Kinematical and Body Mass Index Analysis of Standing Broad Jump by Kinovea Software

Amit[1*], Ravinder Pal Ahalawat[2], Nitesh Kumar Singh Kushwaha[3], Gajender Singh[4]

[1,3] Research Scholar, Department of Physical Education and Sports, Central University of Haryana, India, 123031
[2] Professor, Department of Physical Education and Sports, Central University of Haryana, India, 123031
[4] Assistant Professor, Department of Physical Education and Sports, Central University of Haryana, India, 123031

---***---

Abstract - *The purpose of this study was to investigate the kinematic and BMI factors that affect the standing broad jump performance of individuals with three to five years of experience who are between the ages of 21 and 25. Fifteen healthy male athletes' performances were recorded using a Sony ZV-E10 high-resolution camera with a 16-55mm Sony lens (1080p HD video, 60 fps). All kinematic and BMI variables showed a strong correlation with both estimated and measured jump distance, except for the BMI at standing broad jump, BMI at angle of take-off, angle of take-off at maximum shoulder extension, and take-off ankle at maximum shoulder extension. The recorded video was examined using Kinovea 2023 Motion Analyzer software. Subsequently, the collected data were analyzed utilizing Jamovi software, with the significance level established at 0.05. The variation in jump distance was predominantly accounted for by take-off distance and take-off speed among all the kinematic factors. It is essential for physical education teachers and coaches to meticulously observe anthropometric and kinematic parameters to improve athletes' standing broad jump performance.*

Key Words: Kinematic parameters, standing broad jump, physical education and sports, kinovea software, and video analysis.

1. INTRODUCTION

The standing long jump is alternatively referred to as the standing broad jump. This sport was last featured in Olympic events until 1912. The standing broad jump is a variant of track and field jumping events, which also encompasses standing high jumps and triple jumps. In a standing long jump, athletes position their feet slightly apart while taking their stance behind a designated line on the ground. This article will discuss the standing long jump as a competitive sport and the standing broad jump test. (Monika Wasuja et al., 2022).

Specific biomechanical angles define the take-off, flight, and landing phases of the standing broad jump. The athlete's hip and knee angles are critical during take-off, with a 90-degree knee angle frequently being ideal. In the standing broad jump, the take-off angle, which refers to the angle at which the body is propelled into the air, typically measures less than 45 degrees. The centre of mass of the body follows a parabolic trajectory throughout the flying phase. To minimize the risk of injury, the athlete flexes their hips and knees during the landing phase. The hip angle, defined as the angle between the thigh and the torso, along with the knee angle, which is the angle between the thigh and the lower leg, are essential factors at the onset of the take-off phase. A study published by World Scientific Publishing indicates that the optimal knee angle at the start of the jump is 90 degrees. Power generation also encompasses the hip angle. A study published by World Scientific Publishing indicates that arm swing plays a crucial role in the standing broad jump by facilitating the anterior displacement of the centre of mass and enhancing leap distance. (Wen-Lan Wu et al., 2003).

The jumper's centre of mass is like a projectile in free flight during the standing long jump's flight phase. To maximize the distance of the jump, 45 is probably not the best projection angle. Only when the magnitude of the projection speed produced by the jumper is constant across all projection angles is a 45-degree angle suitable. It is well known that as the projection angle increases in the long jump, javelin, and shot put, the athlete's (or tool's) projection speed decreases. (Masaki Wakai, 2005).

Insulin resistance, clustering cardiometabolic risk, and inflammatory proteins during childhood and adolescence have all been found to be inversely and independently correlated with muscular fitness, a significant indicator of health. (Artero et al., 2012) According to longitudinal research, alterations in central and total adiposity, systolic blood pressure, blood lipids, and lipoproteins are linked to changes in muscle fitness from childhood to adolescence. (Ruiz et al., 2009) These results also reinforce the need of evaluating young people's muscular fitness. Maximum isometric strength, muscular endurance, and explosive strength are some of the various aspects of physical fitness that can be evaluated during adolescence. One of the aspects of muscular fitness that is frequently included in youth fitness test batteries is lower-body explosive strength. (Castro-Pinero et al., 2010) (Jorge R. Fernandez-Santos et al., 2017).

