

A Biomechanical Analysis Of Bowling's 5-Step Approach

This is an initial biomechanical review of the sport of bowling. The objective of the sport is to approach and roll a ball behind a foul line, down a lane, and into a set of ten pins attempting to knock as many down as possible. A second chance is given if the bowler is unsuccessful knocking down all ten pins on the first ball. The game is scored according to how many pins are knocked down each frame with frames accumulating a total score. Bonus scoring is awarded during those frames in which all the pins are tumbled.

Knocking down all ten pins on the first ball is constituted as a strike (X). Knocking down all ten pins on the second ball is termed a spare (/). Once a game is completed, the registered score will range from 0 to 300, 300 being twelve strikes in succession.

The biomechanical analysis is an anatomical study of the stance, approach, and delivery of a right-handed 5-step bowler. Three phases will be analyzed (preparation, movement, and follow through). The preparation phase occurs when the bowler assumes the stance position. The movement phase begins with the initiation of the first step of the approach and ends with the release (delivery) of the ball. The follow through phase begins immediately after the release of the ball. All musculoskeletal joints will be analyzed during each phase.

Preparation Phase

The preparation phase begins when a person steps onto the approach, grasps a ball off the ball return, aligns the body to the target (including eyes), places the hand in the ball, and assumes the starting position. The bowler is now ready to initiate the approach to the foul line and delivery of the ball (Berglund, 1983; Kouros, 1976).

- Right Hip Joint - slightly extended to provide a 4"- 6" recession of the right foot.
- Right/Left Knee Joints - flexed 15 degrees.
- Trunk - 10 - 15 degree trunk flexion.
- Right Shoulder Joint - isometric elevation due to ball's weight depressing joint.
- Right Shoulder Girdle - slight isometric upward rotation.
- Right Elbow Joint - isometric flexion at 90 degrees.
- Right Wrist Joint - isometric flexion due to ball weight.
- Right Hand Finger Joints - flexion (slight).

In the stance, the left arm is used to support the weight of the ball. The left hand is placed under or aside the ball to provide about 30% support (Burglund, 1983). Other bowling instructor's philosophies vary on the amount of weight the support arm should carry..Left Shoulder Joint - horizontal flexion.

- Left Elbow Joint - medially rotated and isometrically flexed.
- Left Shoulder Girdle - abducted.
- Left Wrist and Finger Joints - isometrically flexed to hold the ball's weight.

Movement Phase

The movement phase begins with the initiation of the first step continuing through the release of the ball. Since we are diagraming the 5-step approach, each step will be analyzed during the movement phase.

First Step

The first step of the 5-step approach is a small shuffle or half step taken with the left foot to get the momentum of the bowler started (Borden, 1986). The transfer of weight forward eases the ability to start the remaining movements.

- Left Hip Joint - flexion.
- Left Knee Joint - extension.
- Right Hip Joint - extension.
- Right Knee Joint - extension.
- Right Ankle Joint - plantar flexion.

Second Step

The second step is taken with the right foot. Simultaneously, as the step begins to move, the bowler initiates the ball into the armswing. This action, commonly termed as "the pushaway" is accomplished by extending the right arm forward allowing it to drop into the armswing (Kouros, 1976). The left arm and hand equally support the weight of the ball and assist with extension, or the bowling pushaway with the right arm..Right Hip Joint - flexion.

- Right Knee Joint - extension.
- Left Hip Joint - extension.
- Left Knee Joint - flexion.
- Left Ankle Joint - plantar flexion.
- Right Shoulder Joint - flexion.
- Right Shoulder Girdle - abduction.
- Right Elbow Joint - extension.
- Right Wrist and Finger Joints - isometric flexion.
- Left Shoulder Joint - flexion.
- Left Shoulder Girdle - abduction.
- Left Elbow Joint - extension.
- Left Wrist and Finger Joints - isometrically flexed.

Third Step

The third step is taken with the left foot. As this occurs, the balance arm moves completely off the ball as the right arm descends from the starting height. The arm swing begins its downward arc as a free-swinging pendulum, often analogized to the pendulum on a grandfather clock. The back swing, downward and backward motion of the arm swing, is facilitated by both the weight of the ball and arm, and the gravitational pull on the arm and ball. If complete shoulder, chest, arm and upper back muscular relaxation is achieved, then the swing should stay within the sagittal plane absent of lateral movement.

