

## TENPIN BOWLING TECHNIQUE ON ELITE PLAYERS

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The objective of this study was to profile the elite level tenpin bowlers in delivery technique and to compare any difference between male and female bowlers. Twelve bowlers (seven males and five females) were filmed using a JVC GY-X2 video camera (50Hz) to capture the sagittal movement plane of the bowlers starting from the third last stride to the ball released of the bowlers. Then the selected video materials were processed by the Peak Motus System to produce co-ordinates for selected body landmarks. There were significance differences between the male and female bowlers in toe foul line, arm swing at release, and hip shoulder wrist angle. Moreover, the pace and the stepping pattern of the footwork could help to establish a better timing, balance, and strong finish.

**KEY WORDS:** tenpin bowling, kinematic.

**INTRODUCTION:** Tenpin bowling was a game played by delivering (rolling) a ball down an alley or lane. The ball rolled toward a rack of 10 pins set in an equilateral triangular formation. The objective of the game was to knock down all of the pins with one or two deliveries of the ball. Therefore, cumulative bowling score could be obtained (Strickland, 1996). The increasing acceptance of ten-pin bowling as a sport, as well as the keen competition amongst bowlers necessitates the identification of performance indicators to aid training. Everyone has a different bowling style. Professional bowlers have their own outlandish styles that are very effective for that particular person. The problem is that, because there are so many different and varied styles, many bowling instructors have given up trying to teach a correct way to bowl. Instead, they allow a bowler to develop his or her own style (Borden, 1988). So, the kinematic information in tenpin bowlers can broaden the knowledge of coaches on patterns used in this sport. It is anticipated that this will also help the tenpin bowling coaches to train their athletes more effectively. The objective of this study was to profile the elite level tenpin bowlers in delivery technique and to compare any difference between male and female bowlers.

**METHODS:** Twelve bowlers (seven males and five females) performed three deliveries. A JVC GY-X2 video camera (50Hz) was used to videotape the delivery approach of the bowlers on the bowling lane. The distance between the motion plane and video camera was about 10m. This fixed position the camera was able to capture the movement on the sagittal plane of the bowlers starting from the third last stride to the ball released. The video materials were processed by Peak Motus System to calculate the co-ordinates of selected body landmarks. Then the following variables were determined. These included 1) Maximum ball height, 2) Toe foul line, 3) Distance between front and back toe at release, 4) Arm swing, 5) Hip shoulder wrist angle, 6) Angular velocity of arm swing, 7) Backward shoulder extension and 8) Maximum ROM for shoulder during approach. The definitions of the above variables were defined as follows. Maximum ball height was the maximum wrist height of bowling arm. Toe-Foul line was the distance between front toe and foul line. Arm swing was the angle between the intersection of horizontal line and the line connecting wrist and shoulder at release of bowling arm. Backward shoulder extension was the angle of wrist-shoulder-hip at maximum wrist height of bowling arm. ROM was the range of motion of wrist-shoulder-hip between maximum height and release. Mean and standard deviation values were determined for all variables. An independent t-test was performed to test for significance of group differences between male and female bowlers.

**RESULTS AND DISCUSSION:** Table 1 shows the mean value of male and female bowlers on kinematic parameters. The maximum ball heights for male and female were similar (1.4m). That seems the body posture of different sexes did not affect the maximum ball height. So, the potential energy gain by the ball was similar provided that the mass of ball was the same. The distance between front toe and foul line for male bowlers was larger than female bowlers. The toe foul lines for male and female bowlers were 0.348m and 0.155m.

