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Effects of Various Anthropometric Measurements on Fastball Velocity in Professional Relief Pitchers

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MLB HEIGHT, WEIGHT, AND FASTBALL VELOCITY CORRELATIONS

Effects of Various Anthropometric Measurements on Fastball Velocity of Professional Relief Pitchers

A THESIS

APPROVED FOR THE DEPARTMENT OF KINESIOLOGY AND HEALTH STUDIES

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Abstract

This research study was conducted to compare the height and weights of Major League Baseball (MLB) relief pitchers to their average fastball velocity during the 2007 season. The purpose was to find what correlations may exist between each independent variableand the dependent variable. In essence, how well does height and weight predict average fastball velocity? The participants included qualifying MLB relief pitchers that finished in the top seventy-five of average fastball velocity. Data was collected from Baseball Info Solutions regarding height, weight, and fastball velocity and placed into IBM's SPSS statistical analysis software. The statistical technique used to analyze the data was multiple regression with a set wise progression. The overall model displayed no significant correlation (r value; 0.131, p value; .535) and also showed that the independent variables accounted for only 1.7% of the dependent variable's value (R^2 = .017). The mean average fastball velocity was 93.256 mph while average heights and weights of the players were, 189.68cm, and 97.35kg, respectively. Results showed that there was no significant correlation between fastball velocity and weight (r value;0.132) or height (r value; 0.380). While there were no significant correlations found in the general anthropometric measurements used there may be other predictors present that can better account for average fastball velocity. Future research is needed to find these predictors and what affect they have on the ability to throw with a high velocity.

Chapter One – Introduction

The modern age of baseball has seen a huge influx in variation of statistical interpretations, many of which are now used as predictions for specific outcomes. Many of these statistics are based on performance while some are based on different biomechanical aspects of techniques used to achieve certain goals, such as throwing a baseball. One of the most important positions being studied is that of the pitcher. This importance is because he starts every play of a game and is the only player on the field that has the ability to singlehandedly stop an opponent's offense.

The aspects that make up a successful pitcher can stretch over a multitude of different variables and can be argued differently by numerous researchers and sabermetricians. One attribute of many successful pitchers is that of pitch velocity, especially in the case of the fastball. The fastball is a pitch that can be gripped with a couple of variations but, for the most part, is characterized by a lack of horizontal and vertical movement and a faster velocity in comparison with other pitches.

Pitchers that throw with a greater velocity have been shown to have longer career duration when compared to pitchers of the same caliber that throw with less velocity, even though they are more susceptible to injury (Bushnell et al., 2010). Urbin et. al (2013) stated that a risk of injury at the shoulder and elbow joints would be reduced only by decreasing pitch velocity. This substantiates the importance velocity has on success at a higher level, that even though throwing velocity comes with a high risk of injury.

The quest for taller and heavier players has led to an increase in both average height and weight in players since 1869 (Onge et al., 2008). Onge's et al. stated that although diagnosing height and weight data, "...we specifically excluded pitchers because they are likely to be selected on pitching speed; arm length is directly correlated with height and is a significant predictor of pitching speed..."

(Onge et al., 2008, p. 483). The fact that previous researchers deemed this group as an outlier due to abnormal height being an important characteristic of the pitching position shows the importance that has been placed on the variable by Major League Baseball teams.

Significance of the Study

Since there is evidence that pitchers that throw with a faster velocity have a longer professional career than their slower throwing counterparts (Bushnell et al., 2010; Fleisig et al., 1999), then it would be beneficial for teams to constantly scout and draft players that are capable of doing this. The purpose of this study is to determine what characteristics correlate with or predict throwing velocity, specifically in the case of general anthropometric measurements.

Statement of the Problem

There is a lack of research on anthropometric measurements as predictor variables for Major League Baseball (MLB) relief pitcher's fastball velocities. With a greater understanding of factors that contribute to the velocity of a fastball, MLB scouts can better predict the possible velocity that can be obtained by a certain pitcher.

Hypothesis

There will be a significant relationship between height and average fastball velocity as well as weight and average fastball velocity.Therefore, MLB relief pitchers that are taller and heavier will have a higher average fastball velocity.

Limitations

The study, although aimed to be as accurate as possible, has some possible limitations. The first limitation is that the heights and weights of the players recorded by the *Bill James Handbook* are measured to the closest inch so there may have been certain errors related to this fact. Second, different pitchers have different throwing techniques and arm angles that may have an effect on fastball velocity.

Delimitations

The delimitations of the study include that the participants must (a) be a professional MLB pitcher, (b) be a qualifying reliever in terms stated previously by the MLB, and (c) rank in the top seventy-five in average fastball velocity in 2007, as recorded by Baseball Info Solutions.

Assumptions

The study assumes that a higher average fastball velocity is vital in a relief pitchers success in the game of baseball. Also the author assumes that the data provided by Baseball Info Solutions is accurate and truthful.

Definition of Terms

Angular velocity – the velocity of a radius rotated around a specified axis.

Linear velocity – the velocity of an object in respect to distance covered and direction of motion.

Major League Baseball (MLB) – is the top professional baseball league in North America.

Relief Pitcher – any pitcher that replaces another in a baseball game.

Sabermetrics – the analysis of baseball statistics, especially in order to evaluate performance of individual players.

Momentum – the amount of mass an object has multiplied by its velocity ($p = m \bullet v$).

Conservation of Momentum – the initial momentum of an object will not change unless it is acted upon by an external force.

Chapter Two - Review of Literature

The throwing motion is very complex and consists of many different intricate movements. These movements can be affected by various things strength of the athlete, range of motion of both the shoulder and elbow, injuries sustained by the athlete, and technique. The throwing motion also lends itself to be broken down by different laws of physics including the conservation of momentum and can be analyzed using both linear velocity and angular velocity. To understand exactly how height and weight may affect velocity all of these variables must be examined.

Throwing Stages

In order to complete the pitching motion a pitcher must go through three different phases of throwing: cocking, acceleration, and follow-through (Pappas et al., 1985). The first phase of the pitch is started by the windup and is completed when the pitcher's shoulder has reached its maximum external rotation. The acceleration phase is then started with the shoulder at maximum external rotation and is completed when the ball is released. This middle stage is the most important in terms of creating and sustaining velocity (Murray et al., 2001). The final stage, known as the follow-through, is completed when the throwing motion is completely stopped and is characterized by the deceleration of the arm (Pappas et al., 1985).