Movement is seen and characterized using the biomechanical method to movement analysis, which allows for both qualitative and quantitative examination of movement. According to this method, the motion characteristics of a person or an item is explained by parameters like speed and direction, how forces inside and outside the body cause motion, and the best body positions and actions for effective, efficient motion. (Akwinder & Nishan, 2016), (Samson, 2019)

1.1 Biomechanics (Standing Broad Jump and Kinematic Parameters)

In a standing long jump, the jumper seeks to project his body for the greatest horizontal distance beyond a take offline. The jumper begins in a static standing position and uses a countermovement in conjunction with a double-arm swing and a double-leg take-off to achieve a large take-off speed. The jumper swings their legs forward under their body in preparation for landing during the flight phase, which is characterized by a significant forward lean of the torso during take-off. The jumper typically falls with the feet stretched far ahead of the hips and a noticeable forward lean of the trunk. The jumper must maintain balance after landing and avoid falling backward into the pit to receive credit for a successful jump. (Samson, 2019).

The take-off for a standing broad jump (SBJ) is a fast, forceful motion in which the athlete swings their arms and bends their knees to produce force and propel themselves forward. when the athlete swings their arms and bends their knees to propel themselves ahead. With the knees pushing off the ground and the arms swinging forward, the body should be in a low, athletic position. A new amateur sport called a Biomechanical Motion Analysis (BMA) gives coaches and athletes precise data on joint angles, body positions, velocity, and energy transfer during a repeatable motion that is sport-specific (and often position-specific). Even at the highest levels, athletes will always falter when the modifications. Improved performance and injury prevention are inevitable outcomes of BMA. "Biomechanics is the study of the structure and functioning of living systems through the application of mechanical principles." (Ajithkumar L et al., 2022).

1.2 Kinovea Software

The three-dimensional (3D) motion analysis laboratory is one of the most exacting and scientifically verified systems utilized in kinematic analysis, and it produces very accurate data. Its usage in research and in clinics may be limited, nevertheless, by its technical challenges with interpretation and setup, as well as its expensive programs and equipment. These days, new low-cost 2D technologies are accessible; some of them may be as precise as the most expensive high-end reference systems, but they are also far less expensive. Prior to becoming standardized for use in assessing human gait, for example, it is imperative that these tools have proven their validity and reliability. One such inexpensive tool is Kinovea, a free 2D motion analysis program developed in 2009 by a non-profit team of researchers, athletes, coaches, and programmers from around the globe under a GPLv2 license. It makes it possible to analyse spatial-temporal metrics, coordinates, angles, and distances from a video recording frame by frame. These measurements can be made from different angles since the software calibrates in planes that are not perpendicular to the camera-object line being analysed. Three primary areas have made use of Kinovea: sports clinical analysis and evaluating the dependability of other emerging technologies. Kinovea is a free, portable, and user-friendly instrument that can be used in actual field settings; no prior knowledge is needed to get precise and trustworthy measurements. Its validity as a tool for evaluating time-related variables has already been established. (Albert Puig-Divi et al., 2019).

1.3 BMI

A popular indicator of lower body explosive strength, the standing broad jump shows correlations with kinematic factors and body mass index (BMI), especially in youngsters. While kinematic factors like take-off speed and distance are important predictors of jump length, studies indicate that increased BMI can have a negative effect on performance on this test. Higher BMIs are typically linked to shorter jump distances, particularly in younger populations, according to several studies showing an inverse association between BMI and standing broad jump performance. This is probably because having more body mass makes it harder to exert enough force for a strong jump. (T Halme et al., 2009)

2. METHODOLOGY

A. Subjects

A total of 15 physical education students from the Central University of Haryana, each possessing 3 to 5 years of experience in various sports, were selected as participants for the study. The objective of this study is to analyze the performance of the standing broad jump in relation to kinematic variables.

B. Procedures

The researcher thoroughly explained the purpose of the study to the subjects prior to data collection. Before the competition, the long jumper warms up for ten minutes. The jumpers began their jump from takeoff after the researcher blew the whistle. Every student jumped as high as they could from the takeoff board, and the official scored their best performance. Three trials were given to each person, and the best trial was used for analysis. broad jump while standing. The athlete places both feet over the line of the sandpit, uses their arms and legs to bend and jump as far as they can, and lands both feet in the sandpit. The distance between the jumper's initial touch and the edge of the sandpit is noted by the assistant. The jumper repeats the test twice. The helper

International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 13 Issue: 08 | Aug 2026 www.irjet.net p-ISSN: 2395-0072

uses the longest distance recorded to gauge the jumper's leg strength.

