Effects Of Grip And Finger Strength On Baseball Spin Rate

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Abstract

The purpose of this study was to observe the effects of grip and finger strength and hand and finger measurements on generating spin rate on a pitched baseball. Fifty-nine healthy pitchers participated in this study by partaking in grip and finger strength evaluations before throwing each pitch type in their repertoire against a ball-tracking technology unit that measures velocity and spin rate. For fastballs, grip strength shared the strongest relationship with spin rate (r = 0.45; p < 0.001). However, its correlation to SVR or Spin to Velocity Ratio, a more reliable measure when comparing spin rates across different velocity ranges, was weak and insignificant (r = -0.01, p = 0.92). For breaking balls, grip strength (r = 0.25, p = 0.038), index finger length (r = 0.28, p = 0.023), and thumb length (r = 0.37, p = 0.0022) had firm and significant correlations to total spin. As was the case for the fastballs, these variables did not hold significant relationships against Spin to Velocity Ratio. For offspeed pitches, the only statistically significant relationship was shared between hand circumference and Spin to Velocity Ratio (r = -0.34, p = 0.02). The results show that a few relevant measurements share significant relationships with spin rate; however, when spin rate is normalized for velocity (Spin-to-Velocity Ratio) none of these measurements had a statistically significant effect on creating more spin.

Keywords

Spin rate, grip strength, finger strength, pitching

Introduction

Since the inception of utilizing ball-tracking technologies in baseball player development and evaluation, there has been an increasing emphasis for pitchers to be able to raise their spin rates and produce more movement on their pitches (Sarris, 2020). Depending on factors such as pitch type, the axis a baseball is rotating on, pitch location, batter talent level, etc, this optimization of pitch movement and spin often induces weaker contact and whiffs for pitchers in a competitive environment (Sarris, 2020). Although a rosin (a sticky substance extracted from the sap of fir trees) bag which is provided on the field to pitchers for an enhanced grip on the baseball (Baseball Reference, 2020), has been found to increase a player's spin rates when applied, some pitchers in amateur and professional settings have also used foreign substances to either impart even more spin on their pitches or maintain their present abilities throughout a season (Sarris, 2021). Under much scrutiny, Major League Baseball implemented a new foreign substance rule that disciplined players if they were caught possessing or applying sticky substances during the 2021 season (The Athletic, 2021). This stricter enforcement of substances applied to a pitcher's throwing hand has likely caused players to look towards other methods to gain their edge.

Both before and after the stricter enforcement of foreign substances, players and coaches alike have been motivated to find "legal" ways to increase spin rates. Commonly, players try to alter their specific grip on certain pitch types to varying degrees of success. These grip changes can involve leveraging seams at different angles or parts of the baseball as well as applying more pressure to certain fingers relative to others. Some have concluded that the ability to spin a baseball at elite levels cannot be taught and is a result of raw talent and genetics, while others believe that it is due to the nature of how one pronates or supinates at ball release and how much shear force they're applying right before the fingers come off of the baseball (Kinoshita, 2017). On the other hand, it has been confirmed that spin rate is linearly related to velocity, therefore one way to increase spin rate is by increasing velocity (O'Connell, 2016).

It has also been hypothesized that the lengths of the hand and fingers covering the baseball can have an effect on how a pitcher is able to apply force on the baseball. However, there is currently a lack of credible research in the public sphere testing the theories regarding the effects of grip, finger strength, and finger length on a baseball pitch's spin rate.

Within the unique training environment at Driveline Baseball (Kent, Washington, USA) where pitchers from all levels often throw on ball-tracking technology, this study was designed to collect grip and finger strength evaluations plus hand and finger measurements and use them to observe the effects of these qualities on spin rate and velocity measured. We hypothesized that having more grip and finger strength would result in higher spin rates, when controlling for pitch velocity.

Methods

Participant requirements

A total of 59 healthy pitchers with High School, College, or Professional-Level Experience volunteered to participate in this study. Of these subjects, forty-nine were right-handed pitchers and ten were left-handed pitchers.

Prior to participating, subjects were provided a verbal explanation of the study and were asked to read and sign an Informed Consent document that detailed all of the risks associated with taking part in the study.

The Informed Consent Documents were approved by Hummingbird IRB, who granted approval to carry out the study at the author's facilities: Hummingbird IRB #: 2019-11, Protocol (01-23-2019) Version 1.0.