Papas et al. (1985) reported that during the acceleration phase of the throwing motion "-lasting approximately 50 ms, peak angular velocities were measured averaging 6,180 and 4,595 deg/sec for shoulder internal rotation and elbow extension respectively" (Pappas et al., 1985, p.216) the angular velocities of the internal rotation of the shoulder and elbow extension are directly related to the linear velocity that can be placed on the ball. This relationship is represented as follows: linear velocity (v) is equal to the angular velocity (ω), measured in radians per second, multiplied by the radius (r) of the lever arm, or $v=r\omega$. This means that the longer the radius, if kept at constant angular velocity, will result in a faster linear velocity. Therefore Fleisig et al. reported that "the combination of more arm angular velocity and longer arm segments resulted in greater linear ball velocity for the adult pitcher" (Fleisig et al., 1999, p.1374). Since total arm length has been shown to have a high correlation to height (r=0.68), the latter characteristic that is influential for producing linear velocity, in theory, can be directly related to the height of the pitcher based on proportionality (Mitchell & Lipschitz, 1982).

Physics and Velocity

Strength training procedures, especially those that emphasize ballistic training, have been shown to increase the velocity of overhead throwers (DeRenne, 1994; Van den Tillaar, 2013). Multiple studies have also shown that the velocity increase is also accompanied by an elevated mass of the participant (Carvajal, 2009; Hoffman, 2009; Werner, 2008; Escamilla, 2007; Lehman, 2013). This increase in mass might be related to the increase in velocity through a concept known as the conservation of momentum.

In physics the laws of conservation of momentum ($m_1v_{f1} – m_1v_{i1} = m_2v_{f2} – m_2v_{i2}$) states that momentum can be transferred from one object to another without any loss in momentum. Since momentum is mass multiplied by velocity, an athlete with greater mass can transfer greater momentum to a low inertia object, such as a baseball, creating a substantial increase in velocity. In principle, the greater the mass driven into the ball, the greater the momentum transferred to the ball. Since the ball does not change in mass, this greater momentum is manifested in a greater velocity. Van den Tillaar and Ettema (2004) found that substituting a baseball of normal specifications with one of greater mass showed correlation with decreased ball velocity (r=.098). It therefore can be theorized that a lever of greater mass acting upon a baseball of normal proportions will result in an increased velocity.

Anthropometric measurements have been found to influence ball velocity in female handball players as well (Zapartidis et al., 2009). Researchers found that the velocity of a standing throw from female handball players were highly correlated with height and weight, with p-values =0.001 and

<0.001 respectively.

In male handball players researchers found that the positions, excluding goalies, which had a greater height also had a greater ball velocity (Zapartidis et al., 2011). The p-values of height, weight and hand length to ball velocity came to 0.001, 0.418, and 0.223 respectively. After analysis it can be seen that although there was a higher velocity found in athletes with larger weight and hand length the only significant anthropometric predictor of ball velocity was height (Zapartidis et al., 2011). This was supported when researchers found that general anthropometric variables such as height and body mass correlated highly with ball velocity (Debanne & Laffaye, 2011).

In a similar study that used amateur and elite handball players and measure throwing velocity, researchers found that not only was the average throwing velocity higher in elite players but their body mass and lean mass were as well (Gorostiaga et al., 2005). These researchers also found that while body mass variables were significantly higher, on average 13.2kg, there was not a significant difference in body height.

Factors Influencing Velocity

In pitching, especially at the professional level, there are many factors other than the length of a lever arm that may have an effect on the final velocity. While some factors cannot be measured qualitatively, such as psychological stability, there are many other variables that can and have been measured in comparison to velocity. These variables include: strength, injuries, power, and range of motion of the throwing shoulder.

During the act of throwing a baseball there are many different torques that are placed on a player’s body. The largest torques are seen in the individual’s elbow and shoulder, which also have shown to have a high correlation with increased fastball velocity (Stodden et al., 2005). These torques placed on the joints are key factors that help determine how much velocity can be put into a pitch and how likely the player is to injure his/her throwing elbow (Anz et al., 2010).

Murray et al., (2001) reported that a lack in range of motion (ROM) of the throwing shoulder, especially maximal external rotation, showed a decrease in pitch velocity. Mechanical flaws, such as different positioning of the lead foot or a shortened stride, have been shown to be associated with decreased velocity of the fastball (Fortenbaugh et al., 2009). Stodden et al., (2001) also showed that trunk orientation of a pitcher has an effect on final velocity of the fastball. Throwing technique, although important, may be theorized to be null in most cases because players at this level have been instructed and analyzed by what can be considered the best coaches in the game to perfect their skill.

According to Lin et al., (2003), the technique of pitching a baseball is a motion that starts with movement from the lower body then transfers the force through the core then finally into the upper arm. This force that starts in the lower body relates to the generation of momentum. With greater muscle mass comes greater force to accelerate. Additionally, with greater mass comes greater momentum to transfer to the ball. This increased force, if paired with adequate shoulder and elbow flexibility, would also lead to an increased external rotation of the upper arm due to an increased torque put on the joints of the upper arm. The increased torques on the joints were found by Fleisig et al. (1999) to be the largest biomechanical differences in pitchers between levels.

Chapter Three - Methodology

Data was collected using a database that has already been established by Baseball Info Solutions. This company is used by various major league teams as well as MLB scouts and agents. Baseball Info Solutions has their own hired video scouts analyze video from each MLB game and track various statistics such as pitch velocity, pitch type, and pitch location as well as many other traditional statistics. This data is made publicly available at www.fangraphs.com by Baseball Info Solutions and statistical data for MLB players. Furthermore, this database has been deemed “public domain” by the

United States Supreme Court, so that public use is permitted (C.B.C, 2006).

Participants

The data used was derived from MLB relief pitchers from the 2007 season. The author believes that five years of audits is sufficient to ensure the accuracy needed for a successful research study.

