



Quantitative Analysis of Recreational Golfer Club Hitting Distances: Measured versus Perception

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1. Summary

A quantitative analysis of recreational golfer hitting distance measured versus personally estimated data was conducted by the USGA during the 2021-2023 golf seasons. Ratios were calculated and compared to show how accurately recreational golfers estimate their actual club distances for driver, 7-iron and pitching wedge. This study also presents the results of analyzing other launch monitor data gathered for golfers from a wide variety of demographic groupings including the effects of aging.

2. Introduction

During the summer of 2021, the fall of 2022 and throughout the 2023 season, the USGA conducted a research study using TrackMan 4 launch monitors to measure the hitting distances of recreational golfers. A sample of 627 golfers with a range of skill levels and ages from both public and private facilities were studied. The three clubs measured in this study were driver, 7-iron, and pitching wedge. The primary goal of this detailed study was to compare the estimated club distances of the golfers to their actual measured distances using TrackMan 4.

Each golfer hit seven balls with each of the three clubs for a total of 21 shots. Two parameters were defined and calculated to evaluate the seven shots with each club. The first parameter referred to as, “**ability**”, is the median of the seven shot distances. The second parameter referred to as “**capability**” is the average of the longest two shots of the seven taken for each club.

3. Golfer Sample

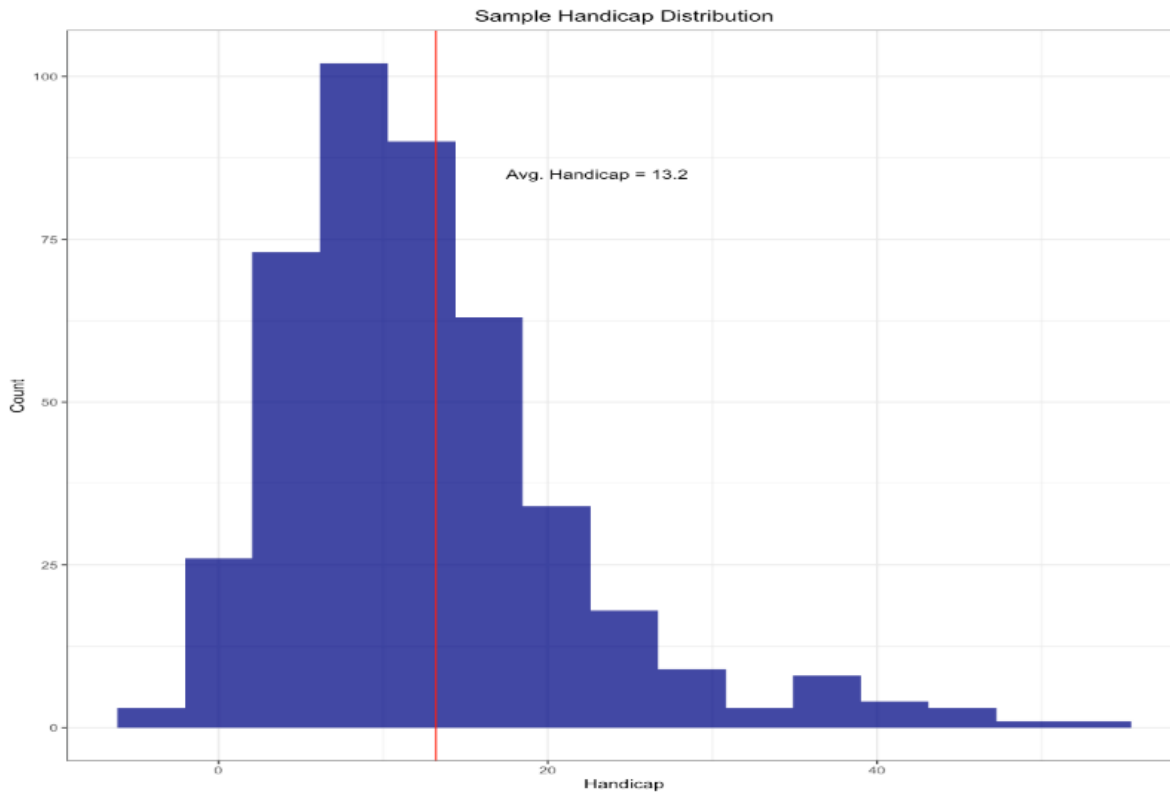
There are 627 total golfers with a variety of backgrounds and experience levels in the sample. The sample consists of 548 Males (87%) and 79 Females (13%). In Table 1, the age breakdown of the sample is shown. Most golfers that participated in the study were between the ages of 45 and 74 years old.

Table 1: Age Distribution of the Sample

Age	% Of Sample
Less than 18	4%
18 - 29	13%
30 - 44	17%
45 - 59	21%
60 - 74	38%
More than 74	7%

Additionally, golfers were asked about their Handicap Index™. 26% of golfers did not have a Handicap Index. For the 74% of golfers who did have a Handicap Index, the distribution is shown in Figure 1 and centered around an average of 13.2.

Figure 1: Golfer Handicap Index Distribution of the Sample



35% of golfers that participated in the study have been golfing for more than 30 years. The overall distribution golf experience is shown in Table 2. Most golfers in the sample have 16 or more years of experience.

Table 2: Golf Experience Distribution of the Sample

Years of Experience	% Of Sample
0 - 2	7%
3 - 7	15%
8 - 15	17%
16 - 30	26%
More than 30	35%

Finally, nearly all of the golfers in the sample play golf frequently during the year. 90% of golfers in the sample normally play 18 holes during a round compared to only 10% who typically play 9 holes as their normal experience. Table 3 shows the number of rounds in a year that the golfers typically play or practice. 47% of the golfers in the sample play or practice over 50 times per year.

Table 3: Distribution of Rounds (or Days of Practice) in a Year of the Sample

Rounds in a Year	% Of Sample
1 - 8	9%
9 - 24	21%
25 - 49	23%
More than 50	47%

4. Handicap Index™ vs. Ability

The hitting distance data can examine trends between Handicap Index (HI) and total distance. In Figures 2 and 3, HI versus total driver ability is plotted by gender. These plots demonstrate that for both males and females on average, more skilled golfers have longer driver distances. HI accounts for 57% of variation in driver distance data for males and 74% for females. The correlations developed show male driving distance increases 30.2 yards for every decrease of 10 points of HI and female driving distance increases 23.4 yards for every decrease of 10 points of HI.

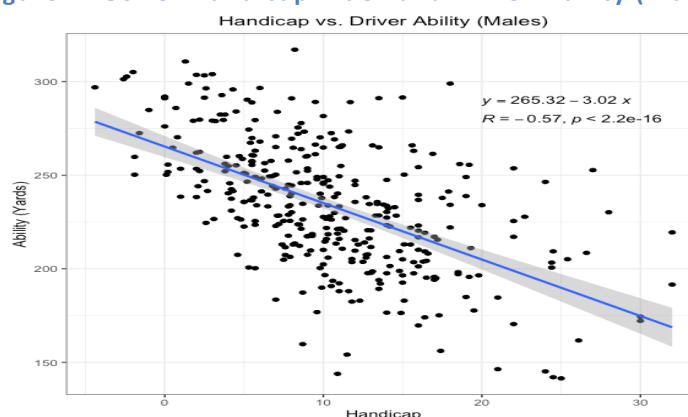
Figure 2: Golfer Handicap Index and Driver Ability (Males)

Figure 3: Golfer Handicap Index and Driver Ability (Females)

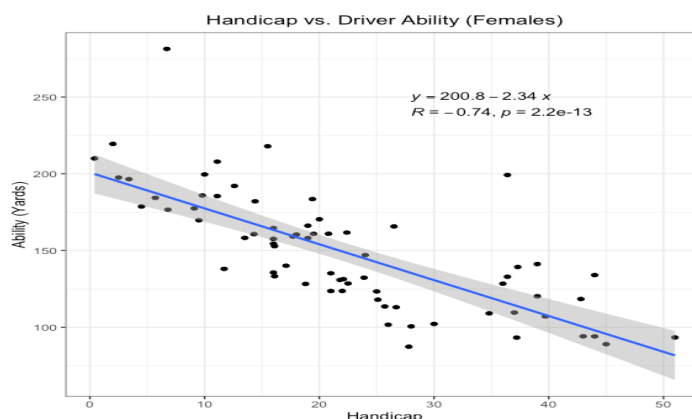


Table 4 shows the calculated driving distance for male and female golfers of various HI using the gender specific correlation.

Table 4: Driving ability by gender based on correlations developed

Handicap Index™	Female Driving Ability (yds)	Male Driving Ability (yds)
10	177	235
20	154	205
30	131	175

5. Club Speed versus Ball Speed relationships

TrackMan 4 also measures the club swing speed and ball speed of each shot. These two metrics are compared to driver distance ability in Figures 4 and 5. Both club swing speed and ball speed have very strong relationships with driver ability. Club speed accounts for 92% of variation in driver ability whereas ball speed accounts for 94% of the variation in driver ability. This demonstrates the relationship between higher club and ball speeds resulting in longer driver distances among recreational golfers on average. Driving ability increases 2.84 yards for every 1 MPH of swing speed and increases 2.02 yards for every 1 MPH increase in ball speed.

