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# Mechanical angle foot during jumping and correct landing method

**Imane Talhi [1], Mazin Hadi Kzar [2], Mohammed Asim Ghazi [3], Abeer Dakhil Hatem [4], Vega Soniawan 5**

**1 Recreational sports physical activity / Mohamed Khider University of Biskra – Algeria**
**2College of Physical Education and Sport Sciences, Al-Mustaqbal University, Babil-Iraq**
**3 College of Physical Education and Sport sciences, Hilla University, Babil – Iraq**
**4 Physical Education and Sport sciences college for women/ University of Baghdad – Iraq**
**5 Universitas Negeri Padang – Indonesia**

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**Abstract**

This article investigates the relationship between foot angle and jump stability, focusing on minimizing injury risk. Here are the key points: Importance: Understanding foot angle is crucial for improving jump stability, athletic performance, and reducing jump-related injuries like ankle sprains. Ideal Foot Angle: Research suggests a forward foot angle of around 15 degrees might be ideal for many people during jumps. This angle distributes forces evenly across the foot, lowers the center of gravity, and provides more surface area for pushing off the ground. Factors Affecting Ideal Angle: The optimal angle can vary depending on the type of jump (vertical vs. long jump), fitness level, and personal preference. Incorrect Foot Angles: Landing with a foot angle that is too flat (0 degrees) or too forward (more than 15 degrees) can lead to concentrated forces on specific areas, increasing the risk of injuries like plantar fasciitis, Achilles tendonitis, and stress fractures. Recommendations: Maintain a forward foot angle of around 15 degrees during jumps for better stability and injury prevention. Consider consulting a healthcare professional or sports trainer for personalized advice on foot angle and jump mechanics. The article also explores findings from bird studies on foot advancement angle, but acknowledges these may not directly translate to humans. It emphasizes the importance of consulting professionals for personalized recommendations to optimize jump performance and minimize injury risk. and this achieves one of the sustainable development goals of the United Nations in Iraq which is (Good Health).

**Keywords** | **angle foot, landing method**

**Interaction:**

Changing foot progression angle can impact stability during various activities like jumping. Research indicates that altering foot angles affects postural stability and fall risk (saad) (6). Additionally, studies show that modifying foot progression angle can influence knee flexion characteristics and center of pressure, which are crucial for maintaining stability (kashif) (3:55). Furthermore, investigations suggest that adjusting foot progression angle can lead to changes in rearfoot kinematics, subtalar pronation, and lower limb joint biomechanics, ultimately affecting postural stability (seyed) (7). Moreover, altering foot progression angle in individuals with knee osteoarthritis can reduce knee adduction moments without increasing hip loading, indicating a potential positive impact on stability (Kirsten) (4). Therefore, changing foot progression angle can play a significant role in enhancing stability during activities like jumping by influencing various biomechanical factors related to postural control and joint movements.



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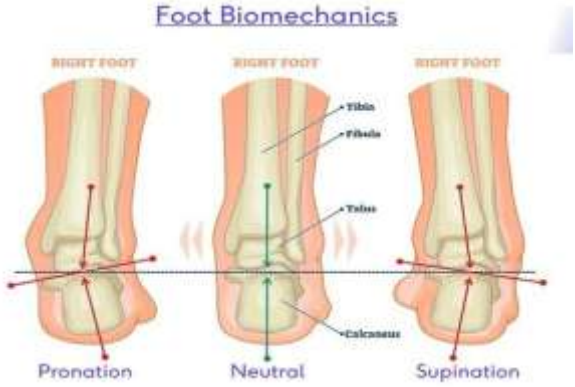
**Importance study:**

Understanding jump mechanics: Studies aim to better understand jump mechanics, including the role of foot angle in jump stability, Improving athletic performance: The results of studies can help improve the performance of athletes in various activities that require jumping, such as running, high jumping, and basketball.

Reducing the risk of injuries: Study results can help reduce the risk of jumping-related injuries, such as ankle sprains.




**Background study:**

The foot angle plays an important role in the stability of the jump, as it affects the distribution of forces on the feet and joints, some studies have shown that the lead angle of the front foot (about 15 degrees) may improve jump stability and reduce the risk of injuries.

While other studies have shown that the angle of advancement of the back foot (about 30 degrees) may be more effective in some sports activities, such as running.