Instrumentation

The players' fastball velocity was taken from the Baseball Info Solutions data that is displayed publicly on www.fangraphs.com and their heights and weights were collected from the *Bill James Handbook 2008.* This handbook has been published annually since 2003; however, James has been publishing statistical abstracts since 1977. Bill James is currently the Senior Baseball Operations Advisory for the Boston Red Sox and part of the Baseball Info Solutions team. The reason for using the 2008 version is that this version was published November, 2007 and more likely reflects the players' actual playing weight during the current season than the previous version.

Procedures

Each player's average fastball velocity was placed into a spreadsheet along with their height and weight. After the height and weight of each player was entered each player was be randomly assigned a number so that they cannot be individually identified. This data was then entered into SPSS for statistical analysis.

Statistical Analysis

The data collected was analyzed throughSPSS version 20.0 statistics program. The data collected consisted of the height and weight of each qualifying MLB relief pitcher as well as their average fastball velocity during the 2007 season. These variables were put through a multiple regression to find the correlation between each independent variable (height, weight) as a predictor of the dependent variable (average fastball velocity). To reduce the chance of having a type I error, the alpha (α) level of significance were set at 0.05.

Multiple regression analysis was used due to the nature of the problem stated. In a multiple regression the results are able to show not only if the independent variables significantly account forthe variance in the dependent variable but also which of the independent variables accounts for the largest proportion of the variance.

The process used to run a multiple regression of the data through SPSS wasdone by using the following steps:

1. The Analyze dropdown menu was selected, then the regression option was selected under this menu.
2. Under the regression option, linear was selected.
3. After selecting the linear regression option, Average Velocity was inputted as the dependent variable. Height and weight were inputted as the independent variables.
4. The method used to run the progression was the ENTER method. This method allows all the independent variables to be run through a progression. This is also the default method setting of SPSS.
5. Under the Statistics option the Model fit, R-squared change, Descriptives, and the Part and partial correlations options were selected.
6. Under the Plots option, ZRESID was placed in Y: and ZPRED was placed in Z:. The Histogram option was then selected.

To reduce the chance of error between pitchers that throw from arm angles that hinder velocity, such as sidearm or submarine, only data from the seventy-five qualifying relievers with top average velocity were used. This also helped eliminate relievers that rely highly on deception or horizontal ball movement instead of velocity to be successful.

Chapter Four - Results

Descriptive Data

The results showed that the 75 relief pitchers had a mean height of 189.68cm as well as a mean weight of 97.35kg with a standard deviation of 4.83cm and 10.90kg respectively. The mean fastball velocity was 93.25mph with a standard deviation of only 1.21mph.

Correlational Data

After analyzing the 75 relief pitchers the results indicated that there was no correlation between height and velocity of a fastball as well as weight and fastball velocity of MLB relief pitchers. As Figure 1 and Figure 2 show there are no patterns that can be distinguished between either height or weight and the dependent variable.The overall model was not significant $F(2,72)=.631$; $p = .535$. Statistical analysis showed unstandardized Beta weights of -.003; $t = .921$ and .015; $t = .284$ respectively (Table 1). The results of the model summary showed that the $R^2 = 0.017$, so that the independent variables only accounted for 1.7% variance shown by the dependent variable.

Pearson correlations of height and weight as compared to fastball velocity were $r = .036$ and $r = .131$ respectively, thus showing little correlation. The p-values were shown to be .380 and .132 respectively (Table 2).Since these values are above 0.05 then I failed to reject the null hypothesis. These show that no significant correlation could be found between the independent variables and the dependent variable.

Results of Hypothesis

The findings lead me to reject the alternative hypothesis that "MLB relief pitchers that are both taller and heavier will have a higher average fastball velocity".

Chapter Five - Discussion

Summary of Findings

After the data was analyzed it was clear that there was no correlation between the dependent variable and the independent variables. The values that were found after the analysis showed that the lack of correlation was so small with $R^2 = .017$, that it can almost be theorized that height and weight have no influence on the average fastball velocity of major league relief pitchers.

Interpretation of Results

Descriptive data shown in Table 1 shows that MLB relief pitchers are above the norm in both height and weight as compared to the United States population (McDowell et al., 2008). These increased heights and weights across the entire population tested may be the reason that no correlation was found between the variables. It may be that pitchers of smaller size and lower weight that could show a correlation have been eliminated at a lower level due to a lack of ability to throw with a consistent high velocity however, this cannot fully account for the lack of correlations found.

Relationship of Results to Literature

The results of the study showed a lack of significance between height and weight and the average fastball velocity. This may be due to the vast amount of variables that can affect a pitcher's ability to throw with a high and sustained velocity. Fleisig et al. (1999) showed that although a longer arm did show some significance in fastball velocity the most significant difference between college and professional pitchers was that of maximum pelvis velocity. The authors found that this increase in velocity was only obtained by longer armed pitchers if there was a subsequent increase in angular velocity of the arm (Fleisig et al., 1999). The lack of significance found in height could be related to a decrease in the ability to keep up a sufficient amount of angular velocity in the throwing arm potentially due to the probable increase in rotational inertia.

The lack of significance of height may be due to its lack of correlation to shoulder strength (Hurd et al., 2011). Height and forearm length were shown to be less effective in predictingthe amount of variability that was found when researchers tried to develop an anthropometric strategy to measure muscle force of uninjured baseball players. Weight was a better variable in predicting muscular force variability (Hurd et al., 2011). Since weight has been shown to be a better predictor of the amount of muscle force able to be produced by a pitcher it is consistent with the findings of this study.

The ability to produce maximal force in the shoulder joint was shown to be the key factor of spike velocity in men’s volleyball, a similar motion to the arm of a pitcher (Forthomme et al., 2005). Spike velocity also positively correlatedwith BMI, $r = 0.040$. In another sport that included an overhead motion similar to throwing a baseball, tennis, researchers found that an increased serve velocity was directly related to the flexibility and strength of the shoulder (Cohen et al., 1994). These studies, although completed with sports other that baseball, give insight to the fact that velocity of the shoulder may be due more to strength and flexibility than the height and weight of the athlete.