Figure 4: Average Club Swing Speed vs. Driver Ability

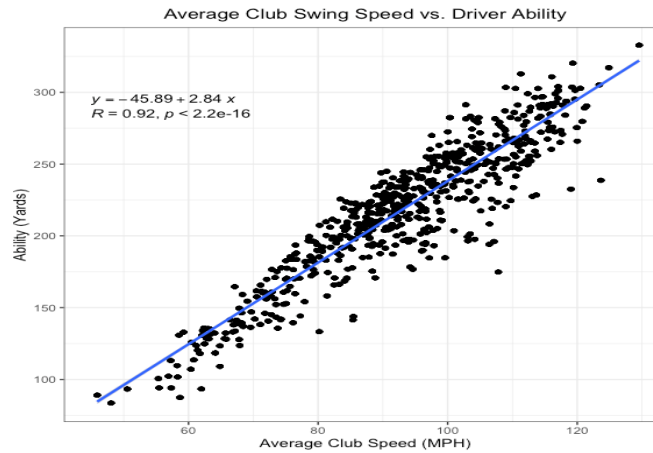
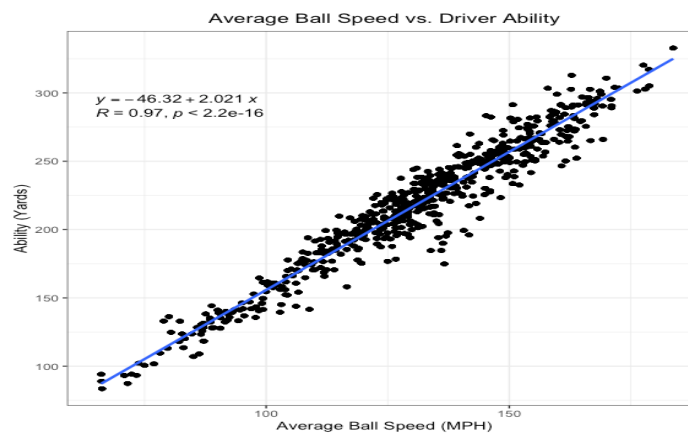
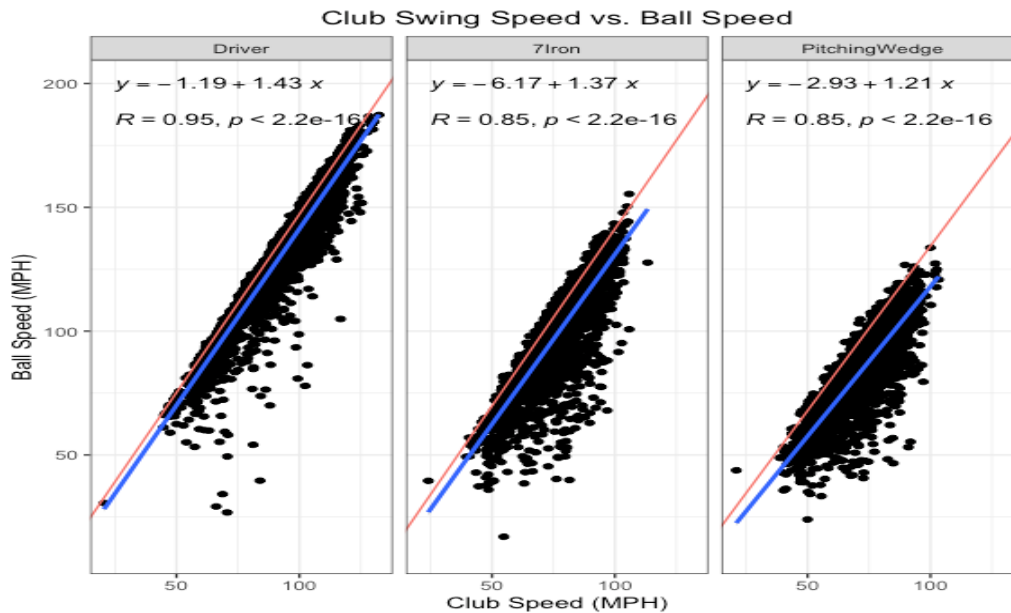


Figure 5: Average Ball Speed vs. Driver Ability



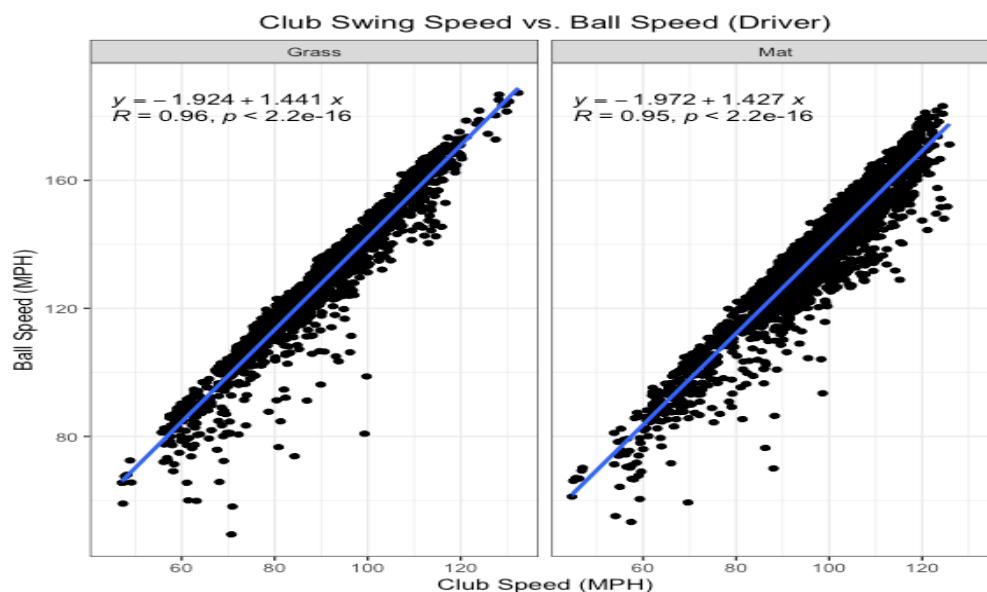
In addition, club speed can be directly compared to ball speed to evaluate the average smash factor for recreational golfers. Figure 6 shows the correlations for all three clubs used in the study. The correlation is strongest for drives with club speed accounting for 95% of the variation in ball speed. From the slope of the driver trend line (red line – which reduces the effect of mishits), every 1 MPH in swing speed increases ball speed by 1.43 MPH meaning that the smash factor is 1.43 for these driver data. For 7-iron, the smash factor was 1.37 and for pitching wedge it was 1.21.

Figure 6: Club Swing Speed vs. Ball Speed



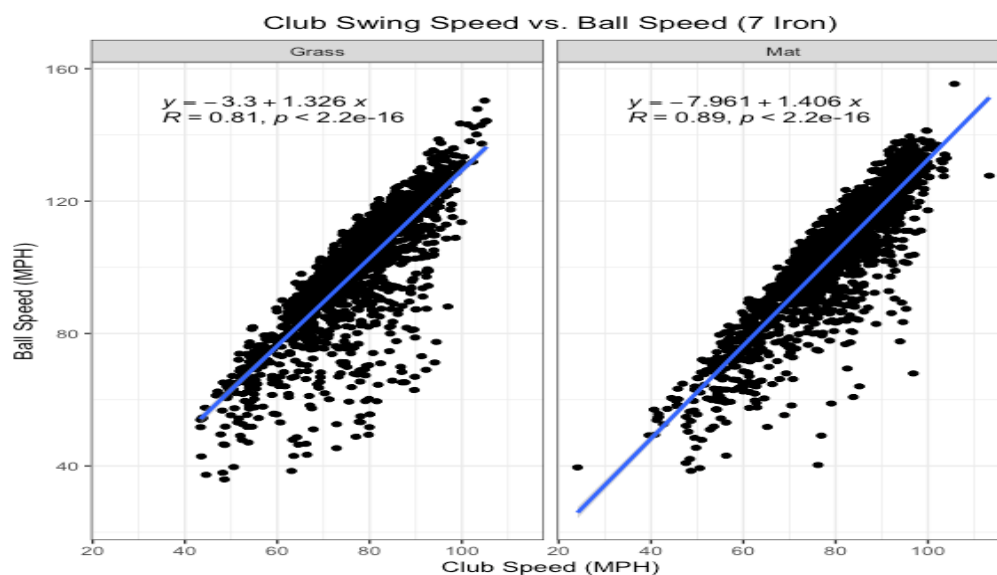
Furthermore, both natural grass and synthetic turf mat surfaces were used throughout the study. Figures 7-9 show the relationship between ball speed and club speed for each club and type of hitting surface to determine if these different surfaces had an impact on smash factor in the sample. Figure 7 shows there is no significant difference in driver smash factor between the two different surfaces. Excellent correlation coefficients exist between ball speed and club speed of 96% off of grass and 95% off of mats. More importantly, the smash factors are nearly identical (1.44 off grass and 1.43 off mats) which is not surprising given that in both cases, balls are resting on a golf tee for driver shots. The slightly higher smash factor off grass could represent the easier ability to adjust the tee height off grass.

Figure 7: Club Swing Speed vs. Ball Speed by Hitting Surface (Driver)



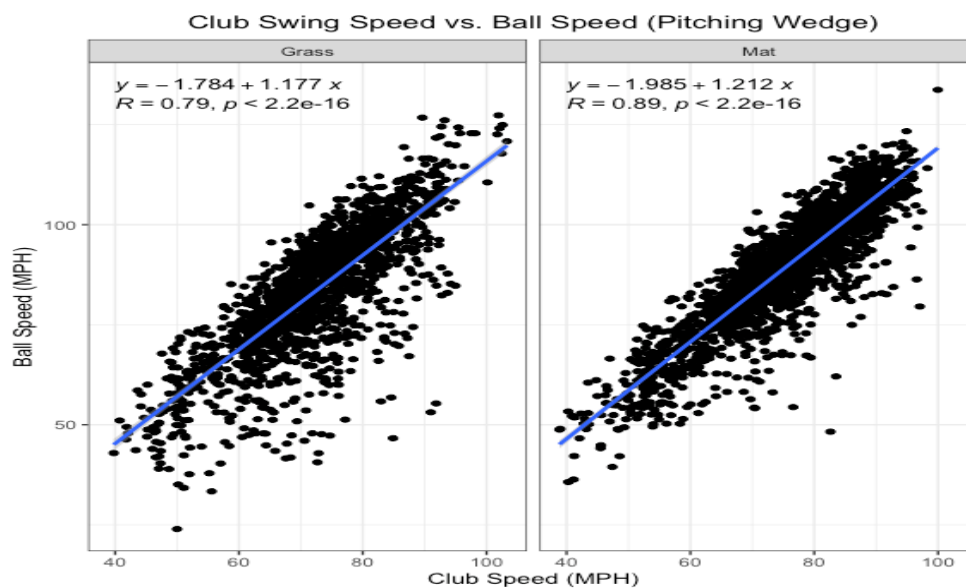
There is a clear smash factor difference for 7-Iron shots between hitting surfaces. In Figure 8 below, the relationship between club and ball speed is plotted for 7-Iron shots only. Ball speed and club speed have an 81% correlation off grass and an 89% correlation off of mats. Importantly, the average smash factor off grass was 1.33 compared to 1.41 off of mats showing that it is easier to make good contact off mats.