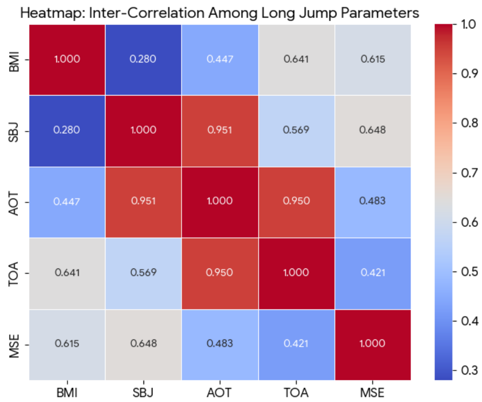
C. Videography Technique (Videography Equipment and Location)

To record the student's performance using a high-resolution camera (Sony ZV-E10 with 16-55 mm kit lens, and 4k 60 fps) to obtain kinematical data. The chosen kinematic characteristics for this were BMI (Body Mass Index), SBJ, standing broad jump performance, AOT, TOA, and MSE. The camera was positioned 20 meters away and perpendicular to the sagittal plane on the left side of the takeoff board. The camera was set to four feet above the ground using a tripod. The selected jumpers performed for all of the students.

D. Measurement and Analysis (Kinovea Software)

The best jump of each jumper was identified and chosen. With the use of Kinovea 2D Motion Analysis Software, the selected trails were played after the video recording session to save separate clips for each jumper. The Kinovea Software was opened with each of the single clips. The software has provisions to examine the SBJ (Standing Broad Jump), AOT (Angle of Take off), TOA (Take off Ankle) and MSE (Maximum Shoulder Extension), stand broad performance the numeral data were acquired from the variables by digitizing software kinovea given in Fig. 1 which shows the AOT in degree and Fig. 2 show MSE.

Table -1: Inter Correlation Among Long Jump Performance, Body Mass Index and Kinematic Parameters



BMI and SBJ were not significant (0.280) at the 0.05 level because the obtained values were less than the required value of 0.514 for 13 degrees of freedom. SBJ, take off Angle (0.951**), Take off Ankle (0.569*) and MSE (0.648**) were significantly correlated Fig. 2 Shows the SBJ correlation value. Take off Angle and MSE were no significant (0.483) at the 0.05 level because the obtained values were less than the required r value of 0.514 for 13 degrees of freedom. Take off Angle and Take off Ankle were strongly significantly correlated (0.648**) fig.3 shows the Take off Angle correlation value.

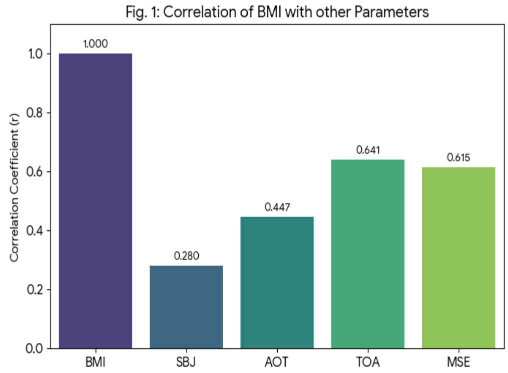


Fig -1: Graphical representation of correlation value on BMI performance

BMI and SBJ were not significant (0.280) at the 0.05 level because the obtained values were lesser than the required r value of 0.514 for 13 degrees of freedom. SBJ, take off Angle (0.951**), Take off Ankle (0.569*) and MSE (0.648**) were significantly correlated Fig. 2 Shows the SBJ correlation value.

Take off Angle and MSE were no significant (0.483) at the 0.05 level because the obtained values were less than the required r value of 0.514 for 13 degrees of freedom. Take off Angle and Take off Ankle were strongly significantly correlated (0.648**) fig.3 shows the Take off Angle correlation value.

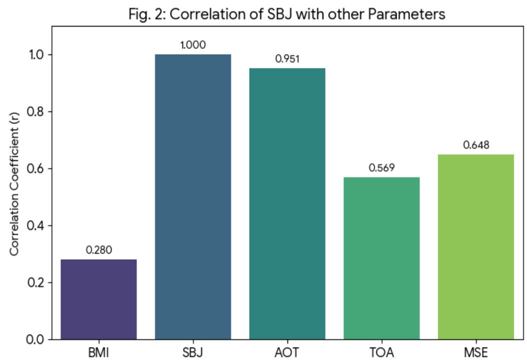


Fig -2: Graphical representation of correlation value on SBJ performance

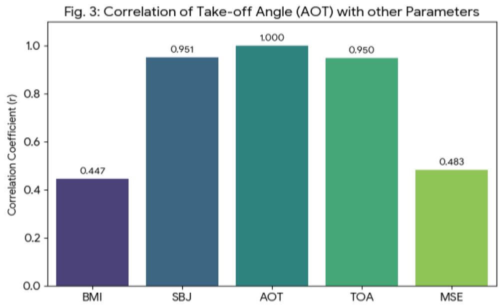


Fig -3: Graphical representation of correlation value on Take off Angle performance

Take off Because the obtained values were less than the necessary r value of 0.514 for 13 degrees of freedom, Ankle and MSE were not significant (0.421) at the 0.05 level. Figures 6 and 7 display the Ankle and MSE correlation values.