Much of the power that is related to throwing a ball with a high velocity comes from the lower body and torso in relation to the force that can be produced in the transverse plane (Fleiseg et al., 1999). In another transverse motion, swinging a baseball bat, the highest velocity changes were most correlated to the rotational torso strength produced by the athlete (Syzmanski et al., 2010). Total upper body strength has also been shown to be correlated to a higher throwing velocity (Lachowetz, 1998; Tillaar, 2013). These add more variables that relate to strength and power and have been found to have a significant correlation to the ability to create transverse power and throwing velocity.

Other variables that might be influential could be that of correct pitching mechanics, specifically those that could lead to better stride length, elbow flexion, and maximal shoulder external rotation (Guo et al., 2010). Guo et al. (2010), found that a major part of the difference in ball velocity between amateur and professional baseball players was due to mechanical differences that existed.

Although the pitchers that were used as participants in this study were elite-caliber Major League relievers, does not mean that they all demonstrated pitching mechanics that were most advantageous to increase ball velocity in terms of their body makeup. It could be theorized that if every pitcher consistently practiced mechanics that could produce maximal velocity for his body type then those with a bigger frame would have higher velocity. Unfortunately the variability of pitching mechanics between the participants used may vary too much to account for in simple anthropometric testing.

Another variable that might have beensignificant is the type of fastball that the pitchers in this study throw consistently. Although fastballs are a pitch with a much higher average velocity in comparison to pitches such as curveballs, change ups, and other off-speed variations they are not always the same. An object with a higher lift coefficient can be thrown with more velocity due to its increased aerodynamic characteristics and it has been proven that a four-seam fastball has a lift coefficient of three times that of a two-seam fastball (Alaways & Hubbard, 2010). Depending on which pitch is primarily thrown it may affect the outcome of the data presented.

What is consistent in the current study is the above-average size of the population. Onge et al. (2008) found that from 1869-1983 the average height and weight of MLB players has significantly increased and are far above those of the normal U.S. Population. Although theaforementioned study does not exclusively involve pitchers, it helps to illustrate the larger size of men that play in the MLB in comparison to the United States norm and confirms that pitchers may be seen as outliers due to excessive height. Cuban elite baseball players were also found to have above average heights and weights, with more successful pitchers having a more muscular body type than less successful pitchers (Carvajal et al., 2009).

Application of Results

The lack of correlation between the variables gives insight into just what makes a pitcher throw with a velocity that could be considered elite. These results indicate that contrary to what may have been previously thought, a pitcher's height and weight have no significant bearing on the velocity that the athlete can throw a fastball. These results also show that while there is an emphasis by professional scouts on the size of players it may not be correlated with their potential to throw with high velocities.

Recommendations for Future Study

Although there were no significant correlations between the independent and dependent variables that were used in this study it does not mean that there are not correlations related to different arm and leg length measurements. This study was completed using the simplest variables that could be measured. Specific measurements such as lower and upper arm, or upper and lower leg could show correlations that were missed by this study.

The fact that so many different variables make-up the pitching mechanics may be a problem when trying to measure what has the largest effect on the velocity that can be obtained by a fastball. It may be more appropriate to test different power parameters that are produced on the joints used in the motion than to measure the physical components of the joints themselves. The power produced in the hip or torso may be significantly different between different players independent of differences in height and weight and this could be the reason that the latter two variables are rendered to be null when compared to fastball velocity.

Height could be a factor still due to a decreased distance from the plate that could occur due to a release point being closer to the plate for a taller pitcher. According to the official rules of Major League Baseball (MLB) a baseball must “weigh not less than five nor more than 5 ¼ ounces…” (Official Baseball, 2011, p.6). The baseball is thrown from the pitcher’s plate towards the rear edge of the home base, the measurement between the two being exactly 60’6” The pitcher must keep his rear foot in contact with the pitcher’s plate as he goes through the act of throwing the ball to home base (Official Baseball, 2011). This rule gives favor to pitchers that have an increased height due to the stride length of an athlete being longer and therefore completing the throwing motion closer to the baseball’s final destination.

The height of a pitcher may have more to do with the amount of reaction time a hitter has to hit a baseball than the actual velocity that a pitch can be thrown. Reaction time for a hitter to hit a pitch would be calculated by finding the average speed of a baseball in feet per second and dividing this by the distance from the pitcher's release point to home plate. Feet per second can be found by using the following two-step equation:

Speed (mph)/0.682= Feet per second

Distance from release to plate/Speed (ft/s) = Reaction time of Hitter

Or in one step:

Distance from release to plate/ (Speed (mph)/0.682) = Reaction time of Hitter

After finding feet per second and reaction time it is easy to see the difference of reaction time that is caused by a taller pitcher that throws the same velocity. For example if a five-foot nine inch pitcher and a six-foot five inch pitcher both throw 97 mph, and both have the same mechanics it can be assumed that the taller pitcher would leave the hitter with less time to react to a pitch due to the decreased distance from release point to home plate. If one inch of height is equal to one inch of decreased distance from release to home plate than the reaction times could be represented as follows:

Pitcher 1 (5'9”) - 53.5/ (97.0/0.682) = 0.376 seconds

Pitcher 2 (6'5”) - 52.8/ (97.0/0.682) = 0.371 seconds

This change in reaction time comes to a 1.1% difference or .005s, which may not be a significant factor in a hitter’s ability to hit a pitch but could affect how hard the ball is put into play. This may not be the significant factor that supports the increased height of pitchers in the MLB but nevertheless is an aspect that should be researched further.

A final variable to take into consideration that may have affected the outcome of this study would be that of flexibility. In future studies it may be beneficial to look at the degrees of range of motion in joints, especially in hip extension and elbow and shoulder external rotation.

Conclusions

Although this study failed to yield significant correlations between height, weight, and fastball velocity it has brought to light the fact that these variables are not what provide the ability to throw a fastball with high velocity. This research can potentially help future researchers in their decisions of what should be tested and what should not in relation to throwing velocity.

While a pitcher having above average anthropometric variables may be important in the ability to throw with a high enough velocity to make it to the MLB what sets pitchers apart once at the elite level still needs to be found. Most variables that have consistently been found to have high correlation with throwing velocity involve muscular strength and power, both in the transverse and sagittal planes of motion. These types of variables are what should be researched further.