Once subject approval was obtained, biographical information such as height, weight, and age were recorded. All athletes were also required to have medical clearance and approval from a certified athletic trainer before throwing. Any athlete that could not perform a bullpen at 100% RPE (Rating of Perceived Exertion) was excluded from participating.

Warm-up protocols

Subjects were given as much time as necessary to prepare to throw off of a mound at maximum exertion. Once ready, the investigator asked subjects to fulfill the grip and pinch strength portion of the study before starting their bullpen.

The instrument used to measure grip strength was a Baseline Hydraulic Hand Dynamometer with a Standard 200 lbs. Capacity, while the instrument used to measure pinch strength was a Baseline HiRes Pinch Gauge with a 50 lbs. Capacity. All measurements were executed on a one-to-one basis.

At the investigator's mark, subjects were asked to squeeze the instrument provided at 75% RPE for three seconds as a trial run before performing two more tests at 100% RPE that were recorded for analysis.

Once the readings were recorded, subjects were then asked to proceed to their bullpen session.

Bullpen session

Subjects performed their bullpen session on a standard rubber mound that was regulation size and 60'6" from home plate. To measure desired ball flight metrics such as spin rate and velocity, a Rapsodo 2.0 unit (Rapsodo, Inc., Chesterfield, MO, USA) was set up before the start of each subject's bullpen.

During the bullpen session, subjects threw regulation-sized baseballs without any added substances on their fingers, hand, or glove (mud, resin, pine tar, etc.) Each session started with subjects throwing their primary fastball (four-seam fastball or sinker) before progressing to their off-speed (changeup, splitter, and/or palmball) and breaking ball pitches (slider, curveball, and/or cutter). In total, each subject threw about fifteen to thirty-five pitches, with a minimum of three pitches recorded for each pitch type grouping.

Hand and finger measurements

After completing their bullpen, subjects were asked to place their throwing hand flat on a nearby table. With loose measuring tape, the investigator then measured and recorded each subject's finger length, defined as the distance

from the beginning of the proximal phalanx of the finger to the end of the distal phalanx.

In the same position, the investigator then measured each subject's hand length by placing measuring tape from wrist crease to the end of the distal phalanx of the middle finger.

After measuring hand length, the instructor then measured each subject's hand circumference by wrapping measuring tape around each subject's hand, starting and ending at the middle of the palm. Upon completion, subjects were free to perform recovery exercises as they deemed necessary.

Statistical Analysis

Of the 59 total participants, eight were excluded from the analysis due to a loss of Rapsodo data or failure to comply with all of the necessary instructions. Of the 51 remaining participants, Rapsodo data was grouped by pitch type classification and paired with each subject's coinciding anatomical and strength measurements.

Means and standard deviations were calculated for each measure. SVR or Spin-Velo Ratio, was also calculated to control for the collinearity between spin and velocity itself.

Using Pearson's product moment of correlation coefficient, the linear relationships between pitch-level metrics (Velocity, Spin Rate, and SVR) and anatomical hand-measurements (Finger Strength, Finger Length, Grip Strength, and Hand Length) were assessed. A Holm-Bonferroni correction was also applied to control for familywise error rates.

Results

Table 1: Biographical Information.

Number of Subjects	Age (Years)	Height (Inches)	Weight (Pounds)
51	19.4 ± 3.7 yrs	72.3 ± 2.9 in	183.8 ± 25.6 lbs

Table 2: Averages of Grip Strength and Pinch Strength trials, Hand and Finger Measurements.

Measurement	Mean & Standard Deviation
Grip Strength (lbs)	86 ± 21.9
Index Finger Pinch Strength (lbs)	18.2 ± 4.4
Middle Finger Pinch Strength (lbs)	16.3 ± 3.8
Hand Width (cm)	22.4 ± 1.5
Hand Length (cm)	19.6 ± 0.9
Hand Circumference (cm)	22.6 ± 1.4
Thumb Length (cm)	6.7 ± 0.7
Index Length (cm)	7.4 ± 0.5
Middle Length (cm)	8.3 ± 0.5
Ring Length (cm)	7.6 ± 0.4
Pinky Length (cm)	6.1 ± 0.6

Table 3: Averages of Rapsodo metrics for each Pitch Type.