Figure 8: Club Swing Speed vs. Ball Speed by Hitting Surface (7 Iron)



Similarly, there is a smash factor difference for grass and mat surfaces for pitching wedge shots. This relationship is shown in Figure 9. Club and ball speeds have a 79% correlation off of grass compared to an 89% correlation off of mats. The average smash factor for pitching wedges off grass is 1.18 compared to 1.21 off mats, again showing it to be easier to make good contact off mats.

Figure 9: Club Swing Speed vs. Ball Speed by Hitting Surface (Pitching Wedge)

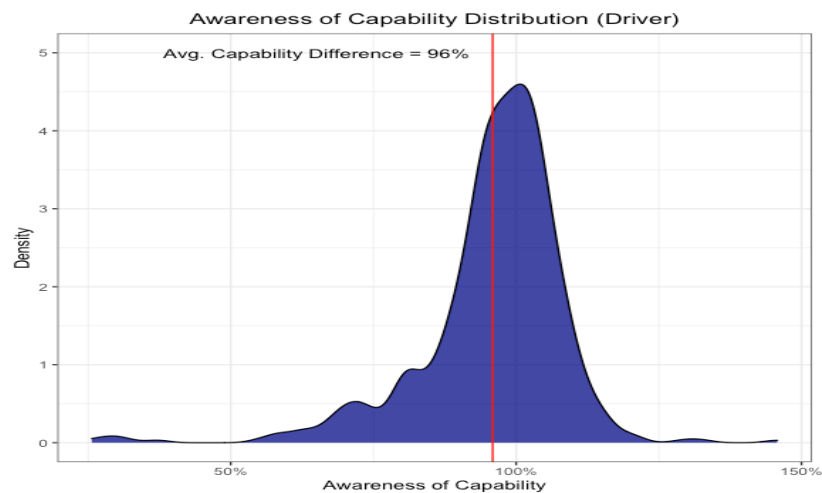


6. Actual Distance vs. Estimated

The main objective of this study was to compare golfers estimated hitting distances to the measured distances with their clubs. In this section, self-awareness of club distance distributions is plotted for each club recorded (driver, 7-iron, pitching wedge). Awareness is calculated by dividing the golfers' actual ability and capability by their estimated distance.

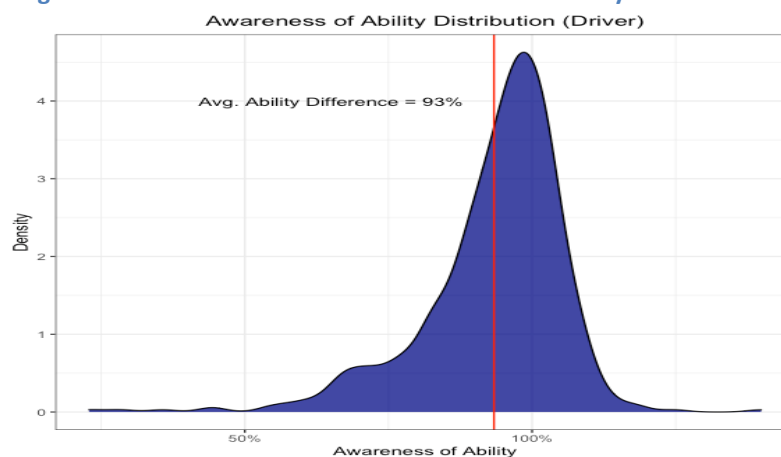
Golfer awareness of distances for driver capability and ability are seen in Figure 10 and 11. Golfers overestimate even their best drives by 4% their driver distance. This can be seen in the capability awareness plot where the average awareness is 96% (Perfect estimates are 100% awareness. Ratios less than 100% mean that golfers overestimate their capability or ability).

Figure 10: Awareness of Driver Distance Capability Distribution



Golfers overestimated their driver ability on average even more. In the plot below, the average awareness is 93% suggesting that golfers on average overestimate their driver abilities by 7%.

Figure 11: Awareness of Driver Distance Ability Distribution



The same analysis was applied to golfers' 7-iron distance capabilities and abilities. Golfers were more accurate in estimating their hitting distances with the 7-iron. In Figures 12 and 13, awareness of capability and ability distributions are plotted. It can be seen that golfers on average overestimated their 7-iron capability by 1%. Golfers overestimated their 7-iron ability by 4% on average.

Figure 12: Awareness of 7-iron Distance Capability Distribution

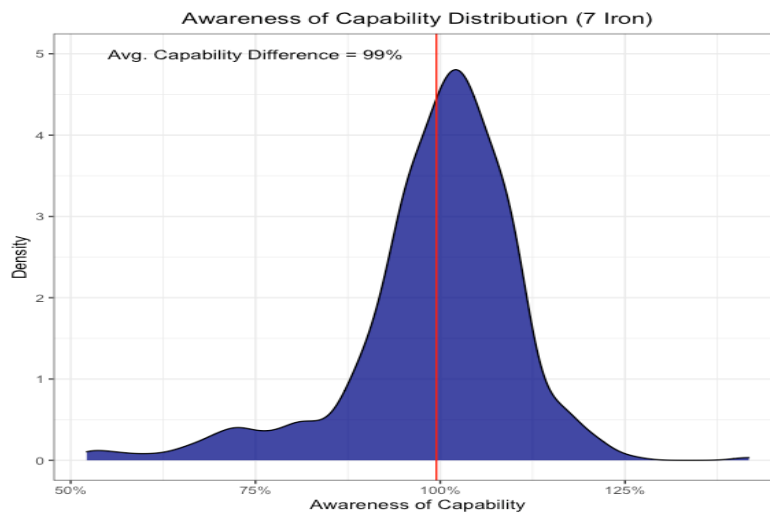
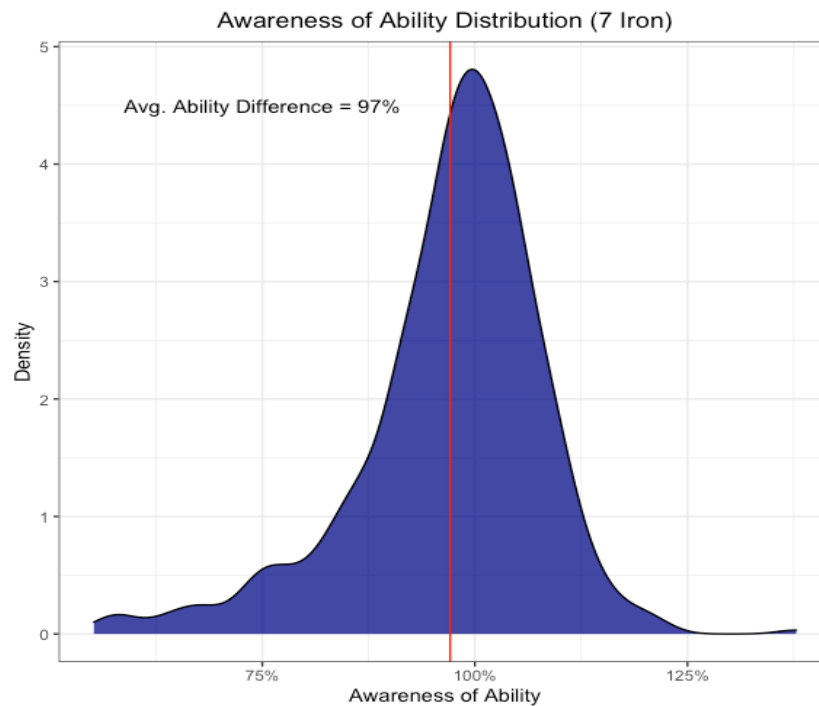


Figure 13: Awareness of 7-iron Distance Ability Distribution



Finally, awareness distributions are plotted for pitching wedge capability and ability in Figures 14 and 15 below. On average, golfers underestimated their capability distance by 5% on average. This could be due to some golfers hitting a few balls “thin” during their session. Alternatively, golfers were extremely accurate in estimating their pitching wedge ability with an average awareness of 101%.

