Effect of Club Length on Potential Distance

March 8, 2016

1. Summary

The work of six teams of researchers on the effect of club length on drive distance potential has been summarized. Four of the cited research studies use human test subjects; the other two summarize modeling efforts. On average, the cited research predicts an increase in clubhead speed, ball speed and distance of over 1% for an increase of club length from 46 inches to 48 inches. This equates to an approximate five yard distance increase for a long driving professional.

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2. Literature and Review

Several papers studying the effect of club length on golf ball launch and distance have been published. These papers include both the findings of human testing as well as the results of modeling efforts. Six publications have been reviewed in order to estimate the potential distance increase when considering increasing driver length from forty six inches to forty eight inches.

2.1. Human Testing

Given the limited opportunities to practice and become familiar with clubs other than the subjects' own, and given the myriad of tunable driver characteristics (shaft stiffness profiles, swingweight, clubhead mass properties, etc.), it is challenging to fully assess the potential drive performance effects of club length. Furthermore, it is difficult, if not impossible to change driver length without affecting other club characteristics.

It should be noted that the research reported in Kenny et al. and Wallace et al. were supported in part by the R&A. The study by Jones was commissioned by the USGA.

2.1.1. Jones (1997) – Long shaft study

Jones studied the drive and scoring performance of players on the PGA TOUR for the years 1994 through 1997 (comprising over 5,700 records). Shaft length was analyzed for its effect on drive distance, drive accuracy, greens in regulation and scoring. It was found that drive distance increased significantly as shaft lengths increased from 44 to 46 inches. Drive accuracy, greens in regulation and scoring were not found to be statistically, significantly affected.

2.1.2. Reyes, Mittendorf (1999) – A mathematical swing model for a long-driving champion

Reyes and Mittendorf propose a two link mathematical model of a golfer swing and validate the model with a long drive champion. The paper provides club head speed using 47 and 51 inch drivers. It was found that the longer driver lead to higher swing speed.

2.1.3. Wallace, Otto, Nevill (2007) - Ball launch conditions for skilled golfers using drivers of different lengths in an indoor testing facility

Wallace et al. studied the effect of club length on driver launch conditions. Four driver lengths were considered (46, 47, 49 and 52 inches). Swingweight and frequency of the assembled clubs were not kept constant. It was found that for the subject golfers, ball launch speed significantly increased with increasing club length.

2.1.4. Kenny, Wallace, Otto (2008) – Influence of shaft length on golf driving performance

Kenny et al studied the effect of club length on driving performance for golfers with handicaps near scratch (0.21 ±2.41). Clubs with length of 46, 48 and 50 inches (1.168m and 1.270m) were studied. Swingweight and frequency of the assembled clubs were not kept constant for the three club lengths. It was found that for these golfers, increasing club length resulted in significantly increased ball speed.

Carry distance was also longer but was not statistically significantly so. Drive accuracy was not significantly changed.

2.2. Modeling

Given the difficulties of effectively gaging the performance potential of club length using human subject, two modeling efforts have also been reviewed. It should be noted that the work by Johnson and McPhee was supported in part by the USGA and that the simulations cited here are the result of specific requests from the USGA.

2.2.1. Werner, Greig (2000)

Werner and Greig describe a theoretical model in their book "How Golf Clubs Really Work and How to Optimize their Design". Club length is one variable that they study using their model. As summarize in table 20-2, they conclude that increasing club length contributes to longer drive distances.

2.2.2. Johnson, McPhee

Johnson and McPhee extended work previously conducted by Dr. John McPhee at the University of Waterloo. Their model attempts to mimic the physiological behavior of a human golfer. Their model then attempts to optimize the swing with a club having realistic shaft dimensions and flexibility and club head mass and geometric properties to, in this case, maximize drive distance while maintaining an accurate shot. In the work cited here, the club mass also a variable to be optimized for each club length. In the range of club lengths from 40 to 50 inches, the optimum clubhead mass ranged from 189g to 217g. Surprisingly, the optimum clubhead mass was not a smoothly varying function of club length as can be seen in Figure 1.



Figure 1 Optimum driver mass for drivers of various lengths

2.3. Summary of Effect of Clublength on Performance

The performance measures included in the papers reviewed are not consistent. As a result, three measures have been compared:

- Clubhead speed
- Ball speed
- Distance (carry or total)

Also, the nominal test subjects vary widely from paper to paper. Therefore, rather than comparing absolute performance, each measure is normalized for a 46 inch long club and percentage differences at other lengths are summarized here.