Group	Four-Seam Fastballs	Sinkers	Cutters	Sliders	Curveballs	Changeups	Splitters	Palmballs
Sample Size	49	14	5	27	36	44	6	1
Velocity (mph)	80.7 ± 5.7	79.3 ± 7.1	75.7 ± 10.5	70.8 ± 6.4	65.8 ± 6.7	72.4 ± 5.7	75.3 ± 4.8	75.7
Spin Rate (rpm)	1994.4 ± 187.1	1902.8 ± 214.1	1969.4 ± 310.9	1979.6 ± 282.8	1907.4 ± 374.5	1613.0 ± 277.9	963.1 ± 372.3	604.5
SVR (mph/rpm)	24.7 ± 1.7	24.0 ± 2.0	26.0 ± 2.3	28.0 ± 3.3	29.1 ± 5.6	22.3 ± 3.2	12.6 ± 4.5	7.9

Table 4: Averages of Rapsodo Metrics for each Pitch Group (Fastballs, Breaking Balls, Off-Speed Pitches).

Group	Fastballs	Breaking Balls	Off-Speed Pitches
Sample Size	63	68	51
Velocity (mph)	80.4 ± 6.0	68.6 ± 7.5	72.8 ± 5.6
Spin Rate (rpm)	1974.1 ± 195.4	1940.6 ± 333.7	1516.8 ± 376.6
SVR (mph/rpm)	24.6 ± 1.8	28.4 ± 4.7	20.9 ± 4.9

P-values, correlations, and Holm-Bonferroni Alpha for relationships between Rapsodo metrics and Grip/Finger Strength, Hand/Finger Measurements.

Table 5: Fastballs & Spin Rate

Group	R	P-Value	Adjusted Alpha Levels
Grip Strength	0.45	**0.0002*****	0.0045
Index Finger Pinch Strength	0.34	0.006**	0.0050
Index Length	0.32	0.011*	0.0056
Middle Finger Pinch Strength	0.25	0.05*	0.0063
Thumb Length	0.23	0.07	0.0071
Hand Circumference	0.09	0.49	0.0083
Middle Length	0.09	0.51	0.0100
Ring Length	0.08	0.53	0.0125
Hand Width	0.07	0.58	0.0167
Hand Length	0.07	0.59	0.0250
Pinky Length	0.06	0.65	0.0500

Table 6: Breaking Balls & Spin Rate

Group	R	P-Value	Adjusted Alpha Levels
Thumb Length	0.37	**0.0022****	0.0045
Index Length	0.28	**0.02***	0.0050
Grip Strength	0.25	**0.04***	0.0056
Index Finger Pinch Strength	0.18	0.15	0.0063
Hand Circumference	0.18	0.15	0.0071
Hand Length	0.17	0.16	0.0083
Ring Length	0.16	0.19	0.0100
Middle Length	0.14	0.26	0.0125
Pinky Length	0.14	0.27	0.0167
Hand Width	0.13	0.28	0.0250
Middle Finger Pinch Strength	0.09	0.47	0.0500

Table 7: Off-Speed Pitches & Spin Rate

Group	R	P-Value	Adjusted Alpha Levels
Hand Circumference	-0.25	0.07	0.0045
Index Finger Pinch Strength	-0.16	0.26	0.0050
Hand Width	-0.1	0.48	0.0056
Index Length	-0.1	0.50	0.0063
Ring Length	-0.07	0.62	0.0071
Grip Strength	-0.06	0.69	0.0083
Middle Finger Pinch Strength	0.05	0.73	0.0100
Thumb Length	0.03	0.83	0.0125
Middle Length	0.03	0.86	0.0167
Hand Length	0.01	0.92	0.0250
Pinky Length	-0.0008	1	0.0500

Table 8: Spin-to-Velocity Ratio & Fastballs

Group	R	P-Value	Adjusted Alpha Levels
Hand Circumference	-0.15	0.23	0.0045
Pinky Length	-0.14	0.26	0.005
Index Finger Pinch Strength	0.12	0.37	0.0056
Index Length	0.09	0.49	0.0063
Hand Width	-0.01	0.65	0.0071
Thumb Length	0.05	0.69	0.0083
Ring Length	-0.05	0.71	0.01
Middle Finger Pinch Strength	0.03	0.83	0.0125
Grip Strength	-0.01	0.92	0.0167
Middle Length	-0.01	0.92	0.025
Hand Length	-0.06	0.96	0.05

Table 9: Spin-to-Velocity Ratio & Breaking Balls.

