# CORRELATIONS BETWEEN JUMP HEIGHT AND VELOCITY COMPONENTS OF DIFFERENT APPROACH STRIDES IN POWER SPIKING

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The aim of present work was to find correlations between approach velocity components and jump height in power spike. Fourteen top elite volleyball players have been served for this study. A Mikro-Mak Motion Analyzer with Win-Analyze program has been used for 2D study. A Kodak video camera with 240 frames per second has also been used to better trace the markers on the shoulder, hip, knee, ankle, and toe. The program enabled us to find out the displacement and velocity of all parts and especially the hip in order to estimate subjects CG velocity components. Our findings showed that there were significant correlations between vertical component and jump height in all strides; short ($r=0.71$, $P\leq0.05$), normal ($r=0.70$, $P\leq0.05$), and long strides ($r=0.88$, $P<0.001$). The highest correlation was achieved for long stride, where the CG of players is more displaced horizontally as well as vertically. There were no meaningful correlations between Height jump and horizontal velocity component and deviation.

**KEY WORDS**: volleyball, different CG displacements, spike performance

**INTRODUCTION:** The approach velocity components (horizontal and vertical) are critical components of a successful offense in volleyball. According to Prsala (1982), the spiker will use the approach velocities to achieve a high jump with minimal horizontal motion and maximal vertical motion. But on the contrary, according to Dusault (1986), greater height in jump is predicated on greater horizontal velocity in the approach and so far, it is believed that the spiker should maximize horizontal velocity at touch-down and minimize it at take-off, in order to achieve a remarkable height. This contradictory discussion has not been so far verified by other researchers and therefore was the aim of our study. The game involves many physical skills and successful performance is highly related with an individual's ability to propel themselves into the air during both offensive and defensive maneuvers. In both of these ballistic activities, the need of higher jump is obvious. It is important to consider that spikes and blocks are not only jumps, but jump-landing sequences. During the execution of a jump spike, the player jumps high into the air, strikes the ball at the highest point of their jump in an effort to propel the ball rapidly, and purposefully downwards the opposing side of the net, Coleman (1993). Nearly all the landings were bilateral landing technique in order to not lead to loss of balance (Kovacs et al., 1997). Previous research on jumping and spiking has concentrated on finding correlations between different last stride lengths in approaching and the jump height and deviation in landing, Shahbazi et al., (2007) and also the implications of impact and determination of the ball velocity Shahbazi (2002). The purpose of this study was to find out the exact correlations between height jump and velocity components in different approach strides which have not been reported so far.

**METHODS:** Fourteen adult male volleyball players at National Team level (age=19.4± 4.94 yrs, height=191± 3 cm, and mass=76.67±10.51 kg) served as subjects in this study. Each subject executed several approach jumps with different stride lengths: normal, short, and long. The starting location and a pseudo net were adjusted until realistic jumps were achieved. The data were collected through Kodak camera at 240 Hz and analyzed by Win-Analyze software (Mikro-Mak System). A spiker should position himself three to four strides from the net then anticipate where the ball is going so that he can jump and intercept it with the palm of his hitting hand at the extent of his reach, above and slightly forward of his head. He then explodes to that interception point with his first step raising both hands in front of his torso. While simultaneously swinging his arms behind him like a pendulum then should

swing them forward and up while jumping; this helps him rocket into the air and places him in proper hitting position then hammers the ball with his open right hand, snapping the wrist and swiveling his torso to put the maximum amount of topspin and velocity on it.
Subjects were encouraged to produce maximal effort, but were not verbally coached on any of the variables of this study. Reflective markers were placed at estimated joint centers and the right side of the subject was video filmed. In order to determine the velocity components, different type of strides was categorized by corresponding jump. Each videotape was played back manually (frame by frame) in order to accurately observe several aspects of stride length, in order to determine the velocity components. Each activity was categorized by stride length type (long, short, and normal) and the related velocity components and jump. The study was designed to evaluate the effect of approach velocity components in different stride lengths on jumping height utilized by fourteen expert male volleyball players. All of offensive jumps were performed using both feet, which we believed that jumping with both feet provides a wide base of support resulting in stable force production and allowing the forces to be generated by both limbs for maximal vertical performance. All the landings were made with two feet than one to ensure good landings with maximum balancing.
The deviation from vertical line in landing may be characterized by the following traits: a forward flexed and rotated back, hip adduction and internal rotation, knee flexion and vagus positioning, external tibial rotation, and a lack of control of opposite foot. In this position, the muscles that would normally help the athletes remain erect cannot function properly because they were working at different mechanical positions before jumping.