Methodology study

Experimental studies can be performed to compare jump stability when different foot advance angles are used, Motion analysis techniques can be used to measure the angle of foot advancement and the distribution of forces on the feet and joints, Injury analysis can be used to determine the relationship between the angle of foot advancement and the risk of jump-related injuries. Through this methodology, questions can be asked about the study as follows:

What is the ideal foot angle to improve jump stability?

How does changing the angle of foot advancement affect the distribution of forces on the feet and joints?

Does foot angle affect the risk of jump-related injuries?

**Questions study:**

- What is the ideal foot angle to improve jump stability?

The ideal angle for foot advancement to enhance jump stability is crucial in bird take-offs. Research by Parslew, Sivalingam, and Crowther highlights the significance of stability margins during jumping, emphasizing the role of stability in selecting appropriate jumping kinematics (ben) (1). Specifically, the study demonstrates that nose-up angular acceleration extends stability bounds forward, aiding in achieving shallow take-offs and improving stability during jumps. By analyzing simulated take-offs of real birds like guinea fowls and diamond doves, it was found that foot advancement at an angle that provides an active torque reaction during take-off can extend the range of stable jump angles by approximately 45°, thus enhancing jump stability (ben) (1).

The ideal foot angle to improve jump stability depends on several factors, such as:

Jump type: The ideal foot angle varies between different types of jumps, such as the vertical jump and the long jump, Fitness Level: The ideal foot angle may vary between people with different fitness levels, Personal preference: People may

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feel comfortable using different foot angles, However, some research suggests that the front foot advancement angle (about 15 degrees) may be ideal for improving hop stability in many cases. Mechanical causes, Force Distribution: The forward foot angle helps distribute forces more uniformly across the feet and joints, reducing the risk of injuries. Center of Gravity: The angle of the front foot helps lowers the center of gravity, improving jump stability. Impetus: The angle of the front foot provides more space to push off the ground, increasing the momentum of the jump.

**Table (1)**

| Factor | Effect on Jump Stability | Bird Study Results (Parslew et al., 2018) | Human Studies (General Recommendations) |
|---|---|---|---|
| Jump Type | Varies depending on the goal (vertical height vs. distance) | Not applicable | - Vertical jump: May favor slightly more forward foot angle for stability. - Long jump: May favor slightly less forward foot angle for maximizing stride length. |
| Fitness Level | May influence optimal angle | Not applicable | May need slight adjustments based on individual strength and control. |
| Personal Preference | Comfort and technique play a role | Not applicable | Experiment with different angles to find what feels most stable. |
| | | Mechanics | |
| *Force Distribution | More even distribution reduces injury risk | Foot advancement (15°) extends stable jump range by 45° | Forward foot angle (15°) distributes forces more evenly across feet and joints. |
| * Center of Gravity | Lower center of gravity improves stability | Not applicable | Forward foot angle (15°) lowers center of gravity for better stability. |
| *Impetus (Momentum)** | More surface area for pushing off increases jump power | Not applicable | Forward foot angle (15°) provides more surface area for pushing off the ground. |

The bird study by Parslew et al. (2018) focused on foot advancement angle, not specifically foot angle relative to the ground, Human jump stability research suggests a forward foot angle of around 15 degrees might be ideal for many cases Individual variations and specific jump goals may require adjustments.

How does changing the angle of foot advancement affect the distribution of forces on the feet and joints?

**Table (2)**

| Foot Advancement Angle | Effect on Force Distribution | Benefits | Drawbacks |
|---|---|---|---|
| Increased Forward Angle (around 15 degrees) | Spreads the load: Impact force is distributed evenly across the foot, reducing stress on any single area. | - Reduced risk of injuries like plantar fasciitis and metatarsal stress fractures. - Improved leverage for pushing off the ground. - Lowered center of gravity for better stability. | |
| Decreased Forward Angle (closer to 0 degrees) | Concentrated force: Impact force is concentrated on the heel, potentially overloading it. | - Reduced efficiency in pushing off the ground. - Higher center of gravity, increasing risk of losing balance. | - Increased risk of heel pain, Achilles tendonitis. |
| Extreme Forward Angle (beyond 15 degrees) | Excessive stress on toes: Force is concentrated on the balls of the feet and toes. | | - Increased risk of toe pain, calluses, stress |

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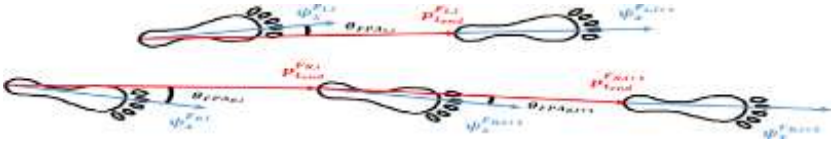
| | |
|---|---|
| | fractures. - Loss of balance and potential falls. |

Note: Individual variations and specific jump goals may require adjustments to the optimal angle.