2.3.1. Clubhead Speed

Both Kenny et al. and Reyes and Mittendorf, along with the extension of the work by Johnson and McPhee at Waterloo, report the effect of club length on clubhead speed. Figure 2 summarizes the findings.

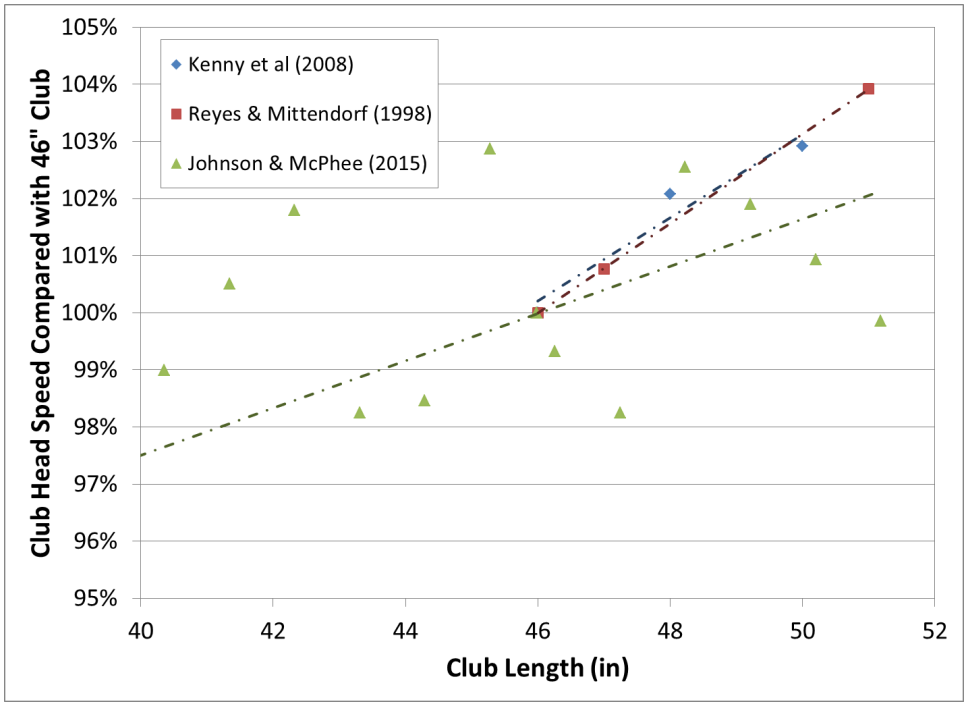


Figure 2 Effect of club length on clubhead speed

The three findings shown in Figure 2 predict an average an increase in clubhead speed of 1.3% for an increase in club length from 46 inches to 48 inches. This represents an increase of 1.5 miles per hour for a long driving professional with a swing speed of 120 miles per hour with a 46 inch club. This would be expected to result, on average, in an increased drive distance of between 4 and 5 yards.

2.3.2. Ball Speed

Kenny et al., Wallace et al., and the Johnson and McPhee models report ball speed increases with increasing club length. Given the variable club head mass predicted by the Johnson and McPhee model, ball speed is a more stable predictor of distance potential. It is also not as subject to test conditions as carry distance or overall drive distance. Figure 3 summarizes the findings.