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Tables

Table 1

Descriptive Statistics

	Mean	Std. Deviation	N
FBv	93.2560	1.21547	75
Ht	189.6872	4.83665	75
Wt	97.3590	10.90321	75

Table 2

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.131[a]	.017	-.010	1.22158
a. Predictors: (Constant), Wt, Ht				

Table 3

Pearson Correlations and Significance

		FBv	Ht	Wt
Pearson Correlation r values	***FBv***	1.000	.036	.131
	Ht	.036	1.000	.358
	Wt	.131	.358	1.000
Sig. (1-tailed) p values	***FBv***	.	.380	.132
	Ht	.380	.	.001
	Wt	.132	.001	.

Table 4

ANOVA

	Model	Sum of Squares	df	Mean Square	F	Sig.
1	**Regression**	1.883	2	.941	.631	.535[b]
	Residual	107.442	72	1.492		
	Total	109.325	74			

a. Dependent Variable: FBv

b. Predictors: (Constant), Wt, Ht

Figures

Figure 1

Frequency of Fastball Velocities

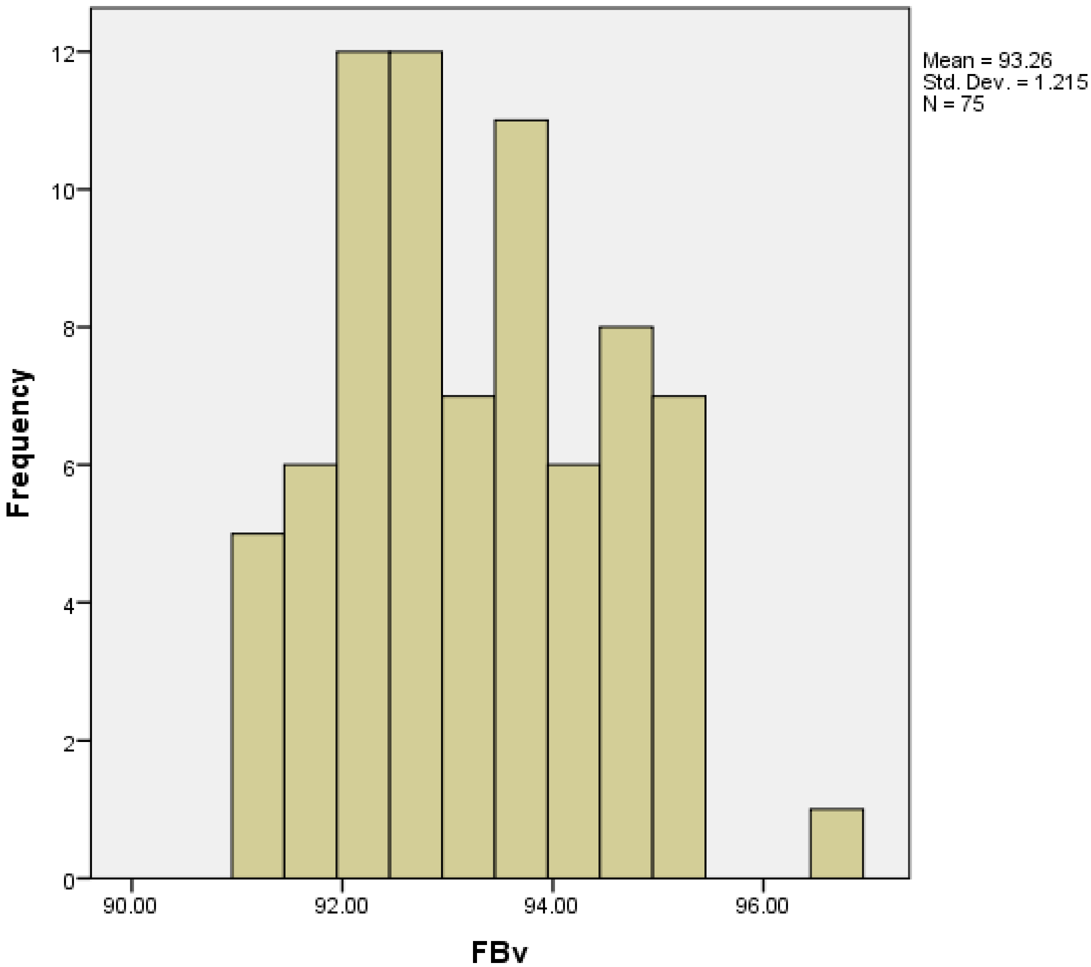


Figure 2

Fastball Velocity as compared to Height

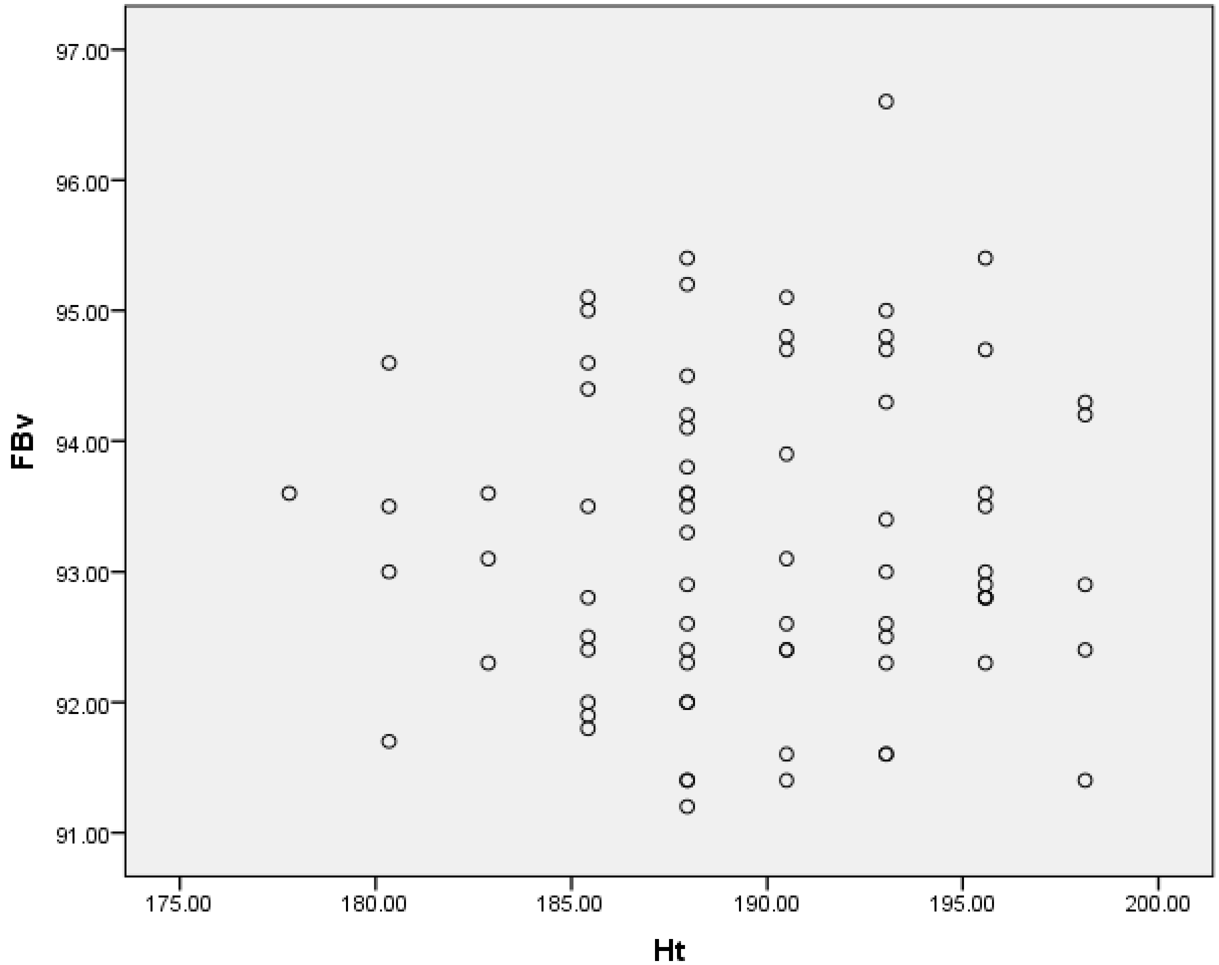
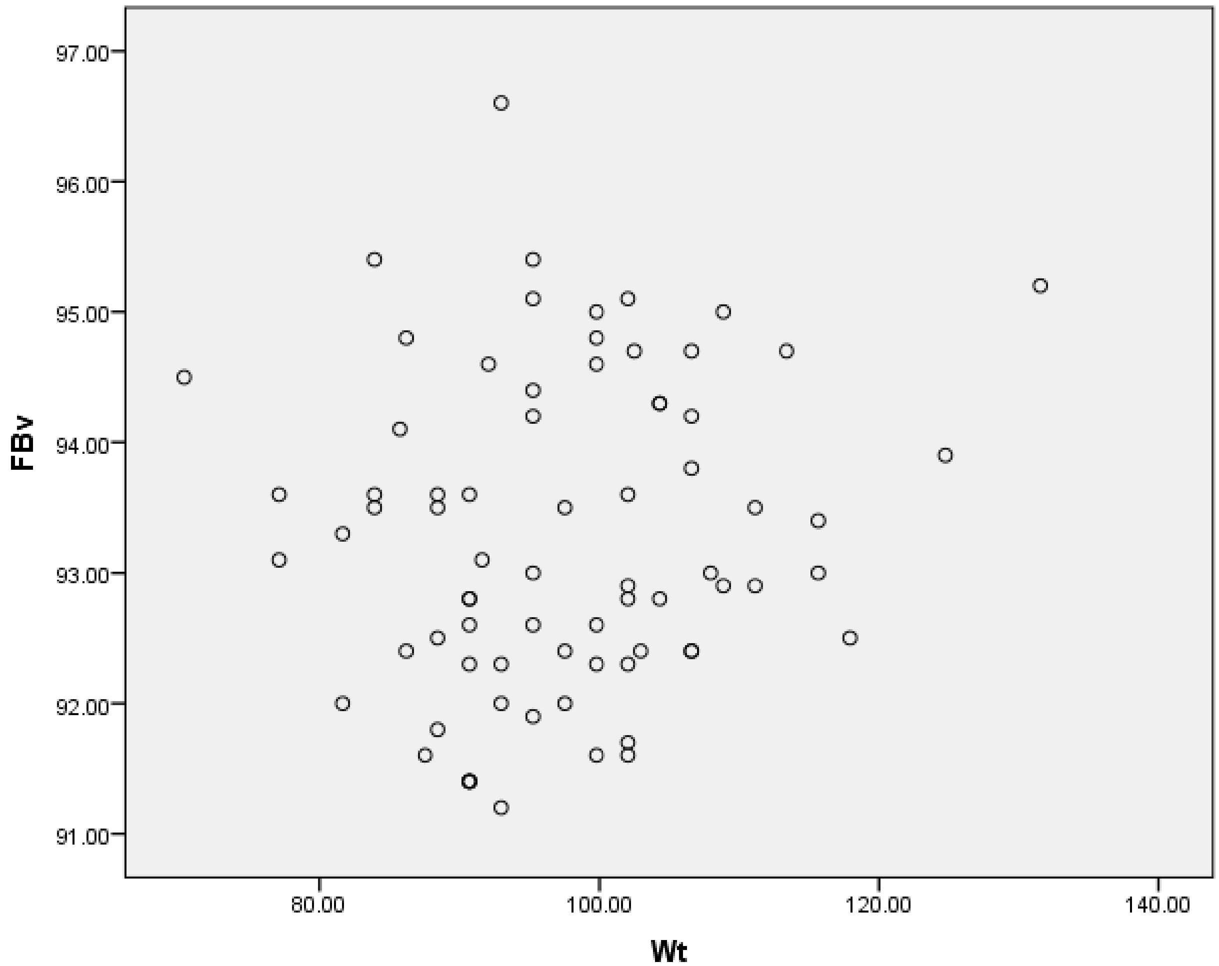


Figure 3

Fastball Velocity as compared to Weight



Appendix A

University of Central Oklahoma
Institutional Review Board

Request for Review of Exempt Category Research

ALL research involving human subjects requires review and consideration of the UCO IRB prior to initiation. Some research projects may be “exempt” from Full Board Review and thus qualify as “Exempt Category” research. To determine if your research project is in the category, provide information using this form. Note that proof or declaration of PHRP training is required for all study personnel using private identifiable data, and must accompany this form. Also, an incomplete application or supporting documentation will delay review and approval of this project. If it is determined that your research project does NOT meet Exempt category research, you will need to re-submit a full protocol and completed *IRB Application for Review of Human Subjects Form*. Information about what research might qualify as Exempt is available on our website.