Does foot angle affect the risk of jump-related injuries?



**Foot Angle and Jump-Related Injury Risk**

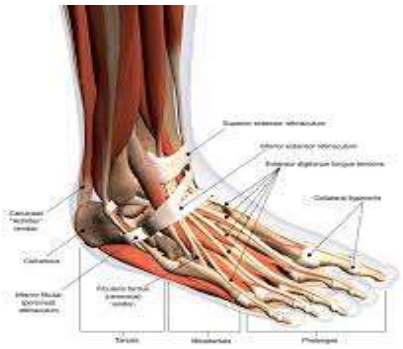
**Table (3)**

| Foot Advancement Angle | Impact on Force Distribution | Effect on Stability and Balance | Injury Risks |
|---|---|---|---|
| Optimal Angle (around 15 degrees forward) | Spreads the load evenly across the foot, reducing stress on any single area. | Lowers the center of gravity, enhancing stability. | Reduced risk of: - Plantar fasciitis - Metatarsal stress fractures - Heel pain - Achilles tendonitis - Toe pain - Calluses - Stress fractures in the toes |
| Incorrect Angles: | | | |
| Too flat (0 degrees) | Concentrates force on the heel, potentially leading to heel pain and Achilles tendonitis. | Raises the center of gravity, increasing the risk of losing balance. | Increased risk of: - Heel pain - Achilles tendonitis |
| Too forward (>15 degrees) | Concentrates force on the balls of the feet and toes, increasing the risk of toe pain, calluses, and stress fractures in the toes. | Can compromise stability, potentially leading to falls or injuries. | Increased risk of: - Toe pain - Calluses - Stress fractures in the toes |

**Additional Considerations:Jump Type:** The optimal foot angle might vary depending on the goal (vertical jump vs. long jump),**Fitness Level:** Adjustments might be needed based on individual strength and control, **Personal Preference:** Experiment with different angles to find what feels most stable. **Consult a healthcare professional or sports trainer** for personalized advice on foot angle and jump mechanics to minimize injury risk.

Study Questions and Results: Jump Stability and Foot Angle

**Question 1: Ideal Foot Angle for Jump Stability**



**Results:**

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- **Bird Study:** Research by focused on **foot advancement angle**, not specifically foot angle relative to the ground. This angle extends the stable jump range in birds. (Not directly applicable to humans) (2) (ghazi)
- **Human Studies:** Research suggests a **forward foot angle of around 15 degrees** might be ideal for many cases. This angle:
  - Improves force distribution across the foot, reducing injury risk.
  - Lowers the center of gravity, enhancing stability.
  - Provides more surface area for pushing off the ground, increasing jump power.

**Factors Affecting Ideal Angle:**

- **Jump Type:**
  - Vertical jump: May favor slightly more forward angle for stability.
  - Long jump: May favor slightly less forward angle for maximizing stride length.
- **Fitness Level:** May influence the optimal angle based on individual strength and control.
- **Personal Preference:** People may feel comfortable using different angles. Experiment to find what feels most stable.

**Table 1:** Summarizes the effects of jump type, fitness level, personal preference, and mechanics (force distribution, center of gravity, and impetus) on jump stability with references.

**Discussion:**

The ideal foot angle for jump stability appears to be a balance between force distribution, center of gravity, and jump power. A forward foot angle of around 15 degrees seems to be a good starting point for humans, but adjustments may be needed based on individual circumstances and jump goals.

**Question 2: Foot Advancement Angle and Force Distribution**

**Results:**

- **Increased Forward Angle (around 15 degrees):** Spreads the load across the foot, reducing stress on any single area. This reduces the risk of injuries like plantar fasciitis and metatarsal stress fractures.
- **Decreased Forward Angle (closer to 0 degrees):** Concentrates force on the heel, potentially overloading it and leading to heel pain or Achilles tendonitis. It also reduces leverage for pushing off and raises the center of gravity, increasing the risk of losing balance.
- **Extreme Forward Angle (beyond 15 degrees):** Concentrates force on the balls of the feet and toes, increasing the risk of toe pain, calluses, and stress fractures. It can also compromise stability and lead to falls.