Figure 14: Awareness of Pitching Wedge Distance Capability Distribution

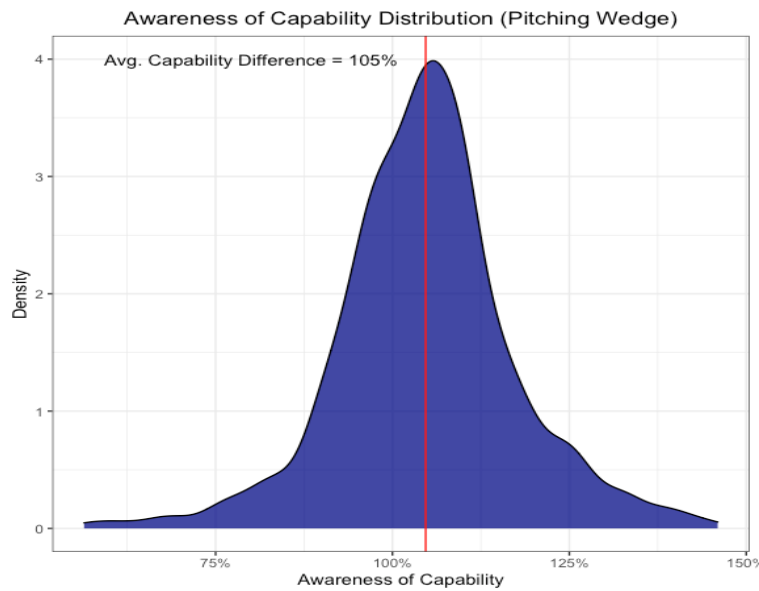
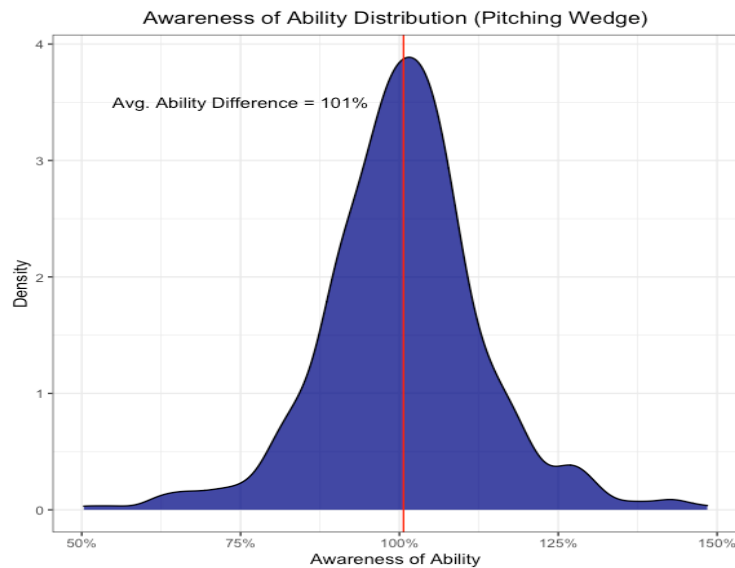


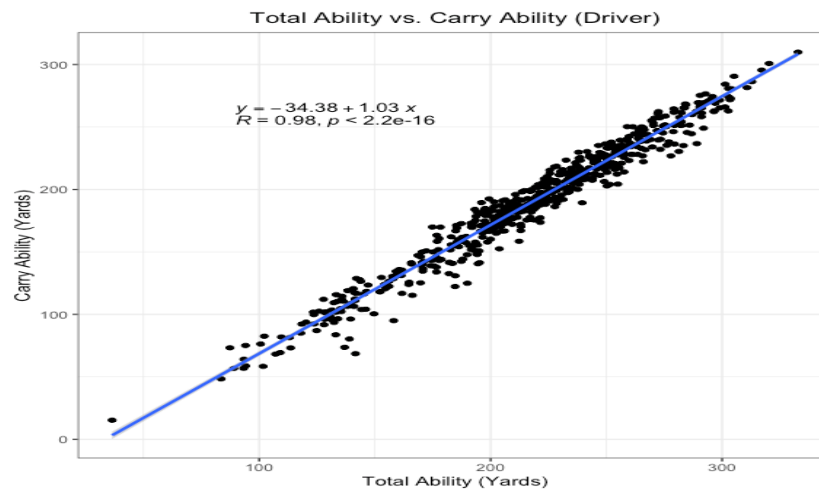
Figure 15: Awareness of Pitching Wedge Distance Ability Distribution



7. Total Distance vs. Carry Distance

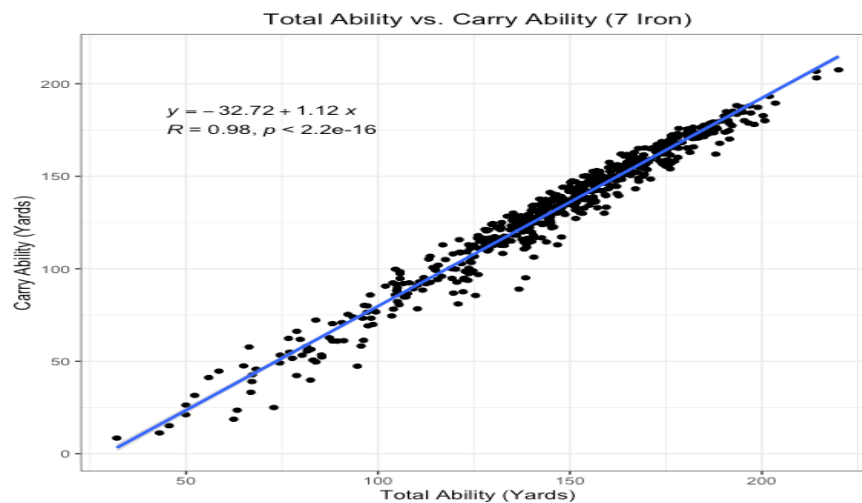
TrackMan also measured carry distance for each shot recorded. In this section, relationships between carry and total distances are analyzed. First, Figure 16 displays the relationship of driver total distance ability versus carry distance ability. This relationship is very strong with total distance accounting for 98% of the variation in carry distance.

Figure 16: Total Distance Ability vs. Carry Distance Ability (Driver)



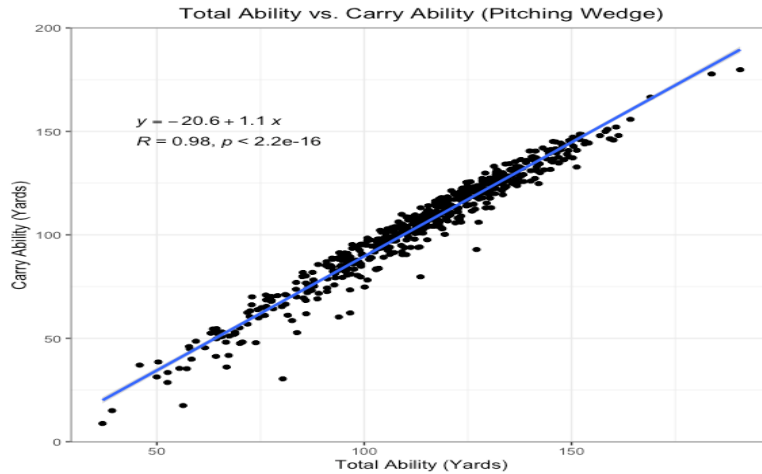
This analogous relationship is seen for 7-irons during the study. In Figure 17, 7-iron total distance ability is plotted versus 7-iron carry distance ability. Similar to drivers, the relationship is very strong. Total 7-iron Distance accounts for 98% of the variation in carry distance.

Figure 17: Total Distance Ability vs. Carry Distance Ability (7-iron)



Finally, a nearly identical relationship is seen in the pitching wedge data. Total Distance Ability again has a strong relationship with Carry distance ability. Total Distance accounts for 98% of the variation in Carry Distance as shown in Figure 18.

Figure 18: Total Distance Ability vs. Carry Distance Ability (Pitching Wedge)



8. Club Distance Ratios

Relationships between the hitting distances for each club can also be determined as golfers hit three different clubs during their session. In Figures 19, 20, and 21, three different club ability relationships are shown. It can be seen in all three plots that on average, higher distance with one club leads to higher distance with another club. These relationships are strong for each two-club comparison. Figure 19 shows that 7-iron distance is 22 yards plus 56% of driver distance longer on average.

Figure 19: Driver vs. 7-iron Ability



Figure 20 shows that pitching wedge distance is 22 yards plus 42% of driver distance on average.

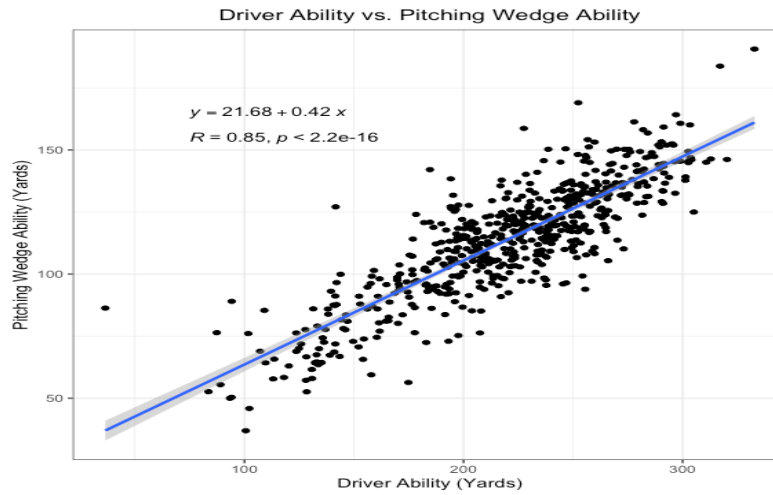
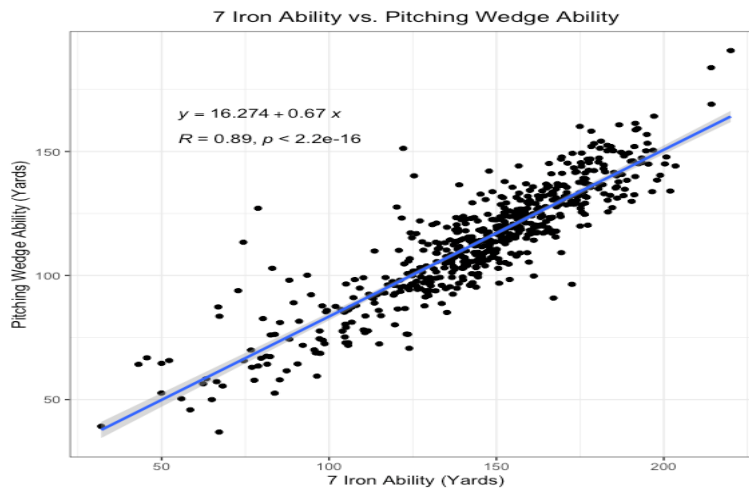
Figure 20: Driver vs. Pitching Wedge Ability

Figure 21 shows that pitching wedge distance is 16 yards plus 67% of 7-iron distance on average.