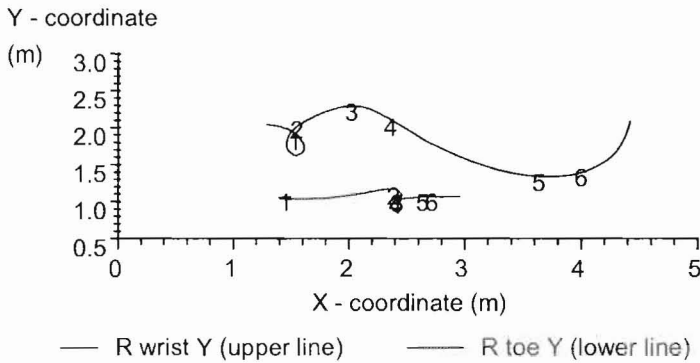
That means, female bowler got closer to the foul line. Male bowlers were about 20cm further from the foul line compared with female bowlers. Maybe the momentum of the male bowler - ball system was much greater than the female bowler- ball system. So, male bowler required more buffer space for stopping and ball release. There was no significance difference between the male and female bowlers in front toe and back toe separation. The toe separation was about one meter. There was significance difference between the male and female bowlers in arm swing at release. The distance between front and back toe at release was about 1.1m. The arm was in a more horizontal position for male bowlers than female bowlers. These may be due to the stronger muscle strength of male athletes so that the male bowlers lift their arms closer to the horizontal. There was a significant difference between male and female bowlers in maximum hip shoulder wrist angle. The maximum hip shoulder wrist angle of male bowler was greater than female bowler. Male bowler shoulder angle was approaching 92 degrees and nearly ten degrees less in female bowlers. The angular velocity of arm swing was around 610 degrees/s. There was no significant difference in angular velocity of arm swing between male and female bowlers. This may be due to the ball used in female was lighter than the male. This may compensate the lack of muscle strength in female bowlers. The backward shoulder extension of male and female bowlers was not greater than 100 degrees. There was no significant difference in backward shoulder extension between male and female bowlers. The shoulder extension was slightly greater than 90 degrees. In addition, there was no significance difference in ROM. The range of motion for the ball hand was around 150 degrees.

**Table 1.** Independent t-test on Male and Female Bowlers on Kinematic Parameters.

	Sex	Mean	S. D.	Sig. (2-tailed)	
Maximum ball height (m)	M	1.436	0.164	0.790	
	F	1.460	0.125		
Toe foul line (m)	M	0.348	0.089	0.002	*
	F	0.155	0.051		
Distance between front and back toe at release (m)	M	1.164	0.202	0.486	
	F	1.095	0.067		
Arm swing (Degree)	M	52.940	4.813	0.019	*
	F	60.727	4.678		
Hip shoulder wrist angle (Degree)	M	91.960	10.160	0.032	*
	F	78.960	6.523		
Angular velocity of arm swing (Degree/s)	M	617.270	118.969	0.734	
	F	600.595	32.780		
Backward shoulder extension (Degree)	M	91.769	8.012	0.156	
	F	98.766	7.467		
Maximum ROM for shoulder during approach (Degree)	M	156.050	15.982	0.470	
	F	150.172	11.149		

\* At 0.05 significant level.

From Figure 1, during the third last and second last heel touch, the arm path showed that the bowler performed the pushaway. After that, the bowler executed a free pendulum swing within a normal walking pace. The pace and the stepping pattern of the footwork could help to establish a better timing, balance, and strong finish. Moreover, heel to toe footwork during the approach kept your centre of gravity over the centre of a stable base support. In addition, heel to toe footwork synchronized with the swing cadence to produce a smooth and rhythmic approach with a high leverage "power push" finish in which more rotation could be impacted to the ball. A consistent, well co-ordinated delivery contained no wasted movements and allowed for fewer opportunities to commit errors throughout the delivery.



1: Third last heel touch, 2: Second last heel touch, 3: Ball highest point, 4: Last heel touch, 5: Bowling arm perpendicular to floor, and 6: Ball released.

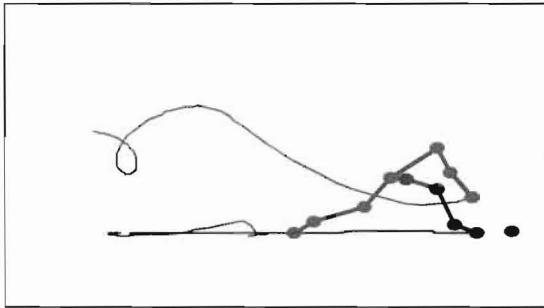


Figure 1. The movement of right wrist and right toe for the last two steps.

**CONCLUSIONS:** The distance between front toe and foul line for male bowlers was larger than female bowlers. This may be explained that the momentum of the male bowler - ball system was much greater than the female bowler - ball system. So, male bowler required more buffer space for stopping and ball release. The arm was in a more horizontal position for male bowlers than female bowlers at release. These may be due to the stronger muscle strength of male athletes so that the male bowlers lift their arms closer to the horizontal. There was a significant difference in maximum hip shoulder wrist angle. The maximum hip shoulder wrist angle of male bowler was greater than female bowler. The pace and the stepping pattern of the footwork could help to establish a better timing, balance, and strong finish. In addition, heel to toe footwork synchronized with the swing cadence to produce a smooth and rhythmic approach with a high leverage "power push" finish in which more rotation could be imparted to the ball.

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