Date:5/31/2013 **UCO IRB Number:**

Title of Research Project: Effects of various anthropometric measurements on fastball velocity in major league relief pitchers.

<u>Personnel Information</u>

Principal Investigator Name: Cory Cook **Title:**Mr.

Department/Program: Wellness Management **Campus Box:**N/A

Email (UCO Preferred):ccook30@uco.edu **Daytime Phone:**614-571-8166

Faculty ☐ **Staff** ☐ **Graduate Student** ☒ **Undergraduate Student** ☐

Co-PI Name: Paul House **Title:**Dr.

(Faculty Co-PI required for student projects)

Department/Program: Wellness Management **Campus Box:**189

Email (UCO Preferred):phouse@uco.edu **Daytime Phone:**(405) 974-5259

Faculty ☒ **Staff** ☐ **Graduate Student** ☐ **Undergraduate Student** ☐

<u>Project Description</u>

Briefly describe the objective(s) and procedures of the project. Attach additional pages as needed.***See attached.***

Will you publish or present (in any setting other than a classroom setting), oral or written results of this project? Yes☐ No☒

[Answer the set of questions below that best describes your project.]

Retrospective Record or Chart Review (check all that apply)**:**

☐ Medical or other clinical records
Was HIPPA Form signed? Yes☐ No ☐

☐ Employment records
☐ Student records
☒ Other records: ***Publicly available records of Major League Baseball players***

Name of institution or agency from which records will be obtained: ***Major League Baseball via Baseball Info Solutions***

(Attach a letter or email authorization to use records)

Authorization of use of records is not needed according to the United States Supreme Court due to all information collected involving game stats of Major League Baseball players is "public domain" (C.B.C., 2006).Baseball Info Solution data that may be copyrighted by the company is permitted to be used for research or educational purposes according to the Fair Use provision that is found in copyright laws (17 USC, Sec. 107, Copyright.gov).

Data collection time period: ***June 20th, 2013 – July 5th, 2013***

Will investigators have access to subject identifiers? Yes☒ No☐

Will a master list of identifiers be kept? Yes*☐ No☒

If "yes", for how long?

(*may not qualify for Exempt Category)

Research Involving Existing Human Biological Specimens

Describe the type of specimens:

Indicate the source of the specimens and attach documentation:

Were the specimens obtained under informed consent? Yes☐ No☐

Was a HIPPA form originally signed? Yes☐ No☐

How long will the specimens be kept?

Explain the procedures for disposal of specimens:

<u>Secondary Data Set Study (e.g. census, voting records)</u>

Source of the data: ***Baseball Info Solutions***

Were data originally collected for research purposes? Yes☐No☐ Don't know☒

Was informed consent given originally? Yes☐No☐ Don't know☒

Is the data set publically available? Yes☒ No☐

If "yes", was it IRB approved? Yes☐ No☒

By whom? ***N/A***

Attach a copy of information/website indicating where the dataset can be located or obtained. ***See Attached***

Does the dataset include personal identifiers? Yes*☒ No☐

If "yes", what specific identifiers are included?***First and Last Names***

(* may not qualify for Exempt Category)

Players' names and statistics that have or are currently playing for Major League Baseball (MLB) teams are "public domain" and cannot be copyrighted by the MLB (C.B.C., 2006). Baseball Info Solution data that may be copyrighted by the company is permitted to be used for research or educational purposes according to the Fair Use provision that is found in copyright laws (17 USC, Sec. 107, Copyright.gov).

<u>Attach To This Form:</u>

PHRP certificates for all study personnel

Required documentation as specified above

Objectives and Procedures of the Project

Data will be collected using a database that has already been established by Baseball Info Solutions. This company is used by various major league teams as well as MLB scouts and agents. Baseball Info Solutions has their own hired video scouts analyze video from each MLB game and track various statistics such as pitch velocity, pitch type, and pitch location as well as many other traditional statistics. This data is made publicly available at www.fangraphs.com by Baseball Info Solutions and statistical data for MLB players. Baseball Info Solution data that may be copyrighted by the company is permitted to be used for research or educational purposes according to the Fair Use provision that is found in copyright laws (17 USC, Sec. 107, Copyright.gov).Furthermore, this database has been deemed “public domain” by the United States Supreme Court, so that public use is permitted (C.B.C, 2006).

The data used is derived from MLB relief pitchers from the 2007 season. The author believes that five years of audits is sufficient to ensure the accuracy needed for a successful research study.

The players’ fastball velocity will be taken from the Baseball Info Solutions data that is displayed publicly on www.fangraphs.com and their heights and weights will be collected from the *Bill James Handbook 2008.* This handbook has been published annually since 2003; however, James has been publishing statistical abstracts since 1977. Bill James is currently the Senior Baseball Operations Advisory for the Boston Red Sox and part of the Baseball Info Solutions team. The reason for using the 2008 version is that this version was published November, 2007 and more likely reflects the players’ actual playing weight during the 2007 season than the previous version that was published in 2006.

Each player’s average fastball velocity will be placed into a spreadsheet along with their height and weight. After the height and weight of each player is entered each player will be randomly assigned a number so that they cannot be individually identified. The names of all players will be deleted permanently upon receiving all data from Baseball Info Solutions database.