Figure 21: 7-iron vs. Pitching Wedge Ability

9. Club Distance Distributions

In this section, distributions of the actual club hitting distances for the sample are plotted by gender. These distributions can be seen in the Figures 22 – 24 below.

Figure 22: Distribution of Driver Total Distances by Gender

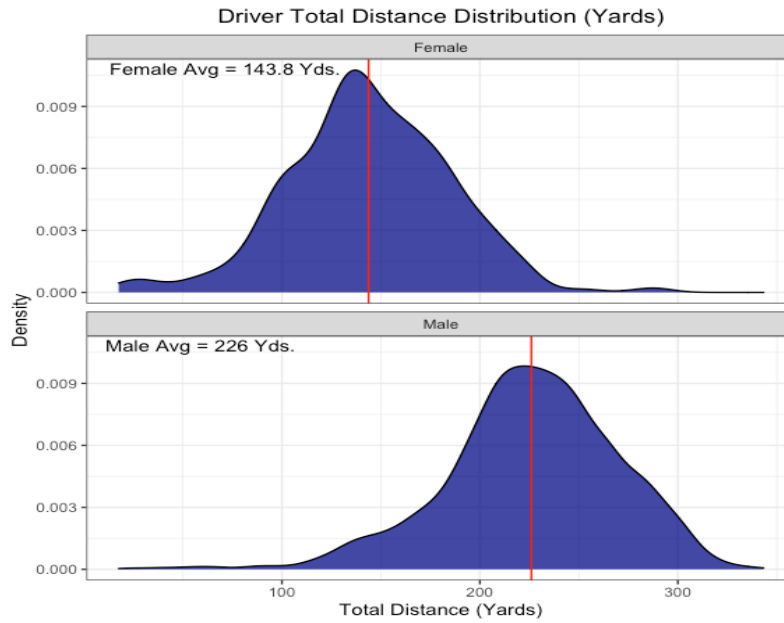


Figure 23: Distribution of 7-iron Total Distances by Gender

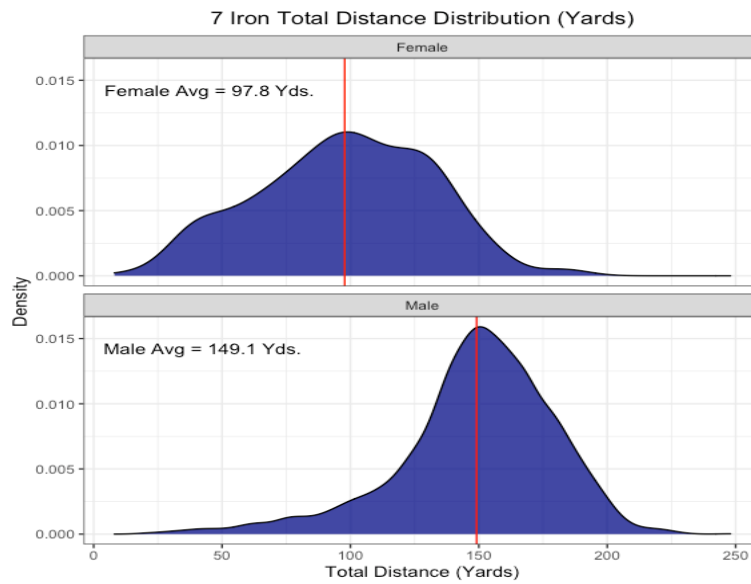


Figure 24: Distribution of Pitching Wedge Total Distances by Gender

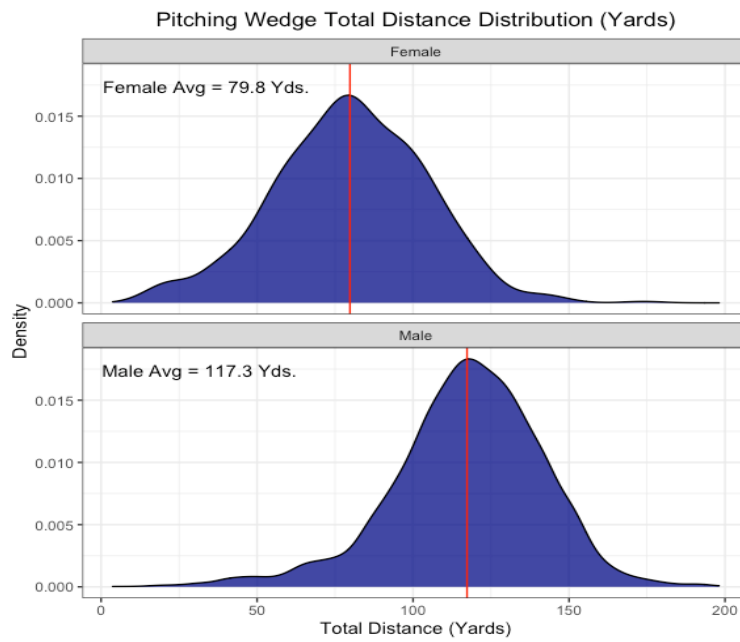


Table 5 summarizes the actual measured shot distance results for each gender & club.

Table 5: Average hitting distance ability by gender based on the correlation developed

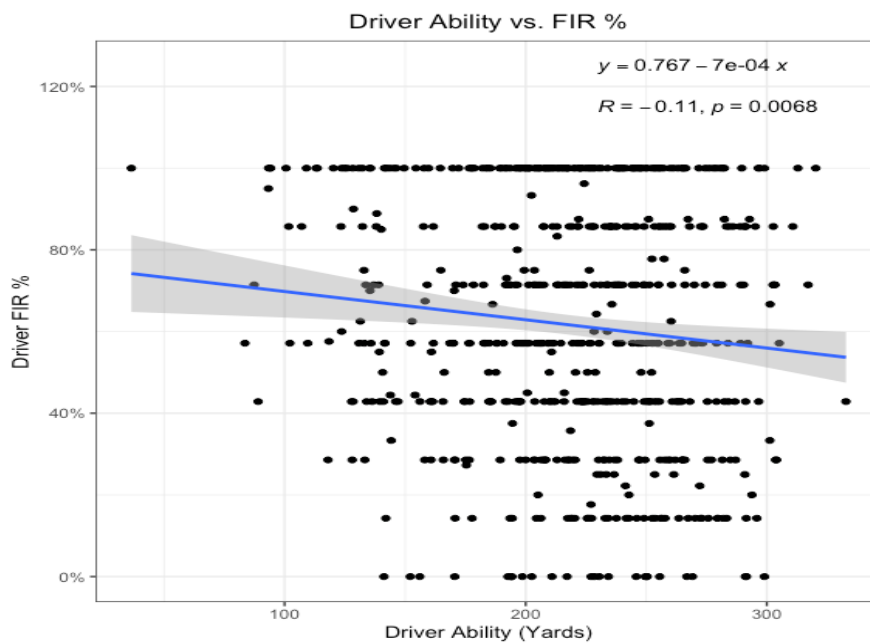
Club	Female Club Distance (yds)	Male Club Distance (yds)
Driver	144	226
7-iron	98	149
Pitching Wedge	80	117

10. Distance vs. Accuracy

The next component of the analysis examined the relationship between distance and accuracy of golfers. TrackMan measures side distance from the target for each shot recorded. By using this side distance and defining a standard fairway width, Fairway in Regulation percentages (FIR%) can be calculated.

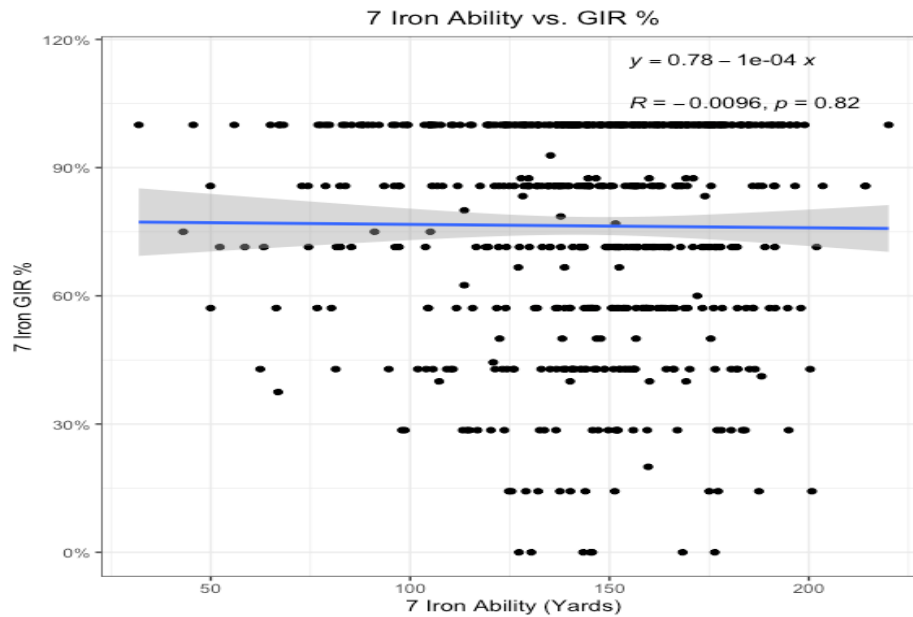
In Figure 25, driver ability is plotted against driver accuracy for a 30-yard-wide fairway. Total driver ability has a weak negative relationship with FIR%. Longer driver abilities generally lead to less accurate shots. Driver ability accounts for about 11% of the variation in FIR%. The correlation estimates that FIR will be about 7% lower for every additional 100 yards of driving distance ability and that a recreational golfer whose driving ability is 250 yards or greater will have a FIR of about 50%.