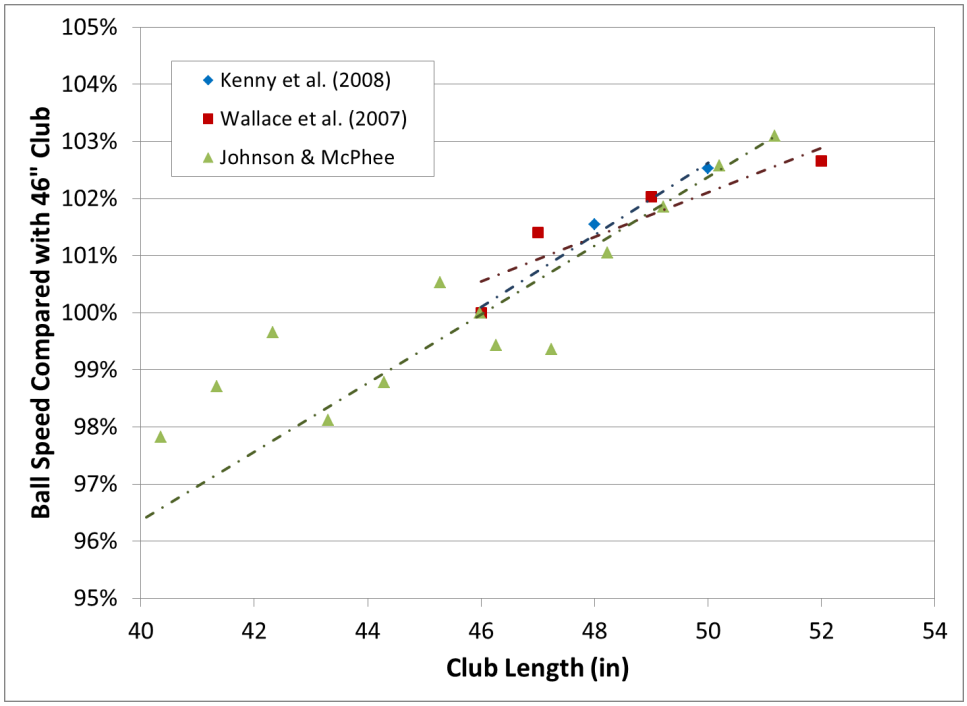


Figure 3 Effect of club length on ball speed

It can be seen that there is excellent agreement between the human testing results of Kenny et al. and Wallace et al. to the model results of Johnson and McPhee. On average, the three findings in Figure 3 predict an increase in ball speed of 1.1% going from a 46 inch club to a 48 inch club. It would be expected that this increase in ball speed would result in a drive distance increase of approximately 4 yards.

2.3.3. Distance

Kenny et al. reports carry distance for human test subjects. Werner and Greig report model predictions of overall drive distance. The Johnson and McPhee model reports carry distance predictions. Figure 4 summarizes the findings of these three works.

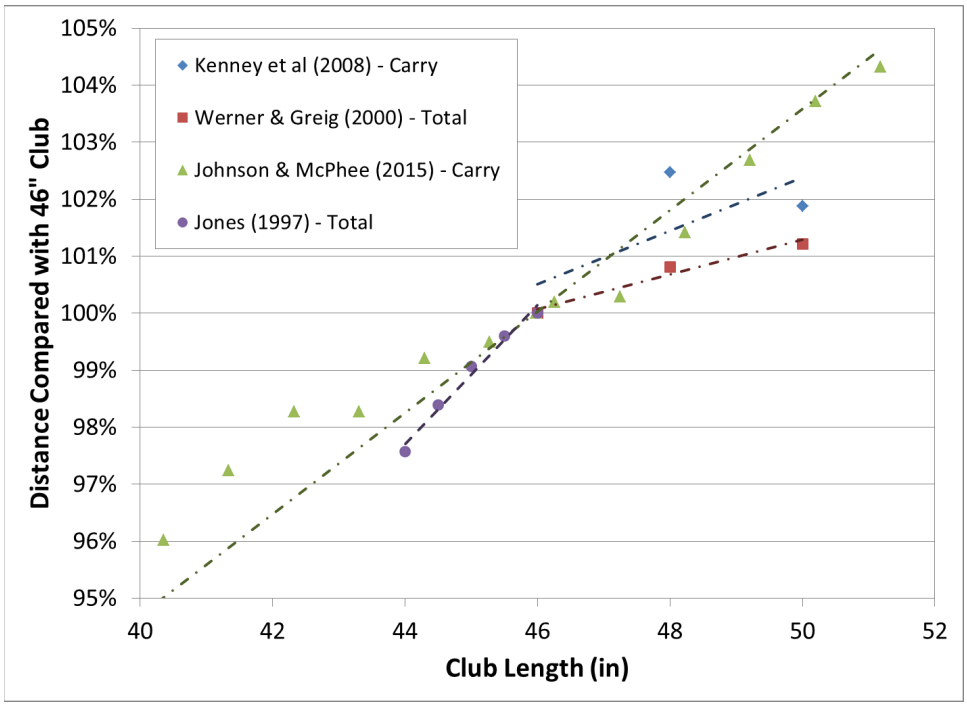


Figure 4 Effect of club length on distance

The average distance increase predicted by the three findings summarized in Figure 3, for a two inch increase in shaft length, is 1.4%. This equates to an increase of five yards with an increase of club length of from 46 inches to 48 inches for a long driving professional who averages 320 yards with a 46 inch driver.

3. References

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