

# R22-01 Launch conditions of male and female golfers of different skill levels

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## 1. Introduction

Understanding the launch conditions of golfers of different skill levels is important in understanding the effect of developments, in rules or equipment for example, on performance. Whilst the launch conditions of professional golfers are relatively accessible (for example; TrackMan, 2015), the launch conditions of golfers of different skill levels are less widely reported. Furthermore, information about the launch conditions of female golfers tends to be less accessible than for male golfers. This report collated launch condition data from several different research projects to present a comprehensive data set of launch conditions for both male and female golfers of different skill levels. This may be useful in understanding the potential differences and similarities in performance between golfers of different genders but similar overall skill level.

## 2. Methods

A search of previously completed research projects uncovered several sources of launch condition data for both male and female golfers; these are summarized in Table 1 and Table 2. Raw data was sourced for each project and data collated into a single dataset consisting of 1,667 driver shots and 897 6-iron shots for female golfers and 16,832 driver shots and 3,010 6-iron shots for male golfers. The large difference in the total number of shots, 19,842 to 2,564 shots for male and female golfers respectively (Table 3 and Table 4), is largely due to the inclusion of PGA Tour TrackMan data from 2018. One investigation also collected 257 female 7-iron shots; this data was excluded from further analysis because the data was only collected for Category 1 golfers.

Data was split into groups based on the amateur status of the golfer, and amateur golfers split into 4 further groups based on the CONGU handicap categories. This split the data into five groups with theoretically decreasing skill. Since the number of variables included in the dataset was high, and multiple statistical hypothesis tests could result in false positive results, this report focussed on descriptive statistics. The mean and standard deviation for each gender, club and handicap category were calculated for all launch and clubhead presentation variables. Separate multiple linear regression models, with ball speed, launch angle and spin as input variables and handicap category as a response variable, were calculated for each gender and club. All analysis was performed using MATLAB (Mathworks, Inc., 2018).

Table 1. Sources of data on launch conditions of female golfers of various skill levels.

Project name	Women's Turnberry	Elite female golfers	US Open	Driver shots	Iron shots	Variability
Primary author	R&A Rules, Ltd.	S. Brown	USGA	N. Betzler	T. Corke	K. Jones
Year	2003	2005	2008	2012	2014	2018
Project type	Research	PhD	Research	Research	PhD	PhD
Club	Driver	Driver and 7-iron	Driver	Driver	6-iron	Driver and 6-iron
Number of females	43	42	152	39	20	27
- Professional	43	0	152	1	9	0
- Category 1	0	16	0	6	3	3
- Category 2	0	0	0	10	3	4
- Category 3	0	0	0	10	2	9
- Category 4	0	0	0	12	3	10
Number of shots per golfer	5-10	10 driver 10 7-iron	1	10	24 6-iron 12 blade 12 cavity	10 driver 10 6-iron
Number of shots	366	276	152	510	500	763
- Driver	366	276	152	510	0	363
- 6 Iron	0	0	0	0	500	397
Measurement method	Stereoscopic Launch Monitor	Stereoscopic Launch Monitor	Trackman	Trackman and clubhead tracking	Trackman and clubhead tracking	Trackman and clubhead tracking
Location	Natural grass	Indoors into net	Competition	Driving range	Natural grass	Driving range

Table 2. Sources of data on launch conditions of male golfers of various skill levels.

Project name	Elite golfers	Driver shots	Iron shots	Variability	Tour Trackman
Primary author	S. Brown	N. Betzler	T. Corke	K. Jones	PGA Tour
Year	2005	2012	2014	2018	2018
Project type	PhD	Research	PhD	PhD	Research
Club	Driver and 7-iron	Driver	6-iron	Driver and 6-iron	Driver
Number of males	9	246	79	78	1601
- Professional	0	0	0	0	1601
- Category 1	9	91	46	28	0
- Category 2	0	93	24	31	0
- Category 3	0	47	5	13	0
- Category 4	0	15	4	6	0
Number of shots per golfer	10 driver 10 7-iron	10	24 6-iron 12 blade 12 cavity	10 driver 10 6-iron	2-4 per competition
Number of shots	90	3400	1985	2033	12334
- Driver	90	3400	0	1008	12334
- 6 Iron	0	0	1985	1025	0
Measurement method	Stereoscopic Launch Monitor	Trackman and clubhead tracking	Trackman and clubhead tracking	Trackman and clubhead tracking	Trackman
Location	Indoors into net	Driving range	Natural grass	Driving range	Competition

Table 3. Number of shots by club and handicap group for female golfers.

