

# The Science of Soccer Online

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## Penalty Kicks... By the Numbers

Penalty kicks are a critical time of decision making for both the goal keeper and the penalty taker. Given that, for most professional games, the average number of goals scored is around 2.5, a penalty kick can have a major influence on the outcome of a match. Penalty kicks may reach speeds near 125 mph and is usually over within a quarter of a second. Thus, the goal keeper must make a decision on how to stop the shot before the ball is struck. Statistics show that goal keepers will most often jump to the left or right, hoping to guess correctly and place him (or her) self in a position to block the kick. Is this action by the keeper the best strategy? Research headed by Michael Bar-Eli at the Ben-Gurion University of the Negev in Israel makes some interesting conclusions about how goal keepers should defend penalty kicks.



The researchers analyzed the video of 286 penalty kicks from professional leagues in Europe and South America as well as from the European Championships and World Cup competitions. They coded each PK into one of three vertical (high, middle or low) and horizontal (right, center or left) directions. Shots that missed the goal were not included in these analyses. They also coded goalkeeper movements (jump right, jump left or stay central) and whether or not they stopped the shot. Using simple statistics, they compared the success of goalkeepers in stopping shots based on their movements and where the ball was placed.

From the penalty kicker's standpoint, 85% of the penalty shots placed on goal were successful. A bit more than half of the shots taken were placed in the lower one-third of the goal (57%). These low attempts were successful ~80% of the time. By comparison, only 13% of shots were placed in the upper third of the goal. However, all of these efforts resulted in a goal scored (100% success).

Slightly more shots were placed to the goal keeper's right side compared to the center or left. Of these three directions, kickers were most successful when shooting at the center of the goal. Shots aimed at the center of the goal were successful 87% of the time compared to an 83% success rate for shots placed at the outer thirds of the goal.

Based on these numbers, professional penalty kick takers most often place the ball at the lower right corner of the goal (40% of attempts). However, they are far more successful when shooting at the upper portion. Thus, the most successful strategy for the penalty kick taker is to place the ball in the upper third of the goal area rather than the lower portion. Assuming that the shot doesn't go over the crossbar, placing the shot in the upper region of the goal will almost insure a successful attempt.

Goal keeping behavior explains part of the goal scoring successes. In attempting to stop the penalty kick, goal keepers jump to the right or left 94% of the time. In doing this, they guess correctly only about 40% of the time (i.e. jump left, shot placed left). However, even when they guess correctly, they only stop 25-30% of the shots. The most intriguing part of the Dr. Bar-Eli's analyses is that when goal keepers remain in the center of the goal and the shot is placed in the center, they make the save 60% of the time. Given that about 30% of penalty kicks are placed in the center third of the goal, remaining stationary in the center of the goal increases the keepers chances of stopping the shot from about 13% to more than 33%.

Thus, the best strategy for goal keepers is to remain in the center of the goal during the penalty kick. Thus the idea that goal keepers should jump left or right and hope they guess correctly is not supported by these numbers.

Why might there be more success when the goal keeper stays in the center of the net? When a keeper jumps in one direction, he/she is only able to cover about 1/9 of the goal area (usually the lower corner) plus a bit of the central area. Thus, if the ball is placed in the side or upper third, the keeper has very little chance of stopping the shot. The keeper is either out of position or in a poor position to stop the shot. However, if the keeper remains in the center of the goal area, he/she can cover closer to one third of the goal area (the upper-, middle- and lower-central areas).

If these numbers are correct, then why do goalies jump left or right in their effort to stop penalty kicks? Part of the decision may be based on experience, reading the shot taker's body language and to opinion that diving is indeed the best strategy. Another reason probably lies in the concept of a "bias towards action". This occurs with a decision is based on perceived need to "do something" rather than nothing. In sports, it is often said that mistakes are more

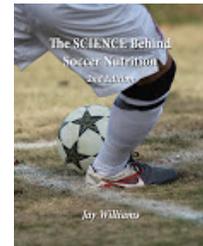
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forgivable if they are made at full speed. Diving to the left or right gives the appearance of effort and avoids the perception that he/or she didn't attempt to make a save. In fact, a survey of goal keepers show that the vast majority feel worse if a goal is scored when they remain central versus diving to the left or right.

The take home message is that from a statistical standpoint, it may be more advantageous for a goal keeper to defend a penalty kick by remaining in the goal's center rather than diving to one side. Despite the need to make a heroic effort, this situation may require doing less rather than more.

#### References:

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