preserve spine, pelvis, and kinetic chain stability when running. Not only does this improve strength, but it also improves balance and coordination.[11] We should also concentrate on pain alleviation in addition to stability exercises. In patients with low back pain, the severity of pain has an effect on dynamic balance, as well as a reduced forward limit of stability.[12,13] As a result, people adopt a forward-leaning posture.[14,15]

While running, spinal stability is even more important for maintaining proper posture and maintaining controlled balance on the lower extremities. The antagonist's abdominal cocontraction is vital for improving spine stability and balance.[16,17] To give stability, the trunk exerts a force on the spine. If the trunk muscles are weak, the force on the lumbosacral disc is reduced by 30% and the force on the lower thoracic section of the spine is reduced by 50%.[18] To avoid damage, it is necessary to train and develop the trunk muscles. The conditioning program before participation in marathon for female amateur runners is required to prevent running related injuries.[19,20] Thus, it is necessary to deal with this issue as well. There are numerous injury-related issues regarding amateur runners that need to be addressed before we can consider them ready for a marathon.

Conclusion

Because there is a link between trunk muscles and lower extremity muscles, a decrease in core muscular strength may increase the risk of injury while running. Based on statistical analyses and the results, we concluded that there is a significant relationship between spinal instability and ankle injuries in amateur marathon runners.

References

1. Burkule N. Marathon running for amateurs: Benefits and risks. J Clin Prev Cardiol 2016;5:113.
2. Lieberman DE, Venkadesan M, Werbel WA, Daoud AI, D'Andrea S, Davis IS, *et al.* Foot strike patterns and collision forces in habitually barefoot versus shod runners. Nature 2010;463:531-5.
3. de Araujo MK, Baeza RM, Zalada SR, Alves PB, de Mattos CA. Injuries among amateur runners. Rev Bras Ortop 2015;50:537-40.
4. Panjabi MM. Clinical spinal instability and low back pain. J Electromyogr Kinesiol 2003;13:371-9.
5. Cruz J, Yang J, Xiang Y. Approaches to study spine biomechanics: A literature review. In: International Conference on Applied Human Factors and Ergonomics. Cham: Springer; 2018. p. 453-62.
6. Khutale M, Shinde SB. Effect of advanced strengthening program on physical fitness test performance in injury prone pre-military trainee cadets. J Evol Med Dent Sci 2020;9:1948-52.
7. Sung PS, Yoon B, Lee DC. Lumbar spine stability for subjects with and without low back pain during one-leg standing test. Spine (Phila Pa 1976) 2010;35:E753-60.
8. Hlaing SS, Puntumetakul R, Wanpen S, Boucaut R. Balance control in patients with subacute non-specific low back pain, with and without lumbar instability: A cross-sectional study. J Pain Res 2020;13:795-803.
9. Seay JF, Van Emmerik RE, Hamill J. Low back pain status affects pelvis-trunk coordination and variability during walking and running. Clin Biomech (Bristol, Avon) 2011;26:572-8.
10. Koblbauer IF, van Schooten KS, Verhagen EA, van Dieën JH. Kinematic changes during running-induced fatigue and relations with core endurance in novice runners. J Sci Med Sport 2014;17:419-24.
11. Fredericson M, Moore T. Core stabilization training for middle-and long-distance runners. New Stud Athl 2005;20:25-37.
12. van Gent RN, Siem D, van Middelkoop M, van Os AG, Bierma-Zeinstra SM, Koes BW. Incidence and determinants of lower extremity running injuries in long distance runners: A systematic review. Br J Sports Med 2007;41:469-80.
13. Soliman ES, Shousha TM, Alayat MS. The effect of pain severity on postural stability and dynamic limits of stability in chronic low back pain. J Back Musculoskelet Rehabil 2017;30:1023-9.

14. Mohite SA, Shinde SB. Effect of early intervention with spinal isometric exercises in acute lumbar intervertabral disc prolapse. Indian J Physiother Occup Ther. 2019;13:170.
15. Brumagne S, Janssens L, Janssens E, Goddyn L. Altered postural control in anticipation of postural instability in persons with recurrent low back pain. Gait Posture 2008;28:657-62.
16. Granata KP, Wilson SE. Trunk posture and spinal stability. Clin Biomech (Bristol, Avon) 2001;16:650-9.
17. Gardner-Morse MG, Stokes IA. The effects of abdominal muscle coactivation on lumbar spine stability. Spine (Phila Pa 1976) 1998;23:86-91.
18. George BA, Shinde SB. Effect of activity specific spinal stabilization exercises on pain and spinal mobility in lumbar spondylosis. Int J Health Sci Res 2019;9:174-82.
19. Geere JL, Cortobius M, Geere JH, Hammer CC, Hunter PR. Is water carriage associated with the water carrier's health? A systematic review of quantitative and qualitative evidence. BMJ Glob Health 2018;3:e000764.
20. Kolhatkar AS, Shinde SB. Effectiveness of a conditioning program on amateur female marathon runners. J Evol Med Dent Sci 2020;9:2040-5.