	Driver		6-iron	
	Frequency	Percent	Frequency	Percent
Professional	528	31.7	221	24.6
Category 1	364	21.8	108	12.0
Category 2	236	14.2	148	16.5
Category 3	243	14.6	183	20.4
Category 4	296	17.8	237	26.5
Total	1,667	100	897	100

Table 4. Number of shots by club and handicap group for male golfers.

	Driver		6-iron	
	Frequency	Percent	Frequency	Percent
Professional	12334	73.3	142	4.7
Category 1	433	2.6	1341	44.5
Category 2	400	2.4	1010	33.5
Category 3	164	1.0	321	10.7
Category 4	101	0.7	196	6.5
Total	16,832	100	3010	100

### 3. Results

Descriptive statistics for all launch variables included in the investigation are shown in Table 5, Table 6 and Table 7. For example, professional female golfers had a clubhead speed with the driver of  $93.8 \pm 3.8$  mph, compared to  $113.7 \pm 4.6$  mph for the male golfers. Average clubhead speed generally increased with decreasing handicap (Figure 1). Similar patterns were observed in ball speed, but there did not appear to be any consistent relationship between handicap and launch angle or spin. However, inspection of the standard deviation of both launch angle and spin values suggests that highly skilled golfers are somewhat more consistent in these variables.

Whilst these standard deviations are of the defined categories, it has been widely reported in biomechanics literature that higher skilled golfers are individually more consistent in 'outcome' variables, including ball launch and clubhead presentation (Betzler, 2012; Jones, 2019). The regression analysis (Table 8) indicated that launch angle and spin were statistically significant in predicting handicap, but the coefficient for spin was consistently small for both genders and clubs.