The left arm, balance arm, should move off the ball after the push-away and extend horizontally providing balance to the shoulders and body. The balance arm provides balance and support to the upper body due to the added weight of the ball to the right side of the body (Martin, 1984; Kouros, 1976)..Left Hip Joint - flexion.

- Left Knee Joint - extension.
- Right Hip Joint - extension.
- Right Knee Joint - extension.
- Right Ankle Joint - plantar flexion.
- Right Shoulder Joint - extension.
- Right Shoulder Girdle - adduction.
- Right Elbow Joint - extension (complete).
- Right Wrist and Finger Joints - isometric flexion.
- Left Shoulder Joint - horizontal extension.
- Left Shoulder Girdle - adduction.
- Left Elbow Joint - extension.

Fourth Step

The fourth step is known as "the moment of truth" for the bowler and is taken with the right foot. This step is the moment before the bowler releases the ball. The fourth step begins the power phase in bowling because until now the bowler has just been walking with the ball freely swinging. At the completion of the fourth step, the arm swing should have reached the highest point or peak of the back swing. The height of the back swing is determined by several factors to include shoulder and chest flexibility, excessive adipose tissue, amount of trunk flexion, and whether or not the shoulder joint externally rotates.

- Right Hip Joint - flexion.
- Right Knee Joint - extension.
- Left Hip Joint - extension.
- Left Knee Joint - extension.

- Left Ankle Joint - plantar flexion.
- Right Shoulder Joint - extension transition to flexion.
- Right Shoulder Girdle - adduction transition to abduction.
- Right Elbow Joint - extension (complete).
- Right Wrist and Finger Joints - isometrically flexed.

Fifth Step (Delivery of the Ball)

The fifth and final step of the bowler's approach is taken with the left foot. As the step is taken the right leg exerts extra force pushing the bowler into the slide. The left foot begins to slide forward after the step. As the slide is occurring, the bowler slightly drops the hips (increasing hip flexion) without extreme forward tilt to sit into the finish position. This ensures the bowler can release the ball close to the lane without embedding the ball into the lane. The arm swing will begin to increase in speed due to the gravitational force on the ball and arm, the ball and arm's weight, and the increased exertion of muscular force produced from the shoulder joint (Borden, 1986; Northrip, 1979). Simultaneously, the arm swing will reach the bottom of its arc, parallel to the stature of the body and perpendicular to the floor in position to be released. The release of the ball is its natural tendency to slide off the thumb and then fingers lifting upward and outward by the continued motion of the arm swing (Kouros, 1976).

- Left Hip Joint - flexion.
- Left Knee Joint - extension transition to flexion.
- Right Hip Joint - extension.
- Right Knee Joint - extension.
- Right Ankle Joint - plantar flexion.
- Right Shoulder Joint - flexion.
- Right Shoulder Girdle - abduction.
- Right Elbow Joint - extension (complete).
- Right Wrist and Finger Joints - isometric flexion.
- Trunk - flexion.

As the bowler slides and releases the ball, a greater amount of weight is placed on the slide leg. The slide leg is the base of support for the body and therefore, must be able to withstand a majority of the body's weight.

Follow Through Phase

The follow through phase begins as the thumb exits the ball. The arm swing follows its natural directional path upward and outward, lifting with the fingers as they slide out of the holes. This is the only motion of the follow through phase except for the bowler continuing to slide. The body is statically held in position until the ball is well down the lane (Kouros, 1976).

- Left Knee Joint - flexed.
- Left Hip Joint - flexed.
- Right Hip Joint - extension.
- Right Knee Joint - extension.
- Right Ankle Joint - plantar flexed, dragging on tops of toes.
- Right Shoulder Joint - flexion.
- Right Shoulder Girdle - upward rotation and abduction.
- Right Elbow Joint - extended or slightly flexed.
- Right Wrist Joint - static.
- Right Finger Joints - static.

References

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