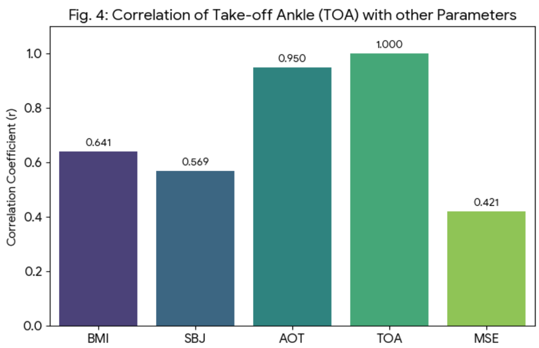


Fig -4: Graphical representation of correlation value on Take off Ankle performance

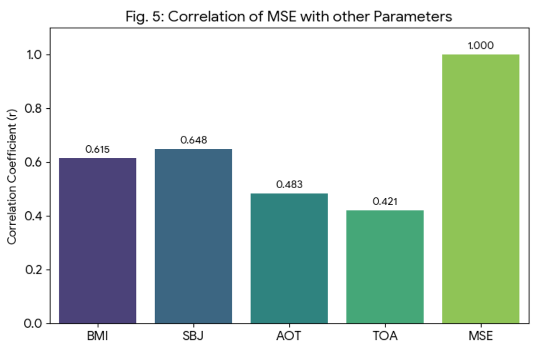


Fig -5: Graphical representation of correlation value on MSE performance

Different levels of relationship between Body Mass Index (BMI), standing broad jump performance, and long jump kinematic parameters were found by the correlation analysis. Higher BMI values were somewhat associated with greater take-off angles and ankle positions, as evidenced by the moderately positive association found between BMI and take-off angle (r = 0.447) and between BMI and take-off ankle angle (r = 0.641). Interestingly, there was a moderate association between BMI and maximum shoulder extension (r = 0.615), indicating that body composition and upper body movement during the leap may be related. The take-off angle (r = 0.951) and maximal shoulder extension (r = 0.648) were shown to have a strong and statistically significant association with the standing wide jump, suggesting that these kinematic parameters are important for jump performance. The take-off angle also demonstrated a very strong and significant relationship with the take-off angle (r = 0.950), reinforcing the biomechanical interdependence of these variables during take-off. Overall, several correlations exceed the critical value of r = 0.514, indicating statistical significance at the 0.05 level with 13 degrees of freedom, particularly highlighting the importance of kinematic coordination for effective long jump execution.

RESULT

The study's findings revealed significant intercorrelations among long jump performance, Body Mass Index (BMI), and various kinematic parameters. Notably, the take-off angle demonstrated a strong positive correlation with the standing broad jump (r = 0.951) as well as with the take-off ankle angle (r = 0.950), both of which exceeded the critical value (r = 0.514) required for statistical significance at the 0.05 level. This indicates that athletes with better take-off angles tend to perform longer jumps. The take-off ankle angle also showed a strong and significant relationship with BMI (r = 0.641) and standing broad jump (r = 0.569). Furthermore, maximum shoulder extension exhibited mild associations with every other variable, including standing broad jump (r = 0.648) and BMI (r = 0.615), suggesting its relevance to performance, even though these numbers were slightly below the threshold for statistical significance. Overall, the data suggests that biomechanical and anthropometric factors play an essential role in long jump performance, with take-off mechanics showing the strongest influence.

3. DISCUSSION

The analysis of the inter-correlation among body mass index (BMI), standing broad jump, take-off angle, take-off ankle angle, and maximum shoulder extension reveals several significant relationships that help explain key factors contributing to long jump performance. Among the most notable findings is the strong positive correlation between the take-off angle and take-off ankle angle (r = 0.950), which exceeds the critical value of 0.514 at the 0.05 level of significance. This indicates a significant relationship, suggesting that as the take-off angle improves, so does the angular positioning of the ankle at take-off. This alignment may enhance the force application and efficiency of propulsion during the jump.