The data collected will be analyzed through IBM’s SPSS Statistics program. The data collected will consist of the height, weight and BMI of each qualifying MLB relief pitcher as well as the average fastball velocity during the 2007 season. These variables will be put through a multiple regression to find the correlation between each independent variable (height, weight) as a predictor of the dependent variable (average fastball velocity). To reduce the chance of having a type I error, the alpha (α) level of significance will be set at 0.05

Sources used in description of objectives and procedures:

- C.B.C. Distribution & Marketing, Inc. v. Major League Baseball Advanced Media, L.P. 443 F.Supp.2d 1077 (2006). Retrieved from LexisNexis Academic database.
- *Copyright Law of the United States of America: And Related Laws Contained in Title 17 of the United States Code.* Retrieved from: http://www.copyright.gov/title17/92chap1.html

Data Set Location

Player fastball velocity:

- *Fangraphs Leaderboards* [Data file]. Retrieved from http://www.fangraphs.com/leaders.aspx?pos=all&stats=rel&lg=all&qual=y&type=10&season=2007&month=0&season1=2007&ind=0&team=0&rost=0&age=0&filter=&players=0

Player Heights and Weights

- Baseball Info Solutions & James, Bill. (2007). *The Bill James Handbook: 2008*. Skokie, IL: ACTA Sports.

Appendix B

Institutional Review Board Approval Letter

UNIVERSITY OF Central Oklahoma

June 18, 2013

IRB Application #: 13109

Proposal Title: Effects of various anthropometric measurements on fastball velocity in major league relief pitchers

Type of Review: Initial-Exempt

Investigators:
Mr. Cory Cook
Dr. Paul House
Department of Kinesiology and Health Studies
College of Education and Professional Studies
Campus Box 189
University of Central Oklahoma
Edmond, OK 73034

Dear Mr. Cook and Dr. House:

Re: Application for IRB Review of Research Involving Human Subjects

We have received your application and materials for review by the UCO Institutional Review Board (IRB). The UCO IRB has determined that the above named application is **EXEMPT** from further review by the board. The Board has provided exempt review under **45 CFR 46.101 (b) (4) Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available or if the information is recorded by the investigator in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects.** Exempt projects are not subject to further review unless procedures or subjects involved in the project change.

Date of Approval: 6/18/2013

On behalf of the UCO IRB, I wish you the best of luck with your research project. If our office can be of any further assistance, please do not hesitate to contact us.

Sincerely,

Douglas P. Reed

Douglas Reed, Ph.D.
Acting Chair, Institutional Review Board
Campus Box 159
University of Central Oklahoma
Edmond, OK 73034
405-974-5497
irb@uco.edu

Office of Research Compliance, Academic Affairs
100 North University Drive · Edmond, Oklahoma 73034 · Phone (405) 974-5497 · Fax (405) 974-3825 · www.uco.edu

Appendix C

Thesis Summary Document

Effects of Various Anthropometric Measurements on Fastball Velocity of Professional Relief Pitchers

There is a lack of research on anthropometric measurements as predictor variables for Major League Baseball (MLB) relief pitcher's fastball velocities. With a greater understanding of factors that contribute to the velocity of a fastball, MLB scouts can better predict the possible velocity that can be obtained by a certain pitcher.

Papas et al. (1985) reported that during the acceleration phase of the throwing motion "-lasting approximately 50 ms, peak angular velocities were measured averaging 6,180 and 4,595 deg/sec for shoulder internal rotation and elbow extension respectively" (Pappas et al., 1985, p.216) the angular velocities of the internal rotation of the shoulder and elbow extension are directly related to the linear velocity that can be placed on the ball. This relationship is represented as follows: linear velocity (v) is equal to the angular velocity (ω) multiplied by the radius (r) of the lever arm, or $v=r\omega$. This means that the longer the radius, if kept at constant angular velocity, will result in a faster linear velocity. Therefore Fleisig et al. reported that "the combination of more arm angular velocity and longer arm segments resulted in greater linear ball velocity for the adult pitcher" (Fleisig et al., 1999, p.1374). Since total arm length has been shown to have a high correlation to height ($r=0.68$), the latter characteristic that is influential for producing linear velocity, in theory, can be directly related to the height of the pitcher based on proportionality (Mitchell &Lipschitz, 1982).

Anthropometric measurements have been found to influence ball velocity in female handball players as well (Zapartidis et al., 2009). Researchers found that the velocity of a standing throw from female handball players were highly correlated with height and weight, with p-values = 0.001 and <0.001 respectively. In male handball players researchers found that the positions, excluding goalies, which had a greater, height also had a greater ball velocity (Zapartidis et al., 2011). The p-values of height, weight and hand length to ball velocity came to 0.001, 0.418, and 0.223 respectively. In a similar study that used amateur and elite handball players and measure throwing velocity, researchers found that not only was the average throwing velocity higher in elite players but their body mass and lean mass were as well (Gorostiaga et al., 2005).

There will be a significant relationship between height and average fastball velocity as well as weight and average fastball velocity. Therefore, MLB relief pitchers that are taller and heavier will have a higher average fastball velocity.

The research methods used were quantitative and data was collected using an existing database. Data was put through a multiple regression using SPSS version 20.0.

After testing the 75 relief pitchers the results indicated that there was no correlation between height and velocity of a fastball as well as weight and fastball velocity of MLB relief pitchers.Pearson correlations of height and weight as compared to fastball velocity were $r = .036$ and $r = .131$ respectively, thus showing little correlation. The p-values were shown to be .380 and .132 respectively. These show that no significant correlation could be found between the independent variables and the dependent variable.

The findings lead me to reject the alternative hypothesis that “MLB relief pitchers that are both taller and heavier will have a higher average fastball velocity”.

The lack of correlation between the variables gives insight into just what makes a pitcher throw with a velocity that could be considered elite. These results indicate that contrary to what may have been previously thought, a pitcher’s height and weight have no significant bearing on the velocity that the athlete can throw a fastball. These results also show that while there is an emphasis by professional scouts on the size of players it may not be correlated with their potential to throw with high velocities.

While a pitcher having above average anthropometric variables may be important in the ability to throw with a high enough velocity to make it to the MLB what sets pitchers apart once at the elite level still needs to be found. Most variables that have consistently been found to have high correlation with throwing velocity involve muscular strength and power, both in the transverse and sagittal planes of motion. These types of variables are what should be researched further.