Group	R	P-Value	Adjusted Alpha Levels
Thumb Length	0.21	0.09	0.0045
Grip Strength	-0.15	0.22	0.005
Index Finger Pinch Strength	-0.09	0.48	0.0056
Middle Finger Pinch Strength	-0.07	0.55	0.0063
Middle Length	-0.07	0.57	0.0071
Hand Length	0.05	0.66	0.0083
Pinky Length	-0.05	0.7	0.01
Hand Width	-0.04	0.73	0.0125
Ring Length	-0.04	0.76	0.0167
Index Length	-0.02	0.87	0.025
Hand Circumference	-0.08	0.98	0.05

Table 10: Spin-to-Velocity Ratio & Off-Speed Pitches

Group	R	P-Value	Adjusted Alpha Levels
Hand Circumference	-0.34	**0.02***	0.0045
Index Finger Pinch Strength	-0.25	0.08	0.005
Grip Strength	-0.23	0.1	0.0056
Index Length	-0.22	0.12	0.0063
Hand Width	-0.16	0.26	0.0071
Ring Length	-0.16	0.26	0.0083
Hand Length	-0.09	0.55	0.01
Pinky Length	-0.06	0.67	0.0125
Middle Finger Pinch Strength	-0.05	0.72	0.0167
Thumb Length	-0.05	0.75	0.025
Middle Length	-0.02	0.9	0.05

Table 11: Velocity & Fastballs.

Group	R	P-Value	Adjusted Alpha Levels
Grip Strength	0.60	**< 0.0001******	0.0045
Index Finger Pinch Strength	0.33	0.01*	0.0050
Middle Finger Pinch Strength	0.31	0.01*	0.0056
Index Length	0.34	0.01*	0.0063
Hand Circumference	0.27	0.03*	0.0071
Thumb Length	0.25	0.05*	0.0083
Pinky Length	0.22	0.08	0.0100
Ring Length	0.16	0.21	0.0125
Hand Length	0.15	0.25	0.0167
Middle Length	0.13	0.32	0.0250
Hand Width	0.11	0.37	0.0500

Table 12: Velocity & Breaking Balls.

Group	R	P-Value	Adjusted Alpha Levels
Grip Strength	0.57	**0.0001*****	0.0045
Index Length	0.40	**0.0009*****	0.0050
Index Finger Pinch Strength	0.35	**0.0035****	0.0056
Hand Circumference	0.29	0.02*	0.0063
Thumb Length	0.26	0.03*	0.0071
Middle Finger Pinch Strength	0.24	0.05*	0.0083
Hand Length	0.22	0.08	0.0100
Middle Length	0.21	0.09	0.0125
Pinky Length	0.21	0.09	0.0167
Hand Width	0.14	0.25	0.0250
Ring Length	0.13	0.29	0.0500

Table 13: Velocity & Off-Speed Pitches.

Group	R	P-Value	Adjusted Alpha Levels
Grip Strength	0.54	**< 0.0001****	0.0045
Index Length	0.34	0.01**	0.005
Middle Finger Pinch Strength	0.31	0.03*	0.0056
Hand Circumference	0.30	0.04*	0.0063
Index Finger Pinch Strength	0.27	0.05*	0.0071
Hand Length	0.28	0.05*	0.0083
Thumb Length	0.22	0.12	0.01
Ring Length	0.22	0.13	0.0125
Hand Width	0.16	0.26	0.0167
Pinky Length	0.15	0.28	0.025
Middle Length	0.09	0.53	0.0500

* denotes p ≤ 0.05

** denotes p ≤ 0.01

*** denotes p ≤ 0.001

**** denotes p ≤ 0.0001

Adjusted Alpha Levels calculated via Holm-Bonferroni correction method for each Pitch Type Group (α / n). Only p-values under the adjusted alpha level were bolded.

Discussion

For the sixty-three fastballs thrown (49 fastballs; 14 sinkers), grip strength shared the strongest relationship with Rapsodo total spin rate ($r = 0.45$; $p < 0.001$). However, the correlation between grip strength and Spin to Velocity Ratio, a more reliable measure when comparing spin rates across different velocity ranges, was weak and insignificant ($r = -0.01$, $p = 0.92$). Therefore, it is likely that the relationship between grip strength and spin rate is almost entirely explained by grip strength's relationship with velocity, rather than spin rate itself.

Both index finger pinch strength ($r = 0.34$, $p = 0.0056$) and middle finger pinch strength held moderate and statistically significant correlations to Rapsodo total spin rate. However, we again find that the relationships between pinch strength for both fingers and Spin-to-Velocity Ratio were also insignificant (Index: $r = 0.12$, $p = 0.37$, Middle: $r = 0.03$, $p = 0.83$). A common coaching cue for throwing fastballs is to “rip down on the seams”, therefore encouraging the ability to apply more pressure from the index and middle fingers to potentially increase spin rate. However, given the results, this cue may not be effective to the throwing population in general if taken literally in practice.