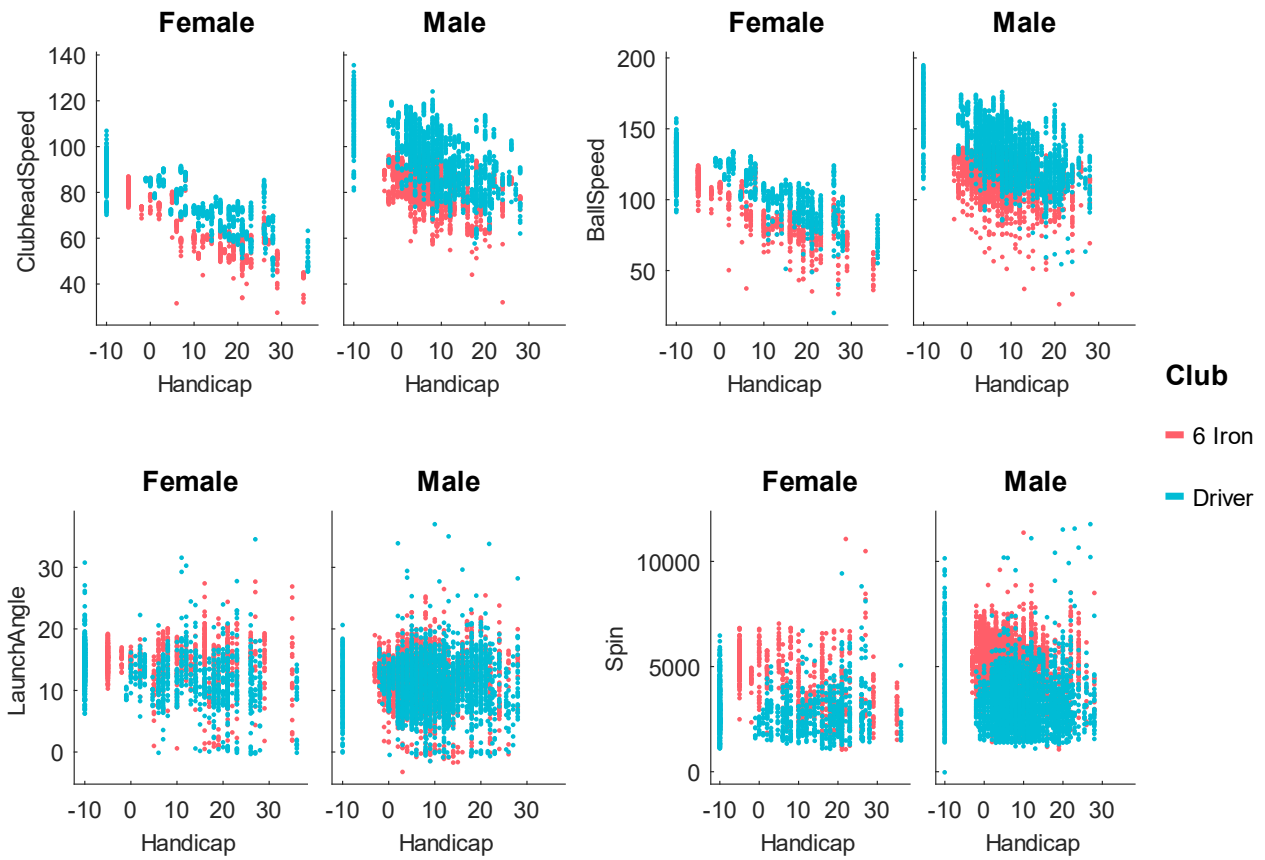


Figure 1. Clubhead speed, ball speed, launch angle and spin rate against handicap for all golfers included in the dataset.

Table 5. Descriptive statistics of clubhead variables.

Gender	Club	Handicap Group	n	Clubhead speed (mph)		Attack angle (°)		Path angle (°)		Effective loft (°)		Effective lie (°)		Face angle (°)		X position (mm)		Y position (mm)	
				Mean	Std	Mean	Std	Mean	Std	Mean	Std	Mean	Std	Mean	Std	Mean	Std	Mean	Std
Female	6 Iron	0	221	79.6	3.4	-2.9	1.3	-0.4	3.4	22.2	2.0	-0.3	3.3	0.8	2.8	-4.4	6.2	-9.5	4.0
		1	108	74.7	4.1	-2.9	2.8	-0.9	4.1	20.9	3.9	0.3	2.9	-0.4	3.5	0.4	12.0	-10.5	8.4
		2	148	64.7	11.1	-0.5	2.5	-0.9	5.5	22.9	5.8	0.7	3.2	-1.6	4.0	1.4	14.6	-13.3	8.5
		3	183	56.5	4.6	-1.8	3.3	-4.3	5.0	21.9	5.9	0.3	4.6	-1.6	4.1	0.4	17.5	-16.9	10.6
		4	237	52.6	7.2	-0.4	4.0	-3.0	4.6	21.8	6.7	-1.1	3.0	1.0	7.0	0.0	20.2	-17.3	14.4
	Driver	0	528	93.8	3.8	2.8	0.6	1.3	0.6	10.3	1.7	-	-	3.4	1.6	0.7	7.2	4.3	4.0
		1	364	86.3	5.7	0.5	3.5	0.2	7.2	12.7	2.3	7.7	1.2	2.3	2.3	1.0	8.6	0.7	8.2
		2	236	77.0	6.5	1.4	3.1	-0.4	4.9	13.4	3.8	6.5	2.2	2.5	3.9	1.8	12.4	3.8	10.7
		3	243	68.4	5.2	-0.2	4.0	-1.7	5.5	11.2	4.2	8.0	4.8	2.7	4.7	2.8	16.0	6.3	12.8
		4	296	62.6	8.5	-1.0	3.8	-3.7	4.6	12.5	5.0	5.2	4.2	3.2	6.7	2.2	19.2	-0.1	14.1
		0	142	89.4	5.4	-4.3	2.2	1.4	2.7	20.7	2.8	-1.4	3.9	92.4	5.6	1.7	6.5	-11.3	5.4
		1	1341	85.7	5.6	-4.5	2.4	-0.2	4.0	19.3	3.3	-2.6	3.3	66.7	40.1	-2.3	10.0	-10.8	6.8
		2	1010	81.0	8.1	-3.7	3.0	-1.1	4.4	19.7	4.7	-2.1	3.8	51.9	43.8	-3.1	12.6	-12.3	8.2
		3	321	77.4	9.1	-2.0	3.7	-1.4	5.6	21.2	4.8	-3.8	3.9	42.0	44.5	-7.2	13.3	-14.1	10.0
Male	6 Iron	4	196	78.5	8.9	-3.1	3.7	-4.2	3.2	19.8	5.8	-4.0	5.7	42.5	43.4	-4.6	20.5	-16.5	11.6
		0	12334	113.7	4.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		1	433	100.5	6.8	0.4	3.0	-0.9	3.9	13.0	2.8	5.4	2.7	0.6	3.6	-0.7	11.7	-0.9	8.6
	Driver	2	400	91.4	9.2	0.7	3.9	-1.9	4.5	13.2	4.0	4.8	4.2	1.6	4.9	0.5	13.0	-1.8	10.2
		3	164	85.8	9.5	0.9	3.8	-3.0	5.9	12.0	4.7	4.5	4.2	0.5	4.3	1.7	12.7	4.9	12.9
		4	101	89.6	9.9	-0.7	2.3	-4.7	3.4	11.0	4.1	5.8	4.5	0.2	5.5	1.7	18.2	-4.4	13.6