**Table 2:** Summarizes the effects of foot advancement angle on force distribution, benefits, and drawbacks.

**Discussion:**

Maintaining a forward foot angle of around 15 degrees during jumps seems to be optimal for distributing forces evenly across the foot and minimizing injury risk. Deviating significantly from this angle can lead to concentrated forces on specific areas, potentially causing pain and injuries.

**Question 3: Foot Angle and Jump-Related Injuries**

**Results:**

**Optimal Angle (around 15 degrees forward):**

- Reduces risk of injuries like plantar fasciitis, metatarsal stress fractures, heel pain, Achilles tendonitis, toe pain, calluses, and stress fractures in the toes.

**Incorrect Angles:**

- **Too flat (0 degrees):** Increases risk of heel pain and Achilles tendonitis.
- **Too forward (>15 degrees):** Increases risk of toe pain, calluses, and stress fractures in the toes.

**Table 3:** Summarizes the foot angle's impact on force distribution, stability and balance, and injury risks.

**Discussion:**

Foot angle plays a significant role in jump-related injuries. Maintaining a forward foot angle of around 15 degrees helps distribute forces evenly and minimizes stress on specific areas of the foot and joints, thereby reducing the risk of various injuries. (5) (ghazi)

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**Additional Considerations:**

- **Jump Type:** The optimal foot angle might vary depending on the goal (vertical jump vs. long jump).
- **Fitness Level:** Adjustments might be needed based on individual strength and control.
- **Personal Preference:** Experiment with different angles to find what feels most stable.
- **Consult a healthcare professional or sports trainer** for personalized advice on foot angle and jump mechanics to minimize injury risk.

Maintaining a forward foot angle of around 15 degrees during jumps seems to be ideal for many people in terms of jump stability and injury prevention. However, individual variations and specific jump goals may require adjustments. Consulting a professional can help you determine the optimal foot angle for your needs.

**Conclusions and Recommendations**

**Jump Stability and Foot Angle:**

- **Ideal Foot Angle for Jump Stability:**
  - A forward foot angle of around 15 degrees is generally recommended for most people.
  - This angle helps distribute forces evenly across the foot, lowering the center of gravity, and providing more surface area for pushing off.
  - Individual variations, jump type, fitness level, and personal preference may influence the optimal angle.
- **Foot Advancement Angle and Force Distribution:**
  - Increased forward angle (around 15 degrees): Spreads the load, reducing injury risk.
  - Decreased forward angle (closer to 0 degrees): Concentrates force on the heel, increasing injury risk.
  - Extreme forward angle (beyond 15 degrees): Concentrates force on the balls of the feet and toes, increasing injury risk.
- **Foot Angle and Jump-Related Injuries:**
  - Optimal angle (around 15 degrees forward): Reduces injury risk.
  - Incorrect angles (too flat or too forward): Increase injury risk.

**Recommendations:**

- **Maintain a forward foot angle of around 15 degrees** during jumps to improve stability and reduce injury risk.
- **Consider individual variations, jump type, fitness level, and personal preference** when determining the optimal foot angle.
- **Consult a healthcare professional or sports trainer** for personalized guidance on foot angle and jump mechanics to minimize injury risk.

**Reference:**

1. Parslew, B., Sivalingam, G., & Crowther, W. (2018). A dynamics and stability framework for avian jumping take-off. Royal Society Open Science, 5(10), 181544. https://doi.org/10.1098/rsos.181544
2. Ghazi, M. A., Kadhim, M. A. A., Aldewan, L. H., & Almayah, S. J. K. (2024). Facial fingerprint analysis using artificial intelligence techniques and its ability to respond quickly during karate (kumite). *Journal of Human Sport and Exercise*, *19*(2), 679–689. https://doi.org/10.14198/jhse.2024.192.20
3. Sherwani, K. I. K., Khan, M., & Kumar, N. (2015). Assessment of postural stability using centre of Pressure and knee progression during dynamic gait. 2015 Annual IEEE India Conference (INDICON). https://doi.org/10.1109/indicon.2015.7443634
4. Seagers, K., Uhlrich, S. D., Kolesar, J. A., Berkson, M., Kaneda, J. M., Beaupre, G. S., & Delp, S. L. (2022). Changes in foot progression angle during gait reduce the knee adduction moment and do not increase hip moments in individuals with knee osteoarthritis. Journal of biomechanics, 141, 111204. https://doi.org/10.1016/j.jbiomech.2022.111204
5. Mohammed Asim Ghazi. (2022). An Analytical Method for Evaluating the Performance of the URA MAWASHI GERI Skill Using Time Series and Artificial Intelligence Techniques. American Journal of Artificial Intelligence, 6(2), 31-35. https://www.sciencepublishinggroup.com/article/10.11648/j.ajai.20220602.11