**RESULTS AND DISCUSSION:** In terms of deviation, all of fourteen subjects exhibited positive deviation of CG (centre of gravity) at landing. The exception was the most skilled subject who had negative deviation of CG at landing. A broader interpretation of these results is limited by the fact that deviation is rarely measured in vertical jumping studies. However, the present deviations are similar to but larger than the deviations reported for an intermediate jumper Spina et al.(1996),
Regarding the correlations between horizontal and vertical velocities in different strides with jump height, our study revealed that as the CG (centre of gravity) of the players is displaced longer distance in long stride than other strides, therefore necessitates higher horizontal speed, whereas a higher jump. This finding apparently supports well the report of Dusault (1986) but there is no significant correlation. On the other hand, according to Prsala (1982) in short stride horizontal motion is minimal while vertical motion is maximal to achieve a high jump. Our findings did not support Dusault (1986) but somehow supported Prsala (1982). The findings also showed that all depends on players' skills, abilities, and the way they had already got used to it. In Table1, vertical velocity component had significant correlations with jump height in short stride ($r=0.71$, $p<0.05$), normal stride ($r=0.70$, $p<0.05$) and especially in long stride ($r=0.88$, $p<0.001$), while horizontal component had no meaningful correlations with jump height. Our findings also showed, in Table 2, that there are no correlations between different stride lengths velocity components and landing deviation and different jump height and landing deviation. Although the basic training and strategy of volleyball playing, especially in approaching for offense do not vary greatly, individuals of lesser expertise, or those playing under different conditions may utilize different strides for higher jumping and better landing techniques. Designing practice routines and sequences that teach athletes to approach and land correctly seem important for volleyball coaching professionals.

**CONCLUSIONS:** Regarding the controversial discussion about whether horizontal or vertical movements may mainly contribute to jump height, our study revealed that the best correlation has been achieved in long stride ($r=0.88$, $p<0.001$). Our findings showed that in short and normal strides the correlations are about the same; ($r=0.71$, $p<0.05$) and($r=0.70$, $p<0.05$) respectively. According to our findings, the players are to make a long stride in order to achieve higher jump height. The results of this study may provide practitioners with some

important implications in regard to approach velocity components to jumping and landing techniques, however the data collected and the results should be interpreted with caution

**Table 1- Correlations between jump height and velocity components**

| JUMP HEIGHT IN: | Vertical- Component | Horizontal-Component | Deviation |
|---|---|---|---|
| Short-stride | 0.71 | 0.45 | 0.4 |
| Pearson | <0.05 | <0.5 | <0.6 |
| Normal-stride | 0.70 | 0.47 | 0.5 |
| Pearson | 0.05 | <0.4 | <0.9 |
| Long-stride | 0.88 | 0.46 | - 0.33 |
| Pearson | <0.001 | < 0.5 | <0.7 |

**Table 2- Correlations between deviation and velocity components**

| DEVIATION IN: | Vertical-Component | Horizontal-Component | Jump-Height |
|---|---|---|---|
| Short-stride | 0.65 | 0.2 | 0.39 |
| Pearson | <0.1 | <0.9 | <0.6 |
| Normal-stride | 0.5 | 0.75 | 0.15 |
| Pearson | 0.4 | <0.05 | <0.9 |
| Long-stride | 0.42 | 0.53 | - 0.33 |
| Pearson | <0.5 | < 0.3 | <0.7 |

**Figure 1- An example of stride procedure presented in by one of the subjects.**

**REFERENCES:**

Coleman, S.G.S., Benham, A.S. &Northcott, S.R. (1993). A three dimensional cinemato-graphical analysis of the volleyball spike. Journal of Sport Sciences, 11, (4), 295-302.

Dusault, C. (1986). A backward shaping progression of the volleyball spike approach and jump. C.V.A. Volleyball Technical Journal, 8, (2), 33-43.

Kovacs, I, Tihanyi, J., DeVita, P., Racz, L., Barrier, J. and Hortobagyi, T. (1997). Foot placement modifies kinematics and kinetics during drop jumping. Med. & Scie. In Sports & Excersise 31, 708-716.

Prsala, J. (1982). Improving your spiking in volleyball. C.V.A. Volleyball technical Journal, 7, (2), 57-64.

Shahbazi M.M. (2002). New Technique for ball speed, force and torque applied to the joints in volleyball. Journal of Sport Biomechanics, 1, (2), pp 229-237.

Spina, M.S., Cleary, T.D. & Hudson, J.L. (1996). An exploration of balance and skill in the jump shot. In: T. Bauer (ed.), Proceedings of the XIIIth International Symposium on Biomechanics in Sports pp 294-297.

Shahbzi, M.M., Mirabedi, A., Gaeini, A.A. (2007). The Volleyball Approach: An Exploration of Run-Up Last Stride Length with Jump height and Deviation in Landing. Proceedings of XXV International Symposium on Biomechanics in Sports. Pp.574-578.

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