Figure 25: Driver Ability vs. Driver Accuracy (FIR %)



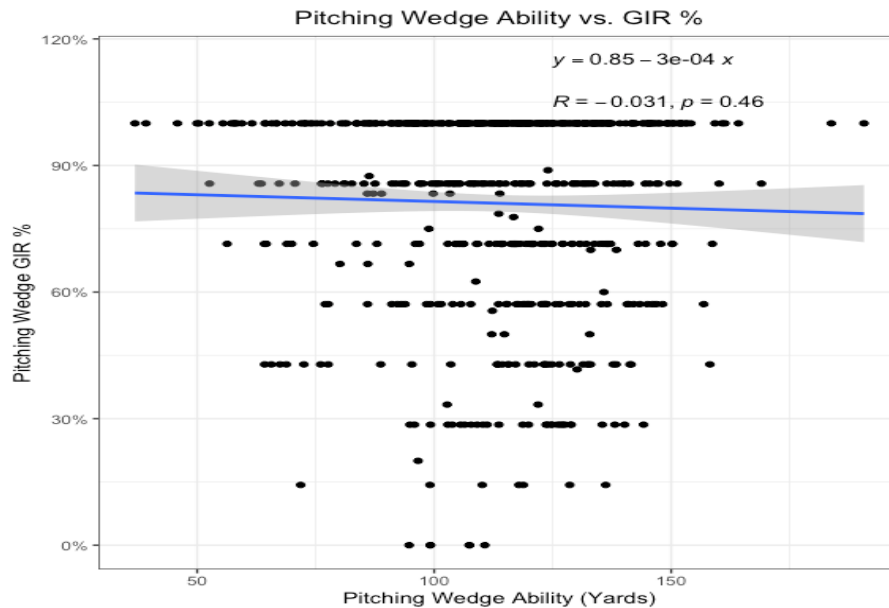
An analogous analysis was applied to 7-iron data from the study. However, instead of using FIR%, Green in Regulation (GIR%) was used for 7-irons. Figure 26 shows the relationship between 7-iron ability and 7-iron GIR% is essentially flat to the 82% confidence level. That means that a golfer with a 7-iron in hand is just as likely to hit the green in regulation as another golfer, regardless of how far they hit their 7-iron.

Figure 26: 7-iron Ability vs. 7-iron Accuracy (GIR %)



Finally, the accuracy analysis was applied to pitching wedge data. The statistical model shown in Figure 27 is very weak compared to driver and 7-iron and is not statistically significant.

Figure 27: PW Ability vs. PW Accuracy (GIR %)



11. Effects of Age

The effects of age for both male and female golfers were examined resulting in a number of important observations and results.

Figures 28 – 39 show the raw data carry and total distance in yards for three clubs each for both genders. Each plot shows the 10th, 50th and 90th percentile for each age bracket.