Additionally, a high correlation is observed between the standing broad jump and take-off angle (r = 0.951), implying that athletes with better standing broad jump performance tend to generate more optimal take-off angles during the long jump. This result emphasizes the relevance of horizontal power and explosiveness, as measured by the standing broad jump, in determining jump distance in long jump events.

BMI showed moderate correlations with several variables, such as take-off ankle angle (r = 0.641) and maximum shoulder extension (r = 0.615), indicating that while body composition may influence performance-related parameters, it is not a definitive predictor by itself. These numbers are marginally below the significance level, indicating possible patterns rather than absolute correlations. Nonetheless, these patterns might still provide useful information for athlete fitness and coaching adjustments.

Interestingly, maximum shoulder extension demonstrated moderate correlations with both standing broad jump (r = 0.648) and BMI, which could reflect the role of upper body mechanics and posture in generating momentum during take-off. These associations highlight the possible significance of flexibility and full-body coordination in optimizing jump performance, even if they were not statistically significant at the 0.05 level. All things considered, the evidence points to the importance of biomechanical elements in long jump success, especially those related to take-off technique and explosive force. These findings may guide targeted training programs that emphasize improving take-off angles, ankle positioning, and horizontal power development through drills and strength training.

4. CONCLUSION

The analysis of the standing wide jump using 2D digital motion analysis and anthropometric evaluation shows that it is an extremely technical exercise, with success dependent on the exact coordination of joint angles and upper-body momentum. The study's most significant finding is that the take-off angle and ankle position have a significant impact on the ultimate performance. With an almost perfect correlation to jump distance, the take-off angle is the most crucial aspect for coaches to keep an eye on. Furthermore, it has been established that the arm swing a crucial connection between preparation and propulsion is the primary cause of the horizontal displacement. Body Mass Index and other anthropometric parameters have been found to have moderate influence on joint posture, but they are not reliable performance measures in populations with training. This shows that certain physical constraints can be effectively overcome by technical training and biomechanical optimization. The data itself supports the notion that a good standing broad jump is the outcome of a well-timed triple extension and a synchronized arm swing, which sets up the best possible projectile trajectory, despite a few minor discrepancies in the paper's reporting of statistical data regarding shoulder extension. By digitizing and analysing these movements with tools like Kinovea, practitioners can target the precise kinematical flaws limiting an athlete's explosive potential rather than relying solely on distance measurements. This combination of easily accessible technology and basic biomechanical theory will shape athletic assessment in the future by guaranteeing that training regimens are as accurate as the movements they aim to enhance.

REFERENCES

1) Ajithkumar L et al. (2022). Kinematical analysis of long jumper techniques by using silicon coach software. International conference on smart and sustainable technologies in energy and power sectors.

2) Akwinder & Nishan. (2016). Kinematical Analysis of Javelin Throw. International Journal of Physiology, Nutrition and Physical Education, 86-88.

3) Albert Puig-Divi et al. (2019). Validity and reliability of the Kinovea program. Plos One.

4) Artero et al. (2012). Effects of muscular strength on cardiovascular risk factors and prognosis. Journal of Cardiopulmonary Rehabilitation and Prevention, 351-358.

5) Castro-Pinero et al. (2010). Criterion related validity of field-based fitness tests in youth. British Journal of Sports Medicine, 934-943.

6) Jorge R. Fernandez-Santos et al. (2017). Kinematic analysis of the standing long jump in children 6- to 12-years-old. MEASUREMENT IN PHYSICAL EDUCATION AND EXERCISE SCIENCE, 70-78.

7) Masaki Wakai, N. P. (2005). Optimum take-off angle in the standing long jump. Human Movement Sciences.

8) Monika Wasuja et al. (2022). Physical Education. Delhi: Central Board of Secondary Education.

9) Ruiz et al. (2009). Predictive validity of health-related fitness in youth: A systematic review. British Journal of Sports Medicine, 909-923.

10) Samson, W. &. (2019). THE EFFECT OF DIFFERENT JOINTS' ANGLES ON THE PERFORMANCE OF. INDIAN JOURNAL OF PHYSICAL EDUCATION, SPORTS AND APPLIED SCIENCE.

11) T Halme et al. (2009). Relationships between standing broad jump, shuttle run and Body Mass Index in children aged three to ei. J Sports Med Phys Fitness, 395-400.

12) Wen-Lan Wu et al. (2003). BIOMECHANICAL ANALYSIS OF The Standing Long Jump. Biomedical Engineering Applications, Basis & Communications.