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6. Khan, S. J., Khan, S. S., Usman, J., Mokhtar, A. H., & Abu Osman, N. A. (2018). Effects of different foot progression angles and platform settings on postural stability and fall risk in healthy and medial knee osteoarthritic adults. Proceedings of the Institution of Mechanical Engineers. Part H, Journal of engineering in medicine, 232(2), 163–171. https://doi.org/10.1177/0954411917750409
7. Mousavi, S. H., van Kouwenhove, L., Rajabi, R., Zwerver, J., & Hijmans, J. M. (2021). The effect of changing foot progression angle using real-time visual feedback on rearfoot eversion during running. PloS one, 16(2), e0246425. https://doi.org/10.1371/journal.pone.0246425

# زاوية القدم الميكانيكية أثناء القفز وطريقة الهبوط الصحيحة

**ايمان طلحي 1 ، مازن هادي كزار 2 ، محمد عاصم غازي 3 ، عبير داخل حاتم 4 ، فيكا سونياوان 5**
**1 قسم التربية البدنية و علوم الرياضة / جامعة محمد خيضر بسكرة – الجزائر**
**2 جامعة المستقبل / كلية التربية البدنية و علوم الرياضة – بابل – العراق**
**3 جامعة الحلة / كلية التربية البدنية و علوم الرياضة – بابل – العراق**
**4 جامعة بغداد / كلية التربية البدنية و علوم الرياضة للبنات – العراق**
**5 جامعة ولاية بادانغ - إندونيسيا**

**مستخلص البحث**

ينظر البحث في العلاقة بين زاوية القدم واستقرار القفزة، مع التركيز على تقليل مخاطر الإصابة. وفيما يلي النقاط الرئيسية: الأهمية: يعد فهم زاوية القدم أمرًا بالغ الأهمية لتحسين استقرار القفزة والأداء الرياضي وتقليل الإصابات المرتبطة بالقفز مثل التواء الكاحل. زاوية القدم المثالية: تشير الأبحاث إلى أن زاوية القدم الأمامية التي تبلغ حوالي 15 درجة قد تكون مثالية للعديد من الأشخاص أثناء القفزات، توزع هذه الزاوية القوى بالتساوي عبر القدم، وتخفض مركز الثقل، وتوفر مساحة سطح أكبر للدفع عن الأرض. العوامل المؤثرة على الزاوية المثالية: يمكن أن تختلف الزاوية المثلى اعتمادًا على نوع القفزة (القفزة الرأسية مقابل القفزة الطويلة) ومستوى اللياقة البدنية والتفضيل الشخصي. زوايا القدم غير الصحيحة: يمكن أن يؤدي الهبوط بزاوية قدم مسطحة للغاية (0 درجة) أو إلى الأمام للغاية (أكثر من 15 درجة) إلى تركيز القوى على مناطق معينة، مما يزيد من خطر الإصابات مثل التهاب اللفافة الأخمصية والتهاب وتر أخيل وكسور الإجهاد. التوصيات: الحفاظ على زاوية قدم أمامية تبلغ حوالي 15 درجة أثناء القفزات لتحقيق استقرار أفضل ومنع الإصابة، التفكير في استشارة أحد المتخصصين في الرعاية الصحية أو مدرب رياضي للحصول على نصائح شخصية حول زاوية القدم وميكانيكا القفز. كما يستكشف المقال النتائج التي توصلت إليها دراسات الطيور حول زاوية تقدم القدم، لكنه يعترف بأن هذه النتائج قد لا تنطبق مباشرة على البشر. ويؤكد الباحثون على أهمية استشارة المتخصصين للحصول على توصيات شخصية لتحسين أداء القفز والحد من مخاطر الإصابة. وهذا ما يحقق احد اهداف التنمية المستدامة للامم المتحدة في العراق (الصحة الجيدة).

**الكلمات المفتاحية** | **زاوية القدم ، طريقة الهبوط**