Figure 28

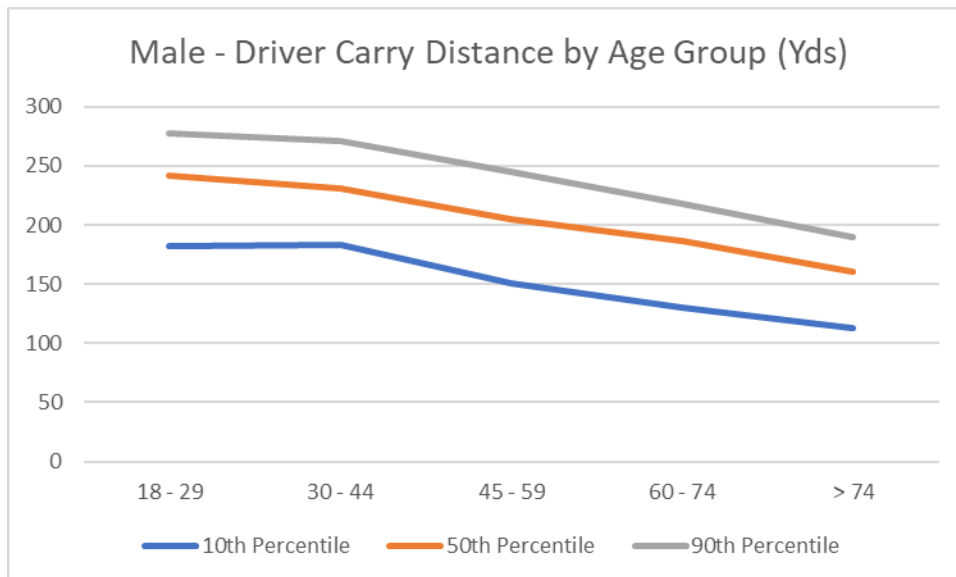


Figure 29

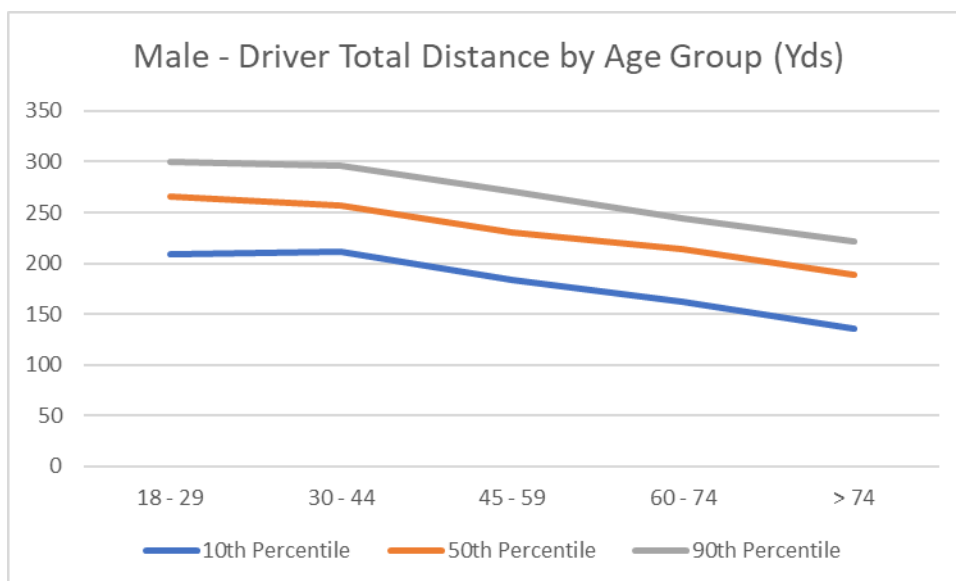


Figure 30

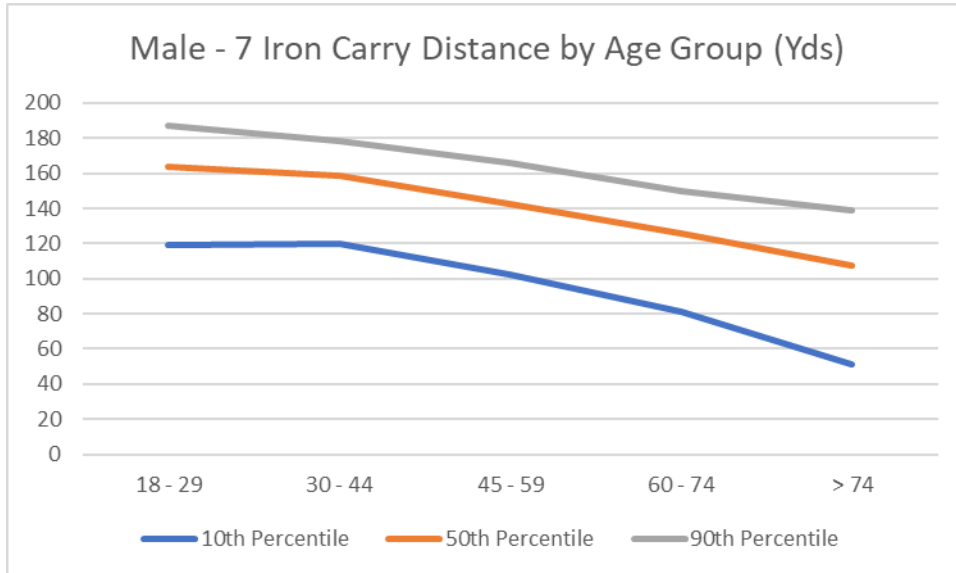


Figure 31

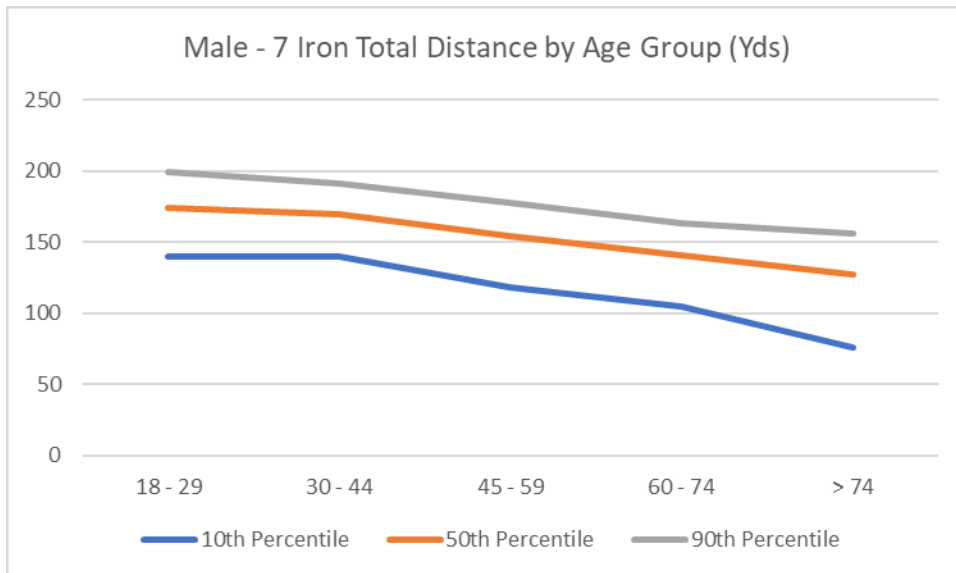


Figure 32

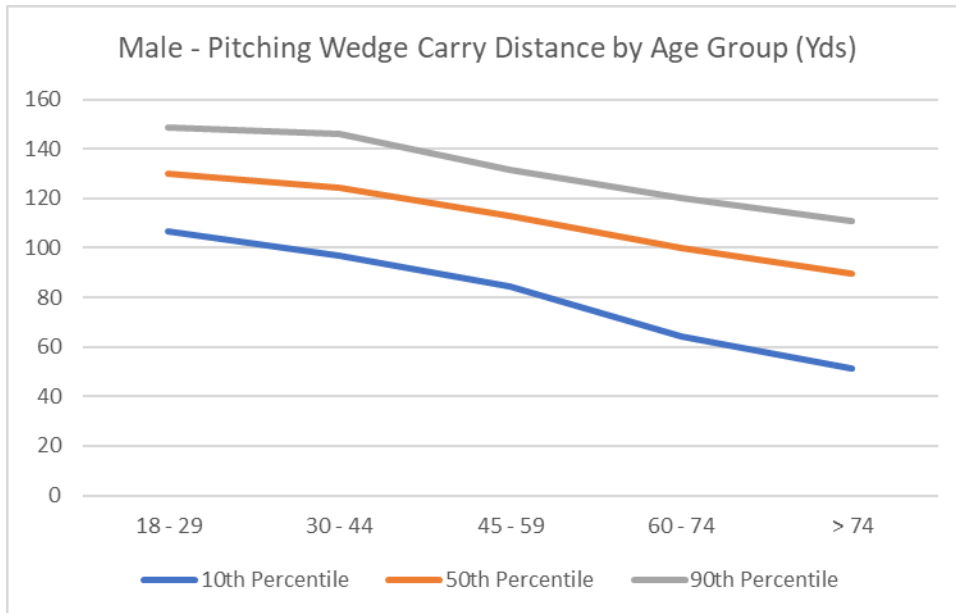


Figure 33

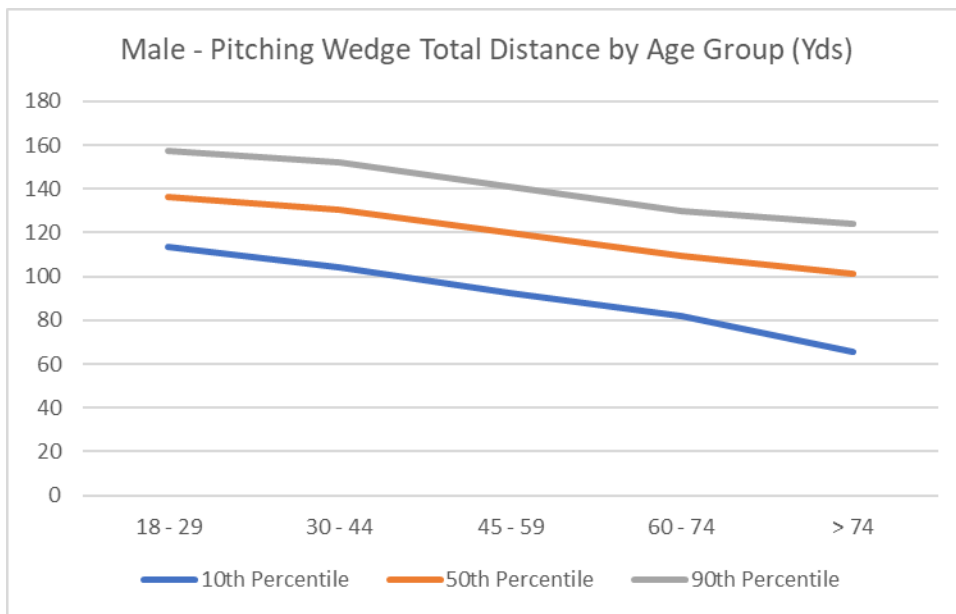


Figure 34

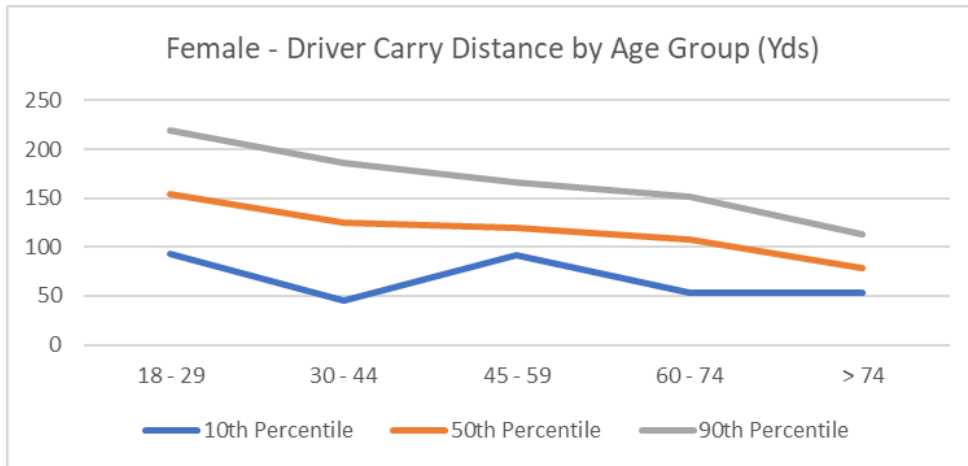


Figure 35

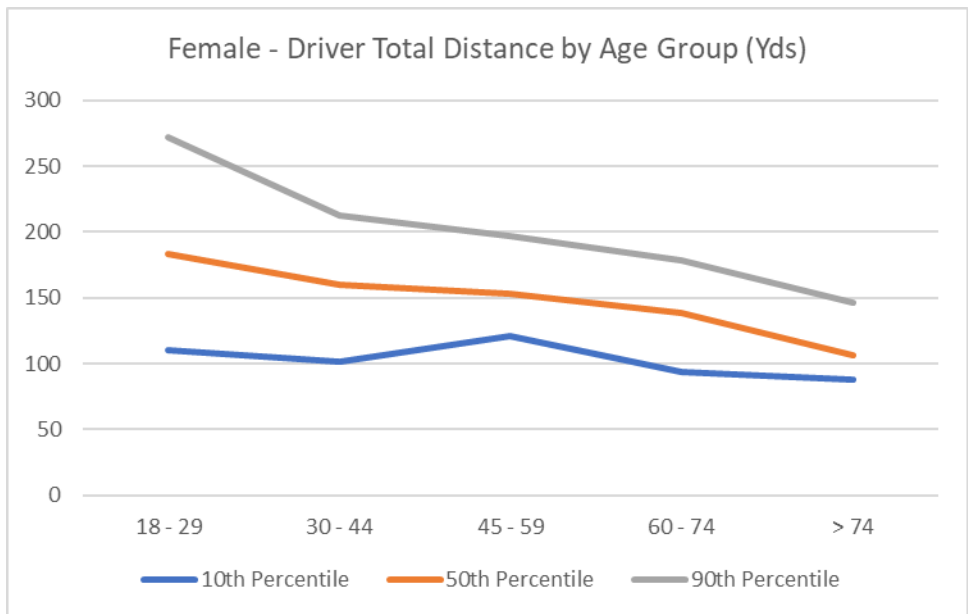


Figure 36

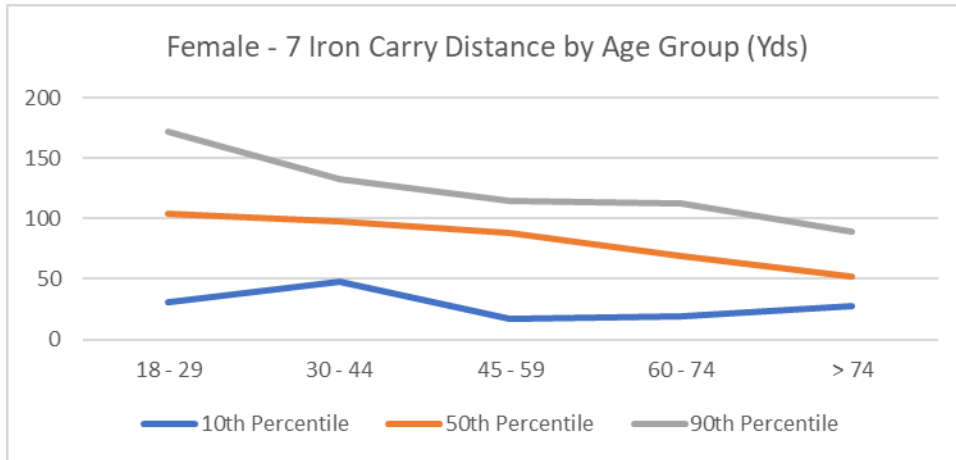


Figure 37

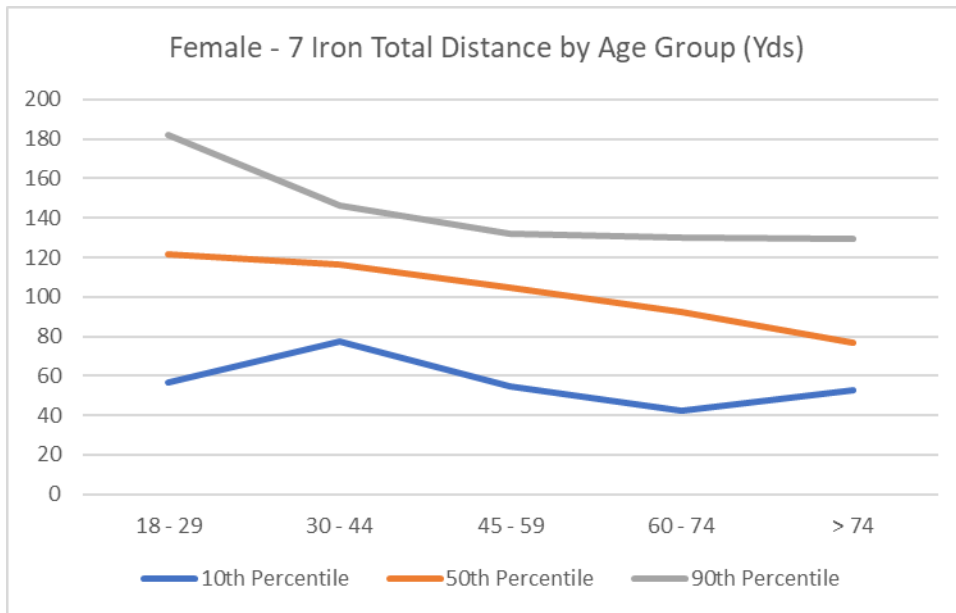


Figure 38

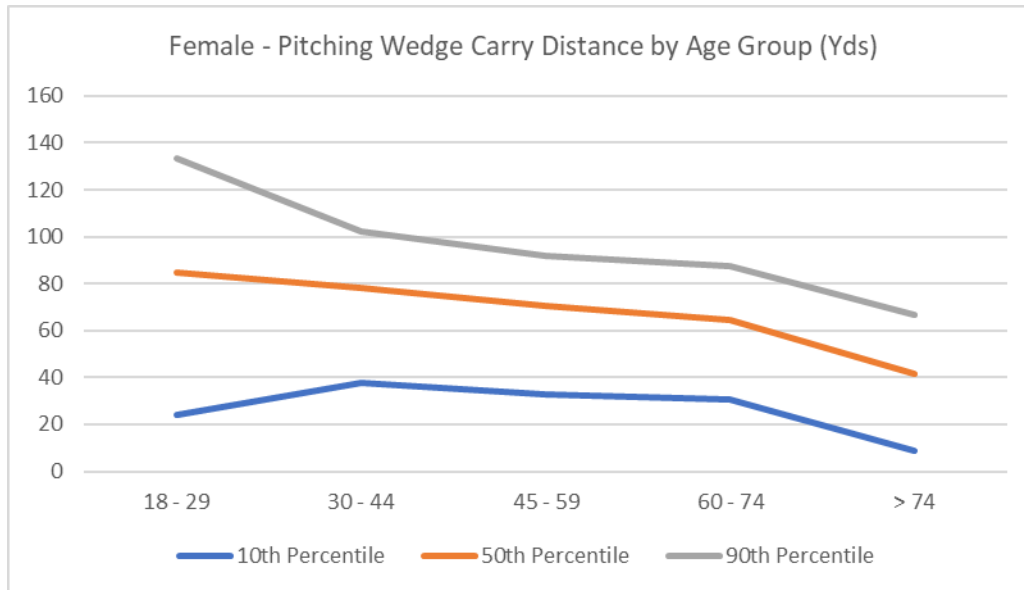
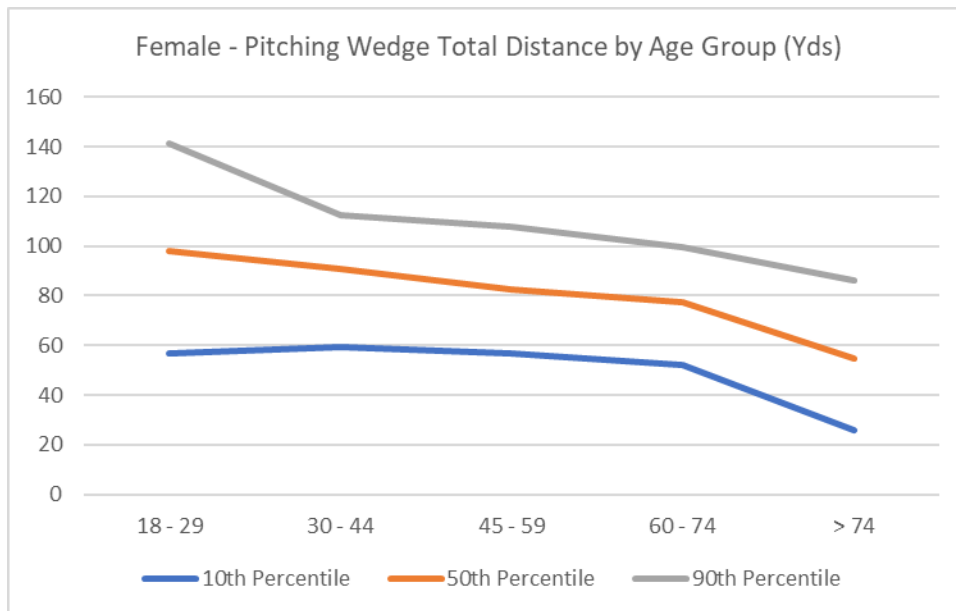


Figure 39



Beyond the raw data shown in the previous twelve figures, additional analysis shows that for both genders, performance generally decreases as golfers age. Figure 40 shows that getting older reduces female hitting distance to a greater percentage compared to male golfers. Looking at the three columns on the left show less of a drop-off for males for all three clubs compared to the female data shown in the right three columns.

Figure 40

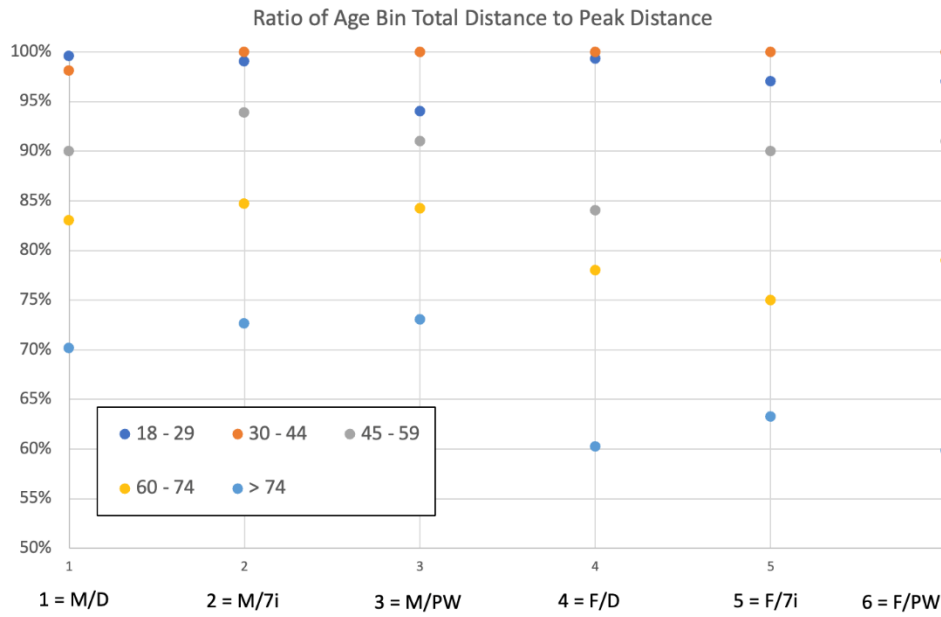


Table 6 shows the models gender differential for each club, on average and independent of age bracket between male and female golfers for the 50th percentile.

Table 6 Hitting distance difference between the average male and female golfer.

Club	Average Hitting Distance Difference (yds)
Driver	82
7-iron	51
Pitching Wedge	37

As shots get shorter, regardless of the club, the fraction of the shot that is carry decreases. On an absolute basis, males have about 4 – 5 yards less of bounce and roll on all shots compared to females.

Finally, maximum forced carry information can be determined from these data. Using the 10th percentile data for each age group, driver data can be used for tee shot maximum forced carry. For approach shot forced carry, using the 10th percentile of 7-iron allows for the additional buffer required the lap-up prior to a forced carry. Table 7 and 8 show the carry distance capability of golfers resulting in the maximum forced carry recommended for each gender by age bracket.