Index finger length had the only considerable and significant relationship to Rapsodo total spin rate ($r = 0.32$, $p = 0.011$) among fastballs. This may in part be because longer fingers can allow the thrower to add space between the baseball and their palm and apply most of the pressure on the pad of the finger, possibly essential to the coaching cue mentioned above. Finger length could be a predictor for height which is typically a determinant for fastball velocity and, consequently, more spin. Unfortunately, when controlling for velocity, the relationships between spin rate and index finger length for all pitch groups are not statistically significant.

There were sixty-eight breaking balls thrown by the subjects (36 curveballs, 27 sliders, 5 cutters). Before filtering for pitches > 1000 rpms of spin, grip

strength (r = 0.25, p = 0.038), index finger length (r = 0.28, p = 0.023), and thumb length (r = 0.37, p = 0.0022) had firm and significant correlations to total spin. As was the case for the fastballs, these variables did not hold significant relationships against Spin to Velocity Ratio. These findings go against the common pitch design cue of putting an emphasis on middle finger pressure in developing effective breaking balls.

In the study, there were fifty-one off-speed pitches (44 changeups, 6 splitters, 1 palm ball. Off-speed pitches are not intended to be thrown with more spin; therefore, results are less relevant to the main objectives of the study. The only statistically significant relationship was shared between hand circumference and Spin to Velocity Ratio (r = -0.34, p = 0.02).

Some studies have examined the effect of rosin powder application on the sliding friction interaction between the finger pad and a baseball leather sheet, ultimately finding that it stabilizes friction under both wet and dry conditions and may be able to increase shear force applied to the ball during ball release. However, the study had an enormous limitation –the subjects were not actually going through the motion of pitching in order to properly record and compare their baseball velocities and spin rates (Yamaguchi et.al, 2020). An extensive study on the forces applied by individual fingers (thumb, index, middle, ring) on the baseball appear to show that high velocity fastballs demand exertion of near maximal finger forces and shear force peaks of the index and middle fingers occurred at nearly the same time with total amplitudes exceeding 100 Newtons (Kinoshita, 2017). Other studies have tried to confirm whether finger joints flex before or after the instant of ball release and quantify the force applied to the baseball (Matsuo, 2017).

Limitations

The majority of the subjects were amateur baseball players at the high school and early collegiate level. Hence there was a dearth of elite professional talent among the data collected.

Subjects from the first iteration of the study did not provide insight on how tight they gripped or squeezed the baseball for each pitch type in their repertoire. Those from the second iteration were asked “On a scale from one

to three, how do you grip the ball? One being loose. Two being moderate. Three being firm." to control for each individual leveraging their grip strength. Throwers differ in how hard they grip their pitches. The majority of subjects expressed that they held their fastballs and breaking balls with a moderate to a firm grip while offspeed pitches such as changeups were typically thrown with a loose grip. This poses a limitation for the study since it is difficult to determine whether possessing greater grip or finger strength is effective in creating more spin when subjects are more than likely not utilizing their full potential in gripping the baseball for most pitches thrown.

Table 14: Firmness of Grips

Pitch Type	Loose	Moderate	Firm
Four-Seam	7	27	7
Sinker	0	0	4
Curveball	4	18	12
Slider	2	7	8
Cutter	0	1	0
Changeup	25	6	7
Splitter	0	1	1

Another probable confounding variable is the type of grips used. The subjects used a variety of grips for each pitch type leading to a broad range of ball movement profiles especially for breaking balls. For breaking balls, subjects displayed various ways to have the index finger on or off the baseball which could basically eliminate the influence their length and strength have on producing spin rate. One way to potentially reduce the influence of different grips is to set a standard grip for each pitch type in a future study.

Conclusion

The purpose of this study was to observe the effects of grip and finger strength and hand and finger measurements on generating spin rate on a pitched baseball. Subjects were evaluated using dynamometers, measuring tape, and tracking technology to collect the necessary data. The results show that a few relevant measurements including grip strength, index finger strength, and index finger length share significant relationships with spin rate; however, when spin rate is normalized for velocity (Spin-to-Velocity Ratio) none of these measurements had a statistically significant effect on creating more spin. For future studies, researchers may have subjects throw pitches using the same grips and/or focus on the pitch types that typically require more spin to be effective.

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