Table 6. Descriptive statistics of ball launch variables.

Gender	Club	Handicap Group	n	Ball speed (mph)		Efficiency ( )		Launch angle (°)		Launch direction (°)		Spin rate (rpm)		Spin axis (°)	
				Mean	Std	Mean	Std	Mean	Std	Mean	Std	Mean	Std	Mean	Std
Female	6 Iron	0	221	112.9	5.7	1.40	0.1	15.1	1.8	-0.5	2.7	5217	678	2.1	4.4
		1	108	102.8	8.2	1.37	0.1	14.2	2.9	-0.5	3.6	4685	955	1.4	6.2
		2	148	90.5	15.1	1.36	0.1	15.1	3.2	-1.1	5.8	4096	1252	1.3	10.4
		3	183	77.6	9.5	1.33	0.1	13.7	5.2	-1.3	4.9	3712	1230	4.1	9.8
		4	237	71.2	13.5	1.29	0.2	14.3	4.9	1.2	6.3	3460	1565	6.3	9.8
		0	528	127.6	11.3	1.44	0.1	14.3	2.7	1.2	1.3	2872	910	1.5	10.4
		1	364	122.2	10.6	1.43	0.1	14.1	2.9	1.1	3.2	3067	1057	7.7	17.7
	Driver	2	236	109.6	9.8	1.44	0.1	13.2	4.6	0.0	3.9	2784	983	5.8	17.9
		3	243	97.0	9.1	1.41	0.1	11.3	3.9	-0.4	4.6	2671	909	4.3	20.3
		4	296	86.8	13.9	1.39	0.1	10.4	5.1	-0.2	6.5	3095	1392	10.9	22.6
		0	142	125.0	9.2	1.39	0.1	12.8	2.4	0.3	2.5	6097	645	0.8	4.8
		1	1341	120.2	9.9	1.38	0.1	12.4	3.0	-0.1	3.1	5171	925	0.9	6.2
		2	1010	112.2	13.2	1.37	0.1	12.1	4.0	-0.8	3.8	4835	1191	1.5	7.5
		3	321	105.9	15.0	1.33	0.1	12.5	4.7	-0.4	4.1	4354	1333	0.6	10.1
Male	6 Iron	4	196	103.8	19.2	1.30	0.2	11.7	5.1	-1.6	5.2	4942	1492	6.4	10.9
		0	12334	169.0	6.6	1.49	0.0	11.1	2.3	-0.2	3.3	2259	1120	-	-
		1	433	143.8	9.9	1.43	0.0	11.4	2.8	0.9	3.4	3274	780	0.3	7.4
		2	400	130.6	13.1	1.43	0.1	10.7	3.6	0.7	4.4	3313	1140	1.1	10.8
	Driver	3	164	121.9	15.3	1.42	0.1	12.2	4.9	-0.2	4.6	3202	1250	2.0	12.9
		4	101	125.6	16.6	1.39	0.1	10.2	4.8	-0.1	5.3	3839	1309	8.4	9.4

Table 7. Descriptive statistics of ball flight variables.