Table 7: Female Maximum Forced Carry (yds)

<u>Age Bin</u>	Tee Shot - Maximum Forced Carry – Driver 10th percentile	Approach Shot - Maximum Forced Carry – 7-iron 10th percentile
18 – 29 yrs. old	94	47
30 – 44 yrs. old	99	67
45 – 59 yrs. old	74	43
60 – 74 yrs. old	62	19
>74 yrs. old	53	19

Table 8: Male Maximum Forced Carry (yds)

<u>Age Bin</u>	Tee Shot - Maximum Forced Carry – Driver 10th percentile	Approach Shot - Maximum Forced Carry – 7-iron 10th percentile
18 – 29 yrs. old	182	119
30 – 44 yrs. old	184	120
45 – 59 yrs. old	150	102
60 – 74 yrs. old	130	91
>74 yrs. old	111	51

12. Conclusions

The overall goal of this analysis was to explore recreational golfer club hitting metrics that were recorded by the USGA during 2021 through 2023. The main objective of the study was to compare golfer estimated club hitting distances to their actual measured distances. Through the comprehensive analysis, it was shown that recreational golfers have a relatively accurate understanding of their median hitting distances with different clubs. Drivers had the biggest difference in estimated versus actual because golfers typically refer to their best drives when estimating their drive distance instead of their average shot distance, and even then, overestimate their capability.

Strong positive relationships between total and carry distance, club speed and ball speed, and Handicap Index versus club hitting distance were quantified. Additionally, club hitting distance distributions were plotted which can be compared to other data sources.

Using TrackMan shot charting of off-center distances, it was demonstrated that on average, longer distances for each club typically result in less accurate shots (As defined by FIR/GIR percentages).

The analysis finished up examining the effect of aging on golfer hitting performance. Importantly, aging affects female golfers more severely than male golfers and forced carries are substantially more of an obstacle for female golfers.