Gender	Club	Handicap Group	n	Max height (yards)		Flight time (s)		Carry length (yards)		Carry side (yards)		Total length (yards)	
				Mean	Std	Mean	Std	Mean	Std	Mean	Std	Mean	Std
Female	6 Iron	0	221	23.7	3.3	5.3	0.4	155.5	12.1	2.6	7.6	168.1	13.6
		1	108	16.9	5.6	4.1	0.9	132.0	23.4	0.1	8.6	149.5	20.6
		2	148	12.9	8.8	4.2	1.4	106.7	32.7	-0.7	9.5	127.2	27.8
		3	183	7.2	4.8	3.1	1.0	75.1	29.3	-0.4	6.5	99.1	26.0
		4	237	6.0	4.7	2.1	1.0	64.5	32.5	3.4	9.1	88.6	31.5
		0	528	27.4	3.1	5.7	0.2	216.7	13.3	0.6	14.7	245.3	15.3
	Driver	1	364	18.9	7.2	4.6	1.0	173.6	25.4	-3.7	11.9	202.0	21.3
		2	236	13.3	6.1	4.0	0.9	135.8	25.9	4.6	11.2	166.8	22.4
		3	243	7.7	4.8	3.0	1.0	100.1	29.3	2.2	9.3	137.3	25.3
		4	296	5.6	5.2	2.1	0.9	76.5	37.5	5.0	12.5	112.3	34.3
		0	142	25.1	6.1	5.5	0.6	176.4	18.1	2.7	13.0	190.5	17.8
		1	1341	23.3	6.4	5.4	0.8	164.4	23.1	0.9	11.8	178.5	21.8
Male	6 Iron	2	1010	18.9	7.9	4.9	1.1	145.5	31.5	-0.6	13.4	161.9	26.9
		3	321	16.2	8.1	4.2	1.7	129.9	39.3	-0.2	14.3	150.5	32.2
		4	196	14.8	9.8	4.4	1.5	119.2	47.6	3.7	18.2	137.5	41.6
		0	12334	-	-	6.5	1.7	262.2	66.9	-0.4	17.5	294.6	22.1
	Driver	1	433	27.8	8.5	-	-	215.1	23.4	-1.3	17.8	233.7	24.4
		2	400	21.1	8.8	-	-	183.6	34.5	5.3	17.8	206.3	31.0
		3	164	16.3	8.0	-	-	163.3	33.6	4.4	19.3	191.1	34.3
		4	101	17.6	11.1	-	-	163.1	49.7	13.1	19.2	185.2	43.5

Table 8. Regression models predicting handicap from ball speed, launch angle and spin.

Female/Driver:	R <sup>2</sup> = 0.72	F = 1150, P < 0.01	
	b	SE B	p
(Intercept)	85.08	1.50	< 0.01
Ball speed	-0.59	0.01	< 0.01
Launch Angle	-0.81	0.05	< 0.01
Spin	-0.00	0.00	< 0.01
Male/Driver:	R <sup>2</sup> = 0.75	F = 1660, P < 0.01	
	b	SE B	p
(Intercept)	65.4	0.42	< 0.01
Ball speed	-0.42	0.00	< 0.01
Launch Angle	-0.35	0.01	< 0.01
Spin	0.00	0.00	< 0.01
Female/6 iron:	R <sup>2</sup> = 0.75	F = 808, P < 0.01	
	b	SE B	p
(Intercept)	62.68	1.40	< 0.01
Ball speed	-0.56	0.01	< 0.01
Launch Angle	0.16	0.07	< 0.01
Spin	-0.00	0.00	< 0.01
Male/6 iron:	R <sup>2</sup> = 0.20	F = 243, P < 0.01	
	b	SE B	p
(Intercept)	35.32	1.28	< 0.01
Ball speed	-0.22	0.01	< 0.01
Launch Angle	-0.18	0.04	< 0.01
Spin	-0.00	0.00	< 0.01

## 4. Conclusion

This paper presents a summary of a collated data set of launch conditions including both male and female golfers of different ability levels. The collated data set may be useful in that it provides some indication of the launch conditions of golfers of a range of ability. Whilst ball speed increases with decreasing handicap for both male and female golfers, there does not appear to be a strong relationship between handicap and launch angle or spin for either gender.

There is significantly more data available on launch conditions for elite male golfers, which have been collected on the PGA Tour since 2007. This may allow an analysis into whether launch conditions had changed for professional male golfers over that time period. In contrast, there is not as much data available for female golfers, or golfers over a range of skill levels, that may allow reliable conclusions to be drawn on changes in launch conditions over time.



## 5. References

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